Source Reduction Evaluation Review and Plan
For the DOE California Sites
U.S. Department of Energy (DOE)

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Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

I. Introduction

The Department of Energy (DOE) is the owner of multiple facilities in Northern California. The facilities include Lawrence Livermore National Laboratory (LLNL), Lawrence Berkeley National Laboratory (LBNL), Sandia National Laboratories/California (SNL/CA) and SLAC National Accelerator Laboratory (SLAC) among other sites. Through their operations, the facilities generate hazardous waste and, thereby, are subject to the requirements of Chapter 31 of the Title 22 California Code of Regulations, Waste Minimization. The Northern California sites are primarily research and development facilities in the areas relating to national security, high-energy physics, bioscience and the environment.

Lawrence Livermore National Laboratory: LLNL is managed and operated by the Lawrence Livermore National Security (LLNS) for the DOE. LLNL includes two sites, Livermore Site (Site 200) and Site 300. The Livermore Site is located in Livermore and covers approximately one square mile in Alameda County. Site 300 is approximately ten square miles and is near the City of Tracy in San Joaquin County and Alameda County. LLNL was established in 1952 and employs approximately 7,400 employees and contractors. LLNL is a large quantity hazardous waste generator and operates hazardous waste treatment, storage and disposal facilities under hazardous waste treatment and storage permits at the Livermore site and site 300. LLNL also operates hazardous waste treatment units at Livermore site under the California Tiered Permit Program.

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EPA ID #	Livermore Site:	CA2890012584
	Site 300:	CA2890090002

The address is:
Lawrence Livermore National Laboratory (Main Site)
7000 East Avenue L-626
Livermore, CA 94550-9234
SIC Code: 8733, 9611
NAICS: 54171, 928110, 541380

Lawrence Livermore National Laboratory Site 300
Corral Hollow Road
Tracy, CA 95376
SIC: 8733, 9611
NAICS: 92811, 54171, 541380, 928110

Lawrence Berkeley National Laboratory (Berkeley Lab) is located on a 202-acre site in the hills above the UC Berkeley campus. Berkeley Lab is a U.S. Department of Energy (DOE) research facility operated by the University of California (UC). Established in 1931 by Ernest Orlando Lawrence, Berkeley Lab has been awarded 13 Nobel Prizes for achievements in multiple fields of scientific research. Currently, the Lab employs approximately 3,816 permanent employees, 457 students, 441 post-doctorates and many visiting scholars.

The multidisciplinary research in energy sciences, general sciences, biosciences, and computing sciences conducted at the facility, as well as facility operation, maintenance, construction, and demolition activities, results in the production of various wastes. The Berkeley Lab main site is classified as a large-quantity generator and operates a hazardous waste storage facility under one hazardous waste treatment and storage permit. Berkeley Lab also operates hazardous waste treatment units under the California Tiered Permit Program.

Contact Person: David Kestell, Department Head, Environmental, Waste and Radiation Protection

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The address is:
Lawrence Berkeley National Laboratory
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SIC Code: 9611, 8733
NAICS: 54171

SLAC National Accelerator Laboratory: SLAC is managed and operated by Stanford University under contract with DOE. The site occupies 426 acres and is located in the City of Menlo Park in San Mateo County. Today, SLAC is a multipurpose national laboratory with strong programs in cosmology, chemistry, biology, materials science and energy research, leveraging the lab's historical strength in particle physics and accelerator research to power discoveries across an even greater range of scientific disciplines. SLAC operates the world's first hard X-ray free-electron laser, which generates light of unprecedented brilliance that enables the capture of atomic-scale snapshots. SLAC also helps companies use synchrotron radiation to design better pharmaceuticals, stronger materials and more efficient sources of energy, and continues to build on a solid foundation in particle physics to peer into the farthest reaches of the universe, using ever more sophisticated tools and techniques.

SLAC was established in 1962 and employs 1,600 full-time employees. It is recognized internationally with 4,000 visiting scientists from US universities, national laboratories, industrial concerns and foreign countries. SLAC is a large quantity hazardous waste generator (a 90-day waste accumulation facility) and operates hazardous waste treatment units under the California Tiered Permit Program. SLAC is not an operator of a treatment, storage, and disposal facility.

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SLAC National Accelerator Laboratory
2575 Sand Hill Road
Menlo Park, CA 94025
SIC Code: 9611, 8733
NAICS: 541712

Sandia National Laboratories/California: Sandia National Laboratories is a multi-mission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. The SNL/CA site occupies approximately 410 acres in the City of Livermore in Alameda County. It was established in 1956 and employs approximately 1,600 employees, contractors and interns. SNL/CA is a large quantity hazardous waste generator and operates a hazardous waste storage facility under a hazardous waste treatment and storage permit. SNL/CA also operates hazardous waste treatment units under the California Tiered Permit Program.

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Livermore, CA 94551-0969
SIC Code: 9611, 8733
NAICS: 92811

The DOE Livermore Site Office has prepared this multi-site Plan, Progress Report and Summary Progress Report in accordance with the requirements of Chapter 31 of the Title 22 CCR and Guidance Manual for complying with the Hazardous Waste Source Reduction & Management Review Act of 1989, dated December 2010. The reporting year for this document is calendar year 2018 and the baseline year is 2014.

For preparation of the Plan in this document, routine hazardous wastes generated in calendar year 2018 at each site were considered separately to identify the “major” waste streams. Routine waste streams were separated into Category A, B and C waste streams.

Table 1, Total routine hazardous waste, including Category A, B & C wastes, generated in CY 2018

	Sites			
Hazardous Waste Generated	LLNL	SNL/CA	SLAC	LBNL
Category A	258,464	43,959	500,781	3,876,780
Category B	126,727 + 852,409[1]	87,453	36,281	68,944
Category C	231	0	693	18
Total	1,237,833	131,412	537,755	3,945,742

Quantity in pounds

[1] Aqueous waste that is treated and reclaimed for reuse on site. Because this single waste stream is so large, it was excluded when calculating total LLNL Category B wastes so as not to dwarf other waste streams of significance.

Category A waste streams consist of wastes that were processed through an on-site wastewater processing unit and discharged to a publicly owned treatment works. Major Category A waste streams were identified for California Waste Codes (CWCs) that consisted of five percent or more of Category A and Category B waste streams combined.

Table 2, Major Category A waste streams generated in CY 2018 for each Site

	Sites			
CWC	LLNL	SNL/CA	SLAC	LBNL
132	258,464	--	500,781	--
134	--	--	--	--
791	--	43,959	--	3,849,424

Quantity in pounds

Category B wastes streams include all other hazardous wastes except for extremely hazardous waste streams. Major Category B waste streams were waste streams that consisted of five percent or more of the total Category B wastes streams.

Table 3, Major Category B waste streams generated in CY 2018 for each Site

	Sites			
CWC	LLNL	SNL/CA	SLAC	LBNL
122	11,755	9,700		
132	24,571	--	--	--
134	852,409[1]	--	--	--
135	11,408	11,021	--	--
181	22,026	12,077	7,431	3,895
221	11,762	--	12,555	6,732
223	16,827	20,795	16,295	--
343	9,154	--	--	--
352	10,234	4,756	--	8459
551	--	13,221	--	9,582
741	--	--	--	9,285
751	8,990	--	--	--
792	--		--	3,112

Quantity in pounds

[1] Treated and reclaimed for reuse on site.

Category C waste streams were all the routine extremely hazardous waste streams. Major Category C waste streams were CWC-identified waste streams that consisted of five percent or more of the total Category C waste streams.

Table 4, Major Category C waste streams generated in CY 2018 for each Site

	Sites			
CWC	LLNL	SNL/CA	SLAC	LBNL[1]
135	34	--		--
141	124	--	--	10
181	--	--	693	--
331	--	--	--	7
551	--	--		1
791	73	--	--	--

Quantity in pounds

[1]LBNL generated less than 24 lb of Category C waste streams in 2018, therefore, it will be omitted from the rest of this report.

As mentioned above these DOE sites are primarily research and development facilities. Each site generally contains many small laboratories that conduct academic research. The research projects vary in duration and span a wide variety of areas. In contrast to manufacturing facilities or continuous processes, the waste generated is varied and sometimes in small quantities. Therefore, even though this document breaks down the waste streams based on CWC, as required by the regulations, the quantities of waste within one waste code category could be from many different locations and dissimilar processes. Because of the nature of work at the sites, it is not always economically feasible to try to implement source reduction measures for every process that generates a portion of the identified major waste stream. This document identifies those processes that generate major portions of the waste within an identified major waste stream and evaluates source reduction opportunities for the waste generating process.

Many of the activities that generate hazardous waste under a specific CWC are from different processes, as well as from many different users. To help focus on reducing major hazardous waste streams in a systematic approach, SLAC applied the Pareto Principle to filter out its larger waste-generating departments associated with major waste streams. The Pareto Principle helped identify the top 20 percent of the SLAC departments that generated 80 percent of the hazardous waste. The top waste-generating departments were given additional review to determine how they contributed to the generation of the major waste stream.

If there were many small generators of a given major waste stream, consideration was also given to providing a generalized measure that could apply to all of these generators, rather than trying to be process-, operation-, or activity-specific.

The Plan part of this document is organized by CWC; and where possible the common information about a particular CWC for different sites has been described in one section. The CWC-specific sections include the following information:

- Generating site(s),
- Calendar year 2018 waste generation quantities in pounds (lb),
- A block process or flow diagram for waste generating and/or handling processes,
- A narrative explanation of the generating process including identification of hazardous characteristics and hazardous constituents where necessary,
- An explanation of waste reduction/pollution prevention activities to date,
- An evaluation of planned waste reduction/pollution prevention activities for the next four years.

Where appropriate, each waste reduction/pollution prevention activity evaluation includes the following:

- Description of source reduction measure,
- Technical feasibility,
- Economic feasibility,
- Evaluation of effects in product quality,
- Evaluation of effects on employee health and safety,
- Federal, state and local regulatory agency requirements,
- Discussion of releases and discharges,
- Evaluation of effects on land, water and air, and
- Schedule for implementation.

The evaluation of source reduction measures considered the following approaches:

- Input changes,
- Operational improvements,
- Production process changes,
- Product re-formulation, and
- Administrative steps.

II. CATEGORY A Waste Streams

Category A waste streams are defined as “Hazardous wastes that are processed through an on-site wastewater treatment unit prior to discharge to a publicly owned treatment works (POTW) or to a receiving water under a National Pollution Discharge Elimination System (NPDES) permit.”

1. CWC 132: Aqueous Solutions with Reactive Anions with Metals

Site	2018 quantity (lb)
SLAC	500,781
LLNL	258,464

1.1 Rinse Water from Copper Cyanide Plating - Metal Finishing Operations

Site	2018 quantity (lb)
SLAC	500,781

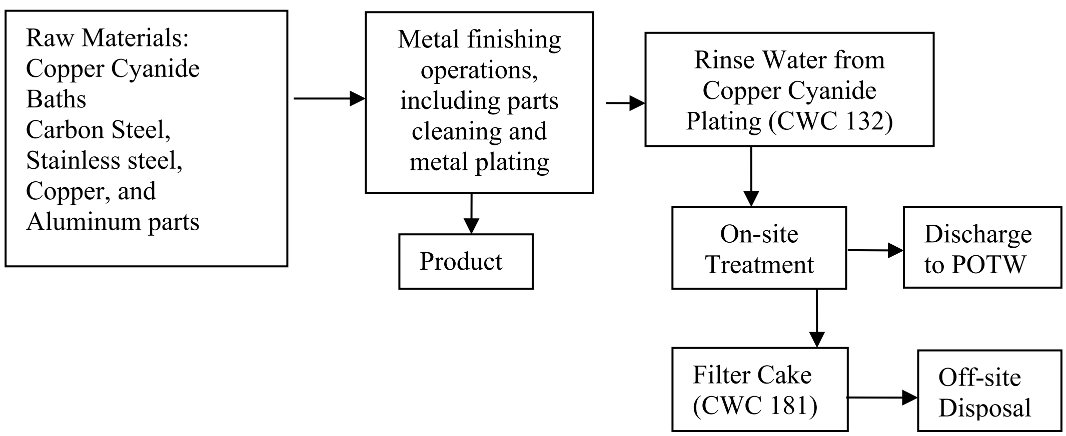

FIGURE II.1.1: METAL FINISHING PROCESS WASTE GENERATION PROCESS

Hazardous Waste and Process Description

The hazardous waste is rinse water containing drag-out of the copper cyanide plating bath. The process is the plating of parts dipped in the copper cyanide plating bath. An overview of metal finishing operations is provided below to give some background information on the generation of this hazardous waste and on the supporting processes and operation that are associated with this waste.

