Proposed Plan for Environmental Cleanup at the Pit 7 Complex Lawrence Livermore National Laboratory Site 300

UCRL-AR-215719

United States Department of Energy • Livermore Site Office – February 2006

Introduction

The United States Department of Energy (DOE) and Lawrence Livermore National Laboratory (LLNL) request public comments on this Proposed Plan for cleanup of contaminated soil and ground water at the Pit 7 Complex landfills at the LLNL Site 300 Experimental Test Facility.

This Proposed Plan summarizes site conditions and cleanup alternatives analyzed for the Pit 7 Complex, and presents the rationale for identifying the preferred cleanup alternative. The preferred cleanup alternative is considered an interim remedy because cleanup at Site 300 is occurring under an Interim Record of Decision (*ROD*)[a]. The final remedy for the Pit 7 Complex will be included in the Final Site-Wide ROD for Site 300 scheduled for completion in 2008. This Proposed Plan was prepared in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (*CERCLA*) of 1980. Figure 1 shows where the Pit 7 Complex remediation is in the CERCLA process. DOE/LLNL have completed a detailed environmental investigation (referred to as a *Remedial Investigation*), and a thorough screening and evaluation of possible remediation (cleanup) alternatives (referred to as a *Feasibility Study*) for the Pit 7 Complex area. The Remedial Investigation/Feasibility Study is available to the public in the Information Repositories at the LLNL Visitors Center and the Tracy Public Library

How do I participate in the process?

DOE invites the public to attend a meeting at 6 p.m. on **April 5, 2006** in the Tracy Community Center, 300 East 10th Street, Tracy, CA. Representatives from DOE, LLNL, U.S. EPA, and the State of California will discuss the proposed interim cleanup plan and answer questions during the meeting.

A 30-day public review and comment period on this document begins on **March 21, 2006** and ends on **April 21, 2006**. All interested members of the public are encouraged to review and comment on the Proposed Plan. You can submit your comments verbally at the public meeting or in writing. Written comments should be received by **April 21, 2006** and addressed to:

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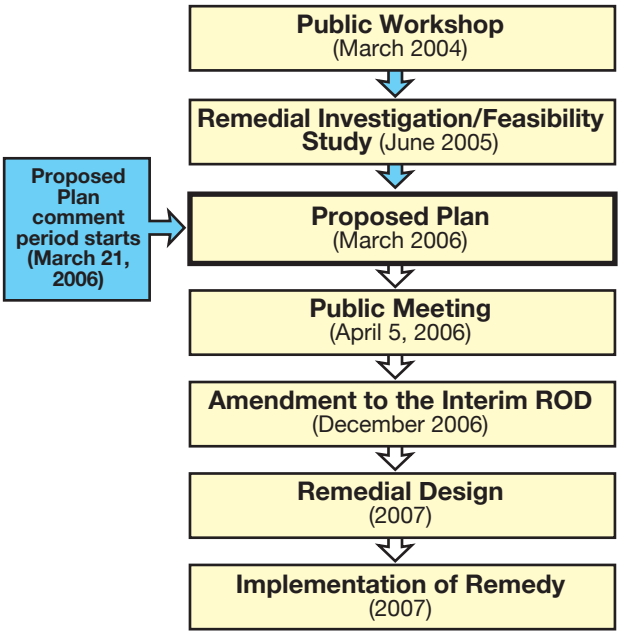


Figure 1. CERCLA Process and Schedule for the Pit 7 Complex.

(see page 11 for addresses and telephone numbers). Information summarized in this Proposed Plan is described in greater detail in the Final Remedial Investigation/Feasibility Study for the Pit 7 Complex at LLNL Site 300.

DOE/LLNL and the regulatory agencies encourage the public to review and comment on the proposed plan during the 30-day public comment period. All comments received during the public comment period will be considered prior to making a final decision on the interim remedy for the Pit 7 Complex.

Following public comment, DOE will select an interim cleanup remedy for the Pit 7 Complex and describe it in an Amendment to the Interim Site-Wide ROD. Because a cleanup remedy for the Pit 7 Complex was not included in the Interim Site-Wide ROD, a ROD Amendment will be submitted to the regulatory agencies for approval. All comments received at the public meeting and during the public comment period will be

[a] **Definition or descriptions of italicized words are provided in the Glossary on page 11.**

considered and used, as appropriate, to prepare the ROD Amendment. In addition, all public comments will be addressed in a Responsiveness Summary section of the ROD Amendment.

The ROD Amendment will document the remedial action for the Pit 7 Complex area, and will require that the effectiveness of remediation be evaluated every five years. In accordance with CERCLA, if technical evidence indicates that the implemented remedy is not effective, appropriate changes would be discussed and proposed during the Five Year Review process.

The ROD Amendment is scheduled to be finalized in December 2006. Following the ROD Amendment, DOE/LLNL will prepare a Remedial Design document by November 2007 and then implement the selected interim remedy for the Pit 7 Complex. The ROD Amendment will not contain ground water cleanup standards for the Pit 7 Complex. The final ground water cleanup standards will be selected in the Final Site-Wide ROD in February 2008. The ROD Amendment will have a public process similar to the Pit 7 Proposed Plan.

Role of the Regulatory Agencies

The U.S. EPA, the California Department of Toxic Substances Control (DTSC), and the Central Valley Regional Water Quality Control Board (RWQCB) provide guidance to DOE/LLNL on the investigation and remediation of contaminants at the Pit 7 Complex. The regulatory agencies review and comment on all CERCLA compliance reports prepared by DOE/LLNL, provide *applicable or relevant and appropriate requirements (ARARs)* for the site, review and evaluate remedial technologies and alternatives, participate in the selection of the final remedy, and provide oversight and enforcement of State and Federal environmental regulations. In addition, the regulatory agencies monitor and review public acceptance of the proposed remedy. In doing so, the regulatory agencies will actively participate in the public meeting for the Pit 7 Complex at the Tracy Community Center on **April 5th, 2006**.

