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Lawrence Livermore National Security, LLC, Livermore, California 94551

LLNL-AR-411239

Compliance Monitoring Plan and Contingency Plan for Environmental Restoration at Lawrence Livermore National Laboratory Site 300

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October 2009

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Environmental Restoration Department

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Summary

Lawrence Livermore National Laboratory (LLNL) Site 300 is a U.S. Department of Energy (DOE) facility operated by Lawrence Livermore National Security, Limited Liability Corporation. Site 300 is situated in the eastern Altamont Hills about 17 miles east of Livermore and 8.5 miles southwest of downtown Tracy, California. Site 300 is a remote experimental testing facility where DOE conducts research, development, and testing of high explosives and integrated non-nuclear weapons components. This work includes formulating, processing, machining, assembling, and detonating explosives.

During past Site 300 operations, contaminants were released to the environment from surface spills and piping leaks, leaching from unlined landfills and pits, high-explosive test detonations, and disposal of waste fluids in lagoons and dry wells (sumps). The contaminants of concern at Site 300 include volatile organic compounds, high explosive compounds, perchlorate, tritium, depleted uranium, nitrate, polychlorinated biphenyls, dioxins, furans, silicone oils, and metals.

DOE is the lead agency for environmental restoration at Site 300. The U.S. Environmental Protection Agency (U.S. EPA) and the State of California oversee Site 300 environmental restoration activities. DOE began environmental restoration activities in 1981, and the site was placed on the U.S. EPA National Priorities List in 1990.

In 2001, DOE completed an Interim Site-Wide Record of Decision for OUs 2 through 8 (the Interim ROD). This ROD was designated as interim to ensure that cleanup continued while additional site characterization, evaluation of remedial technologies, and negotiation of final ground water cleanup standards occurred. The Interim ROD specified remedies for most of the contaminant releases at Site 300, but did not include some areas where site characterization was in progress or a final remedy had already been selected. The remedies included monitoring, monitored natural attenuation, risk and hazard management, soil vapor and ground water extraction and treatment, and soil excavation and remediation.

After the Interim ROD, DOE completed a Remedial Design Work Plan that outlined DOE's overall strategy and schedule for implementing the selected interim remedies. A Site-Wide ROD was completed in 2008 that selected ground water cleanup standards for Site 300.

In 2002, a Compliance Monitoring Plan/Contingency Plan (CMP/CP) was prepared for the OUs 2 through 8 that were included in the Interim ROD. The 2002 CMP/CP contained procedures to monitor the progress of remediation, detect any new contaminant releases, control risks and hazards, manage the data obtained during monitoring, and includes contingency procedures and measures DOE will implement if cleanup does not proceed as planned. Prior to completion of the 2002 CMP/CP, there was no comprehensive monitoring plan for environmental restoration activities at Site 300. The 2002 CMP/CP consolidated and superseded the elements of a number of existing area-specific monitoring plans. DOE agreed to revise and update the CMP/CP following completion of the Site-Wide ROD in 2008.

In 1997, an area-specific ROD was signed for the General Services Area (GSA) OU. A GSA-specific CMP/CP was completed and included in the GSA Remedial Design Report. The GSA OU CMP/CP requirements are incorporated as part of the revisions for this CMP/CP so that all the procedures and requirements for OUs 1 through 8 are contained in one document.

The major change from the 2002 CMP/CP is the inclusion of the GSA and Pit 7 Complex in this CMP/CP.

This CMP/CP provides the overall guidance for generating detailed sampling and analysis plans. Detailed plans will be generated after the CMP/CP is finalized and modified periodically to reflect changing site conditions, new monitor and extraction wells, and stakeholder concerns. These plans will be presented every six months in the Compliance Monitoring Reports. At a minimum, these plans will be consistent with the guidelines included in this document. In some cases, DOE may collect data beyond that specified in this CMP/CP to support more detailed hydrogeologic interpretations, improve contaminant distribution and migration evaluations, manage and optimize extraction and treatment systems and other remedial actions, or to ensure that human health and the environment are protected. This CMP/CP will be implemented in the first quarter of 2010.

Section 1 of this document provides an overview of the environmental restoration program at Site 300, describes the areas of contamination, and defines the scope of the document. This CMP/CP only applies to the areas of environmental contamination in OUs 1 through 8. Some areas of current or potential contamination were not included in the Site-Wide ROD and are not addressed by this CMP/CP because a remedy has not yet been selected (Buildings 812 and 865). Similarly, monitoring programs to comply with non-CERCLA facility-specific RCRA or RWQCB closure requirements are in effect in some areas (i.e., the Pit 1 Landfill and the High Explosives Open Burn Facility) and will not be affected by this CMP/CP. This CMP/CP will also not affect the surveillance monitoring of water-supply wells, air, vegetation, and storm water runoff conducted by the LLNL Environmental Protection Department.

Section 2 describes the overall objectives of this CMP/CP and reiterates the Remedial Action Objectives established in the Site-Wide ROD. The Remedial Action Objectives include goals for restoring ground water and preventing risk and hazard to human and ecological receptors. The general objectives of this CMP/CP are to provide the framework for:

- Sampling and analyzing ground and surface water to monitor the effectiveness of the remedial actions.
- Conducting detection monitoring, inspection, and maintenance at the Pit 2, 3, 4, 5, 7, 8, and 9 Landfills to identify and prevent future contaminant releases from these landfills.
- Monitoring the performance of soil vapor and ground water extraction and treatment facilities to ensure regulatory compliance.
- Managing risks and hazards to human and ecological receptors to prevent unacceptable exposure from occurring during remediation and after active remediation is complete.
- Implementing procedures to ensure the quality of monitoring data.
- Reporting the results of monitoring data.
- Implementing contingency measures if cleanup does not proceed as planned.

Section 3 describes the Ground and Surface Water Monitoring Program. This program includes the regular sampling and analysis of water samples from ground water monitor wells and surface water bodies. Some Site 300 monitor wells are designated as "guard wells" to provide timely indication of contaminant movement that may impact water-supply wells, contaminate water-supply aquifers, or result in migration across the site boundary. The guard wells will be sampled more frequently than other monitor wells. Many of the other monitor wells at Site 300 are designated as "plume tracking wells," including plume interior tracking wells and plume boundary tracking wells. Samples from these wells are used to determine the distribution and concentration of contaminant plumes in ground water. Depending on the location of each well in relation to the contaminant plumes, plume-tracking wells will be sampled semiannually, annually, or biennially. Background wells will also be monitored to evaluate natural variation in and background conditions for naturally occurring ground water constituents (i.e., nitrate and uranium). All onsite and nearby offsite springs will be sampled.

Section 4 describes the Detection Monitoring, Inspection, and Maintenance Program for the Pit 2, 3, 4, 5, 7, 8, and 9 Landfills. Debris was placed in these landfills from the 1950s to the 1980s. Ground water monitoring will be conducted to detect any future releases of contaminants from these landfills. Ground water samples will be collected annually from designated "detection monitor wells" at the landfills and analyzed for all constituents that could reasonably be expected in the buried waste.

The landfills will be inspected to identify any degradation or damage to the surface of the landfills that could lead to increased infiltration of precipitation, exposure of the landfill contents, or flow of surface water on or adjacent to the landfill. Any required maintenance will be performed promptly.

Section 5 describes the Extraction and Treatment Facility Monitoring Program. All ground water extraction wells will be sampled at the same frequency as nearby plume interior tracking wells or plume boundary tracking wells. Aqueous treatment system influent samples will be analyzed quarterly and effluent samples will generally be analyzed monthly. These samples will be analyzed for all contaminants identified in any ground water extraction well connected to the treatment system or that could potentially be captured by an extraction well. However, the monitoring of nitrate in treatment system influent and effluent will not be conducted for treatment areas where either: (1) monitored natural attenuation is the selected remedy for nitrate in ground water, or (2) the effluent is discharged via misting and no nitrate discharge limit is specified. More frequent sampling will be performed upon initial startup of a facility, a shutdown due to non-compliance with discharge requirements, or any treatment system shutdown or modification that could result in non-compliance. The effluent of soil vapor treatment facilities will be monitored weekly, and soil vapor samples from extraction wells will be analyzed semiannually for VOCs.

The Risk and Hazard Management Program in Section 6 describes the measures DOE will implement to ensure that the interim remedies protect human health and the environment during cleanup. For protection of human health, DOE will re-evaluate risk and hazards annually based on current contaminant concentrations in areas where an unacceptable risk or hazard has been identified and is still present. Building or area occupancy will be reviewed regularly, and risk and hazard estimates will be revised to reflect current conditions. Institutional or engineering controls, including land use controls, will be maintained or implemented where necessary to prevent exposure. The ecological portion of this program includes sampling and periodic hazard re-evaluation, and steps to mitigate impacts to plants and animals, if needed.

Section 7 summarizes the Data Management Program that controls the structure and flow of data collected during site characterization, remediation, and monitoring. The management of data, both hard copy and electronic, follows a process that tracks information from the sampling plan through storage to archiving. The data management process includes chain-of-custody tracking, application of quality control procedures, data presentation, and use of data in decision-support tools, such as risk assessment and compliance monitoring.

Section 8 describes the Quality Assurance/Quality Control procedures and systems used to ensure the quality of data collected during site characterization, monitoring, and remediation. A Quality Assurance Project Plan has been implemented for the Site 300 environmental restoration project that includes the framework and requirements for planning, performing, documenting, and verifying the quality of work activities and data collected. Standard Operating Procedures have been developed for most activities described in this CMP/CP.

Section 9 outlines the scope and content of reports that will be generated to convey project information to the regulatory agencies and other stakeholders. DOE will regularly inform the Remedial Project Managers of project status, compliance issues, and any new contaminant releases or detections. DOE will submit semiannual compliance monitoring reports.

The Contingency Plan in Section 10 describes how DOE and the regulatory agencies plan to address foreseeable problems that may arise during the remediation of Site 300. Both technical and logistical contingencies are addressed.

Technical contingencies are related to the physical remediation of soil, bedrock, and ground water at Site 300 and include loss of hydraulic control of ground water contaminant plumes or sources, increases in contaminant concentrations, impacts to water-supply aquifers, concerns over the performance of monitored natural attenuation remedies, new sources or releases of contaminants, and uncontrollable natural events such as earthquakes.

Logistical contingencies include changes in access restrictions, building/land use, personnel, funding, the mission and operation of LLNL, and future property ownership.

In the 2008 Site-Wide ROD, DOE agreed to prepare an analysis after ground water contaminant concentrations have been reduced to Maximum Contaminant Level cleanup standards in OUs 2 through 8 to determine the technical and economic feasibility of continuing remediation to further reduce contaminant concentrations to Water Quality Numeric Limits or background concentrations. The Site-Wide ROD specified that the details of the approach that will be used to perform the technical and economic feasibility analysis would be provided in this revised CMP/CP. Therefore, the technical and economic feasibility analysis process, the general schedule for conducting this analysis, and a discussion of how the results of this analysis will be used are included in Appendix A of this CMP/CP.

1. Introduction

1.1. Overview

Lawrence Livermore National Laboratory (LLNL) Site 300 is a United States (U.S.) Department of Energy (DOE) experimental test facility operated by the University of California until transfer to the Lawrence Livermore National Security (LLNS), Limited Liability Corporation in 2007. Site 300 encompasses 11 square miles and is situated in the eastern Altamont Hills about 17 miles east of Livermore and 8.5 miles southwest of downtown Tracy, California (Figure 1-1). Site 300 is located primarily in San Joaquin County, except for the westernmost portion that lies within Alameda County.

DOE is the lead agency for environmental restoration at Site 300. The U.S. Environmental Protection Agency (U.S. EPA) Region IX, the California Department of Toxic Substances Control (DTSC), and the California Regional Water Quality Control Board (RWQCB) Central Valley Region oversee Site 300 environmental restoration activities. A Federal Facility Agreement (FFA) is in place between DOE and these regulatory agencies (U.S. DOE, 1992). DOE began environmental restoration activities at Site 300 in 1981, and the site was placed on the U.S. EPA National Priorities List in 1990. Since then, the majority of environmental restoration work has been conducted in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA), and State of California regulations. Other environmental restoration activities are regulated under the Resource Conservation and Recovery Act (RCRA).

LLNL Site 300 has been divided into nine Operable Units (OUs) based on the nature and extent of contamination to effectively manage site cleanup:

- General Services Area (GSA) (OU 1) including the Central and Eastern GSA.
- Building 834 (OU 2).
- Pit 6 Landfill (OU 3).
- High Explosives (HE) Process Area (OU 4) including Building 815, the HE Lagoons, and the HE Burn Pit.
- Building 850/Pit 7 Complex (OU 5).
- Building 854 (OU 6).
- Building 832 Canyon (OU 7) including Buildings 830 and 832.
- Site-Wide (OU 8) including Buildings 801, 833, 845, and 851 and the Pit 2, 8, 9 Landfills.
- Building 812 (OU 9).

An OU-specific Record of Decision (ROD) was signed in January 1997 for the GSA (OU 1) (U.S. DOE, 1997a). An Interim ROD for LLNL Site 300 (U.S. DOE, 2001) was signed for OUs 2 through 8 in February 2001. This Interim ROD was designated as interim to ensure that cleanup continued while additional site characterization, evaluation of remediation technologies, and negotiation of final ground water cleanup standards occurred. After the Interim ROD, DOE completed a Remedial Design Work Plan for the Interim Remedies (Ferry et al., 2001a) that outlined DOE's overall strategy and schedule for implementing the selected remedies. Remedial Design documents have been completed for OU 1 (Rueth et al., 1998), OU 2 (Gregory et al., 2002), and OUs 4 through 7 (Madrid et al., 2002 and 2006; Taffet et al., 2004 and 2008; Daily et al., 2003). Remedial Design documents are not required for areas where monitoring only or monitored natural attenuation are the sole component of the remedy (OUs 3 and 8). The Pit 7 Complex of OU 5 was not included in the Interim ROD. An Amendment to the Interim ROD (U.S. DOE, 2007) for the Pit 7 Complex was signed in January 2007.

A Site-Wide ROD (U.S. DOE, 2008) was signed in 2008 for OUs 2 through 8 that selected ground water cleanup standards and finalized the interim remedies. Cleanup standards for ground water COCs in OUs 2 through 8 are presented in Table A-1 of Appendix A.

At the time of the Interim ROD, three areas were still under investigation, Building 812, Building 865, and the Sandia Test Site to determine if contaminants have been released and whether cleanup is necessary. The Building 812 Complex was designated as OU 9 in April 2007. A Remedial Investigation/Feasibility Study report for the Building 812 OU is currently underway and a Proposed Plan is scheduled for 2011. The regulatory agencies agreed that the Sandia Test Site did not require any further action. A characterization summary report (Ferry and Holtzapple, 2006) was completed for the Building 865 area in 2006. A clean up remedy for the Building 865 and OU 9 will be selected in an Amendment to the Site-Wide ROD currently scheduled for 2012.

Following the signing of the Interim ROD, a Compliance Monitoring Plan/Contingency Plan (CMP/CP) for OUs 2 through 8 (excluding the Pit 7 Complex) was completed in 2002 (Ferry et al., 2002). Prior to the 2002 Interim CMP/CP, monitoring of CERCLA removal action activities (e.g. treatment facility and wellfield monitoring) was conducted through a variety of regulatory mechanisms, or voluntarily by DOE. The objective of the CMP/CP was to create a single plan to monitor and evaluate the effectiveness of the remedial actions selected in the Interim ROD. DOE and the regulatory agencies agreed to update the CMP/CP to reflect any changes in the Final Site-Wide ROD, such as incorporating the Pit 7 Complex portion of OU 5, updating the primary and secondary COCs for each OU for consistency with the 2008 Final ROD COC list, and modifying monitoring requirements to be consistent with the final selected remedy. In addition, the compliance monitoring requirements, risk and hazard management components, and contingency plan elements for the GSA OU 1 from the GSA Remedial Design Report (Rueth et al., 1998) were also added to this CMP/CP in order to make it a comprehensive CMP/CP for the entire site. Some additional changes from the 2002 CMP/CP were made to reflect regulatory agreements, changes in contaminant conditions, and to specify monitoring durations relative to the achievement of cleanup standards.

This revised CMP/CP supersedes the 2002 CMP/CP for OUs 2 through 8, the 1998 GSA CMP/CP, and the monitoring plan for the Pit 7 Complex contained in its Remedial Design (Taffet et al., 2008). The Building 812 and Building 865 are not included in this CMP/CP and will be incorporated in a later addendum following the completion of the Building 812 Remedial Design document scheduled for 2012. This CMP/CP will be implemented in the first quarter of 2010.

This CMP/CP includes:

- Ground and Surface Water Monitoring Program – Describes routine sampling and analysis of samples from ground water monitor wells and surface water bodies and the measurement of ground water elevations to monitor the effectiveness of the remedial actions. Springs are the only surface water bodies at Site 300 applicable to the monitoring programs included in this CMP/CP.
- Detection Monitoring, Inspection, and Maintenance Program for the Pit 2, 3, 4, 5, 7, 8, and 9 Landfills – Specifies requirements for sampling monitor wells in the vicinity of these landfills with the objective of identifying any releases of contaminants to ground water beneath the landfills. Provisions are included for regularly inspecting the landfills and associated drainage systems to identify any erosion, subsidence, or breaching of the landfill surfaces, and performing as-needed maintenance.
- Treatment System Monitoring Program – This program specifies the sampling of ground water and soil vapor extraction wells and treatment system influent and effluent, water level measurements in extraction wells, and frequency of flow volume measurements and visual inspections.
- Risk and Hazard Management Program – Includes modeling, sampling, and analysis procedures to ensure that the remedies protect human health and the environment during cleanup, and describes the institutional/land use controls that will be implemented and maintained.
- Data Management Program – Describes the structure and flow of environmental restoration data collected during cleanup.
- Quality Assurance/Quality Control Program – Specifies procedures and systems to ensure the quality of data collected during cleanup.
- Reporting – Describes how DOE will convey information collected during the implementation of the above-mentioned Programs and on the progress and status of Site 300 remediation activities to the regulatory agencies and other stakeholders.
- Contingency Plan – Describes the measures and procedures to be implemented if cleanup does not proceed as planned.

Consistent with the 2002 Interim CMP/CP, the 2009 Revised CMP/CP provides the overall guidance for generating detailed sampling and analysis plans. Detailed OU-specific plans will continue to be generated and presented in the semi-annual Compliance Monitoring Reports. This will allow for modifications to the detailed OU-specific plans to reflect changing site conditions and stakeholder concerns. However, these plans will be consistent with the provisions of this CMP/CP, at a minimum. In some cases, DOE may collect data beyond that specified in this CMP/CP to support more detailed hydrogeologic interpretations, improve contaminant distribution and migration evaluations, or to manage and optimize extraction and treatment systems and other remedial actions. The results of any additional sampling and analyses will be reported in the semi-annual Compliance Monitoring Reports.

1.2. Site Description

Site 300 is primarily a high-explosives test facility supporting the LLNL weapons program in research, development, and testing associated with weapon components. Operations at Site 300 include four defense program activities: (1) hydrodynamic testing, (2) charged particle beam research, (3) physical, environmental, and dynamic testing, and (4) HE formulation and fabrication. No actual fissionable material is used in these hydrodynamic tests. Fencing and full-time security guards restrict access to Site 300.

During past Site 300 operations, contaminants were released to the environment from surface spills and piping leaks, leaching from unlined landfills and pits, high-explosive test detonations, and disposal of waste fluids in lagoons and dry wells (sumps). Environmental investigations identified 24 locations where contaminants were released to the environment (Figure 1-2). All release sites at Site 300 are assigned to one of nine operable units, as shown on Figure 1-2. The contaminants of concern (COCs) at Site 300 include:

- Volatile organic compounds (VOCs), primarily trichloroethylene (TCE) that were used as heat-exchange fluids and degreasing solvents.
- HE compounds, primarily High-Melting Explosive (HMX) and Research Department Explosive (RDX) that were formulated and tested at Site 300.
- Perchlorate, a component of many explosives.
- Tritium used in explosive tests.
- Depleted uranium used in explosive tests.
- Nitrate resulting from releases of explosives formulation rinsewater, septic-system effluent, and/or leaching of naturally occurring nitrate from bedrock.
- Polychlorinated biphenyls (PCBs), dioxins, and furans that were present in capacitors and transformers destroyed in explosive tests.
- Tetra-butyl-orthosilicate (TBOS) and tetra-kis-2-ethylbutylorthosilicate (TKEBS), silicone oils that were used in TCE-based heat-exchange systems to lubricate pumps and seals.
- Metals (beryllium, cadmium, lead, copper, nickel, and zinc) that occur as byproducts of explosives tests and in rinsewater discharges.

Figure 1-3 shows the ground water contaminant plumes that have resulted from the releases of COCs discussed above. Nitrate and TBOS/TKEBs are not shown on Figure 1-3 because the contamination in ground water is too limited to appear on the map scale. PCBs and metals have been identified as COCs in surface soil and have not impacted ground water. The PCB-contaminated soil in the Building 854 OU and the Building 850 portion of OU have been or are in the process of being remediated. Remedial actions that have been implemented at Site 300 are shown on Figure 1-4. Many of the remedial actions are continuations of previous treatability studies, removal actions, or area-specific interim remedial actions. Figure 1-4 does not show the remedial actions to address contaminated soil at Buildings 850 and 812 as these remedial actions have not yet been implemented. The remedial actions in each OU also include monitoring and risk and hazard management.

A brief description of each OU is presented below. Summaries of COCs, human health risks, ecological hazards, and selected remedy components for each OU are presented in Tables 1-1 through 1-4. Current COC concentrations and remediation progress for OUs 1 through 8 will continue to be reported in the semiannual Compliance Monitoring Reports.

1.2.1. GSA OU (OU 1)

The GSA OU has been separated into the Central GSA and the Eastern GSA based on differences in hydrogeology and the distribution of environmental contaminants. DOE has performed two Five-Year Reviews for the GSA OU (Ferry et al., 2001b and Dibley et al., 2006a).

1.2.1.1. Central GSA

Chlorinated solvents, mainly TCE, were used as degreasing agents in craft shops in the Central GSA. Rinse water from these degreasing operations was disposed of in dry wells that were gravel-filled holes about 3 to 4 feet (ft) deep and two ft in diameter. As a result, subsurface soil and ground water was contaminated with VOCs. There are no COCs in surface soil in the central GSA. The Central GSA dry wells were used until 1982. In 1983 and 1984, these dry wells were decommissioned and excavated.

Ground water cleanup began in the Central GSA in 1992 and soil vapor extraction started in 1994 as removal actions. In 1997, a Final ROD for the GSA OU was signed and ground water and soil vapor extraction and treatment continued as a remedial action. The selected remedy for the Central GSA includes monitoring, risk and hazard management, and ground water and soil vapor extraction and treatment. The remedial design was completed in 1998 and construction completion for the OU was achieved in September 2005.

Operation of the ground water and soil vapor extraction and treatment systems to remove VOCs from the subsurface are ongoing. Remediation has reduced maximum VOC concentrations in ground water from 272,000 micrograms per liter (µg/L) to 1,100 µg/L and has mitigated the risk to onsite workers from inhalation of VOCs inside Building 875.

1.2.1.2. Eastern GSA

The source of contamination in the Eastern GSA is an abandoned debris burial trench that received craft shop debris. Leaching of solvents on the debris resulted in the release of VOCs to ground water.

Ground water cleanup began in the Eastern GSA in 1991 as a removal action. In 1995, a Final ROD the GSA OU was signed and ground water extraction and treatment continued as a remedial action. The remedial design was completed in 1998 and construction completion for the OU was achieved in September 2005. A ground water extraction and treatment system operated from 1991 to 2007 to remove VOCs from ground water.

As of February 2007, remediation had reduced VOC concentrations in on- and offsite ground water to meet cleanup standards. The treatment system was shut off and placed on standby. Post-shutdown monitoring is being conducted to determine if VOC concentrations rebound above cleanup standards. If VOC concentrations remain below cleanup standards for five years, the treatment system and associated wellfield will be decommissioned.

1.2.2. Building 834 (OU 2)

From 1962 to 1978, intermittent spills and piping leaks resulted in contamination of the subsurface soil and rock and ground water with VOCS and silicone oils (TBOS/TKEBs). Nitrate in ground water results from septic system effluent but may also have natural sources. There are no COCs in surface soil.

Completed remedial activities include excavating VOC-contaminated soil (1983) and installing a surface water drainage diversion system to prevent rainwater infiltration in the contaminant source area (1998). Ground water and soil vapor extraction and treatment began in 1986 as treatability studies. An area-specific Interim ROD for the Building 834 OU (U.S. DOE, 1995) was superseded by the Interim ROD and subsequent 2008 Site-Wide ROD. The Building 834 OU remedy includes monitoring, risk and hazard management, and ground water and soil vapor extraction and treatment. Significant *in situ* bioremediation is occurring in Building 834 ground water and a treatability study focusing on understanding and enhancing this process is currently underway. The remedial design was completed in 2002 and construction completion for the OU was achieved in September 2005.

Remediation has reduced VOC concentrations in ground water from a historical maximum of 1,060,000 µg/L to a maximum of 190,000 µg/L in 2008. TBOS in ground water has also been reduced from a maximum historical concentration of 7,300,000 µg/L in 1995 to a 2008 maximum concentration of 780 µg/L. While nitrate concentrations have decreased from a historic maximum of 749 milligrams per liter (mg/L) in 2000 to 310 mg/L in 2008, the continued elevated nitrate concentrations indicate an ongoing source of ground water nitrate. It is likely that there are multiple sources of nitrate at Building 834. One possible anthropogenic source is the septic system leach field located in the vicinity of wells W-834-S1. A second probable source is natural soil nitrate. Additional sources could be nitrogenous compounds, like nitric acid or barium nitrate, that might have inadvertently been discharged into the septic system via a test cell floor drain or to the ground during accidental spills and/or pipeline leaks that released TCE to the environment. Nitrate is reduced locally by anaerobic bacteria in the Building 834 Core and T2 areas by denitrification.

DOE has performed two Five-Year Reviews for the Building 834 OU (Ferry et al., 2002 and Dibley et al., 2007a).

1.2.3. Pit 6 Landfill (OU 3)

From 1964 to 1973, approximately 1,900 cubic yards (yd^3) of waste from LLNL Livermore Site and Lawrence Berkeley Laboratory was buried in nine unlined trenches and animal pits at the Pit 6 Landfill. Infiltrating rainwater leached contaminants from pit waste resulting in tritium, VOC, and perchlorate contamination in ground water. Nitrate contamination in ground water results from septic system effluent. No COCs were identified in surface or subsurface soil.

In 1971, DOE excavated portions of the waste contaminated with depleted uranium. In 1997, a landfill cap was installed as a CERCLA removal action to prevent infiltrating precipitation from further leaching contaminants from the waste. Because of decreasing VOC concentrations in ground water, the presence of TCE degradation products, and the short half-life of tritium (12.3 years), the selected remedy for VOCs and tritium at the Pit 6 Landfill is monitored natural attenuation (MNA). Because ground water monitoring data for perchlorate and nitrate are limited, DOE will continue to monitor ground water to determine if and when an active remedy for these contaminants might be necessary. The remedy also includes risk and hazard management. Construction completion was achieved in October 2002. No Remedial Design document was required for this area.

The extent of contamination at the Pit 6 Landfill is limited and continues to decrease with concentrations/activities near and below cleanup standards. Natural attenuation has reduced VOCs in ground water from a historical maximum of 250 µg/L in 1988 to a maximum concentration of 10 µg/L in 2008. Tritium activities are well below cleanup standards and continue to decrease towards background levels. Perchlorate is not currently detected in any wells above cleanup standards. Nitrate concentrations exceeding cleanup standards continue to be limited to one well. Installation of the landfill cap mitigated the onsite worker inhalation risk.

A Five-Year Review for this OU is scheduled for 2012.

1.2.4. HE Process Area (OU 4)

From 1958 to 1986, surface spills at the drum storage and dispensing area for the former Building 815 steam plant resulted in the release of VOCs to ground water and subsurface soil and bedrock. HE compounds, nitrate, and perchlorate detected in ground water are attributed to wastewater discharges to former unlined rinsewater lagoons that occurred from the 1950s to 1985. VOCs, nitrate, and perchlorate have also been identified as COCs in ground water near the former HE Burn Pits. HE compounds are COCs in surface soil. HE compounds and VOCs are COCs in subsurface soil. VOCs are COCs at Spring 5.

The HE Open Burn Facility was capped under RCRA in 1998. In 1999, DOE implemented a CERCLA removal action to extract ground water at the site boundary and prevent offsite TCE migration. The HE Process Area remedy includes ground water extraction and treatment for VOCs, HE compounds, and perchlorate, MNA for nitrate (except at Building 829 where nitrate is extracted and treated), monitoring, and risk and hazard management. The remedial design was completed in 2002. Construction completion for the OU was achieved in September 2007. Six ground water extraction and treatment systems currently operate in the OU.

Ground water remediation efforts have reduced VOC concentrations from a historical maximum of 450 µg/L in 1992 to a maximum of 50 µg/L in 2008. RDX in ground water has also been reduced from a maximum historical concentration of 350 µg/L to a maximum concentration of 99 µg/L in 2008. Natural denitrification processes are reducing nitrate concentrations in ground water to background levels. Perchlorate concentrations have decreased from a historic maximum of 50 µg/L in 1998 to 29 µg/L in 2008. Remediation has also mitigated risk to onsite workers in the HE Process Area OU.

DOE has performed a Five-Year Review for the High Explosives Process Area OU (Dibley et al., 2007b).

1.2.5. Building 850/Pit 7 Complex

This OU has been divided into two areas for cleanup evaluation purposes: the Building 850 Firing Table area and the Pit 7 Complex.

1.2.5.1. Building 850 Firing Table (OU 5)

High-explosives experiments were conducted at the Building 850 Firing Table from 1958 to 2008. Tritium was used in some of these experiments, primarily between 1963 and 1978. As a result of the destruction and dispersal of test assembly debris during detonations, surface soil was contaminated with metals, PCBs, dioxins, furans, HMX, and depleted uranium. Leaching from firing table debris has resulted in tritium and depleted uranium contamination in subsurface soil and ground water. Nitrate and perchlorate are also COCs in ground water. Tritium is the only COC in surface water (Well 8 Spring).

Gravel was removed from the firing table in 1988 and placed in the Pit 7 Landfill. PCB-contaminated shrapnel and debris was removed from the area around the firing table in 1998. The Building 850 remedy consists of MNA, monitoring, and risk and hazard management. A remedial design was completed in 2004. The remedial design included the excavation and off-site disposal of contaminated surface soil and sand pile. This remedy was not implemented due to a large increase in transportation and offsite disposal costs. DOE and the regulatory agencies agreed to perform remediation of contaminated surface soil as a non-time critical removal action. An Engineering Evaluation/Cost Analysis (Dibley et al., 2008) and Action Memorandum (U.S. DOE, 2008) were completed in 2008. A new remedial design was completed and implemented in 2009 for the excavation and solidification of PCB-, dioxin-, and furan-contaminated soil and sand pile. Metals in surface soil at Building 850 do not pose a risk to human health or threat to ground water, therefore a no further action remedy was selected. However, metals in surface soil will be removed during the soil excavation/solidification removal action.

Natural attenuation has reduced tritium activities from a historical maximum of 566,000 picoCuries per liter (pCi/L) in 1985 to a 2008 maximum of 56,100 pCi/L. Uranium activities are below the cleanup standard and are within the range of natural background levels. The extent of nitrate with concentrations above cleanup standards is limited and does not pose a threat to human health or the environment. The historic maximum perchlorate concentration in the OU of 75.2 mg/L in 2005 has declined slightly to 69 µg/L in 2008. The metals, HMX, and uranium in surface soil do not pose a risk to human or ecological receptors or a threat to ground water. The soil remediation is underway to address the risks to human health and ecological receptors associated with the PCBs, dioxins, and furans in surface soil at Building 850.

A Five-Year Review for this OU is scheduled for 2012.

1.2.5.2. Pit 7 Landfill Complex (OU 5)

The Pit 3, 4, 5, and 7 Landfills are collectively designated the Pit 7 Landfill Complex. Firing table debris containing tritium, depleted uranium, and metals was placed in the pits in the 1950s through the 1980s. The Pit 4 and 7 Landfills were capped in 1992. During years of above-normal rainfall (i.e., 1997-1998 El Niño), ground water rose into the bottom of the landfills and the underlying contaminated bedrock. This resulted in the release of tritium, uranium, VOCs, perchlorate, and nitrate to ground water. There are no COCs in surface water or surface soil. Tritium and depleted uranium are COCs in subsurface soil.

DOE and the regulatory agencies agreed that the Pit 7 Complex required additional study so this area was not included in the 2002 Interim ROD and an area-specific Remedial Investigation/Feasibility Study (Taffet et al., 2005) was completed. An Amendment to the

Interim ROD for the Pit 7 Complex was signed in 2007 that described the selected remedy for the Pit 7 Complex including monitoring, risk and hazard management, MNA, ground water extraction and treatment, and source control. The interim remedial design and remedy implementation were completed in 2008. A hydraulic drainage diversion system was constructed to control contaminant sources by preventing ground water from rising into the pit waste and underlying contaminated bedrock. In addition a ground water extraction and treatment system was constructed to treat uranium, nitrate, perchlorate, and VOCs in ground water.

- Natural attenuation has reduced tritium activities in ground water from a historical maximum of 2,660,000 pCi/L in 1998 to a 2008 maximum of 291,000 pCi/L and has mitigated risk to onsite workers from inhalation of tritium vapors. Uranium activities have also decreased from a historical maximum of 781 pCi/L in 1998 to a 2008 maximum of 140 pCi/L. VOC concentrations are currently near or below Maximum Contaminant Levels (MCLs). Nitrate concentrations in ground water remain relatively stable, while perchlorate concentrations have decreased.

A Five-Year Review for this OU is scheduled for 2012.

1.2.6. Building 854 (OU 6)

TCE was released to soil and ground water through leaks and discharges of heat exchange fluid, primarily between 1967 and 1984. Nitrate and perchlorate are also COCs in ground water. HE compounds, PCBs, dioxins, furans, tritium, and metals were identified as COCs in surface soil. No further action was selected as the remedy for metals, HMX, and tritium in surface soil.

TCE-contaminated soil was excavated at the northeast corner of Building 854F in 1983. Ground water extraction and treatment has been conducted since 1999 to reduce VOC, nitrate, and perchlorate concentrations in ground water. PCB-, dioxin-, and furan-contaminated soil in the Building 855 former rinsewater lagoon was excavated in 2005. The selected remedy for this OU includes monitoring, risk and hazard management, and ground water and soil vapor extraction and treatment. The interim remedial design was completed in 2003. Construction completion for the OU was achieved in September 2007. Three ground water extraction and treatment systems and one soil vapor extraction and treatment system currently operate in the OU.

Ground water remediation has reduced VOC concentrations from a historical maximum of 2,900 µg/L in 1997 to a maximum of 40 µg/L in 2008. Nitrate concentrations have decreased from a historical maximum of 260 mg/L in 2003 to a 2008 maximum of 230 mg/L. Perchlorate concentrations in ground water have also decreased from 27 µg/L to a 2008 maximum concentration of 22 µg/L. Risks to onsite workers from inhalation of VOC vapors and from exposure to PCBs, dioxins, and furans in surface soil have been mitigated.

A Five-Year Review of remediation in the Building 854 OU was completed in January 2009 (Dibley et al., 2009).

1.2.7. Building 832 Canyon (OU 7)

Contaminants were released from Buildings 830 and 832 through piping leaks and surface spills during past activities at these buildings. VOCs, nitrate, and perchlorate are COCs in ground water. VOCs, nitrate, and HMX are COCs in subsurface soil. HMX is also a COC in surface soil. VOCs are COCs in surface water at Spring 3.

Ground water and soil vapor extraction and treatment has been conducted since 1999 to reduce contamination in ground water and subsurface soil. The Building 832 Canyon OU remedy includes monitoring, risk and hazard management, MNA for nitrate, and ground water and soil vapor extraction and treatment. The interim remedial design was completed in 2006. Construction completion for the OU was achieved in September 2007. Three ground water extraction and treatment systems and two soil vapor extraction and treatment systems currently operate in the OU.

Remediation has reduced VOC concentrations from a historical maximum of 30,000 µg/L in 1997 to a 2008 maximum of 4,700 µg/L. Perchlorate concentrations have been reduced from a historical maximum of 27 µg/L in 2003 to a 2008 maximum of 15 µg/L. Nitrate concentrations in ground water remain fairly stable, and are possibly the result of the ongoing contribution of nitrate from septic systems and natural bedrock sources. However, natural denitrification processes continue to reduce nitrate concentrations to background levels towards the site boundary. Remediation has also mitigated risk to onsite workers in several locations in the Building 832 Canyon OU.

A Five-Year Review for this OU is scheduled for 2011.

1.2.8. OU 8

Operable Unit 8 includes the contaminant release sites that have a monitoring-only remedy: the Building 801 Dry Well and Pit 8 Landfill, Building 833, Building 845 and Pit 9 Landfill, the Building 851 Firing Table, and the Pit 2 Landfill. Operable Unit 8 release sites have a monitoring-only interim remedy because either: (1) contaminants in surface and subsurface soil/bedrock do not pose a risk to humans or plant and animal populations or a threat to ground water, (2) there is no ground water contamination, (3) contaminant concentrations in ground water do not exceed regulatory standards, and/or (4) the extent of contamination in ground water is limited. These release sites are summarized below.

1.2.8.1. Building 801 Dry Well and the Pit 8 Landfill (OU 8)

The Building 801 Firing Table was used for explosives testing and operations resulted in contamination of adjacent soil with metals and uranium. Use of this firing table was discontinued in 1998, and the firing table gravel and some underlying soil were removed. Waste fluid was discharged to a dry well (sump) located adjacent to Building 801D from the late 1950s to 1984. The dry well was decommissioned and filled with concrete in 1984. VOCs, perchlorate and nitrate are COCs in ground water due to the past releases from the Building 801 Dry Well. VOC and nitrate concentrations in ground water are currently near or below cleanup standards or at background levels. Perchlorate is not currently detected in ground water. VOCs are COCs in subsurface soil, but do not pose a risk to human health. The adjacent Pit 8 Landfill received debris from the Building 801 Firing Table until 1974, when it was covered with compacted soil. There is no evidence of contaminant releases from the landfill.

The selected remedy for this area includes monitoring and risk and hazard management. No Remedial Design documents are required for this area.

A Five-Year Review for this OU is scheduled for 2012.

1.2.8.2. Building 833 (OU 8)

TCE was used as a heat-exchange fluid in the Building 833 area from 1959 to 1982 and was released through spills and rinsewater disposal, resulting in TCE-contamination of subsurface soil and shallow perched ground water. No contamination has been detected in the deeper regional aquifer. No COCs were identified surface soil at Building 833.

The selected remedy for Building 833 includes monitoring and risk and hazard management. No Remedial Design document is required for this area. Ground water monitoring at Building 833 has shown a decline in VOC concentrations from a historical maximum of 2,100 µg/L in 1992 to a 2008 maximum of 180µg/L.

A Five-Year Review for this OU is scheduled for 2012.

1.2.8.3. Building 845 Firing Table and the Pit 9 Landfill (OU 8)

The Building 845 Firing Table was used from 1958 until 1963 to conduct explosives experiments. Leaching from firing table debris resulted in minor contamination of subsurface soil with depleted uranium and HMX, however no unacceptable risk to human or ecological receptors or threat to ground water was identified. No contaminants have been detected in surface soil or in ground water at the Building 845 Firing Table. Debris generated at the Building 845 Firing Table was buried in the Pit 9 Landfill. There has been no evidence of contaminant releases from the Pit 9 Landfill.

The selected remedy for Building 845 and the Pit 9 Landfill includes monitoring and risk and hazard management. No Remedial Design documents are required for this area.

A Five-Year Review for this OU is scheduled for 2012.

1.2.8.4. Building 851 Firing Table (OU 8)

The Building 851 Firing Table has been used for high-explosives research since 1962. VOCs and uranium-238 were identified as COCs in subsurface soil, and RDX, uranium-238, and metals as surface soil COCs. However, there is no risk to humans or animal populations, or threat to ground water associated with these contaminants in surface and subsurface soil. Uranium-238 was identified as a COC in ground water. However, it poses no risk to human or ecological receptors, and uranium activities are well below cleanup standards and are within the range of background levels.

In 1988, the firing table gravel was removed and has been replaced periodically since then. The selected remedy for Building 851 includes monitoring and risk and hazard management. No Remedial Design document is required for this area.

A Five-Year Review for this OU is scheduled for 2012.

1.2.8.5. Pit 2 Landfill (OU 8)

The Pit 2 Landfill was used from 1956 until 1960 to dispose of firing table debris from Buildings 801 and 802. Ground water data indicate that a discharge of potable water to support a red-legged frog habitat located upgradient from the landfill may have leached depleted uranium from the buried waste. The frogs were relocated and the water discharge was discontinued, thereby removing the leaching mechanism. No contaminants were identified in surface or subsurface soil at the Pit 2 Landfill. No risk to human or ecological receptors has been identified at the Pit 2 Landfill.

The selected remedy for the Pit 2 Landfill includes monitoring and risk and hazard management. Monitoring data indicate that uranium activities remain below the cleanup standard. No Remedial Design document is required for this area.

A Five-Year Review is scheduled for OU 8 in 2012.

1.2.9. Building 812 (OU 9)

The Building 812 Complex was built in the late 1950s-early 1960s and was used to conduct explosives tests and diagnostics until 2008. A Characterization Summary Report for this area was completed in 2005 (Ferry and Holtzapple, 2005). The Building 812 Complex was designated as OU 9 in March 2007 based on characterization results that indicated the presence of uranium, VOCs, HE compounds, nitrate, and perchlorate in environmental media. A draft Remedial Investigation/Feasibility Study (RI/FS) presenting the results of characterization activities and remedial alternatives for the Building 812 OU was submitted to the regulatory agencies in 2008. A DOE task force reviewed the soil washing alternative and determined that it would not be effective at Site 300, therefore a soil washing treatability study will not be performed. DOE is currently evaluating a new remedial strategy for contaminated soil at Building 812. The RI/FS will be completed following the negotiations with the regulatory agencies. A Proposed Plan will subsequently present the alternatives and a preferred remedy for public comment. A remedy will then be selected in an Amendment to the Site-Wide ROD. Building 812 will be incorporated into the CMP/CP thereafter.

1.2.10. Building 865/Advanced Test Accelerator

Building 865 facilities were used to conduct high-energy laser tests and diagnostics in support of national defense programs from 1980 to 1995. The Building 865 Complex housed a 275-foot linear electron accelerator called the Advanced Test Accelerator (ATA). The ATA was designed to produce a repetitively pulsed electron beam for charged particle beam research. A Characterization Summary Report for this area was submitted in 2006 (Ferry and Holtzapple, 2006). Freon 113, Freon 11, and tetrachloroethene (PCE), were identified as COCs in ground water. The remediation pathway for Building 865 is currently being negotiated. Building 865 will be incorporated into the CMP/CP thereafter.

1.3. Scope of the Compliance Monitoring Plan and Contingency Plan

This CMP/CP describes the monitoring activities and procedures to be followed during implementation of the selected remedies and includes the following programs:

- Ground and Surface Water Monitoring Program (Section 3).
- Detection Monitoring, Inspection, and Maintenance Program for the Pit 2, 3, 4, 5, 7, 8, and 9 Landfills (Section 4).

- Extraction and Treatment System Monitoring Program (Section 5).
- Risk and Hazard Management (Section 6).
- Data Management Program (Section 7).
- Quality Assurance/Quality Control Program (Section 8).
- Reporting (Section 9).

A Contingency Plan is presented in Section 10 that describes how DOE and the regulatory agencies plan to address foreseeable problems that may arise during the remediation and monitoring of contaminants conducted under the ROD.

In the 2008 Site 300 Site-Wide ROD, DOE agreed to prepare an analysis after ground water contaminant concentrations have been reduced to MCL cleanup standards in OUs 2 through 8 to determine the technical and economic feasibility of continuing remediation to further reduce contaminant concentrations to Water Quality Numeric Limits (WQNLs) or background concentrations. The Site-Wide ROD specified that the details of the approach that will be used to perform technical and economic feasibility analysis would be provided in this Revised Site-Wide Compliance Monitoring Plan/Contingency Plan. Therefore, the technical and economic feasibility analysis process, the general schedule for conducting this analysis, and a discussion of how the results of this analysis will be used is included in Appendix A of this CMP/CP.