The Metal Finishing Operations Group (MFO) in the SLAC Mechanical Fabrication Department (MFD) performs plating of carbon steel, stainless steel, copper, and aluminum parts and uses several processes for cleaning and plating of metal parts. The process operations are rarely mass production-oriented. Instead, MFO operates on a job-shop or small-batch basis. Parts are subjected to several process steps, depending on the substrate metal and the plating that is added to the substrate surface. Typical process steps include chemical cleaning of materials for ultra-high vacuum such as copper, stainless steel, aluminum, molybdenum, inconel, beryllium copper, delrin, ceramic-to-metal feedthroughs, welded bellows, copper-gold alloy, titanium, tantalum, Teflon, phosphorous bronze, niobium, ceramics, glass [alkaline cleaning to remove organics, acid cleaning to remove oxidation, electroplating or electroless plating, and drying], bead or sand blasting to remove scale, vapor degreasing to remove machining oils and other organics. Metals that are plated by MFO include mainly copper, nickel, tin, rhodium, indium, silver, and gold. The process steps employed depend on the surface finishing specifications required of the research being performed and the application of the equipment being fabricated.

MFO has traditionally used copper cyanide to plate parts, for example, in the high-voltage klystrons used in the two-mile linear accelerator at SLAC. Copper cyanide plating provides unique coating properties that are not readily replicated with non-cyanide copper plating baths. MFO also uses its cyanide plating capabilities to support other national laboratory research throughout the country. Other laboratory researchers have also requested copper cyanide in their surface finishing specifications.

After the parts are immersed in the cyanide bath, they are handled carefully to reduce drag-out before the parts are immersed in a single-stage rinse water bath. The rinse water is treated on-site in batch mode in treatment tanks, using a conventional, two-step alkaline and sodium hypochlorite oxidation process to destroy the cyanide.

After the cyanide destruction processing, the treated rinse water is forwarded to the Metal Finishing Pretreatment Facility (MFPF), a conventional pH adjustment-flocculation-sedimentation pretreatment system of tanks, to precipitate and remove the copper and other heavy metal before discharging the treated water to the sanitary sewer. This cyanide rinse water is considered Category A because it is treated on-site and treated water is discharged to the POTW. The water is treated to meet discharge requirements of the POTW under the Clean Water Act.

The copper is precipitated and collected in a settling tank in the form of a metal hydroxide sludge in the MFPF. The sludge is concentrated in a filter press to form a filter cake. The filter cake is dried and packaged for shipment to an off-site, permitted treatment, storage and disposal facility. The copper cyanide treatment process, the MFPF, and the sludge drying processes are authorized to operate under the California Tiered Permitting program.

MFO also works with gold and silver cyanide baths. Drag-out and rinse waters are typically minimal, as the parts being plated tend to be small. As a result, drag-out and rinse waters are returned to the bath to conserve gold and silver use, eliminating the need for treatment of a rinse water waste stream. This approach is not as easily done with copper cyanide, since the parts can be larger in size and bath integrity can be more difficult to control.

<u>Hazardous Waste Management Approaches</u>
Source reduction measures implemented to date include careful monitoring of all the baths, including cyanide baths, to prolong their useful life.

Alternative measures in the form of operation changes, such as using a countercurrent rinse bath, are not technically feasible due to space limitations. Some efforts have been made in the last four years to consolidate larger jobs requiring copper cyanide plating so that the baths are further used to their full extent before requiring replacement.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
<u>Description of Measure:</u> A major source reduction measure that has been considered is the replacement of cyanide copper plating with a non-cyanide copper alternative. In 2010, SLAC has had a third-party consultant review the options for replacement of cyanide baths in SLAC metal finishing operations. The resulting review did not identify and clear alternatives but recommended considering bench-scale testing of alternative non-cyanide plating chemicals offered by vendors. This is expected to be a research project in itself that requires fabrication and plating of actual parts to meet and gain approval by the SLAC research community. Application of non-cyanide plating alternatives will be considered on a case-by-case basis to test fabricated parts in both cyanide and non-cyanide plating applications, and to see if non-copper cyanide techniques can meet specifications. SLAC will continue to review opportunities in the replacement of cyanide baths after 2020. Over the last several years, SLAC has had significant major construction projects, including LCLS-II. The MFO has been very hard at work on providing 100% collaborative manufacturing services to LCLS-II, a revolutionary new X-ray that will be the forefront of X-ray science. LCLS-II first light is expected in the fall of 2020.

1.2 Tank Farm Aqueous Solution Treatment

Site	2018 quantity (lb)
LLNL	258,464

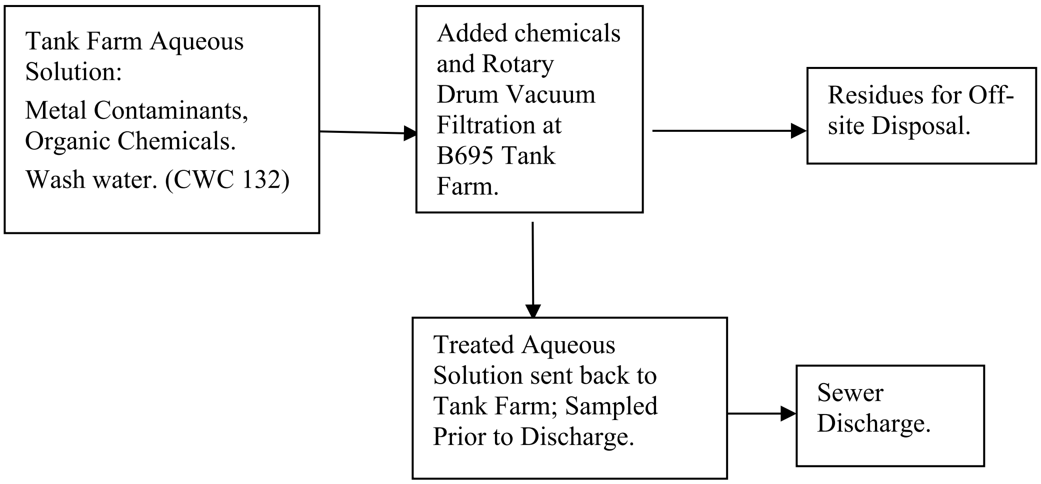

FIGURE II.1.2: CWC 132 PROCESS FLOW DIAGRAM FOR TANK FARM AQUEOUS SOLUTION TREATMENT PROCESS

Compatible aqueous solutions generated from various LLNL programmatic activities and operations such as debris washing, sample preparation and analysis and equipment maintenance and cleanout are consolidated at the B695 Tank Farm for treatment.
The treatment process involves addition of appropriate treatment chemicals followed by filtration using a rotary drum to separate solids from liquids. The liquid portion of the waste is tested to ensure it meets POTW discharge limits prior to discharging to the sanitary sewer. Residual solids are sent offsite for disposal.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: The volume of waste received into the Tank Farm for processing is dependent on the volume of programmatic wastes generated. As such, there are no direct opportunities for reducing the volume received. However, Tank Farm operators minimize rinse water used in the rotary drum unit, and spill controls are in place to minimize further waste generation.

2. CWC 791: Liquids with pH≤2

Site	2018 quantity (lb)
SNL/CA	43,959
LBNL	3,849,424

2.1 Microstructures Laboratory

Site	2018 quantity (lb)
SNL/CA	43,959

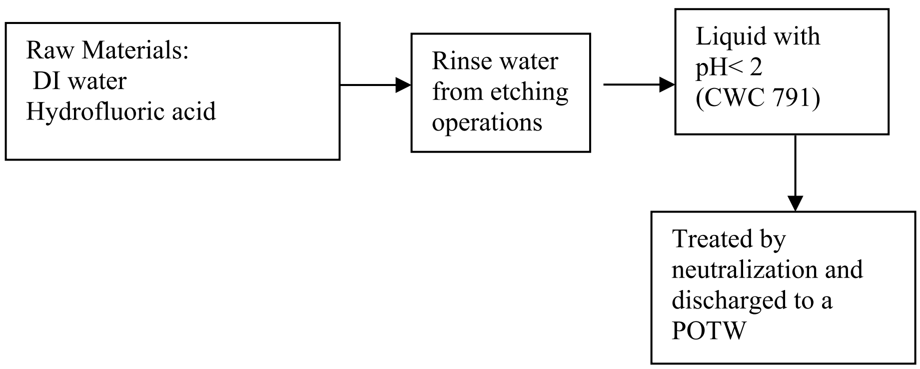

FIGURE II.2.1: MICROSTRUCTURE LABORATORY WASTE GENERATION PROCESS

The Microstructures Laboratory is a multi-discipline clean room facility used to conduct research in semiconductor micro-fabrication processing technology. The Microstructures Lab is dedicated to the fabrication of small electronic, mechanical, optical and flow system devices and experiments in Material Science. These devices are fabricated using photolithography, vacuum thin film deposition, spin casting, chemical vapor deposition, wet chemical and dry plasma etching.

Operations that generate waste water to the Liquid Effluent Control System (LECS) include rinsates from the Building 968 Neutralization Unit. This waste is generated from wet etching and from photolithographic developing. Other waste water discharges include washing/rinsing of laboratory glassware, utensils, and finally drainage from our wafer dicing saw and spin rinse/dryers.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
<u>Description of Measure:</u> None identified. SNL/CA has experienced a significant decrease in work requiring process water in the clean room. The principal investigator provides water conservation training and awareness to all clean room users as well as providing suggestions of how to minimize producing excess rinse water. Users continue to

conduct initial washing and rinsing of glassware and utensils over the bath and the second (final) rinse at the sink. This measure reduces the volume of water used for washing and rinsing of glassware and utensils significantly.

2.2 Acid Neutralization

Site	2018 quantity (lb)
LBNL	3,849,424

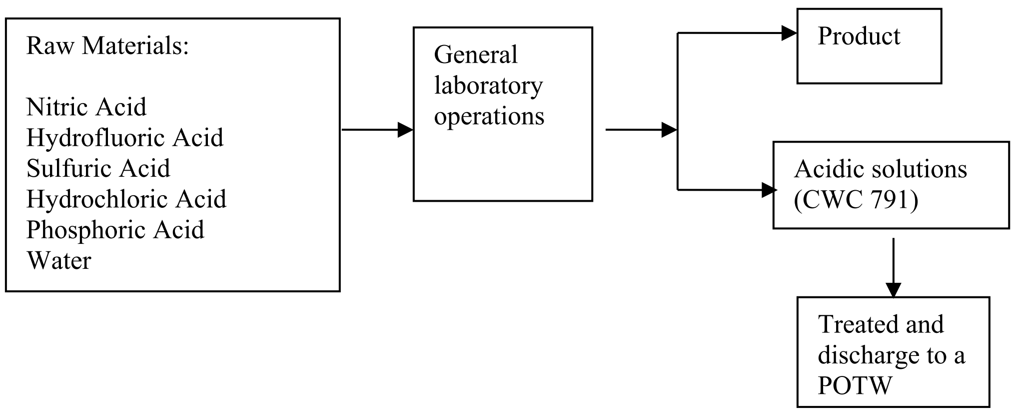

FIGURE II.2.2: BUILDING 2, BUILDING 70A AND BUILDING 67 GENERAL LABORATORY WASTE GENERATION PROCESSES

This waste stream consists of acidic wastewaters, and is generated as a result of metal and electronic parts cleaning operations. The waste stream is generated primarily in three research buildings, Building 2 Chemical Science and Material Science Divisions, Building 67 Molecular Foundry, and 70A Engineering and Chemical Science Divisions where wastewater from multiple sinks in different laboratories is collected in a retention tank.

The wastewater is subsequently neutralized and discharged to a POTW. The neutralization process is authorized by California Tiered Permitting program under Conditional Authorization.

The quantities of this waste stream increased due to maintenance issues in October 2018. LBNL will continue to review and investigate source reduction opportunities, however, there are no other source reduction activities planned at this time.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: LBNL will continue to investigate source reduction opportunities, however, there are no source reduction activities planned at this time.

III. Category B Waste Streams

Category B waste streams are defined as "All other hazardous wastes, including waste shipped off-site for treatment, recycling or disposal, manifested waste, and waste that is treated or disposed on site."

1. CWC 122: Alkaline solution without metals (pH ≥ 12.5)

Site	2018 quantity (lb)
LLNL	11,755
SNL/CA	9,700

1.1 <u>CWC 122 – NIF B391 Grating Debris Shield (GDS) Optics Processing</u>

Site	2018 quantity (lb)
LLNL	6,013

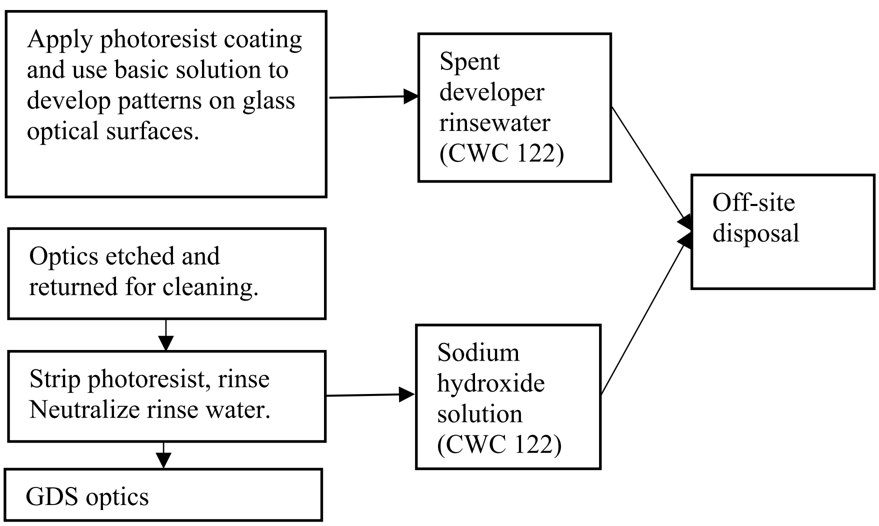

FIGURE III.1.1: NIF B391 GRATING DEBRIS SHIELD (GDS) OPTICS PROCESSING

This process generates two CWC 122 waste streams. First, the optics are prepared for etching by applying a photoresist coating, which is developed using an alkaline solution. An acid is then used to etch the pattern into the optics. The photoresist film is stripped from the optics using an NaOH solution and the generated rinse water is neutralized in an automated batch neutralizer. Spent developer and NaOH solution is sent for off-site disposal. During 2018, 1,765 lbs. of spent developer rinse water and 4,248 lbs. of NaOH solution were generated.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION

Description of Measure:
Sodium hydroxide used for stripping is being reused for all optics processed the same day. On a typical day, stripping 2-3 optics would generate 3 to 4.5 gallons of NaOH waste. Reusing the stripper reduces the NaOH waste generated to only 1.5 gallons per day. No other source reduction measures are planned at this time.

