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Community Guide: Lawrence Livermove National Laboratory - Site 300

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Tri-Valley Communities Against A Radioactive Environment

COMMUNITY GUIDE:

LAWRENCE LIVERMORE NATIONAL LABORATORY

SITE 300

SUPERFUND SITE

PREPARED FOR

TRI-VALLEY CAREs
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List of Acronyms

ARAR	Applicable or relevant and appropriate requirements
BTEX	Benzene, toluene, ethyl benzene, and xylene
CAL/EPA	California Environmental Protection Agency
CDF	California Department of Forestry
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
COCs	Chemicals of Concern
CVRWQCB	Central Valley Regional Water Quality Control Board
DCE	Dichloroethene
DNAPL	dense non-aqueous phase liquids
DoD	Department of Defense
DOE	Department of Energy
DTSC	California Department of Toxic Substances Control
EE/CA	Engineering Evaluation/Cost Analysis
EFA	East Firing Area
EPA	Environmental Protection Agency
FFA	Federal Facilities Agreement
FS	Feasibility Study
GAC	Granular Activated Charcoal
gpm	gallons per minute
GSA	General Services Area
HE	high explosives
HI	hazard index
HMX	High Explosive Compound

Major Hydrologic Units

Qal	Quaternary alluvial deposits
Qt	Quaternary terrace deposits
Qls	Quaternary landslide deposits
Tmss	Miocene Cierbo Formation
$Tnbs_1$	Miocene Neroly Formation - Lower Blue Sandstone
$Tnbs_2$	Miocene Neroly Formation - Upper Blue Sandstone
$Tnsc_1$	Miocene Neroly Formation - Middle Siltstone/Claystone Sandstone
$Tnsc_2$	Miocene Neroly Formation - Upper Siltstone/Claystone Sandstone
Tps	Tertiary non-marine sediments

ILCR	incremental lifetime cancer risk
LLNL	Lawrence Livermore National Laboratory
µg/L	micrograms per liter (equal to parts per billion, or ppb)
µg/kg	micrograms per kilogram (equal to parts per billion, or ppb)
MCL	maximum contaminant level
mg/L	milligrams per liter (equal to parts per million, or ppm)
mg/kg	milligrams per kilogram (equal to parts per million, or ppm)
NCP	National Contingency Plan
NNSA	National Nuclear Security Administration
NPDES	National Pollution Discharge Elimination System
NPL	National Priority List
OU	Operable Unit
PCB	polychlorinated biphenyls
PCE	tetrachloroethene

pCi/L	Pico curies per liter (one-trillionth of a curie or 10^{-12})
ppb	parts per billion
ppm	parts per million
PRG	preliminary remediation goal
PRP	Potentially Responsible Party
PTU	Portable Treatment Unit
RAO	Remedial Action Objective
RBES	Risk-Based End State
RCRA	Resource Conservation and Recovery Act (1976)
RD	Remedial Design
RDX	Research Department Explosive
RfD	reference dose
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
SARA	Superfund Amendments and Reauthorization Act (1986)
SDWA	Safe Drinking Water Act
SVE	Soil Vapor Extraction
SWAT	Solar-powered Water Activated-carbon Treatment units
SWRB	State Water Resources Board
SWRI	Site-Wide Remedial Investigation
TAG	Technical Assistance Grant
T-BOS	tetra t-butyl orthosilicate
TCA	trichloroethane
TCE	trichloroethene
VOC	volatile organic compound
WFA	West Firing Area

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LAWRENCE LIVERMORE NATIONAL LABORATORY SITE 300

I. INTRODUCTION

The purpose of this report is to provide a background analysis of environmental remediation planning and cleanup activities at Lawrence Livermore National Laboratory Site 300 for reference and use by interested members of the community. This report was prepared by PM Strauss & Associates, a consulting firm that was chosen as the Technical Advisor to Tri-Valley CAREs. Tri-Valley CAREs received a Technical Assistance Grant (TAG) from the U.S. Environmental Protection Agency (EPA) to fund this report.

The information in this report is based on a review of documents and conversations with personnel from the US Environmental Protection Agency (EPA), the Lawrence Livermore Laboratory Environmental Restoration Division, the Department of Energy, the Central Valley Regional Water Quality Control Board (CVRWQCB), and the California Department of Toxic Substances Control (DTSC). This document is an updated version of the Community Guide that was prepared in December 1997. This report provides a starting point for discussion and action in the community most affected by the events that take place at Site 300.

This report is divided into the following sections:

- the Superfund process
- background on Site 300
- major issues that could affect cleanup at Site 300
- cleanup activities Site 300
- community participation
- key contacts
- where to find documents

II. THE SUPERFUND PROCESS

The Comprehensive Environmental Response, Compensation, and Liability Act, or CERCLA, was enacted in 1980 and is commonly referred to as the Superfund. Actions taken under CERCLA (Superfund) deal with sites where there have been past releases of hazardous substances. Other laws such as the Resource Conservation and Recovery Act, or RCRA, regulate the day-to-day management, transportation and disposal of hazardous wastes. At some Superfund sites, usually active sites with ongoing operations, these laws and regulations overlap. It is then up to the regulatory agencies to determine which set of regulations is most appropriate to use.

Superfund was amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA). [1] Among other things, SARA introduced Section 117(e) "Grants for Technical Assistance," which is the source of funding for this project.

The National Oil and Hazardous Substance Contingency Plan, usually shortened to the National Contingency Plan (NCP), provides the regulatory and procedural framework for implementing the cleanup responsibilities established under CERCLA. The Superfund process involves the following steps:

Step 1: National Priorities List (NPL)

After initial site discovery, a site is inspected and rated in terms of potential endangerment to public health. If a site scores high enough, it is placed on the National Priorities List (NPL) and becomes a Superfund site.

Step 2: Remedial Investigation and Feasibility Study (RI/FS)

After a site is placed on the NPL, the Remedial Investigation and Feasibility Study (RI/FS) are each prepared. This stage is known as the RI/FS process.

a) Remedial Investigation (RI)

The RI includes a detailed characterization of the site and a human health risk assessment. The site characterization identifies chemicals of concern, describes the geology and hydrology of the site, describes the ecosystem at the site (including sensitive animal and plant species), and describes how chemicals of concern are situated. This risk assessment addresses how humans or ecological receptors can possibly be exposed to the identified chemicals, and estimates the health and ecological risks.

The risk assessment defines the level of risk that may be posed to residents and/or workers in the contaminated area, based on sometimes very complicated risk assessment techniques. Human health risks must be below a certain level for the EPA to accept the remediation strategy. Acceptable risk for potential cancer-causing agents lies within the range of 1×10^{-4} (one person per 10,000 population) to 1×10^{-6} (one person per 1,000,000 population) incremental lifetime cancer risk (ILCR). Risk below 1×10^{-6} is considered *de minimus* (negligible), and thus is considered acceptable. In the United States, a cancer incidence of 3,000 persons per a 10,000 population is expected (or 300,000 per 1,000,000), without exposure to additional contamination. At an ILCR level of

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1 CERCLA is in the process of being revised. With the changes in Congress, it is difficult to anticipate what a final statute will look like.

$1x10^{-4}$, 3,001 people in a population of 10,000 would develop cancer; at a level of 1×10^{-6}, 300,001 per 1,000,000 people would develop cancer. For non-cancer health risks, acceptable levels of risk are based on a hazard index (HI). Any HI of 1.0 or above presents an unacceptable health risk. [2]

b) Ecological Assessment

Concurrent with the development of the RI, an ecological assessment is prepared. Rather than focusing on public health, the ecological assessment focuses on how chemicals at the site will affect sensitive "ecological receptors" (i.e., plants and animals potentially present at the site that could be exposed to chemical contaminants). The ecological assessment surveys the site for receptors that are classified as threatened, endangered, rare, or have some special status, or specific sensitivity to contaminants present at the site. It also evaluates whether there any observable effects as a result of the contamination and evaluates cleanup options for the site. The methods for performing ecological risk assessments are in their early stages of development. Often, we don't know what species are present, and we rely on information about what levels of contaminants pose a potential threat based on old data or data extrapolated from information about other similar species.

c) Feasibility Study

The FS evaluates cleanup options. The FS usually includes an estimate of costs, an analysis of various technologies, and an estimate of cleanup time. Cleanup standards are also set forth. For any given site, these standards, in general, are called ARARs (Applicable or Relevant and Appropriate Requirements). ARARs encompass all federal, state and local laws, regulations, and regulatory guidance that must be adhered to during cleanup. Often, the FS is the first report that specifically identifies the clean-up plan for the site. The FS does evaluate ecological effects of various remedies. There are usually several drafts that are available for regulatory and public comment.

Step 3: <u>Proposed Plan</u>

After completion of the RI/FS, a proposed plan is presented (sometimes it is referred to as the Remedial Action Plan). This is a relatively short document summarizing the clean-up choice and includes a justification for that choice. This document may modify the cleanup options designated in the FS. The proposed plan is subject to public comment and a public hearing.

Step 4: <u>Public Comment and Public Hearing</u>

A public comment period and public hearing follow the release of the proposed plan to the public. The comment period lasts a minimum of 30 days and can be extended by a minimum of 30 days with a timely request. If, based on the public's comments, the proposed plan is significantly altered, additional public comment may be sought on a revised proposed plan. The final remedy selection is made by the lead agency (i.e., the agency or agencies that have ultimate responsibility to ensure that the cleanup process meets all standards and is carried

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[2] In simple terms, the HI is the relationship between an expected daily intake of a substance and the daily reference dose for a substance. The reference dose is a threshold level of substance intake below which a human population, including sensitive populations such as children, may be chronically exposed without significant adverse health effects. To measure the HI for combined effects of substances, one adds the HI for each substance, with some adjustments.

out) and is presented in the Record of Decision (ROD). At federal facility Superfund sites, the remedy selection is a joint decision between the facility manager and the EPA, or, in the case of disagreement, by the EPA only.

Step 5: Record of Decision (ROD)

The ROD presents the selected remedial action and presents a response to public comments. It specifies clean-up requirements, dates for complying with certain additional actions, and any special conditions. EPA and other agencies with jurisdiction (such as the California State EPA and the DTSC) must be approve the ROD. No further public hearings are required under CERCLA after the ROD is signed, unless specified in previous agreements, or if there are substantial changes made to the ROD during the clean-up process. The ROD is a legally binding document.

Step 6: Remedial Design

The Remedial Design (RD) specifies the precise design of the technologies that are going to be used and provides precise details where extraction wells, recharge wells and monitoring wells will be located. Once the RD is complete, construction and remedial action begin. At this stage in the process, contingency plans are often developed and discussed in this report. However, there has been discussion among policy makers that contingency plans should be made earlier in the process, and included in the ROD.

Step 7: Source Control Measures and Removal Actions

The National Contingency Plan allows the lead agency to undertake certain source control measures or removal actions before the formal cleanup process begins to mitigate risks to public health or the environment. Typical removal actions are tank removals or excavation of highly contaminated soil. (In some cases, removal actions may also take place under RCRA under a corrective action plan.) Although allowance of too many actions tends to fragment the cleanup process, if done efficiently and to high standards, further contamination may be substantially reduced. When removal actions are time critical (i.e., contamination presents an immediate risk to human health), they are obviously most important.

Many agencies use removal actions that are "non-time critical". In effect, these are smaller actions that can be implemented without all the paperwork necessary for typical remedial actions undertaken under CERCLA. Before a non-time critical action is implemented, the proponent must prepare an Engineering Evaluation/Cost Analysis (EE/CA). This document is a shorter version of an FS, and states the reasons why the removal action is necessary. EE/CAs are subject to review and comment by the public and the regulatory agencies. This period lasts no less than 30 days after the EE/CA is made available to the public. This period can be extended by at least 15 days if a request is made in a timely manner. There is no ROD, and there is not a requirement for a public hearing. An Action Memorandum is prepared following the public comment period, and authorizes implementation of a removal action. As such, the removal actions do not have the same degree of public and regulatory scrutiny as traditional remedies under CERCLA. [3] Underlying the motivation for these approach actions is the assumption that it will save both time and money, and would be commensurate with the overall remedy for the site.

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3 At Site 300, LLNL has agreed to hold a public meeting for each EE/CA, if requested by the public.

The following are other relevant provisions of the Superfund process:

* One of the more practical aspects of CERCLA is that at large sites, such as Site 300, agencies have the option of dividing the site into Operable Units (OUs). This is usually done because areas have distinctly different types of problems, and cleanup schedules for different areas can proceed at different times. If the area is divided into OUs, an RI/FS for each OU is needed, as well as a ROD.
* The Superfund Amendments and Reauthorization Act (SARA) provides that "(S)ubstantial continuous physical onsite remedial actions...be commenced no later than fifteen (15) months after completion of the [remedial] investigation and [feasibility] study." [4]
* Petroleum-related contamination is generally not covered under CERCLA. Therefore, EPA cannot use the enforcement powers of CERCLA to require cleanup of these substances. Fuel-related discharges from underground storage tanks are regulated under RCRA, and enforcement of discharges from these sources may take a parallel course to that of CERCLA. However, when constituents of gasoline such as benzene, toluene and xylene, or other fuel products are commingled with contaminants regulated by CERCLA, they are covered under CERCLA.
* The remediation strategy must satisfy a number of criteria to be accepted by EPA. Among these criteria is Community Acceptance. For community organizations such as Tri-Valley CAREs, this is perhaps its most powerful tool for effecting changes to the cleanup strategy. Disagreements that the community has with the cleanup strategy should be carefully documented, and reiterated throughout the process. Since the ROD is the key decision document in this process, it is very important that concerned citizens be heard prior to its release. However, community acceptance is not defined in the regulations. For Site 300, TVC developed a set of community acceptance criteria, which were distributed to a larger community. Below is a summary of the community acceptance criteria that were developed and submitted to the agencies. **Attachment 1** contains the full text of the criteria.

—— Complete the cleanup project in a timely manner.
—— Cleanup levels should support many uses of the property that are unrestricted by environmental contamination.
—— Cleanup levels should be set to the strictest state and federal government levels.
—— Remedies that actively destroy contaminants are preferable.
—— The tritium source and plume should be controlled at the earliest possible time in order to prevent further releases to the environment.
—— Radioactive substances should be isolated from the environment.
—— The ecosystem should be protected and balanced against the cleanup remedies.
—— Decisions should not rely on modeling alone.
—— Additional site characterization is needed and must be budgeted for over many years.
—— A contingency plan should be completed and subject to public review prior to the signing of a ROD.
—— The public should be involved in cleanup decisions.