Site Background and Characteristics

Site 300 is located in the Altamont Hills, in San Joaquin and Alameda counties, approximately 17 miles east of Livermore and 8.5 miles southwest of Tracy (Figure 2). Site 300 is a restricted-access DOE experimental test facility used in the research, development, and testing of non-nuclear weapon components. DOE plans to use Site 300 in this capacity for the foreseeable future.

The Pit 7 Complex is located in the northwest portion of Site 300 with the closest site boundary located approximately 2,500 feet to the north (Figure 3). From 1958 until 1988, debris from explosives tests was disposed in the Pit 7 Complex. The Complex includes unlined landfill Pits 3, 4, 5, and 7. The waste placed in the pits included wood, plastic, material and debris from tent structures, pea gravel, and exploded test assemblies that were contaminated with *volatile organic compounds*, nitrate, perchlorate, *tritium*, and *depleted uranium*.

In 1982, DOE/LLNL discovered contamination in ground water under the Pit 7 Complex. A Remedial

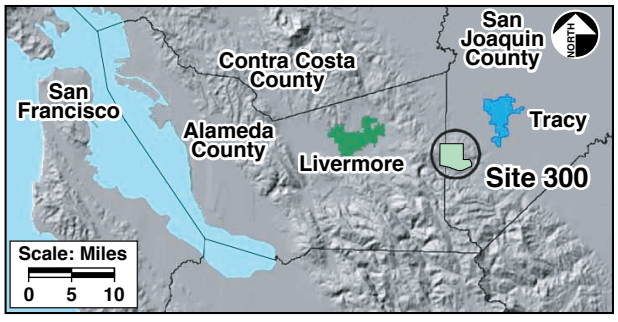


Figure 2. Location of LLNL Site 300.

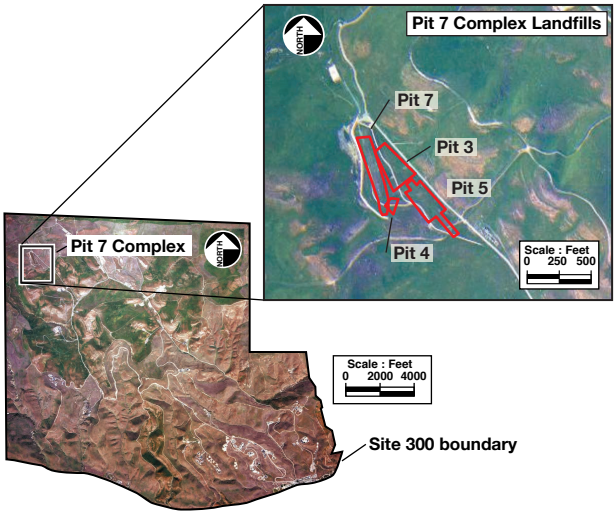


Figure 3. Location of the Pit 7 Complex at LLNL Site 300.

Investigation was conducted to determine the nature and extent of contamination in this area. As part of this investigation, soil, rock, and water samples were collected and analyzed to identify:

1. Contaminants that had been released from past activities at the site,
2. The extent of contamination,
3. Soil and rock characteristics and water-bearing properties that could influence contaminant movement in the subsurface, and
4. Risk to human health or the environment posed by the contamination.

Definition or descriptions of italicized words are provided in the Glossary on page 11.

Extent of Contamination

The Remedial Investigation results indicated that ground water rises into the bottom of the Pit 7 Complex landfill during years of heavy rainfall (e.g., the 1998 El Niño). As a result, contaminants in the buried waste were released to subsurface soil/rock and ground water in stream channel (alluvial) sediments in the valley bottom and the underlying shallow bedrock.

DOE/LLNL has identified *contaminants of concern* for the Pit 7 Complex. Contaminants of concern are chemicals, metals, or radioactive constituents present in surface soil, subsurface soil/rock, surface water, or ground water as a result of site activities that:

- Pose an unacceptable risk to human health or the environment,
- Could impact ground water, or
- Exceed regulatory standards.

Table 1 presents the contaminants of concern present at the Pit 7 Complex, and the reason they were identified as a contaminant of concern.

Media of Concern	Contaminants of Concern	Rationale
Surface soil	None	No risk or threat to ground water identified
Surface water (Spring 24)	None	No risk identified
Subsurface soil/rock	Tritium and uranium	Tritium inhalation risk for onsite workers Threat to ground water
Ground water	Tritium, uranium, volatile organic compounds, nitrate, and perchlorate	Present in ground water above drinking water standards or other water quality objectives

Table 1. Contaminants of concern at the Pit 7 Complex.

Tritium and uranium were identified as contaminants of concern in subsurface soil and rock, with maximum activities generally detected at a depth of 15 to 25 feet below ground surface. Significant contamination in subsurface soil and rock was not detected outside the immediate vicinity of Pits 3 and 5.

As shown in Table 2, tritium, uranium, nitrate, and perchlorate have been detected in ground water at concentrations exceeding drinking water standards or *Public Health Goals* when no drinking water standards exist. While concentrations of volatile organic compounds in ground water are below drinking water standards, they are listed in Table 2 to meet the RWQCB requirement that any constituent with concentrations exceeding background in ground water be listed as a contaminant of concern.