1.2 CWC 122 – NIF B392 Aqueous Basic Solution Rinse from Optics Cleaning Operation

Site	2018 quantity (lb)
LLNL	3,034

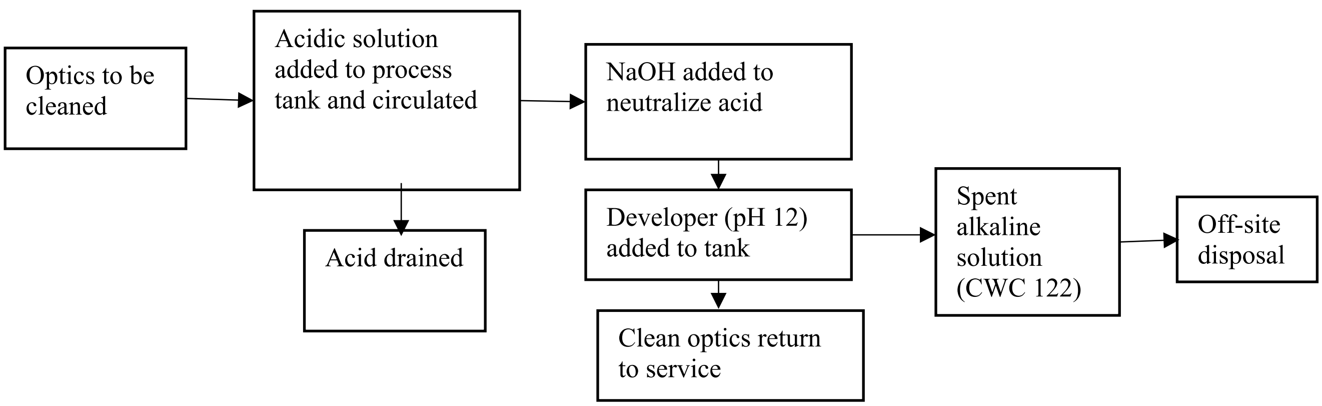

FIGURE III.1.2: NIF B392 AQUEOUS BASIC SOLUTION RINSE FROM OPTICS CLEANING OPERATION

This process removes surface contaminants from etched optics using an acid cleaning station. Optics to be cleaned are transferred to the station and an acid solution is introduced into the process tank. The liquid is circulated to clean the optics and the acid is then drained. NaOH is added to the tank to neutralize any remaining acid, the optics are rinsed and the solution is drained. Finally, an alkaline developer solution is added and the optics are rinsed again. The aqueous basic solution from the neutralization and developer steps is sampled and either sent out as hazardous waste or discharged to sanitary sewer, depending on the analytical results and environmental approvals.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: LLNL plans to continue with current source reduction measures, disposing of the aqueous waste offsite only when analytical results indicate that the wastewater cannot be discharged to sanitary sewer. No other source reduction measures are planned at this time.

1.3 CWC 122 – Building 943 Surface Cleaning Operations

Site	2018 quantity (lb)
SNL/CA	9,700

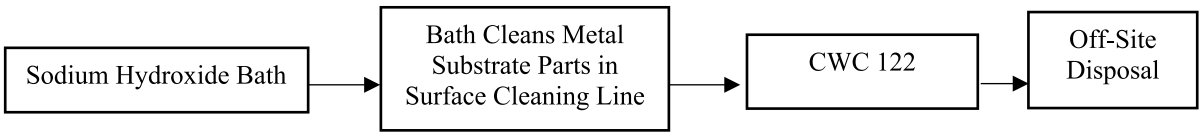

FIGURE III.1.3: BUILDING 943 SURFACE CLEANING OPERATIONS PROCESS

The Building 943 Surface Cleaning Operations provides surface cleaning services in support of SNL/CA site-wide weapon programmatic requirements. Based on customer specifications and metal substrate, various chemicals are used during the surface cleaning process.

The Building 943 Surface Cleaning Operations continually monitors the baths to prolong the usefulness and life of the bath.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure None identified. This waste stream is generated from the Building 943 Surface Cleaning Operations. The surface cleaning operation saw a significant increase in their workload (approximately 30%) in CY18 due to an increase in DOE programmatic work. The increase in the workload resulted in the surface cleaning baths needing to be changed out more frequently.

2. CWC 132: Aqueous Solution With Metals

Site	2018 quantity (lb)
LLNL	24,571

2.1 CWC 132 – Engineering (321A Main Bay) Coolant from Machining Operations

Site	2018 quantity (lb)
LLNL	5,554

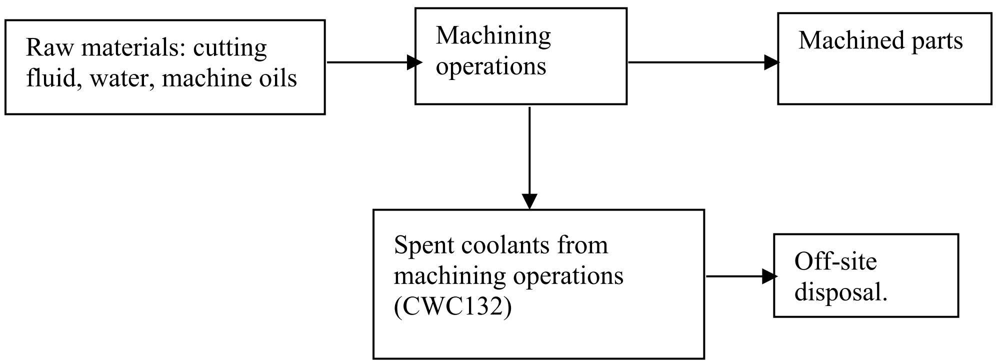

FIGURE III.2.1 ENGINEERING (321A MAIN BAY) COOLANT FROM MACHINING OPERATIONS

Oil from machining operations can intrude into the coolant over time and cause the coolant to become contaminated. A skimmer or disk is used periodically to skim off the oil, along with some of the coolant. The residue is then collected for disposal.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: Engineering 321A Main Bay is switching to a new type of coolant and is implementing a filtration system in 2019. These changes are anticipated to reduce the amount of CWC 132 waste generated from Main Bay machining operations.

2.2 CWC 132 – Engineering (321, 321C) coolant from machining operations

Site	2018 quantity (lb)

LLNL	5,405

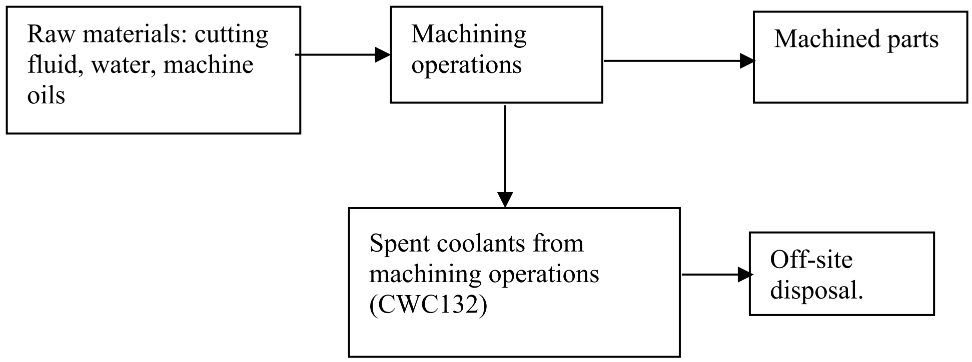

FIGURE III.1.1 ENGINEERING (321, 321C) COOLANT FROM MACHINING OPERATIONS

Oil from machining operations is usually in the form of soluble oil that is mixed with water and acts as a coolant for parts and tools in machining processes. In addition, non-soluble oils, usually called "tramp oils" are generated from lubrication of mechanical parts in the machine, such as gears and sliding worktables.

Acquisition of numerically controlled machines, which internally recycle and filter the cutting fluid will continue to help reduce machining coolant waste in the future for comparable production levels. In addition, LLNL utilizes alternative cutting technologies such as high-power water jet machining.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: LLNL plans to continue to upgrade and expand capacity with machines with more modern internal coolant recycling systems. No other source reduction measures are planned at this time.

3. CWC 134: Aqueous Solution With Total Organic Residues Less Than 10 Percent

Site	2018 quantity (lb)
LLNL	852,409

3.1 B322 Plating Shop Rinsewater Recycling

Site	2018 quantity (lb)
LLNL	852,409

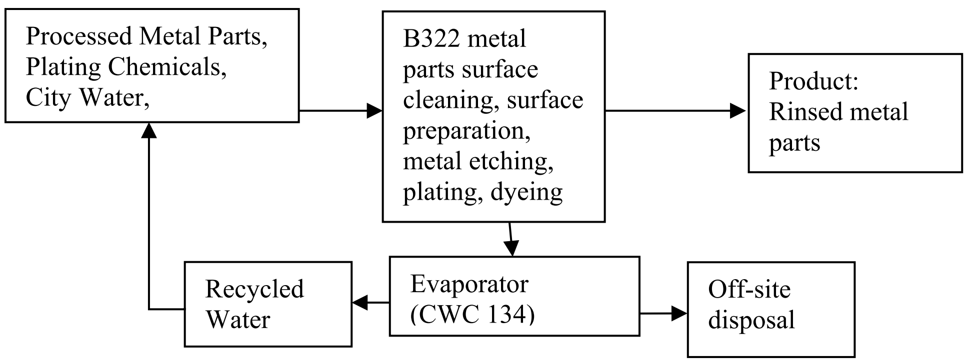

FIGURE III.3.1: PLATING SHOP FLOW DIAGRAM FOR RECLAIMED RINSE WATER PROCESS

Water generated from the rinsing of parts in the B322 plating shop is typically contaminated with organic chemicals and hazardous metals used in plating operations.
While the shops employ pollution prevention measures to minimize wastewater generation during rinsing operations by using spray rinsing of parts rather than drag out rinsing, this is still one of the largest hazardous waste streams at LLNL. However, the bulk of this waste stream is reconditioned and recycled through B322 evaporator unit. Because this single waste stream is so large, it was excluded when calculating LLNL Category B wastes so as not to dwarf other waste streams of significance.

The volume of waste is dependent on workload and can vary from year to year.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
<u>Description of Measure:</u> LLNL plans to continue with current source reduction measures using the evaporator to reclaim rinse water and return it back to the plating shop for reuse as a water conservation measure. No other source reduction measures are planned at this time.

4.0 CWC 135: Unspecified Aqueous Solution

Site	2018 quantity (lb)
LLNL	11,408
SNL/CA	11,021

4.1 CWC 135 – B391 HF etching solution

Site	2018 quantity (lb)
LLNL	10,717

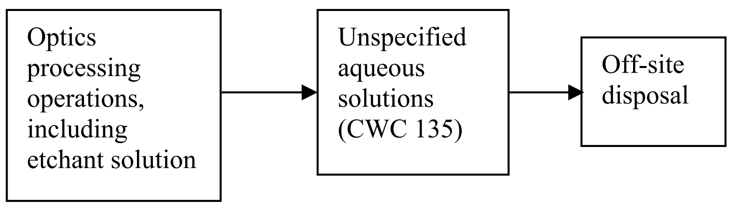

FIGURE III.4.1: NIF OPTIC PROCESSING FLOW DIAGRAM

This waste stream is generated from NIF optics processing operations. These processes have been optimized to generate the minimal amount of waste while producing the high quality optics required. For example, optics are batched to minimize solution change out between types, and baths are reused before spent etchant must be discarded and replaced.

In 2009, NIF started implementation of an optics repair process to extend the life of the optics. This operation has continued to expand and reduces both the need to acquire new replacement optics and the chemicals used to process them.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: LLNL plans to continue existing best management practices to minimize this waste stream. No other source reduction measures are planned at this time.