This CMP/CP applies to OUs 1 through 8. The following areas and programs are not included in this CMP/CP:

- Pit 1 Landfill – RCRA Closure and Post-Closure documents (Corey, 1988; Rogers/Pacific, 1990) have been approved and this facility is currently monitored under Waste Discharge Requirements issued by the RWQCB. This monitoring will not be affected by this CMP/CP.
- Building 865 – A report summarizing characterization activities at Building 865 is currently in review by the regulatory agencies and a CERCLA pathway for this area has not yet been determined. DOE will continue to monitor this area until the remediation pathway is determined and the Building 865 is incorporated into the CMP/CP.
- Building 812 – The RI/FS is in progress. DOE will continue to monitor this area until it is formally incorporated into the Site-Wide ROD and Building 812 is incorporated into the CMP/CP.
- Building 850 Soil Removal Action – Implementation of a soil excavation and solidification remedy is in progress. Inspection and maintenance requirements associated with the remedy will be incorporated into the operations and maintenance plan. However, contingencies that could impact the effectiveness of the remedial action are addressed in the CP.
- Pit 7 Hydraulic Drainage Diversion System – Inspection and maintenance requirements are incorporated into the Hydraulic Drainage Diversion System operations and maintenance plan. However, contingencies that could impact the effectiveness of the Hydraulic Drainage Diversion System are addressed in the CP.

- Surveillance Monitoring Program – The monitoring of water-supply wells, air, vegetation, and storm water runoff by the LLNL Environmental Protection Department will not be affected by this CMP/CP.
- Pit 6 Landfill Detection Monitoring Program – The designated "detection monitor wells" for this landfill will continue to be sampled as specified in the Detection Monitoring Plan contained within the Post-Closure Plan for this landfill (Ferry et al., 1998). This monitoring will not be affected by this CMP/CP. Wells in the area that are not designated as detection monitor wells will be sampled as described in the Ground and Surface Water Monitoring Program presented in Section 3.
- High Explosives Open Burn Facility – A RCRA Closure Plan has been approved and this facility is monitored as specified in that document. This monitoring will not be affected by this CMP/CP.
- Standards for the discharge of treated ground water remain in the RWQCB Substantive Requirements and the Site-Wide ROD and are not affected by this CMP/CP.

2. Objectives

2.1. General Objectives

This CMP/CP describes the monitoring and compliance activities to be conducted in support of the remedies selected in the Site-Wide ROD, including:

- Performing regular ground and surface water sampling and analysis and ground water elevation measurement to monitor the effectiveness of the remedial actions.
- Conducting detection monitoring, inspection, and maintenance of the Pit 2, 3, 4, 5, 7, 8, and 9 Landfills to identify and prevent future contaminant releases from these landfills.
- Monitoring soil vapor and ground water extraction and treatment facilities to ensure the regulatory compliance.
- Managing human and ecological receptors risks and hazards to prevent unacceptable exposure from occurring, including institutional and land use control implementation.
- Managing the collection, processing, and quality of monitoring data.
- Reporting monitoring results and interpretations to the regulatory agencies and other stakeholders.
- Establishing contingency measures and procedures to be implemented if cleanup does not proceed as planned.

2.2. Remedial Action Objectives

The National Contingency Plan specifies that Remedial Action Objectives (RAOs) be developed which address: (1) COCs, (2) media of concern, (3) potential exposure pathways, and (4) preliminary remediation levels. The development of these goals involves evaluating applicable or relevant and appropriate requirements (ARARs) and the results of the baseline human and ecological risk assessments.

RAOs for the Site 300 OUs addressed by this CMP/CP are:

For Human Health Protection:

- Restore ground water containing contaminant concentrations above cleanup standards.
- Prevent human ingestion of ground water containing contaminant concentrations (single carcinogen) above cleanup standards.
- Prevent human incidental ingestion and direct dermal contact with contaminants in surface soil that pose an excess cancer risk greater than 10^{-6} or hazard index greater than 1, a cumulative cancer risk (all carcinogens) in excess of 10^{-4}, or a cumulative hazard index (all noncarcinogens) greater than 1.
- Prevent human inhalation of VOCs and tritium volatilizing from subsurface soil to air that pose an excess cancer risk greater than 10^{-6} or hazard index greater than 1, a cumulative excess cancer risk (all carcinogens) in excess of 10^{-4}, or a cumulative hazard index (all noncarcinogens) greater than 1.
- Prevent human inhalation of VOCs and tritium volatilizing from surface water to air that pose an excess cancer risk greater than 10^{-6} or hazard index greater than 1, a cumulative excess cancer risk (all carcinogens) in excess of 10^{-4}, or a cumulative hazard index (all noncarcinogens) greater than 1.
- Prevent human inhalation of contaminants bound to resuspended surface soil particles that pose an excess cancer risk greater than 10^{-6} or hazard index greater than 1, a cumulative excess cancer risk (all carcinogens) in excess of 10^{-4}, or a cumulative hazard index (all noncarcinogens) greater than 1.
- Prevent human exposure to contaminants in media of concern that pose a cumulative excess cancer risk (all carcinogens) greater than 10^{-4} and/or a cumulative hazard index greater than one (all noncarcinogens).

For Environmental Protection:

- Restore water quality to ground water cleanup standards within a reasonable timeframe and to prevent plume migration to the extent technically practicable. Maintain existing water quality that complies with ground water cleanup standards to the extent technically and economically practicable. This will apply to both individual and multiple constituents that have additive toxicology or carcinogenic effects.
- Ensure ecological receptors important at the individual level of ecological organization (listed threatened or endangered, State of California species of special concern) do not reside in areas where relevant hazard indices exceed 1.
- Ensure existing contaminant conditions do not change so as to threaten wildlife populations and vegetation communities.

There is no remedial action objective for human health protection/ARAR compliance for ingestion of surface waters (i.e., water from Site 300 springs) because there is not a complete exposure pathway for ingestion of surface waters for humans at Site 300. Humans do not drink water from Site 300 springs. In addition, the springs in which contaminants are detected do not produce a sufficient quantity of water to be used as a water supply (greater than 200 gallons per day).

3. Ground and Surface Water Monitoring Program

The Site 300 Ground and Surface Water Monitoring Program includes the sampling of ground water monitor wells and surface water as described in Section 3.1, and the measurement of ground water elevations described in Section 3.2. Ground water and surface water monitoring will continue until cleanup of these environmental media are complete, as described in Section 3.3. Excluded from this program are:

- Monitor wells already included in other monitoring programs (see Section 1.3).
- Surveillance monitoring of onsite and nearby offsite water-supply wells (see Section 1.3).
- Detection monitoring wells at the Pit 2, 3, 4, 5, 6, 7, 8, and 9 Landfills (see Section 4).
- Monitoring of ground water extraction wells (see Section 5).

Data from the monitoring activities listed above will be evaluated along with those obtained from this Ground and Surface Water Monitoring Program to facilitate comprehensive analyses of hydrogeologic conditions, contaminant distribution and migration, and the progress of remediation.

This program supersedes the ground water monitor well sampling requirements previously included in Monitoring and Reporting Programs issued by the RWQCB for the GSA, Building 834, High Explosives Process Area, Building 854, and Building 832 Canyon OUs and the monitoring program for the Pit 7 Complex in the Remedial Design report.

Monitoring will be performed using the Standard Operating Procedures and quality assurance/quality control measures described in Section 8.

Reporting requirements are described in Section 9. Changes to the monitoring program will continue to be documented in the semiannual Compliance Monitoring Reports.

3.1. Ground and Surface Water Sampling and Analysis

Ground and surface water sampling locations are divided into the following three categories:

1. Guard wells to provide timely indication of contaminant movement that could impact water-supply wells, water-supply aquifers, or approach the site boundary (Section 3.1.1).
2. Plume tracking wells to define the lateral and vertical extent of ground water contamination (Section 3.1.2).
3. Surface water (Springs) (Section 3.1.3.)

Sections 3.1.1 through 3.1.3 present the general approach for collecting and analyzing samples from wells and springs. This CMP/CP provides the overall guidance for generating sampling and analysis plans, but does not include detailed plans for each well or spring. Detailed sampling and analysis plans, including lists of monitoring locations and types, analytes, and sampling frequency for all ground water monitor wells categories and springs, will continue to be generated quarterly and presented in the semiannual Compliance Monitoring Reports. The plans will be modified as needed to reflect changing site conditions, new or decommissioned wells, and stakeholder concerns. At a minimum, these plans will be consistent with the guidelines included in the following sections. Any changes to the monitoring program will continue to be documented in the semiannual Compliance Monitoring Reports described in Section 9.

3.1.1. Guard Wells

A subset of all Site 300 wells are designated as guard wells, where time-sensitive information is needed to identify contaminant movement that may:

- Impact water-supply wells (shown on Figure 1-3).
- Migrate vertically and contaminate unimpacted water-supply aquifer(s).
- Result in migration across the site boundary.

Other wells of strategic importance may also be designated as guard wells (e.g., a well near a suspected new contaminant release). Guard wells will generally be sampled more frequently than other wells.

Guard wells are located in the GSA, Building 834, Pit 6 Landfill, High Explosives Process Area, Building 850, and Building 832 Canyon OUs. Guard well locations, hydrostratigraphic completion interval, analytes, and sampling frequency will continue to be presented in detailed sampling and analysis plans contained in the semi-annual Compliance Monitoring Reports. Figure 3-2 shows an example of guard well locations for the $Tnsc_{1b}$ hydrostratigraphic unit (HSU) in the Building 832 Canyon OU.

Ground water contaminant plumes in other areas of the site (e.g., Buildings 801, 851, 854, and at the Pit 7 Complex) are located in the interior portion of Site 300, well away from the site boundary and water-supply wells and the rate of contaminant migration is relatively low. Time-sensitive contaminant concentration data are not needed to monitor these plumes, and all monitor wells in these areas will be sampled as described in Section 3.1.2.

The list of guard wells will be reviewed annually and modified as needed. Any changes will be documented in the annual Compliance Monitoring Reports. Section 10.1.1.3 describes procedures that would be implemented for evaluating guard wells that have been impacted by site contaminants and should be considered for replacement.

3.1.2. Plume Tracking Wells

Plume tracking wells are used to monitor changes in the distribution and concentrations of COCs identified in the ROD as a result of remediation, significant recharge events, and/or natural attenuation processes. For compliance monitoring purposes, primary and secondary COCs are defined for each area of Site 300.

Primary COCs are those that generally exhibit:

1. Higher migration rates than secondary COCs.
2. Larger horizontal and vertical extent of contamination than secondary COCs.

3. Any other contaminant or area-specific consideration that indicates that a more frequent sampling schedule is appropriate (e.g., a highly toxic contaminant).

The extent of a ground water plume is defined by the presence of contamination above the analytical detection limit. Primary COCs will be monitored at a higher frequency than secondary COCs. Vadose zone COCs are those which have been detected in the unsaturated zone but have not been detected in ground water.

Table 3-1 presents the preliminary analytes for the Ground and Surface Water Monitoring Program, and shows the contaminants that have been designated primary and secondary COCs for each area of Site 300. Plume tracking well locations, analytes, and sampling frequency will continue to be presented in detailed sampling and analysis plans contained in the semi-annual Compliance Monitoring Reports. The list of plume tracking wells and COCs will be reviewed annually and modified as needed. Any changes will be documented in the annual Compliance Monitoring Reports.

Samples from wells within and adjacent to the lateral and vertical extent of a primary COC plume will be analyzed semiannually for primary COCs. Samples from wells within and adjacent to the lateral and vertical extent of a secondary COC plume will be analyzed annually for secondary COCs. As shown in Figure 3-2, where there are multiple, commingled plumes of varying extent, plume tracking wells for primary COCs may be located downgradient of plume tracking wells for secondary COCs. Where this occurs, the plume tracking wells for primary COCs will be sampled for the secondary COCs at a reduced frequency (i.e., biennially). Wells that show no evidence of anthropogenic contamination will be monitored biennially (every other year) for all primary and secondary COCs identified in the area. Figure 3-2 shows an example of how this sampling program would be implemented for primary and secondary COCs in the $Tnsc_{1b}$ HSU in the Building 832 Canyon OU.

A subset of wells in each area will be sampled biennially for COCs that have been identified in the vadose zone, but not detected in ground water. The objective of sampling for these analytes is to detect contaminants that may migrate downward into ground water. The wells will be chosen based on the lateral extent, depth, and concentration of COCs in the vadose zone. The list of vadose zone COCs for which ground water will be monitored is presented in Table 3-1.

Some plume tracking wells that provide redundant data (i.e., wells in close proximity to one another, completed in the same HSU with similar yield and contaminant concentration) may be excluded from the sampling program, sampled at a reduced frequency, or their sampling schedule will alternate with the nearby redundant well.

Because the extent of contaminant plumes will change as remediation progresses, well status may change over time as discussed in Section 3.1.5. Well status changes will continue to be reported in the semi-annual Compliance Monitoring Reports.

3.1.3. Surface Water (Springs)

Site 300 has at least 23 springs; 19 are perennial and 4 are intermittent. Most of the springs have very low flow rates and are recognized only by small marshy areas, pools of water, or vegetation. The location of Site 300 springs and surface water bodies are shown on Figure 3-1. Only springs that are located in areas of contamination that have been impacted or have the potential to be impacted by ground water contamination are included in this CMP/CP:

- Spring 7 (Pit 6 Landfill OU)
- Spring 15 (Pit 6 Landfill OU).
- Spring 5 (HE Process Area OU).
- Spring 14 (HE Process Area OU).
- Spring 24 (Building 850 area).
- Well 8 Spring (Building 850 area).
- Spring 10 (Building 854 OU).
- Spring 11 (Building 854 OU).
- Spring 3 (Building 832 Canyon OU).
- Spring 4 (Building 832 Canyon OU).

The analytes and sampling frequency criteria for each spring will be identical to that for a well present in that location, but the time of sampling may be adjusted to accommodate sampling during the wet season when most flow occurs. However, spring sampling frequency will be reduced to biennially if surface water has not been present historically.

3.2. Ground Water Elevation Measurements

Ground water elevations will be measured quarterly in all onsite monitor wells and in offsite monitor wells in the vicinity of Site 300. For some wells, the measurement frequency may be increased to provide additional information on seasonal fluctuations or extraction wellfield performance monitoring, or to interpret hydraulic capture, optimize wellfield operations, evaluate the effectiveness of the engineered drainage diversion system, and/or to determine specific yield and injection well capacity.

3.3. Completion of Ground and Surface Water Monitoring

For OUs 2 through 8, ground water cleanup will be complete when ground water samples demonstrate that cleanup standards are achieved, either as specified in 2008 Site-Wide ROD or following the technical and economic feasibility analyses. This will be achieved when contaminant concentrations in samples collected from all monitor wells within an OU are below the cleanup standards. When contaminant concentrations in ground water have been reduced to the cleanup standards, the ground water extraction and treatment systems will be shut off and placed on standby. For OUs 2 through 8, ground water post-closure monitoring will be performed for two years after pumping ceases to determine if contaminant concentrations rebound. Per the 1997 GSA ROD (OU 1), ground water monitoring will be performed for five years after pumping ceases to determine if contaminant concentrations rebound. Post-shutdown sampling frequency for COCs will continue at the same frequency as the sampling conducted prior to shutdown.

Cleanup will be considered complete when contaminant concentrations in ground water remain below the cleanup standards for two years (OUs 2 through 8) or five years (GSA). After concurrence with the regulatory agencies that cleanup is complete, ground water monitoring will cease and the monitor wells within the OU will be decommissioned in compliance with all applicable regulations. Wells will be closed by *in situ* casing perforation and pressure grouting, or by well removal as appropriate, consistent with the approved LLNL Livermore Site and Site 300 Environmental Restoration Project Standard Operating Procedures (Goodrich and Wimborough, 2006).

Because surface water in Site 300 springs is the result of ground water discharge at the surface, ground water remediation efforts will also clean up surface water. Surface water monitoring will cease when: (1) any risk or hazard associated with surface water is mitigated, and/or (2) contaminant concentrations in surface water are reduced to meet ground water cleanup standards.

Section 10.1.1.2 discusses the actions to be taken if concentrations rebound above the cleanup standards during post-shutdown monitoring.

4. Detection Monitoring, Inspection, and Maintenance Program for the Pit 2, 3, 4, 5, 7, 8, and 9 Landfills

The remedies selected in the Site-Wide ROD for the Pit 2, 3, 4, 5, 7, 8, and 9 Landfills included: (1) ground water monitoring to detect any future releases of contaminants from these landfills (Sections 4.1 and 4.2), and (2) landfill inspection and maintenance (Section 4.3). The Detection Monitoring, Inspection, and Maintenance Program for these landfills includes:

- Collecting and analyzing ground water samples as specified in Table 4-1.
- Annually inspecting the landfills to identify any erosion, subsidence, or breaching of the landfill surface.
- Maintaining the landfill surfaces and drainage ways as needed.

There is no evidence of contaminant releases from the Pit 8 and 9 Landfills, and no unacceptable risk or hazard to human or ecological receptors has been identified. Therefore, detection monitoring and landfill inspection and maintenance only, as described in this section, will be conducted at these landfills. Section 10.1.4 describes procedures that would be implemented if contaminant releases from Pits 8 and 9 are detected.

Contaminant releases have already occurred from the Pit 2, 3, 4, 5, 6, and 7 Landfills. Therefore, the ground and surface water sampling and analysis program described in Section 3.1 will be implemented at these landfills, in addition to the detection monitoring, inspection, and maintenance program described in this section.

The detection monitoring, inspection, and maintenance program will be conducted as long as the waste buried in the Pits 2, 3, 4, 5, 7, 8, and 9 landfills poses a potential threat to ground water.

Detection monitoring will be performed using the Standard Operating Procedures and quality assurance/quality control measures described in Section 8.

Reporting requirements are described in Section 9. Changes to the monitoring program will continue to be documented in the semiannual Compliance Monitoring Reports.

The detection monitoring, inspection, and maintenance program for the Pit 1 and 6 Landfills is not included in this CMP/CP. The Detection Monitoring, Inspection, and Maintenance Program for the Pit 6 Landfill is described in the Pit 6 Landfill Post-Closure Plan. The Detection Monitoring, Inspection, and Maintenance Program for the Pit 1 Landfill is contained in Waste Discharge Requirements issued by the RWQCB.

4.1. Ground Water Sampling and Analysis

Detection monitor wells, situated in close proximity to the landfills, will be used to identify any impact to ground water resulting from future releases from the landfills.

Ground water samples will be collected quarterly from the detection monitor wells. Table 4-1 presents the list of analyses to be performed on the ground water samples. The list of analytes includes all constituents that could reasonably be expected in the buried waste in these landfills based on an evaluation of operational records and procedures.

Detailed sampling and analysis plans will continue to be presented in the semi-annual Compliance Monitoring Reports that shows, the location, completion interval, sampling frequency, and analyte list for all detection monitor wells.

4.2. Ground Water Elevation Measurements

Ground water elevations will be measured quarterly in all detection monitor wells for the Pit 2, 3, 4, 5, 7, 8, and 9 Landfills.

4.3. Landfill Inspection and Maintenance

The Pit 2, 3, 4, 5, 7, 8, and 9 Landfills will be inspected quarterly to identify any degradation or damage to the landfill surfaces or damage or blockage of the drainage ways that could lead to: (1) increased infiltration of precipitation, (2) exposure of the landfill contents, and (3) flow of surface water on or adjacent to the landfill.

LLNL Maintenance and Utilities Services staff will perform the landfill inspections and the annual subsidence monitoring required by DOE. Any required maintenance will be performed promptly, and measures to prevent reoccurrence of the degradation or damage will be implemented.

5. Extraction and Treatment System Monitoring Program

The Site 300 Extraction and Treatment System Monitoring Program includes regular sampling, flow measurements, and maintenance of ground water and soil vapor extraction wells and treatment systems. The Site 300 Extraction and Treatment System Monitoring Program is applicable to treatment systems in the following OUs/areas:

- Central GSA area
- Building 834 OU

- HE Process Area OU
- Pit 7 Complex area
- Building 854 OU
- Building 832 Canyon OU

This program supercedes all extraction well and ground water treatment system monitoring requirements included in Monitoring and Reporting Program issued by the RWQCB for the above listed OUs/areas. The Eastern GSA treatment system is not included in this CMP/CP because the treatment system was shutdown in 2007 after reaching cleanup standards.

Discharge specifications and prohibitions for treated ground water are contained in the Substantive Requirements issued by the RWQCB, and effluent discharge limitations are contained in the Site-Wide ROD, and are not affected by this CMP/CP.

Monitoring requirements and effluent discharge limitations for treated soil vapor are contained in the Permit Unit Requirements issued by the San Joaquin Valley Unified Air Pollution Control District (2008). This Extraction and Treatment System Monitoring Program is consistent with, but does not supersede, District requirements.

Monitoring will be performed using the Standard Operating Procedures and quality assurance/quality control measures described in Section 8.

Reporting requirements are described in Section 9. Modifications to the monitoring program will continue to be documented in the semiannual Compliance Monitoring Reports.

5.1. Ground Water Extraction and Treatment

Sections 5.1.1 and 5.1.2 describe the compliance monitoring activities for ground water extraction wells and treatment systems (GWTSs). The monitoring of ground water extraction wells and treatment systems will continue until ground water cleanup is complete, as described in Section 5.1.3.

5.1.1. Ground Water Extraction Well Monitoring

Monitoring of ground water extraction wells will follow the same guidelines as described above in Section 3. In general, monitoring of extraction wells will mirror that for nearby plume interior or plume boundary tracking wells. Water levels in all extraction wells will be measured quarterly.

5.1.2. Ground Water Treatment System Monitoring

Water samples will be collected, at a minimum, at the influent and effluent points of the treatment stream. Additional influent or effluent samples may be collected at intermediate points within the process stream to manage the performance of the treatment system. There will be sufficient time allowed between sampling events to avoid sample clustering. Influent samples will be collected at approximately the same time as the effluent samples. Influent or effluent samples may be collected more frequently to manage the performance of the treatment system.

Generally, influent samples will be collected and analyzed quarterly, and effluent samples will be collected and analyzed monthly, with some exceptions. For treatment areas where the entire extraction wellfield is located outside the detectable extent of the secondary COC(s), but within the footprint of the primary COC, influent monitoring for the secondary COC(s) will be discontinued, and effluent monitoring frequencies for the secondary COC(s) will be reduced to quarterly. Should a secondary COC be detected in future sampling of the extraction wellfield, the monitoring for that COC will revert back to the normal CMP frequency. For example, there have been no detections of HE compounds over the last fourteen years in the extraction wells for the Building 815-Proximal ground water treatment system. These extraction wells are acting as HE plume boundary tracking wells. Although the extraction wells will be left on the normal CMP schedule for primary COCs (semi-annually) and secondary COCs (annually), ground water treatment system influent HE monitoring would be discontinued and effluent HE monitoring will be conducted quarterly. Granular activated carbon is still in place at this ground water treatment system for VOC removal, and would adsorb HE in the unlikely event that HE was detected. For treatment systems such as the Building 815-Distal Site Boundary where the extraction wells are only within the footprint of the primary COC, only the primary COCs will be monitored at the facility. The sampling frequencies for each treatment system will continue to be presented in the semiannual Compliance Monitoring Reports.

The influent and effluent samples will be analyzed, at a minimum, for all COCs identified in any ground water extraction well connected to the treatment system or that could potentially be captured by any extraction well. However, the monitoring of nitrate in treatment system influent and effluent will not be conducted for treatment areas where either: (1) MNA is the selected remedy for nitrate in ground water, or (2) the effluent is discharged via misting and no nitrate discharge limit is specified. If needed, nitrate input to a treatment system and mass of nitrate discharged can be determined by individual extraction well nitrate mass calculations. Table 5-1 presents the preliminary sampling and analysis plan for each ground water treatment facility at Site 300. The final selection of analytes and monitoring frequencies will be defined in detailed sampling and analysis plans, and any future changes to these plans will continue to be presented in the semi-annual Compliance Monitoring Plans.

All aqueous treatment facility effluent is discharged to the atmosphere through misting towers or is returned to ground water through infiltration trenches or reinjection wells. No effluent is discharged into surface water drainage, so no receiving water sampling is required.

Upon: (1) initial startup of a facility, (2) a facility shutdown due to non-compliance with discharge requirements, or (3) any treatment system shutdown or modification that could result in non-compliance, effluent samples will be collected and analyzed within two days of system restart, one week after restart, and return to the normal sampling schedule thereafter. No additional sampling will be performed after shutdowns due to routine maintenance or for modifications that do not affect compliance.

For quality control, one sampling blank and one duplicate sample will be collected and analyzed for every twelve samples collected. These quality control samples will be analyzed for the same constituents as the other samples collected.

All treatment facilities will be visually inspected weekly to identify any maintenance issues or other problems that could affect facility performance or compliance.

Detailed sampling and analysis plans for the treatment facilities will be generated as needed. These plans will be modified as needed to reflect changing site conditions, new extraction wells, and stakeholder concerns.

5.1.3. Completion of Ground Water Extraction Well and Treatment System Monitoring

When contaminant concentrations in ground water have been reduced to the cleanup standards, the ground water extraction and treatment systems will be shut off and placed on standby. As described in Section 3.3, ground water post-closure monitoring will be performed for two years for OUs 2 through 8 or five years for the GSA (OU 1) after pumping ceases to determine if contaminant concentrations rebound. Because the treatment systems will not be operating during this post-closure monitoring period, treatment system monitoring will not be conducted. The monitoring of extraction wells will be conducted to determine rebound during this period. Post-shutdown sampling frequency for COCs will continue at the same frequency as sampling conducted prior to shutdown.

Cleanup will be considered complete when contaminant concentrations in ground water remain below the cleanup standards for two years for OUs 2 through 8 or five years for the GSA. After concurrence with the regulatory agencies that cleanup is complete, ground water monitoring will cease and the extraction wells and treatment systems within the OU will be decommissioned.

5.2. Soil Vapor Extraction and Treatment

Sections 5.2.1 and 5.2.2 describe the compliance monitoring activities for soil vapor extraction wells and treatment facilities. The monitoring of soil vapor extraction wells and treatment systems will continue until cleanup is complete, as described in Section 5.2.3.

5.2.1. Soil Vapor Extraction Well Monitoring

All wells used to extract soil vapor will be sampled and analyzed semiannually for VOCs. The negative pressure in each extraction well will be measured monthly, and more frequently where needed to manage the performance of the facility.

5.2.2. Soil Vapor Treatment System Monitoring

This monitoring program is consistent with, but does not supersede, the provisions of the Permit Unit Requirements which are part of the facility-wide Permit to Operate for Site 300 issued by the San Joaquin Valley Unified Air Pollution Control District (2008). The Permit to Operate and Permit Unit Requirements are modified and reissued periodically, and are incorporated into this CMP/CP by reference. Future modifications will not require an amendment to this CMP/CP.

A flame-ionization detector, photo-ionization detector, or other District-approved VOC detection device will be used to monitor the effluent vapor stream weekly. Records of the cumulative running time and effluent concentrations will be maintained.

5.2.3. Completion of Soil Vapor Extraction Well and Treatment System Monitoring

As discussed in Section 10.1.2, the soil vapor extraction and treatment systems will operate until it is demonstrated that: (1) unacceptable VOC inhalation risk to onsite workers has been mitigated, and (2) VOC removal from the vadose zone is no longer technically or economically feasible in meeting the aquifer cleanup standards sooner, more cost effectively, and more reliably. The decision on whether it is appropriate to shut off the soil vapor extraction system will be made based on the results of the "Soil Vapor Extraction System Shut-Off Evaluation" discussed in Appendix C of the Site-Wide ROD (DOE, 2008).

After concurrence with the regulatory agencies that cleanup is complete, the soil vapor extraction wells and treatment systems will be decommissioned. Wells will be closed by *in situ* casing perforation and pressure grouting, or by well removal as appropriate, consistent with the approved LLNL Livermore Site and Site 300 Environmental Restoration Project Standard Operating Procedures (Goodrich and Wimborough, 2006).

5.3. Treatment System Operation and Maintenance

All treatment systems will be operated and maintained to ensure proper operation and compliance with discharge requirements. Operation and maintenance procedures and safety plans for soil vapor and ground water treatment facilities are contained in the following documents:

- Operations and Maintenance Manual, Volume I: Treatment Facility Quality Assurance and Documentation (LLNL, 2004).
- Operations and Maintenance Manual, Volume VI: Treatment Facility at Central General Services Area (Daily, 2004).
- Operations and Maintenance Manual, Volume VII: Treatment Facility at Eastern General Services Area (Martins, 2006).
- Operations and Maintenance Manual, Volume VIII: Treatment Facility at Building 830 (Martins, 2006).
- Operations and Maintenance Manual, Volume XII: Portable Treatment Units (Martins, 2006).
- Operations and Maintenance Manual Volume XIII: Miniature Treatment Units, Ground Water Treatment Units, and Solar Treatment Units (Martins, 2007).
- (Draft Operations and Maintenance Manual Volume XVI: Treatment System at the Pit 7 Complex (in preparation) (Daily and Gregory, 2009).
- Integration Work Sheet Safety Procedure #1341: Ground Water and Soil Vapor Treatment Facility Operations at Site 300.
- LLNL Livermore Site and Site 300 Environmental Restoration Project Standard Operating Procedures (Goodrich and Wimborough, 2006).
- Quality Assurance Project Plan, Livermore Site and Site 300 Environmental Restoration Projects (Dibley, 1999).

- Permit to Operate and Permit Unit Requirements issued by the San Joaquin Valley Unified Air Pollution Control District (2008).

6. Risk and Hazard Management Program

The goals of the Risk and Hazard Management Program, including institutional/land use controls, are to prevent exposure to contaminants, protect the integrity of the remedy, and ensure future property use is consistent with the current industrial land use.

Baseline risk assessments were included in the Site-Wide Remedial Investigation report for Site 300 (Webster-Scholten et al., 1994), an addendum to that report (Taffet et al., 1996), and the Remedial Investigation/Feasibility Study for the Pit 7 Complex assessment (Taffet et al., 2005) that identified potential exposure pathways for people, plants, and animals that must be addressed by the cleanup actions. The risks and hazards to human and receptors identified in the baseline risk assessment are summarized in Table 1-2. Hazards to ecological receptors are summarized in Table 1-3. These risks and hazards assumed no cleanup would take place.

In the context of this Risk and Hazard Management Program, the term "risk" is used to refer to carcinogenic health effects, and "hazard" is used to refer to non-carcinogenic (toxic) health effects as expressed by the hazard quotient or hazard index. The term "hazard" does not refer to physical hazards, such as construction-related injuries. For carcinogens, risk for humans is expressed as the probability of developing cancer over a lifetime. Risk and hazard management is a component of the selected remedies presented in the Site-Wide ROD.

Risk and hazard management is included as part of the remedy where the risk at any exposure point exceeds 1×10^{-6} or the hazard index is greater than 1, exclusive of ingesting contaminated ground water. Measures to prevent ingestion of ground water, as discussed in Section 6.1.5, are included in risk management wherever ground water contamination may adversely impact human health.

The Risk and Hazard Management Program to protect human health and the environment is described in Sections 6.1 and 6.2, respectively. Reporting requirements for the Risk and Hazard Management Program are described in Section 9. Modifications to the program will be documented in the semiannual Compliance Monitoring Reports.

6.1. Human Health Risk and Hazard Management

Risk and hazard management protects human health by restricting access to or activities in areas of elevated risk or hazard (institutional/land use controls), thereby preventing unacceptable exposure to contaminants. The institutional/land use controls are non-engineered actions or measures that will be used to manage risk and prevent exposure as part of the Risk and Hazard Management Program. Engineering controls will be implemented to mitigate exposure when institutional controls are not sufficient to manage exposure.

The baseline human health risk assessments evaluated two primary exposure scenarios. Both scenarios assumed that no soil or ground water remediation would be performed at Site 300. The adult onsite worker scenario assumed that Site 300 workers could be exposed to contaminants by:

1. Inhaling contaminants volatilizing from the subsurface into the atmosphere or into buildings.
2. Inhaling contaminants bound to resuspended surface soil.
3. Direct dermal contact with contaminated soil.
4. Incidental ingestion of contaminated soil.

A number of areas at Site 300 where unacceptable risk or hazard is present were identified. An onsite adult exposure scenario for a ground water ingestion pathway was not evaluated, because cleanup standards for ground water are based on the more stringent of Federal and State drinking water standards, not on risk. Workers at the site primarily consume bottled water and contamination has never been detected above drinking water standards in ground water from onsite water-supply Well 20.

The second scenario (offsite residential) assumed that members of the public living adjacent to Site 300 could potentially be exposed to contaminated ground water withdrawn from private offsite water-supply wells, but not to contaminated soil within the site boundary, or to resuspended particulates or volatilized contaminants transported through the atmosphere across the site boundary. In the baseline risk assessment, future impacts to ground water quality (assuming no remediation was performed at Site 300) were estimated at nearby private water-supply wells and at hypothetical water-supply wells that might be installed at the Site 300 boundary downgradient from onsite ground water contaminant plumes.

Fencing and a full-time security force prevent access to Site 300 by unauthorized members of the public, and only risk and hazard management measures that supplement these existing institutional controls are included in this CMP/CP. Site 300 building occupancy and site use restrictions are necessary only to prevent exposure of onsite workers. These restrictions are implemented and maintained by Site 300 management.

Sections 6.1.1 through 6.1.8 describe the specific measures that will be taken to manage human exposure to contaminants within Site 300 and the adjacent offsite area.

6.1.1. Inhalation of VOCs Volatilizing from the Subsurface to Indoor Ambient Air

In the baseline risk assessments, risk and hazard were calculated for volatile contaminants in the subsurface migrating upward through the floors of buildings into indoor ambient air and being inhaled by workers within the building. These assessments assumed that an onsite worker would spend 8 hours a day, 5 days a week, for 25 years within the buildings. An unacceptable risk or hazard was identified within seven buildings:

1. Building 834D – Cumulative risk 1 x 10^{-3}, hazard index 36, due to TCE and PCE.
2. Building 854A – Cumulative risk 6 x 10^{-6}, due to six VOCs. No VOCs were detected in past ambient air samples, and risk was calculated using detection limits.
3. Building 854F – Cumulative risk 9 x 10^{-6}, due to TCE, chloroform, and other VOCs.
4. Building 830 – Cumulative risk 2 x 10^{-6}, due to TCE and vinyl chloride.
5. Building 832F – Cumulative risk 3 x 10^{-6}, due to dichloropropane.
6. Building 833 – Cumulative risk 1 x 10^{-6}, due to TCE and chloroform.

7. Building 875 – Cumulative risk 1 x 10^{-5}, hazard index <1, due to multiple VOCs.

The 2002 CMP/CP required that the risk and hazard associated with volatile contaminants in the subsurface migrating upward into indoor ambient air and being inhaled by workers be re-evaluated annually using current data. The risk and hazard management is complete when the estimated risk is below 10^{-6} and the hazard index is below 1 for two consecutive years. The risk and hazard management is complete for the following buildings:

- Building 832F (confirmed by risk re-evaluations in 2003 and 2004, building demolished in 2005).
- Building 854F (building demolished in 2005).
- Building 854A (confirmed by risk re-evaluations in 2005 and 2006).
- Building 875.

Building 875 was not included in the 2002 CMP/CP, however, the risk was re-evaluated in 2000 and was below 10^{-6} (9.5 x 10^{-7}) (DOE, 2000 and Ferry, 2001b).

In 2007 and 2008, the risk evaluation for Building 833 for indoor ambient air showed cumulative excess cancer risk below 10^{-6} and a hazard quotient below 1. However, wells in the Building 833 area were dry in 2007, and as a result, risk was calculated using data collected during a previous year. Because 2007 data were not available, risk and hazard management will continue at Building 833 until the estimated risk has remained below 10^{-6} and the hazard quotient has remained below 1 using data collected during two consecutive years.

As of 2008, the following buildings continue to have risk and/or hazard above acceptable levels:

- Building 834D – Cumulative risk 5 x 10^{-5}, hazard index below 1, due to TCE and PCE.
- Building 830 – Cumulative risk 3 x 10^{-6}, hazard index below 1, due to TCE and vinyl chloride.

Table 6-1 presents the current risk and hazard for these buildings. There are no workers occupying Buildings 834D and 830 and building occupancy restrictions are in effect. Engineering controls are in place at Building 833. These institutional and engineering controls will remain in pace until risk is reduced to acceptable levels. Table 6-1 presents the current risk and hazard for these buildings.

To prevent exposure inside the three buildings, risk and hazard management measures will continue to be implemented using the following process, also shown on Figure 6-1:

1. Inhalation risk and hazard resulting from transport of VOC vapors from ground water to the building foundations and subsequently into indoor ambient air will be estimated using the Johnson-Ettinger Model (U.S. EPA, 2002). The model results will be updated to reflect the chemical-specific toxicity criteria referenced in the "Interim Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air" (DTSC, 2005). The modeling will be performed annually.
2. If the estimated risk is below 10^{-6} and the hazard index is below 1, maintain the building occupancy restrictions at Buildings 834D and 830, and engineering controls at Building 833 and continue annual modeling and risk estimation. If the estimated risk

remains below 10^{-6} and the hazard index remains below 1 for two years, risk and hazard management is complete for the building.

3. If the estimated risk exceeds 10^{-6} or the hazard index exceeds 1, annually review the building occupancy conditions. If workers do not occupy or plan to occupy the building in the near future, maintain the building occupancy restrictions and continue the annual modeling and risk estimation.

4. If the estimated risk is above 10^{-6} or the hazard index exceeds 1 and the building is occupied or occupation is planned, maintain or implement engineering controls such as installing a building ventilation system or requiring personal protective equipment within the building. Continue the annual modeling and risk estimation.

6.1.2. Inhalation of VOCs Volatilizing from the Subsurface to Outdoor Ambient Air

In the baseline risk assessments, risk and hazard were calculated for volatile contaminants in the subsurface migrating upward into outdoor ambient air and being inhaled by onsite workers. This assessment assumed a worker would spend 8 hours a day, 5 days a week, for 25 years working in these areas. An unacceptable risk or hazard was identified at six locations:

1. Building 834D – Cumulative risk 6×10^{-4}, hazard index 22, due to TCE and PCE.
2. Building 815 – Cumulative risk 5×10^{-6}, due to TCE and PCE.
3. Building 854F – Cumulative risk 1×10^{-5}, due to chloroform and 1,2-dichloroethane (DCA).
4. Building 830 – Cumulative risk 1×10^{-5}, due to chloroform, 1,2-DCA, and vinyl chloride.
5. Pit 6 Landfill – Cumulative risk 5×10^{-6}, due to multiple VOCs.
6. Pit 3 Landfill – Cumulative risk 4×10^{-6}, due to tritium.

The 2002 CMP/CP required that the risk and hazard associated with volatile contaminants in the subsurface migrating upward into outdoor ambient air and being inhaled by workers be re-evaluated annually using current data. The risk and hazard management is complete when the estimated risk is below 10^{-6} and the hazard index is below 1 for two consecutive years. The risk and hazard management is complete for the following locations:

- Building 834D (confirmed by risk re-evaluations in 2003 and 2004).
- Building 815 (confirmed by risk re-evaluations in 2003 and 2004).
- Building 854F (confirmed by risk re-evaluations in 2003 and 2004).
- Building 830 (confirmed by risk re-evaluations in 2003 and 2004).
- Pit 6 Landfill (discussed below).
- Pit 3 Landfill (discussed below).

Pit 6 and Pit 3 were not re-evaluated as part of the 2002 CMP/CP Risk and Hazard Management Program. Although an unacceptable risk was identified in the baseline risk assessment for the Pit 6 Landfill, an engineered cap was later placed over the Pit 6 Landfill in

1997 that includes an impermeable geomembrane layer covering the entire landfill area that prevents VOC vapors from reaching outdoor ambient air where workers could be exposed. Therefore, no further risk management measures are needed to prevent inhalation of VOCs at the Pit 6 Landfill.

A risk re-evaluation was performed for the Pit 3 Landfill as part of the Remedial Design (Taffet et al, 2008). The current estimated risk is below 10^{-6} based on tritium decay that occurred between 1992 and 2007. Therefore, no further risk management measures are needed to prevent inhalation of tritium at the Pit 3 Landfill.

Because unacceptable risks or hazards from volatile contaminants in the subsurface migrating upward into outdoor ambient air and being inhaled by onsite workers have been mitigated, risk and hazard management measures are no longer required for this potential exposure pathway.

6.1.3. Inhalation of COCs Volatilizing from Surface Water to Outdoor Ambient Air

In the baseline risk assessment, risk and hazard were calculated for contaminants in surface water volatilizing into the atmosphere and being inhaled by onsite workers. This assessment assumed an onsite worker would spend 8 hours a day, 5 days a week, for 25 years working near the contaminated surface water.

An unacceptable risk or hazard was identified for the inhalation of VOCs at four locations:

1. Spring 3 (Building 832 Canyon) – Cumulative risk 7 x 10^{-5}, hazard index 2.3 due to TCE and PCE.
2. Spring 5 (High Explosives Process Area) – Cumulative risk 1 x 10^{-5}, due to 1,1-dichloroethene (DCE) and TCE.
3. Spring 7 (southeast of the Pit 6 Landfill) – Cumulative risk 4 x 10^{-5}, hazard index 1.5 due to TCE, PCE 1,2-DCA, and chloroform.
4. The Carnegie State Vehicular Recreation Area pond (east of the Pit 6 Landfill) – Cumulative risk 3 x 10^{-6} (hypothetical), due to TCE.

The 2002 CMP/CP required that the risk and hazard associated with volatile contaminants in surface water volatilizing into outdoor ambient air and being inhaled by workers be re-evaluated annually using ambient air sampling data when surface water is present. The risk and hazard management is complete when the estimated risk is below 10^{-6} and the hazard index is below 1 for two consecutive years.

The ambient air above Spring 3 was sampled and the risk was re-evaluated in 2003. VOCs were detected above their respective Preliminary Remediation Goals (PRGs). The annual risk re-evaluation was not conducted in 2004 through 2006 due to lack of water. Ambient air samples were collected in 2007 and 2008 since water was present. TCE was detected in air samples above the ambient air PRG in 2007. In May 2008, PRGs were replaced with Regional Screening Levels for Chemical Contaminants at Superfund Sites. In 2008 ambient air sampling results were compared to the Industrial Air Screening Levels. All contaminant concentrations were below their respective screening levels. No workers inhabit the area around Spring 3 except during semiannual sampling. Risk and hazard management will continue as described below.

Spring 5 has been dry since 2003, therefore the risk could not be re-evaluated. The original risk was due to detections of TCE and 1,1-DCE in well W-817-03A located adjacent to Spring 5, since the actual flow in the spring is generally too low to measure and the spring consists primarily of moist soil with wetland vegetation. VOC concentrations in the ground water that feeds the spring have decreased from 150 µg/L in 1987 to 46 µg/L in 2007. Therefore, the cancer risk estimated in the baseline risk assessment has decreased correspondingly. In addition, more than half of the estimated risk resulted from the presence of 1,1-DCE that was detected once in 1987 in ground water sampled from well W-817-03A. There are no site employees that regularly work in the vicinity of Spring 5. However, because there has been insufficient water in this spring to quantify risk reduction, risk and hazard management will continue as described below.

Spring 7 has been dry since 2003, therefore the risk could not be re-evaluated. This spring flows at the ground surface only during extremely wet years. The original risk was due to detections of TCE, PCE, 1,2-DCA, and chloroform in the spring water. Chloroform and 1,2-DCA are no longer detected in Pit 6 Landfill OU ground water and TCE and PCE are below or near their respective Maximum Contaminant Levels (MCLs). In addition, there are no site employees that regularly work in the vicinity of Spring 7. However, because there has been insufficient water in this spring to quantify risk reduction for two consecutive years, risk and hazard management will continue as described below.