4 Section 120(e)(2)

—— Cleanup should be given priority over further weapons development.
—— Any ongoing activities at Site 300 should be designed to prevent releases to the environment.

* As discussed in the section on the RI/FS, SARA requires that Applicable or Relevant or Appropriate Requirements (ARARs) be used to set cleanup standards. These ARARs are either based on federal environmental laws or more stringent state laws or accepted guidelines. The Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) and Clean Water Act Water Quality Criteria are applied when appropriate. California State law sometimes requires stricter standards. In most cases, if there is a potable drinking water supply that is potentially effected, the ARARs for groundwater are at least as stringent as the MCLs.

There are no federal cleanup levels that are established for soil contamination. Contaminated soil can be ingested, inhaled, may contaminate the groundwater, or all three. Therefore, standards must be set on a site-by-site basis. There is also no standard methodology for determining whether soil contamination will effect the groundwater to the extent that it will exceed the MCLs. At some sites, detailed modeling of the potential migration of contaminants from the soil to the groundwater has been done to determine whether soils needed remediation. At other sites, soil cleanup standards are set less scientifically (e.g., in Santa Clara County, where there are well over 20 federal Superfund sites, the soil cleanup level is set at 100 times the groundwater MCL for a given contaminant.)

III. SITE 300 BACKGROUND

The Lawrence Livermore National Laboratory (LLNL) Site 300 encompasses approximately 10.5 square miles in the Altamont Hills of northern California between the cities of Livermore and Tracy. Site 300 is located about 12 miles southeast of the LLNL Main Site in Livermore and 8.5 miles southwest of Tracy. The Site has been surrounded by open space used mainly for ranching and recreation. However, a residential neighborhood is being developed one mile from the site. The climate of the Site is semi-arid and windy, and the topography consists of rugged hills and canyons.

Site 300 is a Department of Energy (DOE) high-explosives test facility. It is currently operated by the University of California. Since 1955, it has been used for the processing and testing of high explosive materials, mainly used in nuclear weapons, and surrogate nuclear detonations. Historic activities include formulating, processing and fabricating chemical high explosive compounds and weapons components; thermal and mechanical testing and measuring of physical properties of explosives; transport, receipt, use, storage and disposal of high explosive compounds and waste; and decontamination of high explosive equipment. Testing of weapons materials was done on firing tables: open concrete and gravel pads where small-scale weapons were detonated. [5] These tests attempted to simulate how materials and components of the weapons would perform in a real nuclear explosion.

Often, radioactive substances such as depleted uranium and tritium were used in test explosions. Some of these materials were later released to the environment.

Chemicals of concern at the site include: high explosives materials, depleted uranium, tritium, and volatile organic compounds (VOCs), most often trichlorethene (TCE), perchlorate rocket fuel, nitrate, PCBs, dioxins and furans, and some silicate based lubricating fluids. There have been significant releases due to poor operations and waste disposal practices. Areas within Site 300 have extremely high concentrations of contamination. In some cases, there is evidence that pure VOC product that is not dissolved in the water is present in the ground or in crevices below groundwater zones. This pure liquid product is known as non-aqueous phase liquid (NAPL). NAPLs slowly release molecules to the groundwater, and act as a continuing source of pollution. This form of pollution is difficult to find and clean up, particularly if it more dense than water.

The geology and hydrology of Site 300 is complex. There are at least five different geological formations at Site 300, and several fault zones. A unique geological feature at the site is the Patterson Anticline,[6] which runs roughly east-west through the middle of the site. The area north of the anticline dips slightly to the northeast and the area south of it dips to the south. As groundwater follows the incline of the bedrock, this feature effects the direction of groundwater flow, the rate of movement, and may effect whether shallower aquifers are in communication with the deeper aquifers. As a result of the complex geology of the site, modeling and characterizing the groundwater flow is especially difficult. For purposes of this report, there are three main aquifers (i.e. a geological unit that is saturated and can yield economically significant amounts of water) at the site. [7] First, upper aquifers are formed in permeable deposits and are often

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[5] See Appendix A, Photographs of Selected Activities at Site 300

[6] An anticline is a rock formation in which rock folds downward on both sides of a median line.

[7] This is a simplification. There are at least six different water-bearing units. At Site 300, the so-called $Tnbs_1$ makes up the major regional aquifer of concern. There are several hydrogeological units

separated from lower aquifers by layers of siltstone/claystone or by thick layers of clay and rock. These units are sometimes called shallow or perched aquifers, [8] meaning that they are separated by a layer of unsaturated rock, clay, or soil from lower aquifers. Second, is the regional aquifer. It exists primarily in lower blue sandstone, designated as the $Tnbs_1$ formation, although it may also be present in the upper blue sandstone formation ($Tnbs_2$). Third, is a deeper regional aquifer zone (called the Tmss). The deep aquifer exists below the sandstone formations, and is not very well defined at the site.

There is a diverse and rich ecosystem at Site 300, enhanced by the complex topography and hydrology of the site. There are two known federally-listed endangered species: the San Joaquin Kit Fox and the Large-Flowered Fiddleneck (Amsinckia grandflora) in addition to many other plant and animal species that are at potential risk from contaminants at the Site. About 25% of Site 300 is Kit Fox habitat. 91 acres near Building 858 has been set aside as an ecological preserve to protect the Large-Flowered Fiddleneck. Habitat for the California Red-Legged Frog, a threatened species occurs in the southwest portion of the site. Localized habit for the tiger salamander also occurs in the eastern part of the site.

above this formation which make up what is grouped as the shallow aquifer. Below the $Tnbs_1$ there is the deeper Tmss regional aquifer.

8 A perched aquifer is a saturated zone that lies above an impervious layer, usually clay or hardpan, which does not allow it to communicate with groundwater below.

IV. Major Issues that Could Limit the Effectiveness of the Clean-up at Site 300

A. Policy Issues

1. Accelerated Cleanup and Performance Management Plan

Every year, the cleanup budget for Site 300 has come under intense scrutiny. All too frequently, it has been cut back. LLNL has had several responses to budgetary constraints. In 1996, for example, the U.S. Department of Energy (DOE) first proposed to "accelerate" cleanup, largely by relaxing cleanup standards in the face of budgetary restrictions. As a general principle, while reducing documentation requirements and even lengthening the cleanup schedule *may be* reasonable responses to budgetary restrictions, cleanup standards should not be tampered with unless changes are based on sound scientific principles.

In 2001, DOE decided to accelerate cleanup at some sites while reducing the budget for other sites. When the accelerated cleanup fund was originally announced, it seemed that additional funds would be spent to clean up certain sites. LLNL and Site 300 were not originally included in the sites that were accelerated. After considerable protest by some excluded sites, DOE instituted a "top-to-bottom" review of cleanup at all of its sites to articulate how cleanup could be accelerated. This culminated in a Performance Management Plan (PMP) for each site that laid out goals, commitments and milestones should cleanup funds become available.

As a result of this process, DOE is committed to achieving the following "end state" for Site 300 by 2008:

1. All ground water and soil vapor extraction and treatment systems will be in place and in operation, reducing risk and preventing further plume migration.
2. All contaminant source areas will be controlled, preventing further degradation of groundwater.
3. Excavation and removal of contaminated soil at the Building 850 Firing Table will be completed, reducing the unacceptable risk to onsite workers and preventing further impacts to ground water.
4. Monitoring networks for the “monitoring-only” and “monitored natural attenuation” remedies will be completed and operational.
5. The risk and hazard management program to prevent impacts to human health and ecological receptors during cleanup will be fully implemented.
6. Compliance monitoring programs will be in place to assess: (1) the effectiveness of the remedial actions, and (2) changes in plume size and concentration that could impact downgradient receptors.
7. Final cleanup standards and remedial actions will be established.
8. All CERCLA-required documentation will be completed, with the exception of ongoing Five-Year Reviews and regular compliance reporting during Long Term Stewardship (LTS).
9. Characterization of remaining confirmed and potential release sites will be completed.

Generally, Tri -Valleys CAREs supports these commitments. However, DOE’s policy of trading one site off against another, "robbing Peter to pay Paul", lets politics dictate which facilities get funds for cleanup. Thus, it is not certain whether the environmental restoration program for Site 300 will be funded in order to achieve the end-state articulated in the PMP.

2. Risk Based End State Vision.

In late 2003, DOE tasked each site with formulating an "End State" and cleanup strategy based solely on human health risk that would be contrasted to the "Current End State". The implementation of this Risk Based End State (RBES) policy raises grave concerns over cleanup at Site 300 and other sites in the U.S. nuclear weapons complex, including:

- ***The RBES plan places pressure on site managers to alter remediation plans on the basis of questionable risk calculations rather than complying with previous commitments. The Policy Guidance from DOE appears to allow no leeway for LLNL to make a decision to pursue the "Current State" condition.***
- Specifically as it relates to Site 300, the Risk-Based End State Vision would be a substantial rollback of the cleanup strategy at Site 300. Some of its provisions seriously undermine the State's and the U.S. EPA's role in setting environmental cleanup standards.
- The Plan will encourage Site 300 to assume permanent federal control as the future land-use, an assumption that TVC has argued against.
- The RBES sets the point of measuring compliance with environmental laws at the Site boundary. Therefore, contaminants will be left to migrate to the fence line and be cleaned up only if the plume crosses the boundary. This will allow contaminants to pollute a much larger area than if the contamination were controlled at the source. This violates a long held principle of environmental cleanup: it takes much more effort to clean up contaminants spread out over a large area than cleaning them up at the source. In fact, during the 1990's, LLNL's own staff endorsed this principle, dubbed "Engineered Plume Collapse" as the strategy that helped it to save time and money during cleanup.
- The RBES plan will encourage adoption of monitored natural attenuation as a remedy for most sites. DOE argues that "a significant portion of DOE's groundwater cleanup costs are associated with operation of pump-and-treat systems, yet it has long been recognized that pump-and-treat remedies may not achieve restoration within a reasonable time frame in many settings typical at DOE sites." This view is questionable, especially considering the substantial success of pump-and treat at the GSA Operable Unit, and significant reduction in contaminant mass at Building 834 due to aggressive groundwater extraction and treatment and soil vapor extraction.

3. The Devolution of Environmental Management

As part of DOE's accelerated cleanup program, the Office of Environmental Management is going to transfer its responsibility over each sites to one of two entities. For sites that remain active with an ongoing mission, all environmental management responsibility will be transferred to the National Nuclear Security Administration (NNSA). Although it makes some sense to require the "polluter" to clean up after itself, the NNSA's mission is building and maintaining the nuclear weapons arsenal within a culture of secrecy. As this bureaucratic shift occurs, there is a risk that the budget for environmental management will become an even lower priority than it is now. For sites that do not have a weapons mission, responsibility for environment programs will be shifted to the Office of Legacy Management (OLM). Part of the responsibility of OLM will be to ensure that cleanup continues and long-term stewardship measures are implemented. Tri-Valley CARES is concerned that this new Office will not have a sufficient budget to accomplish the enormous tasks in front of it.

4. Establishing Cleanup Levels [9]

The Site Wide Interim ROD established cleanup objectives without specifying numerical cleanup levels. However, DOE made a commitment to TVC and the regulators that for groundwater, cleanup levels would be a least as stringent as MCLs (Maximum Contaminant Levels), and possibly lower to be consistent with California requirements to clean up to background levels.[10] Interim remedies were instituted to determine if the strictest levels of cleanup could be attained.

Regulators can negotiate cleanup standards. For example, some standards may be waived if they are technically impracticable. Institutional controls such as deed restrictions may substitute for a cleanup standard. Conversely, stricter standards may be applied to the site, as was the case at the Tucson International Airport Superfund Site where the community was highly sensitive because it had been consuming contaminated water for almost 30 years. For example, at the Tucson International Airport Superfund Site, groundwater is treated to a risk-based standard so that groundwater would not exceed a one in one million additional cancer rate. At both the Livermore Main Site and Site 300, groundwater is cleaned up to the California and Federal Maximum Contaminant Level (MCL) for drinking water, a standard that loosely approximates a one in one-million additional cancer rate.

At Site 300, there are several changes since the previous edition of this Community Guide was published.

First, perchlorate, which has contaminated large areas of Site 300, has been added to the chemicals of concern. Perchlorate is used primarily as a rocket propellant, secondarily in explosives. The major health concern regarding perchlorate is that it blocks iodide uptake in thyroid. Iodide is critical in regulating growth and metabolism, especially in fetuses and young children. In leafy food crops such as lettuce, 90% of the perchlorate in water is absorbed into the plant within four weeks. EPA's provisional reference dose is 4-18 ppb in groundwater, although some states have developed their own standards. Massachusetts and Maryland have developed a standard of 1 ppb. California adopted a 4-ppb action level, requiring that wells testing above 4 ppb be removed from service. This compound is being studied further at the national level.

Second, EPA has reassessed the toxicological risk of trichloroethene (TCE), one of the major contaminants of concern at Site 300, and concluded that previous studies had understated its risk to small children by as much as 65 times.

For several contaminants found at Site 300 there is no Maximum Contamination Level (MCL). These include RDX (used to make explosives) and perchlorate. For the former, there is a Preliminary Remediation Goal (PRG) established by Region IX of the USEPA. The PRGs are levels of chemicals found in soil, drinking water, or air that the EPA recommend be used as preliminary screening number for initial cleanup goals to determine whether a chemical presents an unacceptable risk. “Unacceptable risk” is defined two ways: first, exposure cannot exceed one in one million increased cancer risk,

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[9] See Table for existing groundwater cleanup levels.

[10] For example in the Site Wide ROD, pp. 65, 67, 75, 79, 82 and 85 all have the same statement: "The preliminary cleanup levels are set at maximum contaminant levels allowed in drinking water or State Water Quality objectives, whichever is more stringent, or below. These cleanup levels could change once the Final Record of Decision, scheduled to be released in 2007, is completed."

and second, for non-cancer health risks, acceptable levels of risk are based on a hazard index (HI). For planning purposes, and in some cases for implementation, the PRGs are good action levels

The EPA has also found evidence at other sites that TCE vapors were entering buildings. Although EPA has not required LLNL to re-evaluate any of the buildings at Site 300, it may be a candidate for future study. The PRG for TCE in tap water, which Region IX of the US EPA has "provisionally" adopted, is 0.028 ppb, three orders of magnitude lower than the MCL.

