

STATE OF SUPERFUND

Lawrence Livermore National Laboratory Superfund Sites

Main Site (Site 200) and Site 300

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1. Introduction

The purpose of this report is to familiarize the community members about the status of the Superfund cleanup at the two Superfund Sites managed by Lawrence Livermore National Laboratory (LLNL). The information in this report is based on extensive review of documents obtained from the U.S. Environmental Protection Agency (EPA), the U.S. Department of Energy (DOE), the State of California Department of Toxic Substances Control (DTSC), and the Lawrence Livermore National Laboratory Environmental Restoration Division, as well as meetings with the regulatory agencies and the Department of Energy. It also incorporates information obtained through our role as Technical Assistance Grant recipient and other research projects.

LLNL was founded in 1952 by Edward Teller and E.O. Lawrence to develop the hydrogen bomb, thus becoming the United States' second nuclear weapons design lab after Los Alamos National Laboratory in New Mexico. Prior to this, the land was used by the Navy as an aircraft maintenance facility. The Main Site stretches over one square mile; located on the eastern edge of the City of Livermore. Homes, apartments, little league fields and more are built up to the fence line. There are approximately 50,000 people living within 2 miles of the main site, and 7 million within a 50-mile radius. The second Superfund site, known as "Site 300", is LLNL's high explosives testing range near the City of Tracy. Both sites have soil and groundwater that are contaminated with toxic and radioactive materials. Cleanup of both is projected to last until the end of the 21st century.

This short summary highlights some of the progress and issues involved in cleaning up these two sites.

II. The Main Site

LLNL conducts experiments with hazardous substances, including weapons grade plutonium, enriched uranium, and tritium (radioactive hydrogen used in the hydrogen bomb). Since the 1960's, LLNL has released approximately one million curies of radiation into the environment. Tritium gas has been released in substantial quantities over the years through normal operations and accidental releases. Tritium releases are especially a concern because of Livermore's large agricultural sector; where it can enter the food supply.

Also, laboratory processes used and released a variety of other non-radioactive chemicals. Much of the cleanup to date has focused on other chemicals that were used in experiments or were byproducts of laboratory work, or residuals from the previous landowner – the Navy. These chemicals include fuel hydrocarbons (mostly gasoline), metals, PCBs and volatile organic compounds (VOCs), most often trichloroethylene (TCE). TCE is an

industrial solvent that is known to cause cancer in humans and other non-cancer health effects such as impacts to the liver and kidneys, and negative neurological, immunological, reproductive, and developmental impacts. TCE is a factor in congenital fetal heart defects during the first trimester of pregnancy. In operating the facility over 60 years, LLNL has had accidental releases of these substances, as well as extensive groundwater pollution that threatened the City of Livermore's water supply.

In 1987, the Main Site was placed on the Environmental Protection Agency's (EPA) "Superfund" list, a list of the most contaminated sites in the nation. In 1992 a Record of Decision (ROD) was signed and full cleanup began in 1995. It had a priority to capture the off-site plume and reduce it to safe drinking water standards known as Maximum Contaminant Levels (MCLs). At the same time, a plan was developed to treat the most heavily contaminated source areas. For the most part, LLNL pumps the contaminated groundwater to the surface, treats it through air strippers or granular activated carbon (GAC), and discharges the treated water. In some areas, highly contaminated soil is treated using soil vapor extraction technology. Originally, estimated cleanup time was 53-years: in 2011, LLNL estimated cleanup would not be completed until the year 2080 with a remaining cost of one billion dollars.

Depth to groundwater at the site varies from 130 feet in the southeast corner to 25 feet in the northwest corner. Municipal wells about two miles from the site supply Livermore residents; groundwater to the south and west is used for irrigation. Highly permeable channels carry groundwater, each separated from one another by a layer of non-saturated material that restricts vertical groundwater flow. These channels are known as hydrostratigraphic units (HSUs). Sediment layers that have hydraulic communication are grouped together as one HSU. As active remediation began and as time, experience and knowledge have progressed, LLNL has exceeded expectations about plume capture and mass removal. This is due in part to a much better understanding of the hydrogeology underlying the site and innovations in well-field management that allows LLNL to target source areas.