4.2 Building 963 Sump Wastewater

Site	2018 quantity (lb)
SNL/CA	4,805

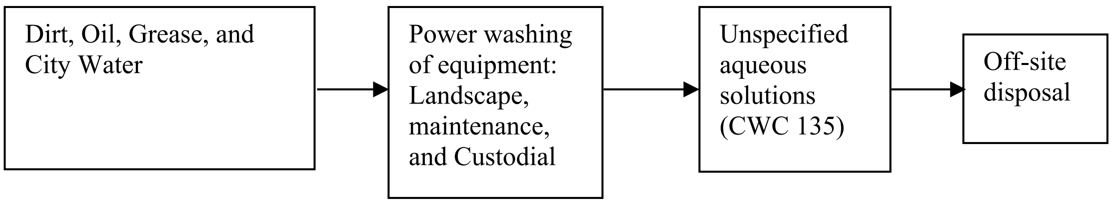

FIGURE III.4.2: BUILDING 963 SUMP WASTEWATER PROCESS

The Facilities Maintenance Department power-washes various types of equipment at the Building 963 wash down pad. The types of equipment that are power-washed include landscaping equipment, maintenance utility carts, and custodial equipment. This activity generates wastewater that is contaminated with oil, dirt and grease. Currently this waste is collected in the oil and water separator located at the Building 963 wash down pad and disposed of as a non-RCRA hazardous waste. The waste is normally pumped out once a year.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: To meet Pollution Prevention goals and California drought water restrictions, conservation efforts have been implemented that affect the routine washing of vehicles and equipment. The landscapers and maintenance workers no longer provide routine power washing of their equipment. Additionally, if a member of the workforce power-washes their equipment they try to minimize the frequency of the cleanings and the volume of water used to clean the equipment. These actions continue to reduce the volume of waste generated.

4.3 Building 943 Surface Cleaning Operations

Site	2018 quantity (lb)
SNL/CA	5,872

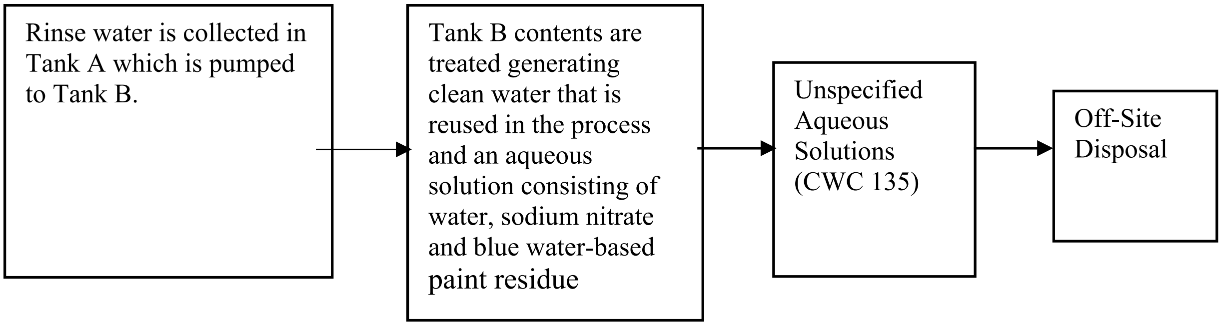

FIGURE III.4.3: BUILDING 943 PLATING OPERATIONS

The Building 943 Surface Cleaning Operations provides surface cleaning services in support of SNL/CA site-wide weapon programmatic requirements. Based on customer specifications and metal substrate, various chemicals are used during the surface cleaning process.

The Building 943 Surface Cleaning Operations continually monitors the baths to prolong the usefulness and life of the bath.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: None identified. This waste stream is generated from the Building 943 Surface Operations. The surface cleaning operation saw a significant increase in their workload (approximately 30%) in CY18 due to an increase in DOE programmatic work. The increase in the workload resulted in the surface cleaning baths needing to be changed out more frequently. No source reduction activities are planned for this waste stream.

5.0 CWC 181: Other Inorganic Solid Waste

Site	2018 quantity (lb)
LLNL	22,026
SNL/CA	12,077
SLAC	7,431
LBNL	3,895

5.1 WCI (B191) Firing Tank/Chamber Debris

Site	2018 quantity (lb)
LLNL	4,363

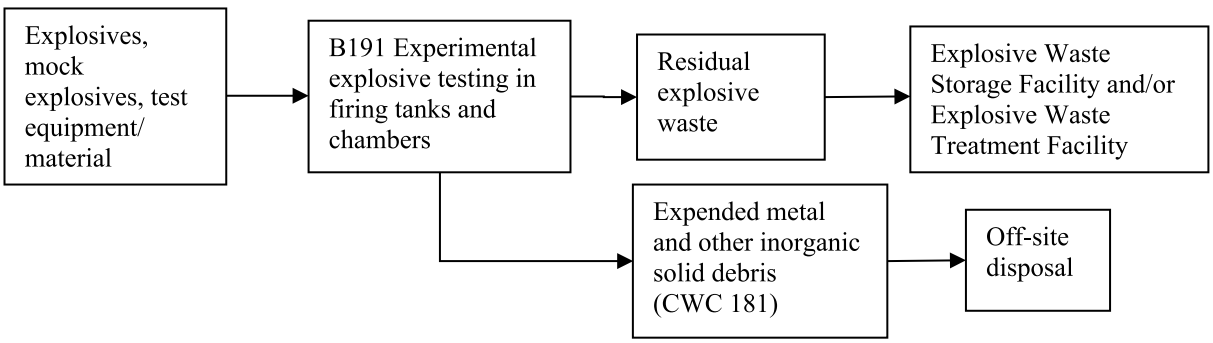

FIGURE III.5.1: WCI (B191) FIRING TANK/CHAMBER DEBRIS PROCESS

This waste stream is generated from WCI experimental explosive testing in firing tanks and chambers at the High Explosives Applications Facility (HEAF). These tests conducted under well-controlled conditions with complete dynamic diagnostics are used to characterize and study the detonation and thermal ignition of explosive assemblies. Residual explosive wastes are removed and either sent to Explosive Waste Storage Facility and/or treated at the Explosive Waste Treatment Facility (EWTF). Expended explosive wastes containing metal and other inorganic solid debris are sent off-site for disposal.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: LLNL plans to continue existing best management practices to minimize this waste stream. No other source reduction/pollution prevention measures are planned.

5.2 Gun Range Ballistic Bricks with Residual Ammunition

Site	2018 quantity (lb)
SNL/CA	6,847

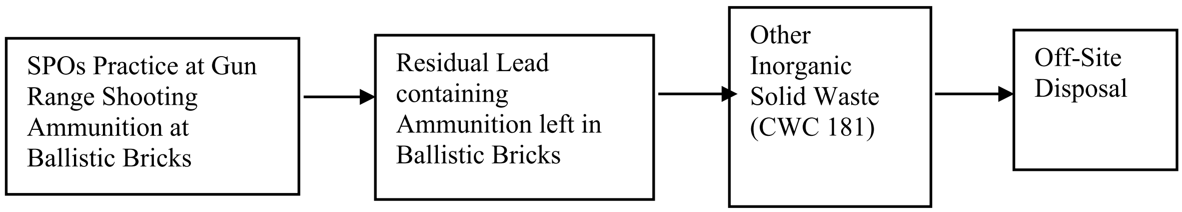

FIGURE III.5.2: GUN RANGE BALLISTIC BRICKS WITH RESIDUAL AMMUNITION PROCESS

Site Protective Officers (SPO) practice shooting their weapons at the Gun Range. The SPO use ammunition that contains lead. The ammunition is shot into ballistic bricks. This activity leaves residual lead containing ammunition in the ballistic bricks. The bricks are contaminated with lead. The bricks are replaced every few years and disposed of as a RCRA hazardous waste.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
<u>Description of Measure:</u> SNL/CA plans to continue to use lead containing ammunition and will remove the ballistic bricks as needed in the future.

For SLAC

<u>Overall Hazardous Waste and Process Description</u>
In 2018, 7,431 pounds of CWC 181 waste generated at SLAC. A breakdown by waste descriptions used in the SLAC hazardous waste tracking system is provided in the table below.

Waste Description		-	**2018 Quantity (lb)**
Inorganic Solid Waste*		-	6,308
Filter Cake			1,123
Total			**7,431**

* RCRA contaminated debris, debris with non-RCRA metals,
spent resins with copper, acid/alkaline debris

Of the 7,431 pounds of CWC 181 waste generated in 2018 included RCRA Contaminated Debris, Filter Cake, Debris with Non-RCRA Metals, Spent Resins with Copper, and acid/alkaline debris.

The processes generating these wastes are:

- Repair/upgrade and removal of experimental equipment and lead shielding generating lead and lead debris
- Metal finishing operations (discussed earlier) generating filter cake from rinse water and aqueous waste treatment processes
- Sector 0-10 Equipment Removal project in preparation for LCLS-II construction
- Cleanup and maintenance activities that generate debris with non-RCRA metals
- Closed-loop, low-conductivity cooling water system generating spent deionization resins with copper
- Use of chemicals metal finishing operations that generate empty chemical containers, acid and alkaline debris.

Each of the processes and wastes are further discussed below.

5.3 Experimental Equipment with Lead Shielding - Repair/Upgrade and Removal

Site	2018 quantity (lb)
SLAC	1,069

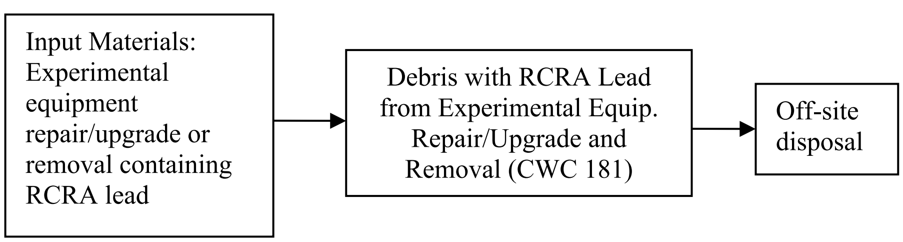

FIGURE III.5.3: EXPERIMENTAL EQUIPMENT REPAIRS/UPGRADES AND REMOVALS WASTE GENERATION PROCESS

Hazardous Waste and Process Description

Equipment that uses lead shielding in various forms was dismantled, resulting in lead contaminated debris. While this waste stream may appear to be routine for SLAC, much of it constitutes legacy waste in the form of shielding that was in place over a period of several years and is now be removed because of discontinuation of certain experiments.

Lead is essential to many experiments at SLAC to ensure that workers, the public and the environment are not exposed to unsafe levels of radiation. SLAC is committed to ALARA, i.e., seeing that radiation exposure is As Low As Reasonably Achievable (ALARA). Shielding is an important part of ALARA and lead is an essential shielding material in spite of its health hazards. Much of the lead waste generated at SLAC is from cleanup of old experimental areas that are being reused or demolished.

Hazardous Waste Management Alternatives

Lead contamination occurs from the oxidation of lead shielding. Where feasible, SLAC tries to coat new lead shielding installations when there are no increased radiological hazards resulting from the coating. Over the long term, this waste stream will continue to exist, but it is expected that the quantities of waste generated will decrease over time, due to continuous improvements in reducing environmental impacts from this material, e.g., better storage and containment procedures and coatings where feasible and recycling.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: SLAC implements good waste segregation and inventory processes where feasible, to reduce mixing non-hazardous waste with hazardous waste. Over time, this waste stream can vary from year to year, depending on the need to demolish or decommission older experimental facilities. Where feasible, SLAC tries to reuse lead where technically feasible and in conformance with ALARA and safety and health requirements. In some situations, SLAC may consider using alternative materials for shielding other than lead; however, such situations have to be considered on a case-by-case basis.

5.4 Filter Cake from Metal Finishing Pretreatment Facility

Site	2018 quantity (lb)
SLAC	1,123

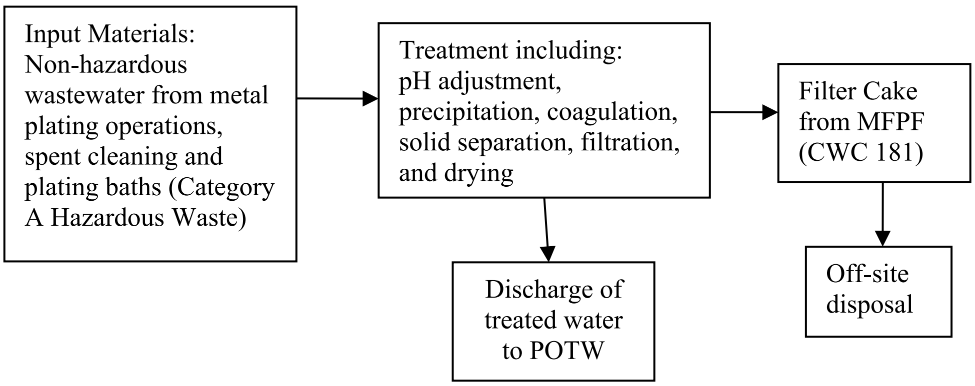

FIGURE III.5.4: RINSE WATER TREATMENT PROCESS AND WASTE GENERATION PROCESS

Hazardous Waste and Process Description

The major generator of this waste stream at SLAC is the Metal Finishing Operation Group (MFO) in the Mechanical Fabrication Department (MFD), which performs plating of carbon steel, stainless steel, copper and aluminum parts. The various baths clean parts and plate them with metal such as nickel, copper, tin, rhodium, indium, silver and gold.