Water-supply well CARNRW-2 is used to fill the Carnegie State Vehicular Recreation Area pond. The baseline risk assessment indicated that if the VOC source in the Pit 6 Landfill OU was not controlled, contaminated ground water could migrate to well CARNRW-2 and result in an unacceptable risk from inhaling VOC vapors volatilizing from the pond. While low concentrations of trihalomethanes (e.g., chloroform) have been sporadically detected in well CARNRW-2, these constituents are likely due to backflow of chlorinated water from the Carnegie State Vehicular Recreation area treatment of well water. An engineered cap was later placed over the Pit 6 Landfill that included an impermeable geomembrane layer that prevents infiltration of precipitation and further releases of contaminants from the landfill. Section 10 describes the steps if VOCs are detected in the upgradient guard wells (described in Section 3.1) or in well CARNRW-2. To prevent exposure, risk and hazard management measures will continue to be implemented for Springs 3, 5, and 7 using the following process, also shown on Figure 6-2:

1. Collect annual samples of outdoor ambient air above contaminated surface water (when surface water is present) to determine VOC concentrations. Air sampling will be conducted using the SUMMA™ canister sampling methodology outlined in "Estimation of Baseline Air Emissions at Superfund Sites" (U.S. EPA, 1990a, 1990b), the "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air" (U.S. EPA, 1999a), and LLNL Standard Operating Procedure (SOP) 1.11 (Goodrich and Wimborough, 2006). The SUMMA™ canister samples will be collected in triplicate and analyzed for the VOCs listed in Table 6-2 using U.S. EPA Method TO-15 with a reporting limit of 0.5 parts per billion by volume. Samples will be collected at a height of approximately 2 ft above the spring surface to simulate worker exposure conditions. A time-integrated sample will be collected over an 8-hour time period.

2. Compare the measured VOC concentrations to the Regional Screening Levels for Chemical Contaminants at Superfund Sites for Industrial Air (Table 6-2). If the concentrations are below the screening levels maintain site use restrictions and continue the annual sampling. If the concentrations remain below the screening levels for two years, risk and hazard management is complete for the site.
3. If concentrations exceed the screening levels, annually review the local site use conditions. If workers do not occupy or plan to occupy the site in the near future, maintain the site use restrictions and continue the annual sampling. If workers occupy or plan to occupy the site in the near future, recalculate the risk and hazard based on projected actual exposure.
4. If the recalculated risk is below 10^{-6} and the hazard index is below 1, continue the annual sampling. If the risk remains below 10^{-6} and the hazard index remains below 1 for two years, risk and hazard management is complete for the site. If risk and hazard have not been below these standards for two years, continue the annual sampling.
5. If the recalculated risk is above 10^{-6} or the hazard index exceeds 1 and the site is occupied or occupation is planned, implement engineering controls such as ground water extraction or requiring personal protective equipment while in the area. Continue the annual sampling.

An unacceptable cumulative risk of 1 x 10^{-3} was identified for the inhalation of tritium at Well 8 Spring in the Building 850 area. The risk associated with the inhalation of tritium vapors volatilizing from Well 8 Spring is based on the maximum tritium activity detected (770,000 pCi/L in 1972. The tritium activities in Well 8 Spring have steadily declined over the decades. The 2007 maximum tritium activity detected in Well 8 Spring was 15,200 pCi/L. The 2002 CMP/CP did not present risk and hazard management processes to re-evaluate the risk associated with tritium in Well 8 Spring. Henceforth, the risk associated with tritium in surface water volatilizing into outdoor ambient air and being inhaled by workers will be re-evaluated annually when surface water is present. The surface water will be sampled and analyzed for tritium semi-annually. The maximum activity will be compared to the current tritium vapor PRG for tap water. If the activity exceeds the PRG, the local site use conditions will be reviewed. If workers do not occupy or plan to occupy the site in the near future, the site use restrictions will be maintained and the annual sampling continued. If workers occupy or plan to occupy the site in the near future, the risk based on projected actual exposure will be recalculated. If the recalculated risk is above 10^{-6} or the hazard index exceeds 1, engineering controls will be implemented to prevent exposure for workers occupying the area. If the activity is below the PRG, land use restrictions will be maintained and the annual sampling continued. If the activity remains below the PRG for two years, risk and hazard management is complete for the site. This process is summarized on Figure 6-2.

6.1.4. Inhalation, Ingestion, and Dermal Contact with Contaminants in Surface Soil

In the baseline risk assessment, risk and hazard were calculated for inhalation of resuspended particulates, incidental ingestion of surface soil, and direct dermal contact with contaminated surface soil. These estimates assumed an onsite worker would spend 8 hours a day, 5 days a week, for 25 years working near the contamination. An unacceptable risk was identified at two locations:

1. Building 850 – Cumulative risk 6 x 10^{-4}, due to PCBs, dioxins, and furans.
2. Building 855 (within the Building 854 OU) – Cumulative risk 7 x 10^{-5}, due to PCBs.

The surface soil sampling, analysis, and PRG comparison plan presented in the 2002 CMP/CP were performed for these two areas. The risk and hazard were above acceptable levels, therefore the plan called for implementation of engineering controls and excavation of the soil.

In 2005, PCB-, dioxin-, and furan-contaminated surface and shallow subsurface soil from the former Building 855 lagoon in the Building 854 OU was excavated and disposed, mitigating the unacceptable cancer risk for onsite workers (Holtzapple, 2005). Because the soil was cleaned up using industrial soil PRGs, the risk and hazard management measures described in Section 6.1.6 (land use restrictions) apply to this area.

The excavation and remediation of the Building 850 soil is scheduled for 2009. The Building 850 area is not currently occupied on a full-time basis, and local site use restrictions are in effect. Because the soil will be cleaned up to industrial soil PRGs, the risk and hazard management measures described in Section 6.1.6 (land use restrictions) will apply to this area.

6.1.5. Ingestion of Contaminants in Ground Water

The following sections address the potential ingestion of ground water from onsite and offsite water-supply wells. The locations of these wells are shown on Figure 1-3.

6.1.5.1. Potential Onsite Receptors

Onsite water-supply Well 20 is currently used to supply water to workers at Site 300 and is monitored regularly. No contamination has been detected above drinking water standards in ground water from onsite water-supply Well 20. LLNL plans to connect to the Hetch-Hetchy water-supply system in the near future and no additional water-supply wells are planned for Site 300. All other water-supply wells at Site 300 are used only as backup wells for fire suppression, or have been sealed and abandoned.

6.1.5.2. Potential Offsite Receptors

In the baseline risk assessment, risk and hazard were calculated for ingestion of ground water over a 30-year period from a hypothetical (i.e., not currently existing or planned) offsite well located at the Site 300 boundary. An unacceptable risk was identified at two locations:

1. GSA – Cumulative risk 7 x 10^{-2}, hazard index 560.
2. HE Process Area – Cumulative risk 1 x 10^{-5}.

DOE's planned actions if any offsite property owner proposes to install a water-supply well downgradient of a contaminant plume are discussed in the Contingency Plan (Section 10).

6.1.6. Institutional/Land Use Controls

The institutional/land use controls are non-engineered actions or measures that are used to manage risk and prevent exposure as part of the risk and hazard management program. The general types of institutional/land use controls that are used to prevent human exposure to contamination include:

- Access controls – Measures such as fences, signs, and security forces that are used to prevent exposure by controlling and/or restricting access to areas of contamination.
- Administrative controls – Measures such as pre-construction review and controls for limiting or restricting access to contaminated areas and prohibitions on water-supply well drilling.

Institutional/land use controls are a component of the Risk and Hazard Management Program applicable to all OUs included in this CMP/CP. Tables 6-3 through 6-11 present a description of: (1) the institutional/land use control objective and duration, (2) the risk necessitating land use controls, and (3) the specific institutional/land use controls and implementation mechanisms used to prevent exposure to contamination. These institutional/land use controls were selected as part of the cleanup remedies in the Site-Wide ROD (DOE, 2008). Figures 6-3 through 6-13 show the OUs at Site 300 where the institutional/land use controls will be implemented and maintained.

Administrative controls are the basis of most risk management measures, i.e., measures to prevent people from drinking contaminated ground water. DOE/LLNL will implement these measures to ensure that the selected remedies protect human health and the environment.

To ensure that human health is protected, access to Site 300 will continue to be restricted and all personnel working onsite will be briefed on areas of contamination and possible hazards. Site 300 is enclosed within a security fence, posted with signs noting the restricted access, and manned by a full-time security force to prevent unauthorized intrusion.

No excavation shall occur within areas of contamination or at landfills except for approved remedial actions. Activities in landfill areas will be restricted to those that will not expose landfill material or compromise the integrity and protectiveness of landfill caps. No activity inconsistent with this use restriction may commence without the prior written concurrence of the FFA signatories. DOE will ensure inspection and maintenance of the Pits 2, 3, 4, 5, 6, 7, 8, and 9 landfill caps and ground water monitoring system as specified in the appropriate post-closure plan or this CMP/CP.

Site 300 Management must approve building use changes. Site 300 Management will notify the LLNL Hazards Control and Environmental Restoration Departments of any proposed changes to building occupancy or local site use in areas of unacceptable risk. Warning signs are posted in all areas and buildings where an unacceptable risk or hazard has been identified, stating that permanent occupancy of the facility (or area) on a full-time basis must be approved by the LLNL Hazards Control Department. If full-time use is required, the LLNL Environmental Restoration Department will work with the program requesting the change in building occupancy or site use to implement the appropriate engineering controls necessary to prevent unacceptable worker exposure to contaminants. Building use changes are discussed further in Section 11. Engineering controls are discussed in Section 6.1.7. The EPA, RWQCB, and DTSC will be notified if internal procedures change and affect land use controls.

In addition, DOE will work with LLNL Site 300 Management to incorporate these institutional/land use controls into the Site 300 Integrated Strategic Plan or other appropriate institutional planning documents. The EPA Land Use Control Implementation Plan Checklist is presented in Appendix B.

Inspection of institutional controls will be conducted annually using the checklist presented in Appendix B. Maintenance will be conducted as necessary based on the results of the institutional controls monitoring and reported per the requirements discussed in Section 9. Any activity that is inconsistent with the institutional control objectives or use restrictions, or any other action that may interfere with the effectiveness of the institutional control will be addressed by DOE as soon as practicable, DOE will notify EPA, RWQCB, and DTSC as soon as practicable but no longer than ten days after discovery of any activity that is inconsistent with the institutional control objectives or use restrictions, or any other action that may interfere with the effectiveness of the institutional control. DOE will notify EPA, RWQCB, and DTSC regarding how DOE has addressed or will address the issue within 10 days of sending EPA, RWQCB, and DTSC the initial notification.

DOE shall not modify or terminate land use controls, implementation actions, or modify land use without approval by EPA, RWQCB, and DTSC. DOE shall seek prior concurrence before any anticipated action that may disrupt the effectiveness of the land use controls or any action that may alter or negate the need for land use controls.

It is assumed that Site 300 will remain under the control of DOE and that the access restrictions to the site (fencing, security patrols) currently in place will continue. All remedies would be re-evaluated if transfer of ownership or change in land use is anticipated. DOE will meet its commitments in the Site 300 FFA, Sections 28 (Transfer of Real Property) and 37 (Facility Closure), regarding its cleanup obligations if property ownership and/or land use changes in the future. Future property use at those areas identified to have baseline cancer risks greater than 10^{-6} or non-carcinogenic hazard indices greater than 1 will be restricted to the current industrial land use, remediation activities, and surface storage of equipment or material, until such time as new risk assessments show the risk and hazard have fallen below those thresholds. Property transfer and land use changes are discussed further in Section 10.

6.1.7. Engineering Controls

Under some circumstances, full-time building occupancy or local site use may be required in areas where and unacceptable risk or hazard has been identified. In these cases, engineering controls will be implemented to prevent unacceptable worker exposure to contaminants.

Engineering controls may include installing a building ventilation system, paving an area to minimize volatilization of contaminants into the atmosphere, or requiring personal protective equipment while in the area. If construction or other temporary ground-disturbing activities become necessary in areas of soil contamination, controls such as wetting the soil to prevent resuspension of soil particles or the use of personal protective equipment will be implemented.

6.1.8. Changes to Risk and Hazard Estimates

DOE will notify the regulatory agencies of any changes to risk and hazard estimates through the semiannual Compliance Monitoring Reports described in Section 9. This notification will include any proposed response action necessary to provide adequately protect workers (e.g., implementing engineering controls or increasing access restrictions). The regulatory agencies will also be notified of any relaxation in access restrictions or discontinuation of engineering controls in response to a decrease in risk or hazard levels.

The LLNL Environmental Restoration Department will also notify Site 300 Management and the LLNL Hazards Control of changes to risk or hazard levels that require changes to institutional or engineering controls.

6.2. Ecological Risk and Hazard Management

Ecological risk and hazard management measures are developed to meet the Remedial Action Objectives for environmental protection. These objectives are to:

1. Ensure ecological receptors important at the individual level of ecological organization (special-status species, i.e., State of California or federally-listed threatened or endangered species or State of California species of special concern) do not reside in areas where relevant hazard indices exceed 1.
2. Ensure changes in contaminant conditions do not threaten wildlife populations and vegetation communities.

Section 6.2.1 updates the ecological risk and hazard management process for receptors important on an individual level for contaminants of ecological concern identified in the 2002 CMP. Section 6.2.2 describes how the results of the re-evaluation of contaminant and ecological conditions at Site 300 conducted since the 2002 CMP/CP are integrated into the ecological risk management process. Section 6.2.3 describes the ecological risk and hazard management process to address future changes in contaminant and ecological conditions.

6.2.1. Ecological Risk and Hazard Management Process Update for Previously Identified Hazards

In the 2002 CMP, ecological risk and hazard management measures and processes were developed to protect receptors important on an individual level from exposure:

- Through the inhalation of VOCs in subsurface burrow air at Building 834 and the Pit 6 Landfill, and
- From the ingestion and inhalation of cadmium in surface soil at Buildings 834 and 850; PCBs in surface soil in the Building 854 area; and PCBs, dioxins, and furans in surface soil in the Building 850 area.

The results of the risk and hazard management process conducted for these ecological exposure pathways and contaminants are summarized in Table 3-1 and are described in Sections 6.2.1.1 (VOCs in subsurface burrow air) and 6.2.1.2 (cadmium, PCBs, dioxins, and/or furans in surface soil). Table 1-3 also contains a summary of the baseline ecological risk assessment results.

6.2.1.1. Inhalation of VOCs in Subsurface Burrow Air

In the baseline ecological assessment included in the Site-Wide Remedial Investigation (SWRI) report (Webster-Scholten, 1994), hazard (defined as a hazard index greater than 1) was identified for ground squirrel and kit fox associated with the inhalation of VOCs in burrow air in the Building 834 and Pit 6 Landfill areas (Table 3-1). In the baseline assessment, kit fox (a State and Federal endangered species) was used as a representative important (species important and the individual level) fossorial (burrowing) vertebrate species. This estimate of hazard was based on conservative modeling assumptions. As required by the 2002 CMP, a burrow air-sampling program was undertaken to further define the hazard associated with VOCs in burrow air.

The CMP–required burrow air sampling for the presence of VOCs in the Pit 6 Landfill and Building 834 survey areas was completed in 2004 and reported in the First Semester 2004 CMR (Dibley et al., 2004b). The results indicated that burrow air did not contain VOCs at concentrations that would result in a hazard quotient (HQ) greater than 1. Since there is no potential for ecological harm, VOCs in burrow air have been deleted from the list of ecological contaminants of concern and will no longer be included in the Ecological Risk and Hazard Management Program.

6.2.1.2. Ingestion and Inhalation of Cadmium, PCBs, Dioxins, and Furans in Surface Soil

In the baseline ecological assessment, hazard, defined as a hazard index greater than 1, was associated with the ingestion of cadmium at several areas at Site 300; PCBs in the Building 854 area; and PCBs, dioxins, and furans in the Building 850 area (Table 3-1). Hazard was identified for ground squirrel, deer, and kit fox. In the baseline assessment, kit fox were used as a representative important fossorial vertebrate species. Ecological risk and hazard management measures were developed to ensure individuals of important fossorial vertebrate species do not reside in portions of Site 300 associated with a hazard index greater than 1 for kit fox (Buildings 834 and 850). While a hazard associated with cadmium in soil was also identified for ground squirrels and deer at Buildings 801, 834, 850, and 851, and the HE Process Area, wildlife surveys found no impacts to the squirrel or deer populations. In 2003, an exposure analysis was conducted to estimate hazard for cadmium, PCBs, dioxins, and furans in surface soil to burrowing owls in the Building 850 area, because surveys conducted subsequent to the baseline risk assessment indicated the periodic presence of this species of concern in the area. For PCBs, dioxins, and furans in surface soil, a hazard index greater than 1 was identified for burrowing owls. The hazard assessment for cadmium in surface soil indicated that this metal was unlikely to pose a hazard to burrowing owls nesting in this area.

Cadmium: The estimate of ecological hazard from cadmium in the Building 834 area was based on extremely limited soil data. Therefore, as required by the 2002 CMP, additional soil sampling for cadmium was conducted in the Building 834 area to further refine the estimate of hazard. The CMP-required surface soil sampling and analysis for the presence of cadmium conducted in the Building 834 survey area was reported in the 2003 Annual CMR (Dibley et al., 2004a). The results indicated no potential for ecological hazard from cadmium in surface soil, therefore cadmium at Building 834 has been deleted from the list of ecological contaminants of concern and will no longer be included in the Ecological Risk and Hazard Management Program.

Because no special-status species were identified and deer and squirrel populations were not impacted, additional sampling and analysis of cadmium in surface soil was not conducted at Buildings 801 or 851, or in the HE Process Area. Available biological survey data are periodically evaluated to identify changes in the abundance of these species over time that could indicate impacts to the populations.

Although no impacts to special-status species were identified and deer and squirrel populations were not impacted, a re-evaluation of the hazard associated with cadmium in surface soil at Buildings 801 or 851, or in the HE Process Area will be conducted to determine if continuation of risk and hazard management measures are necessary. Therefore, the following process will be conducted in these areas:

- Collect surface soil samples from the HE Process Area, and Buildings 801 and 851 areas for cadmium analyses. The sampling areas will be selected based on the results of previous cadmium surface soil samples collected in these areas.
- Compare surface soil samples results against EPA's Ecological Soil Screening Levels for cadmium.
- If cadmium concentrations are below Ecological Soil Screening Levels, risk and hazard management measures will be discontinued.
- If cadmium concentrations exceed Ecological Soil Screening Levels, the concentration data will be integrated into hazard index calculations to determine the current hazard posed by cadmium in surface soil. Hazard indices will be calculated for any important (e.g., special-status) species located in these areas, and for ground squirrels and deer.
- Should the actual exposure be significant, modifications to the ecological risk and hazard management process will be made as necessary. If the actual exposure is not significant, the risk management process is complete for the species in the specific area. The remaining risk management process will be revised as appropriate.

PCBs, Dioxins, and Furans: Evaluation of the ecological significance of the results of surface soil sampling for the presence of PCBs at Building 854 and PCBs, dioxins, and furans at Building 850 was conducted and reported in the First Semester 2004 CMR. The results of this evaluation showed amphibians to be potentially at risk at Building 854 and burrowing owls at Building 850 to be potentially at risk from the presence of PCBs in surface soil. As discussed in the First Semester 2005 CMR (Dibley, 2005b), the contaminated soil at Building 854 was removed in July 2005, effectively eliminating the ecological hazard. The excavation and remediation of PCB-, dioxin-, and furan-contaminated soil at Building 850 is underway that will effectively eliminate the ecological hazard in this area. Since these remedial actions have mitigated the potential for ecological harm, surveys for important burrowing species in these areas will no longer be included in the Ecological Risk and Hazard Management Program.

6.2.2. Integration of Ecological Risk Re-evaluation into the Risk Management Process

This section describes how the results of the re-evaluation of contaminant and ecological conditions at Site 300 conducted since the 2002 CMP/CP were integrated into the ecological risk management process.

DOE re-evaluated contaminant and ecological conditions at Site 300 to determine if contaminant or ecological conditions have changed sufficiently to warrant re-evaluation of the conclusions reached in the baseline ecological risk assessment. As part of this process, new analytical data for ecologically relevant media (surface water and soil to a depth of 6 ft) were examined for the presence of previously undetected contaminants. Hazard indices were calculated for any chemical that the literature suggests is ecologically significant. For those chemicals historically present at Site 300, maximum concentrations detected with the re-evaluation period were compared to historical maxima. Hazard indices were recalculated for contaminants whose current maxima exceed the historical maxima by 50%. To evaluate changes in ecological conditions at Site 300, all available ecological survey results for Site 300 obtained over the re-evaluation period were reviewed (e.g., pre-construction survey data, biological monitoring data, surveys conducted for Environmental Impact Report/Environmental Impact Statement [EIR/EIS] preparation), noting the presence of any new important species and any changes in the presence and abundance of species over time. If the newly identified special-status species or suitable habitat was present in an OU for which there was a viable pathway by which these species could be exposed to contamination, the species was included in the re-evaluation of ecological risk. The results of the re-evaluation of contaminant and ecological conditions at Site 300 was presented in the 2008 Annual LLNL Site 300 Compliance Monitoring Report. Table 6-12 summarizes new ecological hazards that were identified as a result of this re-evaluation.

Hazard indices greater than one were identified for the ingestion of uranium-238 in the Building 850 sandpile by ground squirrels, burrowing owls, and kit fox at Building 850. Excavation and remediation of the sandpile is currently underway as part of the Building 850 Soil Removal Action, thereby mitigating this ecological risk.

Since the SWFS, borings were taken and samples of pit waste were collected from the Pit 3 and 5 landfills. Samples collected from the Pit 3 and 5 landfills contained uranium-234, -235, and -238 at activities that posed a hazard greater than one if ingested by ground squirrels, burrowing owls, and kit fox. While this area represents potential habitat for burrowing owls and kit fox, neither species has been observed in this area. As part of the inspection and maintenance program for the Pit 7 Complex, the landfills are inspected and any burrows or holes in the cover are filled to prevent animals from unacceptable exposure to the pit waste.

No new ecological hazards were identified that required risk and hazard management measures in any other OU as a result of this review of current ecological and contaminant conditions.

6.2.3. Evaluating Future Changes in Contaminant and Ecological Conditions

To ensure changes in contaminant conditions do not threaten wildlife populations and vegetation communities, DOE will evaluate changes in existing contaminant and ecological conditions in OUs 1 through 8 every five years. The purpose of these evaluations is to determine if contaminant or ecological conditions have changed sufficiently to warrant re-evaluating the conclusions reached in the baseline ecological risk assessment.

For COCs historically present in ecologically relevant media (surface water, surface soil and subsurface soil to a depth of 6 ft), the maximum concentrations detected within the five-year evaluation period will be compared to historical maxima. Because the Site 300 environmental restoration project is now in the post-remedial investigation and buildout stage, this data will be primarily limited to surface water in springs as this is the only ecologically relevant media that will continue to be monitored on a regular ongoing basis. However, the data for any new surface soil or subsurface soil samples (to a depth of 6 ft) collected during the five-year period will be evaluated.

The hazard index for the inhalation of VOCs in burrow air will be calculated in the event that ground water VOC concentrations increase to levels that previously posed a risk to burrowing animals.

Hazard indices will be recalculated for COCs whose current maxima exceed either: (1) the historical maxima by 50%, or (2) the concentrations used in the most recent hazard re-evaluation, for ecological receptors identified for a specific OU. COCs with hazard indices greater than one will be added to the ecological risk and hazard management process. In addition, any biological survey data collected in OUs 1 through 8 over the five year evaluation period (e.g., pre-construction survey data, biological monitoring data, surveys conducted for EIR/EIS preparation) will be evaluated for changes in the presence and abundance of species for which a hazard has been identified over time. Any significant changes will be considered in evaluating necessary changes to the ecological risk and hazard management process.

The results of the evaluations of existing contaminant and ecological conditions in OUs 1 through 8 will be reported in the first annual Compliance Monitoring Report prepared after the evaluation period ends. In consultation with the regulatory agencies, modifications to the ecological risk and hazard management process will be made as necessary after considering the results of the contaminant and ecological condition reviews.

If concentrations of COCs in ecologically relevant environmental media do not exceed the historical maxima by 50% or the concentrations used in the most recent hazard re-evaluation for two consecutive five-year re-evaluation periods, the re-evaluation of contaminant and ecological conditions will be discontinued. The process to address new contaminants in ecologically relevant media and new ecological receptors is discussed in Sections 10.1.4 of the Contingency Plan.

7. Data Management Program

This section describes the systems used to manage environmental data collected during site remediation and monitoring activities at Site 300.

7.1. Overview

The LLNL Environmental Restoration Department uses the Taurus Environmental Information Management System (TEIMS) database to serve sample planning, chain-of-custody tracking, data storage and retrieval needs. TEIMS contains sample tracking, sample location, media, geological information, and analytical results. The database is maintained on a Solaris server with Oracle relational database software.

The flow of data, both hard copy and electronic, follows a process that tracks information from the sampling plan through storage to archiving. The data management process includes chain-of-custody tracking, analytical result receipt, quality control procedures, data presentation, and electronic use of data in decision support tools, such as risk assessment and compliance monitoring. The use of this system promotes and provides a consistent data set of known quality. Quality assurance and quality control are performed uniformly on all data.

7.2. Structure and Flow

A sampling and analysis plan is developed prior to data collection to establish the sampling method, frequency, type, location, and requested analyses. The plan is entered into the Sample Planning and Chain-of-Custody Tracking (SPACT) application and the sampling events are scheduled. Sampling technicians print out electronic chains-of-custody forms and sample container labels. Field logbooks and chain-of-custody forms confirm that the collection of the samples and the requested analyses are consistent with this plan. A unique document control number is assigned to each sample. A controlled system of field logbook labels permits electronic tracking of an environmental sample from field collection through receipt of the analytical result. The flow of data is managed using SPACT. The important fields in each SPACT record are the chain-of-custody number, document control number, sample location, sampling date, analytical laboratory, analytical laboratory log number, and the analyses requested. SPACT also tracks invoice information. SPACT records are updated upon receipt of official printed analytical results and invoices. A data record is marked complete only when all analytical results have been received.

Analytical results are also stored in the relational database. These tables are accessed by the Sample and Analysis application and contain fields identical to those in SPACT. Additional information is included for each analysis that describes the requester, project, sample media, sample type, units, error, detection limit, dilution factor, dates of extraction and analysis, analytical results, and comments. Data sources for these tables include analytical hardcopy reports, geologic borehole logs, surveyor reports, and field and laboratory measurements. Other types of data stored include descriptive sample information, such as coordinates, elevations, lithology, and screened intervals of monitoring wells, as well as measurements and analytical information, including physical and chemical parameters, media identification, and ground water elevation measurements.

Data verification and validation are achieved through a combination of methods. Computerized verifications check data for duplication, empty fields, and reported results that are inconsistent with reported detection limits. Data are also thoroughly checked manually before being formally added to the database. Electronically delivered laboratory data are groomed by filling in empty fields and ensuring consistency in format. Random audits are conducted to compare electronically delivered results against official printed results. Analytical results in the database are reviewed and validated by a qualified LLNL Environmental Restoration Department chemist and a quality assurance specialist.

The database also stores all quality control data reported from the analytical laboratories for each batch of samples. These data include laboratory control standard recovery, matrix spike and matrix duplicate relative percent difference, duplicate relative percent difference, and method blank results. These data are used to validate analytical results.

The database also contains fields dedicated to internal quality control. These fields include flags indicating analytical result qualification and data quality level. The result qualifier flags show dilution factors greater than one, compound detection in method blanks, or other quality control information. Data quality levels can range from screening-level field analyses to U.S. EPA approved methods performed by a certified analytical laboratory.

8. Quality Assurance/Quality Control Program

A Quality Assurance Project Plan (QAPP) (Dibley, 1999) has been implemented for the Site 300 environmental restoration project that contains the framework and requirements for planning, performing, documenting, and verifying the quality of activities and data. The QAPP was prepared for CERCLA compliance and ensures that the precision, accuracy, completeness, and representativeness of project data are known and are of acceptable quality. The QAPP was prepared following U.S. EPA guidance and specifications (U.S. EPA, 1980; 1987; 1994a, b; 1997a) and approved by the regulatory agencies. The QAPP is used in conjunction with the LLNL Environmental Restoration Department Standard Operating Procedures (SOPs), Site Safety Plans, work plans, Operations and Maintenance Manuals, and Integrated Work Sheets (IWS). SOPs have been established for all aspects of well drilling and logging, soil and water sampling, hydraulic testing, quality control procedures, and data management (Goodrich and Wimborough, 2006). Current LLNL Environmental Restoration Department SOPs are listed in Table 8-1.

9. Reporting

9.1. Compliance Monitoring Reports

Formal compliance monitoring reports will be submitted to the regulatory agencies semiannually no later than the last day of the third month following the reporting period. The following elements will be included in the compliance monitoring reports:

1. Ground and Surface Water Monitoring Program
   - Contaminant concentration and distribution summary.
   - Summary of remediation progress.
   - Remedy performance issues.
   - Sampling and analysis plans, including the identification of monitor well designations and any modifications from previous plans.
   - Evaluation of guard well selection, analytes, and sampling frequency (annual).
   - Analytical and ground water elevation data collected during the semester (annually).
   - Isoconcentration maps (annual, but maps for some areas may be generated semiannually upon the request of the regulatory agencies).
   - Potentiometric surface elevation contour maps (annual, but maps for some areas may be generated semiannually upon the request of the regulatory agencies).
2. Detection Monitoring, Inspection, and Maintenance Program for the Pit 2, 3, 4, 5, 7, 8, and 9 Landfills
   - Contaminant concentration and distribution summary.
   - Sampling and analysis plans, including any modifications from previous plans.

- Analytical and ground water elevation data collected during the semester (annually).
- Isoconcentration maps (annual, but maps for some areas may be generated semiannually upon the request of the regulatory agencies).
- Potentiometric surface elevation contour maps (annual, but maps for some areas may be generated semiannually upon the request of the regulatory agencies).
- Results of landfill inspections (annual).
- Results of subsidence monitoring (annual).
- Description of any maintenance performed (annual).

3. Extraction and Treatment Facility Monitoring Program
   - Facility performance assessment.
   - Operations and maintenance issues and corrective measures taken.
   - Compliance summary.
   - Facility sampling plan evaluation and modifications.
   - Facility and extraction wellfield modifications.
   - Capture zone analyses (annual).
   - Treatment system influent/effluent analytical data collected during the semester.
   - Contaminant mass removal data.
   - Operational hours and flow volume measurements.
4. Risk and Hazard Management Program

   Human Health:

   - Results of vapor intrusion inhalation risk re-evaluation.
   - Results of spring ambient air inhalation risk re-evaluation.
   - Activities planned in response to the results of the human health risk estimation.
   - Results of building access and use conditions review.
   - Reporting of the institutional control monitoring results including the status of the institutional controls and how any deficiencies or inconsistent uses have been addressed. The annual evaluation will address whether the use restrictions and controls were communicated in the deed(s), whether the owners and state and local agencies were notified of the use restrictions and controls affecting the property, and whether use of the property has conformed with such restrictions and controls.

Data and information related to the human health risk and hazard management program will be reported annually in the Compliance Monitoring Reports.

Ecological:

- Results of hazard re-evaluation associated with cadmium in surface soil at Buildings 801 and 851, and in the HE Process Area, and any resulting revisions to the risk and hazard management activities.
- Results of the evaluation of future changes in contaminant and ecological conditions (every five years).
  - Results of identification of significant increases in concentrations for existing contaminants.
  - Results of identification of changes in the presence and abundance of species for which a hazard has been identified over time relevant.
  - Results of any calculations or recalculation of ecological hazard for existing contaminants exhibiting a significant increase in concentration.
  - Recommendations for modifications to ecological risk and hazard management.
- Annual reporting of ecological risk and hazard management activities conducted based on five-year review recommendations.

5. Data Management Program
   - Modifications to procedures.
   - New procedures.
6. Quality Assurance/Quality Control Program
   - Modifications to procedures.
   - New procedures.
   - Self-Assessments.
   - Quality issues and corrective actions.
   - Analytical Quality Control.
   - Field Quality Control.

10. Contingency Plan

This Contingency Plan describes how DOE and the regulatory agencies plan to address foreseeable problems that may arise during the remediation and monitoring of contaminants conducted under the ROD. It also describes the approaches for modifying Site 300 remediation systems as remediation progresses and as additional information is collected.

This Contingency Plan is designed to address routine, long-term contingencies and uncontrollable natural events (e.g., earthquakes) that could impact the effectiveness of the remedial actions. Numerous LLNL Health and Safety documents identify physical hazards that could be associated with remediation activities and include controls for these hazards; they are not addressed in this Contingency Plan.

This Contingency Plan does not apply to the Building 812 OU and Building 865 area because remedial options are still being evaluated. These areas will be addressed in an addendum to this CMP/CP.

Potential contingencies are presented in Sections 10.1 (Technical Contingencies), 10.2 (Logistical Contingencies), and 10.3 (Regulatory Framework). Technical contingencies are related to the physical remediation of ground water, bedrock, and soil at the site. Logistical contingencies include funding and other personnel issues. The regulatory framework section describes the approach that will be used to accommodate changes to the selected remedy if needed to achieve Remedial Action Objectives and cleanup standards.

Table 10-1 summarizes the potential contingencies including the planned responses DOE may implement if cleanup does not proceed as planned.

Actions DOE may implement in response to the issues described in this Contingency Plan will be performed in consultation with the regulatory agencies. Significant modifications to this Contingency Plan will also be subject to concurrence by the regulatory agencies. The possible actions described to address contingencies do not constitute modifications to the selected remedies. Section 10.3 discusses the regulatory framework for considering and implementing changes to remedies selected in the ROD.

10.1. Technical Contingencies

Potential technical contingencies that may arise during the remediation of soil, bedrock, and ground water at Site 300, and a discussion of uncontrollable events such as natural disasters, are presented in Sections 10.1.1 through 10.1.6. DOE's planned response is described with each issue.

10.1.1. Ground Water Remediation

The selected remedies for ground water at Site 300 include ground water extraction and treatment, monitored natural attenuation, and monitoring.

Site characterization, hydraulic tests, and ground water modeling have been conducted to understand the Site 300 ground water flow system. However, there are uncertainties regarding the effectiveness of any ground water remedy, as discussed below.

10.1.1.1. Insufficient Hydraulic Control of Plumes or Sources

Ground Water Extraction and Treatment

The effectiveness of the Site 300 ground water extraction and treatment facilities will be determined by measuring ground water elevations in extraction wells and surrounding monitor wells, and by measuring contaminant concentrations in ground water extracted from these wells. Ground water elevation contour maps showing the estimated hydraulic capture area of each extraction wellfield will be constructed. In conjunction with isoconcentration contour maps that show the distribution of contaminants in each HSU, the estimated capture areas will be used to determine whether the plumes are being successfully contained.

If ground water elevation contour maps and/or isoconcentration contour maps indicate insufficient plume hydraulic capture in a particular HSU, the flow rates of nearby extraction wells will be evaluated. Flow rates will be adjusted, if possible, to increase the overall hydraulic capture area and/or eliminate stagnation zones within the appropriate HSU. If monitoring still indicates inadequate plume capture after extraction well flow rates have been adjusted, DOE may consider modifying the remedial system, possibly by expanding the extraction wellfield. DOE may also consider other remedial technologies, such as bioremediation, to address insufficient plume capture. Section 10.3 describes the process to modify the ROD and change the remedial strategy.

Pit 7 Complex Hydraulic Drainage Diversion System

An engineered hydraulic drainage diversion system was installed at the Pit 7 Complex in 2008 to reduce recharge to ground water and prevent subsequent inundation of the Pits 3, 4, 5, and 7 landfills and underlying contaminated bedrock. The remedy component is intended to isolate contaminant sources, effectively preventing further releases from the landfill waste and vadose zone bedrock. As described in Section 4, designated detection monitor wells, situated in close proximity to the landfills, will be monitored to identify any future releases from the landfills. Ground water elevation data collected from wells in the Pit 7 Complex area will be used to evaluate the effectiveness of the drainage diversion system in preventing inundation of the landfill waste and underlying contaminated bedrock. As discussed in the Remedial Design for the Pit 7 Complex, indications that the hydraulic drainage diversion system is not effective in preventing releases of contaminants to ground water include all of the following criteria:

- Ground water elevation responses to rainfall events observed in key monitoring wells are similar to those observed before the installation of the drainage diversion system.
- Observation of historic maximum ground water rises into the pit waste and underlying contaminated bedrock as indicated by ground water elevation data.
- Increasing trends in tritium, uranium, VOC, or perchlorate activities/concentrations are observed over a period of at least four quarters in ground water samples from wells downgradient of the landfills.

If all three of these criteria are met, indicating that the current design is not effective in controlling/isolating the contaminant source and preventing releases, DOE/LLNL will evaluate possible modifications/improvements to the drainage diversion system to further reduce ground water recharge and prevent inundation. For example, the current system design is comprised of several components that could be expanded or modified. These components include the interceptor trenches on the western hillslope, which can be expanded with longer and deeper trenches, and the placement of additional drains on the eastern slope.

These modifications would be evaluated and implemented in consultation with and with the concurrence of the regulatory agencies. DOE may also consider other remedial technologies or approaches, to address insufficient hydraulic control of the contaminant sources at the Pit 7 Complex landfills. Section 10.3 describes the process to modify the ROD and change the remedial strategy.

10.1.1.2. Increases in Contaminant Concentrations in Ground Water

Ground water chemistry data are inherently variable. Concentration fluctuations over time occur in response to:

- Climatic changes, such as variable precipitation and infiltration rates.
- Changes within the aquifer, including variable hydraulic gradients, water levels, sorption/desorption, and contaminant transport rates in response to ground water extraction.
- Changes in conditions unrelated to the site environment, such as minor variations inherent in analytical methods and laboratory procedures.

Therefore, not all fluctuations in contaminant concentration require extraction well/treatment facility modification.

DOE will continue to measure contaminant concentrations in Site 300 monitor and extraction wells throughout the cleanup. If ground water contaminant concentrations increase in a consistent and significant manner for reasons not attributable to remediation efforts (e.g., cyclic pumping), or natural aquifer or laboratory variables, DOE will notify the regulatory agencies and modifications to the remedial action will be considered. If possible, extraction rates will be adjusted to obtain better hydraulic control of the contaminant plume(s). However, if adjusting the flow rate(s) does not effectively improve hydraulic control of the plume, DOE may modify the remedial systems (e.g., by increasing treatment facility capacity and/or expanding the extraction wellfield).

If contaminant concentrations increase in areas outside of active remediation, DOE may conduct additional field investigations, if warranted. Based on these investigations, the need for modifications to the remedial action will be evaluated. Section 10.3 describes the process to modify the ROD and change the remedial strategy.

If contaminant concentrations rebound above the cleanup standards during post-shutdown monitoring, verification samples will be collected. The regulatory agencies will be notified of the verification sampling results. Notification will occur within six months of the original detection above cleanup standards. If rebound is verified, options will be discussed with the regulatory agencies.

10.1.1.3. Impacts to Guard Wells

If a guard well were to become impacted by contaminants, DOE would confirm the results by resampling. If contaminants are confirmed, DOE will report the results to the regulatory agencies and develop a plan to evaluate whether the guard well should be replaced. Possible actions that DOE may take include:

- Designating an existing, appropriately completed downgradient well, if available, to replace the impacted well.
- Conducting additional field investigation to assess the distribution of contaminants in the area of the impacted guard well to site a new guard well downgradient of the plume margin.
- Conducting contaminant transport modeling to predict plume migration and assist with siting of an appropriate new guard well.

- Evaluate additional remedial measures (e.g., expanding an extraction wellfield) to prevent plume migration. The decision to replace a guard well will be reviewed with the regulatory agencies prior to implementation.

10.1.1.4. Impacts to Water-Supply Aquifers

If monitoring detects significant additional impacts to water-supply aquifers from Site 300 contaminants, DOE will confirm the detections by resampling. If contaminants are confirmed, DOE will report the results to the regulatory agencies, evaluate the possible sources of the contamination, and develop a plan to address the contaminants. Possible actions include:

- Investigating the source(s) of the contaminants detected in the aquifer.
- Increasing the frequency and locations of monitoring.
- Conducting fate and transport modeling to assess the migration of the detected contaminants and estimate future concentrations.
- Assessing health and ecological risks.
- Installing additional wells to monitor the extent of contamination and/or begin ground water extraction to hydraulically control the contaminants.
- Installing or expanding systems to treat water extracted from the affected aquifer.
- Treating water at the point of use.

Section 10.3 describes the process to modify the ROD and change the remedial strategy.

10.1.1.5. Ineffective Monitored Natural Attenuation

Monitored natural attenuation (MNA) is a component of the remedies selected in the ROD in several OUs. As discussed in U.S. EPA (1997b), the effectiveness of monitored natural attenuation should be evaluated by "trigger" criteria that, if exceeded, would signify unacceptable performance. These triggers include:

- Increasing contaminant concentrations in soil or ground water at specified locations.
- Large increases in contaminant concentrations in wells located near source areas indicating a new or renewed release.
- Detection of contaminants in wells located outside the original plume boundaries at concentrations exceeding ground water cleanup standards.
- Insufficient rate of contaminant concentration decrease to meet remediation objectives.
- Changes in land and/or ground water use that adversely affect the protectiveness of the monitored natural attenuation remedy.

If monitoring demonstrates that one or more of these triggers is activated, DOE will notify the regulatory agencies, assess the possible causes of the increasing concentrations or plume migration, and recommend future actions, if appropriate.

The future actions may include sampling soil, bedrock, or ground water to search for an undiscovered source, removal of a source, and/or installing an active remediation system, such as ground water extraction and treatment, to hydraulically control and remediate affected ground water. Section 10.3 describes the process to modify the ROD and change the remedial strategy.

10.1.2. Vadose Zone Remediation

The soil vapor extraction and treatment systems in several OUs will operate until it is demonstrated that: (1) unacceptable VOC inhalation risk to onsite workers has been mitigated, and (2) VOC removal from the vadose zone is no longer technically or economically feasible in meeting the aquifer cleanup standards sooner, more cost effectively, and more reliably. The decision on whether it is appropriate to shut off the soil vapor extraction system will be made based on the results of the "Soil Vapor Extraction System Shut-Off Evaluation" discussed in Appendix C of the Site-Wide ROD (DOE, 2008).

The following sections describe possible vadose zone remediation contingency issues.

10.1.2.1. Potential Impacts of Vadose Zone Contaminants of Concern on Ground Water

Soil vapor extraction and treatment was selected as part of the remedy in several OUs. VOC concentrations will be monitored at soil vapor extraction wells throughout vadose zone remediation. If ground water and/or soil vapor monitoring data indicate that a soil vapor extraction system is not effectively remediating volatile contaminants, the remedial system operation may be modified to increase the VOC mass removal rate and the extent of pressure influence, if possible. If monitoring data indicate that system operation modifications are not sufficiently effective, measures such as installing additional soil vapor or ground water extraction wells will be evaluated and implemented as appropriate.

If monitoring indicates that vadose zone contaminants may be impacting ground water in an area where vadose zone remediation is neither in progress nor planned, additional investigations will be considered. These additional investigations may include:

- Sampling soil, bedrock, soil vapor, and/or ground water.
- Performing fate and transport modeling.
- Conducting additional risk assessment.
- Considering new or additional institutional controls.

Ground water will be monitored locally for the non-volatile Site 300 vadose zone contaminants known or suspected to present a threat to ground water quality. If monitoring determines that such contaminants are unacceptably impacting ground water, DOE will notify the regulatory agencies, evaluate the impacts, and prepare a preliminary plan for addressing the impacts. Possible courses of action may include:

- Sampling soil and/or bedrock to determine the vertical and horizontal extent of the vadose zone contaminants.
- Additional soil/bedrock excavation and removal, if technically and economically feasible.
- Vadose zone and/or ground water fate and transport modeling.
- Evaluating *in situ* technologies that may be applicable to the contaminants and determining the feasibility of application at Site 300.

- Extraction and treatment to contain, remove, and remediate the contaminants in ground water.

Section 10.3 describes the process to modify the ROD and change the remedial strategy.

10.1.2.2. Increases in VOC Concentrations in Soil Vapor

As with ground water chemistry data, soil vapor chemistry data are also inherently variable. Concentration fluctuations over time occur in response to:

- Climatic changes (variable precipitation and infiltration rates).
- Changes within the unsaturated zone (soil moisture content, water level changes, sorption/desorption).
- Changes in contaminant transport rates in response to soil vapor extraction.
- Changes in conditions unrelated to the site environment (minor variations inherent in analytical methods and laboratory procedures).

Therefore, not all fluctuations in soil vapor contaminant concentrations necessitate extraction well/treatment facility modification.