Contaminants of Concern	Historical maximum concentration	Maximum concentration in 2004	Drinking Water Standard
VOCs			
1,1-DCE	6.2 µg/L (1985)	0.73 µg/L	7.0 µg/L[a] 6.0 µg/L[b]
TCE	15 µg/L (1995)	2.9 µg/L	5.0 µg/L[a, b]
Radionuclides			
Tritium	2,660,000 pCi/L (1998)	437,000 pCi/L	20,000 pCi/L[a, b]
Uranium	726 pCi/L (1998)	112.4 pCi/L	30 µg/L[a] 20 pCi/L[b]
Other			
Nitrate (as NO^3)	363 mg/L (2003)	71.9 mg/L	45 mg/L[a, b]
Perchlorate	19 µg/L (2003)	21 µg/L	6.0 µg/L[c]

a. Federal drinking water standard.
b. State of California drinking water standard.
c. State of California Public Health Goal; no Federal drinking water standard established.

Table 2. Concentrations of contaminants of concern in ground water at the Pit 7 Complex.

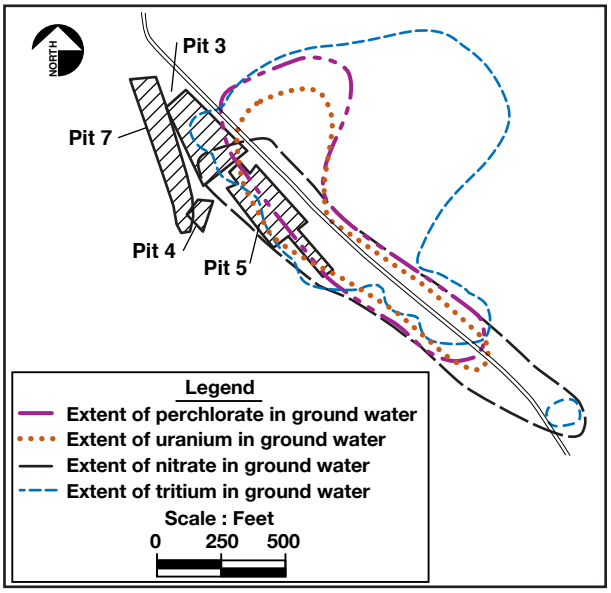


Figure 4. Extent of uranium, tritium, nitrate and perchlorate at concentrations above drinking water standards or public health goals in ground water (2003 or most recent data).

Definition or descriptions of italicized words are provided in the Glossary on page 11.

Figure 4 shows the extent of uranium, nitrate, and tritium in ground water that exceeds drinking water standards and the extent of perchlorate that exceeds the Public Health Goal. Because concentrations of volatile organic compounds in ground water are currently below drinking water standards, only detected in four wells, and are continuing to decrease toward background concentrations, a plume map is not presented. Depth of contamination in alluvial/weathered bedrock ground water extends to a maximum of 35 to 40 feet below ground surface, and to a maximum of 275 to 300 feet below the hilltops in the shallow bedrock water-bearing zone.

As defined by EPA, the principal threat at the Pit 7 Complex is the landfill waste because contaminants associated with the waste are found at high concentrations, are toxic, and can be mobilized when ground water rises into the pit waste. Contaminants found in subsurface soil/rock are considered a low-level threat because of their impacts to underlying ground water. Although contaminants in ground water exceed drinking water standards, it is not considered a *principal threat waste* because contaminated ground water is generally not considered by EPA to be a source material. Measures were included in the cleanup alternatives and preferred interim remedy to address the contaminant ground water plumes, as well as to control the sources of ground water contamination in the pit waste and underlying soil and rock. Because no contaminants of concern were identified in surface soil or surface water, measures to address these environmental media were not included in the cleanup alternatives or preferred interim remedy.

What are "principal and low-level threat wastes"?

The U.S. EPA defines "principal threat wastes" as contaminant source material that is highly toxic or highly mobile that cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. "Low-level threat wastes" are contaminant source materials that can be reliably contained and that would present only a low risk in the event of release.

Summary of Site Risks

A *baseline risk assessment* was conducted to identify potential exposure pathways for people, plants, and animals that must be addressed by the cleanup alternatives. It indicates what risks might exist if no action were taken at the Pit 7 Complex and contains the basis for identifying risks.

Risk for humans is expressed as the probability of developing cancer over a lifetime and as the potential for noncancer adverse health effects (e.g., effects to central nervous system, liver, kidney) to occur due to long-term exposures. For example, an excess cancer risk of one in one million (expressed as 10^{-6}) indicates the probability of one additional cancer in a population of one million people. An excess cancer risk of 10^{-6} is an acceptable level according to the *National Contingency Plan*. An excess cancer risk between 10^{-4} (one in ten thousand) and 10^{-6} may be acceptable provided risk is sufficiently managed.

An ecological risk assessment evaluates the potential for adverse impact to plants and animals from long-term exposure to chemicals. The ecological assessment focuses on potential reproductive damage and reductions in reproductive life span.

Baseline risk assessments typically use conservative assumptions because of uncertainties in the assessment. However, actual human or nonhuman exposures and risks may be lower than those calculated for the risk assessments.

What are the risks from contamination at the Pit 7 Complex?

The estimated baseline human health risks and hazards for the Pit 7 Complex were evaluated for adult onsite exposure and offsite residential exposure. The results of the risk assessment indicated that the only unacceptable risk to human health posed by contaminants in the Pit 7 Complex area was inhalation of tritium evaporating from subsurface soil by onsite workers. This risk was estimated to be 4×10^{-6} (four in one million) and was calculated based on the assumption that a worker spends 8 hours a day, 5 days a week for 30 years at the Pit 7 Complex. However, there are only periodic monitoring activities that are conducted at the landfills and no workers actually spend this amount of time in the area. In addition, there is some potential for onsite workers to be exposed to the contaminants in the pit waste if waste were to be unintentionally excavated or exposed.