The treatment process includes pH adjustment, precipitation, coagulation, solid separation, filtration and drying processes to remove metals and adjust the pH of the water before discharge. As a result of the process, a filter cake is generated, which is subsequently sent off-site for disposal to a permitted treatment, storage and disposal facility.

Hazardous Waste Management Approaches

Two noteworthy practices have been implemented by MFO that have helped to continue and reduce filter cake and chemical usage in the MFPF:

1. One major source reduction measure that has been implemented since 2006 was the electrochemical generation of ferric hydroxide, which is used as a coagulant/flocculating agent used in the sedimentation of metal precipitates. The electrochemical system provides better control of ferric hydroxide in the treatment process. An improved ferric chloride metering system acts as a backup for the electrochemical system. The electrochemical process provides tighter control of the iron hydroxide than ferric chloride injection. This in turn reduces the volume and weight of the sludge that is generated during the removal of metals in the sedimentation process.

2. A second source reduction measure was eliminating the use of hexavalent chromium in cleaning and plating operations in the 2006 to 2007 time period and using alternative

technologies that provide the benefits of hexavalent chromium without any of the drawbacks. The elimination of hexavalent chromium provided several side-benefits that are not easy to quantify, but definitely contributed to the following achievements :

a. Eliminated the need to treat hexavalent chromium rinse waters in the MFPF, thus helping to eliminate the tank that was used to convert hexavalent chromium to trivalent chromium.
b. Reduced the generation of heavy metal sludge and treatment chemical usage associated with the treatment of hexavalent chromium in the MFPF.
c. Eliminated the potential for worker exposure from hexavalent chromium in the metal finishing and MFPF work areas.

The opportunities to further reduce filter cake are limited. Changing the composition of the sludge to make it lighter may result in more metals passing through to the POTW. The purity of rinse water used by MFO is high in order to retain a high degree of quality that is needed for parts that can be in service in ultra-high vacuum environments used by SLAC to operate the accelerator, as well as to conduct various experiments demanding high purity materials under ultra-high vacuum conditions.

Rinse water is necessary to meet the stringent cleaning and plating specifications required at SLAC. MFO strives to reduce quantities of rinse water usage in its operations where feasible. The MFPF is a conventional pH adjustment-flocculation-sedimentation pretreatment system that is economical for SLAC metal finishing operations. Alternative treatment technologies to reduce water usage can reduce usage of treatment chemicals, but are not always reliable, due to the variable conditions that can occur in these operations for the metal finishing work performed.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: The opportunity of treating and reusing rinse water in a closed-loop water treatment system is being evaluated, but needs further investigation of technical and economic feasibility. SLAC continues to look at the opportunity of reusing treated rinse water.

Rejected alternatives and rationale: Additional countercurrent rinsing in SLAC metal finishing operations because of space limitations and spray rinsing is not used because of ventilation issues and the potential to fall short of cleaning requirements.

5.5 Debris with Non-RCRA Metals from Cleaning and Maintenance Activities

Site	2018 quantity (lb)
SLAC	1,371

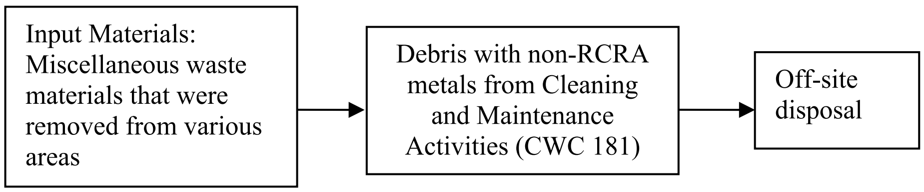

FIGURE III.5.5: CLEANING AND MAINTENANCE WASTE GENERATION PROCESS

Hazardous Waste and Process Description
This waste is in the form of solids containing non-RCRA metals that are generated from miscellaneous cleaning and maintenance activities.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: No recommended reduction measures except to maintain equipment to maximize efficiency of operations and improve awareness with regard to source reduction and waste minimization activities.

5.6 Spent Resins with Copper for SLAC Closed-Loop Low-Conductivity Cooling Water System

Site	2018 quantity (lb)
SLAC	2,055

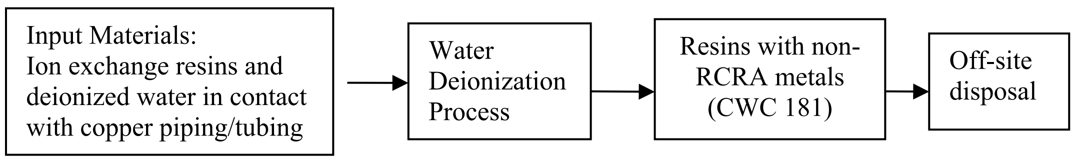

FIGURE III.5.6: DEIONIZED COOLING WATER AND ION EXCHANGE RESIN WASTE PROCESS

Hazardous Waste and Process Description
Ion exchange resins are installed in-line as part of SLAC's closed-loop, low-conductivity cooling water (LCW) system. LCW is used to cool sections of the two-mile linear accelerator and other research equipment. The LCW is initially produced from potable water using a front-end deionization system and the ion exchange resins of this system are recycled with an outside water services vendor. This closed-loop cooling system is constructed of copper tubing and heat exchangers, releasing copper ions that are in turn removed by the in-line ion exchange resins. In-line ion exchange resins are strategically used to polish or remove copper ions from the LCW as it goes through the closed-loop cooling system. The use of LCW and copper heat exchange equipment is essential to controlling the operation of the accelerator and associated equipment.

The generation of spent ion exchange resins as a hazardous waste varies depending on how long the resins were in service in an experimental area and the heat load placed on the closed-loop cooling water system. Spent resins are generated from the operation of the linear accelerator and other experimental equipment and may come from different parts of the experimental facilities based on their availability for access and maintenance.

SLAC has also helped reduce the generation of this waste stream since the last 2006 by more fully implementing a resin recycling program in which old resins are managed and new resins are returned to SLAC by an outside vendor.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: No recommended reduction measures except to maintain equipment to maximize efficiency.

5.7 Acid and Alkaline Debris

Site	2018 quantity (lb)
SLAC	1,813

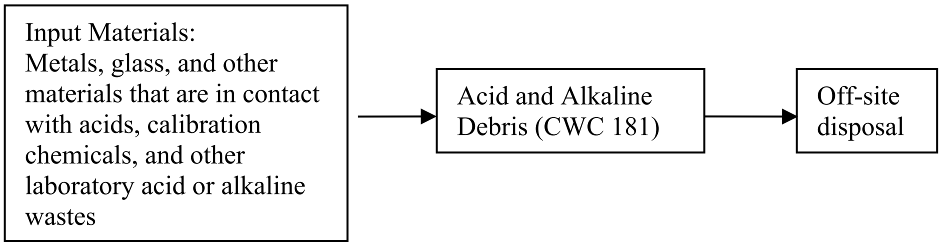

FIGURE III.5.7: ACID AND ALKALINE DEBRIS WASTE GENERATION PROCESS

Hazardous Waste and Process Description

The majority of this waste is in the form of containers for which there are limited recycling options.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: SLAC will continue to increase employee awareness and employee waste reduction efforts to reduce the generation of acid and alkaline debris waste.

5.8 Lab Clean Out Debris

Site	20142018 quantity (lb)
LBNL	3,895

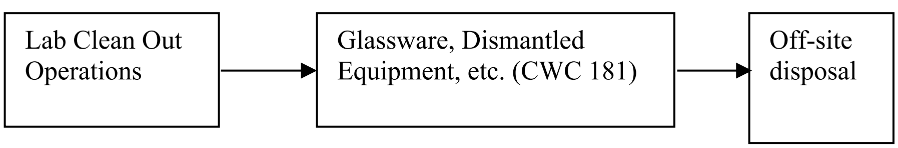

FIGURE III.5.8: LAB CLEAN OUT DEBRIS GENERATION PROCESS

This waste stream consists of clean-out debris from laboratories that were shut down and/or relocated. The debris included predominantly glassware and dismantled experimental equipment. Due to the increased turnover of experimental activities at the lab, large scale clean-out commonly includes disposal of used glassware rather than cleaning and reuse. Equipment evaluated during clean outs as outdated and/or no longer of use is routinely disposed of and frequently is characterized as having contaminates present, which render it as hazardous.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION

Description of Measure: LBNL plans to continue existing best management practices to minimize this waste stream. Other approaches include ongoing hazardous waste management training and segregation of hazardous and non-hazardous glassware enabling the use of recycling/reuse opportunities. LBNL regularly inspects these labs and educates researchers on how to minimize the generation of lab debris contaminated with hazardous materials. Proper waste segregation activities are encouraged to reduce the mixing of non-hazardous trash with contaminated debris as much as feasible.

6. CWC 221: Waste Oil and Mixed Oil

Site	2018 quantity (lb)
LLNL	11,762
SLAC	12,555
LBNL	6,732

6.1 WCI (B801) Waste water and oil

Site	2018 quantity (lb)
LLNL	1,700

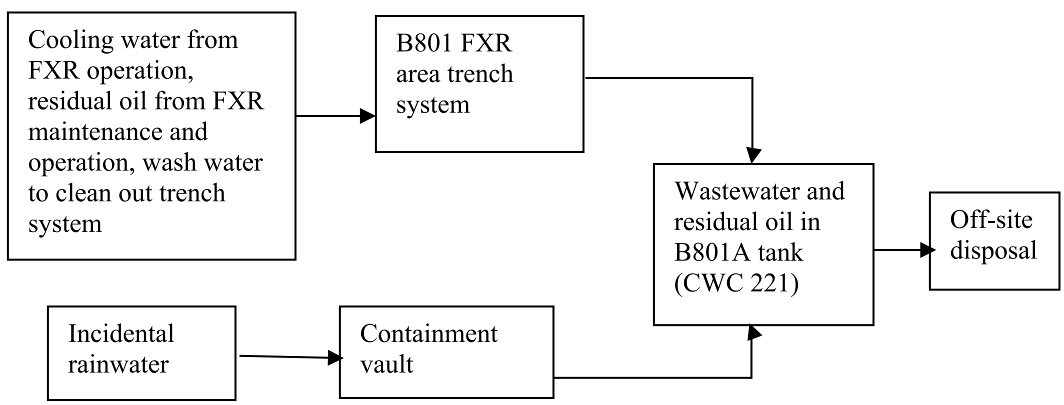

FIGURE III.6.1: WASTE OIL GENERATION PROCESS

This waste stream is generated from operation of the WCI Flash X-Ray (FXR), trench system, containment vault and B801A tank at B801. The FXR area trench system receives residual oil from the FXR during maintenance and operations, minor amounts of cooling water from FRX operation during start-up, and periodically, wash water used to clean out the trench system. The trench system drains into B801A tank. Incidental amounts of rainwater may enter the containment vault where it is also directed into the B801A tank.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: The B801A tank and containment vault are currently being upgraded to include improved lid design and other measures to prevent rainwater intrusion.

6.2 Electrical, Mechanical and Machining Equipment Oil Replacement and Maintenance

Site	2018 quantity (lb)
SLAC	12,555

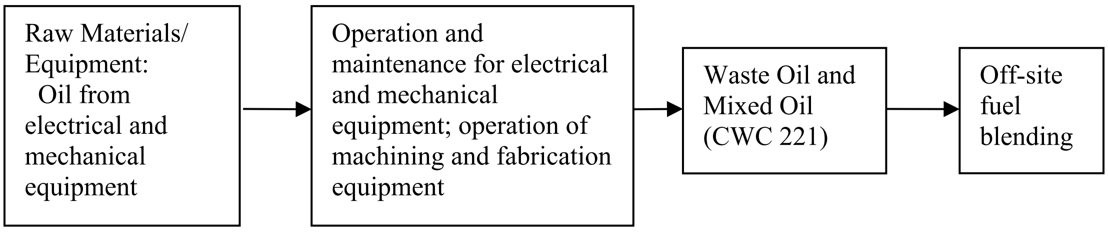

FIGURE III.6.2: WASTE OIL GENERATION PROCESS

Hazardous Waste and Process Description
This waste stream is generated from oils used to operate electrical, mechanical (pumps, compressors), T20s (modulators), chokes (subboosters) and machining equipment. Oil is an important component in the successful operation of electrical and mechanical equipment, and in machining operations performed at SLAC.

Oil is also used as a dielectric fluid in high-voltage equipment such as transformers, modulators, power supplies and klystrons. High-voltage electrical equipment is essential to the operation of the experimental research performed by SLAC. SLAC always strives, when feasible, to increase the operating life of oils used in this equipment as a way of reducing maintenance costs.

Hazardous Waste Management Approaches
The following source reduction measures have been implemented:

- SLAC has been redesigning equipment, as it fails due to age, to eliminate water intrusion and to provide better heat transfer for critical components.
- When feasible, SLAC reconditions oil by removing particulates and moisture and returning it to electrical equipment.
- Where appropriate, air cooling is used to cool dielectric oils and electrical equipment.

SLAC has implemented, and will continue to implement, these and other such measures where technically and economically feasible.

Oils from mechanical equipment such as pumps and compressors and from machining equipment are usually changed in accordance with equipment requirements and performance periods.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION

Description of Measure: Oil containing T20s are being replaced with air cooled T20s. Old Klystrons have been removed and recycled. Old/legacy oil containing pumps, compressors not in use are being removed from service.