DOE will monitor VOC concentrations in soil vapor extraction wells. DOE will analyze trends and variability of contaminant concentrations in these wells. If the contaminant concentration in a soil vapor extraction well increases in a consistent and significant manner over time, DOE will notify the regulatory agencies and the relationship between VOC concentration data, historical data trends, and factors that can affect VOC concentrations in soil vapor (e.g., climatic changes, changes within the unsaturated zone, cyclical pumping) will be evaluated. If appropriate, the sampling frequency will be modified. If increases in soil vapor VOC concentration are known to be associated with a planned remediation optimization effort, the soil vapor sampling frequency will not be altered.

If contaminant concentrations in the vadose zone soil/bedrock or soil vapor are increasing in a consistent and significant manner for reasons not attributable to remediation efforts or natural unsaturated zone or laboratory variables, the need for modifications to the remedial action will be considered. If possible, soil vapor extraction rates will be adjusted to obtain better removal of volatile contaminant mass from the unsaturated or dewatered zone. However, if adjusting the flow rate(s) does not effectively increase VOC mass removal, or if another technology must be used to remediate non-volatile contaminants of concern, DOE may consider modifying the remedial strategies, perhaps by increasing soil vapor extraction treatment facility capacity, expanding the soil vapor extraction wellfield, and/or testing and employing an alternate technology.

If contaminant concentrations increase in areas outside of active remediation, as discussed in Section 10.1.4, DOE will consider additional field investigations. Based on these investigations, the need for modifications to the remedial actions will be evaluated.

10.1.3. Surface Soil Remediation

No further action is the selected remedy for surface soil containing metals, HMX, and tritium in the Building 854 OU, HMX at Building 832 Canyon OU, and RDX and metals in the

Building 851 area. Excavation, solidification, and consolidation are the selected remedy for surface soil containing PCBs, dioxin, and furan compounds in the Building 850 area. The Building 850 remedy was implemented in 2008-2009.

If additional surface soil contamination is discovered at Site 300, DOE will notify the regulatory agencies and develop a remediation pathway as discussed in Section 10.1.4 below.

As described in Table 6-7, inspection of the Corrective Action Management Unit (CAMU) containing solidified and consolidated PCB-, dioxin-, and furan-contaminated soil at Building 850 will be conducted at least annually and maintenance performed as needed. Maintenance may include filling of cracks and repair of any minor structural deficiencies that are observed over the years. If a significant structural deficiency develops that cannot be repaired by the use of available equipment and personnel or that poses the risk of mobilizing contaminated soil to the environment or exposure to humans or ecological receptors, a plan will be developed for the timely repair of the solidified and consolidated soil unit. During this time, institutional and/or engineered controls will be implemented, if necessary, to prevent mobilization of or exposure to contaminants, until repairs are made. The repair plan will be presented to the regulatory agencies for concurrence prior to implementation.

10.1.4. New Sources, Releases, or Contaminants

As the Site 300 remedies are implemented and operated, evidence of new sources, new releases, and/or new contaminants may be identified by:

- Increasing contaminant concentrations in soil vapor or ground water.
- Appearance of new contaminants in surface soil, subsurface soil/bedrock, or ground water, or changes in regulatory standards for existing contaminants.
- High concentrations of contaminants in soil samples collected from boreholes or during construction activities.

DOE will notify the regulatory agencies if monitoring and/or investigations indicate that a:

- Previously undetected contaminant source has impacted ground water;
- New release has occurred from an existing potential source, such as an onsite landfill; and/or
- New contaminant is present for which the remedies will not meet Remedial Action Objectives.

DOE will then evaluate the new data and develop plans to address the new source, release, or contaminants. Anticipated actions may include:

- Increased monitoring to identify potential source(s).
- Delineating contaminant distribution by field sampling.
- Source investigation and delineation.
- Ground water and/or vadose zone fate and transport modeling to assess potential impacts on ground water.
- Risk assessment to evaluate the potential impact to human health and the environment.

- Conducting source control or removal activities.
- Modifying existing extraction wellfields and/or treatment systems to capture and treat new contaminants.
- Installing and operating new extraction or monitor wells.

For potential contaminant release from existing landfills at Site 300 that could result from damage or degradation of the landfill surface, possible responses include:

- Assessing the damage and degree of contaminant exposure or migration.
- Repairing the damage or degradation.
- Removing released contaminants by soil vapor and/or ground water extraction.
- Implementing additional engineering controls if needed to prevent future exposure or mobilization of the landfill contents, such as diverting surface water.
- Installing an engineered landfill cover.
- Excavating landfill contents and relocating the material onsite or disposing offsite.

Contingency actions for the Pit 7 Complex source control remedy component (drainage diversion system) are discussed in Section 10.1.1.1.

Any new constituents detected in ecologically relevant media (surface water, surface soil and subsurface soil to a depth of 6 ft) will be evaluated. Because remedial investigation and buildout are nearly complete in OUs 1 through 8, these data will be primarily limited to any emerging contaminants that the regulators identify for which additional sample analyses are requested.

Concentrations of new constituents detected in surface soil or subsurface soil (to a depth of 6 ft) that the literature and the areal extent suggest are ecologically significant, will be compared to any relevant Federal or State ecological soil screening levels (if available) as a first step in the evaluation process. If concentrations of these newly identified constituents exceed the ecological soil screening levels, hazard indices will be calculated. Hazard indices will be calculated for potentially impacted species in the OU in which the new constituent is detected. Toxicity quotients will be calculated for any new constituents identified in surface water from springs. Constituents with hazard indices or toxicity quotients greater than 1 will be added to the ecological risk and hazard management process which will be documented in a Compliance Monitoring Report. If chemical concentrations do not exceed ecological soil screening levels or if hazard indices and toxicity quotients are less than 1, it will be assumed that the chemical does not pose a risk to ecological receptors and that no ecological risk and hazard management are necessary. Figure 10-1 shows the contingency process to evaluate new constituents in ecologically relevant media.

In addition, available biological survey data (e.g., pre-construction survey data, biological monitoring data, surveys conducted for EIR/EIS preparation) will be periodically reviewed for presence of new special-status species, as described in Section 6.2.3. Figure 10-2 shows the contingency process to evaluate new ecological species that may be impacted by contamination in OUs 1 through 8. The evaluation results will be reported the annual Compliance Monitoring Reports.

10.1.5. New Technologies

DOE is continually investigating and evaluating new and innovative technologies and remediation techniques for ground water and vadose zone cleanup. While many of these techniques and technologies may not be economically feasible, it is possible that a rapid and cost-effective remediation strategy will be developed that could potentially shorten cleanup time or reduce residual contaminant concentrations. These technologies may be employed at Site 300 if site conditions change, or if technology development and testing indicate a potential for cost-effective and expedited remediation. Any proposed changes to the remedies or remedial strategy would be discussed with the regulatory agencies. Section 10.3 describes the process to modify the ROD and change the remedial strategy.

10.1.6. Uncontrollable Events

Uncontrollable natural events may occur during the Site 300 cleanup that could disrupt monitoring or remedial activities, including wildfires, large magnitude earthquakes, floods, or severe atmospheric storm events. DOE will immediately notify the regulatory agencies of such an occurrence. If significant damage occurs to treatment facilities or extraction wellfields, ground water and/or soil vapor remediation may temporarily cease. If significant damage occurs to landfill caps or the soil solidification/consolidation CAMU at Building 850, DOE would implement institutional and/or engineered controls necessary to prevent exposure to contamination until the damage can be repaired. Because the drainage diversion system at the Pit 7 Complex handles only clean water and damage to this system would not result in exposure to contaminants, it would not be necessary to implement special controls in the interim period until the damage is repaired. DOE will then evaluate the damage to the remedial infrastructure and estimate the time and funding needed to return to normal operation. Damaged infrastructure will be modified, replaced, or decommissioned.

10.2. Logistical Contingencies

Logistical contingencies include, but are not limited to, changes in personnel; funding; ground water use and demand; land use including changes in site development, building use, and property transfer; and changes to LLNL mission and operation.

10.2.1. Personnel

As with any long-term project, personnel changes will occur during the Site 300 cleanup. Past personnel changes at DOE, LLNL, and regulatory agencies have been accommodated while minimizing adverse impact to the project. Remedial Project Managers and other knowledgeable staff will continue to assist new personnel to familiarize them with the project. This teamwork approach will be employed for any future personnel changes. New personnel can refer to the completed Site 300 CERCLA documents, the Site 300 FFA, the Site 300 Administrative Record, and the Site 300 Standard Operating Procedures for information regarding the approved remediation plan and schedule.

Changes in DOE contractors and subcontractors have been successfully implemented in the past, and LLNL procurement practices will continue to enable smooth transitions in the future. If DOE believes that an outgoing incumbent contractor or subcontractor can provide valuable knowledge to help ensure a smooth transition, DOE will request a phase-in/phase-out period to allow the incumbent to work directly with the new contractor or subcontractor for an appropriate period of time.

10.2.2. Funding

DOE will take all necessary steps to request timely and sufficient funding to meet its obligations under the FFA. The regulatory agencies will be notified of any potential budget constraints that may affect Site 300 milestones or operations.

If the regulatory agencies agree that budget reductions constitute *force majure* as outlined in Section 10 of the FFA for LLNL Site 300, or "good cause" pursuant to Section 9.2 of the FFA, milestone extensions may be granted. Interested community representatives will be provided an opportunity to provide input to this process.

Any revision of milestones will follow the priorities established for site remediation. The current order of priorities for Site 300 environmental restoration funding is:

1. Protecting worker health and safety.
2. Monitoring to ensure the remedies are effectively protecting human health and the environment.
3. Preventing offsite plume migration and remediating plumes that extend offsite.
4. Preventing further contamination, and/or conducting remediation of the water-supply aquifers.
5. Preventing further contamination, and/or conducting remediation of contamination in soil and ground water within the site boundary.

Tasks based on these priorities will be accomplished in an order established by DOE. Thus, if funding is less than projected, tasks will be performed in the same relative order as funding allows, but over a longer period of time. The community will be informed of significant actions and provided an opportunity to remain involved throughout this process.

10.2.3. Ground Water Use and Demand Changes

If routine monitoring indicates that others may be using contaminated ground water originating from Site 300, or if ground water use by others is adversely affecting remediation, DOE will: (1) notify the U.S. EPA, RWQCB, and DTSC, (2) acquire all available information on location, magnitude, and duration of the private ground water use, and (3) develop a mitigation plan, if necessary. Possible mitigations include altering the remedial pumping scheme, negotiating with landowners, seeking regulatory intervention, providing alternative water supply, and installing point-of-use treatment at existing private water-supply wells, if necessary.

If DOE becomes aware of plans for local property owners to install a well or wells downgradient of a contaminant plume that could adversely impact the Site 300 cleanup, DOE will: (1) notify the U.S. EPA, RWQCB, and DTSC, (2) notify the San Joaquin County Public Health Services Environmental Health Division, the agency responsible for issuing the well permit, (3) evaluate the potential impacts on the contaminant plume, and (4) develop a mitigation plan, if necessary. Possible mitigations may include negotiating with the landowner to relocate the well to a more favorable location, restricting use of the new well, or providing an alternate supply of water to the landowner.

A number of water-supply wells are in use near Site 300. In the event that Site 300 COCs are confirmed in private water-supply wells, DOE will report the detections to the regulatory agencies and develop an action plan, if necessary, for discussion with the well owners and regulatory agencies. Possible actions include providing alternate water supplies (e.g., bottled water, using alternative or new wells) or treatment at point-of-use.

10.2.4. Changes in Land Use

Implementation and operation of the remedial actions at Site 300 could be affected by land use changes including: (1) future site development (Section 10.2.4.1), changes in building access restrictions or use (Section 10.2.4.2), or (3) property transfer (Section 10.2.4.3).

10.2.4.1. Future Site Development

Future onsite development may restrict available locations for piezometers, monitor wells, and extraction wells, or other remedial infrastructure. Current onsite DOE planning procedures require thorough environmental review and sampling prior to any significant construction activities that mitigates the potential for inadvertent development at critical remedial locations. Designating portions of Site 300 or adjacent lands as critical habitat could also restrict the locations of piezometers, extraction wells, monitor wells, treatment facilities, and other remedial infrastructure. If critical habitat designation(s) limit optimal siting of remediation infrastructure, DOE will discuss options with the appropriate regulatory agencies, including the U.S. Department of Fish and Wildlife Service.

Offsite land restrictions are expected to have less impact on remedial activities because the highest contaminant concentrations detected in ground water, and therefore the extraction well locations, are all onsite.

10.2.4.2. Changes in Building Access Restrictions or Use

Site 300 management must approve any changes in Site 300 building use or access restrictions and will notify LLNL Hazards Control and Environmental Restoration Departments of any proposed changes to building occupancy or land use where such changes may result in exposure and unacceptable risk. The LLNL Environmental Restoration Department will work with the program implementing the change to install engineering controls or other measures to prevent worker exposure to contaminants, as discussed in Sections 6.1.6 and 6.1.7.

10.2.4.3. Property Transfer

DOE will meet its commitments regarding its cleanup obligations if property ownership and/or land use changes in the future, as such commitments are contained in the Site 300 Federal Facility Agreement (FFA), Sections 28 (Transfer of Real Property) and 37 (Facility Closure), and Section 2.6.2 of the Site-Wide ROD (DOE, 2008). The FFA prohibits transfer of any real property interest comprising the site except in accordance with Section 120(h) of CERCLA. DOE will notify EPA, RWQCB, and DTSC 45 days in advance of any proposed land use changes that are inconsistent with land use control objectives or the selected remedy. In the event of a property transfer, DOE will take the following steps in accordance with the Site 300 FFA stipulations, Site-Wide ROD requirements, and EPA's Land Use Control implementation requirements:

- Prior to transfer of ownership, DOE will give written notice of release of hazardous substances, information regarding the environmental use restrictions and controls, and property necessary for the performance of the remedial action, to the recipient of the real property interest and will include such information in the contract for such transfer. Each transfer of fee title from the United States will include a CERCLA 120(h)(3) covenant that will have a description of the residual contamination on the property and the environmental use restrictions, expressly prohibiting activities inconsistent with the performance measure goals and objectives. The environmental restrictions are included in a section of the CERCLA 120(h)(3) covenant that the United States is required to include in the deed for any property that has had hazardous substances stored for one year or more, or known to have been released or disposed of on the property. Each deed will also contain a reservation of access to the property for DOE, EPA, RWQCB, and DTSC, and their respective officials, agents, employees, contractors, and subcontractors for purposes consistent with the FFA. The deed will contain appropriate provisions to ensure that the restrictions continue to run with the land and are enforceable by DOE. Equivalent restrictions would be implemented upon the lease of the property.
- Prior to seeking approval from the EPA, RWQCB, and DTSC, the recipient of the property must notify and obtain approval from DOE of any proposals for a land use change at a site inconsistent with the use restrictions and assumptions described in the GSA or Site-Wide RODs.
- Consistent with the FFA, DOE will notify the EPA, RWQCB, and DTSC as soon as possible, but no later than 30 days prior to any sale or transfer of any property subject to institutional controls, Section 120(h) of CERCLA, or the FFA, and involve these FFA signatories in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective institutional controls. In addition to the land transfer notice and discussion provisions above, DOE further agrees to provide EPA, RWQCB, and DTSC with similar notice, within the same time frames, as to federal-to-federal transfer of property. DOE will provide a copy of executed deed or transfer assembly to EPA, RWQCB, and DTSC.
- DOE will take appropriate actions to ensure that all activities and removal or remedial actions undertaken pursuant to the FFA will not be impeded or impaired by any transfer involving an interest or right in real property relating to the site. Such actions include but are not limited to providing the following in any deed, lease, or other instrument for the transaction:
    - Notification of the existence of the FFA.
    - The parties to the FFA shall have rights of access to the property, as set forth in the FFA.
    - Provisions for complying with all health and safety plans approved in accordance with the FFA.

- There shall be provisions for complying with all health and safety plans for operation of any response or remedial actions on the property such as wells and treatment facilities.
- No subsequent transactions relating to the property shall be made without provisions for such access rights, for compliance with all health and safety plans approved in accordance with the FFA, and for operation of any removal or remedial actions on such property.
- Copies of any property transaction documents must be sent by certified mail within 14 days of the effective date of the transaction.
- Those involved in subsequent transactions relating to the property transferred shall provide copies of the instrument evidencing such transaction to each of the parties to the FFA by certified mail within 14 days of the effective date of the transaction.

In the event of a property transfer, DOE will also execute a land use covenant in compliance with Title 22 California Code of Regulations, Division 4.5, Chapter 39, Section 67391.1 as specified in Section 2.6.2 of the 2008 Site-Wide ROD. A Memorandum of Understanding between DOE and DTSC will be prepared to document this agreement.

Since LLNL's mission and operation are not expected to change in the foreseeable future (Section 10.2.5 below), no significant change in the use of Site 300 is expected. The FFA and the Site-Wide ROD (DOE, 2008) apply to any land use changes for any portion or all of the site.

10.2.5. LLNL Site 300 Mission and Operation

Site 300's current and future mission and operation will include CERCLA compliance and cleanup implementation as specified in the Site 300 FFA and GSA or Site-Wide RODs. In addition, DOE is committed to honoring its responsibilities for environmental restoration independent of any possible future decisions regarding the continued existence of LLNL. While DOE recently evaluated the consolidation of activities throughout the DOE complex that could result in changes to activities conducted at Site 300, DOE control of the site is expected to continue for the foreseeable future. There are no plans to open the land for recreational or residential uses. As discussed in Section 10.2.4, provisions in the Site 300 FFA, Site-Wide ROD, and in law assure that DOE will not transfer lands with unmitigated contamination that could cause potential harm.

10.3. Regulatory Framework

Over the course of the Site 300 cleanup, changes to the selected remedies may be needed to achieve the Remedial Action Objectives and/or cleanup standards. A modification to the GSA or Site-Wide RODs may be necessary to accommodate such changes. The lead agency (DOE), with the concurrence of the regulatory agencies, will determine if the proposed change is: (1) non-significant or minor, (2) significant, or (3) fundamental, as described in U.S. EPA guidance (U.S. EPA, 1999b).

A non-significant change generally reflects modifications to optimize performance and minimize cost. Non-significant changes are documented in the Administrative Record.

A significant change is generally a change to a remedy component that does not fundamentally alter the overall remedial approach (e.g., adjustments to cleanup standards). For a significant change, an Explanation of Significant Differences will be prepared and a brief description and notice of availability of the Explanation of Significant Differences will be published in a major local newspaper. The Explanation of Significant Differences will be available to the public through the Administrative Record and information repository.

A fundamental change requires reconsidering the remedial approach selected in the GSA or Site-Wide RODs. For a fundamental change, the required public participation and documentation procedures include preparing a revised Proposed Plan, providing a public comment period, and preparing a ROD Amendment and Public Responsiveness Summary before implementing the change.

The regulatory agencies and DOE will discuss community recommendations regarding Site 300 cleanup. The regulatory agencies and DOE will evaluate community suggestions based on the nine EPA evaluation criteria (overall protection of human health and the environment, compliance with applicable or relevant and appropriate requirements, long term effectiveness, reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, cost, and State acceptance) and will report their findings publicly. If regulations change, DOE and the regulatory agencies will determine how these changes may affect cleanup. The community will be informed of any regulatory changes that affect the Site 300 cleanup.

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13. Acronyms and Abbreviations

ARARs	Applicable or Relevant and Appropriate Requirements
ATA	Advanced Test Accelerator
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CMP	Compliance Monitoring Plan
COCs	Contaminants of Concern
CP	Contingency Plan
DCA	Dichloroethane
DCE	Dichloroethene
DOE	Department of Energy
DTSC	(California) Department of Toxic Substances Control
EIR/EIS	Environmental Impact Report/Environmental Impact Statement
EPA	Environmental Protection Agency
FFA	Federal Facility Agreement
ft	Feet
GSA	General Services Area
HE	High Explosives
HI	Hazard Index
HMX	High Melting Explosive
HSU	Hydrostratigraphic unit
IWS	Integrated Work Sheets
LLNL	Lawrence Livermore National Laboratory
LLNS	Lawrence Livermore National Security, Limited Liability Corporation
MCL	Maximum Contaminant Level
mg/L	Milligrams per liter
MNA	Monitored natural attenuation
OU	Operable Unit
PCBs	Polychlorinated biphenyls
PCE	Perchloroethylene, also known as tetrachloroethylene
pCi/L	PicoCuries per liter
PRGs	Preliminary Remediation Goals
QAPP	Quality Assurance Project Plan
RAOs	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act

RDX	Research Department Explosive
ROD	Record of Decision
RWQCB	(California) Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act
SOPs	Standard Operating Procedures
SPACT	Sample Planning and Chain-of-Custody Tracking
TBOS	Tetrabutyl orthosilicate
TCE	Trichloroethylene
TEIMS	Taurus Environmental Information Management System
TKEBS	Tetrakis (2-ethylbutyl) silane
U.S.	United States
VOCs	Volatile organic compounds
WQNLs	Water quality numeric limits
yd^3	Cubic yards
µg/L	Micrograms per liter

Figures

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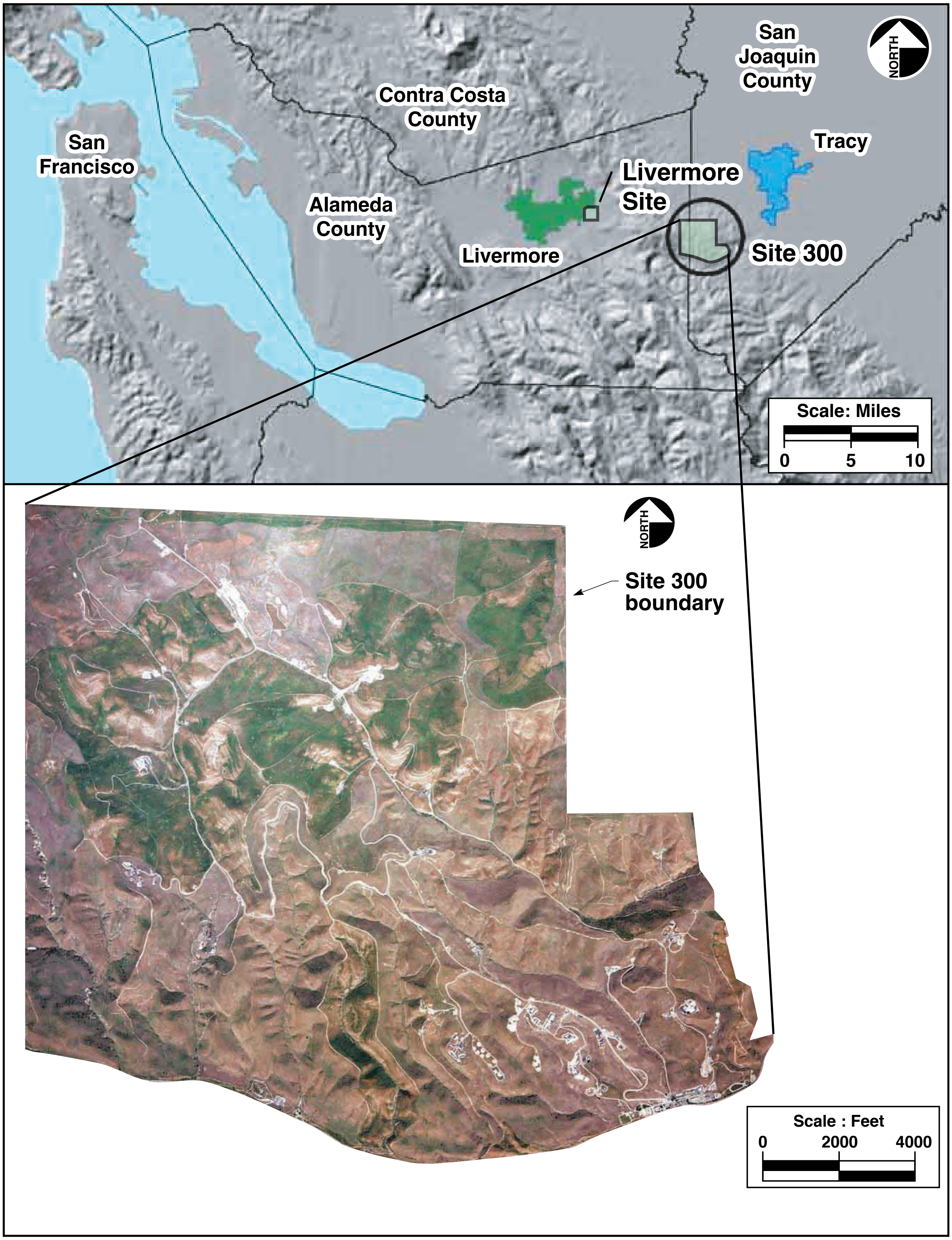

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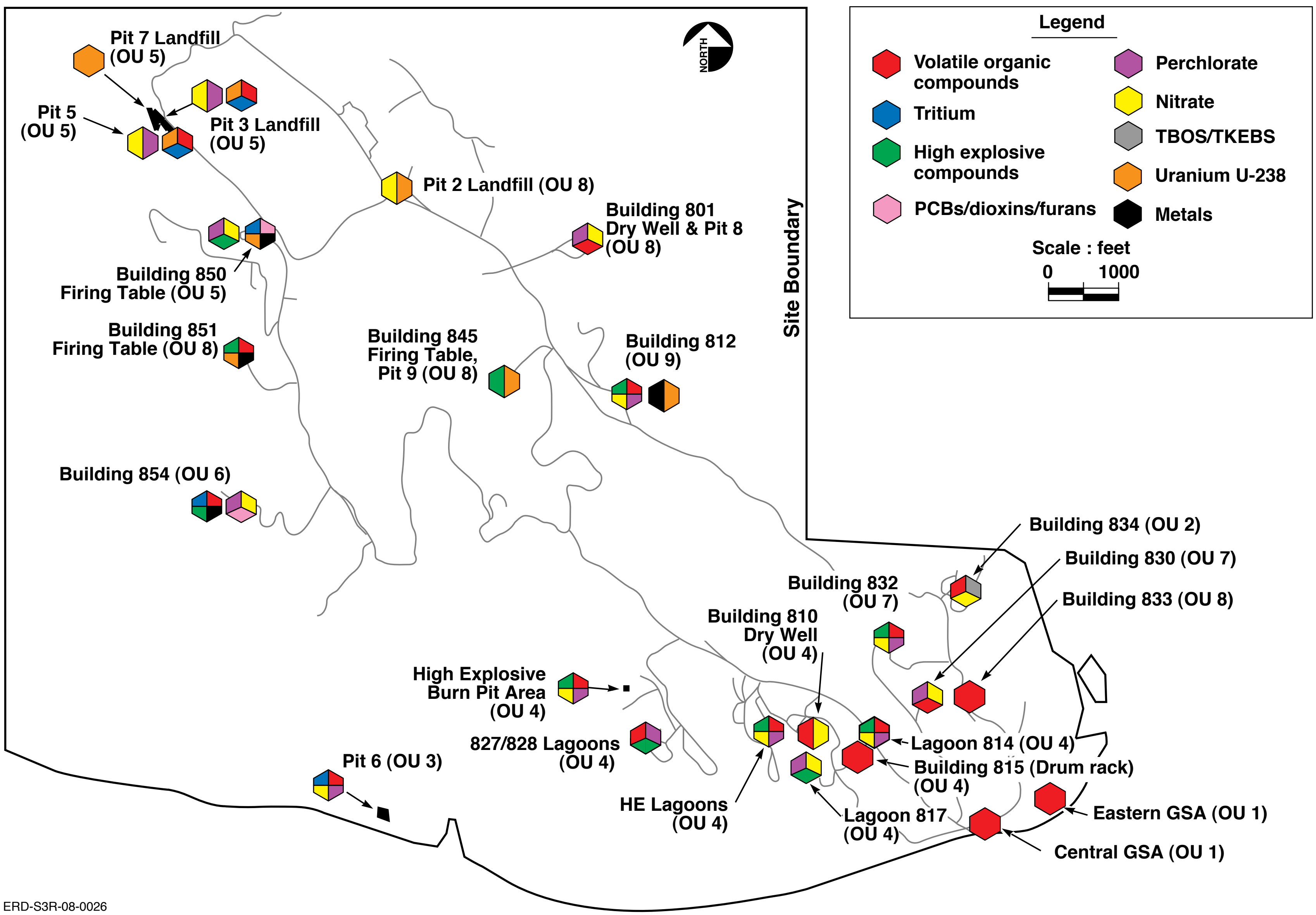
Figure 1-1. Location of LLNL Site 300.



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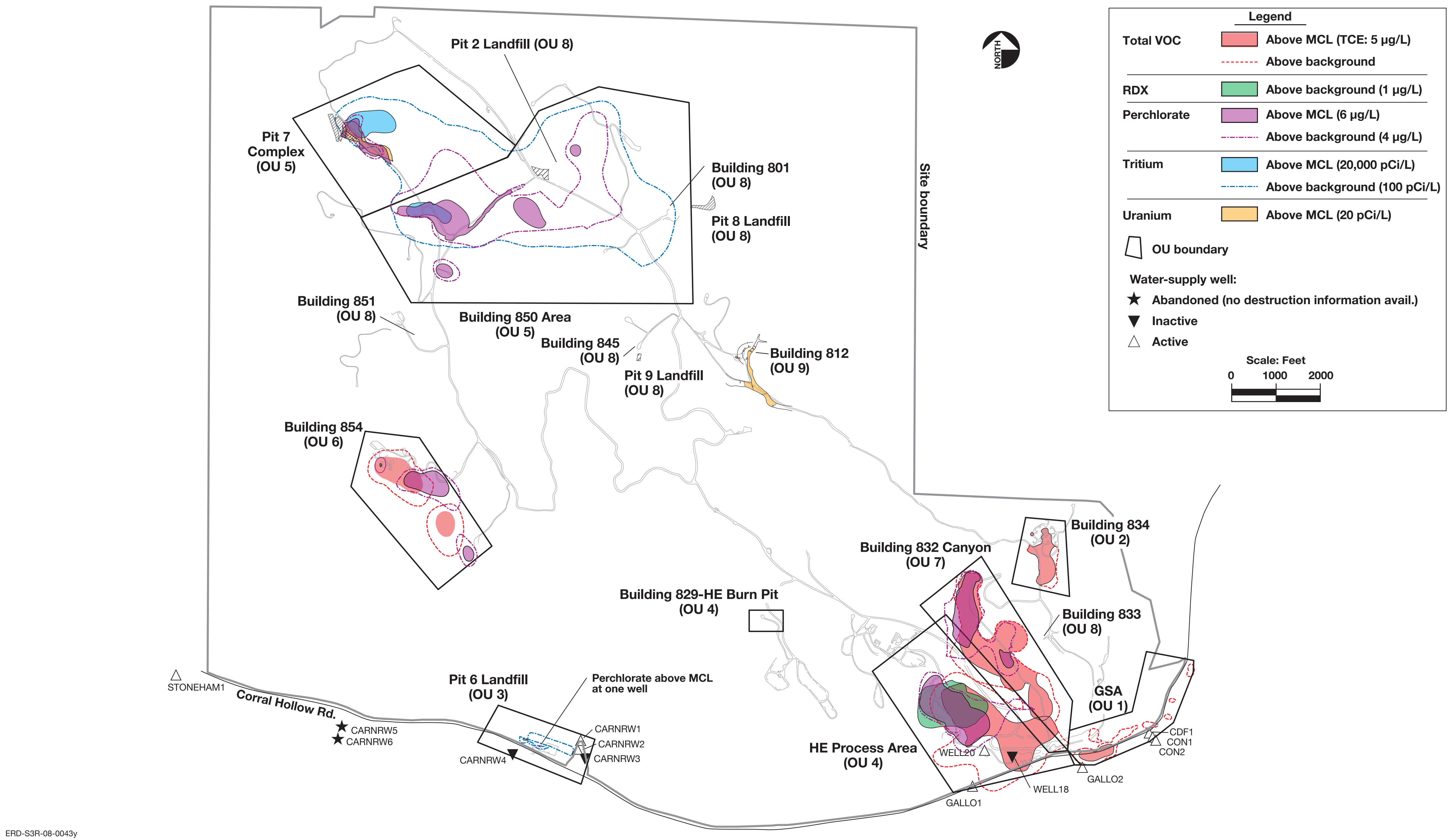

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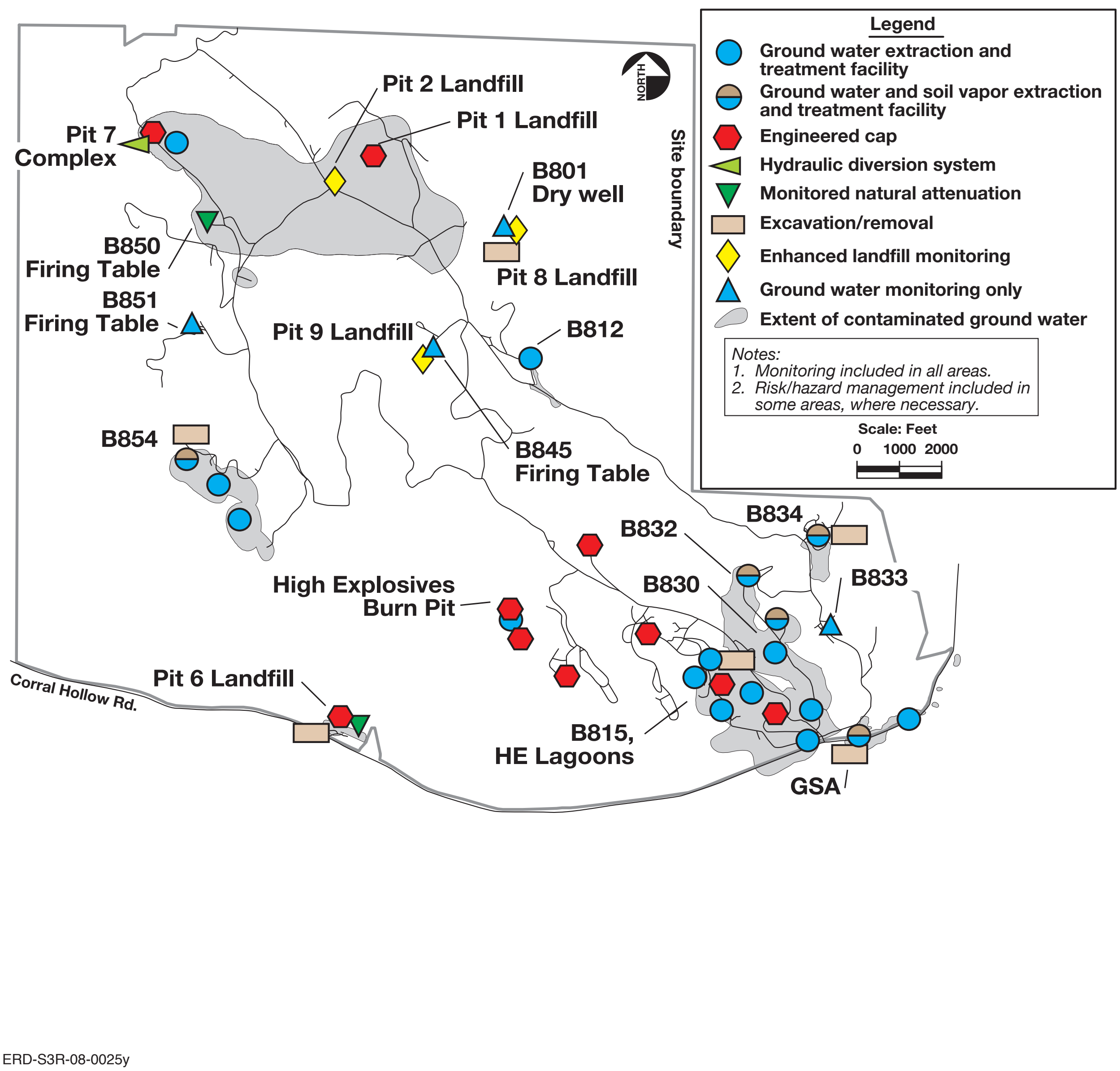

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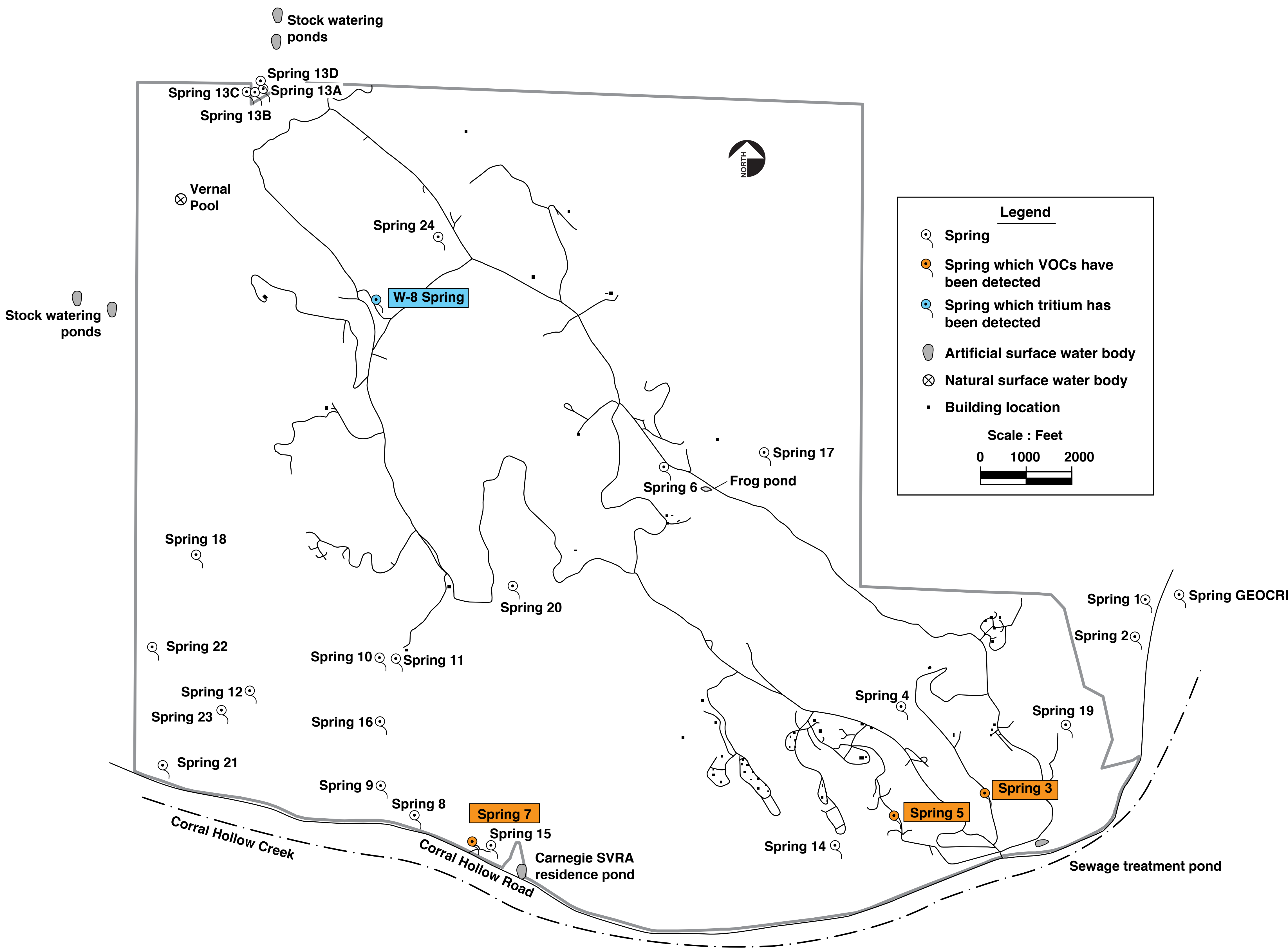

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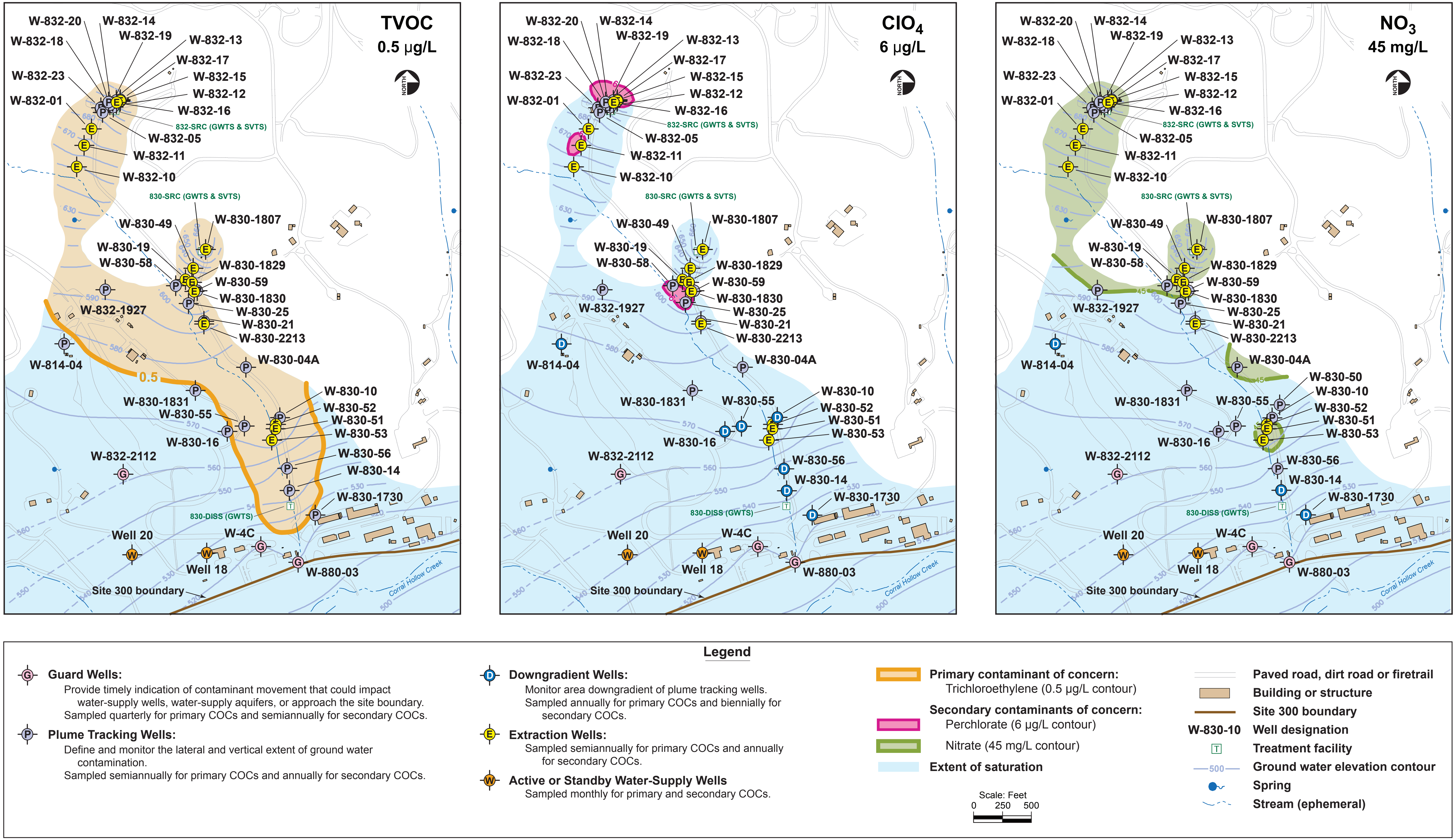