Finally, the Interim ROD will be revised in 2007 and will establish final cleanup goals. It is crucial that the community maintain a strong and uncompromising voice in demanding that the strictest cleanup levels that are achievable be established: PRGs should be adopted for all other chemicals of concern found at Site 300, unless it can be shown why they are not applicable. Two other Superfund sites in the Bay Area, the Naval Weapons Station Concord and the MEW Site in Mountain View) have adopted the PRGs for some contaminants.

5. Non-Degradation of Potential Drinking Water

California State Water Resources Control Board Resolution 68-16 implies a stricter standard than drinking water standards. This is known as the non-degradation policy. That is, it is state policy that a polluter cannot degrade groundwater quality. Practically speaking, groundwater should be maintained at *background* levels if it can be shown that it is technically and economical feasible. Resolution 68-16 allows alternatives if the polluter can show that non-degradation cannot be practically achieved or it is not more protective of human health. While Resolution 68-16 does not apply to existing polluted groundwater, if a plume is allowed to migrate, it degrades water quality downstream, just as if someone were dumping pollutants into the groundwater.

Resolution 68-16 has been state policy and strictly interpreted by the Central Valley Regional Water Quality Control Board (CVRWQCB). State Water Resources Control Board Resolution 92-49 [11] also comes into play when setting cleanup standards. As part of the Interim ROD, DOE/LLNL agreed to conduct a Basin Plan Compliance Evaluation by 2005. Five scenarios were set forth under the proposed evaluation:

- Groundwater extraction at source and downgradient areas to maximize mass removal and reduce levels to MCLs, followed by natural attenuation to background.
- Groundwater extraction with complete hydraulic capture of concentrations above MCLs, followed by natural attenuation.
- Groundwater extraction at source and downgradient areas to maximize mass removal and reduce levels to background. Natural attenuation may be relied upon to reduce levels to background near plume boundaries.
- Groundwater extraction with complete hydraulic capture of concentrations above 2.3 ppb one-in one -million cancer risk for TCE, followed by natural attenuation to background.
- Groundwater extraction with complete hydraulic capture of concentrations above background to reduce concentrations to background. For TCE, background will be considered the detection limit of 0.5 ppb.

[11] Policies and Procedures for the Investigation and Cleanup and Abatement Under Section 12204 of the Water Code

We believe that the Community must actively review this analysis and keep pressure on the State to require adherence with the non-degradation policy.

B. Technical Issues

1. Monitored Natural Attenuation (MNA).

The definition of natural attenuation is controversial. Natural attenuation refers to a decrease over time in chemical concentrations measured at the same location. Often, it refers to a biological process in which the contaminant is “naturally” broken down into harmless constituents by naturally occurring bacteria. However, it also refers to physical processes (dispersion, dilution, and adsorption), which do not clean up the material. The US EPA recently developed guidelines for evaluating Monitored Natural Attenuation. These guidelines require the removal of the source of contamination, substantial analysis, using multiple lines of evidence, to show that natural attenuation occurs in a "reasonable time frame", and a substantial effort in monitoring contaminant levels.

One of the key questions raised by the Risk-Based End State Vision is whether MNA will be effective at Site 300. At several isolated areas (such as Pit 6), LLNL’s current remedial strategy for Site 300 assumes that TCE will undergo natural attenuation prior to it reaching the site boundary, and therefore will not present a risk to public health. If TCE is degraded by chemical or biological factors, we would expect to see fairly high concentrations of vinyl chloride, as TCE has been in the ground and groundwater for some time. Vinyl chloride, a known human carcinogen, is a natural breakdown product of TCE in many groundwater environments. TCE has been found at extremely high concentrations at OUs 1 and 2, and is present in many other locations at the site. The baseline health risk assessment does not include an assessment of vinyl chloride because it has not been found at Site 300. Interestingly, natural attenuation was evaluated as a remedy for the Building 815 Operable Unit. It was rejected as a potential remedy in part because of “the absence of detectable concentrations of TCE degradation products, such as 1,2-DCE and vinyl chloride.” [12]

Also of issue is the tritium plume emanating from the Pit 7 Complex (OU 5) and Building 850. Although we know that tritium has a half-life of approximately 12 years (natural radioactive decay), we know much less about how it is transported. Recently, when the Pits were re-characterized, a new hydrologic stratum was found that explains some of the anomalous readings that had been puzzling environmental staff. We highlight this because we do not have confidence that LLNL fully understands the complex hydrogeology at Site 300 to be able to predict the direction and velocity of groundwater.

Furthermore, it is one of the basic principles of environmental management in the U.S. that dilution <u>cannot and should not</u> be used as a solution to contamination problems. Therefore, if natural attenuation occurs at Site 300 only because of physical processes such as dilution, it should not be included as a potential remedy. On the other hand, where biodegradation is a main component of natural attenuation, such as is the case at the Building 834 OU, we support this method in conjunction with plume control.

2. Vapor Intrusion

Vapor intrusion is the phenomena whereby contaminants in the groundwater or the soil change phases (in this case liquid to gas), and are emitted into the overlying air. If there is a building above contaminated soil or groundwater, there is a danger that vapor will mix with the air in buildings, either through cracks in the foundation or from the outside air.

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[12] Draft EE/CA for B815 OU, LLNL Site 300, p. A-4, July, 1997

This is a growing concern throughout the country, and many Superfund sites with high levels of VOCs such as TCE are now being re-evaluated to understand the risk that this new pathway may pose. As noted in the issue on cleanup standards, the toxicity of TCE has also been re-evaluated by EPA and initial findings are that this chemical poses a much greater risk than previously thought.

DOE changed its prior position to conduct air sampling within the vadose zone to ambient air modeling (both indoors and outdoors). These models are based on the Johnson-Ettinger model. This model has come under intense criticism, and we recommend that it only be used in conjunction with ambient air modeling. Also, the risk assessment for the various buildings is based on old data pertaining to TCE vapors. LLNL should revise its risk assessments using the latest information on this chemical.

Also, releases of tritium to the air, both as a result of experiments with gaseous tritium and as a result of tritium released from the subsurface should also be considered in any analysis.

3. Location of DNAPL

Non-aqueous phase liquids (NAPLs) are compounds that are in liquid form but do not dissolve in water at normal pressure and temperature. As they degrade, or as there are changes in either of these parameters, these compounds slowly release soluble constituents to the groundwater. Most common are petroleum products that are lighter than water. We have all seen oil slicks. These are called Light Non-Aqueous Phase Liquids, or LNAPLs. Non-aqueous phase liquids that are heavier than water sink to the bottom of the water body because they are denser than water. These are called Dense Non-Aqueous Phase Liquids, or DNAPLs. When released at the surface, DNAPL moves downward through the soil under the force of gravity until it is absorbed by soil particles or trapped in pores, or comes to some impermeable barrier, such as bedrock. Once DNAPL is trapped in the subsurface, it is very difficult to recover, unless its exact location is known. While DNAPL or potential DNAPL exists at many sites, remedies are illusive without knowing the precise location. Conventional pump-and-treat methods usually remove only a small fraction of the trapped residual DNAPL. DNAPL that remains in the soil or groundwater acts as a continuing source of contamination as it slowly dissolves, preventing complete restoration of an area for many years.

There are several locations at Site 300, including the Central GSA and Building 834 where DNAPL has been located. Several alternative treatment technologies are being tested to better locate DNAPL. We encourage LLNL to continue to find ways of removing DNAPL so that the site can be cleaned up to drinking water standards. It's important to note that only one 55-gallon drum of TCE (in its liquid form a DNAPL) can contaminate 11 billion gallons of water to the 5-ppb drinking water standard.

4. Risk Assessment

Risk assessment defines the pathways through which contaminants may reach human populations. For example, the risk assessment will define how contaminants (i.e., chemicals of concern) are mobilized in the environment, and how humans can be exposed. Therefore, when using health-based risk assessments in cleanup decision-making, the future use of the site is either implicitly or explicitly assumed. If the site is assumed to be used for purposes similar to current uses, risks may fail to provide a sound basis for long-term environmental cleanup. For example, if groundwater is not currently used at the site, a risk assessment may fail to identify it as a risk, even though drinking groundwater would pose a risk to a future resident.

Risk assessment methods are based on limited information: based on a snapshot in time and by limited data. Even if we had good and representative data, our limitation of knowledge about toxicity is a major deficiency in risk assessment.

In order to calculate risk, one must first know what level of a chemical is harmful to humans, know what level of a chemical is present at the point of exposure, and know how this chemical will move over time.

The first piece of information is based on limited human health data. For most chemicals, risks are based on animal studies, where relatively small numbers of animals are exposed to large quantities of chemicals. The health effects are then extrapolated to large populations of humans. Risks are considered to be additive, not synergistic, as may actually be the case. That means that when exposed to two substances, the interaction of those substances is not multiplied, it is simply added. Additionally, cancer, and the causes of cancer are not well understood. In theory, some forms of cancer are caused by a series of cellular breakdowns that may be caused by one substance acting one way, and another acting in another fashion. Causes of much non-cancer related disease, particularly immune deficiency diseases such as Lupus, are also not well understood.

The latter two pieces of information include many assumptions. Hydrogeologic models used to calculate exposure to chemicals are based on limited data about what is present and how they will migrate. Additionally, gross estimates are made to estimate how these chemicals degrade and/or transform over time.

The risk assessment for Site 300 analyzes exposure using two exposure routes. Neither assumes the use of on-site groundwater. One scenario is exposure to contaminated soil by an adult on-site worker through vapor inhalation and dermal (i.e., skin) contact. The second scenario is exposure to contaminated groundwater by future residents drinking well water beneath their property at the boundary of Site 300. In the latter scenario, the health risk assessment assumes that contaminated plumes migrate from the original source before affected groundwater is consumed. During the process of migration, it is assumed that contaminant plumes undergo significant dilution, dispersion, adsorption onto soil particles, and chemical degradation, thus lowering the risks to humans. Please note that all health risks cited in this Community Guide are based on LLNL's risk assessment that does not consider a scenario where groundwater from on-site wells is used for on-site drinking water. Therefore, Tri-Valley CARES believes that reported health risks are understated.

5. Complete Characterization

TVC is concerned about characterization for two reasons: all areas of contamination are not well defined and DOE has not budgeted for additional characterization. As TVC has long suggested, Site 300 needs additional funds for characterization. Information in the Long-term Stewardship document[13] for Site 300 supports that position, although it is not apparent that any money is set aside for this. The information that supports this position is within the descriptions of each Operating Unit. LLNL admits to a low level of confidence in its estimates of the area, volume and mass of contamination for soil and groundwater. Almost all soil is ranked as having a low-level of confidence, and nearly all groundwater is ranked as having a low or medium level of confidence.

6. Complete Cleanup

Wherever possible, TVC recommends that Site 300 be cleaned up to a level that allows unrestricted use and avoids the need for long-term stewardship. We also recognize that at

[13] DOE, March 15, 2000

a few selected areas this may not be possible due to the nature of the contaminants. Where cleanup to such a level is not practical due to current technical constraints, commitments should be inserted into the final remedy decision detailing the stewardship plan and funding. DOE should develop a program to look for solutions that would minimize or eliminate the need for long-term stewardship. Some contaminants will have to be "stored" in place or at the site for long periods of time. This may be true for many radionuclides and some chemicals, often when they are in the form of dense-non-aqueous phase liquids (DNAPLs). Once decisions are made to leave a contaminant in place, it is difficult to continue research on how the contaminant could be safely treated, thereby avoiding or reducing the need for long-term stewardship measures. DOE should to establish a dedicated program that keeps an eye towards the future and continually looks for solutions to these problems.

C. Institutional Issues

1. Future Land Use

Only a fraction of the 11 square mile subsurface and surface of Site 300 is contaminated. The cleanup strategy for Site 300 assumes DOE's continued stewardship and use of the site. Given the uncertainty about the weapons program, and the rapid growth of nearby communities such as Tracy, DOE's continued stewardship should not be assumed. We recommend that cleanup be driven by the assumption that most, if not all areas, of Site 300 will be returned to unrestricted land use. Other areas where contaminants cannot be removed should be so designated and used for other compatible purposes, including recreation, ecological preserve, industrial research, and agriculture.

As stated in its community acceptance criteria, TVC believes that the Lab should assume multiple uses for the site, including residential areas and ecological preserves. DOE is aware of some of the concerns of nearby neighbors and landowners. These include drinking water issues and the effect on wildlife. The remediation plan detailed in this Record of Decision must fully consider the possibility that future residences will be developed up to the boundary of Site 300, as well as within the site boundary.

2. Funding Commitments

A basic concern is whether funding commitments are sufficient to ensure long-term cleanup and achievement of project milestones. Long-term funding for clean up should be a major commitment. Cutbacks in funds only delay inevitable expenditures, and may make cleanup more costly. Therefore, DOE and LLNL should make all attempts to ensure future adequate funding. If funds are cut, however, the public should be involved in helping to establish priorities for areas of cleanup

3. Long Term Stewardship (LTS)

A working definition of LTS is "the physical controls, institutions, information and other mechanisms needed to ensure protection of people and the environment at sites where DOE has completed plans for cleanup (e.g., landfill closures, remedial actions, removal actions and facility stabilization). The concept of long-term stewardship includes land use controls, monitoring, maintenance and information management".[14]

On a national level, we are concerned about DOE's commitment to implement the necessary plans and activities that this will entail, and maintain steady and necessary levels of funding. All aspects of establishing, maintaining and funding long-term

[14] Long-Term Stewardship Study, DOE 2001.

stewardship activities should be considered and costed out during the remedy selection process. LTS activities at each site should include distribution of health information and a health-monitoring plan. The community should also be involved in periodic reviews, such as the five-year review cycle under CERCLA to re-evaluate the effectiveness and performance of long term stewardship activities. DOE (or subsequent federal managers) should implement a systematic process for re-evaluating and if needed, modifying existing LTS activities to ensure that developments in science, technology and performance are incorporated. The National Research Council recommended that "DOE should plan for uncertainty and fallibility" of some aspects of the long-tern stewardship program; including developing plans "to maximize follow-through on phased, iterative and adaptive long-term institutional management approaches at sites where contaminants remain". Lastly, if contaminants are left in place, DOE should compensate local governments. Even with the best plans, we know that there will be failures. Some of these failures may require emergency medical response due to sudden events (e.g., explosion), but many may lead to negative health affects due to non-sudden events (e.g., failure to contain seeping groundwater plumes leading to contamination of the water supply).