Contaminants are present at concentrations that exceed regulatory standards for the unrestricted use of ground water in the Pit 7 Complex area. However, ground water from the Pit 7 Complex area is not currently used and is not anticipated to be used in the near future.

The results of the baseline ecological assessment indicate there were no unacceptable hazards identified for plants and animals residing in this area. This determination was based on estimates of potential hazard from exposure to contaminants that were calculated for mammals, amphibians, and birds that could potentially inhabit this area, including threatened and endangered species.

Definition or descriptions of italicized words are provided in the Glossary on page 11.

Remedial Action Objectives

Remedial action objectives describe what the alternatives for the Pit 7 Complex are expected to accomplish:

For Human Health Protection:

- Prevent people from drinking ground water containing contaminant concentrations above the State and Federal drinking water standards and any more stringent *water quality objectives*.
- Prevent onsite workers from inhaling tritium volatilizing from subsurface soil to air that poses an unacceptable cancer risk (greater than one in one million [1 x 10^{-6}]) or other health hazard.
- Prevent people from being exposed to any contaminated media (i.e., soil or ground water) that pose an unacceptable additive risk or hazard for all contaminants.

For Environmental Protection:

- Restore water quality, at a minimum, to water quality objectives that protect beneficial uses within a reasonable timeframe and prevent plume migration. Because it is not technically feasible to prevent migration of the tritium plume, plume migration will be limited to the extent possible, while tritium decays below MCLs within 45 years.
- Maintain existing water quality that complies with water quality objectives.
- Ensure existing contaminant conditions do not change so as to threaten wildlife populations and vegetation communities.

Summary of Cleanup Alternatives

Five cleanup alternatives were evaluated to meet remedial action objectives and address contaminants of concern in subsurface soil/rock and ground water in the Pit 7 Complex area. The cleanup alternatives were designed to address these contaminants using different combinations of technologies. Alternative 5a was

Objective	Remedy component	Alternative							
		1	2	3a	3b	4a	4b	5a Preferred Alternative	5b
No action baseline for comparison:	No further action	✓							
Evaluate effectiveness of remedy:	Monitoring		✓	✓	✓	✓	✓	✓	✓
Exposure control:	Risk and hazard management		✓	✓	✓	✓	✓	✓	✓
Control or isolate source to prevent further releases	Waste excavation		✓	✓	✓				
	Hydraulic diversion					✓		✓	✓
	Hydraulic barrier						✓		
Remediate contaminants released to ground water:	Monitored natural attenuation for tritium in ground water		✓	✓	✓	✓	✓	✓	✓
	Natural attenuation of uranium, nitrate, and perchlorate in ground water		✓			✓	✓		
	Extraction and above ground treatment of uranium, nitrate, and perchlorate in ground water (alluvial and bedrock)			✓				✓	
	Subsurface treatment of alluvial ground water + extraction and above ground treatment of bedrock ground water				✓				✓
	Estimated 30-year cost of alternative	$0	$57M	$64M* to $68M**	$74M	$3.7M	$4.3M	$11M* to $15M**	$21M

* *Alluvial* and bedrock ground water removal using extraction wells only.
** Removal of *alluvial* ground water using *funnel and sump* and removal of bedrock ground water using extraction wells.

Table 3. Cleanup alternatives for the Pit 7 Complex.

Definition or descriptions of italicized words are provided in the Glossary on page 11.

identified by DOE/LLNL and the regulatory agencies as the preferred interim remedy for cleanup of the Pit 7 Complex. The cleanup alternatives that were evaluated in the Feasibility Study are summarized in Table 3. The estimated costs shown on the table are the sum of capital, operation, and maintenance costs over 30 years expressed as present-worth values. The costs of previous cleanup actions are not included in the estimates (i.e., landfill capping).

Alternative 1 is a no-action alternative that is required by EPA guidance to provide a baseline for comparison to other cleanup alternatives and is the basis of the baseline risk assessment. Under a no-action response, all monitoring and maintenance activities at the Pit 7 Complex would cease. Institutional controls that are already in place would provide a degree of protection to onsite workers by restricting access to or activities in certain areas of contamination. There are no costs associated with the no-action alternative.

Alternatives 2, 3, 4, and 5 all include monitoring of ground water, risk and hazard management, and *monitored natural attenuation* of tritium in ground water, as described below. These alternatives also include components to control the contaminant source and to address ground water contamination; however the methods to accomplish these goals differ as shown in Table 3 and discussed below.

Ground Water Monitoring

Ground water monitoring is a component of Alternatives 2, 3, 4, and 5. Sampling and analysis of ground water from *monitor wells* in the Pit 7 Complex area would continue to:

- Track changes in concentration and distribution of contaminants in ground water to ensure there is no impact to downgradient water-supply wells.
- Evaluate the effectiveness of the selected cleanup method in meeting remedial action objectives and the cleanup standards to be selected in the Final Site-Wide ROD.
- Verify the attainment of cleanup standards.

Risk and Hazard Management

The overall goals of risk and hazard management are to control exposure to contaminants and to ensure the interim remedy protects human health and the environment.

Institutional controls, such as restricting access to areas of contamination and measures to prevent people from drinking contaminated ground water, are the basis of risk management. DOE assumes that Site 300 will remain under its control, and the site access restrictions currently in place (fencing and security patrols) will continue for the foreseeable future. In the unlikely event that the property is transferred in the future, the interim remedy for the Pit 7 Complex will be re-evaluated and DOE will execute a land use covenant at the time of transfer in compliance with Title 22 California Code of Regulations, Division 4.5, Chapter 39, Section 67391.1.