6.3 Maintenance program

Site	2018 quantity (lb)
LBNL	6,732

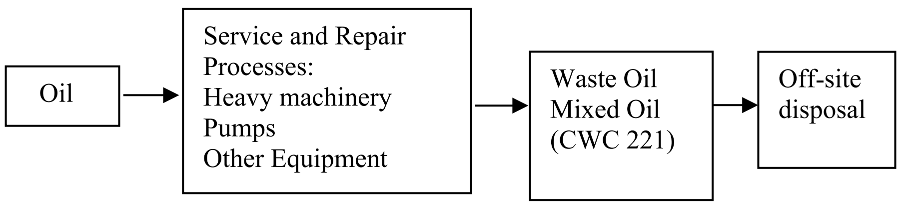

FIGURE III.6.3: MAINTENANCE PROGRAM WASTE GENERATION PROCESS

This waste stream is generated throughout LBNL as a result of maintenance of equipment such as heavy machinery, pumps, etc.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: Source reduction approaches include purchase of oil-less pumps, upgrades of equipment to reduce oil drip releases reducing the generation of oily clean-up rags and absorbent. Other measures employed include a more efficient on-site motor pool, installation of cyclone dewatering devices on tanks, and optimization of oil consolidation strategies at waste accumulation areas. LBNL will continue to search for strategies to further reduce this waste. Although some variation in the waste stream may occur due to planned demolition activities, equipment draining and removal, LBNL will continue to identify and promote best management practices to reduce the volume, such as fixing or replacing leaking equipment.

7. CWC 223 Wastes – Unspecified Oil Containing Waste

Site	2018 quantity (lb)
SNL/CA	20,795
LLNL	16,827
SLAC	16,295

7.1 Building 914 Machine Shop coolant/oil/water

Site	2018 quantity (lb)
SNL/CA	18,209

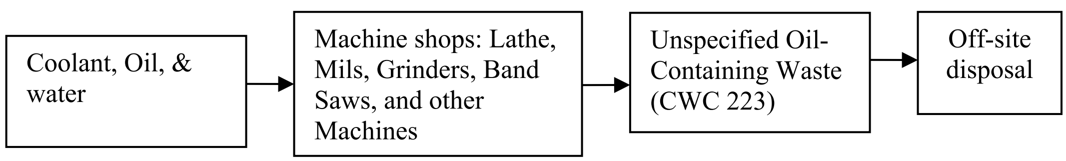

FIGURE III.7.1: BUILDING 914 MACHINE SHOP COOLANT/OIL/WATER WASTE GENERATION PROCESS

The Machine shop uses lathes, milling machines, drill presses, band saws, grinders, and other equipment to produce classified and prototype parts in support of all on-going projects at SNL/CA. Certain machining tools require metal working fluid (coolant). The Machine Shop also uses lubricating and hydraulic oils in machining processes.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: This waste stream is made up of 90% water and 10% coolant/oil and <1% cadmium, chromium and lead. The Building 914 Machine Shop has doubled their workload in CY18 due to an increase in DOE programmatic work. The increase in the workload resulted in the coolant needing to be changed out from the machines more frequently.

7.2 Large Capacitors, non-PCB (B176 and 517)

Site	2018 quantity (lb)
LLNL	3,668

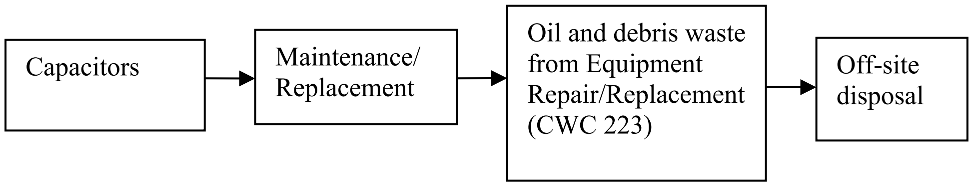

FIGURE III.7.2: CAPACITOR MAINTENANCE AND REPLACEMENT

LLNL continues to replace transformers with more efficient models that require less maintenance and use more environmentally friendly oils. Used oil from the old transformers is the source of the majority of this waste stream. B176 generated 1,438 lbs. of CWC 223 waste and B517 generated 2,230 lbs. of CWC 223 waste from large non-PCB capacitors.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: Additional transformers will be replaced with the more efficient models, based on mission need basis. The annual volume of waste oil generated is anticipated to be the same or lower in the future.

For SLAC

In 2018, 16,295 pounds of CWC 223 waste was generated at SLAC. This waste stream is composed of oily/solvent solid debris/rags, oil-filled equipment, oil/water mixture, cutting fluid/oil/water mixture.

7.3 Oily Solid and Solvent Solid Debris/Rags

Site	2018 quantity (lb)
SLAC	8,543

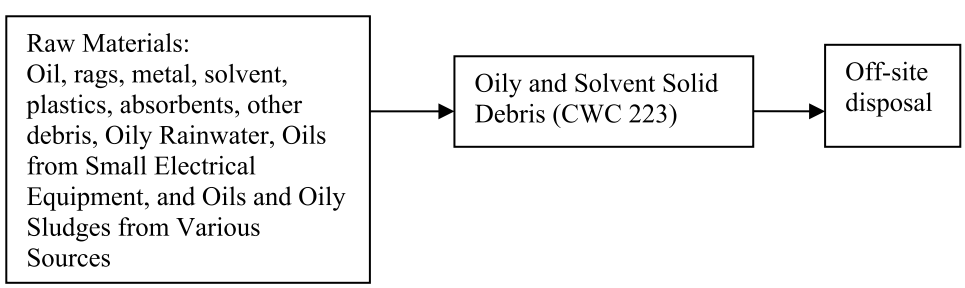

FIGURE III.7.3: OILY AND SOLVENT SOLID DEBRIS WASTE GENERATION PROCESS

Hazardous Waste and Process Description

This waste stream is generated in the forms of:

- Removal of old oil-filled equipment
- Oily rags or wipes to cleanup equipment and machines that are identified above in waste stream CWC 221
- Rags used for cleaning of tools and equipment
- Absorbents and rags from machines that inherently release oil during metal machining operations or from machines that leak
- Miscellaneous oily solids from old containers, cleaning of sumps/secondary containments, roofing and tarring operations, and other similar activities.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
<u>Description of Measure:</u> Additional pollution prevention training has been incorporated into SLAC hazardous waste management training to encourage employees to consider waste reduction measures in their activities. Additionally, the SLAC Waste Management Group encourages employees to assess opportunities to reduce waste generation in their work areas. No additional source reduction opportunities are planned at this time.

Rejected alternatives and rationale: Replacing equipment before the end of its useful life is usually not an economically feasible measure for reducing this waste stream.

7.4 Spent Machine Coolant (Cutting Fluid) from Machining Operations

Site	2018 quantity (lb)
SLAC	6,210

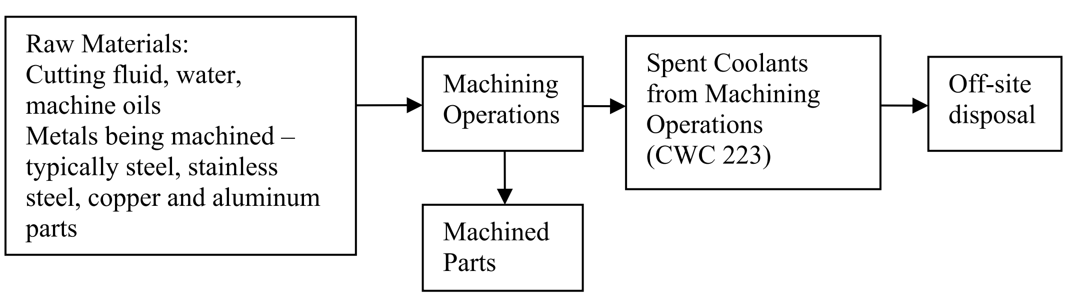

FIGURE III.7.4: WASTE MACHINE COOLANT OIL GENERATION PROCESS

<u>Hazardous Waste and Process Description</u>

Oil from machining operations is usually in the form of a soluble oil that is mixed with water and acts as a coolant for parts and tools in machining processes. In addition, non-soluble oils, usually called "tramp oils," are generated from lubrication of mechanical parts in the machine, e.g., gears and sliding worktables.

Hazardous Waste Management Approaches

Major source reduction measures recently implemented for coolants and tramp oils at SLAC have included the acquisition of new numerically controlled machines which internally recycle and filter the cutting fluid. Other source reduction measures that have been implemented in the past include:

- Selection of long-life coolants
- Coolant makeup control
- Machine cleaning and scrap metal removal
- Machine repair to improve performance
- Eliminating machine leaks
- Eliminating duplicate machines
- Selecting alternative cutting technologies such as electric discharge machining and high-power water jet machining

It is expected that the above mentioned source reduction measures, particularly the acquisition of new machines, will help reduce machining coolant waste in the future for comparable production level.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: SLAC will continue to upgrade to machines with more modern internal coolant recycling systems. The other source reduction measures mentioned above will continue to be used. No other source reduction measures are being considered at this time.

7.5 Oil/Cutting Fluid Water Waste from Maintenance/Repair of Building and Electrical Equipment

Site	2018 quantity (lb)
SLAC	1,542

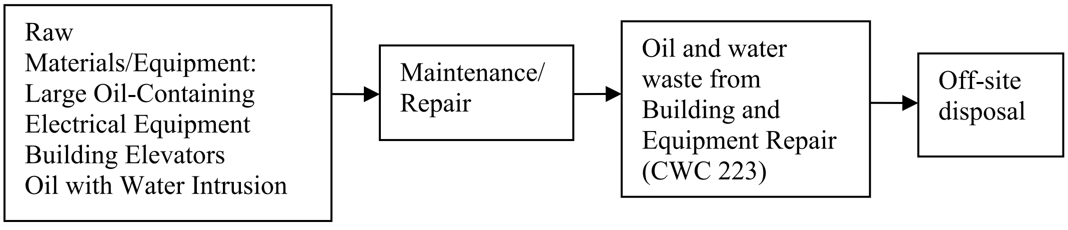

FIGURE III.7.5: OIL-WATER WASTE GENERATED FROM BUILDING MAINTENANCE AND EQUIPMENT REPAIRS WASTE GENERATION PROCESS

Hazardous Waste and Process Description

High voltage electrical equipment is maintained by SLAC Power Conversion Group. Some electrical equipment degrades over time such that water or moisture gets into the dielectric fluid and has to be replaced. If the equipment is at the end of its useful life, it is removed from service and replaced with more reliable electrical equipment.

Hazardous Waste Management Approaches

Some oil-filled equipment are also being phased out due to ongoing changes in operational needs as well as construction of LCLS-II.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: SLAC Power Conversion Group operates each piece of equipment to the end of its service life. When technically and economically feasible, SLAC purchases or replaces new equipment that is more reliable, durable, and requires less maintenance over its useful life.

8. CWC 343: Unspecified organic liquid mixtures

Site	2018 quantity (lb)
LLNL	9,154

8.1 B817 Used Glycerine from Machine Draining

Site	2018 quantity (lb)
LLNL	2,004

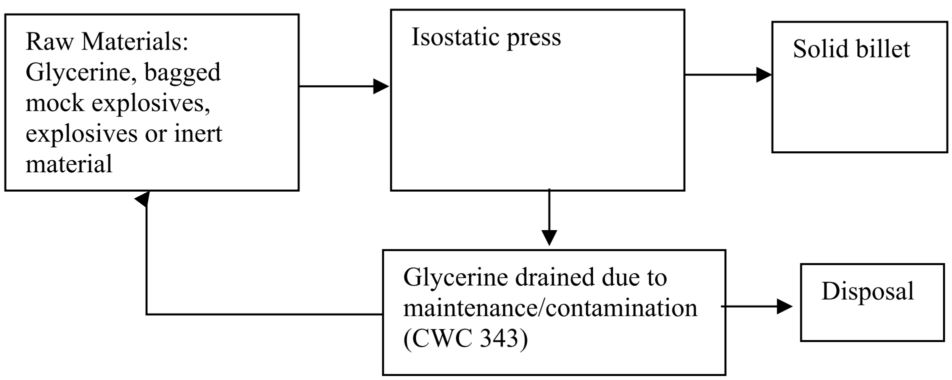

FIGURE III.8.1: S&T EXPLOSIVE PRESS OPERATIONS PROCESS

This waste stream is generated from S&T explosives press operations. An isostatic press is used to form mock explosives, explosives or inert material into solid billets using glycerine as the pressurizing medium. The glycerine is continually reused for subsequent pressing operations with exception of glycerin that is drained from the press when maintenance is required or when glycerine has been contaminated and not fit for reuse.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: LLNL plans to continue existing best management practices (such as reuse) to minimize this waste stream. No other source reduction/pollution prevention measures are planned.