On a local level, LTS plans for Site 300 have only been preliminary in nature, laying some broad assumptions about land-use and future funding needs. Most activities are based on complying with the regulations, maintaining the remedies, and preventing exposure by prohibiting access. The budget is based on construction and operation of treatment facilities to satisfy the requirements of an interim ROD. The interim ROD is notable in that it does not have final cleanup standards. In addition, a large and complex area of Site 300 was excluded from the Interim ROD, so that the overall budget cannot be formulated. Additionally, the budget assumes a 5 % efficiency improvement each year. This is not realistic. Part of the remedy for Site 300 includes "hazard and exposure controls". TVC thinks that with a few exceptions, these should be avoided. Thus there would be no need to institute these controls in the LTS for the site.

V. SUPERFUND ACTIVITIES AT SITE 300

Starting in 1981, initial investigations of potential groundwater contamination were made by LLNL. In August 1990, Site 300 was placed on the National Priorities List (NPL). Subsequent investigations and cleanup have taken place within the framework of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), otherwise known as Superfund. In addition to the DOE, agencies involved in Site 300 cleanup are the Environmental Protection Agency (EPA), the California Regional Water Quality Control Board (CVRWQCB), and the California Department of Toxic Substances Control (DTSC). Because Site 300 is a federally owned facility, Superfund cleanup takes place within the framework of a Federal Facilities Agreement (FFA) signed by these four agencies.

In order to simplify the cleanup process, Site 300 is divided into seven operable units (OUs). A recent revision of the FFA expanded the number of OUs to eight by adding an integrated Site-Wide. Below is a list of the eight OUs.

OU-1:	General Services Area (GSA)
OU-2:	Building 834
OU-3:	Pit 6
OU-4:	High Explosives Process Area
OU-5:	Building 850/Pits 3, 5, and 7
OU-6:	Building 854
OU-7:	Building 832 Canyon
OU-8:	Site 300 (Site Wide) (incorporates Building 834, Pit 6, HE Process Area, Building 850, Building 832 Canyon, and areas not in a specific OU, including: Pit 2, Building 801 and Pit 8, Building 833, Building 845 Firing Table and the Pit 9, Building 851 Firing Table, Building 812, Building 865 and the Sandia Test Site.)

In 2000 and 2001, LLNL prepared a Final Proposed Plan and an Interim Site-Wide Record of Decision (ROD) that addressed the cleanup at all of these Operable Units. A ROD was produced for OU-1 and OU-2 previously, and information was incorporated into the Interim Site-Wide ROD. In addition, characterization of the Pits 3, 5 and 7, which is part of OU 5, is moving on a separate track, and will be incorporated into the Record of Decision after a Feasibility Study and a Proposed Plan are developed. After there has been experience with the remedies, LLNL is scheduled to prepare a final ROD for the Site that will contain explicit clean-up standards. **Table 1** provides the most current standards for the chemicals of concern found at Site 300. This is due in 2007.

Figure 1 is a map of Site 300 showing the location of each of the OUs and unassigned sites.

Table 1: Groundwater Clean-up Standards

Chemical of Concern	Federal Drinking Water Standard[15]	State Drinking Water Standard[14]	Other, if used[14]
TCE	5	5	
PCE	5	5	
1,1-DCE	7	6	
1,2-DCA	5	0.5	
cis-1,2-DCE	70	6	
trans-1,2-DCE	100	10	
1,1,1-TCA	200	200	
Benzene	5	1	
Toluene	100	150	
Tritium	None	20,000pCi/L	
Uranium-238	20pCi/L	20pCi/L	
RDX	None	None	0.7*
Nitrate	None	45,000	
TBOS	None	None	
Perchlorate	None	4**	

* Based on EPA Preliminary Remediation Goal
** Based on State Action Level, standard is under review

[15] In parts per billion, unless noted otherwise.

Figure 1: Site 300 Map

Source: LLNL Handout

TABLE 2: Superfund Schedule[16]

The major regulatory-mandated milestones that will be achieved through 2008 are:

2003: Pit 7 Landfill Complex Remedial Investigation

2004: Building 854 Remedial Design; Building 850 Remedial Design; Pit 7 Landfill Complex Remedial Investigation/Feasibility Study; Building 812 characterization.

2005: ROD Amendment for the Pit 7 Landfill Complex; General Services Area OU ground water extraction and treatment system buildout; Building 832 Canyon OU Remedial Design; Building 850 soil excavation; Building 865 characterization.

2006: Site-Wide Remedial Evaluation Summary; Site-Wide Proposed Plan; Pit 6 Landfill monitoring network; Building 854 ground water extraction and treatment system buildout; Five-Year Review for the General Services Area; Sandia Test Site characterization.

2007: Pit 7 Landfill Complex Remedial Design; Final Site-Wide Record of Decision; Building 834 ground water and soil vapor extraction and treatment system buildout; Five-Year Review for the Building 834 OU; High Explosives Process Area ground water extraction and treatment system buildout; Building 832 Canyon OU ground water and soil vapor extraction and treatment system buildout.

2008: Final Site-Wide Remedial Design Work Plan; Buildout of the monitoring network for the "monitoring-only" and "monitored natural attenuation" remedies; Revised Site-Wide Compliance Monitoring Plan/Contingency Plan.

16 Source: Performance Management Plan - Site 300, August 2002.

Operable Unit 1: General Services Area (GSA)

Site Overview

The General Services Area is approximately 82 acres, located on the southeastern boundary of Site 300. It consists of eleven buildings used for administration offices and equipment fabrication and repair activities. The study area includes off-site property adjacent to Site 300. The GSA has been divided into two areas: central GSA refers to the portion of the GSA that is west of the sewage treatment pond; and eastern GSA refers to the area east of and including the sewage treatment pond. The major source of contamination at the central GSA is found at dry wells south of Building 875. The major source of contamination at the eastern GSA is associated with debris trenches. Both portions include contamination that extends outside of the official Site 300 boundary.

There are two hydrological units underlying the central GSA. First, a shallow aquifer is found at 10 to 20 feet below ground surface. Water from this aquifer naturally flows southward and discharges to Corral Hollow streambed. This aquifer is separated from a second, deeper regional aquifer by a sandstone alluvial layer. The regional aquifer is referred to by its geological designation, $Tnbs_1$, and is found at depths of 35 to 145 feet. In the eastern GSA, this separation of hydrological units is not present, and contaminated groundwater has migrated downward from the shallow groundwater zone into the regional aquifer.

There are five water supply wells located outside of the GSA area that are of concern. CDF-1 and CON-1 are active wells located in close proximity to the GSA southern boundary. Two inactive wells, CON-2 and GALLO-2 are also in the area. An active well known as Sheep Ranch 1 (SR-1) is located 3 miles north of the eastern GSA. Without remediation, modeling predicted that this well would have become contaminated.

Chemicals of Concern

TCE was first detected in 1982 in a Site 300 water supply well. Other chemicals of concern include DCE, DCA, TCA, benzene, chloroform, copper, PCE, Freon 113, toluene, xylene, and zinc. TCE makes up an estimated 85 - 95 percent of the VOC contamination. In the central GSA, unknown quantities of these chemicals were used and disposed of in dry wells [17] along with process and wash waters. In the eastern GSA, unknown quantities and types of chemicals were discarded in debris burial trenches in the 1960s and 1970s. Investigations have identified seven separate release sites: six buildings and dry wells in the central GSA and the debris burial trench in the eastern GSA.

In 1993, in the central GSA, a sample from a Building 875 dry well area detected a groundwater concentration of 240,000 ppb of TCE, indicating the presence of DNAPL. [18] High concentrations of PCE, DCE and other VOCs (25,000 ppb, 4,000 ppb, and 59,000 ppb, respectively) were also detected with this sample. Other samples in this vicinity also indicated the presence of TCE DNAPL, ranging from 800 ppb to 69,000 ppb. Samples taken at this location in 1994 showed a decrease in concentration of TCE to 10,000 ppb. Previous locations with the highest concentrations were dry in 1995, due to dewatering.

[17] A dry well is a hole in the ground that is usually filled with gravel. It is used for the disposal of liquid wastes. By this method, liquid was transmitted directly to the underlying areas. At Site 300, almost all dry wells have been abandoned.

[18] A concentration of TCE that is greater than 11,000 ppb to 110,000 ppb is indicative of DNAPL.

TCE and other VOCs were detected in other central GSA sources. Building 875 dry wells are only 20 feet from the southern boundary of Site 300. The VOC plume extends from the Building 875 dry well into the Corral Hollow Creek stream channel alluvium. However, samples from the deeper regional aquifer have not been nearly as high. For example, in 1989 a maximum concentration of 44 ppb of TCE was detected in the $Tnbs_1$. Maximum concentrations in soil were also found in the dry well area: concentrations reached 360 ppm (mg/kg) of TCE and 390 ppm of PCE.

In the eastern GSA, third quarter 2003 monitoring results indicate substantial decreases in TCE concentrations in groundwater. In 1992, the TCE concentration was 74 ppb; in 2003, the TCE concentration was detected at a maximum of 5.2 ppb. The highest level offsite was 2.85 ppb, measured approximately 200 feet outside of the Site 300 boundary. Maximum concentrations in soil reached 0.19 ppm and 0.009 ppm of TCE and PCE, respectively. Surface water was tested from Corral Hollow Creek and from three springs downgradient from the eastern GSA. VOCs were found at the detection limit of 0.5 ppb. While this is usually considered insignificant in terms of cleanup, it indicates a possible route that the contaminants may be following.

Remedial Activities

Since investigations began in 1982, some remediation and removal actions have taken place at the GSA. Some tanks have been closed and removed, dry wells were closed, and two water supply wells were sealed. The water supply of two offsite wells (CDF-1 and CON-1) that received water from both the shallow and deeper aquifers was replaced.

Currently, groundwater extraction is taking place at eastern GSA near the debris burial trench. Groundwater is extracted from 3 wells and treated by liquid-phase granular activated carbon (GAC) filters and discharged to Corral Hollow Creek. In 1995, influent concentrations (i.e., average concentrations measured before treatment) of TCE were approximately 8 ppb. There are no plans to change the existing system.

In the Central GSA, a total of 19 extraction wells are planned. Seven extraction wells for groundwater and soil vapor extraction (SVE) were installed near the dry wells in 1992. In addition, the Lab is converting six existing monitoring wells to extraction wells, and adding six new extraction wells. A dual-phase extraction and treatment system has been built and is being tested. This technology has proved to be highly effective at other sites for capturing and controlling hot spots of contamination. Liquid-phase GAC will be used as the treatment technology. Based on conversations in 1996/1997 with the project manager at the site, the current average TCE concentration is approximately 1,000 ppb, with the highest average concentration at approximately 7,000 ppb.

The selected remedy for the GSA OU incorporates some already existing treatment systems. It would expand the existing groundwater extraction and treatment system in the central GSA dry well area to prevent migration of VOCs above MCLs into the shallow and regional aquifers. The existing groundwater treatment system in the eastern GSA would continue. Computer models predict that the eastern GSA will reach MCLs in ten years, while for the central GSA it indicates 55 years. Total present-worth cost of this remedy is estimated at $18.9 million.

To date, the total mass of VOCs that has been removed by remedial actions has been 79 pounds. [19]

Risk to Human Health

For adult on-site workers the highest incremental lifetime cancer risk was determined to be $1x\ 10^{-4}$ from soil vapor at the debris trench. This was also the figure for additive risk from several locations within the GSA. The highest hazard index (measuring non-cancer risks) for adult on-site workers was 0.86 (an index of one or more represents an unacceptable risk to human health). In measuring residential risk, a future drinking water well at the site boundary near Building 875 dry well area was assumed. The total incremental lifetime cancer risk for this scenario was determined to be $7x10^{-2}$, well above the EPA acceptable range of $1x10^{-6}$ to $1x10^{-4}$. The hazard index was determined to be 560, far above the acceptable level of 1. Cancer risks at several other off-site locations also exceeded EPA's *de minimus* level of $1x10^{-6}$.

Current Status

The Final Feasibility Study for the GSA was released in November 1995. A Proposed Plan was issued in December 1995. A public hearing on the plan was held April 24, 1996. The Final ROD was issued in January 1997. The Remedial Design was released in 1998, and the first Five-Year Review was completed in 2001.

Key Issues

1) **Locating DNAPLs**

This issue is discussed in more detail previously in Section IV. There are several locations at Site 300, including the Central and Eastern General Services Area where DNAPL was released. The Compliance Monitoring Plan for the GSA (included in the Remedial Design Report) identifies several methods for determining whether, where and how much DNAPL exists at certain locations. These involve a) evaluating solubility to indicate the existence of DNAPL, b) injecting partitioning tracers [20] into saturated and unsaturated zones that may be used to estimate the amount of DNAPL, and c) analyzing the naturally occurring Radon-222 levels in the groundwater. Radon-222 is a natural tracer that preferentially partitions into some NAPLs. Relatively low activity levels can be used to infer the location of DNAPL. We encourage LLNL to continue this search.

2) Cleanup goals

Tri-Valley CAREs suggested that the following remedial action objectives (RAOs) be incorporated into the remedial action plan:

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[19] Draft ROD for the GSA Operable Unit, June 1996. Note that one liter of TCE would contaminate the groundwater covering an area 4,100 feet in a 100 foot thick aquifer to 500 ppb. A liter of TCE weighs approximately 3 pounds.

[20] A partitioning tracer "prefers" DNAPL. By injecting this into the subsurface with a non-partitioning tracer and sampling groundwater downstream, scientists can estimate the relative amount of DNAPL in the groundwater (i.e., if none of the partitioning tracer is found in the samples, then we can assume that a relatively large amount of DNAPL is present).

a) Protect human health and ecological receptors from contact with contaminated groundwater, soil or air.
b) Attain the preliminary remediation goals (PRGs) set by EPA Region 9 (PRGs are based on an estimated health risk of one in one million additional cancer deaths).
c) Conduct cleanup in such a way as to minimize time for remediation.
d) In the Central GSA, continue efforts to remove contaminant mass from the groundwater and soil and locate the source of dense non-aqueous phase liquid (DNAPL).

The Lab responded that these goals are either incorporated into the plan, or were considered in developing the plan.

Operable Unit 2: Building 834

Site Overview

The Building 834 OU consists of four building areas numbered 831, 832, 834 and 838. The facilities were used to conduct thermal testing of weapons components since the 1950s. Types of buildings include control rooms, storage buildings, pump stations, and materials testing cells. A release of chemicals of concern, including DNAPL, has been confirmed at ten different locations. The Building 834 complex operated continuously for several decades with uncontrolled releases of TCE and other contaminants through a leaking pipe. **Figure 3** shows the conceptual site model of Building 834 OU.