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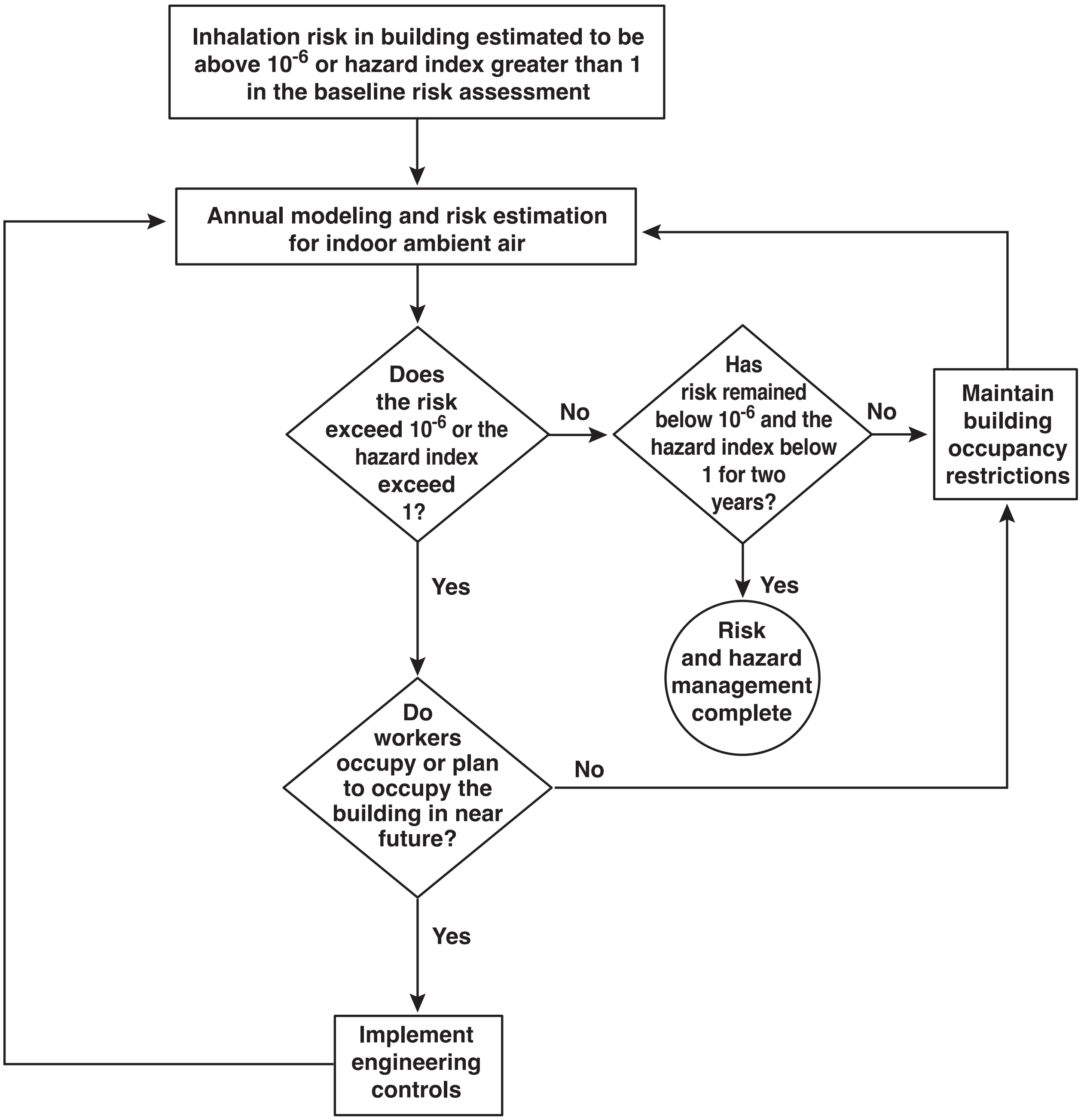

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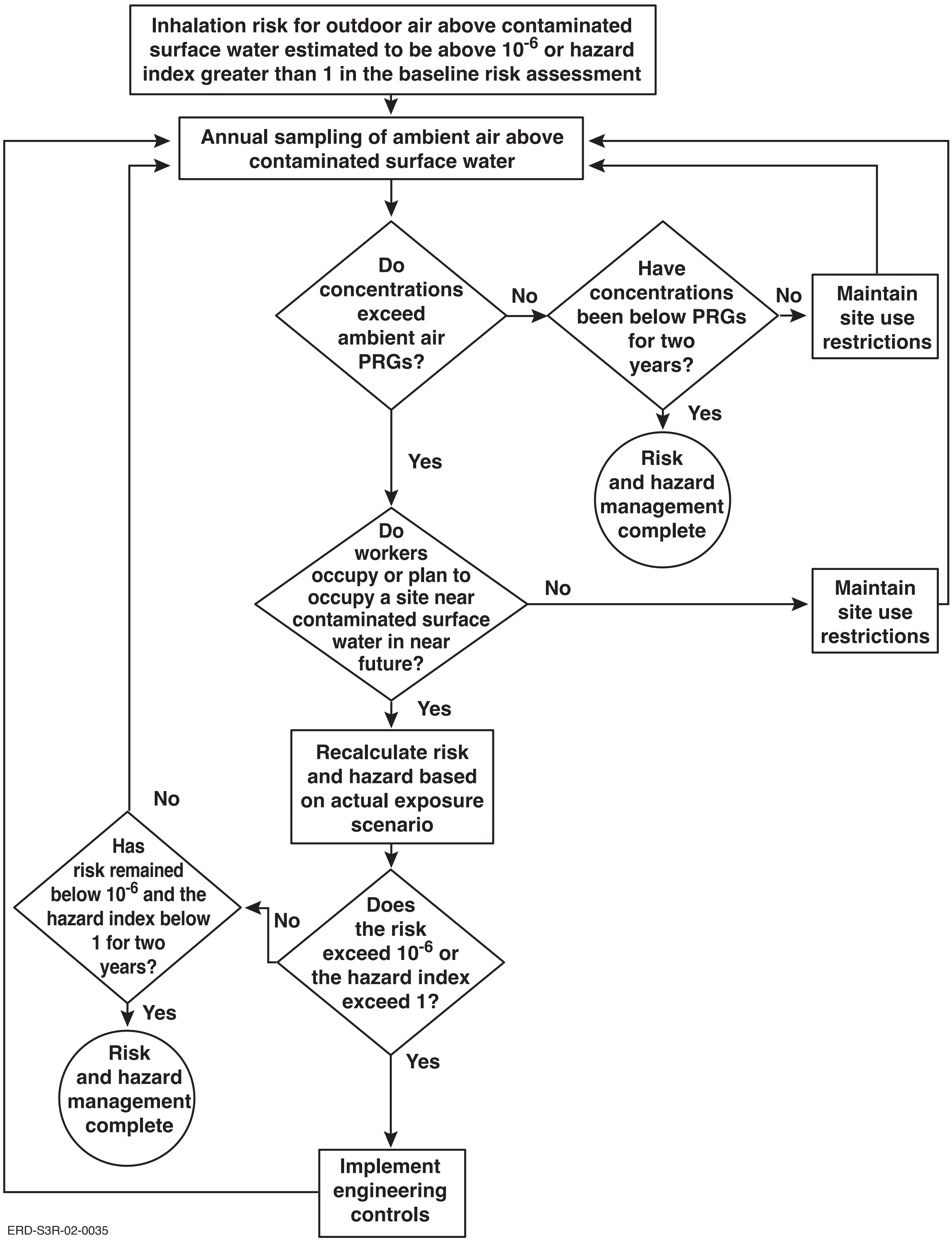

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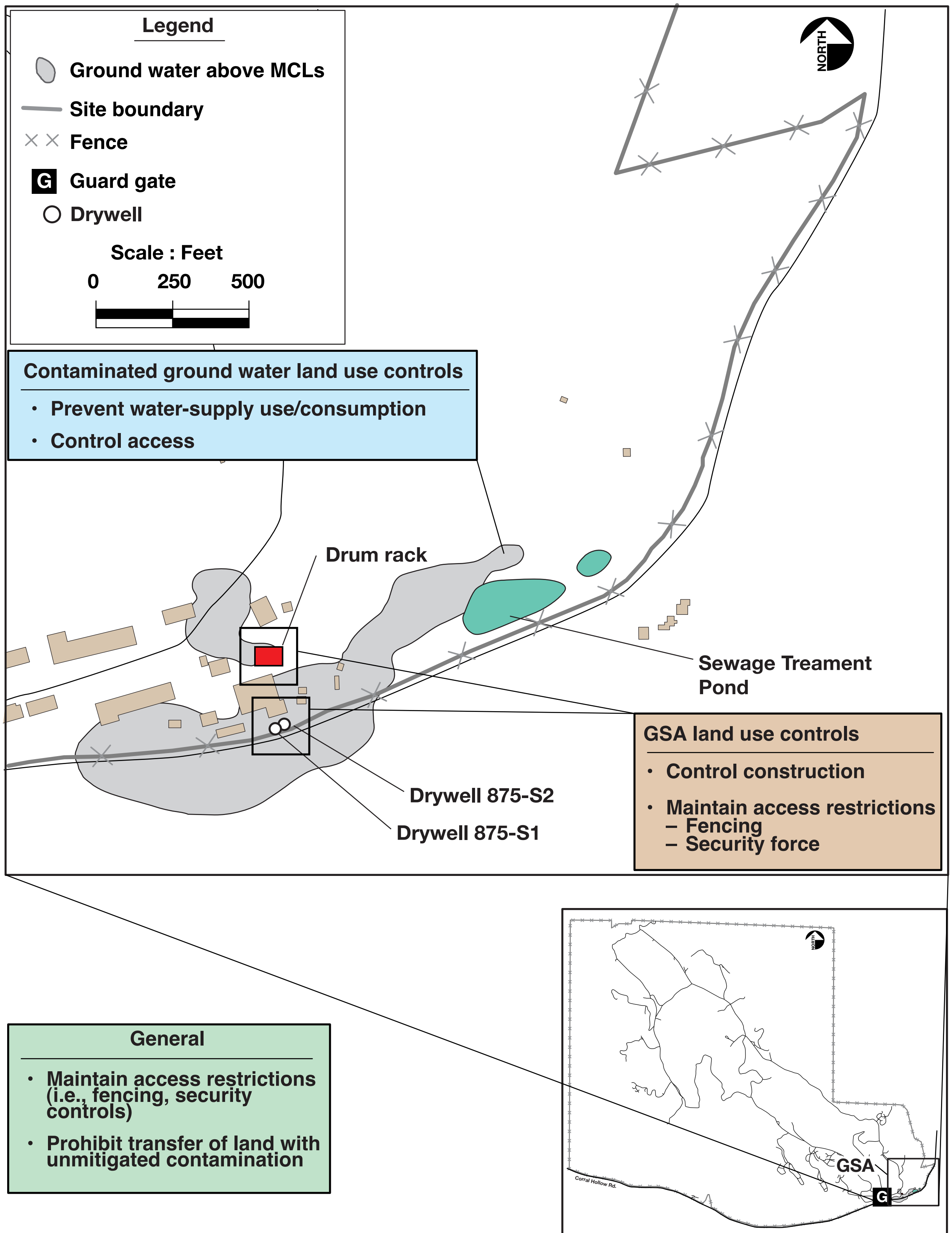

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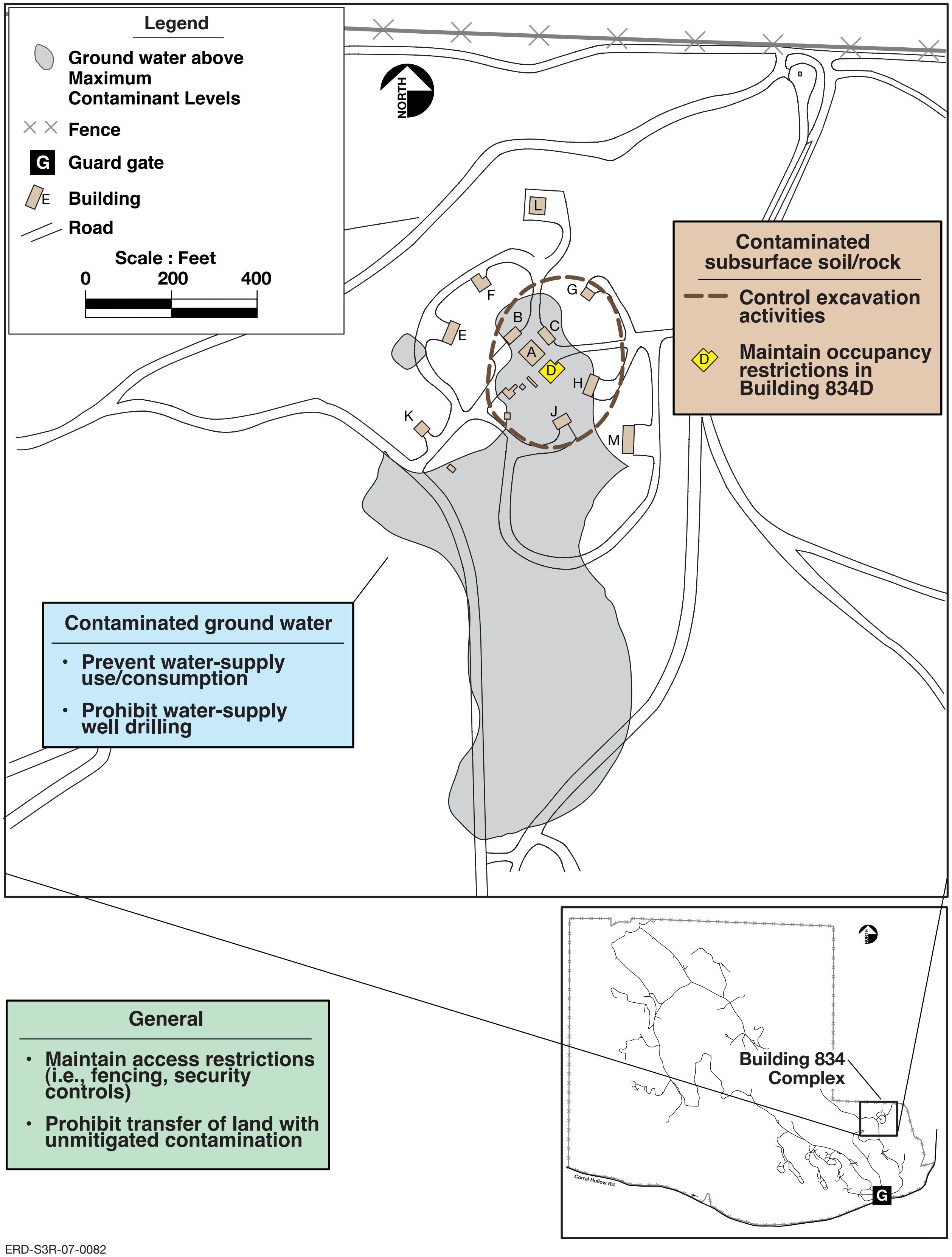

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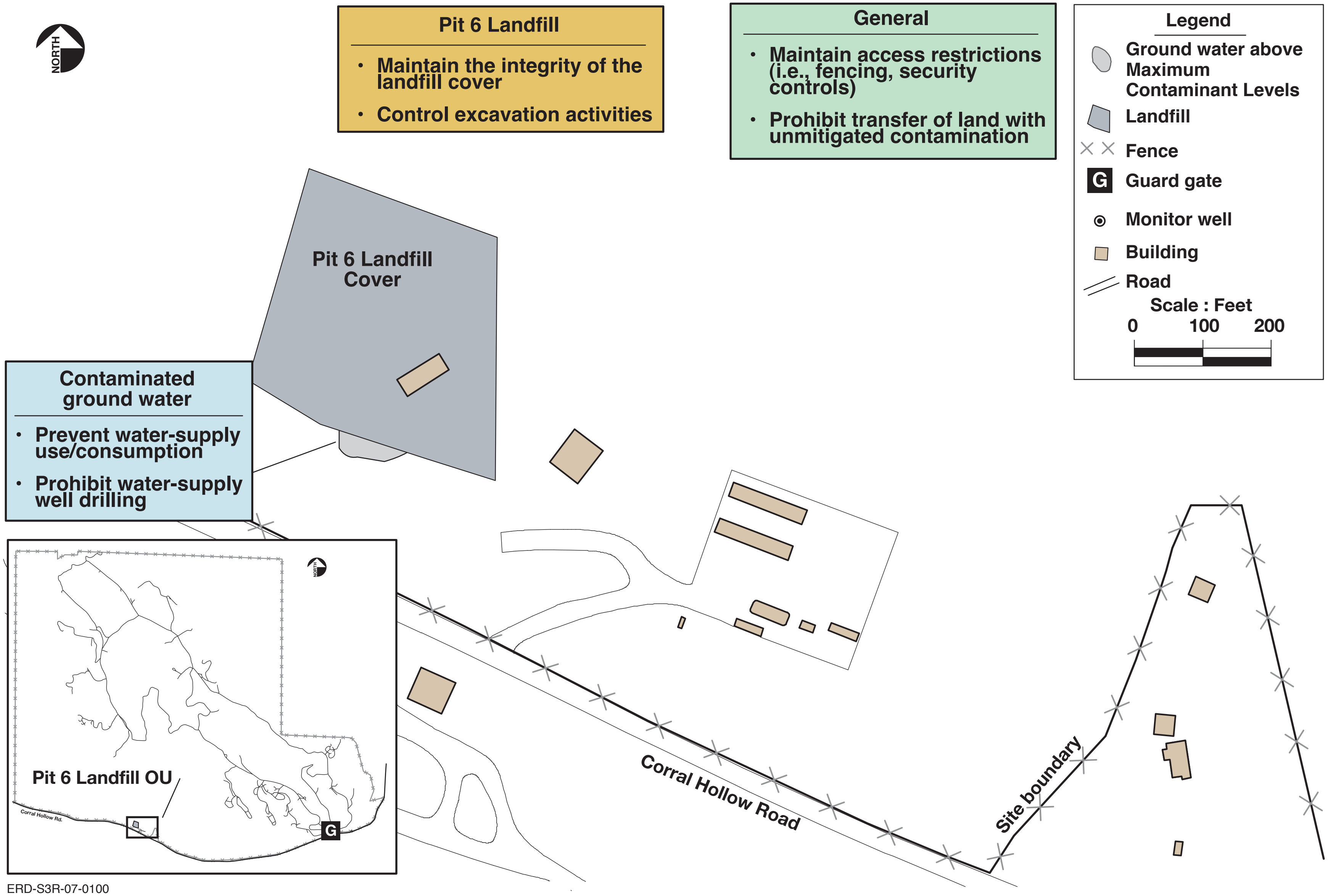

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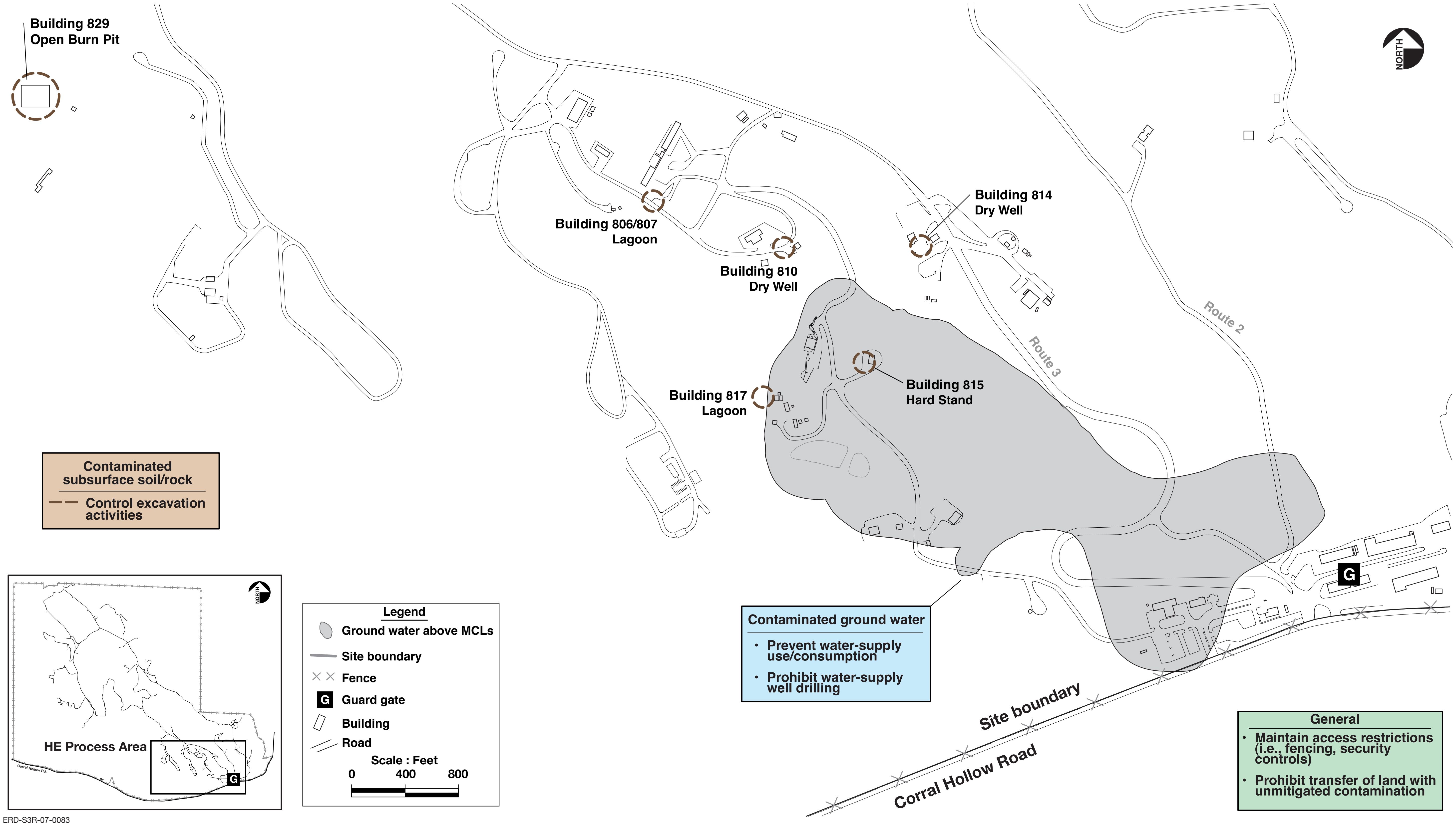

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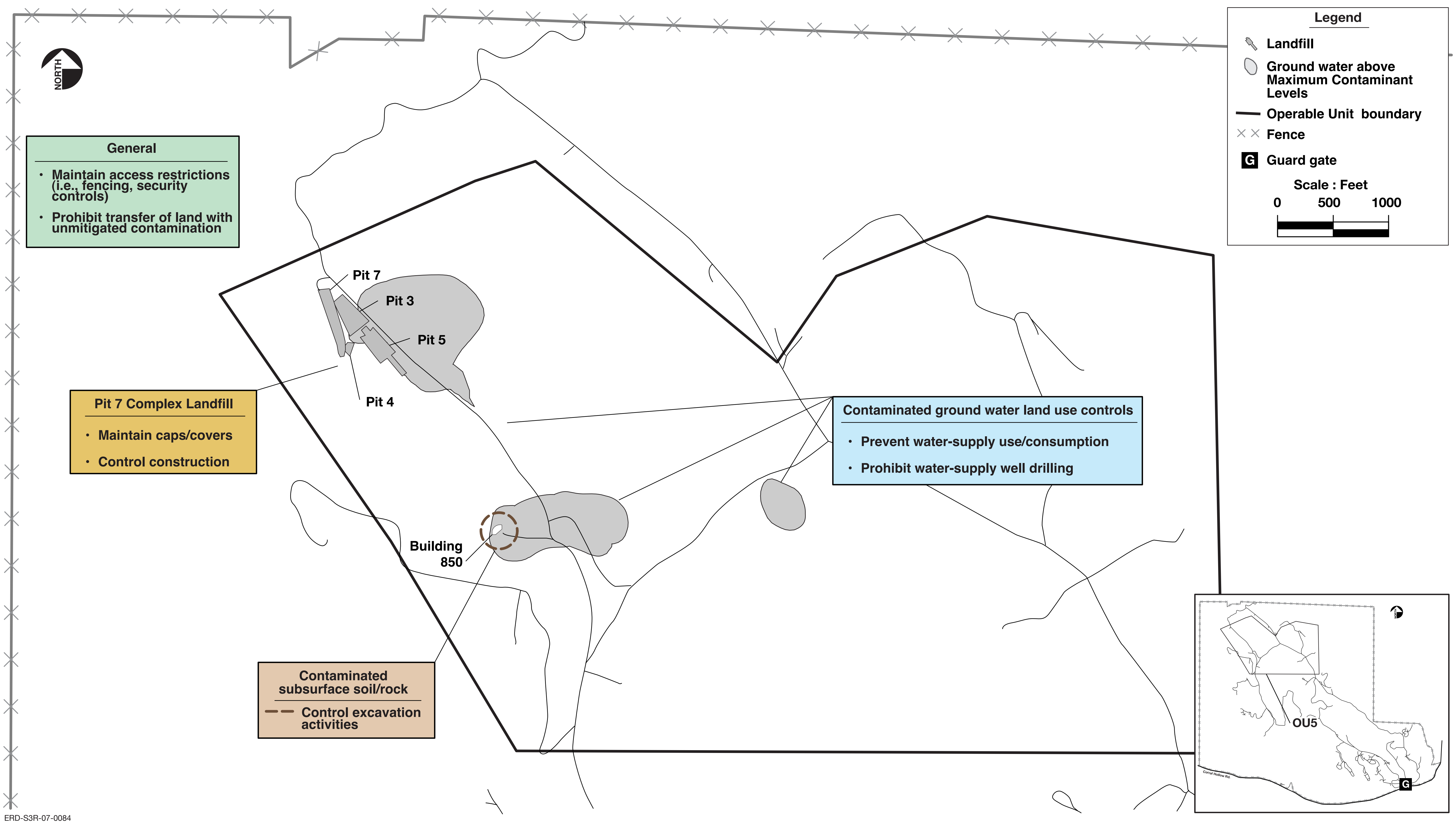

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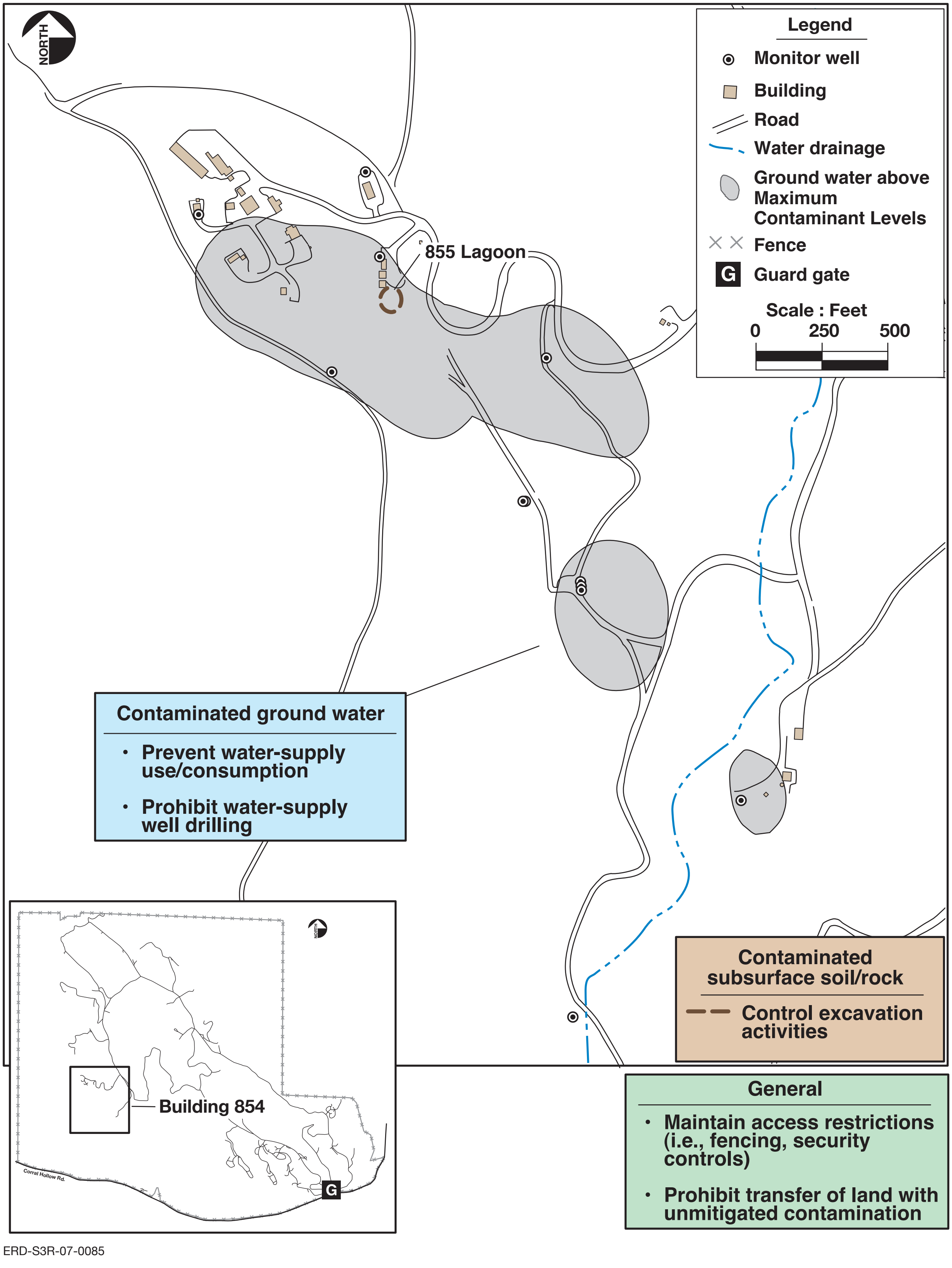

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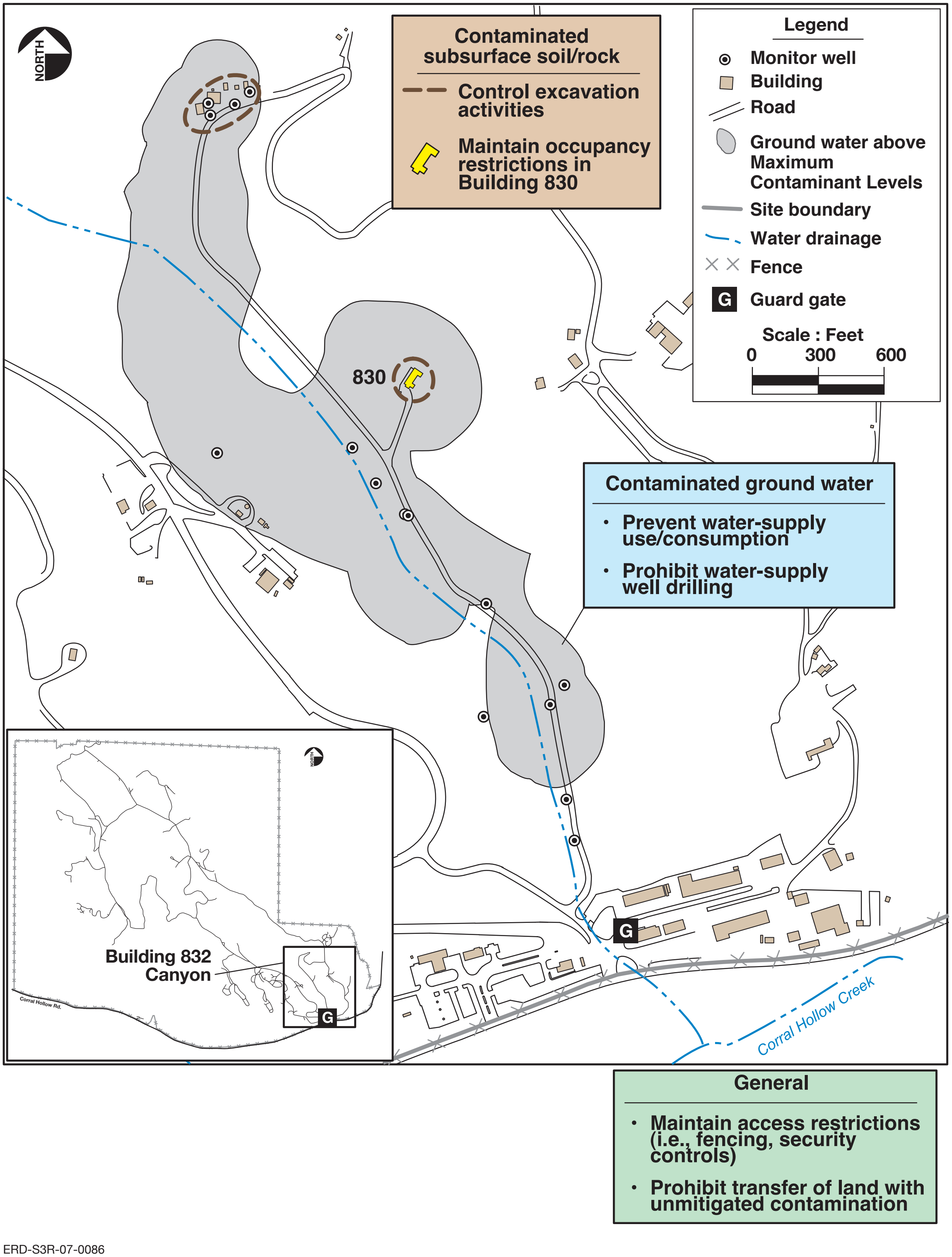

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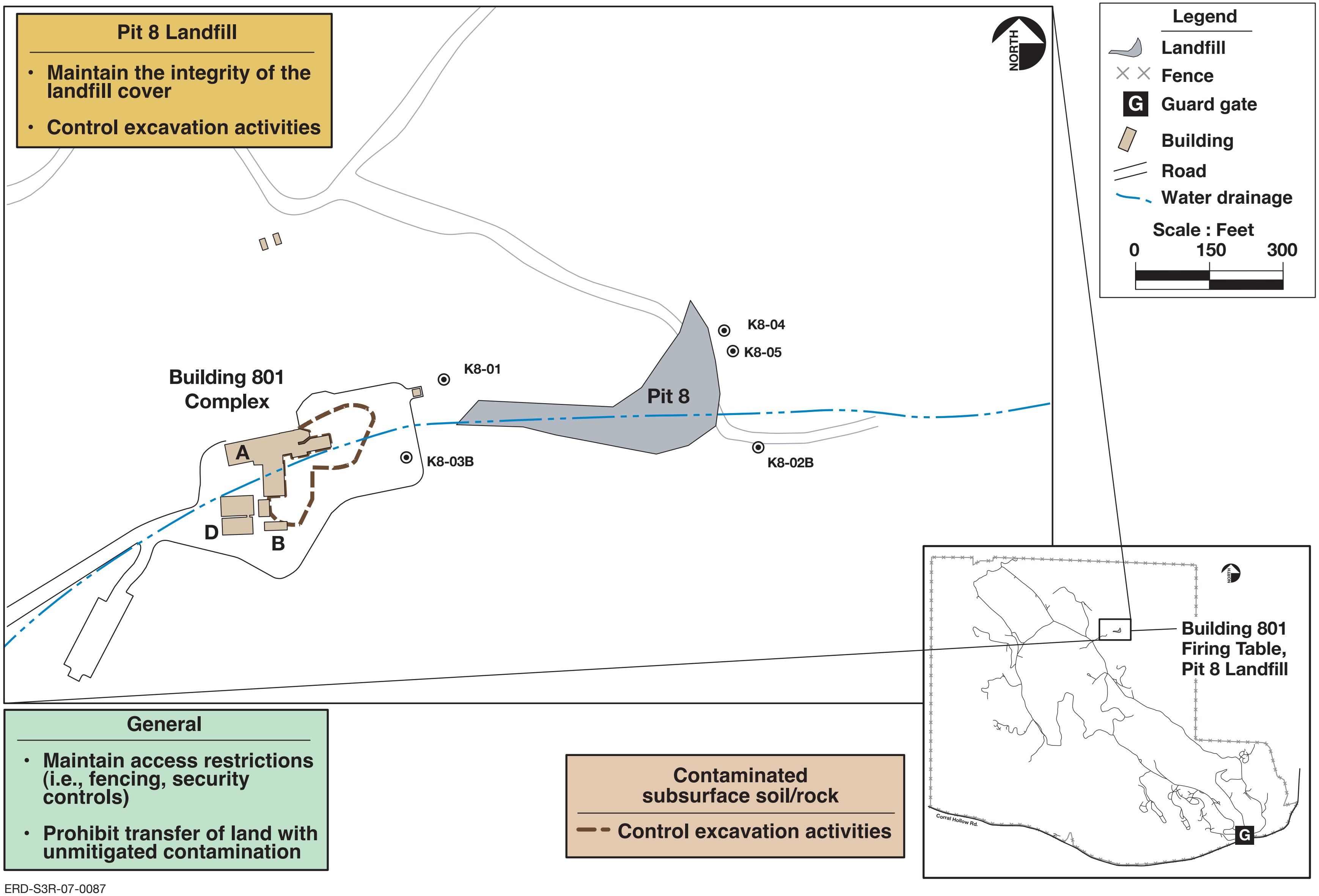

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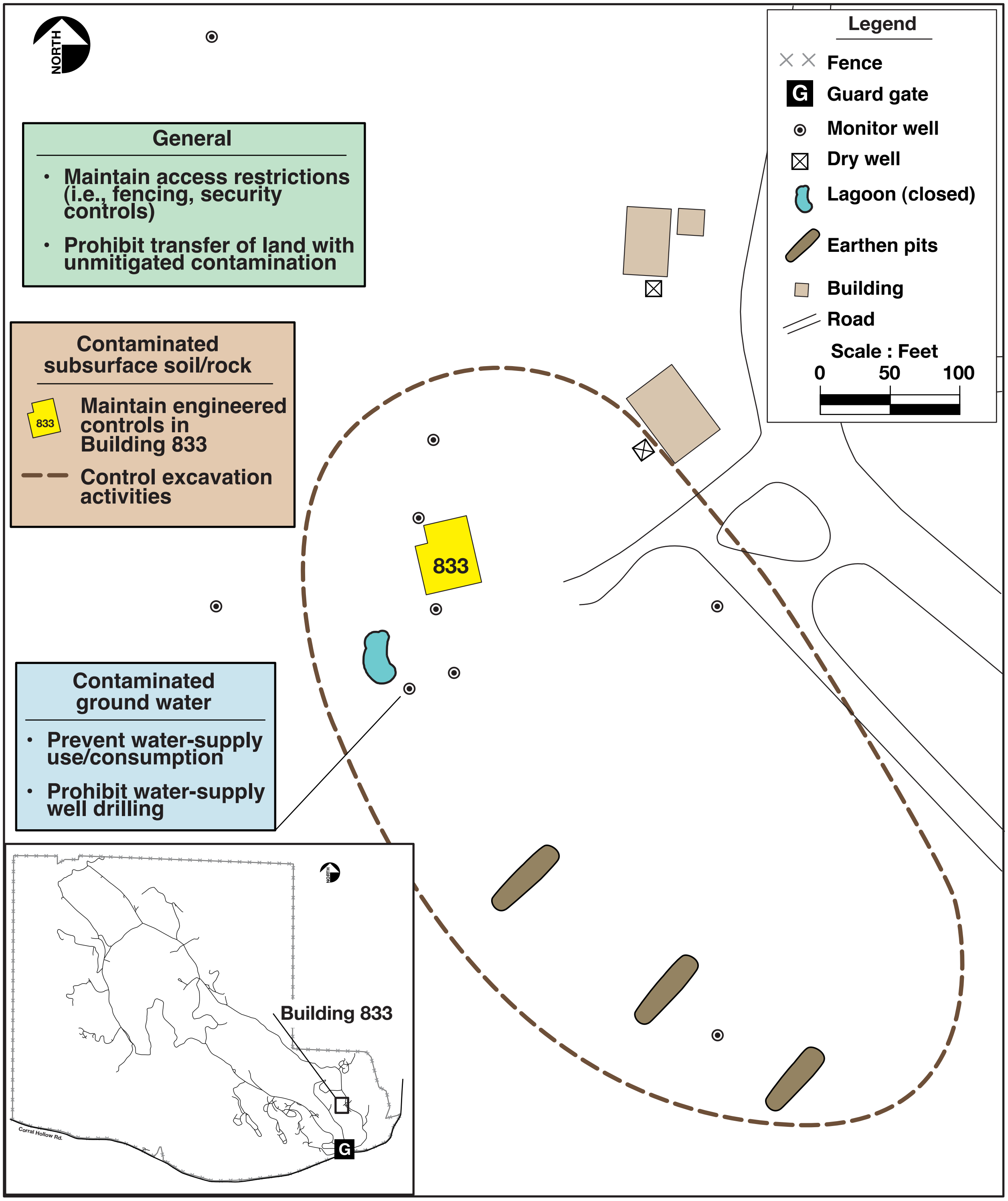

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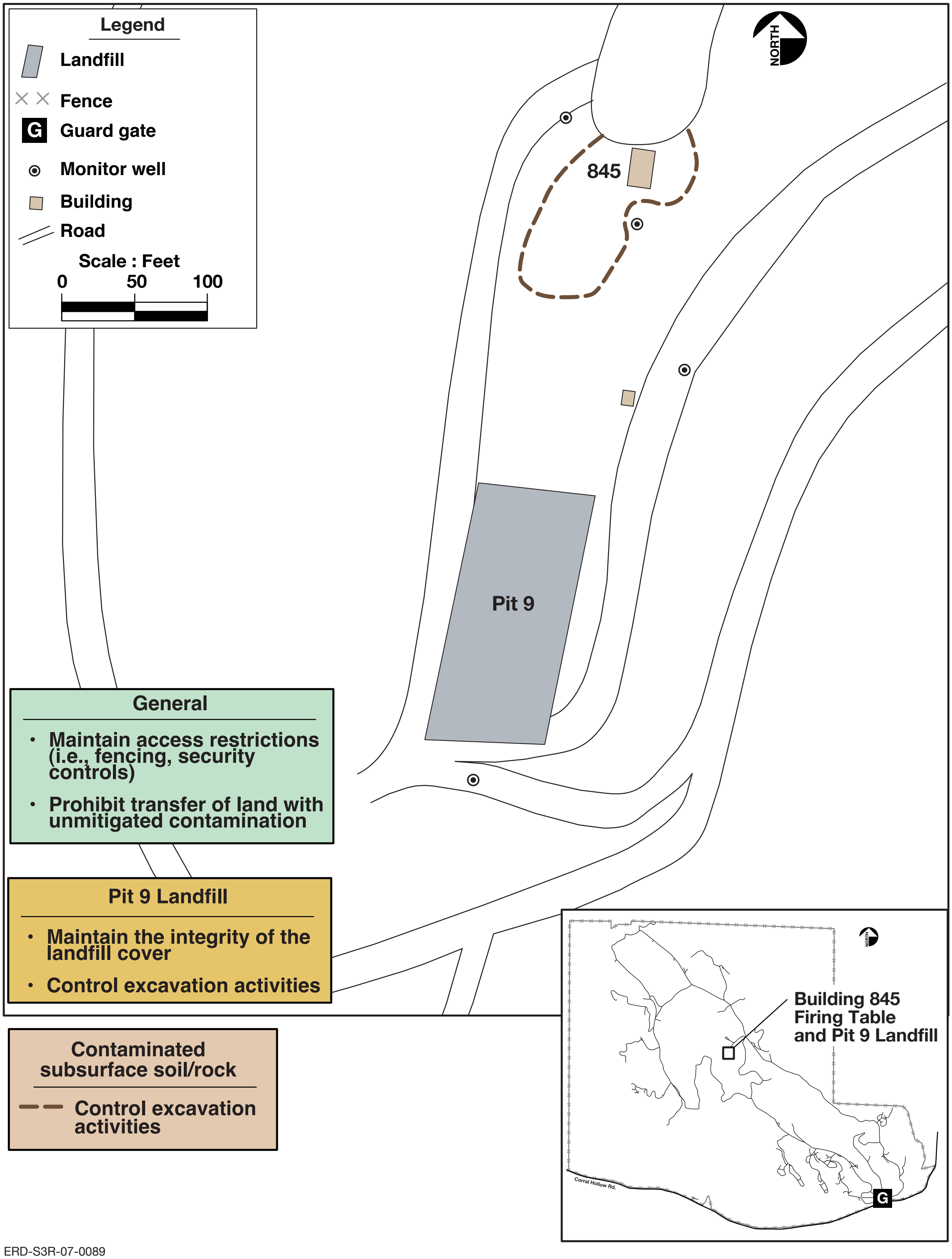