The site is currently divided into seven treatment areas. They are named Treatment Facility A (TFA), TFB, TFC, TFD, TFE, TFG, and TFH. Within TFH, there are three distinct treat areas: TF 406, TF 518, and TF Trailer 5475. ¹ Four areas have soil vapor extraction facilities. These facilities are designated Vapor Treatment Facility (VTF) D Helipad, VTFE Eastern Landing Mat, VTF518 Perched Zone and VTF5474. **Figure 1**, attached at the end of this paper, provides a diagram of the location of the treatment facilities. **Table 1** provides a the cumulative volume of contaminants removed in each treatment area

¹ Note that TF F was contaminated by fuel hydrocarbons in the soil, and was cleaned up by 1996. It is therefore not included in tables and charts

Table 1: Treatment Areas and Volume of Contaminants Removed

Treatment Facility Area	Volume of Groundwater Extracted (Mgal)	Volume of VOC Removed from Groundwater (kg)	Volume of VOC Removed from Soil (kg)	Total Mass Removed (kg)
TFA	2,072	215		215
TFB	497	84		84
TFC	566	113		113
TFD	1,149	887	99	986
TFE	410	232	156	388
TFG	92	12		12
TFH*	179	42	1,277	1,319
Total	4,965	1,585	1532	3,117

*TFH includes TF-406, TF-518, and TF-5475

A. Issues

Advances in technology have greatly helped LLNL to exceed its goals. Yet, there are issues that need to be resolved

1. Funding Commitments

A basic concern is whether funding commitments are sufficient to ensure long-term cleanup and achievement of project milestones. Cutbacks in funds only delay inevitable expenditures, and may make cleanup more costly. Long-term funding for clean up should be a major commitment, and DOE and LLNL should make all attempts to ensure future funding.

2. Complete Cleanup

Wherever possible, Tri-Valley CAREs (TVC) recommends that LLNL be cleaned up to a level that allows unrestricted use and avoids the need for long-term stewardship. We also recognize that at 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.

3. Relaxing Policy for Cleanup

TVC is very concerned that there will be a relaxation of cleanup standards - that the active remediation will shift to passive remediation or that sites will receive waivers from meeting cleanup standards. DOE, because of its massive cleanup around the country is currently searching for new rationales regarding relaxation of current cleanup standards and methods.

4. 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".² TVC is concerned about DOE's commitment to implement the necessary plans and activities that this will entail, and maintain steady and necessary levels of funding. Because of the long-term nature of contaminants found at many of the sites, DOE should develop a record management system that will always be accessible near the location of the stewardship activities, from a regional access point (such as the state archive or library) and from the National Archive system.

5. Mixed Waste and Innovative Technology

In 2009, LLNL prepared a draft Feasibility Study on problems involving mixed chemical and radioactive waste. This problem came to light as some groundwater treatment facilities brought tritium-contaminated water to then surface together with water contaminated with chemicals. The treatment facilities, namely GAC, captured the chemicals and became radioactive at high enough levels to qualify as mixed waste. This FS was sent out for review, but it was later tabled: not because the problem was resolved, but because LLNL was experimenting with innovative technologies that may help resolve this problem. In 2010, LLNL began conducting treatability tests involving in-situ bioremediation, thermally enhanced remediation, pneumatic fracturing and in-situ chemical reduction using ZVI. TVC encourages investigation of small-scale experimental applications, as they may increase mass removal and may be more sustainable in the long run. The results of the treatability tests may identify alternative remedial approaches for other Livermore Site source areas. However, some of these technologies may not be appropriate for wider use and the community should be involved in those decisions.

Therefore, we think that more attention should be placed on completing the FS, and that the treatability studies should be concretely applied to the issue of resolving the mixed waste problem. Additionally, if treatability is going to be used, it must go through a fully transparent process. In particular, we

² Long-Term Stewardship Study, DOE 2001.

note that there is some skepticism about the wide application of pneumatic fracturing in an area riddled with nearby earthquake faults.

III. Site 300

Site 300 is Livermore Lab's high explosives testing facility. It is located in the Eastern Altamont Hills 17 miles east of Livermore and about 10 miles west of downtown Tracy. It encompasses 11 square miles along Corral Hollow Road. Over the years, Tracy has expanded and a major residential development is proposed near Site 300.