There are several known water bearing zones underlying the Building 834 OU. The two principle ones are a four foot thick perched zone that caps the ridge on which the buildings sit and the regional aquifer ranging between 140 and 330 feet below ground surface. The conceptual model for the OU is that during heavy rainfall, water-bearing zones may be hydraulically connected. Outflow from the perched zone is thought to occur through evapotranspiration at locations on the ridge where the zone comes close to the ground surface. Contaminants have been found in the regional aquifer at the Building 834 OU, but not at high concentrations, nor very frequently.

Chemicals of Concern

TCE is the major chemical of concern (COC) at this OU. TCE was transported during operation of the facility in above-ground pipes to the various test cells for use as a heat transfer fluid. The TCE dissolved the seals on the piping and leaked to the ground. The maximum concentration of TCE detected across all of Site 300 was detected at the Building 834 OU at a concentration of 800,000 ppb in the perched groundwater zone. More recent samples (3^{rd} quarter, 2002) at the most contaminated site were measured at 150,000 ppb. In soils, TCE concentrations peaked at 12,000 mg/kg (ppm). Concentrations of TCE in soil vapor tend to increase with depth, suggesting that the vapor may be diffusing upward from the perched groundwater zone. Other VOCs found at the OU include 1,1,1-TCA, 1,1-DCE, cis-1,2-DCE, acetone, benzene, chloroform, ethylbenzene, methylene chloride, PCE, toluene, TCE, Freon 113, and xylene.

T-BOS (tetra t-butyl orthosilicate), another COC at this site, is a silicon lubricant that was used to prevent pipe seal degradation. The highest historical concentration at B-834 OU was 7,300,000 ppb. Currently, the highest concentration is 520,000 ppb (June 2003).

Nitrate is a third COC in groundwater. The highest historical concentration was 750 ppm. Recent measurements were as high as 110 ppm (June 2003).

In soil and bedrock, chemicals of concern (COCs) include TCE, DCE, and TBOS. The highest concentration of TCE is 10,000 to 12,000 ppm in near surface soil and 970 ppm in clay underlying the perched aquifer. [21]

Remedial Activities

Since 1983 various remedial activities have taken place including soil excavation and aeration, sealing of drains, aeration of TCE-contaminated water and the dismantling and removal in 1994 of the TCE piping system. An interim treatment system includes: 1) soil vapor extraction (SVE), designed to reduce soil vapor concentrations in the upper 12 feet of the vadose zone [22] to a risk-based level, corresponding to an HI of 1 and an excess cancer potential of $3x10^{-5}$; 2) dewater the perched aquifer to enhance the SVE system and treat it with a low profile air stripper and GAC emissions control; and, 3) test innovative technologies for enhanced removal of TCE DNAPL.

Groundwater and SVE and treatment systems have been operating since 1995 and 1998 respectively. These systems are located for the most part near Building 834, referred as the B-834 Core Area. The area south is referred as the distal area. The treatment process uses oil-water separator to remove TBOS, followed by air sparging to remove VOCs. Vapors are captured by Granular Activated Carbon (GAC). Treated groundwater is discharged through misting towers. The SVE system also uses GAC to capture VOC vapors.

The current wellfield consists of 15 extraction wells, of which 13 are used for both groundwater and SVE. Two are used just for SVE. Average groundwater extraction rate is approximately 4,300 gallons of water per month. Treated vapors are discharged to the atmosphere in accordance with San Joaquin Valley Unified Air Pollution Control District rules.

There is evidence of biodegradation at this OU, facilitated by the presence of the silicone-based oils. These oils ferment, yielding hydrogen required by microbes that break down the TCE. There is an ongoing effort to study this and evaluate possible application of nutrients to enhance this process.

The mass of VOCs estimated in the groundwater at the Building 834 OU was 65 - 121 kg. (143 - 267 Lbs.). Between 28 and 52 percent of the mass has been removed since groundwater extraction began. In soil, DOE estimates that between 602 and 1,118 kg of VOCs were deposited. Approximately 33 - 62 % has been removed since 1982. DOE estimates that achieving MCLs in the perched aquifer will take from 140 - 220 years, in part because of low water yields and difficulty in removing VOCs from low-permeability sediments.

Risk to Human Health

The adult on-site exposure total individual lifetime cancer risk was determined to be 1×10^{-3} from exposure to VOCs volatizing from subsurface soil into the indoor air of

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21 Remedial Design, p. 6, 2002

22 The vadose zone is the unsaturated zone above the groundwater.

Building 834D. Also above the acceptable range was cancer risk calculated at 6 x 10^{-4} from volatilized VOCs from subsurface soil outside in the vicinity of Building 834D. Non-cancer Hazard Index figures for these areas were well above acceptable levels, at 36 and 22, respectively. Residential exposures estimated using the CDF-1 well, located 300 feet southeast of the Site 300 boundary did not exceed 1x 10^{-6}, nor did the HI exceed 1. Although concentrations of contaminants have decreased at B-834 since remediation began, risks on-site would be on the same order of magnitude.

Current Status

An Interim ROD for Building 834 was completed in September 1995. The Interim Site Wide ROD for Site 300 was signed in 2001, superseding the Interim ROD. A Five-Year Review for Building 834 OU was completed in February 2002. The Interim Remedial Design was also completed in February 2002.

Key Issues

1) Waiver from the Central Valley Regional Water Quality Control Board (CVRWQCB) to exempt the perched layer from meeting drinking water standards

California state law requires that all *potential drinking water sources* must be cleaned up to MCLs. A *potential drinking water source* is defined as an aquifer that has less than 3,000 ppm of total dissolved solids (TDS), and is capable of producing water at a rate of 200 gallons per day (gpd). At least a few sites in California, including the Lab, have discussed a variance from this rule. At OU-2, there is a perched aquifer. [23] As a result, LLNL has proposed this not be classified as a potential drinking water source. This would result in no groundwater standard being applied to the perched aquifer. Tri-Valley CAREs is opposed to waiver of this sort.

2) Cleanup goals

Remedial actions for soil have been proposed, based on cleaning up soil vapor to a 3 x 10^{-5} total excess cancer risk level, instead of the more common and conservative 1 x 10^{-6} excess cancer risk level.

3) Locating DNAPLs

See this issue discussed in more detail in Section IV. There are several locations at this OU where DNAPL was released. Part of the remediation strategy is to evaluate enhanced bioremediation through introduction of nutrients into the soil/groundwater that will feed the microbes which degrade the contaminants. We encourage LLNL to continue this search.

Operable Unit 3: Pit 6

Site Overview

23 A perched aquifer is a saturated zone that lies above an impervious layer, usually clay or hardpan, which does not allow it to communicate with groundwater below.

The Pit 6 OU is located in the southern side of Site 300, and covers approximately 43 acres. It consists of two former solid waste disposal areas: the Pit 6 landfill and the Paper Canyon Area. The Pit 6 landfill is located on a sloping terrace approximately 30 feet above the Corral Hollow Creek and flood plain. It covers approximately 14 acres. Extensive fracturing and shearing of the bedrock occurs under the land surface. Several faults are known to be active in the area of the pit, but are beyond the edge of the landfill. Groundwater under the Pit 6 area is present in several water bearing layers throughout the area. Two active water supply wells are located approximately 1,000 feet from the landfill. They provide water for the Carnegie State Vehicle Recreation Area (SVRA) and are monitored monthly.

The pit operated from 1964 until 1973. The Pit 6 area is made up of three trenches and six "animal pits". Pit 6 and associated trenches were not lined. The pit was used to dispose of bulk solid wastes including empty drums, capacitors, and animal carcasses and wastes from biomedical experiments at LLNL and Lawrence Radiation Laboratory in Berkeley. [24] Included in this waste were VOCs that have since been found in nearby soil, surface water and groundwater. LLNL reports that no significant amounts of PCBs have been detected in surrounding soil or groundwater. The Pit 6 OU also includes an active Small Firearms Training Facility.

Fifty-five shipments of waste were disposed of at Pit 6 during its operating history. The wastes originated from Lawrence Berkeley Laboratory and the main LLNL site. No firing table gravel is known to be buried at Pit 6. Over 2,000 capacitors that may have contained PCBs were placed in the trenches.[25]

Chemicals of Concern

At Pit 6, VOCs and tritium are the primary COCs, with nitrate being a secondary concern. Perchlorate was also detected in three wells at levels exceeding the State Action Level of 4 ppb. The highest level was 12 ppb. All other COCs are now below MCLs. However, tritium was detected at one of the wells, albeit at 136 pico Curies per Liter (pCi/L). As a reference, the state drinking water standard is 20,000 pCi/L. A TCE plume extends from the Pit 6 landfill area approximately 400 feet to the southeast. The highest concentration of TCE in groundwater was recorded was in 1989, at levels of 250 ppb, found in shallow groundwater. The source of the TCE is estimated to be located at the southwest corner of Trench 3. Other VOCs present in the soil vapor include PCE, 1,1,1-TCA, 1,1-DCE and 1,2-DCE.

Remedial Activities

After the Pit 6 landfill was filled in the 1973, it was covered with a native soil clay cap compacted by bulldozer. An estimated 2 feet of soil covered the three main disposal trenches and approximately 14 feet covers the animal trenches. In 1997, a multi-layered cap was installed to prevent leaching of contaminants through the buried waste.

Risks to Human Health

[24] It was reported that biomedical wastes contained short-lived radionuclides, in the milli- and micro-curie quantities.

[25] Anecdotal information from interviews with ex-Lab employees suggests that the capacitors were drained prior to disposal.

The greatest total individual excess lifetime cancer risk level that exceeded the EPA *de minimus* level of $1x10^{-6}$ was from volatilization of VOCs from Spring 7. These were measured at 4×10^{-5} ILCR, with a hazard index (HI) of 1.5. However, Spring 7 has been dry for the last several years. The cancer risk for adult onsite workers at the landfill was calculated at $1x10^{-6.}$ However, these calculations do not consider the new TCE risk numbers.

Current Status

A Final Feasibility Study (FS) was prepared in December 1994 for the Pit 6 study area. Subsequently, LLNL obtained approval to use a removal action for this OU. The FS took the place of an EE/CA. The final EE/CA Addendum for Pit 6 was prepared in November 1996 and the pit was capped in 1997. The Remedial Action Objectives for the area include reducing potential exposure risk to below 1×10^{-6}, mitigating future releases, and preventing further migration of the groundwater plume to offsite areas. The remedial measure chosen was to cap the landfill with a multi-layered cap. Natural attenuation was also accepted for the relatively low concentration off-site plume. However, the selected remedy added a contingency measure that would provide for mass removal through pump-and-treat if VOC concentration is not reduced by natural attenuation.

Key Issue

1) Monitored Natural Attenuation and the Non-Degradation Policy

The plan for Pit 6 includes capping the site, and allowing a TCE plume to undergo "natural attenuation" before it reaches the site boundary. The TCE plume may continue to migrate, albeit more slowly with a cap in place. This strategy poses two major problems: first, it violates the State's Non-degradation Policy (Resolution 68-16) which requires polluters to prevent degradation of groundwater; and second, there is no indication that natural breakdown of chlorinated solvents occurs at Site 300. There is only evidence that concentrations have decreased over time. This may be due to dispersion and dilution.

2) Perchlorate

Perchlorate is used primarily as a propellant and is found in rockets and missiles. It is also added to explosives. In explosives, it has similar properties to gunpowder. The health concern regarding perchlorate center on blocking iodide uptake in thyroid. Iodide is critical in regulating growth and metabolism, especially in growing organisms. It is known to concentrate in leaves and fruit of some plants, and could present a substantial ecological hazard.

When EPA did its dose study using rat pups to come up with an acceptable reference dose, its dose translated to 1 ppb (in drinking water). California's state action level is set at 4 ppb, and other states have advisories from 1 ppb to 18 ppb. Perchlorate is not listed under RCRA as a hazardous waste, not listed under CERCLA and not listed under the Safe Drinking Water Act. It is a candidate for listing under SDWA, but this should take 24 months (2005).

There are essentially three types of treatment systems: ion exchange, reverse osmosis, and enhanced biodegradation. Each has problems: reverse osmosis is expensive and creates a waste brine; ion exchange resins do not regenerate well with perchlorate, and therefore have to be disposed as a hazardous material; biodegradation is very site specific and may not be appropriate in all locations. We encourage LLNL to search for an appropriate remedy, and to control the plume so as not to contaminate water supplies.

Operable Unit 4: The High Explosives (HE) Process Area Operable Unit

Site Overview

The HE process area has been used since the 1950s to formulate explosives used at Site 300, and to machine compounds for detonation charges. Surface spills form Building 815, discharges into unlined rinsewater lagoons, and disposal by burning off-spec compounds all resulted in releases of TCE, RDX, nitrate and perchlorate to the subsurface. The OU is a thin strip of sloping land encompassing approximately 934 acres in the southeastern part of Site 300. It includes 48 buildings and 22 storage magazines. There are twenty distinct release sites at the HE Process Area: nine HE rinsewater disposal lagoons, Building 815, six dry wells, the Building 829 Open Burn Treatment Facility, the Building 827 septic system, and two washdown water disposal lagoons at Buildings 814 and 819. Building 815 is the major release site in this OU. The building was used to make steam, and provided it to nearby facilities involved in processing and formulating HE compounds. Boiler blowdown (fluid in a boiler after cleaning and de-scaling) containing TCE was discharged in a dry well 50 feet north of Building 815.

Several former and currently operating water-supply wells are located in the southern part of this OU. Just off-site, the Gallo family operates a water-supply well designated as Gallo-1. It is located about 2,000 feet from Building 815. Pumping of a former water-supply well and the Gallo-1 well have accelerated migration of TCE southward in the $Tnbs_2$ aquifer. Since 1980, pumping of the on-site well has ceased and TCE releases from this well stopped.

Chemicals of Concern

Primary chemicals of concern at the site are TCE, the high explosives compound known as RDX (Research Department Explosives developed during WW II), nitrate (NO_3), and perchlorate. There are no MCLs for RDX or perchlorate.