Risk and hazard management is included in Alternatives 2, 3, 4, and 5.

Monitored Natural Attenuation of Tritium in Ground Water

Monitored natural attenuation allows contaminants to degrade naturally in the environment. For this approach to be implemented, appropriate long-term monitoring must be conducted, there must be no active source of contamination, and human health and the environment must be protected. A monitored natural attenuation remedy must also achieve cleanup in a timeframe comparable to active remediation. This method has proven effective for radionuclides with short half-lives, such as tritium. The half-life of tritium is 12.3 years, which means that the amount of tritium in ground water is reduced by half every 12.3 years due to radioactive decay.

Modeling results at the Pit 7 Complex show that monitored natural attenuation would reduce tritium activities in ground water to meet remedial objectives within a reasonable time frame (45 years). There are no water-supply wells near the tritium plume and modeling indicates that this plume will not impact any offsite water-supply wells. There are currently no effective or reasonable technologies available to clean up tritium in ground water. Monitored natural attenuation of tritium in ground water is included in Alternatives 2, 3, 4, and 5.

Contaminant Source Control

Because residual contamination is still present in waste in the Pits 3, 4, 5, and 7 landfills and the underlying bedrock, cleanup alternatives 2 through 5 contain measures to prevent further releases of contaminants from the landfills. The method of controlling or isolating the contaminant source differs in each alternative.

Definition or descriptions of italicized words are provided in the Glossary on page 11.

In Alternatives 2, 3a and 3b, the waste in Pits 3 and 5 would be excavated to prevent further releases. Unsaturated rock beneath the pits would not be excavated, as these materials are very hard and very deep and would require special excavation equipment and great expense. Waste in Pits 4 and 7 would not be removed because it has already been capped under the *Resource Conservation and Recovery Act*. The excavated waste from Pits 3 and 5 would be transported to an offsite disposal facility.

Under Alternative 4b, a *grout curtain* (hydraulic barrier) would be installed around the landfills to create a continuous vertical layer of impermeable material that would hydraulically enclose and isolate the landfills. The bottom of the grout curtain would key into impermeable bedrock below the landfills.

Alternatives 4a, 5a, and 5b include construction of an engineered drainage diversion system consisting of interceptor trenches composed of *French drains*, horizontal wells, and shallow terrace drains. These interceptor trenches would be constructed on the western slope above the Pit 7 valley where most of the rainwater infiltration occurs that leads to ground water *recharge* of alluvial/weathered bedrock *aquifer*. A concrete drainage channel would be installed on the eastern slope to divert runoff water from this rock slope before it could recharge the alluvial/weathered bedrock aquifer at the valley bottom. The engineered drainage system would prevent ground water from rising into the landfill waste by reducing the volume of rainwater that infiltrates and reaches the underlying aquifer. The resulting reduction in recharge to shallow ground water would also slow the migration of pre-existing ground water contamination in the area.

Ground Water Cleanup

Volatile organic compounds, tritium, uranium, nitrate, and perchlorate have been released from the Pit 7 Complex landfills and have impacted ground water in this area. Tritium in ground water is addressed by the monitored natural attenuation remedy component of Alternatives 2 through 5 as discussed in the "Monitored Natural Attenuation" section above. The technology used for the cleanup of volatile organic compounds, tritium, uranium, nitrate, and perchlorate in ground water is different for Alternatives 2 through 5, as described below.

Alternatives 2, 4a, and 4b utilize natural attenuation processes to reduce contaminant concentrations to drinking water standards. Modeling indicates that once the contaminant source is controlled, the concentrations of uranium and other contaminants of concern will be reduced to drinking water standards through natural processes within 400 to 500 years. There are currently no water-supply wells in the Pit 7 Complex area and ground water contains naturally high total dissolved solids which makes it an unlikely future source of drinking water. In addition, modeling has shown that ground water contamination will not migrate to existing water-supply wells during the time period necessary for contaminants to naturally attenuate to meet drinking water standards. Therefore, Alternatives 2, 4a, and 4b are capable of achieving applicable or relevant and appropriate requirements (ARARs) without impacting human health or the environment. However, the EPA and the State regulatory agencies do not believe that 500 years is an acceptable timeframe to achieve cleanup standards using monitored natural attenuation.

In Alternatives 3a and 5a, contaminated ground water will be removed from the alluvial sediments either by pumping from *extraction wells*, or by using a *funnel and sump* system. The funnel and sump system involves installing impermeable barriers (i.e., sheet pile walls) in the alluvial sediments to funnel ground water to a sump where it can be extracted for treatment. Extraction wells would be used to pump contaminated ground water from the shallow bedrock. The extraction wells or funnel and sump system would be placed within the areas where uranium, nitrate, and perchlorate concentrations exceed drinking water standards or other appropriate water quality objectives in ground water.

Ground water pumped from the extraction wells or sump would be treated in an aboveground treatment system designed to remove volatile organic compounds, uranium, nitrate, and perchlorate. Because there is currently no viable technology available to treat tritium in ground water, the treated water containing tritium would be reinjected into the alluvial aquifer near the ground water extraction location. Ground water in the alluvial aquifer at this location already contains tritium at activities above background levels. Treated water contaminated with tritium above background levels will not be disposed of or reinjected into pristine ground water outside of the tritium plume boundary. The wellfield design would maintain the volume of water being extracted out of and reinjected into the aquifer. This would prevent ground water from rising into the pit waste and causing additional releases of tritium. Safety precautions would be implemented to prevent exposure to tritium during the extraction and reinjection process.