Since it was founded in 1955, Site 300 operations have included open-air blasts with high explosives and multiple toxic and radioactive materials used in nuclear weapons. Site 300 activities have polluted soil, surface water, springs and regional groundwater aquifers with a mixture of chemical and radioactive wastes including solvents, dioxins, furans, PCBs, perchlorate, high explosive compounds, metals, and radionuclides (namely tritium and depleted uranium). An off-site groundwater plume contaminated with solvents has migrated from Site 300, and traveled under Corral Hollow Road and the nearby Corral Hollow Creek.

Releases to the environment occurred primarily from spills, leaking pipes, leaching from unlined landfills and pits, high explosive test detonations, and disposal of waste fluids in lagoons and dry wells (sumps). Current operations at Site 300 include contained detonations, open-air blasts, explosive and hazardous waste burning, and radioactive and hazardous waste storage. Prevailing winds blow contamination into the Central Valley, and, particularly, toward Tracy and surrounding communities.

Nine Operable Units (OUs) have been designated at Site 300 based on the nature and extent of contamination to effectively manage site cleanup. These are

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

In 1990, because of the magnitude of this contamination, Site 300 was added to the federal Superfund site. LLNL recently acknowledged that it is uncertain when cleanup at Site 300 will be completed, if ever. The

contamination is widespread and complex, and Livermore Lab estimates that its cleanup at Site 300 will cost around \$1.8 billion.

A. Issues

Issues 1 – 4 as described above also apply to Site 300. In addition, Site 300 has the following unique issues.

1. Remediation of open air firing tables (Building 812)

The Superfund cleanup at Site 300 is entering a new and important phase that will extend from 2013 through 2015. Cleanup is starting at one of the last open-air firing tables that had been used often to detonate nuclear weapons experiments with Uranium-238. The area encompasses about 200 acres in the east-central part of Site 300. The firing table is located almost directly over an earthquake fault. The hillsides, canyons and groundwater in this area are contaminated, as is a nearby spring.

In soil samples taken 5 feet below the firing table, total uranium has been measured at a concentration of 22,700 picocuries per gram. For comparison, a DOE report lists the proposed soil cleanup standard for uranium at Building 812 as 3.1 picocuries per gram.

LLNL recently has undertaken an extensive soil survey in the Building 812 area to determine the extent of the Uranium-238 contamination, and a soil and biotic sampling effort to determine the radioactive material's deposition depth and uptake in plants and animals. The sampling has taken a long time, and there are many complications. A proposed remedy with a public hearing is likely to take place in 2015 – 2016.

Tri-Valley CAREs supports efforts to better characterize and understand the contamination at the Building 812 area before publishing a proposed cleanup plan. However, we recommend that LLNL hold a public workshop on B-812 between now and the proposed plan.

2. The Pit 7 Complex

The “Pit 7 Complex” of unlined dumpsites has leaked uranium, tritium (radioactive hydrogen) and other contaminants into the groundwater at high concentrations. A remedy has been selected at that area, but the remedy allows the most contaminants to be left in place, with others (e.g., uranium) being removed from groundwater. A series of drains and other engineered features have been installed to prevent rainwater from entering the pits and further dispersing the pollutants. Continued vigilance is needed to ensure that the remedy works as intended and that the pollutants do not continue to leach into the groundwater and/or migrate further.

3. Remediating Perchlorate in Numerous Areas

Perchlorate is used in explosives and is found in several locations throughout the site. Perchlorate was an emerging contaminant approximately 7 years

ago, and the remedy for the site did not necessarily involve cleanup of this contaminant. In 2011, after the remedy for B-850 was completed, an in-situ Bioremediation Treatability test began to determine if this technology would remediate perchlorate in the groundwater.

IV. Community Involvement

For both sites, the remediation strategy must satisfy a number of criteria to be accepted by EPA. Among these criteria is Community Acceptance. However, community acceptance is not defined in the regulations. For community organizations such as Tri-Valley CAREs, this a powerful tool for effecting changes to the cleanup strategy. We developed acceptance criteria for the Site 300 and the Main Site, and we gauge remedial action plans and Records of Decision against these criteria. Below is a summary of community acceptance 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.
- Radioactive substances should be isolated from the environment.
- Ecosystem protection should be 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.
- DOE should establish a mechanism so that the public is involved in cleanup decisions until the site is cleaned up.
- Cleanup should be given priority over further weapons development.
- Any ongoing activities should be designed to prevent releases to the environment.