Plumes of TCE, RDX and nitrate-contaminated groundwater emanate downward from the Building 815 vicinity in the two uppermost aquifer zones. LLNL used the RDX PRG of 0.61 μg/L as the health-based standard to define the plume. RDX was detected in seven monitoring wells in the $Tnbs_2$ above the PRG. TCE was detected in soil, rock, surface water and groundwater. RDX was detected in soil, rock and groundwater samples. Nitrates (NO_3), resulting from the breakdown of explosives, were detected in groundwater above the Federal MCL of 45 ppm. Perchlorate was only recently added to the list of COCs. TCE contamination in this area was the result of TCE spills at Building 815. The source of RDX, perchlorate and nitrate contamination in this area is mostly from rinsewater discharged into the lagoons. TCE and RDX were also found in the soil and groundwater in the vicinity of the Building 829 HE Open Burn Pit and near the dry wells. Contamination of lower aquifers was found at the downhill end of the study area where no longer used water-supply wells were found.

The main TCE plume covers approximately 58 acres in the regional aquifer. Maximum historical TCE concentrations were detected up to as much as 450 ppb in the shallowest aquifer at Building 815 and 47 ppb downgradient from Building 815. The highest detection in June 2003 was 56 ppb. Trace amounts of TCE were found in off-site and on-site "guard" wells, below the MCL for TCE. TCE was detected in the Gallo-1 well at 0.54 ppb.

The RDX, perchlorate and nitrate plumes cover approximately 15 acres in the northern portion of the $Tnbs_2$ aquifer. Maximum historical RDX concentrations were measured at 350 ppb and 170 ppb in groundwater below the lagoons and downgradient from Building 815, respectively. In 2003, RDX was measured in the Tnbs2 aquifer at 83 ppb. Maximum concentration of perchlorate was measured at 24 ppb. During 2003, nitrate was not detected above its 45 ppm MCL.

In late 1996, TCE was detected moving at a faster rate than had been predicted. Previous models of contaminant migration indicated that TCE would reach the Site 300 boundary in the upper aquifer at a concentration of 6 ppb in 26 years. A revised model indicated that TCE exceeding the MCL would reach the Site 300 boundary in 10 years. RDX is expected to reach the site boundary at 1.3 ppb in 626 years. Previous models predicted that TCE would reach the nearest water supply well at a concentration of 4.0×10^{-3} ppb after 306 years, and RDX would reach the well at 5.0×10^{-2} ppb after 346 years.

The bulk of RDX and nitrate soil contamination is in the vicinity of the rinsewater lagoons. The maximum concentration of RDX detected in soil and rock was 3.25 ppm, ten feet below one of the rinsewater disposal lagoons. The bulk of TCE soil and rock contamination is in the vicinity of Building 815. The maximum TCE soil concentration was 33 ppm in the vicinity of Building 815 at a depth of 69 feet.

Remedial Activities

Remedial actions at the area have included the installation of rinsewater and wastewater storage tank systems, the capping of the nine disposal lagoons, and the decommissioning of dry wells. Steam boilers at Building 815 were removed and TCE is no longer stored at the site. Also, the Burn Pit and the lagoons were capped. In early 1996, LLNL proposed long-term monitoring of the OU, without active remediation.

In late 1996, monitoring well data indicated concentrations of TCE above MCLs were increasing at the leading edge of the plume, which altered LLNL's remediation strategy. A non-time critical removal action was approved, involving groundwater extraction at the TCE plume edge to control migration, and groundwater extraction in areas of high TCE concentration to remove mass. At our suggestion, because of fear that extraction from the TCE plume edge and interior would accelerate RDX plume migration, LLNL modified its proposal to only pump at the trailing edge of the plume and propose a contingency plan if RDX were found in extracted water. LLNL has also installed two offsite groundwater monitoring well clusters near the Gallo Ranch, downgradient from the leading edge of the plume.

A liquid-phase granular activated carbon (GAC) system was installed near the plume edge. Discharges are made into Corral Hollow Creek. If discharges of nitrate exceed regulatory limits, LLNL may have to conduct additional treatment. At Building 815 and the rinsewater lagoons, groundwater extraction will also take place to reduce contaminants at the source. The second system is designed similarly (i.e., liquid-phase GAC). In tests, GAC removed RDX. Ion exchange is used to remove perchlorate. Nitrate (a good source of nutrients for plants) is treated by phytoremediation (i.e., the process whereby plants either absorb the contaminant or metabolize it).

The Site-Wide ROD sets forth the remediation strategy: monitoring ground water and surface water for COCs; preventing human exposure and mitigating ecological impacts; controlling the B-815 TCE and nitrate plumes at the edge of the plume; controlling the rinsewater and B-815 plumes through extraction and treatment at the source; controlling the HE Burn Pit plumes through extraction and treatment at the source. In September 2003, the Building 817 source groundwater extraction system began operation.

Risk to Human Health

Risks to human health have been evaluated in four regions: in airborne soil particles throughout the study area, in air in the vicinity of Building 815, in air near spring 5, and in the upper aquifer $Tnbs_2$ at the Site 300 boundary. The highest total individual excess lifetime cancer risk levels came from volatilization of VOCs from spring 5 and residential exposure from a hypothetical water-supply well contaminated with VOCs and RDX at the site boundary. Cancer risk at both of these locations was estimated at $1x10^{-5}$. Perchlorate was not considered in this risk assessment.

Current Status

A Draft Feasibility Study was scheduled for December 1995, with a Record of Decision scheduled for late 1997. As a result of findings that contaminants moved more quickly than expected a removal action was initiated in 1998. The Site-Wide Feasibility Study and Interim Record of Decision cover the HE Process Area OU, the latter completed in February 2001. In 2007, the ROD will be re-evaluated and final cleanup standards will be decided.

One element unique to this OU was the development of contingencies prior to the development of the EE/CA. These required that if monitoring wells downgradient detected TCE, LLNL would consider a remedial strategy other than merely monitoring. In 1997, as mentioned above, TCE concentrations along the leading edge of the plume increased, thereby requiring the Lab to take active measures to remediate this OU.

Key Issues

1) Groundwater Modeling

This issue refers to both the accuracy of the specific model, and the use of a model to determine long-term remedial action. Not only is it difficult to determine how the Lab estimated that RDX in the $Tnbs_2$ aquifer would reach the site boundary “at a maximum concentration of 1.32 μg/L in about 600 years,” the remedy allows slow but continuing plume migration. Also, because the source of the RDX plume under Building 815 is unknown, models should be treated with a healthy degree of skepticism. The EE/CA proposed to model plume behavior so that the influence of extraction on RDX and nitrates are known prior to and during implementation of the remedial action

2) Natural Attenuation

The EE/CA for the HE Process Area OU has eliminated natural attenuation from consideration because there is no evidence of chemical breakdown. This evaluation should be applied to other OUs at Site 300, unless there is compelling evidence to the contrary.

3) Perchlorate

Perchlorate is used primarily as a propellant for rockets and missiles. It is also added to explosives. In explosives, it has similar properties to gunpowder. Health concerns regarding perchlorate center on blocking iodide uptake in the thyroid. Iodide is critical in regulating growth and metabolism, especially in growing organisms. It is known to concentrate in leaves and fruit of some plants, and could present a substantial ecological hazard.

There are essentially three types of treatment systems: ion exchange, reverse osmosis, and enhanced biodegradation. Each has problems: reverse osmosis is expensive and creates a waste brine; ion exchange resins do not regenerate well with perchlorate, and therefore have to be disposed as a hazardous material; biodegradation is very site specific and may not be appropriate in all locations. We strongly encourage LLNL to secure adequate funding to search for an appropriate remedy, and to control the plume so as not to contaminate water supplies.

Operable Unit 5: Building 850/Pit 7 Complex Operable Unit

Site Overview

The Building 850/Pit 7 Complex OU encompasses over 3,200 acres and is divided into four sub-areas consisting of the Pit 7 Complex, the Building 850/Doall Ravine Area, the Southern-WFA, and the EFA. The area has been operating since 1955 for use in explosives experiments on seven outdoor gravel-covered firing tables. In over 65 buildings in the study area, dynamics testing, linear accelerator research and other work has also taken place. **Attachment 2** is a reproduction of photographs showing the types of explosive testing done at the site. **Figure 6** shows the main tritium plume at the Building 850/Pit 7 Complex OU. Most outdoor explosive testing has been moved to an indoor facility, but some continues at the Building 850 complex.

Wastes generated from experiments on the firing tables were disposed off at several on-site landfills until 1989, after which the wastes began being shipped to a disposal site in Nevada. Two of nine landfills were closed recently under requirements of RCRA. Six others had been closed before that Law was enacted, and did not have to meet its more stringent requirements.

Chemicals of Concern

Primary contaminants of concern throughout the study area are: tritium[26]; TCE and other VOCs; PCBs, furans and dioxins[27]; ^{238}U, and other metals; and HMX. It was reported that 22,670 curies of tritium were used at Site 300. LLNL identified 12 release sites within the four sub-areas. Primary areas of contamination include: three separate groundwater tritium plumes, three separate groundwater ^{238}U plumes, three firing tables

[26] Tritium is radioactive hydrogen. It easily combines with oxygen. When the body is exposed through inhalation or ingestion, internal organs throughout the body are also exposed.

[27] Dioxin in surface soil was identified as 2,3,7,8-TCDD. This is one of the most toxic forms of dioxin, and cleanup levels at other sites are often to 1 ppb in soil. The PRG for this substance in soil at an industrial site is 0.024 ppb.

with contaminated surface soil, two springs, and ten areas of subsurface soil contamination. Recent studies indicate the entire Building 850/Pit 7 Complex OU has surface soil contamination. Maximum concentrations of depleted uranium were measured at 50 pCi/g and 120 pCi/L in soil and groundwater, respectively. Maximum concentrations of tritium were measured at 1.8 million pCi/L groundwater. Maximum concentrations of PCBs, dioxins and furans were measured in soil at building 850 at 180 ppm, 0.004 ppb and 15 ppb, respectively.

Below is a description of each of the four subdivisions of this Area.

a) <u>Pit 7 Complex Sub-area</u>: This sub-area contains pits 3, 4, 5, and 7. Tritium was released from Pits 3 and 5 in the early 1980's due to a rise in the water table that saturated the fill and mobilized the tritium. Concentrations in groundwater were measured as high as 1.8 million pCi/L in 1984. TCE was also released from pit 5 into the groundwater in concentrations of up to 15.6 ppb.

   In December 1996, LLNL reported that a groundwater sample south of Pit 5 contained 1.3 million pCi/L to 1.4 million pCi/L of tritium, a five-fold increase from previous samples. The suspected cause is groundwater rising from beneath the pit, saturating the material, and mobilizing the tritium in the groundwater. It was also posited that direct infiltration of the pit may be responsible. These are the same phenomena that mobilized the tritium in the early 1980's.

b) <u>Building 850/Doall Ravine</u>: This sub-area contains the Building 850 complex and firing table. Over 95% of the tritium used at Site 300 was used at the Building 850 firing table. Most of the gravel used at the firing ranges was deposited in the Pit 7 Complex subarea. From 1962 to 1972, a large volume of sand was stockpiled near B-850 and was periodically used and reused during large experiments. It gradually became very contaminated with tritium, which leached into the soil and groundwater. Maximum historical concentrations of tritium were: in soil moisture, 15.0 million pCi/L; in surface water, 200,000 pCi/L; in groundwater, 566,000 pCi/L. Maximum current (May 2003) concentration of tritium in groundwater was 81,400 pCi/L. ^{238}U, nitrate, and perchlorate were also found in groundwater. The maximum concentration of nitrate and perchlorate found (2003) was 140 ppm and 39 ppb, respectively. The highest level of uranium for the same reporting period was 17.9 pCi/L. Beryllium, cadmium, copper, ^{238}U, PCBs, dioxins, and furans were also found in soil.

c) <u>Southern WFA</u>: This sub-area contains the Building 851 Complex and firing table, and several dynamic-testing sites. Tritium was measured in concentrations as high as 55,000 pCi/L in subsurface soil beneath the Building 851 firing table. Tritium was not found in the water-bearing zone below Building 851, as the vadose zone [28] is approximately 150 feet thick. Cadmium, copper and ^{238}U were also found in soil beneath the firing table. TCE was found in small concentrations (6.0 ppb) in groundwater in the Dynamic Test Complex area.

d) <u>EFA</u>: This sub-area contains Pits 1, 2, 8, and 9, and several building complexes and firing tables. Tritium was measured in concentrations as high as 61,000 pCi/L in the subsurface soil moisture beneath the Building 802 firing table, and up to 310,000 pCi/L at the Building 845 firing table. ^{238}U was detected in

[28] The vadose zone is the unsaturated zone above the groundwater.

subsurface soil at the Building 812 firing table at 23,000 pCi/g. LLNL plans additional studies of the transport of these contaminants in this area. The major tritium groundwater plume in this area is believed to be the result of releases from Building 850/Doall Ravine.

Present soil and groundwater modeling predicts that the maximum tritium contamination will reach the Site 300 eastern boundary in the year 2046 at a concentration of 1,626 pCi/L. Tritium from this plume is expected to reach the spring 6 outfall at 3,890 pCi/L in the year 2032.

Remedial Activities

Remedial actions taken in the study area have included covering the landfills with compacted native clay soil. Gravel and some soil were removed from firing tables and placed in pits 1 and 7, after which they were covered by engineered RCRA-compliant caps. Dry wells have been decommissioned; oil-contaminated soil has been removed. PCB shrapnel and debris were removed from the firing table in 1998. The Building 850 sand pile, a source of tritium and ^{238}U, is scheduled to be removed and disposed of off-site. In addition, surface soil contaminated with various metals, PCBs, dioxins, furans HMX and uranium will be removed. Building 851in the southern WFA will be monitored, as there is no groundwater contamination. Pit 2 will also be monitored.

Control of the tritium plume from the Pit 7 complex has not been initiated; LLNL is still studying alternatives to stop plume migration TVC strongly urges hydraulic control of the advancing plume.

Risk to Human Health

Risks to human health were evaluated by LLNL in various environmental media. The greatest total individual excess lifetime cancer risk is posed by the inhalation of tritium in the Building 850/Doall Ravine sub-area. Cancer risk here was estimated at 2×10^{-4}. The greatest Hazard Index is posed by inhalation of TCE in the southern WFA sub-area (inside Building 854F).[29] The HI is estimated at 9.9.

It is important to note that this risk analysis assumes continued operation as an industrial facility, so that only adult workers are exposed on-site, during the typical work-year. Residential risks are calculated at the site boundary. Tri-Valley CAREs takes exception to this assumption.

Current Status

Building 850 is incorporated into the Site-Wide ROD. The selected remedy includes monitoring of the tritium plume and excavation of the sand pile that is the source of much of the tritium contamination. The EFA and the Southern WFA were also included in the Site-Wide Rod, and they are being monitored.