In Alternatives 3b and 5b, contaminated ground water would be removed from the alluvial sediments using a subsurface *permeable reactive barrier*. A permeable reactive barrier is a trench excavated in the pathway of a contaminant plume that is filled with a substance designed to react with or sorb contaminants in ground water. As ground water passes through the barrier material, the contaminants are destroyed or altered to a non-hazardous substance or sorbed to the treatment media.

Definition or descriptions of italicized words are provided in the Glossary on page 11.

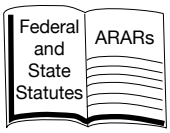
Evaluation of Alternatives

In the Feasibility Study for the Pit 7 Complex, the cleanup alternatives were evaluated using the EPA criteria shown in Figure 5. The Feasibility Study compared the cleanup alternatives by analyzing each alternative against the evaluation criteria, except for the public acceptance criteria that will be evaluated following the public review period. Using the results of this evaluation, DOE/LLNL compared the alternatives and identified a preferred interim remedy for cleanup of the Pit 7 Complex area. As specified by EPA, the two

Each alternative was assessed against the first eight CERCLA evaluation criteria described below. Using results of this assessment, DOE/LLNL, and the regulatory agencies compared the alternatives and selected a preferred alternative for the Pit 7 Complex. Community acceptance will be addressed after public comments have been received.

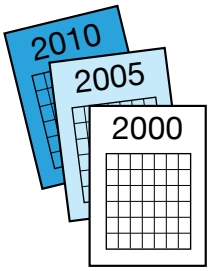
Threshold Criteria

1. **Overall Protection of Human Health and the Environment:** Addresses whether a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

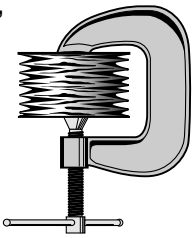


2. **Compliance with Applicable or Relevant and Appropriate Requirements (ARARs):** Addresses whether a remedy will meet all ARARs of Federal and State environmental statutes.

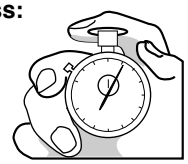
Balancing Criteria



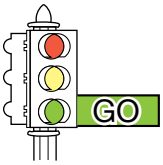
3. **Long-term Effectiveness and Permanence:** Refers to the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup goals have been met.



4. **Reduction of Toxicity, Mobility, or Volume Through Treatment:** Refers to the anticipated ability of a remedy to reduce the toxicity, mobility, or volume of the hazardous components present at the site.



5. **Short-term Effectiveness:** Addresses the period of time needed to complete the remedy, and any adverse impact on human health and the environment that may be posed during the construction and implementation period.



6. **Implementability:** Refers to the technical and administrative feasibility of a remedy, including the availability of materials and services needed to carry out a particular option.

7. **Cost:** Evaluates the estimated capital, and operation and maintenance costs of each alternative.

State/Community Acceptance Criteria

8. **State Acceptance:** Indicates whether, based on its review of the information, the State concurs with, opposes, or has no comment on the preferred alternatives.

9. **Community Acceptance:** Indicates whether community concerns are addressed by the remedy and whether the community has a preference for a remedy.

Figure 5. EPA Evaluation Criteria.

most important criteria are protection of human health and environment, and compliance with Federal and State applicable or relevant and appropriate requirements (ARARs).

Each cleanup alternative was assessed against the first eight CERCLA evaluation criteria described below.

Using results of this assessment, DOE/LLNL, and the regulatory agencies compared the alternatives and identified a preferred alternative for the site. The ninth criterion, community acceptance of this preferred alternative, will be addressed after public comments have been received.

Preferred Alternative

DOE/LLNL, U.S. EPA, RWQCB, and DTSC believe that Alternative 5a is the best cleanup alternative, considering the CERCLA evaluation criteria. While DOE and the regulatory agencies have concurred with the preferred remedy identification, final approval of the selected remedy will occur in the ROD Amendment, after public comments have been received and considered. Cleanup alternative 5a includes:

- Monitoring to determine if the cleanup is adequately protecting human health and the environment and to measure the progress of cleanup.
- Risk and hazard management to control exposure where an elevated risk to human health remains.
- Monitored natural attenuation to allow tritium in subsurface soil/rock and ground water to decline naturally.
- Installing an engineered drainage diversion system to isolate the contaminant sources in the landfills and underlying bedrock from subsurface water, preventing the percolation of rainwater runoff that can result in ground water rising into Pits 3, 4, 5, and 7 and releasing contaminants.
- Pumping and treating ground water to reduce contaminant concentrations in ground water to meet cleanup standards that will be selected in the Final Site-Wide ROD.

Because treatment of principal threat waste in the landfill is not practicable, engineered drainage diversion is used to control and contain the contaminant source. Institutional controls, such as access restrictions, will supplement the engineering controls to prevent exposure to contaminants.

What was the Rationale for Choosing the Preferred Remedy?

The key factors in identifying the preferred interim remedy for the Pit 7 Complex are summarized in Table 4. This table presents the results of the comparative evaluation of the alternatives considered for the Pit 7 Complex against the first eight EPA evaluation criteria (Figure 5).