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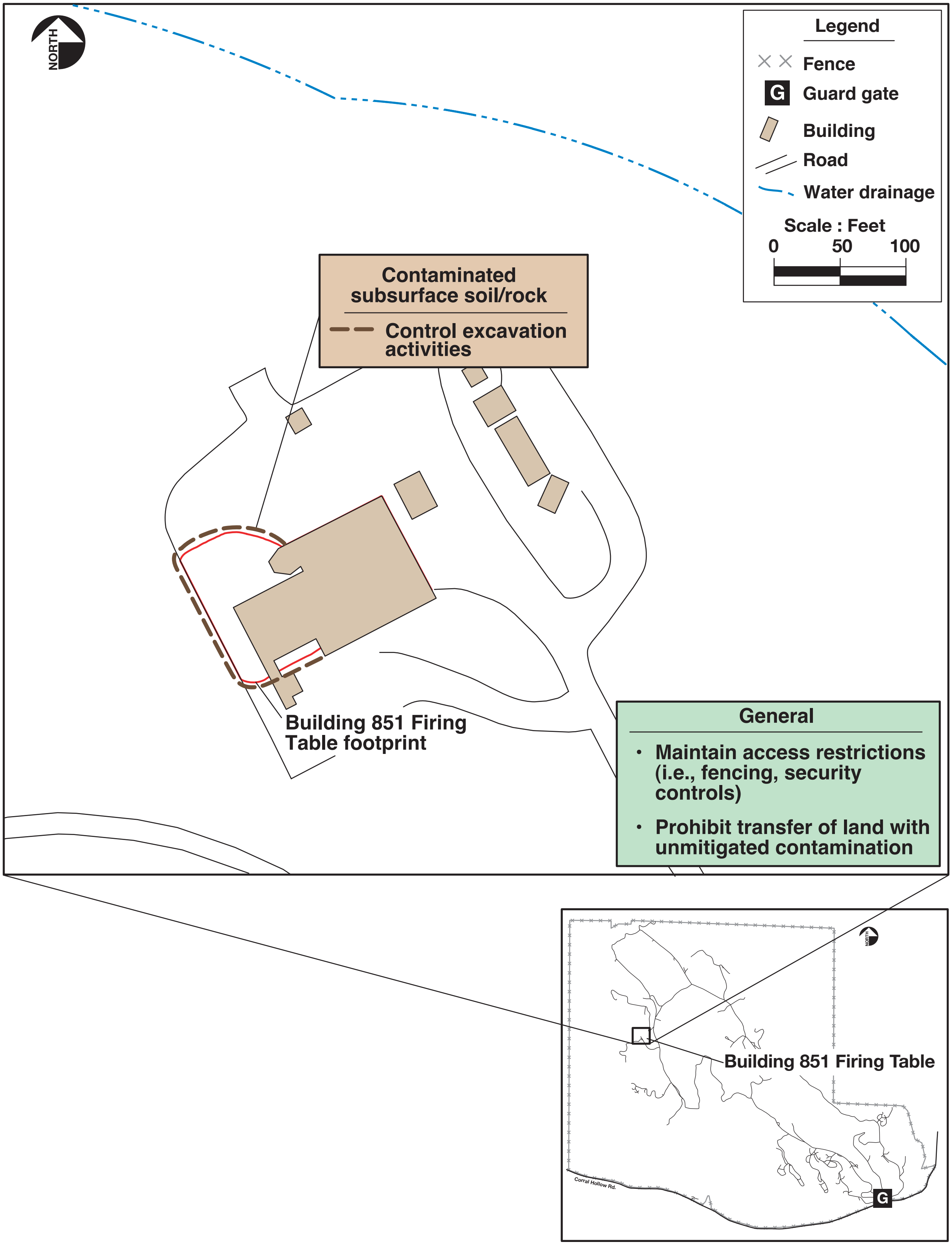

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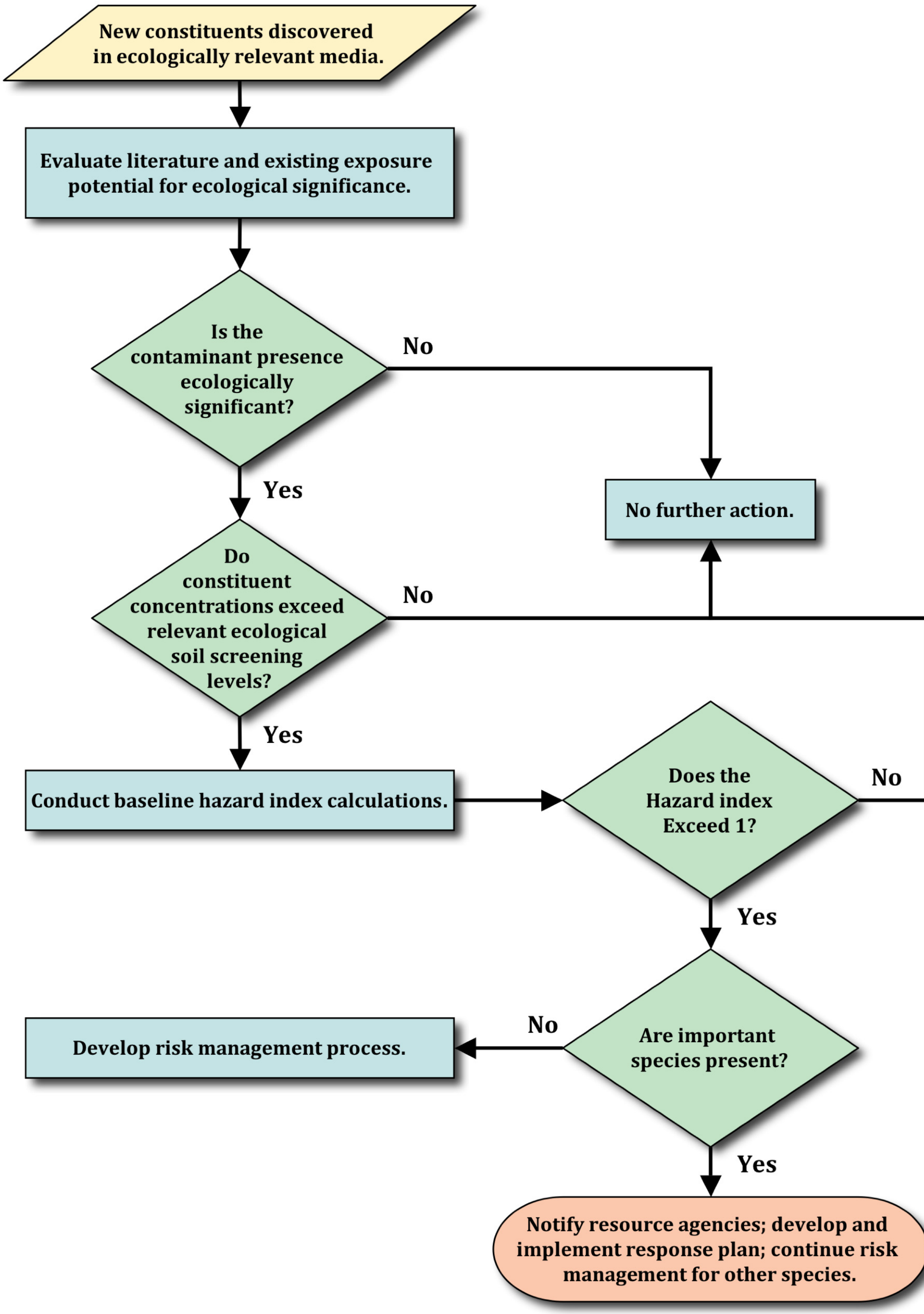

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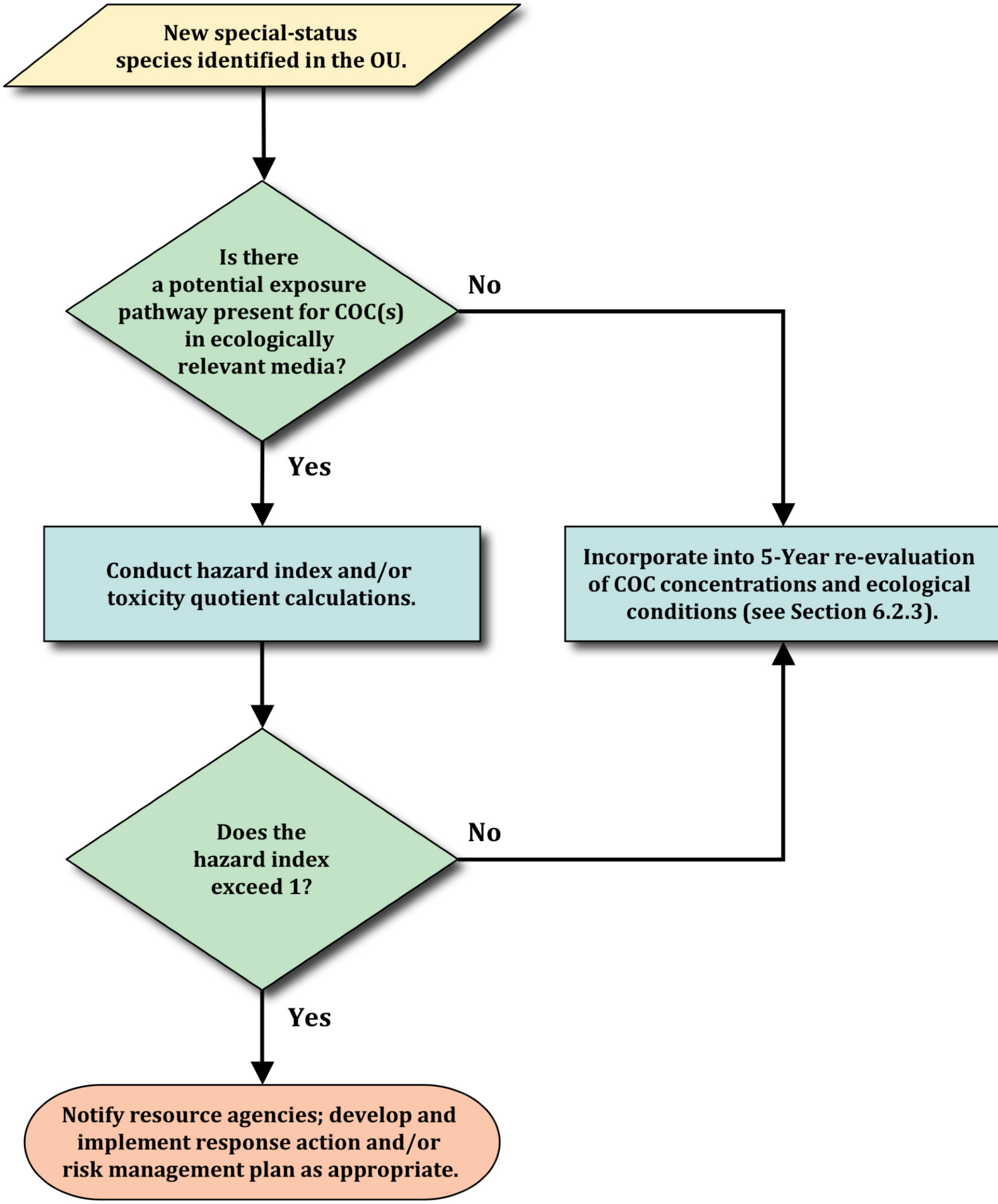

Figure 10-2. Contingency process for new special status species.

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Operable Unit (OU)	Ground Water COCs	Surface Water COCs	Surface Soil COCs	Subsurface Soil COCs
General Services Area (OU 1)				
	VOCs	None	None	VOCs
Building 834 (OU 2)				
	VOCs TBOS/TKEBs Nitrate (as NO_3)	None	None	VOCs
Pit 6 Landfill (OU 3)				
	VOCs Tritium Nitrate (as NO_3) Perchlorate	VOCs	None	None
HE Process Area (OU 4)				
	VOCs HE Compounds Nitrate (as NO_3) Perchlorate	VOCs	HE Compounds	VOCs HE Compounds
Building 850 Firing Table (OU 5)				
	Tritium Uranium-238 Nitrate (as NO_3) Perchlorate	Tritium	Beryllium Cadmium Copper HE Compounds PCBs Dioxins Furans Uranium-238	Tritium Uranium-238
Pit 7 Complex (OU 5)				
	Tritium VOCs Uranium Nitrate (as NO_3) Perchlorate[2]	None	None	Tritium Uranium-238
Building 854 (OU 6)				
	VOCs Nitrate (as NO_3) Perchlorate	None	Lead Zinc HE Compounds PCBs Tritium	VOCs

Table 1-1. Summary of contaminants of concern (COCs) in environmental media for Operable Units (OUs) 1 through 8 at Site 300 (continued).

Operable Unit (OU)	Ground Water COCs	Surface Water COCs	Surface Soil COCs	Subsurface Soil COCs
Building 832 Canyon (OU 7)				
	VOCs	**VOCs**	**HE Compounds**	**VOCs**
	Nitrate (as NO_3)			**HE Compounds**
	Perchlorate			**Nitrate (as NO_3)**
Building 801 Dry Well and the Pit 8 Landfill (OU 8)				
	VOCs	**None**	**None**	**VOCs**
	Nitrate (as NO_3)			
	Perchlorate			
Building 833 Area (OU 8)				
	VOCs	**None**	**None**	**VOCs**
Building 845 Firing Table and the Pit 9 Landfill (OU 8)				
	None	**None**	**None**	**HE Compounds**
				Uranium-238
Building 851 Firing Table (OU 8)				
	Uranium-238	**None**	**Cadmium**	**VOCs**
			Copper	**Uranium-238**
			Zinc	
			HE Compounds	
			Uranium-238	
Pit 2 Landfill (OU 8)				
	Nitrate (as NO_3)	**None**	**None**	**None**

Notes:

COC = Contaminant of concern.
HE = High explosive.
OU = Operable Unit.
PCBs = Polychlorinated biphenyls.
TBOS/TKEBs = Tetrabutyl orthosilicate/tetrakis (2-ethylbutyl) silane.
VOCs = Volatile organic compound.

Table 1-2. Summary of human health risks and hazards for Operable Units (OUs) 1 through 8 at Site 300.

Exposure media	Exposure pathway	Baseline Risk Assessment Risk/HI	2008 Risk/HI
General Services Area Operable Unit (OU 1)			
Volatilization of VOCs from subsurface soil	Inhalation inside Building 875	1×10^{-5}/<1	$<10^{-6}$/<1[a]
VOCs in ground water	Ingestion at hypothetical well at site boundary	7×10^{-2}/560	NC
Building 834 Operable Unit (OU 2)			
Volatilization of VOCs from subsurface soil	Inhalation inside Building 834D	1×10^{-3}/36	5×10^{-5}/<1
Volatilization of VOCs from subsurface soil	Inhalation outside Building 834D	6×10^{-4}/22	$<10^{-6}$/<1[b]
Pit 6 Landfill Operable Unit (OU 3)			
Volatilization of VOCs from subsurface soil	Inhalation at Pit 6 Landfill	5×10^{-6}/<1	$<10^{-6}$/<1[c]
Volatilization of VOCs from surface water	Inhalation at Spring 7	4×10^{-5}/1.5	NC
Volatilization of VOCs from surface water	Inhalation at SVRA pond[d]	3×10^{-6}/<1	NC
High Explosives Process Area Operable Unit (OU 4)			
Volatilization of VOCs from subsurface soil	Inhalation outside Building 815	5×10^{-6}/<1	$<10^{-6}$/<1[b]
Volatilization of VOCs from surface water	Inhalation at Spring 5	1×10^{-5}/<1	NC
VOCs and RDX in ground water	Ingestion at hypothetical well at site boundary[d]	1×10^{-5}/<1	NC
Building 850 Firing Table (OU 5)			
PCBs in surface soil	Inhalation, ingestion, and dermal contact	5×10^{-4}/NC	NC
Dioxins and furans in surface soil	Inhalation, ingestion, and dermal contact	1×10^{-4}/NC	NC
Volatilization of tritium from surface water	Inhalation at Well 8 Spring	1×10^{-3}/NC	NC
Pit 7 Complex (OU 5)			
Volatilization of tritium from subsurface soil	Inhalation at the Pit 3 Landfill	4×10^{-6}/NC	$<10^{-6}$/<1[e]
Building 854 Operable Unit (OU 6)			
Volatilization of VOCs from subsurface soil	Inhalation inside Building 854F	9×10^{-6}/NC	$<10^{-6}$/<1[f]
Volatilization of VOCs from subsurface soil	Inhalation outside Building 854F	1×10^{-5}/NC	$<10^{-6}$/<1[b]
PCBs in surface soil	Inhalation, ingestion, and dermal contact in the Building 855 Lagoon	7×10^{-5}/NC	$<10^{-6}$/<1[g]
Volatilization of VOCs from subsurface soil	Inhalation inside Building 854A	6×10^{-6}/NC	$<10^{-6}$/<1[b]

Table 1-2. Summary of human health risks and hazards for Operable Units (OUs) 1 through 8 at Site 300 (continued).

Exposure media	Exposure pathway	Baseline Risk Assessment Risk/HI	2008 Risk/HI
Building 832 Canyon Operable Unit (OU 7)			
Volatilization of VOCs from subsurface soil	**Inhalation outside Building 830**	**1×10^{-5}/NC**	**$<10^{-6}$/<1[b]**
Volatilization of VOCs from subsurface soil	**Inhalation inside Building 830**	**3×10^{-6}/NC**	**3×10^{-6}/<1**
Volatilization of VOCs from subsurface soil	**Inhalation inside Building 832F**	**3×10^{-6}/NC**	**$<10^{-6}$/<1[b]**
Volatilization of VOCs from surface water	**Inhalation at Spring 3**	**7×10^{-5}/2.3**	**$>10^{-6}$**
Building 801 Dry Well and Pit 8 Landfill (OU 8)			
NA[h]	**NA[h]**	**NA[h]**	**NA[h]**
Building 833 (OU 8)			
Volatilization of VOCs from subsurface soil	**Inhalation inside Building 833**	**1×10^{-6}/<1**	**4×10^{-7}/<1[i]**
Building 845 Firing Table and the Pit 9 Landfill (OU 8)			
NA[h]	**NA[h]**	**NA[h]**	**NA[h]**
Building 851 Firing Table (OU 8)			
NA[h]	**NA[h]**	**NA[h]**	**NA[h]**
Pit 2 Landfill (OU 8)			
NA[h]	**NA[h]**	**NA[h]**	**NA[h]**

Notes appear on the following page.

Table 1-2. Summary of human health risks and hazards for Operable Units (OUs) 1 through 8 at Site 300 (continued).

Notes:

HE = High Explosives.
HI = Hazard Index.
NA = Not applicable.
NC = Not calculated.
OU = Operable Unit.
PCBs = Polychlorinated biphenyls.
SVRA = State Vehicular Recreation Area.
VOCs = Volatile Organic Compounds.

[a] **In 2000, the risk estimate was recalculated to be 9.5×10^{-7}. This revised estimate considered, among other factors, the reduced concentration of VOCs in soil vapor near the building. Inhalation risk within Building 875 is no longer of concern.**

[b] **The estimated risk was below 10^{-6} and the hazard index was below 1 in 2003 and 2004 as reported in the Compliance Monitoring Reports (Dibley et. al., 2004a and Dibley et. al., 2005a).**

[c] **Risk was mitigated through the installation of an engineered landfill cap in 1997.**

[d] **Risk was estimated using fate and transport modeling of maximum VOC concentrations in 1991 to receptor point assuming no remediation or natural attenuation occurred.**

[e] **Risk re-evaluation, based on tritium decay between 1992 and 2007 indicates the estimated risk was below 10^{-6}.**

[f] **Risk was mitigated through the demolition of the building in 2005 (Dibley et. al., 2006b).**

[g] **Risk was mitigated through excavation and disposal of contaminated soil in 2005.**

[h] **No human health risks or hazards were identified.**

[i] **The risk and hazard evaluation for Building 833 will continue until estimated risk has remained below 10^{-6} and the hazard quotient has remained below 1 for two consecutive years using current data.**

Table 1-3. Summary of ecological hazards in Site 300 Operable Units (OUs) 1 through 8 at Site 300.

Media of Concern	Exposure Pathway	Receptors	Contami-nant	Baseline Risk Assessment[a]		Additional Assessments	Current Status	Risk/Hazard Management Measures
				HQ/TQ	Comments			
General Services Area (OU 1)								
All	None	All	All	<1	--	--	No ecological hazard present.	No risk/hazard management measures needed.
Building 834 (OU 2)								
Surface soil	Ingestion	Ground squirrel (individual adult) Kit fox (individual adult) Deer (individual J&A)	Cadmium	>1	Wildlife surveys found no impact to the Site 300 ground squirrel and deer populations and no evidence of kit fox.	Soil sampling conducted in 2003[b] resulted in HQ < 1.	No ecological hazard present.	No risk/hazard management measures needed.
Subsurface soil	Inhalation	Ground squirrel (individual J&A) Kit fox (individual J&A)	TCE	>1	Wildlife surveys found no impact to the Site 300 ground squirrel population and no evidence of kit fox.	Burrow air sampling completed in 2004[c] resulted in HQ < 1.	No ecological hazard present.[d]	No risk/hazard management measures needed.
	Inhalation	Ground squirrel (individual J&A) Kit fox (individual J&A)	PCE	>1	Wildlife surveys found no impact to the Site 300 ground squirrel population and no evidence of kit fox.	Burrow air sampling completed in 2004[c] resulted in HQ < 1.	No ecological hazard present.[d]	No risk/hazard management measures needed.

Table 1-3. Summary of ecological hazards in Site 300 Operable Units 1 through 8 at Site 300 (continued).

Media of Concern	Exposure Pathway	Receptors	Contami-nant	Baseline Risk Assessment[a]		Additional Assessments	Current Status	Risk/Hazard Management Measures
				HQ/TQ	Comments			
Pit 6 Landfill (OU 3)								
Subsurface soil	Inhalation	Ground squirrel (individual juvenile) Kit fox (individual J&A)	TCE	>1	Wildlife surveys found no impact to the Site 300 ground squirrel population and no evidence of kit fox.	Burrow air sampling completed in 2004[c] resulted in HQ < 1.	No ecological hazard present.[d]	No risk/hazard management measures needed.
Subsurface soil	Inhalation	Ground squirrel (individual juvenile) Kit fox (individual juvenile)	PCE	>1	Wildlife surveys found no impact to the Site 300 ground squirrel population and no evidence of kit fox.	Burrow air sampling completed in 2004[c] resulted in HQ < 1.	No ecological hazard present.[d]	No risk/hazard management measures needed.
	Inhalation	Ground squirrel (individual adult) Kit fox (individual adult)	Total VOCs	>1	Wildlife surveys found no impact to the Site 300 ground squirrel population and no evidence of kit fox.	Burrow air sampling completed in 2004[c] resulted in HQ < 1.	No ecological hazard present.[d]	No risk/hazard management measures needed.
High Explosives (HE) Process Area (OU 4)								
Surface soil	Ingestion	Ground squirrel (individual adult) Deer (J&A)	Cadmium	>1	Wildlife surveys found no impact to the Site 300 ground squirrel and deer populations.	Post-SWFS cadmium data not available	Current ecological hazard status undetermined.	Implement risk and hazard management measures (Section 6.2.1.2).

Table 1-3. Summary of ecological hazards in Site 300 Operable Units 1 through 8 at Site 300 (continued).

Media of Concern	Exposure Pathway	Receptors	Contami-nant	Baseline Risk Assessment[a]		Additional Assessments	Current Status	Risk/Hazard Management Measures
				HQ/TQ	Comments			
High Explosives (HE) Process Area (OU 4)								
Surface water (Spring 5)	Aquatic toxicity		Copper	>1	No surface water currently present.	Surface water samples within range of background.	No ecological hazard present.	No risk/hazard management measures needed.
Building 850/ Pit 7 Complex (OU 5								
Building 850								
Surface Soil	Ingestion	Ground squirrel (individual adult) Deer (individual J&A)	Cadmium	>1	Wildlife surveys found no impact to the Site 300 ground squirrel and deer populations.	HQ re-estimate conducted in 2003[b] indicated cadmium unlikely to pose a hazard.	No ecological hazard present.	No risk/hazard management measures needed.
	Ingestion	Ground squirrels (individual adult)	Copper	>1	Wildlife surveys found no impact to the Site 300 ground squirrel populations.		Soil removal action currently underway.	Addressed as part of Building 850 Soil Removal Action.
	Ingestion	Ground squirrel (individual) Deer (individual) Kit fox (individual)	PCBs, dioxins, and furans	NC	Literature review indicated individual animals at risk due to the potential for bioaccumulation. Wildlife surveys found no impact to Site 300 ground squirrel or deer populations and no	HQ estimate conducted in 2003[b] resulted in HQ>1.	Soil removal action currently underway.	Addressed as part of Building 850 Soil Removal Action.

Table 1-3. Summary of ecological hazards in Site 300 Operable Units 1 through 8 at Site 300 (continued).

Media of Concern	Exposure Pathway	Receptors	Contami-nant	Baseline Risk Assessment[a]		Additional Assessments	Current Status	Risk/Hazard Management Measures
				HQ/TQ	Comments			
Building 850 continued								
					evidence of kit fox.			
Subsurface soil	Ingestion	Burrowing owl	Cadmium	NC	Burrowing owl not identified in area at time of baseline.	Wildlife surveys revealed the presence of burrowing owl. HQ estimate conducted in 2003[b] indicated cadmium unlikely to pose a hazard.	No ecological hazard present.	No risk/hazard management measures needed.
	Ingestion	Burrowing owl	PCBs, dioxins, and furans	NC	Burrowing owl not identified in area at time of baseline.	Wildlife surveys revealed the presence of burrowing owl. HQ estimate conducted in 2003[b] resulted in HQ>1.	Soil removal action currently underway.	Addressed as part of Building 850 Soil Removal Action.
Pit 7 Complex								
None	NA	NA	None	-	No contaminants of concern identified in ecologically significant media.	-	No ecological hazard present.	No risk/hazard management measures needed.

Table 1-3. Summary of ecological hazards in Site 300 Operable Units 1 through 8 at Site 300 (continued).

Media of Concern	Exposure Pathway	Receptors	Contami-nant	Baseline Risk Assessment[a]		Additional Assessments	Current Status	Risk/Hazard Management Measures
				HQ/TQ	Comments			
Building 854 (OU 6)								
All	None	All	All	NC	The affected portion of this OU is paved and did not warrant an ecological assessment.	--	No ecological hazard present.	No risk/hazard management measures needed.
Building 832 Canyon (OU 7)								
All	None	All	All	<1	--	--	No ecological hazard present.	No risk/hazard management measures needed.
Site Wide (OU 8)								
Building 801/Pit 8 Landfill								
Surface soil	Oral and inhalation	Individual adult ground squirrels Individual deer (J&A)	Cadmium	>1	Surveys found no impact to populations.	Post-SWFS cadmium data not available.	Current ecological hazard status undetermined.	Implement risk and hazard management measures (Section 6.2.1.2).
Building 833								
All	All	All	All	<1			No ecological hazard present.	No risk/hazard management measures needed.
Building 845 Firing Table/Pit 9 Landfill								
None	NA	NA	None	-	No contaminants of concern identified in ecologically significant media.	-	No ecological hazard present.	No risk/hazard management measures needed.

Table 1-3. Summary of ecological hazards in Site 300 Operable Units 1 through 8 at Site 300 (continued).

Media of Concern	Exposure Pathway	Receptors	Contami-nant	Baseline Risk Assessment[a]		Additional Assessments	Current Status	Risk/Hazard Management Measures
				HQ/TQ	Comments			
Building 851 Firing Table								
Surface soil	Ingestion	Ground squirrels (individual adult) Deer (individual J&A)	Cadmium	>1	Wildlife surveys found no impact to the Site 300 ground squirrel and deer populations.	Post-SWFS cadmium data not available.	Current ecological hazard status undetermined	Implement risk and hazard management measures (Section 6.2.1.2).

Notes:

EWFA = East-West Firing Area.
HE = High explosives.
HQ = Hazard quotient.
J&A = Juvenile and adult.
NC = Not calculated.
OU = Operable unit.
PCBs = Polychlorinated biphenyls.
PCE = Perchloroethylene.
SWFS = Site-Wide Feasibility Study.
TCE = Trichloroethylene.
TQ = Toxicity quotient.
VOCs = Volatile organic compounds.

[a] **Baseline risk assessment includes assessments presented in the Site Wide Remedial Investigation (1994) , Site Wide Feasibility Study (1999), and the Pit 7 Complex Remedial Investigation/Feasibility Study (2005).**

[b] **2003 Annual Compliance Monitoring Report (Dibley et. al., 2004a).**

[c] **2004 First Semester Compliance Monitoring Report (Dibley et. al., 2004b).**

[d] **Volatile organic compounds in burrow air have been deleted from the list of ecological contaminants of concern and are no longer included in the Ecological Risk and Hazard Management Program.**

Table 1-4. Summary of selected remedy components for Operable Units (OUs) 1 through 8 at Site 300.

	Monitoring	Risk and hazard management	Monitored natural attenuation	Ground water extraction and treatment	Soil vapor extraction and treatment	Source control
General Services Area (OU 1)	√	√		√	√	
Building 834 (OU 2)	√	√		√	√	
Pit 6 Landfill (OU 3)	√	√	√			
HE Process Area (OU 4)	√	√	√	√		
Building 850 Firing Table (OU 5)	√	√	√			
Pit 7 Complex (OU 5)	√	√	√	√		√
Building 854 (OU 6)	√	√		√	√	
Building 832 Canyon (OU 7)	√	√	√	√	√	
Building 801 Dry Well and Pit 8 Landfill (OU 8)	√	√				
Building 833 (OU 8)	√	√				
Building 845 Firing Table and Pit 9 Landfill (OU 8)	√	√				
Building 851 Firing Table (OU 8)	√	√				
Pit 2 Landfill (OU 8)	√	√				

Notes:

OU = Operable Unit.

Table 3-1. Preliminary ground and surface water monitoring program analytes[a,b].

Area	VOCs	HE compounds	Nitrate	Perchlorate	TBOS/TKEBS	Tritium	Uranium
GSA	Primary COC						
Building 834	Primary COC		Secondary COC		Secondary COC		
Pit 6 Landfill	Primary COC		Secondary COC	Secondary COC		Primary COC	
HE Process Area	Primary COC	Secondary COC	Secondary COC	Secondary COC			
Building 850			Secondary COC	Primary COC		Primary COC	Secondary COC
Pit 7 Complex	Secondary COC		Secondary COC	Secondary COC		Primary COC	Secondary COC
Building 854	Primary COC		Secondary COC	Primary COC			
Building 830	Primary COC	Vadose zone COC (HMX)	Secondary COC	Secondary COC			
Building 832	Primary COC		Secondary COC	Secondary COC			
Building 801	Primary COC		Secondary COC	Secondary COC			
Building 833	Primary COC						
Building 845		Vadose zone COC (HMX)					Vadose zone COC
Building 851	Vadose zone COC						Primary COC

Notes:

COC = **Contaminant of concern.**

GSA = **General Services Area.**

HE = **High explosives.**

HMX = **High melting explosive.**

RDX = **Research Department explosive.**

TBOS = **Tetra-butyl-orthosilicate.**

TKEBS = **Tetra-kis-2-ethylbutylorthoslicate.**

VOCs = **Volatile organic compounds.**

Notes continued on next page.

Table 3-1. Preliminary ground and surface water monitoring program analytes (continued).

Notes (continued):

Analytical methods:

Analyte	Analytical method
VOCs	U.S. EPA Method 601
HE compounds	U.S. EPA Method 8330 (RDX and/or HMX)
Nitrate	U.S. EPA Method 300.0
Perchlorate	U.S. EPA Method 300.0 or 314.0
TBOS/TKEBS	U.S. EPA Method 8015 (modified)
Tritium	U.S. EPA Method 906
Uranium	U.S. EPA Method
Metals	Various methods

[a] **Final analytes for the Ground and Surface Water Monitoring Program will be defined in detailed sampling and analysis plans presented in the semi-annual Compliance Monitoring Reports.**

[b] **Vadose zone COCs that have impacted ground water are monitored as ground water COCs and are not listed separately.**

Table 4-1. Detection monitoring sampling and analysis plan for the Pit 2, 3, 4, 5, 7, 8, and 9 Landfills.

Analyte	Frequency	Analytical method
Tritium	Annual	U.S. EPA Method 906
Volatile organic compounds	Annual	U.S. EPA Methods 601/602 or 624
Fluoride	Annual	U.S. EPA Method 340.2
High explosive compounds	Annual	U.S. EPA Method 8330
Nitrate	Annual	U.S. EPA Method 300.0
Perchlorate	Annual	U.S. EPA Method 300.0 or 314.0
Uranium (isotopes or total)	Annual	Alpha or mass spectrometry or kinetic phosphorescence analysis (KPA).
Title 26 metals[a]	Annual	Various methods
Lithium	Annual	U.S. EPA Method 200.8
Polychlorinated biphenyls[b]	Annual	U.S. EPA Method 8082

Notes:

[a] Title 26 metal include: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc.

[b] Sampling for polychlorinated biphenyls only applies to the Pit 7 Complex detection monitoring program.

Table 5-1. Ground water treatment system sampling and analysis plan[a, b].

Ground water treatment system	Analytes						
	VOCs	TBOS/TKEBS	Nitrate	Perchlorate	HE compounds	Uranium	Tritium[c]
GSA:							
Central GSA	√						
Building 834:							
B834-SRC	√	√	√				
HE Process Area[c]:							
B815-SRC	√			√	√		
B815-PRX	√			√	√		
B815-DSB[d]	√						
B817-SRC	√			√	√		
B817-PRX	√			√	√		
B829-SRC	√		√	√			
Pit 7 Complex :							
PIT7-SRC	√		√	√		√	√[e]
Building 854:							
B854-SRC	√		√	√			
B854-PRX	√		√	√			
B854-DIS	√		√	√			
Building 832 Canyon[c,f]:							
B832-SRC	√			√			
B830-SRC	√			√			
B830-DISS	√[f]			√			

Notes appear on the following page.

Table 5-1. Ground water treatment system sampling and analysis plan[a, b] (continued).

Notes:

DIS = **Distal.**
DISS = **Distal south.**
DSB = **Distal site boundary.**
GSA = **General Services Area.**
HE = **High explosives.**
PRX = **Proximal.**
SRC = **Source.**
TBOS = **Tetra-butyl-orthosilicate.**
TKEBS = **Tetra-butyl-2-orthoslicate.**
VOCs = **Volatile organic compounds.**

Analytical Methods:

VOCs	U.S. EPA Method 601
HE compounds	U.S. EPA Method 8330 (RDX & HMX)
Nitrate	U.S. EPA Method 300.0
Perchlorate	U.S. EPA Method 300.0 or 314.0
TBOS/TKEBS	U.S. EPA Method 8015 (modified)
Tritium	U.S. EPA Method 906
Uranium	U.S. EPA Method

[a] **Final analyte list will be defined in detailed sampling and analysis plans presented in the semiannual Compliance Monitoring Reports.**

[b] **Table indicates analytes for which samples will be analyzed in the treatment system influent and/or effluent.**

[c] **No monitoring of nitrate in treatment system influent and effluent where: (1) the selected remedy for nitrate is monitored natural attenuation, or (2) the effluent discharge method is misting and no discharge limit is specified. The nitrate input and mass discharged can be determined using monitoring data for extraction wells associated with the treatment system.**

[d] **Only VOCs are detected in the B815-DSB extraction wells.**

[e] **Although tritium is not treated/removed by the PIT7-SRC system, tritium activities will be monitored in the system effluent to determine tritium levels that are being discharged to the infiltration trench.**

[f] **Because ground water is treated at the B830-DISS system only for perchlorate removal, and is then pumped to the Central GSA system for VOC removal, the monitoring of VOCs will be conducted at the Central GSA treatment facility.**

Table 6-1. Summary of current inhalation risks and hazards resulting from transport of contaminant vapors to indoor air.

Area	Pathway and Model	Contaminant	Incremental Risk	Hazard Quotient	Comment
Building 834D	**Indoor – JEM**	**TCE**	**2.3×10^{-4}**	**4.5×10^{-1}**	**Based on a TCE ground water concentration of 25,000 µg/L (April 2007) in well W-834-D4.**
	Indoor – JEM	**PCE**	**7.7×10^{-6}**	**1.2×10^{-1}**	**Based on a PCE ground water concentration of 170 µg/L (February 2007) in wellW-834-D13.**
	Cumulative risk and hazard index		**2.4×10^{-4}**	**5.8×10^{-1}**	**Institutional controls in place, building only used for storage.**
Building 830	**Indoor – JEM**	**Vinyl Chloride**	**6.1×10^{-7}**	**1.2×10^{-3}**	**Based on the vinyl chloride reporting limit of 50 µg/L (July 2007) in well W-830-34.**
	Indoor – JEM	**TCE**	**3.7×10^{-6}**	**7.2×10^{-3}**	**Based on a TCE ground water concentration of 940 µg/L (July 2007) in well W-830-34.**
	Cumulative risk and hazard index		**4.3×10^{-6}**	**8.4×10^{-3}**	**Institutional controls in place.**
Building 833	**Indoor – JEM**	**TCE**	**4.7×10^{-8}**	**9.1×10^{-5}**	**Based on a TCE ground water concentration of 20 µg/L (June 2000) in well W-833-03. Contaminated wells in this area have been dry since 2000.**
	Indoor – JEM	**Chloroform**	**1.8×10^{-9}**	**2.7×10^{-5}**	**Based on the chloroform reporting limit of 0.5 µg/L in sampled wells.**
	Cumulative risk and hazard index		**4.9×10^{-8}**	**1.2×10^{-4}**	**Institutional and engineering controls are in place. The air conditioning unit in Building 833 is operated continuously to maintain neutral pressure differential between the subsurface and indoor air, and to maintain high exchange rates.**

Notes:

JEM = **Johnson-Ettinger Model for indoor air pathway (USEPA, GW-ADV Version 3.1; 02/04), incorporates the updated risk values in DTSC (2005) Interim Final Vapor Intrusion Guidance.**

NC = **Not calculated.**

PCE = **Tetrachloroethene.**

TCE = **Trichloroethene.**

µg/L = **Micrograms per liter.**

Table 6-2. Analyte list for ambient air sampling at Springs 3, 5 and 7.

Constituent	Reporting Limit (ppbv)	Screening Level [a] (ppbv)
Vinyl chloride	0.5	1.1
1,1-Dichloroethene	0.5	220
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	0.5	17,000
Cis-1,2-Dichloroethene	0.5	No SL
Chloroform	0.5	0.11
1,2-Dichloroethane	0.5	0.12
Trichloroethene	0.5	1.1
1,2-Dichloropropane	0.5	0.26
1,1,2-Trichloroethane	0.5	0.14
Tetrachloroethene	0.5	0.31
Trans-1,2-Dichloroethene	0.5	66
Methylene chloride	0.5	7.5

Notes:

ppbv = parts per billion by volume.

Samples will be collected in SUMMA canisters and analyzed by EPA method TO15.

[a] **Industrial Air Regional Screening Levels for Chemical Contaminants at Superfund Sites, as of July 7, 2008 converted from µg/m^3 to ppbv.**

Table 6-3. Description of institutional/land use controls for the General Services Area Operable Unit.

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Prevent water-supply use/consumption of contaminated ground water until ground water cleanup standards are met.	VOC concentrations in ground water exceeding cleanup standards.	**Central GSA:** There are no existing or planned water-supply wells in the Central GSA Operable Unit. Any proposed well drilling activities would be submitted to the LLNL Work Induction Board, and are reviewed by LLNL Environmental Restoration Department to ensure that new water-supply wells are not located in areas of ground water contamination. Existing offsite downgradient water-supply wells are monitored monthly for contaminants of concern in ground water that could potentially impact the wells. There is a Memorandum of Understanding with the owners of the offsite downgradient water-supply wells that includes point-of-use treatment if VOCs above MCLs are detected in the well. **Eastern GSA:** In 2006, VOC concentrations in Eastern GSA ground water have been reduced to below ground water cleanup standards (MCLs) through remediation, therefore this institutional/land use control is no longer needed.
Control excavation activities to prevent onsite worker exposure to VOCs in subsurface soil until it can be verified that concentrations do not pose an exposure risk to onsite workers.	Potential exposure to VOCs at depth in subsurface soil at the Building 875 dry well pad[a].	**Central GSA:** All proposed excavation activities must be cleared through the LLNL Work Induction Board and require an excavation permit. The Work Induction Board coordinates with LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants in the proposed construction areas. If a potential for contaminant exposure is identified, LLNL Hazards Control ensures that hazards are adequately evaluated and the necessary controls are identified and implemented prior to the start of work. The Work Induction Board including the LLNL Environmental Analyst will also work with the Program proposing the construction project to determine if the work plans can be modified to move construction activities outside of areas of contamination. Controls for excavation activities will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents. **Eastern GSA:** Institutional/land use controls are not necessary to prevent worker exposure to VOCs in surface and subsurface soil because concentrations are below the U.S. EPA's industrial and residential Preliminary Remediation Goals.

Table 6-3. Description of institutional/land use controls for the General Services Area Operable Unit (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Maintain engineering controls to prevent onsite site worker inhalation exposure to VOCs inside Building 875 until annual risk re-evaluation indicates that the risk is less than 10^{-6}.	A pre-remediation risk of 1×10^{-5} was identified for onsite workers from inhalation of VOCs volatilizing from subsurface soil into ambient air inside Building 875 (Central GSA).	**Central GSA:** Engineering controls (heating, ventilating, and air-conditioning system for Building 875) were implemented to prevent onsite worker exposure to VOCs that could migrate from the subsurface into the building until the inhalation risk was mitigated through remediation. The risk has been successfully reduced to less than 10^{-6} through ground water and soil vapor extraction and treatment in the Building 875 area as of 2000 (see Section 3.5), therefore this institutional/land use control is no longer needed. **Eastern GSA:** There is no risk or hazard associated with soil in the Eastern GSA.
Prohibit transfer of lands with unmitigated contamination that could cause potential harm under residential or unrestricted land use.	Potential exposure to contaminated waste and/or environmental media.	The Site 300 Federal Facility Agreement contains provisions that assure DOE will not transfer lands with unmitigated contamination that could cause potential harm. In the event that the Site 300 property is transferred in the future, DOE will execute a land use covenant at the time of transfer in compliance with Title 22 California Code of Regulations, Division 4.5, Chapter 39, Section 67391.1. Development will be restricted to industrial land usage. These restrictions will remain in place until and unless a risk assessment is performed in accordance with then current U.S. EPA risk assessment guidance and is agreed by the DOE, U.S. EPA, DTSC, and RWQCB as adequately showing no unacceptable risk for residential or unrestricted land use. These restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning document.

Notes:

DOE = United States Department of Energy.
DTSC = California Department of Toxic Substances Control.
GSA = General Services Area.
LLNL = Lawrence Livermore National Laboratory.
MCLs = Maximum Contaminant Levels.
RWQCB = California Regional Water Quality Control Board.
U.S. EPA = United States Environmental Protection Agency.
VOCs = Volatile organic compounds.

[a] **Risk for onsite worker exposure to VOCs at depth in subsurface soil could not be re-calculated as there are no new subsurface soil data. Land use controls based on the potential exposure to VOCs in subsurface soil during ground-breaking construction activities conservatively assume that the VOCs in subsurface soil may pose a risk to human health.**

Table 6-4. Description of institutional/land use controls for the Building 834 Operable Unit.