The Pit 7 Complex subarea is not part of the Site-Wide ROD. Instead, it is going through its own RI/FS, which will be integrated into a final ROD for the PIT 7 complex. An FS is scheduled for 2004. A removal action was proposed in 1997, but was rejected by the regulators. The rejected plan contained a monitoring plan (with corresponding

29 The Building 854 complex has been assigned its own OU status.

concentrations which, if exceeded, trigger additional actions), subsurface and surface controls to divert surface water and groundwater [i.e., upgradient sub-drains, diversion ditches, conduits, and physical barriers (grout curtain up to 75 feet below surface)], and institutional controls (i.e., warning signs, stakes, and instructions to workers).

Key Issues

1) Continued Threat of Tritium Releases from the Pit 7 Complex

Beginning in the early 1980s, heavy rainfall caused rising groundwater levels. This infiltrated the pits, saturated tritium-contaminated debris and washed it out. Because of the heavy rainfall in 1993, 1995 and 1996, additional releases of tritium occurred as groundwater temporarily rose into the contaminated pits. In 1998, total tritium activity in groundwater was approximately 8 Curies, nearly double the activity in 1994. In 1997, it was estimated that approximately 4.0 Curies remained in the pits. Approximately 12.5 Ci were washed out and remained in the soil. Approximately 7 curies were in the groundwater. There was a five-fold increase in one tritium sample, probably due in part to the same mechanisms that first mobilized it in the 1980s. We are very concerned that DOE's inaction will allow more tritium to contaminate the vadose zone and regional aquifer that is used for drinking water and irrigation as each rainy year occurs with inaction from DOE, more of the tritium will be mobilized and washed out of the pits, into the vadose zone and groundwater. We strongly recommend that the Pit 7 Complex be a candidate for a removal action to prevent additional releases.

2) Remedial Strategy

For the most part, the remedial strategy removes known sources of tritium and other surface contaminants, and allows tritium in the groundwater to naturally decay. We have found fault with LLNL's model for estimating when tritium concentrations will reach the site boundary because there is not enough information or understanding of how the geologic fault lines will affect the water's path.

In the past, LLNL has also expressed doubt whether surface and sub-surface controls will be effective to control the tritium plume. However, we believe that the sub-surface hydraulic controls being discussed by the regulators are a step in the right direction. While capping the landfill pits will not prevent further releases of tritium if the groundwater table rises from underneath, if coupled with subsurface controls, it may slow or halt the spread of the plumes.

Before a remedial strategy can be proposed, tritium sources and tritium plumes need to be properly characterized. There must be a way to validate predicted rates of movement and tritium activity levels. Contingency plans need to be developed to apply if future tritium activities exceed predicted quantities.

Other contaminants also need to be addressed. For example, ^{238}U is classified as a human carcinogen. It has been detected in several wells near the Pit 7 complex and in soil at numerous locations. The Lab has not yet identified a cleanup method. The remediation strategy states that PCBs, furans and dioxins detected near the Building 850 firing table will be eliminated by removing visible capacitor debris. This is a crude way of dealing with these hazardous substances, and a more systematic approach is required, including soil testing to detect dioxins and furans.

3) Groundwater Models

A key issue at Site 300 is whether the tritium-contaminated groundwater presents a threat to human health and the environment. LLNL's risk assessment, based on the contaminant migration model, indicates that it will not pose a risk off-site. We are concerned that not enough information is known about the complex geology and hydrology of the site to have confidence in a model. The SWRI recognizes the limitations of the information.

— For example, it states that "To evaluate tritium mobilization mechanisms, it is important to understand recharge pathways. In the Building 850/Doall Ravine area, it is difficult to assess recharge." [30]

— Another example is the presumption of an aquitard [31] in the Pit 7 area, although it was "difficult to identify the claystone aquitard from the geologic logs of wells and boreholes" drilled in this area. [32]

— Yet another example is the statement that "Although limited information is available about the hydrogeology of this sub-area [Southern WFA], boreholes and wells drilled in the vicinity of Buildings 851 and 854 provide some information." [33]

Given the limitations cited above, Tri-Valley CAREs had its Technical Advisor conduct an independent review. The independent review found that the LLNL models for the three separate plumes of tritium at this OU used different assumptions to determine the tritium activity at the site boundary. As a result, the analyses are inconsistent. TVC's independent review recommended that the mass of tritium in the Pit 5 plume be re-evaluated, along with a re-evaluation of the appropriateness of the model used for the plumes. It also recommended that the fate and transport of the Building 850 plume be modeled in three distinct sections, with appropriate input parameters adjusted for each section.

4) **Cleanup Standards**

A key issue is whether drinking water standards for on-site groundwater must be attained. As it currently stands, cleanup strategies for Site 300 do not assume the use of on-site groundwater. This issue is explained in Section IV.

Operable Unit 6: Building 854

Site Overview

Building 854 is the Dynamic Test Complex area. It is composed of thirteen buildings, including the Building 854 complex (10 buildings), and Building 855, 856, and 857. Facilities were used to test the stability of weapons and components under various conditions, including mechanical and thermal stresses. Various hazardous chemicals were used at the site, and have contaminated the groundwater and soil.

The Building 854 OU covers approximately 1.5 square miles in the southwest portion of Site 300. It extends far beyond the industrial complex reaching the southern and western boundaries of Site 300. Part of the area is a dedicated ecological preserve for the flower

30 See SWRI, 1994, page 11-3-28.

31 An aquitard is a layer of impermeable material that prevents downward migration of groundwater.

32 See SWRI, 1994, page 11-3-19.

33 See SWRI, 1994, page 11-3-30

Amsinckia grandiflora. Most of the area is proposed as habitat for the California Red-Legged Frog, a threatened species. The OU also contains critical habitat for the Alameda Whipsnake.

This OU contained an inactive water supply well, which was contaminated by TCE. The areas of concern are a drainage outfall, infiltration from a dry well, a disposal lagoon, and areas subject to potential leaks from a system that used a TCE-based heat exchange fluid.

Chemicals of Concern

TCE, nitrate and perchlorate have been detected in groundwater at the Building 854 OU. High explosive compounds, PCBs and other solvents have been found in soil. TCE is the major chemical of concern. The source of TCE contamination was a release to soil from pipes containing a TCE brine solution. In 1994, a maximum of 6 μg/L was detected in groundwater samples from an inactive water-supply well 1/4-mile downgradient from Building 854. In 1994, soil samples near a sump measured 1,000 ppm of TCE. The highest historical concentration of TCE in groundwater was 2,900 ppb (1997). The highest concentration of perchlorate was 27 ppb, and nitrate was detected at 200 ppm.

It was estimated in 2003 that there were 9 to 16 kilograms (20 to 35 pounds) of TCE in the groundwater prior to remediation activities. The current mass estimates are nearly half that amount.

Remedial Activities

In 1983, TCE-contaminated soil was excavated near the Building 854 Complex. The inactive water supply well was sealed in 1996 to prevent vertical migration of TCE. In 1999 and 2000, two treatment facilities were installed to extract and treat groundwater. These facilities are located near the source and in the "proximal" area. A later extraction system is designed for the distal area.[34] The source area is contaminated with up to 630 ppb of TCE in groundwater; the proximal area is contaminated with up to 150 ppb of TCE in groundwater.

The source area treatment system uses an ion exchange unit to remove perchlorate followed by liquid-phase GAC to remove TCE. Downstream, the treatment train uses a containerized wetland to treat nitrate and perchlorate, followed by a liquid-phase GAC system. These systems could be altered depending on the performance of the containerized wetland and ion exchange unit. In addition, a soil vapor extraction (SVE) system was tested, but it only showed significant results in the source area.

The remedial design for the area is to expand the source area extraction system, conduct additional treatability analysis for SVE, excavate and dispose of PCB-contaminated material from a lagoon, expand the proximal area extraction network, and install a groundwater treatment facility near the distal area.

Risk to Human Health

34 These names are designated by the Lab to indicate different treatment areas: the source area is close to the original source of the contamination, the distal area is at the farthest points of the plume, and the proximal area is downstream from the source area, but not at the plume edge.

Risks from exposure to PCBs (dermal contact and ingestion) and inhalation of VOCs were identified at increasing the cancer risk by 1 x 10^{-5}.

Current Status

A characterization report for the Building 854 OU was completed in 1998. The OU was included in the Site-Wide Feasibility Study, Proposed Plan, and the Interim Site-Wide ROD. In July 2003, the Lab submitted a Draft Interim Remedial Design. This document sets forth most of the cleanup activities and treatability studies until a final ROD is signed. It also states that PCBs will be further characterized at the OU.

Key Issues

1) Continued Characterization and Support of Innovative Technology

This is an OU that was still being characterized when the last edition of the Guide was published (1997). High concentrations of TCE, nitrate and perchlorate were discovered in groundwater, as well as PCB contaminated soil. There is a need to continue characterization of PCB contamination, as well as the distribution of chemicals in the groundwater. The remedial design document does not commit to treatment technologies, as their effectiveness is still being studied

Operable Unit 7: Building 832 Canyon

Site Overview

The Building 832 OU is located in the southeastern part of Site 300, with the Building 834 OU to the north and the GSA OU to the south. It also is across a canyon from the HE Process Area OU. The Building 832 Canyon OU encompasses approximately 140 acres and includes 13 buildings used primarily for conducting thermal and mechanical tests, explosives research, machine shops and storage, including Building 830 and 832. TCE was used as a heat transfer fluid[35] in a few buildings, which were deactivated in 1982 and 1985. TCE was released to soil and groundwater through leaks and discharges at Buildings 830 and 832 between the 1950s and 1985. **Figure 8** identifies the plumes of the Building 832 OU.

Chemicals of Concern

Chemicals of concern are TCE, nitrate, perchlorate, and the high explosives compound HMX. This latter compound was detected only in soil. TCE has been detected south along the canyon toward the GSA OU. The estimated length of combined alluvial and bedrock plume is 2,800 feet. Contamination has been detected in Spring 3 (200 ppb), which is located toward the southern end of the OU.

Release sites have been identified and include various disposal lagoons, settling basins, leach fields and pits, as well as surface spills. These occur in two major areas, the Building 830 Complex, and the Building 832 Complex. In the vicinity of Building 830, TCE was detected at a historical maximum (1999) of 30,000 ppb in groundwater, one of the worst sites for TCE contamination in the country. At the top of the canyon, near the Building 832 Complex, TCE was detected in the underlying $Tnsc_1$ groundwater zone at

[35] A good analogy for a heat transfer process is refrigerator. A working fluid circulates both inside and outside of the refrigerator, picking up heat when it enters the refrigerator and losing heat outside. The properties of certain fluids make them desirable for transferring heat.

an historical (1998) maximum of 1,800 ppb. TCE was detected at 68 ppb in the lower, regional aquifer ($Tnbs_1$) at the OU.

It is not known whether the plume emanating from Building 832 periodically has commingled with the plume from Building 830, which is down the canyon approximately 1,500 feet. Recently, TCE was detected in the lower end of the canyon near the Site 300 boundary. Consequently, there is a high priority to cleanup this OU to prevent off-site migration.

Remedial Activities

Previous actions included decommissioning dry wells and disposal lagoons, removing a solvent storage shed, and upgrading, modifying or removing the thermal process equipment in portions of the area.

In 1999, LLNL began a treatability study to evaluate groundwater and soil vapor extraction and treatment. The selected interim remedy continues this effort, installing dual-phase extraction systems at both Building 832 and 830. At Building 832 (the source area), 10 extraction wells will be installed. Extracted groundwater will be treated by GAC, followed by a bioreactor to treat nitrate and perchlorate, and ion exchange units when necessary to polish perchlorate. Extracted vapors will by treated by vapor-phase GAC. One or two similar treatment facilities will be installed several hundred feet downgradient from the source area. The first will have 10 extraction wells clustered near Building 830. A second would be installed downgradient to provide plume control. Additionally, an iron filings system would be installed to treat groundwater extracted at this latter facility, as this technique breaks down TCE into carbon dioxide, chlorine and hydrogen. If the iron filings do not remove nitrate, a bioreactor will be installed.

Risk to Human Health

Risk to human health was evaluated in four areas: re-suspended soil particles, Buildings 830, 832, and 833 inside air, air near spring 3, and groundwater in the regional aquifer and the CDF-1 well. At Building 830, adult workers would have a risk of 1×10^{-5} from inhaling outdoor air. Inhaling indoor air posed a risk on the order of 10^{-6}. Vinyl chloride was one of the chemicals contributing to this risk. The greatest total individual excess lifetime cancer risk is posed by inhalation exposures at Spring 3 at a risk of 6×10^{-5} and a total HI of 2.3. The residential risk scenario evaluated exposure from the CDF-1 well, and was below 1×10^{-6} ILCR.

Current Status

A pilot treatment system began in the Spring of 1998. The OU is covered by the Site-Wide ROD, which was signed in 2001. Most treatment systems have been installed.

Key Issues

1) Hydrogeology, Modeling and Assumptions about Land Use.

Spring 3 is located at the southern part of this OU and is close to the southern boundary of Site 300. It is located in a canyon area. Contamination of Spring 3 is thought to originate from a release near Building 832, upgradient in the canyon area. Therefore, it appears that TCE has moved a significant distance for it to be found in Spring 3 at 200 ppb. However, the model to estimate off-site contamination used Building 833 as the source area. Depth to the regional aquifer (Tnbs$_1$) at Building 833 is approximately 200 feet, while depth to the regional aquifer in the canyon is approximately 100 feet. Therefore, it is not clear that sources at Buildings 832 and 830 (also in the canyon) have been adequately considered in modeling probable off-site contamination. Even if this issue is answered, the contaminant sources and pathways are not well understood due to the complex geology. Because the edge of the plume is so near the southern boundary of the site, groundwater should be cleaned to residential standards.

Operable Unit 8: Site 300 (Site-Wide) Operable Unit

This OU was formally defined as "surveillance monitoring of groundwater or other environmental media in areas of Site 300 and adjacent property where such monitoring is appropriate." Tri-Valley CAREs successfully persuaded DOE and the regulators to expand OU 8 into a Site-Wide OU, incorporating previous OUs and unassigned areas. OU 1 (GSA) had a previous Record of Decision, and was not included. The Building 834 OU had an Interim ROD, and the Site-Wide ROD superseded this document.