Alternative number	Overall protection of human health and the environment	Compliance with Applicable or relevant and appropriate requirements (ARARs)	Long-term effectiveness and permanence	Reduction in toxicity, mobility, and volume (TMV)	Short-term effectiveness	Implement-ability	Net present worth cost	State accept-ance	Community† accept-ance
1.	○	○	○	○	◒	●	$0M	○	
2.	●	▨	◔	◔	◔	○	$57M	○	
3a.	●	◔	◔	◒	◔	○	$64M* to $68M**	◔	
3b.	●	◔	◔	◒	◔	○	$74M	◔	
4a.	●	▨	◒	◔	◒	◔	$3.7M	○	
4b.	●	▨	◒	◔	◒	◔	$4.3M	○	
5a. Preferred Alternative	●	●	◒	◒	●	◔	$11M* to $15M**	●	
5b.	●	●	◒	◒	◔	◔	$21M	◔	

Key: ○ Alternative fails to satisfy criterion; ● Alternative fully satisfies criterion; ◒ Alternative partially satisfies criterion; ▨ DOE and the regulatory agencies do not agree on the degree to which the alternative satisfies criterion

* Alluvial and bedrock ground water removal using extraction wells only.
** Removal of alluvial ground water using funnel and sump and removal of bedrock ground water using extraction wells.
† Community acceptance will be evaluated in the ROD Amendment after the conclusion of the public comment period.

Table 4. Comparative evaluation of cleanup alternatives for the Pit 7 Complex.

The preferred interim remedy meets the U.S. EPA threshold criteria of: (1) protecting human health and the environment, and (2) complying with applicable laws and regulations (Figure 5). The preferred interim remedy also provides the best combination of tradeoffs among the alternatives with respect to the balancing criteria.

Threshold Criteria

Protection of Human Health and the Environment and Compliance with ARARs
Alternative 1 (No Action) does not meet the threshold criteria. However, Alternative 1 was compared against the other EPA evaluation criterion for consistency with the Remedial Investigation/Feasibility Study. While DOE/LLNL believes that Alternatives 2, and 4 (a and b) protect human and the environment and are capable of meeting cleanup goals, the regulatory agencies do not believe the timeframes necessary to achieve these goals are reasonable. Alternative 3 may not be as effective in meeting cleanup standards (ARARs) as Alternative 5 because in Alternative 3 only the pit waste would be excavated and ground water could still rise into the contaminated bedrock underlying the pits and further degrade water quality.

Balancing Criteria

Long-term Effectiveness and Permanence
The treatment of uranium, nitrate, volatile organic compounds, and perchlorate under Alternative 5a would reduce contaminant concentrations to meet Federal and State cleanup standards and provide long-term and effective protection of human health and the environment. Alternative 5a would achieve these goals and control the migration of contaminants more rapidly than by natural attenuation only (Alternatives 2 and 4) or by treatment of ground water in the subsurface (Alternative 5b). The source control component of Alternative 5a would isolate contaminant sources in both the pit waste and vadose zone, but would not permanently remove the contaminated waste as would occur in Alternatives 3a and b. However, Alternatives 3a and b would not control contaminant sources in the vadose zone.

Reduction of Contaminant Toxicity, Mobility, or Volume
Alternative 5a would permanently remove volatile organic compounds, uranium, nitrate, and perchlorate from the subsurface and reduce their toxicity, mobility, and volume. The source control component of Alternative 5a would reduce the mobility of contaminants in the pit waste and shallow vadose zone by preventing further releases of contaminants. It would not reduce the toxicity or volume of the contaminants, as the contaminated waste would remain in place. While the excavation component of Alternatives 2, 3a, and 3b would reduce the mobility of contaminants of the pit waste, it would not reduce the toxicity or volume because the waste would be placed in an offsite landfill. In addition, excavation would not reduce the toxicity, mobility, or volume of contaminants remaining in unsaturated bedrock. Alternatives 2, 3, 4, and 5 all rely on natural attenuation to reduce the toxicity, mobility, and volume of tritium in ground water.

Short-term Effectiveness
Alternative 5a is effective in the short-term without impacting human health or the environment. The greatest potential for short-term exposure for workers and impacts to the environment could occur during the waste excavation and disposal included in Alternatives 2, 3a, and 3b. The treatment of uranium included in Alternatives 3a, 3b, 5a, and 5b poses a lesser potential for short-term and long-term exposures as contaminated ground water and spent treatment media are brought to the surface and disposed. Drinking water standards would be achieved more rapidly using Alternatives 3 and 5 than Alternatives 1, 2 and 4 due to the active rather than passive remediation of uranium.

Implementability
Alternative 5a is implementable using existing, proven technologies. The ground water monitoring and exposure control measures are largely in-place and functioning. Additional controls may be needed to prevent exposure to tritium and uranium during *ex situ* treatment of these contaminants. The excavation of landfill waste under Alternatives 2, 3a, and 3b is implementable but would require extensive provisions to prevent exposure and protect the safety of onsite workers, transport personnel, and the public during excavation and transport of the waste. Alternatives 1 and 4 are readily implementable as the monitoring network is in place and functioning.

Cost
Cost estimates for the alternatives were prepared for a 30-year timeframe. The estimated cost of Alternative 5a ($10.9 million [M]) is much lower than Alternatives 2, 3a, and 3b that include $54M to excavate the pit waste. Alternative 5a costs $6.6M to $7.2M more than Alternatives 4 but will achieve cleanup standards in ground water within a timeframe that is acceptable to the regulatory agencies. Alternative 5a costs $10M less than Alternative 5b to accomplish the same objectives.

Modifying Criteria

State Acceptance
The California Department of Toxic Substances Control and the Central Valley Regional Water Quality Control Board have reviewed the Remedial Investigation/Feasibility Study and this Proposed Plan for the Pit 7 Complex. This Proposed Plan is issued with

the concurrence of these State regulatory agencies.

Community Acceptance
Community acceptance will be evaluated after receipt of public comments. DOE, U.S. EPA, and the State regulatory agencies will review and consider public comments in the decision process for selecting the interim cleanup remedy for the Pit 7 Complex. Written and verbal comments given at the public meeting will receive equal consideration.

Based on information currently available, DOE believes Preferred Alternative 5a meets EPA's threshold criteria in that it will:
- Protect human health and the environment, and
- Comply with State and Federal laws and regulations (ARARs).