TVC meets regularly with the regulators and LLNL staff managing environmental cleanup at both sites. This provides us with a heads up on issues that are coming up, as well as providing an exchange where we can discuss technical and policy issues with the regulators. These meetings are extremely helpful for us; however, a wider community exchange is not available on a regular basis.

There are opportunities to get involved at both sites, and aside from listing them, we welcome your suggestions for increasing the level of involvement.

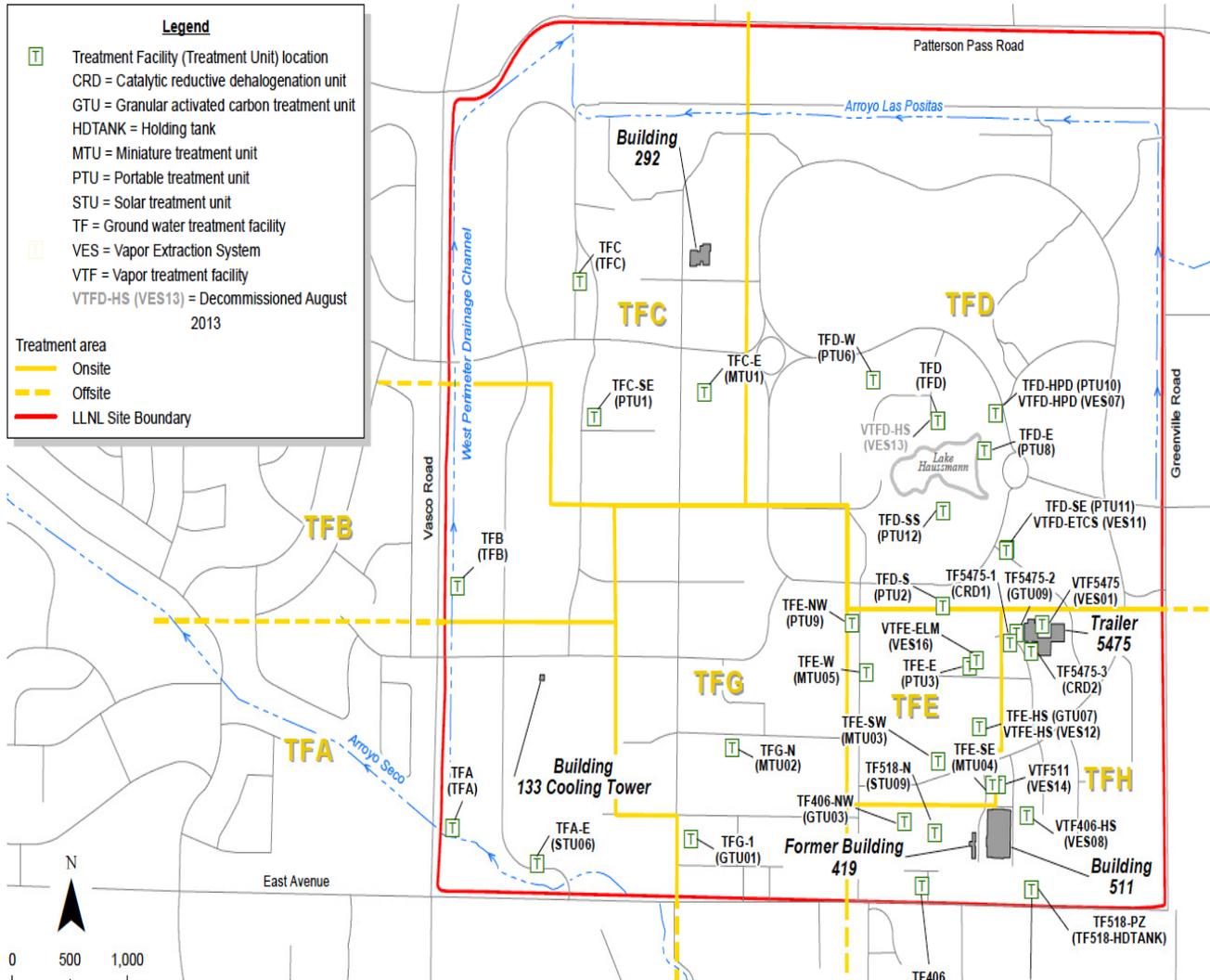
Opportunities include:

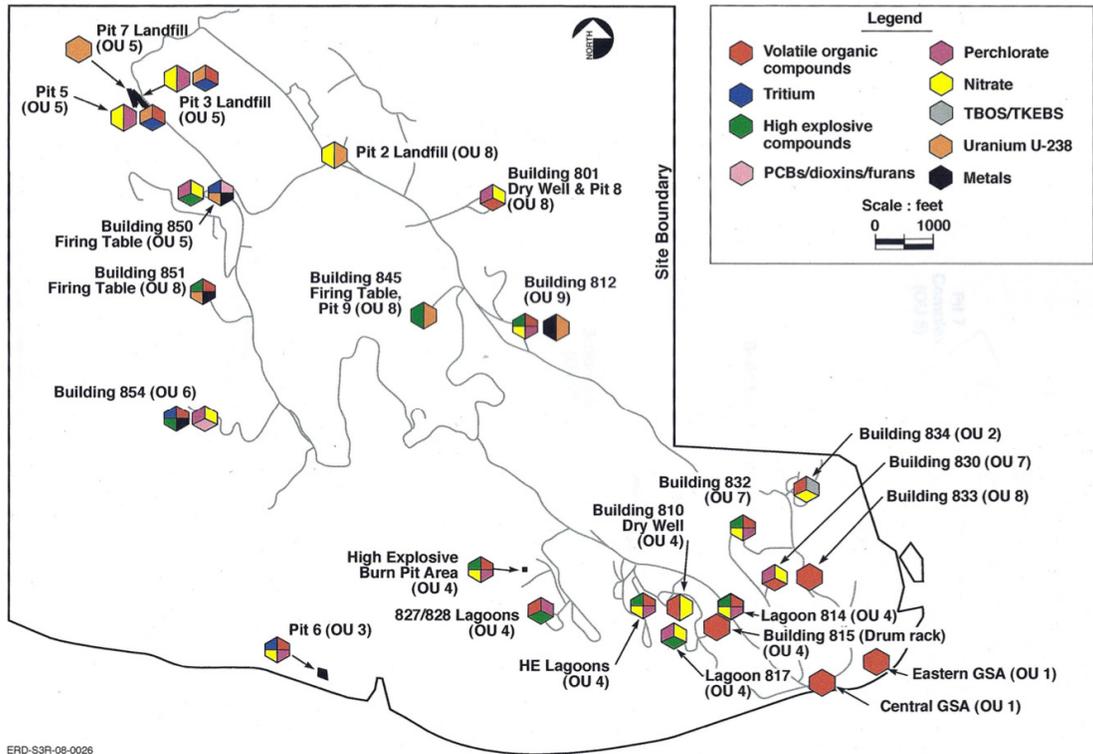
- The Superfund law allows public comment during the initial stages of study and the selection of a proposed plan to remediate the area. These are mostly complete. However, there are still areas for which

public participation is legally required, including the selection of a remedy for the B-812 firing table at Site 300, the proposed plan to manage mixed waste at the Main Site, and any changes in the remedy. Changes in the remedy may include full implementation of one or more of the technologies that are under experiment at the Main Site.

- The Livermore Lab can conduct public workshops beyond those that are legally mandated.
- Every five years, a mandated Superfund Five-Year Review is compiled with the following general purpose: evaluate the implementation and performance of the selected remedy to determine whether it is protective of human health and the environment. In addition, the Five-Year Review identifies issues and/or deficiencies and identifies recommended actions, if necessary. Public comment is welcome for the Five-Year Reviews, although we do not believe that it is publicized.
- As a fundamental principle, it is important to ensure that cleanup remains a priority, and that the Livermore, Tracy and surrounding communities are consulted in decision-making.

Note: LLNL Main Site and Site 300 maps follow, below





ERD-S3R-08-0026

Figure 1-2. Site 300 release sites and Operable Units (OUs).

Release sites and contaminants of concern at Site 300 for surface soil, subsurface soil/rock, surface water, and ground water. UCAR 2009