9. CWC 352 Wastes – Other Organic Solid

Site	2018 quantity (lb)
LLNL	10,234
LBNL	8,459
SNL/CA	4,756

9.1 S&T (Mag 38) Energetic material

Site	2018 quantity (lb)
LLNL	3,554

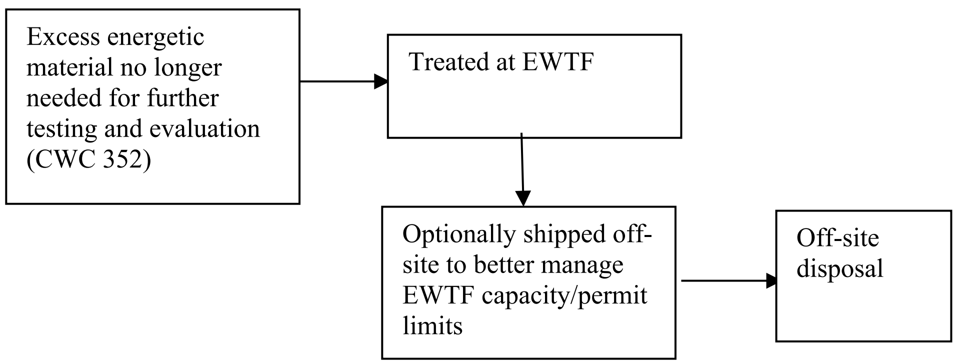

FIGURE III.9.1: S&T MAG 38 ENERGETIC MATERIAL PROCESS

Energetic material for testing and evaluation are stored at magazines at Site 300, such as Mag 38. Excess energetic material that is no longer needed for further testing and evaluation is mainly treated at LLNL's Explosive Waste Treatment Facility (EWTF). To accommodate need for additional material storage at Site 300, a concerted effort was made to reduce the current stored inventory in 2018. However, this reduction effort to remove the excess energetic material would have affected the permitted treatment capacity at EWTF, including its ability to treat other energetic waste that cannot be shipped off-site. Therefore, the excess energetic material (that can be shipped off-site) was consolidated at Mag 38 for off-site disposal.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: LLNL plans to continue existing best management practices to minimize this infrequent waste stream. No other source reduction/pollution prevention measures are planned.

9.2 Contaminated Laboratory and shop trash

Site	2018 quantity (lb)
LBNL	8,459

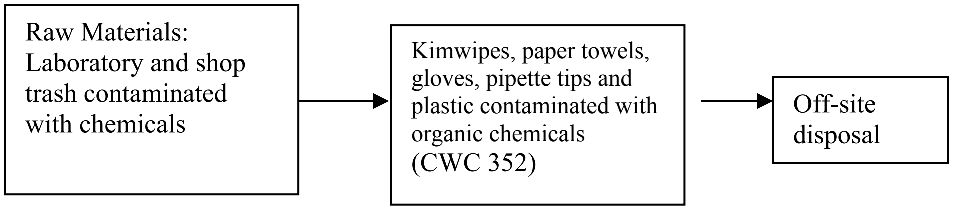

FIGURE III.9.2: CONTAMINATED LABORATORY AND SHOP WASTE GENERATION PROCESS

This waste stream consists of kimwipes, paper towels, gloves, pipette tips, and plastics contaminated with organic materials. This waste stream may vary from year to year depending the type of research activities performed.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: LBNL has created strategies to help lab personnel with contaminated debris to minimize accumulation of these type of materials thus resulting in a decrease of waste. LBNL regularly inspects these labs and educates researchers on how to minimize the generation of lab debris contaminated with hazardous materials. Proper waste segregation activities are encouraged to reduce the mixing of non-hazardous trash with contaminated debris as much as feasible.

9.3 Oil and Solvent Debris

Site	2018 quantity (lb)
SNL/CA	4,756

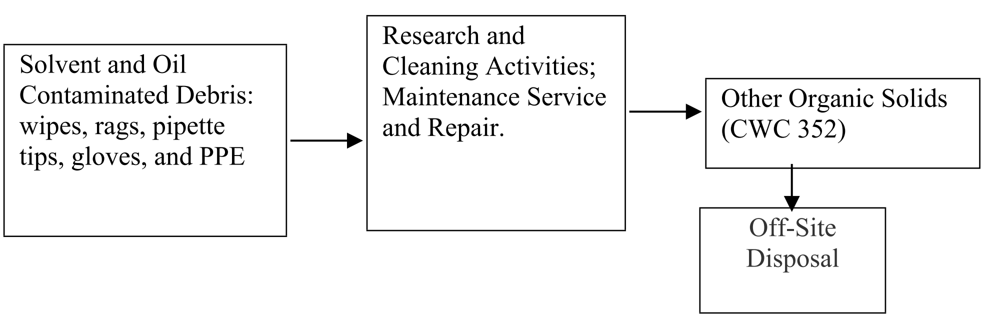

FIGURE III.9.3: SOLVENT DEBRIS WASTE GENERATION PROCESS

In 2018, the largest generators of oil contaminated debris were the Facilities Maintenance Department, Combustion Research Facility and the Machine shops. Solvent contaminated debris was generated by various research operations across the site, including Materials Physics, and Biological Science.

Both oil and solvent debris consists of rags, wipes, PPE, and other solids contaminated with oil and/or solvent. Currently this debris is drummed separately and is predominantly disposed of as a non-RCRA hazardous waste.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: None identified. This waste stream is generated from multiple operations throughout the site. In 2018 an increase in DOE programmatic work has resulted in an increase in waste generation.

10. CWC 551: Laboratory Waste Chemicals

Site	2018 quantity (lb)
SNL/CA	13,221
LBNL	9.582

<u>10.1 Laboratory Waste Chemicals</u>

Site	2018 quantity (lb)
SNL/CA	13,221

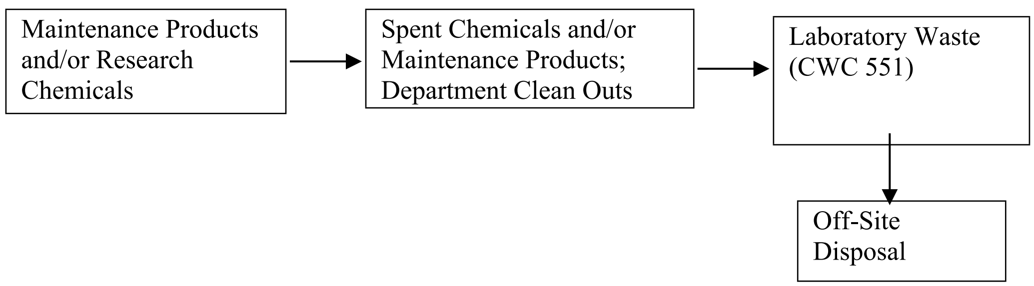

FIGURE III.10.1: LABORATORY WASTE CHEMICAL GENERATION PROCESS

Laboratory Waste Chemicals are generated from multiple operations throughout the site. The largest generators of this waste stream are Facilities Maintenance, Chemical Sciences, Materials Physics, Biological Sciences, and Combustion Research. The Facilities Maintenance Department is responsible for preventative and routine maintenance of the facilities and grounds at SNL/CA. The other departments conduct collaborative research and development with industries and academic institutions resulting in new and enhance technologies that have both commercial and national security benefits. The generation of this waste stream is from the use of chemicals or maintenance products in laboratory operations and/or preventative and/or routine maintenance of the facilities and grounds.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
<u>Description of Measure:</u> SNL/CA has implemented several administrative measures to reduce the generation of laboratory waste chemicals. These measures include: • Disallowing chemical purchases on a Pro-card • ES&H review of each chemical purchase • Utilizing a chemical exchange program In addition, Pollution Prevention staff review SOPs and all proposed new or revised NEPAs for activities conducted onsite. This allows feedback to be provided to staff on possible waste

reduction opportunities. The Pollution Prevention staff also attends the biweekly Interdisciplinary Team (IDT) meetings to ensure new projects or modified projects implement waste reduction opportunities. All of the measures above are ongoing.

In 2018 an increase in DOE programmatic work resulted in an increase in waste generation.

10.2 Laboratory Process Waste Chemicals

Site	2018 quantity (lb)
LBNL	9,582

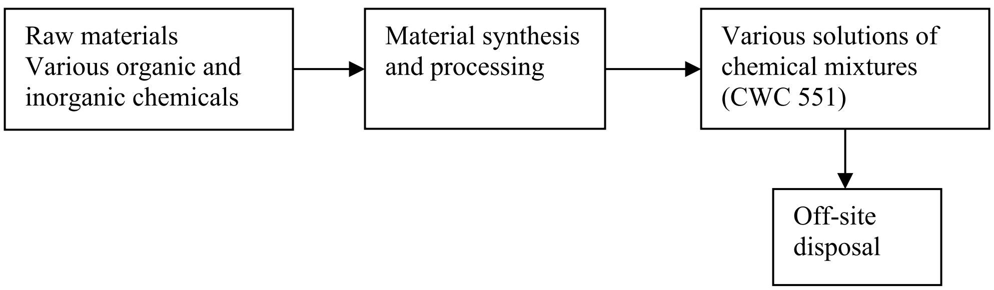

FIGURE III.10.2: LABORATORY PROCESS WASTE CHEMICALS

A variety of chemicals and chemical solutions are used throughout LBNL research Divisions (i.e. Life Sciences, Material Sciences, Chemical Sciences, Physical Biosciences and other research related Divisions) to prepare research samples and conduct experiments. Chemicals are purchased in small amounts and stored in the individual laboratories. Waste stream quantities fluctuate with the volume of research activities in progress. Laboratory shutdowns, remodels and moves result in clean-outs that contribute to this waste stream. Discarding expired chemicals and unnecessary chemical inventory impact this waste stream as well.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION

Description of Measure:

LBNL has implemented source reduction measures to minimize laboratory chemical waste generation. Researchers are encouraged to purchase chemicals in small volumes and limit chemical purchases to what is necessary for their immediate research. Additionally, LBNL has implemented a process by which all large quantities or highly toxic and dangerous chemicals are flagged so EHS can review and make suggestions prior to purchase. EHS has also distributed flyers to promote the idea of checking LBNL's Chemical Management System prior to ordering new or exotic chemicals to avoid unnecessary purchases. LBNL also encourages borrowing chemicals between different divisions. EHS has identified divisions with large quantities of hazardous chemicals. EHS attends the safety meetings of these divisions and encourages reductions in chemical purchases.

11. CWC 741: Liquids with Halogenated Organic Compounds (> 1000 mg/l)

Site	2018 quantity (lb)
LBNL	9,285

11.1 Halogenated Solvent Waste from Research Activities

Site	2018 quantity (lb)
LBNL	9,285

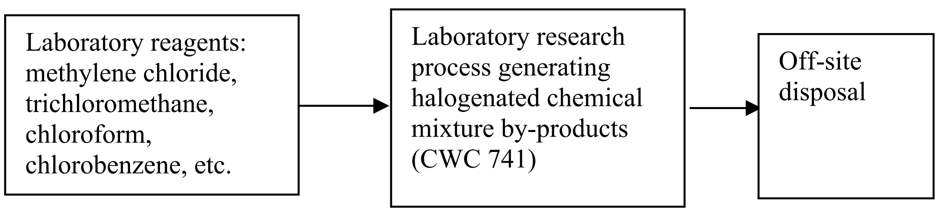

FIGURE III.11.1: HALOGENATED CHEMICAL MIXTURES FROM NANO TECHNOLOGY WASTE GENERATION PROCESS

This waste stream is generated from laboratory research activities. The predominant generator is the nano-technology research facility. The waste streams are comprised of chemical mixtures from research activities include chlorobenzene, methylene chloride, chloroform, toluene, and others. The waste stream varies year from year depending on the volume and type of research activities.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
<u>Description of Measure:</u> LBNL has implemented source reduction measures to minimize laboratory chemical waste generation. Researchers are encouraged to purchase chemicals in small volumes and limit chemical purchases to what is necessary for their immediate research. Additionally, LBNL has implemented a process by which all large quantities or highly toxic and dangerous chemicals are flagged so EHS can review and make suggestions prior to purchase. LBNL creates flyers that encourage researchers to manage their hazardous chemicals and buying smaller quantities. LBNL also invites expert guest speakers to promote chemical reduction and substitution.

12. CWC 751: Solids or Sludges with Halogenated Organic Compounds ≥1000 mg/kg

Site	2018 quantity (lb)
LLNL	8,990

12.1 B438 Granular Activated Carbon

Site	2018 quantity (lb)
LLNL	6,717

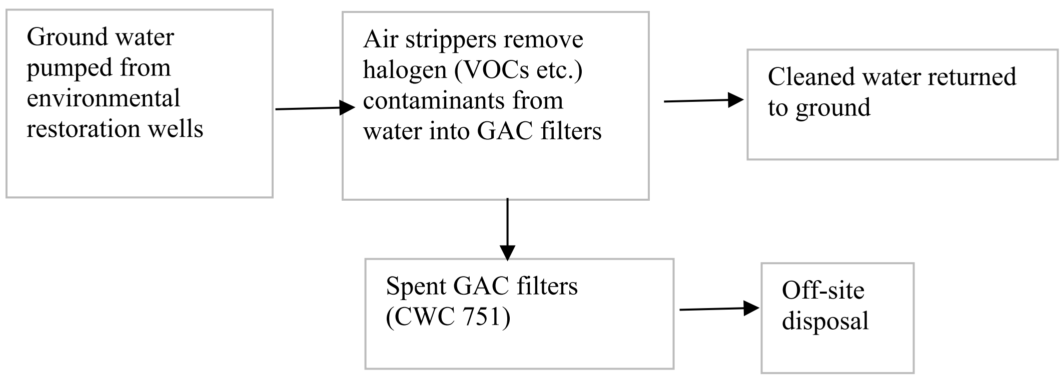

FIGURE III.12.1: B438 GRANULAR ACTIVATED CARBON PEROCESS

Contaminated ground water is pumped from wells throughout the site as part of ongoing environmental restoration efforts. Air strippers bubble air through grates as the water flows through to remove halogenated contaminants, such as VOCs, which are trapped in the granular activated carbon (GAC) filters through carbon adsorption. Both the air and water effluents from this process are monitored and tested regularly.
To minimize waste and extend the useful life of the filters, they are only changed out when the analytical indicates they reach saturation. As the ground water becomes less contaminated, the filters may last for several years without changeout.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: LLNL plans to continue existing best management practices to minimize this waste stream. No other source reduction/pollution prevention measures are planned.