Unassigned areas that are included in the Site-Wide ROD are briefly described below:

— Pit 2 Landfill - This pit was used for disposal of firing table debris from Buildings 801 and 802. The pit is covered by local soil. VOCs were detected in groundwater in 1989, but have not been detected since. Tritium in groundwater at this location originated from Building 850. Except for the tritium, no unacceptable risk at the site was found.

— Building 801 Dry Well/Pit 8 Landfill - Liquid waste containing TCE was placed in the B-801 dry well. The dry well was filled with concrete in 1984. TCE below MCLs (4.6 ppb) was detected in the regional aquifer in 1999. Nitrate was also detected in groundwater slightly above the MCL. The Pit 8 landfill received waste from Building 801. No COCs have been identified.

— Building 833 - TCE was used as a heat exchange fluid at Building 833, and was released through spills, building washdown and rinsewater disposal in an adjacent lagoon. TCE was detected in soil at 1.5 ppm. TCE was found in the perched aquifer at historical highs of 2,000 ppb. In 1999, levels were 30 ppb.

— Building 845 Firing Table and Pit 9 - High explosive experiments occurred at this firing table from 1958 to 1963. Depleted uranium and HMX were detected in shallow bedrock at 1.2 pCi/L and 54 ppb, respectively. No contamination has been detected in groundwater. In 1988, the firing table gravels WERE removed and deposited in Pit 1. The Pit 9 Landfill was used until 1968 for firing table gravels. Although tritium, uranium and HMX could have been deposited in these gravels, no contaminants have been released to groundwater.

— Building 851 Firing Table - Experiments at this site released cadmium, copper, zinc, uranium, and RDX to surface soil. Depleted uranium was detected in the upper aquifer at 1.3pCi/L.

— In addition to the above sites, Building 812, Building 865, and the Sandia Test Site remain uncharacterized. In 2003, LLNL installed 23 monitoring wells in the Building 812 area, and sampled soil at 41 locations. Characterization of this site will be reported in September 2004.

<u>Remedial Activities</u>

— Pit 2 Landfill - The remedy selected consists of sampling and analysis of groundwater in the vicinity to monitor if releases should occur. Additional monitoring wells may be necessary.

— Building 801 Dry Well/Pit 8 Landfill - The remedy selected was for no further action at the Building 801 dry well, and to monitor groundwater near Pit 8. Additional monitoring wells may be necessary.

— Building 833 - The remedy selected is to monitor groundwater for VOCs, hazard management to prevent human exposure, and mitigate impacts to plants and animals. If the Building is going to be used, a new ventilation system will be installed and operated.

— Building 845 Firing Table and Pit 9 - The remedy selected was for no further action at the Building 845 gravel, and to monitor groundwater near Pit 9 for uranium and HMX. The landfill surface will be inspected annually to ensure that there is no damage that could threaten a release. Additionally, groundwater beneath Build 845 would be monitored for tritium, uranium and HMX.

— Building 851 Firing Table - No further action is proposed for soil and bedrock. Groundwater will be monitored.

Risk to Human Health

The only calculated risk to human health approaching EPA's target range (i.e., 10^{-4} to 10^{-6}) Risks of 1 x 10^{-6} was calculated for inhalation of VOCs inside Building 833. The ROD states that this risk is expected to diminish over time.

Current Status

In 2000 and 2001, LLNL prepared a Final Proposed Plan and an Interim Site-Wide Record of Decision (ROD) that addressed the cleanup at all of the Operable Units, except for OU-1. In addition, characterization of the Pits 3, 5 and 7, which is part of OU 5, is moving on a separate track, and will be incorporated into the Record of Decision after a Feasibility Study and a Proposed Plan are developed. After there has been experience with the remedies, LLNL is scheduled to prepare a final ROD for the Site that will contain explicit clean-up standards. This is due in 2007.

Key Issues

1. Characterization

See discussion of this issue in Chapter IV. In the Site-Wide ROD, we noted that in some instances only one or two data points were used to define a plume. Several areas identified as possible release sites remain uncharacterized.

2. Hazard and Exposure Controls

Tri-Valley CAREs (TVC) does not believe that long term controls, except in a few specific locations, should be part of the remedy. We support these controls during remediation, and perhaps for some short time after, but do not support controls that will have to be in place in perpetuity. TVC believes that exposure controls are not acceptable except in a few cases, such as controlling access to a landfill and during the remediation process itself. In the ROD, there is also no differentiation between short-term and long-term exposure controls. Risk and hazard monitoring and assessment programs for wildlife will be very difficult, if not impossible, to implement. For example, a kit fox crossing an area on any given day might not be sited by contract biologists. At the very least, LLNL should be prepared to have one or two trained personnel on site each day in order to implement this program.

3. Risk Assessment Using Adult On-Site Workers

TVC disagrees in principle that adult on-site workers should be assumed for the risk scenario. Because the on-site worker risk scenario does not include drinking groundwater, a major risk factor is not considered in any of the calculations. Residential scenario should also be considered.

4. Remedy Selection

Building 851 is an active facility with groundwater contamination. A remedial action should be defined in the ROD.

5. Natural Attenuation

In the Site-Wide ROD, no further action is considered where "natural processes will continue to reduce contaminant concentrations over time". We recommend that this criterion be deleted. Many stakeholders are concerned that natural attenuation is equated with no further action. We cannot see the difference between "natural processes that reduce concentrations over time" and "natural attenuation", which is part of the remedy selection for Site 300.

V1. Key Contacts

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V11. Access to Site Documents

Site 300 documents are available for review at the following locations:

LLNL Visitors Center
LLNL Main Site-Greenville Road entrance
Livermore, CA 94551
(510) 422-9797
The complete Administrative Record (i.e., all documents) is on microfiche here

Hours: M, T, TH, and F: 10 AM to 4:30 PM; W: 12:30 PM to 4:30 PM -----Best to call first

Tracy Public Library
20 E. Eaton Avenue
Tracy, CA 95376
(209) 835-2221

Hours: M: 1 PM to 8 PM; T: 10 am to 5 PM; TH: 2 PM to 6 PM; Sat: 12 PM to 5 PM.

Stockton Public Library
605 North El Dorado Street
Stockton, CA 95202
(209) 937-8221
Stockton is an auxiliary repository; not all documents are here. Executive Summaries, Final Feasibility Studies and public information documents are here.

Hours: M, W, TH: 10 AM to 9 PM; T, F: 10 AM to 6 PM; Sat: 10 AM to 5 PM
Closed Sundays and 2nd Wednesday of each month

Tri-Valley CAREs
5720 East Ave., #116
Livermore, CA 94551
(510) 443-7148
Tri-Valley CAREs has Site 300 Fact Sheets available in English and Spanish, CERCLA and RCRA environmental documents for LLNL, research resources and a reading room.

Attachment 1

Community Acceptance Criteria

1. Complete the cleanup project in a timely manner. Set a schedule for cleanup activities and adhere to it. The goal should be to complete cleanup ten years after the DOE's last scheduled ROD, with up to 30 additional years for monitoring of residual contamination. As part of the plan, schedule milestones addressing total mass removal, and trends toward achievement of clean-up goals should be established and committed to by the DOE. Areas that will still be contaminated should be identified. We recognize that cleanup in 10 years after the last ROD will be difficult to achieve in some small areas. Also, because of the nature of tritium, California drinking water standards will not be attained for that contaminant in the near future.

2. Cleanup levels should support multiple use of the property that is unrestricted by environmental contamination. Assumptions about land-use need to be altered. As we can see, residential development is beginning to take place up to the site boundary. Any modeling assumptions should assume large residential communities relying on the regional aquifer for drinking water, thus speeding up groundwater movement. Second, we do not believe that Site 300 will necessarily always remain in DOE's stewardship. The "need" for testing nuclear weapons and components (particularly of new and modified designs) is a political decision, not a technically necessary mandate, and, in our opinion this testing should cease. We recommend that Site 300 future land use assumptions include mixed residential, recreational, ecological preserve and industrial land uses. Yet as it now stands, DOE assumes that Site 300 will remain under its stewardship in perpetuity. As such, risks are calculated for adult onsite workers and people living nearby who consume drinking water from a well located at the site boundary. We recommend that Site 300 assume to be mixed residential, recreational, ecological preserve and industrial land uses. Without full cleanup to standards appropriate for residential use, the residual contamination will restrict the future use of the property.

3. Cleanup levels should be set to the strictest state and federal government levels. We believe that the strictest cleanup levels should be met in cleaning up the site. Federal and state Maximum Contaminant Levels (MCLs) for all groundwater (on-site and off-site) should be the "bottom line below which the cleanup will not fall." In many cases the technology exists (and/or can be developed) that will clean up contamination to "background" levels -- that is to the level that existed in nature at the site before Livermore Lab took over in 1955 and began polluting it. In such cases where "background" cleanup levels that are more protective of human health and the environment can be achieved, they should be achieved. In this regard, Tri-Valley CAREs concurs with a strict interpretation of the California Regional Water Quality Control Board's non-degradation policy for groundwater. MCLs for all groundwater should be the objective, and as soon as possible, migration of contaminants into pristine waters should be halted. At a minimum, the standard of 1 in 1 million excess cancer deaths should be adhered to, as well as meeting a hazard index of less than 1 (non-cancer health effects).

4. Remedies that actively destroy contaminants are preferable. In order of preference, Tri-Valley CAREs recommends the following types of cleanup measures: a) remedies that destroy contaminants (i.e. by breaking them down into non hazardous constituents), such as ultra-violet light/hydrogen peroxide, permeable barriers, or biodegradation; b) active remedies that safely treat or remove contaminants from the contaminated media; c) monitored natural attenuation in so far as it relies on natural degradation (and not further dispersion of the pollution) within a reasonable time frame. What is called "risk and hazard management" (i.e., restrictions on land use, fencing, signs and institutional controls), while potentially useful for reducing short-term risks, is not a valid cleanup in our eyes and should only be used as an

interim measure. In no case do we think that "point of use cleanup" (e.g., placing filters on off-site drinking water wells) is appropriate. In all cases, hydraulic control should be established to halt migration of contaminant plumes to pristine waters. When soil excavation takes place, it should be properly controlled to minimize releases of contaminated soil into the air, and onto adjacent properties.

5. The tritium source and plume should be controlled at the earliest possible time in order to prevent further releases to the environment. The tritium plume, nearly two miles long and growing, cannot be cleaned up in the traditional sense of the word, since it is not feasible to separate the radioactive hydrogen (tritium) component from the water. Therefore, Tri-Valley CAREs recommends the following: a) isolation of the tritium contaminated wastes in the unlined dumps to prevent further and continuing contamination of the groundwater; b) hydraulic control of the plume to prevent further migration; c) aggressive monitoring to ensure no migration while the tritium decays (at a rate of 5.5% per year); and, d) a stringent contingency plan in case these methods fail. As it currently stands, groundwater rises into the waste dumps during heavy rainfall and picks up additional tritium contamination. Isolation of the wastes may be accomplished by means of drains, capturing groundwater upstream from the pits before it is inundated, or removing the tritium-contaminated debris from the pits and store it above ground in a monitored storage facility.

6. Radioactive substances should be isolated from the environment. As is the case with tritium, there are several plumes containing uranium 238 (U^{238}). Technology exists to separate this contaminant from the groundwater. Tri-Valley CAREs recommends that this contaminant be stored in above ground monitored facilities after separation from groundwater.

7. The ecosystem should be protected and balanced against the cleanup remedies. Site 300 sits on 11 square miles of land 30 miles east of San Francisco. It sits on a series of steep hills and canyons, covered by grasslands. Seven major plant communities occur at Site 300, including: coastal sage scrub, native grassland, introduced grassland, oak woodland and three types of wetland. 20 species of reptiles and amphibians, 70 species of bird, and 25 species of mammals also occur. Included may be special, rare and endangered species including the burrowing owl and the San Joaquin Kit Fix and the Large-Flowered Fiddleneck. In order to protect the ecosystem, ecological risks should be no greater than those for humans (i.e., a Hazard Index of less than one for selected species, based on recent data). This involves updating the ecological assessment that was completed in 1994, as there are more complete data developed recently. It also involves making sure that clean-up activities do not inadvertently destroy unique habitat. This could occur from too quickly pumping groundwater, with the effect of destroying natural springs, or by capping large areas and replacing the vegetation with non-native species.

8. Decisions should not rely on modeling alone. The SWFS points out just how complex the hydrogeology of the site is, and how little is known about it. Given this, Tri-Valley CAREs believes that over reliance on modeling to predict the fate and transport of contaminants is not a good idea. Computer modeling should be used as a tool only, and continually updated by field testing as that information becomes available. We believe that if it necessary to base decisions primarily on modeling, the most conservative assumptions should be used.

9. Additional site characterization is needed and must be budgeted for over many years. It is also apparent from this Community Guide that additional characterization (e.g. of soil, groundwater, waste dumps etc.) is necessary, and will have to be budgeted for many years to come.

10. A contingency plan should be completed and subject to public review prior to the signing of a ROD. We recommend that a site wide contingency plan be part of the ROD document or part of the draft Remedial Action Plan. This is needed because the cleanup of a few sites are put

off until the future, there are many uncertainties, innovative technologies will be used, and contingent actions should be part of the cleanup plan and thus incorporated into the site wide Record of Decision (ROD).

11. The public should be involved in cleanup decisions. As it now stands, public involvement takes place through the Technical Assistance Grant (TAG) with Tri-Valley CAREs and at public meetings and hearings. After the ROD is signed, there are no mandatory public hearings or workshops. Likewise, the TAG will run out in one or two years. In this event, we would like a commitment from the Lab to find a mechanism for regularly keeping the public informed. A public record of cleanup activities should be updated regularly, maintained and made accessible at a local public library. Public workshops should be held periodically after the last ROD to discuss problems and progress.

12. Cleanup should be given priority over further weapons development. Perhaps most important of all, Tri-Valley CAREs insists that cleanup of Site 300 be given a priority over further bomb-creating enterprises, and that adequate, stable, long-term funding be assured in order that the job may be done right. The current allocation of approximately one percent of Livermore Lab's annual budget to cleanup at Site 300 (and only another 1 percent to cleanup at the Lab's main site) is insufficient.

13. Any ongoing activities at Site 300 should be designed to prevent releases to the environment. Releases to soil, air, groundwater and surface water from weapons testing are no longer acceptable. Any activities, if they must occur, should take all necessary precautions to avoid any releases to the environment of chemicals of concern.

Attachment 2

Photographs of Selected Activities at Site 300
(attached)