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Prevent water-supply use/consumption of contaminated groundwater until ground water cleanup standards are met.	VOCs and nitrate concentrations in ground water exceeding drinking water standards.	There are no existing or planned water-supply wells in the Building 834 Operable Unit. Any proposed well drilling activities would be submitted to the LLNL Work Induction Board, and are reviewed by LLNL Environmental Restoration Department to ensure that new water-supply wells are not located in areas of ground water contamination. Prohibitions on drilling water-supply wells in areas of ground water contamination will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents. Contamination is limited to onsite ground water and modeling indicates the plumes will not migrate offsite. Therefore, land use controls are not needed to prevent offsite water-supply use/consumption of contaminated ground water.
Control excavation activities to prevent onsite worker exposure to VOCs in subsurface soil until it can be verified that concentrations do not pose an exposure risk to onsite workers.	Potential exposure to VOCs at depth in subsurface soil at the Building 834 Complex[a].	All proposed excavation activities must be cleared through the LLNL Work Induction Board and require an excavation permit. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants in the proposed construction areas. If a potential for contaminant exposure is identified, the LLNL Site 300 Hazards Control Department ensures that hazards are adequately evaluated and the necessary controls are identified and implemented prior to the start of work. The Work Induction Board including the LLNL Environmental Analyst will also work with the Program proposing the construction project to determine if the work plans can be modified to move construction activities outside of areas of contamination. Controls for excavation activities will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents.
Maintain building occupancy restriction to prevent onsite worker inhalation exposure to VOCs inside Building 834D until annual risk re-evaluation indicates that the risk is less than 10^{-6}.	A pre-remediation risk of 1×10^{-3} was identified for onsite workers from inhalation of VOCs volatilizing from subsurface soil into ambient air inside Building 834D.	Building 834 D is not currently occupied. Warning signs are in place and will be maintained prohibiting full time occupancy without notification and authorization by LLNL Site 300 Management. Any significant changes in activities conducted in Building 834D must be cleared through LLNL Work Induction Board. The Work Induction Board coordinates with the LLNL Environmental Restoration Division to identify if there is a potential for exposure to contaminants as a result of the proposed building usage. If a potential for contaminant exposure is identified as a result of the changes in building use, the LLNL Site 300 Hazards Control Department will be notified and determine any necessary engineered control requirements to prevent exposure. If full-

Table 6-4. Description of institutional/land use controls for the Building 834 Operable Unit (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Building occupancy restrictions *(continued)*		time building occupancy is proposed, engineering controls will be implemented to prevent onsite worker exposure that could migrate from the subsurface into the building until the inhalation risk was mitigated through remediation. This building occupancy restriction will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents. DOE will conduct annual risk re-evaluations to determine when the tritium inhalation risk inside Building 834D has been mitigated. The risk re-evaluation results will be reported in the Annual Site-Wide Compliance Monitoring Reports. The baseline risk assessment also identified a pre-remediation risk of 6×10^{-4} for onsite workers continuously inhaling VOC vapors volatilizing from the vadose zone into outdoor air in the vicinity of Building 834D over a 25-year period. However this risk has been successfully mitigated through ground water and soil vapor extraction and treatment, therefore institutional/land use controls are no longer needed to prevent onsite worker exposure to VOCs in outdoor air.
Prohibit transfer of lands with unmitigated contamination that could cause potential harm under residential or unrestricted land use.	Potential exposure to contaminated waste and/or environmental media.	The Site 300 Federal Facility Agreement contains provisions that assure that DOE will not transfer lands with unmitigated contamination that could cause potential harm. In the event that the Site 300 property is transferred in the future, DOE will execute a land use covenant at the time of transfer in compliance with Title 22 California Code of Regulations, Division 4.5, Chapter 39, Section 67391.1. Development will be restricted to industrial land usage. These restrictions will remain in place until and unless a risk assessment is performed in accordance with then current U.S. EPA risk assessment guidance and is agreed by the DOE, U.S. EPA, DTSC, and the RWQCB as adequately showing no unacceptable risk for residential or unrestricted land use. These restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning document.

Notes:

DOE = United States Department of Energy.
DTSC = California Department of Toxic Substances Control.
U.S. EPA = United States Environmental Protection Agency.
LLNL = Lawrence Livermore National Laboratory.
RWQCB = California Regional Water Quality Control Board.
VOCs = Volatile organic compounds.

[a] **Risk for onsite worker exposure to VOCs at depth in subsurface soil could not be re-calculated as there are no new subsurface soil data. Land use controls based on the potential exposure to VOCs in subsurface soil during ground-breaking construction activities conservatively assume that the VOCs in subsurface soil may pose a risk to human health.**

Table 6-5. Description of institutional/land use controls for the Pit 6 Landfill Operable Unit.

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Prevent water-supply use/consumption of contaminated groundwater until ground water cleanup standards are met.	VOCs, and nitrate concentrations in ground water exceeding drinking water standards.	There are no existing or planned water-supply wells in the Pit 6 Landfill Operable Unit. Any proposed well drilling activities would be submitted to the LLNL Work Induction Board, and are reviewed by the LLNL Environmental Restoration Department to ensure that new water-supply wells are not located in areas of ground water contamination. Prohibitions on drilling water-supply wells in areas of ground water contamination will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents. Contamination is limited to onsite ground water. TCE is present in only one well at a concentration slightly exceeding the drinking water standard; all other VOCs in ground water are below drinking water standards. Nitrate is detected at a concentration exceeding the drinking water standard in only one well. The elevated nitrate is likely due to septic system discharge rather than from the Pit 6 Landfill. Therefore, land use controls are not needed to prevent offsite water-supply use/consumption of contaminated ground water.
Maintain the integrity of landfill cap as long as the pit waste remains in place.	Potential exposure to contaminants in pit waste[a].	DOE will inspect and maintain the landfill cap, and ground water monitoring system. Landfill cap maintenance and inspection requirements are specified in post-closure plan for the Pit 6 Landfill.
Control construction and other ground-breaking activities on the Pit 6 Landfill to prevent cap/cover damage and/or inadvertent exposure to pit waste as long as the pit waste remains in place.	Potential exposure to contaminants in pit waste[a].	All proposed ground-breaking construction activities must be cleared through LLNL Work Induction Board and require an excavation permit. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants in the proposed construction areas. If a potential for contaminant exposure is identified, the LLNL Hazards Control ensures that hazards are adequately evaluated and necessary controls identified and implemented prior to the start of work. The Work Induction Board including the LLNL Environmental Analyst will also work with the Program proposing the construction project to determine if the work plans can be modified to move construction activities outside of areas of contamination. Controls for construction and other ground-breaking activities will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents.

Table 6-5. Description of institutional/land use controls for the Pit 6 Landfill Operable Unit (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Maintain access restrictions to prevent inadvertent exposure of onsite workers to the pit waste as long as the waste in the Pit 6 Complex Landfill remains in place.	Potential exposure to contaminants in pit waste[a].	Signage is in place and will be maintained at the Pit 6 Landfill access points prohibiting unauthorized access and requiring notification and authorization by LLNL Site 300 Management to enter, dig, excavate, or otherwise disturb soil or vegetation in this area (see administrative controls for ground-breaking construction activities above). These access restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents.
Maintain access restrictions to prevent inadvertent exposure of unauthorized trespassers to the pit waste as long as the waste in the Pit 6 Complex Landfill remains in place.	Potential exposure to contaminants in pit waste[a].	Site access by unauthorized trespassers is prevented by fences and warning signs at the site boundary and control entry systems at Site 300. These measures are maintained by the LLNL Security Department. There is no offsite contamination associated with the Pit 6 Landfill to which the public could be exposed. These access restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents.
Maintain land use restriction in the vicinity of Spring 7 until annual risk re-evaluation indicates that the risk is less than 10^{-6}.	A 4 x 10^{-5} risk was identified for onsite workers continuously inhaling VOC vapors volatilizing from Spring 7 into outdoor air.	Spring 7 has been dry since 2003. Current activities in the vicinity of the Well 8 Spring are restricted to semi-annual spring sampling. The time spent sampling is well below the exposure scenario for which the unacceptable exposure risk was calculated, which assumed a worker would spend 8 hours a day, five days a week for 25 years working at Spring 7. DOE will conduct annual risk re-evaluations when water is present in Spring 7 to determine when the inhalation risk has been mitigated. The risk re-evaluation results will be reported in the Annual Site-Wide Compliance Monitoring Reports. Any significant changes in activities conducted in the Spring 7 area must be cleared through the LLNL Work Induction Board. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants as a result of the proposed area usage. If a potential for contaminant exposure is identified as a result of these changes in activities or area use, LLNL Hazards Control is notified and determines any necessary personal protective equipment to prevent exposure.

Table 6-5. Description of institutional/land use controls for the Pit 6 Landfill Operable Unit (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Prohibit transfer of lands with unmitigated contamination that could cause potential harm under residential or unrestricted land use.	Potential exposure to contaminated waste and/or environmental media.	The Site 300 Federal Facility Agreement contains provisions that assure that DOE will not transfer lands with unmitigated contamination that could cause potential harm. In the event that the Site 300 property is transferred in the future, DOE will execute a land use covenant at the time of transfer in compliance with Title 22 California Code of Regulations, Division 4.5, Chapter 39, Section 67391.1. Development will be restricted to industrial land usage. These restrictions will remain in place until and unless a risk assessment is performed in accordance with then current U.S. EPA risk assessment guidance and is agreed by the DOE, U.S. EPA, DTSC, and the RWQCB as adequately showing no unacceptable risk for residential or unrestricted land use. These restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning document.

Notes:

DOE = U.S. Department of Energy.

DTSC = California Department of Toxic Substances Control.

U.S. EPA = United States Environmental Protection Agency.

LLNL = Lawrence Livermore National Laboratory.

RWQCB = California Regional Water Quality Control Board.

TCE = Trichloroethylene.

VOCs = Volatile organic compounds.

[a] **A risk for exposure to contaminants in the pit waste could not be calculated due to safety restrictions on penetrating landfill waste. Land use controls based on the potential exposure to contaminants in pit waste conservatively assume that the waste contaminants may pose a risk to human health.**

Table 6-6. Description of institutional/land use controls for the High Explosives Process Area Operable Unit.

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Prevent water-supply use/consumption of contaminated groundwater until ground water cleanup standards are met.	VOCs, RDX, nitrate, and perchlorate concentrations in ground water exceeding drinking water standards.	There are two onsite water-supply wells in the HEPA Operable Unit (Wells 18 and 20). Contamination in HEPA ground water is contained in an aquifer that is 250 ft above, and hydraulically separated from the deeper, clean aquifer in which Well 20 is screened. While Well 18 is no longer used as a water supply well, it is a backup well for emergency fire suppression. Well 18 is cased through the contaminated aquifer. Therefore, onsite workers are not at risk from drinking contaminated water from Wells 18 and 20. Wells 18 and 20 are sampled monthly for contamination. Any proposed well drilling activities would be submitted to the LLNL Work Induction Board, and are reviewed by the LLNL Environmental Restoration Department to ensure that new water-supply wells are not located in areas of ground water contamination. Prohibitions on drilling water-supply wells in areas of ground water contamination will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents. Ground water extraction is underway at the site boundary to prevent offsite migration of the VOC plume. Therefore, land use controls are not needed to prevent offsite water-supply use/consumption of contaminated ground water.
Control excavation activities to prevent onsite worker exposure to contaminants in subsurface soil until it can be verified that concentrations do not pose an exposure risk to onsite workers.	Potential exposure to VOCs, HMX, and RDX at depth in subsurface soil at the HEPA OU[a].	All proposed excavation activities must be cleared through the LLNL Work Induction Board and require an excavation permit. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants in the proposed construction areas. If a potential for contaminant exposure is identified, LLNL Hazards Control ensures that hazards are adequately evaluated and necessary controls identified and implemented prior to the start of work. The Work Induction Board including the LLNL Environmental Analyst will also work with the Program proposing the construction project to determine if the work plans can be modified to move construction activities outside of areas of contamination.
Maintain land use restriction in the vicinity of Building 815 until annual risk re-evaluation indicates that the risk is less than 10^{-6}.	Pre-remediation risk of 5×10^{-6} for onsite workers from inhalation of VOCs volatilizing from the subsurface soil into outdoor air in the vicinity of Building 815.	This risk has been successfully mitigated since 2004 through ground water extraction and treatment, therefore this institutional/land use control is no longer needed.

Table 6-6. Description of institutional/land use controls for the High Explosives Process Area Operable Unit (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Maintain land use restriction in the vicinity of Spring 5 until annual risk re-evaluation indicates that the risk is less than 10^{-6}.	1×10^{-5} risk for onsite workers continuously inhaling VOC vapors volatilizing from Spring 5 into outdoor air over a 25-year period.	The spring has been dry since 2003. There are currently no active facilities located in the vicinity of the Spring 5 and there is no surface water present in the spring. Current activities in the vicinity of the Spring 5 are restricted to semi-annual spring sampling. The time spent sampling is well below the exposure scenario for which the unacceptable exposure risk was calculated, which assumed a worker would spend 8 hours a day, five days a week for 25 years working at Spring 5. DOE will conduct annual risk re-evaluations when water is present in Spring 5 to determine when the inhalation risk has been mitigated. The risk re-evaluation results will be reported in the Annual Site-Wide Compliance Monitoring Reports. Any significant changes in activities conducted in the Spring 5 area must be cleared through LLNL Work Induction Board. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants as a result of the proposed area usage. If a potential for contaminant exposure is identified as a result of these changes in activities or area use, LLNL Hazards Control is notified and determines any necessary personal protective equipment to prevent exposure.
Prohibit transfer of lands with unmitigated contamination that could cause potential harm under residential or unrestricted land use.	Potential exposure to contaminated waste and/or environmental media.	The Site 300 Federal Facility Agreement contains provisions that assure that DOE will not transfer lands with unmitigated contamination that could cause potential harm. In the event that the Site 300 property is transferred in the future, DOE will execute a land use covenant at the time of transfer in compliance with Title 22 California Code of Regulations, Division 4.5, Chapter 39, Section 67391.1. Development will be restricted to industrial land usage. These restrictions will remain in place until and unless a risk assessment is performed in accordance with then current U.S. EPA risk assessment guidance and is agreed by the DOE, the U.S. EPA, DTSC, and the RWQCB as adequately showing no unacceptable risk for residential or unrestricted land use. These restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning document.

Notes appear on the following page.

Table 6-6. Description of institutional/land use controls for the High Explosives Process Area Operable Unit (continued).

Notes:

DOE =	United States Department of Energy.
DTSC =	California Department of Toxic Substances Control.
U.S. EPA =	United States Environmental Protection Agency.
HEPA =	High Explosives Process Area.
HMX =	High melting explosive.
LLNL =	Lawrence Livermore National Laboratory.
RDX =	Research department explosive.
RWQCB =	California Regional Water Quality Control Board.
VOCs =	Volatile organic compounds.

[a] **Risk for onsite worker exposure to VOCs, RDX, and HMX at depth in subsurface soil during excavation activities was not calculated as this was not considered a long-term exposure scenario. As a result, land use controls based on the potential exposure to VOCs, RDX, and HMX in subsurface soil during excavation conservatively assume that the these COCs in subsurface soil may pose a risk to human health.**

Table 6-7. Description of institutional/land use controls for the Building 850 Firing Table.

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Prevent water-supply use/consumption of contaminated groundwater until ground water cleanup standards are met.	Tritium, depleted uranium, and nitrate concentrations in ground water exceeding drinking water standards.	There are no existing or planned water-supply wells in the Building 850 Firing Table area. Any proposed well drilling activities would be submitted to the LLNL Work Induction Board, and are reviewed by the LLNL Environmental Restoration Department to ensure that new water-supply wells are not located in areas of ground water contamination. Prohibitions on drilling water-supply wells in areas of ground water contamination will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents. Contamination is limited to onsite ground water and modeling indicates the plumes will not migrate offsite. Therefore, land use controls are not needed to prevent offsite water-supply use/consumption of contaminated ground water.
Control excavation activities to prevent onsite worker exposure to contaminants in subsurface soil until it can be verified that subsurface soil does not pose an exposure risk to onsite workers.	Potential exposure to tritium and depleted uranium at depth in subsurface soil at the Building 850 Firing Table[a].	All proposed excavation activities must be cleared through the LLNL Work Induction Board and require an excavation permit. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants in the proposed construction areas. If a potential for contaminant exposure is identified, LLNL Hazards Control ensures that hazards are adequately evaluated and necessary controls identified and implemented prior to the start of work. The Work Induction Board including the LLNL Environmental Analyst will also work with the Program proposing the construction project to determine if the work plans can be modified to move construction activities outside of areas of contamination.
Maintain land use restrictions in the vicinity of Building 850 Firing Table until remediation of PCB-, dioxin-, and furan-contaminated soil reduces the risk to onsite workers to less than 10^{-6}.	5×10^{-4} and 1×10^{-4} risk for onsite workers from inhalation or ingestion of resuspended particulates and dermal contact with PCBs, and dioxin and furan compounds in surface soil at the Building 850 Firing Table, respectively.	Current activities in the vicinity of the Building 850 Firing Table are well below the exposure scenario for which the unacceptable exposure risk was calculated, which assumed a worker would spend 8 hours a day, five days a week for 25 years on the firing table. Any significant changes in activities conducted in the Building 850 Firing Table must be cleared through LLNL Work Induction Board. The Work Induction Board coordinates with the LLNL Environmental Restoration Department.

Table 6-7. Description of institutional/land use controls for the Building 850 Firing Table (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Control construction and other ground-breaking activities on or near the soil solidification corrective action management unit (CAMU) to prevent damage and/or inadvertent exposure to soil.	Potential exposure to soil contaminated with PCBs and dioxin and furan compounds.	All proposed ground-breaking construction activities must be cleared through LLNL Work Induction Board and require an excavation permit. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants in the proposed construction areas or for damage to remediation infrastructure. The Work Induction Board including the LLNL Environmental Analyst will also work with the Program proposing the construction project to determine if the work plans can be modified to move construction activities outside of the CAMU area. If construction or ground-breaking activities must be conducted in the CAMU area, the LLNL Environmental Restoration Department will participate in the planning, design, and construction phases of the project to ensure the CAMU is not damaged. If a potential for contaminant exposure is identified, LLNL Hazards Control ensures that hazards are adequately evaluated and necessary controls identified and implemented prior to the start of work. Controls for construction and other ground-breaking activities will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents.
Maintain the integrity of soil solidification CAMU.	Potential exposure to soil contaminated with PCBs and dioxin and furan compounds.	DOE will inspect and maintain the soil solidification CAMU, and ground water monitoring systems. Maintenance and inspection requirements are specified in the addendum to the Remedial Design.
Maintain land use restriction in the vicinity of Well 8 Spring until annual risk re-evaluation indicates that the risk is less than 10^{-6}.	1×10^{-3} risk for onsite workers inhaling tritium volatilizing from Well 8 Spring into outdoor air.	There are currently no active facilities located in the vicinity of the Well 8 Spring and there is no surface water present in the spring. Current activities in the vicinity of the Well 8 Spring are restricted to semi-annual spring sampling. The time spent sampling is well below the exposure scenario for which the unacceptable exposure risk was calculated, which assumed a worker would spend 8 hours a day, five days a week for 25 years working at Well 8 Spring. DOE will conduct annual risk re-evaluations when water is present in Well 8 Spring to determine when the inhalation risk has been mitigated. The risk re-evaluation results will be reported in the Annual Site-Wide Compliance Monitoring Reports. Any significant changes in activities conducted in the Well 8 Spring area must be cleared through LLNL Work Induction Board. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to

Table 6-7. Description of institutional/land use controls for the Building 850 Firing Table (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Maintain land use restriction in the vicinity of Well 8 Spring continued.		contaminants as a result of the proposed area usage. If a potential for contaminant exposure is identified as a result of these changes in activities or area use, LLNL Hazards Control is notified and determines any necessary personal protective equipment to prevent exposure.
Prohibit transfer of lands with unmitigated contamination that could cause potential harm under residential or unrestricted land use.	Potential exposure to contaminated environmental media.	The Site 300 Federal Facility Agreement contains provisions that assure that DOE will not transfer lands with unmitigated contamination that could cause potential harm. In the event that the Site 300 property is transferred in the future, DOE will execute a land use covenant at the time of transfer in compliance with Title 22 California Code of Regulations, Division 4.5, Chapter 39, Section 67391.1. Development will be restricted to industrial land usage. These restrictions will remain in place until and unless a risk assessment is performed in accordance with then current U.S. EPA risk assessment guidance and is agreed by the DOE, the U.S. EPA, DTSC, and the RWQCB as adequately showing no unacceptable risk for residential or unrestricted land use. These restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning document.

Notes:

CAMU = Corrective Action Management Unit.

DOE = United States Department of Energy.

DTSC = California Department of Toxic Substances Control.

U.S. EPA = United States Environmental Protection Agency.

LLNL = Lawrence Livermore National Laboratory.

PCB = Polychlorinated biphenyl.

RWQCB = California Regional Water Quality Control Board.

[a] **Risk for onsite worker exposure to tritium and depleted uranium at depth in subsurface soil during excavation activities was not calculated as this was not considered a long-term exposure scenario. As a result, land use controls based on the potential exposure to tritium and depleted uranium in subsurface soil during excavation/construction activities conservatively assume that the tritium and depleted uranium in subsurface soil may pose a risk to human health.**

Table 6-8. Description of institutional/land use controls for the Pit 7 Complex.

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Prevent water-supply use/consumption of contaminated ground water until ground water cleanup levels are met.	Uranium, tritium, nitrate, and perchlorate concentrations in ground water exceeding drinking water standards or California Public Health Goal.	There are no existing or planned water-supply wells in the Pit 7 Complex area. Any proposed onsite well drilling activities will be submitted to the LLNL Work Induction Board, and reviewed by the LLNL Environmental Restoration Department to ensure that new water-supply wells are not located in areas of ground water contamination. Prohibitions on drilling water-supply wells in areas of ground water contamination will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents. Contamination is limited to onsite ground water and modeling indicates the plumes will not migrate offsite. Therefore, land use controls are not needed to prevent offsite water-supply use/consumption of contaminated ground water.
Maintain the integrity of Pit 7 Complex landfill covers and the drainage diversion system as long as the pit waste remains in place.	Potential exposure to contaminants in pit waste[a].	DOE will inspect and maintain the landfill covers and the drainage diversion system, and ground water monitoring systems. Landfill cap maintenance and inspection requirements are specified in post-closure plans for the landfills and will be included in the revision to the Site-Wide Compliance Monitoring Plan/Contingency Plan for LLNL Site 300.
Control construction and other ground-breaking activities on the Pit 7 Complex landfills to prevent cap/cover damage and/or inadvertent exposure to pit waste as long as the pit waste remains in place.	Potential exposure to contaminants in pit waste[a].	All proposed ground-breaking construction activities must be cleared through LLNL Work Induction Board and require an excavation permit. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants in the proposed construction areas. If a potential for contaminant exposure is identified, LLNL Hazards Control ensures that hazards are adequately evaluated and necessary controls identified and implemented prior to the start of work. The Work Induction Board including the LLNL Environmental Analyst will also work with the Program proposing the construction project to determine if the work plans can be modified to move construction activities outside of areas of contamination. Controls for construction and other ground-breaking activities will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents. In addition, health and safety procedures will be developed as part of the Remedial Design Report for the Pit 7 Complex for both construction and long-term maintenance of the remedial action to ensure worker safety and the proper handling of all hazardous materials.

Table 6-8. Description of institutional/land use controls for the Pit 7 Complex (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Maintain access restrictions to prevent inadvertent exposure of onsite workers to the pit waste as long as the waste in the Pit 7 Complex Landfills remain in place.	Potential exposure to contaminants in pit waste[a].	There are currently no active facilities located in the vicinity of the Pit 7 Complex. Signage is in place and will be maintained at the Pit 7 Landfill Complex access points prohibiting unauthorized access and requiring notification and authorization by LLNL Site 300 Management to enter, dig, excavate, or otherwise disturb soil or vegetation in this area (see administrative controls for ground-breaking construction activities above). These access restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents.
Maintain access restrictions and activities at the Pit 3 Landfill to prevent onsite site worker inhalation exposure to tritium until annual risk re-evaluation indicates that the risk is less than 10^{-6}.	4×10^{-6} risk to onsite workers from inhalation of tritium from subsurface soil in the vicinity of the Pit 3 Landfill.	There are currently no active facilities located in the vicinity of the Pit 7 Complex, and the Pit 3 Landfill was closed and covered with native soil fill in 1967. Current activities in the vicinity of the Pit 3 Landfill are restricted to quarterly sampling of monitor wells. The time spent sampling is well below the exposure scenario for which the unacceptable exposure risk was calculated, which assumed a worker would spend 8 hours a day, five days a week for 25 years working at the Pit 3 Landfill. Any significant changes in activities conducted in the vicinity of the Pit 3 Landfill must be cleared through the LLNL Work Induction Board. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants as a result of the proposed area usage. If a potential for contaminant exposure is identified as a result of these changes in activities or area use, LLNL Hazards Control is notified and determines any necessary personal protective equipment or engineered control requirements to prevent exposure. Signage is in place and will be maintained at the Pit 7 Landfill Complex access points prohibiting unauthorized access and requiring notification and authorization by LLNL Site 300 Management to enter, dig, excavate, or otherwise disturb soil or vegetation in this area. All ground-breaking construction activities must be cleared through the LLNL Work Induction Board and require an excavation permit. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants in the proposed construction areas. If a potential for contaminant exposure is identified, LLNL Hazards Control is notified and provides project hazard control requirements to prevent exposure during construction. These access restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents.

Table 6-8. Description of institutional/land use controls for the Pit 7 Complex (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Access restrictions continued.		DOE will conduct annual risk re-evaluations to determine when the tritium inhalation risk at the Pit 3 Landfill has been mitigated. The risk re-evaluations mechanism, methodology, and frequency will be documented in the Remedial Design Report for the Pit 7 Complex.
Prohibit transfer of lands at Site 300 with unmitigated contamination that could cause potential harm under residential or unrestricted land use.	Potential exposure to contaminated waste and/or environmental media.	The Site 300 Federal Facility Agreement contains provisions that assure that DOE will not transfer lands with unmitigated contamination that could cause potential harm (as described in Section 2.8.2). In the event that the Site 300 property is transferred in the future, DOE will execute a land use covenant at the time of transfer in compliance with Title 22 California Code of Regulations, Division 4.5, Chapter 39, Section 67391.1. Development will be restricted to industrial land usage. These restrictions will remain in place until and unless a risk assessment is performed in accordance with then current U.S. EPA risk assessment guidance and is agreed by the DOE, U.S. EPA, DTSC, and the RWQCB as adequately showing no unacceptable risk for residential or unrestricted land use. These restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning document.

Notes:

DOE = United States Department of Energy.

DTSC = California Department of Toxic Substances Control.

U.S. EPA = United States Environmental Protection Agency.

LLNL = Lawrence Livermore National Laboratory.

RWQCB = California Regional Water Quality Control Board.

[a] **A risk for exposure to contaminants in the pit waste could not be calculated due to safety restrictions on penetrating landfill waste. Land use controls based on the potential exposure to contaminants in pit waste conservatively assume that the waste contaminants may pose a risk to human health.**

Table 6-9. Description of institutional/land use controls for the Building 854 Operable Unit.

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Prevent water-supply use/consumption of contaminated groundwater until ground water cleanup standards are met.	VOCs, nitrate, and perchlorate concentrations in ground water exceeding drinking water standards.	There are no existing or planned water-supply wells in the Building 854 Operable Unit. Any proposed well drilling activities would be submitted to the LLNL Work Induction Board, and are reviewed by the LLNL Environmental Restoration Department to ensure that new water-supply wells are not located in areas of ground water contamination. Prohibitions on drilling water-supply wells in areas of ground water contamination will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents. Contamination is limited to onsite ground water and modeling indicates the plumes will not migrate offsite. Therefore, land use controls are not needed to prevent offsite water-supply use/consumption of contaminated ground water.
Control excavation activities to prevent onsite worker exposure to VOCs in subsurface soil until it can be verified that concentrations do not pose an exposure risk to onsite workers.	Potential exposure to VOCs at depth in subsurface soil at the Building 854 Complex[a].	All proposed excavation activities must be cleared through the LLNL Work Induction Board and require an excavation permit. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants in the proposed construction areas. If a potential for contaminant exposure is identified, the LLNL Site 300 Hazards Control Department ensures that hazards are adequately evaluated and necessary controls identified and implemented prior to the start of work. The Work Induction Board including the LLNL Environmental Analyst will also work with the Program proposing the construction project to determine if the work plans can be modified to move construction activities outside of areas of contamination.

Table 6-9. Description of institutional/land use controls for the Building 854 Operable Unit (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Maintain building occupancy restriction to prevent onsite site worker inhalation exposure to VOCs inside Building 854A until annual risk re-evaluation indicates that the risk is less than 10^{-6}.	Pre-remediation risk of 1×10^{-6} for onsite workers from inhalation of VOCs volatilizing from subsurface soil into ambient air inside Buildings 854A.	Building 854A is not currently occupied. Warning signs will be maintained prohibiting full time occupancy without notification and authorization by LLNL Site 300 Management. Any significant changes in activities conducted in Building 854A must be cleared through the LLNL Work Induction Board. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants as a result of the proposed building usage. If a potential for contaminant exposure is identified as a result of the changes in building use, LLNL Hazards Control will be notified and determine any necessary engineered control requirements to prevent exposure. If full-time building occupancy is proposed, engineering controls will be implemented to prevent onsite worker exposure that could migrate from the subsurface into the building until the inhalation risk was mitigated through remediation. The building occupancy restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents. DOE will conduct annual risk re-evaluations to determine when the inhalation risk inside Building 854A has been mitigated. The risk re-evaluation results will be reported in the Annual Site-Wide Compliance Monitoring Reports. A pre-remediation risk of 9.3×10^{-6} was identified for onsite workers from potential inhalation of VOCs volatilizing from subsurface soil into ambient air inside Building 854F. Building 854F was demolished in 2005 removing the exposure pathway, therefore this institutional/land use control is no longer needed to prevent onsite worker exposure to VOCs in indoor air. The baseline risk assessment also identified a human cancer risk of 1×10^{-5} for onsite workers continuously inhaling VOC vapors volatilizing from the vadose zone into outdoor air in the vicinity of Building 854F over a 25-year period, however this risk has been successfully mitigated since 2004 through ground water extraction and treatment, therefore this institutional/land use control is no longer needed to prevent onsite worker exposure to VOCs in outdoor air.

Table 6-9. Description of institutional/land use controls for the Building 854 Operable Unit (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Maintain land use restrictions at the former Building 855 lagoon until remediation of PCB-, dioxin-, and furan-contaminated soil reduces the risk to onsite workers to less than 10^{-6}.	A pre-remediation risk of 1×10^{-6} was identified for onsite workers from inhalation or ingestion of resuspended particulates and dermal contact with PCBs, and dioxin and furan compounds in surface soil at the former Building 855 lagoon.	In 2005, PCB-, dioxin-, and furan-contaminated soil in the former Building 855 lagoon was excavated for offsite disposal as a remedial action. As a result, the risk to onsite workers was reduced to less than 10^{-6}. Therefore, this institutional/land use control is no longer needed to prevent onsite worker exposure to PCBs, and dioxin and furan compounds in soil at the former Building 855 lagoon. However, a very limited volume of subsurface soil remains at a depth of approximately 8 feet below ground surface with PCBs, and dioxin and furan compound concentrations above residential preliminary remediation goals. The land transfer prohibition control described below prevents exposure under a residential land use.
Prohibit transfer of lands with unmitigated contamination that could cause potential harm under residential or unrestricted land use.	Potential exposure to contaminated waste and/or environmental media.	The Site 300 Federal Facility Agreement contains provisions that assure that DOE will not transfer lands with unmitigated contamination that could cause potential harm. In the event that the Site 300 property is transferred in the future, DOE will execute a land use covenant at the time of transfer in compliance with Title 22 California Code of Regulations, Division 4.5, Chapter 39, Section 67391.1. Development will be restricted to industrial land usage. These restrictions will remain in place until and unless a risk assessment is performed in accordance with then current U.S. EPA risk assessment guidance and is agreed by the DOE, U.S. EPA, DTSC, and the RWQCB as adequately showing no unacceptable risk for residential or unrestricted land use. These restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning document.

Notes appear on the following page.

Table 6-9. Description of institutional/land use controls for the Building 854 Operable Unit (continued).

Notes:

DOE = **United States Department of Energy.**

DTSC = **California Department of Toxic Substances Control.**

U.S. EPA = **United States Environmental Protection Agency.**

LLNL = **Lawrence Livermore National Laboratory.**

RWQCB = **California Regional Water Quality Control Board.**

VOCs = **Volatile organic compounds.**

[a] **Risk for onsite worker exposure to VOCs at depth in subsurface soil during excavation activities was not calculated as this was not considered a long-term exposure scenario. As a result, land use controls based on the potential exposure to VOCs in subsurface soil during excavation activities conservatively assume that the VOCs in subsurface soil may pose a risk to human health.**

Table 6-10. Description of institutional/land use controls for the Building 832 Canyon Operable Unit.

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Prevent water-supply use/consumption of contaminated groundwater until ground water cleanup standards are met.	VOCs, nitrate, and perchlorate concentrations in ground water exceeding drinking water standards.	There are no existing or planned water-supply wells in the Building 832 Canyon Operable Unit. Any proposed well drilling activities would be submitted to the LLNL Work Induction Board, and are reviewed by the LLNL Environmental Restoration Department to ensure that new water-supply wells are not located in areas of ground water contamination. Prohibitions on drilling water-supply wells in areas of ground water contamination will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents. Contamination is limited to onsite ground water and ground water extraction is underway at the distal portion of the VOC plume to prevent offsite migration. Therefore, land use controls are not needed to prevent offsite water-supply use/consumption of contaminated ground water.
Control excavation activities to prevent onsite worker exposure to VOCs in subsurface soil until it can be verified that concentrations do not pose an exposure risk to onsite workers.	Potential exposure to VOCs, HMX, and nitrate at depth in subsurface soil at the Building 832 Canyon Operable Unit[a].	All proposed excavation activities must be cleared through the LLNL Work Induction Board and require an excavation permit. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants in the proposed construction areas. If a potential for contaminant exposure is identified, LLNL Hazards Control ensures that hazards are adequately evaluated and necessary controls identified and implemented prior to the start of work. The Work Induction Board including the LLNL Environmental Analyst will also work with the Program proposing the construction project to determine if the work plans can be modified to move construction activities outside of areas of contamination.

Table 6-10. Description of institutional/land use controls for the Building 832 Canyon Operable Unit (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Maintain building occupancy restriction to prevent onsite site worker inhalation exposure to VOCs inside Building 830 until annual risk re-evaluation indicates that the risk is less than 10^{-6}.	A pre-remediation risk of 3×10^{-6} was identified for onsite workers from inhalation of VOCs volatilizing from subsurface soil into ambient air inside Building 830.	Building 830 is not currently occupied. Warning signs will be maintained prohibiting full time occupancy without notification and authorization by LLNL Site 300 Management. Any significant changes in activities conducted in Building 830 must be cleared through the LLNL Work Induction Board. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants as a result of the proposed building usage. If a potential for contaminant exposure is identified as a result of the changes in building use, LLNL Hazards Control will be notified and determine any necessary engineered control requirements to prevent exposure. If full-time building occupancy is proposed, engineering controls will be implemented to prevent onsite worker exposure that could migrate from the subsurface into the building until the inhalation risk was mitigated through remediation. The building occupancy restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents. DOE will conduct annual risk re-evaluations to determine when the inhalation risk inside Building 830 has been mitigated. The risk re-evaluation results will be reported in the Annual Site-Wide Compliance Monitoring Reports. A pre-remediation risk of 3×10^{-6} was identified for onsite workers from potential inhalation of VOCs volatilizing from subsurface soil into ambient air inside Building 832F. The indoor air risk for Building 832F has been successfully mitigated since 2004 through ground water and soil vapor extraction and treatment, therefore this institutional/land use control is no longer needed to prevent onsite worker exposure to VOCs inside Building 832F. The baseline risk assessment also identified a human cancer risk of 1×10^{-5} for onsite workers continuously inhaling VOC vapors volatilizing from the vadose zone into outdoor air in the vicinity of Building 830 over a 25-year period, however this risk has been successfully mitigated since 2004 through ground water and soil vapor extraction and treatment, therefore this institutional/land use control is no longer needed to prevent onsite worker exposure to VOCs in outdoor air.

Table 6-10. Description of institutional/land use controls for the Building 832 Canyon Operable Unit (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Maintain land use restriction in the vicinity of Spring 3 until annual risk re-evaluation indicates that the risk is less than 10^{-6}.	A pre-remediation risk of 7×10^{-5} for onsite workers inhaling VOC vapors volatilizing from Spring 3 into outdoor air.	The spring has been dry since 2004. There are currently no active facilities located in the vicinity of the Spring 3and there is no surface water present in the spring. Current activities in the vicinity of the Spring 3 are restricted to semi-annual spring sampling. The time spent sampling is well below the exposure scenario for which the unacceptable exposure risk was calculated, which assumed a worker would spend 8 hours a day, five days a week for 25 years working at Spring 3. DOE will conduct annual risk re-evaluations when water is present in the spring to determine when the inhalation risk at Spring 3 has been mitigated. The risk re-evaluation results will be reported in the Annual Site-Wide Compliance Monitoring Reports. Any significant changes in activities conducted in the Spring 3 area must be cleared through the LLNL Work Induction Board. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants as a result of the proposed area usage. If a potential for contaminant exposure is identified as a result of these changes in activities or area use, LLNL Hazards Control is notified and determines any necessary personal protective equipment to prevent exposure.
Prohibit transfer of lands with unmitigated contamination that could cause potential harm under residential or unrestricted land use.	Potential exposure to contaminated waste and/or environmental media.	The Site 300 Federal Facility Agreement contains provisions that assure that DOE will not transfer lands with unmitigated contamination that could cause potential harm. In the event that the Site 300 property is transferred in the future, DOE will execute a land use covenant at the time of transfer in compliance with Title 22 California Code of Regulations, Division 4.5, Chapter 39, Section 67391.1. Development will be restricted to industrial land usage. These restrictions will remain in place until and unless a risk assessment is performed in accordance with then current U.S. EPA risk assessment guidance and is agreed by the DOE, U.S. EPA, DTSC, and the RWQCB as adequately showing no unacceptable risk for residential or unrestricted land use. These restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning document.

Notes appear on the following page.

Table 6-10. Description of institutional/land use controls for the Building 832 Canyon Operable Unit (continued).

Notes:

DOE =	United States Department of Energy.
DTSC =	California Department of Toxic Substances Control.
U.S. EPA =	United States Environmental Protection Agency.
LLNL =	Lawrence Livermore National Laboratory.
RWQCB =	California Regional Water Quality Control Board.
VOCs =	Volatile organic compounds.

[a] Risk for onsite worker exposure to VOCs at depth in subsurface soil during excavation activities was not calculated as this was not considered a long-term exposure scenario. As a result, land use controls based on the potential exposure to VOCs in subsurface soil during excavation activities conservatively assume that the VOCs in subsurface soil may pose a risk to human health.

Table 6-11. Description of institutional/land use controls for the Operable Unit 8.

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Prevent water-supply use/consumption of contaminated groundwater until ground water cleanup standards are met.	*Buildings 801 and 833* VOC concentrations in ground water exceeding drinking water standards.	There are no existing or planned water-supply wells in the vicinity of Buildings 801 or 833. Any proposed well drilling activities would be submitted to the LLNL Work Induction Board, and are reviewed by LLNL Environmental Restoration Department to ensure that new water-supply wells are not located in areas of ground water contamination. Prohibitions on drilling water-supply wells in areas of ground water contamination will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents. 1.2-DCA in Building 801 ground water is limited to only 2 wells at concentrations only slightly exceeding the state drinking water standard and are decreasing. All other VOCs in Building 801 ground water are below drinking water standards. VOCs in Building 833 ground water are limited to a shallow, perched, ephemerally saturated aquifer. There is no pathway for the VOC in ground water to migrate offsite. Therefore, land use controls are not needed to prevent offsite water-supply use/consumption of contaminated ground water.
Control excavation activities to prevent onsite worker exposure to contaminants in subsurface soil until it can be verified that concentrations do not pose an exposure risk to onsite workers.	*Building 801 Dry Well* Potential exposure to VOCs at depth in subsurface soil[a]. *Building 845 Firing Table* Potential exposure to depleted uranium and HMX at depth in subsurface soil[a]. *Building 851 Firing Table* Potential exposure to depleted uranium and VOCs at depth in subsurface soil[a]. *Building 833* Potential exposure to VOCs at depth in subsurface soil[a].	All proposed excavation activities must be cleared through the LLNL Work Induction Board and require an excavation permit. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants in the proposed construction areas. If a potential for contaminant exposure is identified, LLNL Hazards Control ensures that hazards are adequately evaluated and necessary controls identified and implemented prior to the start of work. The Work Induction Board including the LLNL Environmental Analyst will also work with the Program proposing the construction project to determine if the work plans can be modified to move construction activities outside of areas of contamination.

Table 6-11. Description of institutional/land use controls for the Operable Unit 8 (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Maintain engineering controls to prevent onsite site worker inhalation exposure to VOCs inside Building 833 until annual risk re-evaluation indicates that the risk is less than 10^{-6}.	A risk of 1×10^{-6} was identified for onsite workers from potential inhalation of VOCs volatilizing from subsurface soil into ambient air inside Building 833.	Engineering controls (heating, ventilating, and air-conditioning system for Building 833) were implemented to prevent onsite worker exposure to VOCs that could migrate from the subsurface into the building until the inhalation risk was mitigated through remediation.
Maintain the integrity of landfill covers as long as the pit waste remains in place.	*Pit 2, 8 and 9 Landfills* Potential exposure to contaminants in pit waste[b].	DOE will inspect and maintain the landfill covers and ground water monitoring systems. Landfill cap maintenance and inspection requirements are specified in the Site 300 Compliance Monitoring Plan.
Control construction and other ground-breaking activities on the landfills to prevent cap/cover damage and/or inadvertent exposure to pit waste as long as the pit waste remains in place.	*Pit 2, 8 and 9 Landfills* Potential exposure to contaminants in pit waste[b].	All proposed ground-breaking construction activities must be cleared through the LLNL Work Induction Board and require an excavation permit. The Work Induction Board coordinates with the LLNL Environmental Restoration Department to identify if there is a potential for exposure to contaminants in the proposed construction areas. If a potential for contaminant exposure is identified, LLNL Hazards Control ensures that hazards are adequately evaluated and necessary controls identified and implemented prior to the start of work. The Work Induction Board including the LLNL Environmental Analyst will also work with the Program proposing the construction project to determine if the work plans can be modified to move construction activities outside of areas of contamination. Controls for construction and other ground-breaking activities will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents.

Table 6-11. Description of institutional/land use controls for the Operable Unit 8 (continued).

Institutional/land use control performance objective and duration	Risk necessitating institutional/land use control	Institutional/land use controls and implementation mechanism
Maintain access restrictions to prevent inadvertent exposure of onsite workers to the pit waste as long as the waste remains in place.	*Pit 2, 8 and 9 Landfills* Potential exposure to contaminants in pit waste[b].	Signage will be maintained at the landfill access points prohibiting unauthorized access and requiring notification and authorization by LLNL Site 300 Management to enter, dig, excavate, or otherwise disturb soil or vegetation in this area (see administrative controls for ground-breaking construction activities above). These access restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents.
Maintain access restrictions to prevent inadvertent exposure of unauthorized trespassers to the pit waste as long as the waste remains in place.	*Pit 2, 8 and 9 Landfills* Potential exposure to contaminants in pit waste[b].	Site access by unauthorized trespassers is prevented by fences and warning signs at the site boundary and control entry systems at Site 300. These measures are maintained by the LLNL Security Department. There is no offsite contamination associated with the Pit 2, 8, or 9 landfills to which the public could be exposed. These access restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning documents.
Prohibit transfer of lands with unmitigated contamination that could cause potential harm under residential or unrestricted land use.	Potential exposure to contaminated waste and/or environmental media.	The Site 300 Federal Facility Agreement contains provisions that assure that DOE will not transfer lands with unmitigated contamination that could cause potential harm. In the event that the Site 300 property is transferred in the future, DOE will execute a land use covenant at the time of transfer in compliance with Title 22 California Code of Regulations, Division 4.5, Chapter 39, Section 67391.1. Development will be restricted to industrial land usage. These restrictions will remain in place until and unless a risk assessment is performed in accordance with then current U.S. EPA risk assessment guidance and is agreed by the DOE, U.S. EPA, DTSC, and the RWQCB as adequately showing no unacceptable risk for residential or unrestricted land use. These restrictions will be incorporated into the LLNL Site 300 Integrated Strategic Plan or other appropriate institutional planning document.

Notes appear on the following page.

Table 6-11. Description of institutional/land use controls for the Operable Unit 8 (continued).

Notes:

DCA =	**Dichloroethane.**
DOE =	**United States Department of Energy.**
DTSC =	**California Department of Toxic Substances Control.**
U.S. EPA =	**United States Environmental Protection Agency.**
HMX =	**High melting explosive.**
LLNL =	**Lawrence Livermore National Laboratory.**
RWQCB =	**California Regional Water Quality Control Board.**
VOCs =	**Volatile organic compounds.**

[a] **Risk for onsite worker exposure to contaminants at depth in subsurface soil during excavation activities was not calculated as this was not considered a long-term exposure scenario. As a result, land use controls based on the potential exposure to contaminants in subsurface soil during ground-breaking construction activities conservatively assume that these subsurface soil contaminants may pose a risk to human health.**

[b] **A risk for exposure to contaminants in the pit waste could not be calculated due to safety restrictions on penetrating landfill waste. Land use controls based on the potential exposure to contaminants in pit waste conservatively assume that the waste contaminants may pose a risk to human health.**

Table 6-12. Summary of new ecological hazards in Site 300 Operable Units (OUs) 1 through 8.