Preferred Alternative 5a also provides the best balance of the EPA's other evaluation criteria in that it will:
- Provide a long-term, permanent solution to contamination.
- Reduce the toxicity, mobility, and volume of the contaminants of concern in a reasonable timeframe.
- Address any adverse impacts on human health and the environment during construction and implementation of the interim remedy.
- Be cost effective compared to other alternatives.

Who do I contact for more information?

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Where are the information repositories?

Copies of the Pit 7 Complex Remedial Investigation/Feasibility Study and other documents for the LLNL Site 300 Environmental Restoration Project are available at:

LLNL Visitors Center
Enter from Greenville Road
Livermore, CA 94551
(925) 422-9797

Tracy Public Library
20 East Eaton Avenue
Tracy, CA 95377
(209) 835-2221

Both this Proposed Plan and Pit 7 Complex Remedial Investigation/Feasibility Study are available on the LLNL Environmental Public Information website: http://www-envirinfo.llnl.gov

Glossary

Alluvial: Deposited by flowing water, as in a streambed.

Applicable or Relevant and Appropriate Requirements (ARARs): CERCLA requires compliance with any promulgated standard requirements, criteria, or limitation under Federal and State environmental laws.

Aquifer: Rock that is saturated with ground water and is sufficiently permeable to allow the movement of ground water through the rock pore spaces or fractures.

Baseline risk assessment: An evaluation of the risk that would be posed to human health and/or the environment by exposure to contaminants at a site if no cleanup activities were performed.

CERCLA: The Comprehensive Environmental Response, Compensation and Liability Act is a law that authorizes the Federal government to respond directly to releases of hazardous substances that may endanger public health or the environment.

Contaminants of concern: Chemicals, metals, or radioactive constituents present in surface soil, subsurface soil/rock, surface water, or ground water as a result of site activities that: (1) pose an unacceptable risk to human health or the environment, (2) could impact ground water, or (3) exceed regulatory standards for ground water. Because cleanup standards have not yet been selected for ground water contamination at Site 300, all constituents with concentrations exceeding background in ground water are listed as a contaminant of concern to comply with the State Water Resources Control Board's Resolution 92-49 (Anti-degradation policy).

Depleted uranium: The less radioactive residue (predominantly uranium-238) remaining after the highly reactive radioactive component (uranium-235) is removed from uranium ore for use in energy and weapons applications.

Extraction well: A well from which contaminated ground water is extracted or pumped from the ground for above ground treatment.

Feasibility Study: A process used to: (1) establish site cleanup objectives, (2) screen technologies that could be used for site cleanup, (3) assemble the selected technologies into alternatives for site cleanup, and (4) evaluate the alternatives using the U.S. EPA evaluation criteria.

French drain: A trench filled with gravel, rock, or perforated pipe that redirects surface or ground water away from an area.

Funnel and Sump: A ground water extraction technology that involves installing impermeable barriers (i.e., sheet pile walls) in the alluvium to funnel ground water to a collection point (or sump) where it can be extracted for treatment. Extraction wells are used to pump contaminated ground water for aboveground treatment.

Grout curtain: A wall or barrier composed of impermeable material (such as bentonite clay) installed below ground surface to prevent the horizontal flow of ground to isolate or control contamination.

Monitor well: Well from which ground water or soil vapor samples are collected and analyzed to determine the presence and concentration of contaminants.

Monitored Natural Attenuation: Naturally occurring processes, such as radioactive decay or degradation by microorganisms, that transform hazardous substances into less toxic or non-toxic substances.

National Oil and Hazardous Substances Pollution Contingency Plan: (Also known as the National Contingency Plan): Federal regulations that provide the procedures for preparing for and responding to discharges of oil and releases of hazardous substances, pollutants, and contaminants.

Permeable reactive barrier: A long, narrow trench filled with reactive material (called a barrier) constructed below ground in the path of polluted ground water. The barrier is permeable, which means it has tiny holes that allow ground water to flow through it. Reactive materials in the barrier trap contaminants or change them into harmless byproducts.

Principal Threat Waste: Contaminant source material that is highly toxic or highly mobile that cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.

Public Health Goals: Levels of contaminants in drinking water established by the State of California that would pose no significant health risk to people using the water on a daily basis over a lifetime.

Recharge: Replacement or replenishment of ground water by water infiltrating into the subsurface from rain or surface water.

Record of Decision (ROD): A legal document that is signed by the site's responsible party (DOE), the U.S. EPA, and the State regulatory agencies that provides the actions for cleaning up a CERCLA Superfund site.

Remedial Investigation: A process used to identify: (1) contaminants released at a site, (2) media (i.e., soil, rock, ground and surface water) that have been impacted, (3) how far contamination has spread, and (4) potential impacts to human health or the environment as a result of exposure to contamination.

Resource Conservation and Recovery Act: Federal legislation approved in 1976 to regulate the management of hazardous wastes as they are produced.

Tritium: Common name for hydrogen-3, a radioactive isotope of hydrogen. Although tritium can be a gas, its most common form is in water, because, like non-radioactive hydrogen, radioactive tritium reacts with oxygen to form tritiated water. Tritium replaces one of the stable hydrogens in the water molecule, H_2O, and is called tritiated water. Like “normal” water, tritiated water can evaporate to the atmosphere as a gas.

Water quality objectives: Limits or levels of water constituents or characteristics established by the State of California for the reasonable protection of the beneficial uses of water.

Volatile organic compounds: Chemical substances that tend to evaporate easily at room temperature. Some familiar substances containing volatile organic compounds are solvents, gasoline, paint thinners, and nail polish remover.

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