Media of Concern	Exposure Pathway	Receptors	Contami-nant	Post-Baseline Risk Assessment[a]		Current Status	Risk/Hazard Management Measures
				HQ/TQ	Comments		
Building 850 (OU 5)							
Sandpile	Ingestion	Ground squirrel Kit fox Burrowing owl	Uranium 238	>1	Constituent detected at greater than 50% of maximum historical concentration.	Sandpile removal action currently underway.	Addressed as part of Building 850 Soil Removal Action (includes removal of sandpile).
Sandpile	Absorbed radiation	Ground squirrel Kit fox Burrowing owl	Thorium 228	>1	New constituent detected post-SWFS.	Sandpile removal action currently underway.	Addressed as part of Building 850 Soil Removal Action (includes removal of sandpile).
Pit 7 Complex (OU 5)							
Pit waste	Ingestion	Ground squirrel Kit fox Burrowing owl	Uranium, Uranium 234, 235, 238	>1	New constituent detected post-SWFS; maximum activity >background.	Landfill inspected and maintained to prevent exposure of burrowing animals to pit waste.	Implement risk and hazard management measures (Section 6.2.2).

Notes:

HQ = **Hazard quotient.**

OU = **Operable unit.**

TQ = **Toxicity quotient.**

[a] **Discussion of the post-baseline risk assessment conducted as part of the five-year re-evaluation are contained in the 2008 Annual Compliance Monitoring Plan (Dibley et. al., 2009).**

Table 8-1. LLNL Environmental Restoration Department Standard Operating Procedures.

Procedure Number	Title	Revision
SOP-1.1	Field Borehole Logging	Rev. 5
SOP-1.2	Borehole Sampling of Unconsolidated Sediments and Rock	Rev. 5
SOP-1.3	Drilling	Rev. 5
SOP-1.4	Well Installation	Rev. 5
SOP-1.5	Well Development	Rev. 5
SOP-1.6	Borehole Geophysical Logging	Rev. 5
SOP-1.7	Well Closure	Rev. 4
SOP-1.8	Disposal of Investigation-Derived Wastes (Drill Cuttings, Core Samples, and Drilling Mud)	Rev. 3
SOP-1.9	Suction Lysimeter Soil Moisture Sampling	Rev. 5
SOP-1.10	Soil Vapor Surveys	Rev. 5
SOP-1.11	Soil Surface Flux Monitoring of Gaseous Emission	Rev. 2
SOP-1.12	Surface Soil Sampling	Rev. 3
SOP-1.13	Operation of the AMS TR7000 Well Management System	Rev. 0
SOP 1.14	Final Well Development/Specific Capacity Tests at LLNL Livermore Site and Site 300	Rev. 2
SOP 1.15	Well Site Core Handling	Rev. 2
SOP 1.16	Four Wheel All Terrain Vehicle (ATV) Operation	Rev. 1
SOP 1.17	Treatment Facility Vapor Sampling and Analysis	Rev. 3
SOP 1.18	Deployment, Retrieval, Sampling and Maintenance of Instrumented Membrane Technology (IMT) Borehole-Liner Systems	Rev. 2
SOP-2.1	Pre-sample Purging of Wells	Rev. 8
SOP-2.2	Field Measurements on Surface and Ground Waters	Rev. 5
SOP-2.3	Sampling Monitor Wells with Bladder Pumps, Electric Submersible Pumps, and Specific-Depth Grab Sampling Devices	Rev. 6
SOP-2.4	Sampling Monitor Wells with a Bailer	Rev. 7
SOP-2.5	Surface Water Sampling	Rev. 3
SOP-2.6	Sampling for Volatile Organic Compounds	Rev. 6
SOP-2.7	Pre-sample Purging and Sampling of Low-Yielding Monitor Wells	Rev. 6
SOP-2.8	Installation of Dedicated Sampling Devices	Rev. 5
SOP-2.9	Sampling for Tritium in Ground Water	Rev. 7
SOP-2.10	Well Disinfection and Coliform Bacteria Sampling	Rev. 4
SOP-2.12	Ground Water Monitor Well and Equipment Maintenance	Rev. 3
SOP-2.13	Barcad Sampling	Rev. 3
SOP-3.1	Water-Level Measurements	Rev. 7
SOP-3.2	Pressure Transducer Field Calibration	Rev. 3
SOP-3.3	Hydraulic Testing (Slug/Bail)	Rev. 3
SOP-3.4	Hydraulic Testing (Pumping)	Rev. 3
SOP-4.1	General Instructions for Field Personnel	Rev. 7
SOP-4.2	Sample Control and Documentation	Rev. 7

Table 8-1. LLNL Environmental Restoration Department Standard Operating Procedures (continued).

Procedure Number	Title	Revision
SOP-4.3	Sample Containers and Preservation	Rev. 6
SOP-4.4	Guide to Packaging and Shipping of Samples	Rev. 6
SOP-4.5	General Equipment Decontamination	Rev. 5
SOP-4.6	Validation and Verification of Radiological and Nonradiological Data Generated by Analytical Laboratories	Rev. 5
SOP-4.7A	Livermore Site Treatment and Disposal of Well Development and Well Purge Fluids	Rev. 4
SOP-4.7B	Site 300 Treatment and Disposal of Well Development and Well Purge Fluids	Rev. 4
SOP-4.8	Calibration/Verification and Maintenance of Measuring and Test Equipment (M&TE)	Rev. 6
SOP-4.9	Collection of Field QC Samples	Rev. 5
SOP-4.10	Records Management	Rev. 0
SOP-4.12	Quality Improvement Forms (QIFs)	Rev. 2
SOP-4.13	Standard Operating Procedure Process	Rev. 1
SOP-4.14	Mapping with the Trimble Pathfinder Pro XR GPS System	Rev. 0
SOP-4.15	ERD Self-assessments and Walk-abouts	Rev. 1
SOP-4.16	ERD Lockout/Tagout Program	Rev. 1
SOP-4.17	Change of Aqueous and Vapor Phase Granular Activated Carbon	Rev. 1
SOP-4.18	ERD Document Control	Rev. 0
SOP-5.1	Data Management Chain of Custody and Printed Analytical Result Receipt and Processing	Rev. 3
SOP-5.3	Data Management Electronic Analytical Result Receipt and Processing for Sample, Analysis and QC Data	Rev. 3
SOP-5.4	Data Management Hand Entry of Analytical Results	Rev. 2
SOP-5.5	Data Management Revision Receipt and Processing	Rev. 1
SOP-5.6	Ground Water Elevation Reports	Rev. 1
SOP 5.8	Field Logbook Control	Rev. 3
SOP-5.10	Data Management Receipt and Processing Lithology by Electronic Transfer	Rev. 3
SOP-5.14	Issuing New Parameter Codes	Rev. 1
SOP 5.15	Preparation of Required Routine Groundwater and Treatment Facilities Sampling Plans	Rev. 1
SOP-5.20	Cost Effective Sampling (CES) Algorithm Preparation	Rev. 0
SOP-6.1	Decontamination and Decommissioning Team — Standard Operating Procedure 001	Rev. 2

Notes:

SOPs = Standard Operating Procedures.

Table 10-1. Summary of Site 300 remediation contingencies and potential responses.

Contingency	Possible response
Technical	
Insufficient hydraulic control.	**Ground water extraction and treatment systems: Adjust extraction flow rates and/or number/location of extraction wells.**
	Pit 7 drainage diversion system: Evaluate modifications/improvements to the drainage diversion system to further reduce ground water recharge and prevent inundation.
Increasing contaminant concentrations in ground water.	**Adjust extraction flow rates and/or number/location of wells. Assess potential impacts and conduct source investigations, if necessary.**
New impact to regional water-supply aquifers.	**Notify regulators and well owners (if any), evaluate cause of impact, prepare action plan, and discuss with stakeholders.**
Ineffective Monitored Natural Attenuation.	**Evaluate causes, potential impacts, and propose alternatives to regulators.**
Modeling assumptions no longer valid.	**Update conceptual model and validations.**
Chemicals in vadose zone impact ground water.	**Where vadose zone cleanup is in progress, modify remediation system, if possible. If no vadose zone remediation in progress, conduct source investigation and/or implement remedial action, if necessary.**
New contaminant sources discovered, new releases and/or contaminants detected.	**Conduct source investigations where necessary to assess extent of contamination. If ground water is impacted, modify the remedial action plan, if needed. If ground water is not impacted, conduct transport modeling to evaluate need for vadose zone remediation. Propose actions to regulators as needed.**
Improved remediation technologies are developed.	**Conduct cost-benefit analysis and employ economical- and technology-based actions that are acceptable.**
Uncontrollable events impact monitoring and/or remediation efforts.	**Assess damage to infrastructure and, if appropriate, modify, replace, or decommission monitoring and/or remediation system(s).**
Logistical	
Personnel changes.	**Employ phase-in/phase-out period, if appropriate, to ensure smooth transition during personnel changes. Review project documentation and site-related issues that have major impacts at transition.**
Insufficient funding affects planned remediation.	**Follow established Site 300 priority list. If necessary, milestone dates will be revised through coordination with the regulatory agencies.**
Regulations change and/or meeting them is infeasible.	**Include DOE, LLNL, regulators, and the community in the process to determine if and how regulatory changes affect the Site 300 cleanup.**
Ground water use and demand affect monitoring/remediation.	**Alter the remedial pumping scheme, and/or negotiate with landowners. Provide alternative water supply or implement contingency point-of-use treatment at existing water-supply wells, if necessary.**
Future onsite development restricts available locations for remedial infrastructure.	**Environmental review and sampling prior to any significant construction activities mitigate the potential for inadvertent development at critical remedial locations.**

Table 10-1. Summary of Site 300 remediation contingencies and potential responses (continued).

Contingency	Possible response
Changes in building access restrictions/use.	**Assess risk and consider engineered controls if needed.**
Future property transfer from DOE.	**Follow Site 300 Federal Facility Agreement Requirements regarding notifications and deed restrictions.**
Changes to the mission and operation of LLNL.	**Future mission and operation of LLNL will include CERCLA compliance and cleanup implementation as specified in the Site 300 Federal Facility Agreement and Record of Decision.**

Appendix A

Ground Water Remediation Technical and Economic Feasibility Analysis Process Description

Appendix A.

Ground Water Remediation Technical and Economic Feasibility Analysis Process Description

A-1. Introduction

Ground water cleanup standards of Federal drinking water Maximum Contaminant Levels (MCLs) or any more stringent California State MCLs were selected for LLNL Site 300 Operable Units (OUs) 2 through 8 in the Site-Wide Record of Decision (ROD) (U.S. Department of Energy [DOE], 2008). The ground water cleanup standards selected in the ROD are presented in Table A-1.

In addition, to comply with State Water Resources Control Board (SWRCB) Resolution 92-49, DOE agreed to prepare Technical and Economic Feasibility Analyses (TEFA) after ground water contaminant concentrations have been reduced to MCLs in OUs 2 through 8. Resolution 92-49 requires that the remediation of ground water continue until background conditions are restored, unless a waiver is granted or reaching this goal is technically or economically infeasible.

The TEFAs will be performed in conjunction with Five-Year Reviews after MCLs are reached and will evaluate the feasibility of continuing remediation to further reduce contaminant concentrations (e.g., to Water Quality Numeric Limits [WQNLs] or background concentrations).

For OUs where the selected remedy (or part thereof) is monitored natural attenuation or monitoring-only (e.g., OU 8), the analyses will be used to determine the technical and economic feasibility of continuing monitoring until contaminant concentrations are reduced below MCLs (e.g., to WQNLs or background concentrations).

The Site-Wide ROD specified that the details of the approach that will be used to perform the TEFAs would be provided in this Revised Site-Wide Compliance Monitoring Plan/Contingency Plan. Therefore, this appendix presents the TEFA process (Section A-2), the general schedule for conducting these analyses (Section A-3), and discusses how the results of these analyses will be used (Section A-4).

A-2. Technical and Economic Feasibility Analysis Process

This section describes the process DOE will use to analyze the technical and economic feasibility of continuing remediation to further reduce contaminant concentrations below MCLs including:

- Estimating the time and resources needed to continue ground water remediation and/or conduct monitoring until WQNLs or background concentrations are achieved (Section A-2.1).
- Preparing cost estimates to continue operate remediation systems and wellfields, and/or conduct monitoring until WQNLs and background concentrations are achieved (Section A-2.2).
- Evaluating ground water-related environmental factors to assess if the contaminants of concern (COCs) would pose a substantial present or potential hazard to human health or the environment if WQNLs or background levels are not achieved (Section A-2.3).
- Evaluating the economic and technical feasibility of achieving WQNLs and background concentrations (Section A-2.4).

A-2.1. Time and Resource Estimation Process

The process to estimate time and resources to clean up ground water to WQNLs and background concentrations includes:

- Identifying/selecting WQNLs and background concentrations (Section A-2.1.1).
- Estimating the time to cleanup to WQNLs and background concentrations (Section A-2.1.2).
- Estimating the resources (labor and materials) necessary to continue ground water cleanup to the WQNLs and background concentrations (Section A-2.1.3).

A-2.1.1. Identification/Selection of WQNLs and Background Concentrations

The first step in this process will be to identify and/or select appropriate WQNLs for ground water COCs for use in the analysis, which will be conducted in consultation with the RWQCB. However, because WQNLs can change significantly over time, the selection of WQNLs for use in the analysis will be performed at the time that the TEFA is to be performed. Because WQNLs may not be available for all COCs, the estimation of time to cleanup to WQNLs may not be performed for all COCs.

Analytical method detection limits will be used as background levels for anthropogenic COCs (e.g., volatile organic compounds [VOCs]). For constituents that are COCs, but also occur naturally in ground water at Site 300 (e.g., metals, uranium, and nitrate), the background levels established for these constituents in the Site-Wide Feasibility Study (Ferry et al., 1999) will be used. These background levels are identified for each COC in Table A-1.

A-2.1.2. Estimation of Time to Cleanup

Two estimates will be prepared for each of Operable Units (OUs) 2 through 8. The first estimate will include the time to clean up and/or monitor ground water to the selected WQNLs for all COCs still present in ground water at concentrations exceeding the WQNLs in each OU. For OUs where the selected remedy includes active ground water remediation, the estimate will include continuing to operate ground water extraction and treatment and/or *in situ* remediation systems until all COCs are reduced to the selected WQNLs. For OUs where the selected remedy (or part thereof) is monitored natural attenuation or monitoring-only, the estimate will include continued monitoring until contaminant concentrations are reduced to the selected WQNLs.

The second estimate will be similar to the WQNL evaluation process, but will assess the time to clean up and/or monitor ground water to the background concentrations for all COCs still present in ground water above background concentrations in each OU. Table A-1 presents the COCs that will be used to estimate time to cleanup to the selected WQNL and background concentrations by OU.

The estimates of cleanup times to achieve WQNLs and background concentrations will be prepared using contaminant concentration trend analysis and projection. This will consist of plotting COC concentration trends in ground water using actual data. The maximum COC concentration data in the OU or treatment area over time will be used to prepare actual concentration trends for the OU or treatment area to be evaluated. For OUs or areas where the selected remedy includes active ground water remediation, these plots will include ground water data starting when the remediation systems began operation through the date when MCLs or other ground water cleanup standards agreed to in the Site-Wide ROD (DOE, 2008) are achieved. For OUs where the selected remedy (or part thereof) is monitored natural attenuation or monitoring-only, these plots would include all ground water data available through the date when MCLs or other ground water cleanup standards are achieved. These concentration trend plots will then be projected into the future until the selected WQNLs and background concentrations are achieved to estimate cleanup times. In some cases, such as when the data do not demonstrate sufficient trends with which to conduct trend analysis and projection, other prediction methodologies for the estimation of cleanup times may be used.

Because the COCs and cleanup times vary for each OU, the TEFAs will be conducted on an OU-specific basis. DOE will consider and discuss with the regulators conducting the TEFA for a treatment area once MCLs are achieved in that area, rather than waiting for MCLs to be achieved throughout the OU**.** For purposes of the feasibility analysis, a treatment area is defined as contaminant plume(s) within a single hydrostratigraphic unit (HSU) that is remediated using one or more extraction/injection wells, treatment facilities and technologies, and where there is hydraulic or pneumatic communication within the treatment area. For example, the VOC, RDX, perchlorate, and nitrate plumes in the $Tnbs_2$ HSU in the High Explosives Process Area OU would be considered as a treatment area.

A single HSU may contain more than one treatment area if contaminant plumes originate from separate source areas such that there is no significant hydraulic or pneumatic communication within the cleanup duration timeframe. For example, the $Tnbs_1$/$Tnbs_0$ HSU tritium plumes originating at the Pit 7 Complex and Building 850 would be considered as separate treatment areas.

A-2.1.3. Resource Estimation

Resources (labor and materials) necessary to continue ground water cleanup to selected WQNLs and background concentrations will be estimated including:

- Continued operation, maintenance, and compliance monitoring of existing ground water extraction wellfields and treatment systems.
- Possible continued operation, maintenance, and compliance monitoring of existing soil vapor extraction wellfields and treatment systems, if such operation will accelerate ground water cleanup.
- Ground water quality compliance sampling and analyses and water level measurements.

- Wellfield and remedial action optimization that includes the review and evaluation of ground water elevation and contaminant concentration data, extraction well flow rates, mass removal data, and periodic ground water rebound testing.
- Management of data collected to evaluate remediation effectiveness and demonstrate compliance with substantive requirements and other regulatory requirements.
- Preparation of semi-annual Site-Wide Compliance Monitoring Reports and OU-specific Five-Year Reviews.
- Project management and infrastructure support.

Resource estimates may also include labor and materials to design, fabricate, and construct any additional treatment facilities and pipelines, and/or expand (drill and install) any additional monitor and/or extraction wellfields that may facilitate the reduction of COC concentrations to WQNLs and background.

Certain technical factors may impact the economic feasibility of continued remediation. For example, experience in the operation of ground water remediation systems indicates that the efficiency of treatment media (e.g., granular activated carbon) is reduced at lower contaminant concentrations, resulting in more rapid contaminant breakthrough and increased treatment media replacement and disposal costs. Therefore, the efficiency of various treatment media at low concentrations (e.g., below MCLs) will be evaluated to determine cost impacts of continuing ground water extraction and treatment until WQNLs and background concentrations are achieved.

A-2.2. Cost Estimation Process

The estimated cleanup times and resources will be used to develop costs for continued ground water remediation and/or monitoring in OUs 2 through 8 to reduce COC concentrations to WQNLs and background. The estimates will include long-term costs for ongoing treatment and/or *in situ* remediation system operation and maintenance (O&M) and optimization, compliance monitoring and reporting and resources and labor necessary to support those activities. These long-term cost estimates will be based on the treatment facility and wellfield configurations that are in-place and operating at the time that the TEFA is conducted. In addition, the estimates may include capital costs for the construction of any new treatment facilities and/or extraction and monitor wellfield expansions deemed necessary to achieve lower COC concentrations.

The cost estimates may be subject to:

- Variations in specific assumptions, such as long-term O&M, design and construction, effectiveness, and system life.
- Changes in dollar value at the time any construction or other work is conducted.
- Changes in available equipment and technology at the time any construction or other work is conducted.
- Changes in applicable Lawrence Livermore National Laboratory (LLNL) taxes such as General and Administrative taxes, Lab-Directed Research and Development tax, and applicable LLNL charges such a Material Procurement Charge.

- Uncertainties associated with the hydrogeologic characteristics, subsurface heterogeneities, estimated contaminant mass and volume, and estimated life-cycle of remediation.
- Estimated cost accuracy of -30% to +50%.

The U.S. government funding process, which supports the LLNL Site 300 environmental cleanup project, occurs incrementally (i.e., annually) as the project proceeds, and does not allow for funding for the entire project to be set aside or invested at the start of the process. Funding for government-funded remediation projects is allocated at the start of each fiscal year during which the work will occur. Therefore, the cost estimates will not assume initial, up-front investment of the total project cost and accrual of interest over the life of the project, and will be presented as total cost with no discount rate. These non-discounted cost estimates will more accurately represent actual project costs and funding required to complete the remediation project than would present-value analysis costs.

A-2.3. Evaluation of Ground Water-related Environmental Factors

California SWRCB Resolution 92-49, Section III, Subsection H(1) specifies that an analysis of the technical and economic feasibility of achieving water quality objectives, shall take into account environmental characteristics of the hydrogeologic unit(s) and the degree of impact of any remaining pollutants.

Resolution 92-49 references nine ground water-related environmental factors contained in 23 California Code of Regulations (CCR), Section 2550.4 [(d)(1), Subsections (A) through (I)] that are to be considered in evaluating the technical and economic feasibility of ground water cleanup to water quality objectives:

(A) Physical and chemical characteristics of COCs in ground water.

(B) Hydrogeologic characteristics of the water-bearing zones or aquifers containing ground water COCs.

(C) Quantity of ground water and direction of ground water flow.

(D) Proximity and withdrawal rates of ground water users.

(E) Current and potential future uses of ground water in the area.

(F) Existing quality of ground water.

(G) Potential health risks caused by exposure to COCs in ground water.

(H) Potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to COCs in ground water (waste constituents).

(I) Persistence and permanence of the potential adverse effects.

Therefore, DOE will consider these factors to evaluate: (1) the feasibility of reducing COCs concentrations to WQNLs and background, (2) the degree of impact of any remaining pollutants, and (3) the benefit of attaining further reductions in COC concentrations.

In addition, DOE may include an evaluation of any remediation limitations and constraints that could affect the feasibility of reducing COC concentrations in ground water to selected WQNLs and background. For example, studies of ground water extraction systems indicate that some systems show initial decreases in aquifer concentrations, followed by less dramatic decreases that eventually approach an asymptotic concentration levels (EPA, 1989, 1992).

A-2.4. Technical and Economic Feasibility Analysis

The technical feasibility of achieving WQNLs and background concentrations will be analyzed by evaluating:

- The additional time to further reduce COC concentrations in ground water from MCLs to selected WQNLs and background concentrations.
- Remediation limitations or constraints that could affect its ability to further reduce COC concentrations in ground water to selected WQNLs and background.
- Environmental factors (i.e., hydrogeologic and geochemical conditions, contaminant characteristics, etc.) that could impact the technical feasibility of reducing COCs concentrations to WQNLs and background.

SWRCB Resolution 92-49, Section III, Subsection H(1)(b) indicates that economic feasibility is an objective balancing of the incremental benefit of attaining further reductions in COC concentrations as compared with the incremental cost of achieving those reductions. To facilitate the cost-benefit decision-making process to determine the economic feasibility of achieving WQNLs and background concentrations, DOE proposes to use a decision-matrix methodology. The decision-matrix method is a quantitative technique used to rank multidimensional factors within a set of options. As part of this decision-matrix process, a set of weighted criteria is established upon which the various options can be scored and summed to obtain a total score that can then be ranked. The advantage to this methodology is that subjective opinions can be made more objective.

The decision-matrix options would include remediating COCs in ground water to: (1) 2008 ROD cleanup standards (primarily MCLs), (2) selected WQNLs, and (3) background. For each of these options, there are a number of factors to be considered in determining economic feasibility of reducing COC concentrations in ground water including:

- Impacts to human health and the environment.
- Resource impacts.
- Social impacts.
- Costs.

These factor categories may include a number of subfactors for consideration in the decision-matrix. For example, the resource impacts subfactors would include current and future ground water use, sustainability (carbon footprint), and waste generation. Numerical evaluation ranking criteria are established for each subfactor under consideration. The subfactor ranking would be based on the benefit to human health, the environment, resources, and community. For example, the impacts to human health posed by the options could be ranked by determining if implementation of the option results in: (1) increased risk, (2) no change in risk, (3) reduced risk, or (4) no risk. An option that results in no risk (4) would be considered to be of greater benefit than an option that results in increased risk (1) or no change in risk (2). A higher rank number would therefore indicate greater benefit.

Because not all factors/subfactors may be considered of equal importance, a weight is assigned to each factor. For example, impacts to human health could be considered to be more important or of greater benefit than social impacts (i.e., reductions in property values.) The numerical evaluation ranking criteria established for each subfactor would be multiplied by the weighting factor to assign a numerical value for option. These subfactor numerical values would then be totaled to derive a total value number for each option. This total value number for the three options could then be compared to facilitate objective decision-making on the feasibility of continued ground water remediation to WQNLs or background levels.

Table A-2 presents a template for the economic feasibility decision-matrix. In this decision-matrix, DOE has included appropriate factors and subfactors to be considered, and possible evaluation ranking criteria. However, this template is provided primarily to show how the decision-matrix method works. The final decision matrix, including factors/subfactors, evaluation ranking criteria, and weighting factors, will be developed in concert with the RWQCB prior to conducting the first TEFA.

A-3. Schedule for Conducting the Technical and Economic Feasibility Analysis

The technical and economic feasibility analysis will be conducted as part of the Five-Year Reviews after ground water contaminant concentrations have been reduced to MCLs in OUs 2-8.

As discussed in Section A-2.1.2, because the Five-Year Review process is performed separately and COCs and cleanup times vary for each OU, technical and economic feasibility analyses will be conducted on an OU-specific basis. DOE will consider and discuss with the regulators conducting the feasibility analysis for a treatment area once MCLs are achieved in that area, rather than waiting for MCLs to be achieved throughout the OU.

If it is reasonable to conduct the TEFA sooner than at the Five-Year Review (e.g., contaminant concentrations are reduced below MCLs soon after a Five-Year Review has been completed), DOE will discuss accelerating the TEFA with the regulatory agencies.

A-4. Use of the Technical and Economic Feasibility Analysis Results

The TEFA will be reviewed and approved by the RWQCB, DTSC, and EPA. If DOE and the regulatory agencies then agree that it is technically and economically feasible to further reduce contaminant concentrations to the selected WQNL or background levels, remediation would continue. If DOE and the regulatory agencies agree that it is not technically and economically feasible to continue ground water remediation to concentrations below the 2008 Site-Wide ROD cleanup standards, pumping would cease and the ground water extraction and treatment system(s) would be placed on stand-by. Ground water post-closure monitoring will be performed for two years after pumping ceases to determine if COC concentrations rebound above cleanup standards. If COC concentrations remain below the cleanup standards during this two-year period, ground water remediation at Site 300 will be complete. After remediation is complete, the ground water treatment systems and their influent and discharge piping will be decontaminated, dismantled, salvaged, or used at other locations.

A-5. References

Ferry, L., R. Ferry, W. Isherwood, R. Woodward, T. Carlsen, Z. Demir, R. Qadir, and M. Dresen (1999), *Final Site-Wide Feasibility Study for Lawrence Livermore National Laboratory Site 300*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-132609).

U.S. Environmental Protection Agency (U.S. EPA) (1989), *Evaluation of Ground Water Extraction Remedies*, U.S. Environmental Protection Agency, (EPA5402-89/054. Vols. 1-3).

U.S. EPA (1992) *Dense Nonaqueous-Phase Liquids – A Workshop Summary*, Dallas, Texas, April 16-18, 1991, Office of Research and Development, U.S. Environmental Protection Agency (EPA/600/R-92/030).

U.S. DOE (2008), *Site-Wide Record of Decision for Lawrence Livermore National Laboratory Site 300*, Lawrence Livermore National Laboratory, Livermore, Calif. (UCRL-AR-236665).

Table A-1. Ground water contaminants of concern by OU with most recent maximum concentrations and background concentrations.

OU	2008 ROD COCs	2008 maximum COC concentration (in µg/L unless otherwise indicated)	2008 Site-Wide ROD Cleanup Standard (in µg/L unless otherwise indicated)	Background concentration (in µg/L unless otherwise indicated)
Building 834 (OU 2)	**VOCs:**			
	- Chloroform	3.2	80[a]	<0.5[b]
	- Cis-1,2-DCE	26,000	6	<0.5[b]
	- PCE	960	5	<0.5[b]
	- 1,1,1-TCA	<0.5	200	<0.5[b]
	- TCE	190,000	5	<0.5[b]
	Other:			
	- Nitrate	310 mg/L	45 mg/L	91 mg/L[c]
	- TBOS	780	None	
Pit 6 Landfill (OU 3)	**VOCs:**			
	- Chloroform	<0.5	80 [a]	<0.5[b]
	- 1,2-DCA	<0.5	0.5	<0.5[b]
	- Cis-1,2-DCE	2.4	6	<0.5[b]
	- Trans-1,2-DCE	<0.5	10	<0.5[b]
	- PCE	1.2	5	<0.5[b]
	- 1,1,1-TCA	<0.5	200	<0.5[b]
	- TCE	10	5	<0.5[b]
	Radionuclides:			
	- Tritium	407 pCi/L	20,000 pCi/L	100 pCi/L[c]
	Other:			
	- Nitrate	210	45 mg/L	91 mg/L[c]
	- Perchlorate	5.5	6	<4 [b]
HEPA (OU 4)	**VOCs:**			
	- Chloroform	1.6	80 [a]	<0.5[b]
	- 1,1-DCE	1.9	<0.5	<0.5[b]
	- Cis-1,2-DCE	1.2	6	<0.5[b]
	- TCE	50	5	<0.5[b]
	HE Compounds:			
	- RDX	99	1	<1 [b]
	- HMX	110	None	<1 [b]
	- 4-Amino-2,6-dinitrotoluene	<2	None	
	Other:			
	- Nitrate	140 mg/L	45 mg/L	91 mg/L[c]
	- Perchlorate	29	6	<4 [b]
Building 850 (OU 5)	**Radionuclides:**			
	- Tritium	56,100 pCi/L	20,000 pCi/L	100 pCi/L[c]
	- Uranium-238	16 pCi/L	20 pCi/L	9.28/24 pCi/L[d]
	Other:			
	- Nitrate	160 mg/L	45 mg/L	91 mg/L[c]
	- Perchlorate	92	6	<4 [b]

Table A-1. Ground water contaminants of concern by OU with most recent maximum concentrations and background concentrations (continued).

OU	2008 ROD COCs	2008 maximum COC concentration (in µg/L unless otherwise indicated)	2008 Site-Wide ROD Cleanup Standard (in µg/L unless otherwise indicated)	Background concentration (in µg/L unless otherwise indicated)
Pit 7 Complex (OU 5)	**VOCs:**			
	- 1,1-DCE	3.1	<0.5	<0.5[b]
	- TCE	6.8	5	<0.5[b]
	Radionuclides:			
	- Tritium	291,000 pCi/L	20,000 pCi/L	100 pCi/L[c]
	- Uranium-238	91 pCi/L	20 pCi/L	9.28/24 pCi/L[d]
	Other:			
	- Nitrate	72 mg/L	45 mg/L	91 mg/L[c]
	- Perchlorate	20	6	<4[b]
Building 854 (OU 6)	**VOCs:**			
	- TCE	100	5	<0.5[b]
	Other:			
	- Nitrate	230 mg/L	45 mg/L	91 mg/L[c]
	- Perchlorate	22	<4	<4[b]
B832 Canyon (OU 7)	**VOCs:**			
	- Chloroform	1.3	80[a]	<0.5[b]
	- Cis-1,2-DCE	82	6	<0.5[b]
	- PCE	15	5	<0.5[b]
	- TCE	4,700	5	<0.5[b]
	Other:			
	- Nitrate	240 mg/L	45 mg/L	91 mg/L[c]
	- Perchlorate	15	6	<4[b]
OU 8:				
B801/Pit 8	**VOCs:**			
	- Chloroform	<0.7	80[a]	<0.5[b]
	- 1,2-DCA	2.1	0.5	<0.5[b]
	- TCE	3.6	5	<0.5[b]
	Other:			
	- Nitrate	44 mg/L	45 mg/L	91 mg/L[c]
	- Perchlorate	4.1	6	<4[b]
B833	**VOCs:**			
	- Cis-1,2-DCE	<0.5	6	<0.5[b]
	- TCE	170	5	<0.5[b]
B845/Pit 9	None	NA	NA	NA
B851	**Radionuclides:**			
	- Uranium-238	0.64 pCi/L (2006)	20 pCi/L	9.28/24 pCi/L[d]
Pit 2	**Other:**			
	- Nitrate	37mg/L	45 mg/L	91 mg/L[c]

Notes appear on the following page.

Table A-1. Ground water contaminants of concern by OU with most recent maximum concentrations and background concentrations (continued.)

Notes:

DCA =	**Dichloroethane.**
DCE =	**Dichloroethylene.**
COC =	**Contaminant of concern.**
mg/L =	**Milligrams per liter.**
MCL =	**Maximum contaminant level.**
NA =	**Not applicable.**
OU =	**Operable unit.**
PCE =	**Perchloroethylene (Tetrachloroethylene).**
pCi/L =	**Picocuries per liter.**
RDX =	**Research Department Explosive.**
TCE =	**Trichloroethylene.**
µg/L =	**Micrograms per liter.**

[a] **State and Federal Maximum Contaminant Level for trihalomethanes. The current chloroform concentrations (maximum of 3.2 µg/L) in Site 300 ground water area well below the 80 µg/L cleanup standard and continue to decrease.**

[b] **Background for anthropogenic contaminants is the analytical detection limit.**

[c] **Background activities established for nitrate as NO_3 in ground water in the Site-Wide Feasibility Study.**

[d] **Background activities established for uranium-238/total uranium in ground water in the Site-Wide Feasibility Study.**

Table A-2. Economic Feasibility Analysis Decision Matrix.

Factors	Evaluation Ranking Criteria[a]	Weighting Factor	Ground Water Cleanup Objectives for TEFA		
			2008 ROD Cleanup Standards[b]	WQNL	Background[b]
Impacts to Human Health					
- Human health risks	1. Increased 2. No change 3. Reduced 4. No risk				
Impacts to the Environment					
- Ground water COC hazard to ecological receptors	1. Increased 2. No change 3. Reduced 4. No impact				
- Impact of remediation implementation	1. Increased 2. No change 3. Reduced 4. No impact				
Resource Impacts:					
- Current ground water use	1. Not suitable for use 2. Restricted use 3. Unrestricted use		Onsite: Offsite:		
- Future ground water use	1. Not suitable for use 2. Restricted use 3. Unrestricted use		Onsite: Offsite:		
- Carbon footprint (e.g., energy consumption, traffic, TF air emissions)	1. Increased 2. No change 3. Reduced				

Table A-2. Economic Feasibility Analysis Decision Matrix (continued).

Factors	Evaluation Criteria[a]	Weighting Factor	Ground Water Cleanup Objectives for TEFA		
			2008 ROD Cleanup Standards[b]	WQNL	Background[b]
Resource Impacts cont:					
- Waste generation	1. Increased 2. No change 3. Reduced				
Social Impacts:					
- Land use restrictions (With respect to ground water use only. Other cleanup to industrial land use.)	1. Not suitable for use 2. Industrial use 4. Residential use 5. Unrestricted				
- Property values (With respect to ground water use only. Other cleanup to industrial land use.)	1. Reduced 2. No change 3. Increase				
Costs:	1. High 2. Medium 3. Low				
	Total Value:				

Notes:

COCs = Contaminants of concern.
ROD = Record of Decision.
TEFA = Technical and economic feasibility analysis.
TF = Treatment facility.
WQNL = Water quality numeric limits.

[a] **An increase in evaluation criteria ranking numbers indicates an increase in benefit.**

[b] **ROD cleanup standards and background concentrations for ground water COCs are presented in Table A-1.**

Appendix B

Table B-1. EPA Land Use Control Implementation Checklist

Table B-2. Institutional Controls Monitoring Checklist

Table B-1. U.S. EPA Land Use Control Implementation Plan Checklist

The U.S. Environmental Protection Agency (EPA) requires that certain elements be addressed to meet it's Land Use Control Implementation Plan (LUCIP) requirements. These LUCIP elements are contained in a checklist that was provided to the U.S. Department of Energy (DOE) by EPA. The checklist below provides a cross-walk between EPA's LUCIP requirements and the sections of the Compliance Monitoring Plan (CMP) in which they are addressed.

	EPA Checklist Item	CMP/CP Discussion
1.	Commitment by DOE to address any situation that may interfere with the effectiveness of LUC: "Any activity that is inconsistent with the IC objectives or use restrictions, or any other action that may interfere with the effectiveness of the ICs will be addressed by DOE as soon as practicable after DOE becomes aware of the breach."	Addressed in Section 6.1.6.
2.	Commitment by DOE to notify EPA of and address any situation that may interfere with the effectiveness of LUC: "DOE will notify EPA and [the state agency] as soon as practicable but no longer than ten days after discovery of any activity that is inconsistent with the IC objectives or use restrictions, or any other action that may interfere with the effectiveness of the ICs. DOE will notify EPA and [the state] regarding how DOE has addressed or will address the breach within 10 days of sending EPA and [the state] notification of the breach."	Addressed in Section 6.1.6.
3.	Notification to EPA and the state regarding land use changes: "DOE shall notify EPA and state ____ days [45 days suggested] in advance of any proposed land use changes that are inconsistent with land use control objectives or the selected remedy." "In the event of a property transfer, prior to seeking approval from the EPA and [the state] the recipient of the property must notify and obtain approval from DOE of any proposals for a land use change at a site inconsistent with the use restrictions and assumptions described in the ROD."	Land use changes are described in Section 10.2.4.3. Property transfer is addressed in Section 10.2.4.3.
4.	Notification regarding transfers and federal-to-federal transfers: "DOE will provide notice to EPA and [the state] at least six (6) months prior to any transfer or sale of [property at issue] so that EPA and [the state] can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for the facility to notify EPA and [the state] at least six months prior to any transfer or sale, then the facility will notify EPA and [the state] as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to ICs. In addition to the land transfer notice and discussion provisions above, DOE further agrees to provide EPA and [the state] with similar notice, within the same time frames, as to federal-to-federal transfer of property. DOE shall provide a copy of executed deed or transfer assembly to EPA and [the state]."	Property transfer is addressed in Section 10.2.4.3.
5.	Concurrence language: "DOE shall not modify or terminate Land Use Controls, implementation actions, or modify land use without approval by EPA and the [state]. DOE shall seek prior concurrence before any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs."	Addressed in Section 6.1.6.

Table B-1. U.S. EPA Land Use Control Implementation Plan Checklist (continued).

	EPA Checklist Item	CMP/CP Discussion
6.	Monitoring and reporting language: "Monitoring of the environmental use restrictions and controls will be conducted annually [or more or less frequently as may be determined to be necessary based upon site activities or conditions] by DOE. The monitoring results will be included in a separate report or as a section of another environmental report, if appropriate, and provided to the EPA and the [the state]. The annual monitoring reports will be used in preparation of the Five Year Review to evaluate the effectiveness of the remedy. The annual monitoring report, submitted to the regulatory agencies by DOE, will evaluate the status of the ICs and how any IC deficiencies or inconsistent uses have been addressed. The annual evaluation will address whether the use restrictions and controls referenced above were communicated in the deed(s), whether the owners and state and local agencies were notified of the use restrictions and controls affecting the property, and whether use of the property has conformed with such restrictions and controls."	Reporting is addressed in Section 9.
7.	A comprehensive list of LUCs.	Addressed in Section 6.1.6 and Tables 6-3 through 6-11.
8.	For active facilities, a description of the internal procedures for implementing the LUCs (e.g., orders, instructions, Base Master Plan) and a commitment by DOE to notify EPA in advance of any changes to the internal procedures that would affect the LUCs.	Addressed in Section 6.1.6.
Generally, #s 9 and 10 apply at a closing installation, but they may have application elsewhere.		
9.	Other property transfer language:	
	a. "Deed Restrictions: "Each transfer of fee title from the United States will include a CERCLA 120(h)(3) covenant which will have a description of the residual contamination on the property and the environmental use restrictions, expressly prohibiting activities inconsistent with the performance measure goals and objectives. The environmental restrictions are included in a section of the CERCLA 120(h)(3) covenant that the United States is required to include in the deed for any property that has had hazardous substances stored for one year or more, known to have been released or disposed of on the property. Each deed will also contain a reservation of access to the property for DOE, EPA, and [the State], and their respective officials, agents, employees, contractors, and subcontractors for purposes consistent with DOE Installation Restoration Program ("IRP") or the Federal Facility Agreement ("FFA"). The deed will contain appropriate provisions to ensure that the restrictions continue to run with the land and are enforceable by DOE."	Property transfer is addressed in Section 10.2.4.3.
	b. "Lease Restrictions: "During the time between the adoption of this ROD and deeding of the property, equivalent restrictions are being implemented by lease terms, which are no less restrictive than the use restrictions and controls described above, in this ROD. These lease terms shall remain in place until the property is transferred by deed, at which time they will be superceded by the institutional controls described in this ROD."	Property transfer is addressed in Section 10.2.4.3.

Table B-1. U.S. EPA Land Use Control Implementation Plan Checklist (continued).

	EPA Checklist Item	CMP/CP Discussion
	c. "Notice: "Concurrent with the transfer of fee title from DOE to transferee, information regarding the environmental use restrictions and controls will be communicated in writing to the property owners and to appropriate state and local agencies to ensure such agencies can factor such conditions into their oversight and decision-making activities regarding the property."	Property transfer is addressed in Section 10.2.4.3.
10.	Ensure that the document adequately describes pre-transfer LUCs, not just post-transfer LUCs.	Property transfer is addressed in Section 10.2.4.3.

Notes:

CERCLA = Comprehensive Environmental Response, Compensation and Liability Act
DOE = Department of Energy.
EPA = United States Environmental Protection Agency.
FFA = Federal Facility Agreement.
IC = Institutional controls.
LUC = Land use controls.
LUCIP = Land Use Control Implementation Plan
ROD = Record of Decision

Table B-2. Institutional Controls Monitoring Checklist

This checklist will be used to conduct monitoring of institutional and engineered controls that are used to prevent exposure to contamination. The checklist will be completed at least annually and the results will be reported in the annual Compliance Monitoring Reports. Corrective action implementation is discussed in Section 6.1.6.

Institutional Control	Status[a]	Explanation/Observation of Corrective Action
Verify that the occupancy warning signs are visible at Building 834D.		
Verify that the Pit 6 Landfill was inspected within the last year and deficiencies were corrected.[b]		
Verify that signage is in place at the Pit 6 Landfill prohibiting unauthorized access and excavation.		
Verify that the fences and warning signs at the site boundary and control entry are in proper condition.[c]		
Verify that the Building 850 Soil Solidification Corrective Action Management Unit was inspected within the last year and deficiencies were corrected.[d]		
Verify that the Pit 7 Complex Drainage Diversion System was inspected within the last year and deficiencies were corrected.[e]		
Verify that the Pit 7 Complex landfills were inspected within the last year and deficiencies were corrected.[b]		
Verify that signage is in place at the Pit 7 Complex Landfills prohibiting unauthorized access and excavation.		
Verify that the occupancy warning signs are visible at Building 854A.		
Verify that the occupancy warning signs are visible at Building 830.		
Verify that the occupancy warning signs are visible at Building 833.		
Check that the engineered controls (heating, ventilating, and air-conditioning system for Building 833) are functioning properly.		
Verify that the Pit 2 Landfill was inspected within the last year and deficiencies were corrected.[b]		

Table B-2. Institutional Controls Monitoring Checklist (continued).

Institutional Control	Status[a]	Explanation/Observation of Corrective Action
Verify that the Pit 8 Landfill was inspected within the last year and deficiencies were corrected.[b]		
Verify that the Pit 9 Landfill was inspected within the last year and deficiencies were corrected.[b]		

Notes:

[a] **Satisfactory status indicated by "Yes". Unsatisfactory status indicated by "No". Unsatisfactory status requires explanation. The Inspector shall immediately notify the Environmental Restoration Project Leader of any unsatisfactory status.**

[b] **The landfills are inspected and maintained by LLNL Maintenance and Utility Services. Inspections are documented and the results are provided to the Environmental Restoration Project and reported in the annual Compliance Monitoring Reports.**

[c] **Perimeter fences are inspected by LLNL Security annually.**

[d] **The Building 850 Soil Solidification mound is inspected and maintained by LLNL Maintenance and Utility Services. Inspections are documented and the results are provided to the Environmental Restoration Project and reported in the annual Compliance Monitoring Reports.**

[e] **The Pit 7 Drainage Diversion System is inspected and maintained by LLNL Maintenance and Utility Services. Inspections are documented and the results are provided to the Environmental Restoration Project and reported in the annual Compliance Monitoring Reports.**

Inspected by:

____ Date:______________

(Print Name) (Signature)

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