13. CWC 792 - Liquids with pH≤2 with metals

Site	2018 quantity (lb)
LBNL	3,112

13.1 Ultra High Vacuum Cleaning Facility

Site	2018 quantity (lb)
LBNL	3,112

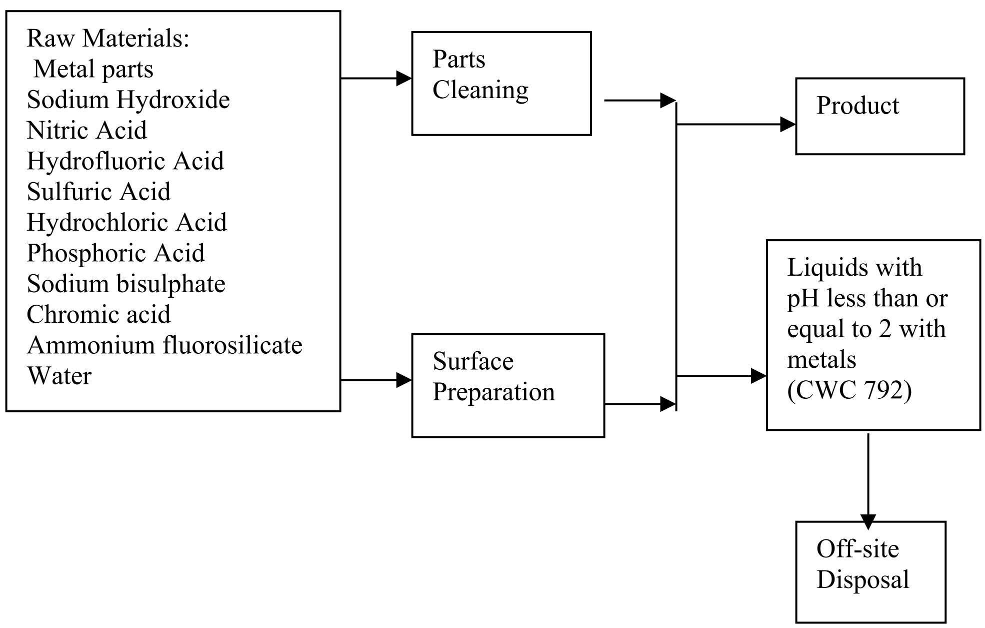

FIGURE III.13.1: ULTRA HIGH VACUUM CLEANING FACILITY WASTE GENERATION PROCESS

This waste stream is generated as a result of metal surface cleaning operations. Metal parts are cleaned through a multi-step process including the following:

- Ultrasonic aqueous degreasing,
- Washing with commercial industrial cleaners,
- Surface cleaning with acidic solutions, and
- DI-water and tap water rinsing.

The waste stream consists of acidic wastes that contain particles and dissolved metals.

Contaminants in this waste stream include Nitric acid, Hydrofluoric acid, Sulfuric acid, Hydrochloric acid, Phosphoric acid, Sodium bisulphate, Ammonium fluorosilicate and heavy metals such as cadmium, nickel, chromium and lead.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: LBL purchases chemicals in small volumes and has implemented source reduction measures which minimizes waste generation. Studies have shown that six months is the maximum useful life of these solutions and any further extension would jeopardize the product. LBNL will continue to search for strategies to reduce this waste.

IV. CATEGORY C Waste Streams

Category C waste streams are defined as "Wastes that are classified as extremely hazardous wastes."

1. CWC 135: Unspecified aqueous solution

Site	2018 quantity (lb)
LLNL	34 lbs

<u>1.1 B153 HF (49%) solution.</u>

Site	2018 quantity (lb)
LLNL	34

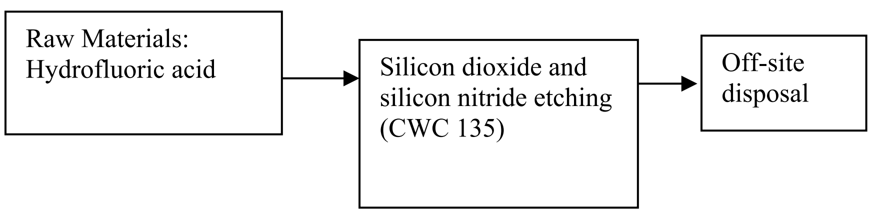

FIGURE IV.1.1: GLASS ETCHING process

This waste stream is generated from routine lab operations and is disposed of off-site.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
<u>Description of Measure:</u> LLNL plans to continue existing best management practices to minimize this waste stream. No other source reduction/pollution prevention measures are planned.

2. CWC 141: Off-specification, Aged, or Surplus Inorganics

Site	2018 quantity (lb)
LLNL	124

2.1 B151 accumulation of small amounts various liquids and solids

Site	2018 quantity (lb)
LLNL	124

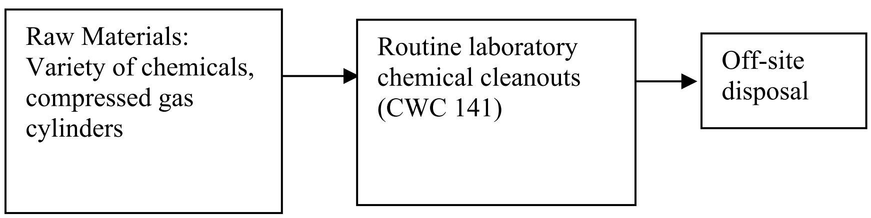

FIGURE IV.2.1: ROUTINE LABORATORY CLEANOUT PROCESS

B151 accumulation of small amounts various liquids and solids from laboratory clean out/remodeling that occurred in four laboratories during 2018 (15 lbs).
B329 excess/unused product (compressed gas cylinders) (109 lbs).

This waste consisted of unused product, and small amounts of various liquids and solids generated through regular laboratory operations, clean-out and/or remodeling activities.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: LLNL will continue to educate researchers and operations personnel on purchases of only those chemicals needed for current research, and will also continue to encourage researchers to substitute less hazardous chemicals whenever possible. Cleanouts of legacy or off-spec chemicals are encouraged as a means of reducing environmental, health and safety risks.

3. CWC 181: Other Inorganic Solid

Site	2018 quantity (lb)
SLAC	693

3.1 Spent Cyanide Filters from Metal Finishing Operations

Site	2018 quantity (lb)
SLAC	693

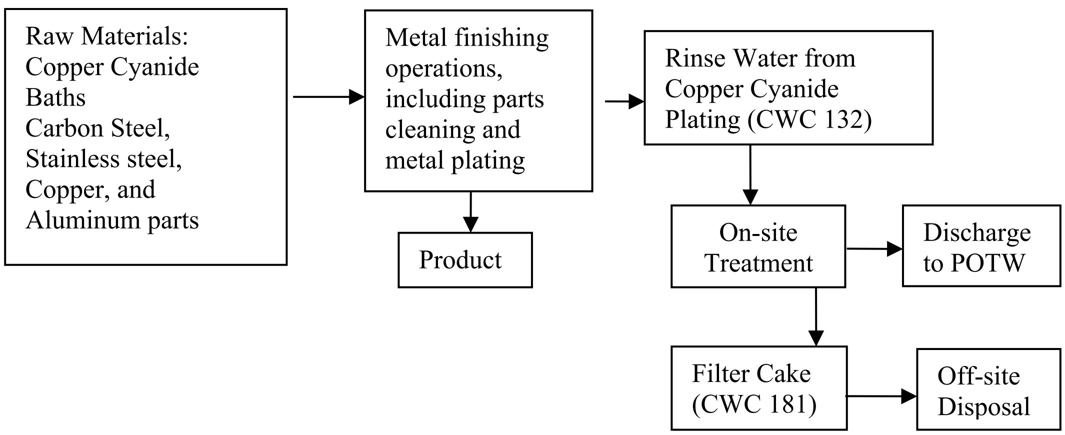

FIGURE IV.3.1: METAL FINISHING PROCESS WASTE GENERATION PROCESS

Hazardous Waste and Process Description
CWC 181 is generated through the Metal Finishing Operations (MFO) Group in the SLAC Mechanical Fabrication Department (MFD), See section 1.1 for explanation of the process.

MFO performs a variety of activities to meet demanding and sometimes unique metal finishing specifications in order to fabricate equipment for high-powered electrical equipment. The use of these materials is essential for successful metal finishing operations. CWC 181 waste, in the form of spent filters used in cyanide baths, is reduced by extending the life of the filters by monitoring their pressure drop.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: Additional waste reduction measures for the filters are not feasible until the cyanide bath usage is actually eliminated.

4. CWC 791: Liquids with pH≤2

Site	2018 quantity (lb)
LLNL	73

4.1 B235 aqueous and acidic liquids from electrochemical experiments

Site	2018 quantity (lb)
LLNL	37

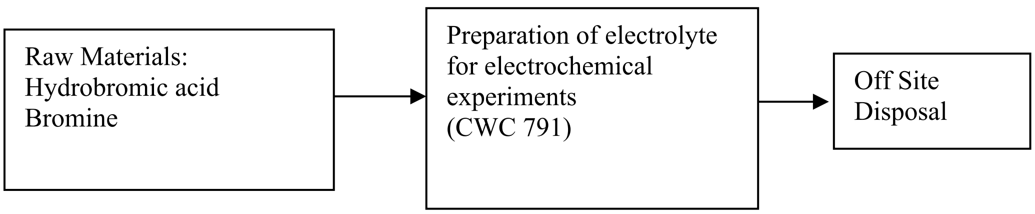

FIGURE IV.4.1: PREPARATION OF MIXTURES AS ELECTROLYTE FOR ELECTROCHEMICAL EXPERIMENTS

This waste was generated from electrolyte mixtures needed for electrochemical experiments focused on flow-through electrodes for energy applications (fuel cells, redox flow batteries). The initial experiments used aqueous solution of bromine in hydrobromic acid and hydrogen gas.

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
Description of Measure: In early 2019, it was discovered that vanadium was a better choice for the goal of the project as well as a safer and less hazardous alternative material. The project now utilizes vanadium solutions (dissolved IV sulfate oxide hydrate in aqueous solution of sulfuric acid). LLNL plans to continue existing best management practices to minimize this waste stream. No other source reduction/pollution prevention measures are planned.

4.2 B153 buffered oxide etch solution

Site	2018 quantity (lb)
LLNL	17

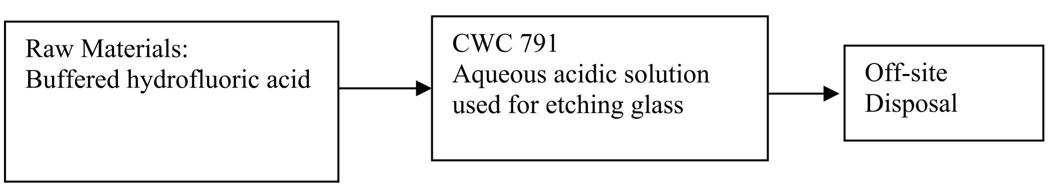

FIGURE IV.4.2: GLASS ETCHING PROCESS

This waste is generated from glass and silica etching activities. An aqueous acid solution consisting of an ammonium fluoride buffer and hydrofluoric acid is used for [add detail].

SOURCE REDUCTION/POLLUTION PREVENTION EVALUATION
<u>Description of Measure:</u> LLNL plans to continue existing best management practices to minimize this waste stream. No other source reduction/pollution prevention measures are planned.

V. Certification Statements

Technical Certification

I certify this Source Reduction Evaluation, Review and Plan meets all of the following requirements:

1. The review and plan addresses each hazardous waste stream identified pursuant to section 67100.5(h), Title 22 of the California Code of Regulations.
2. The review and plan addresses the source reduction approaches specified in section 67100.5(j), Title 22 of the California Code of Regulations.
3. The review and plan clearly sets forth the measures to be taken with respect to each hazardous waste stream for which source reduction has been found to be technically feasible and economically practicable, with timetables for making reasonable and measurable progress, and documents the rationale for rejecting available source reduction measures.
4. The review and plan does not merely shift hazardous waste from one environmental medium to another environmental medium by increasing emissions or discharges to air, water, or land.

____ _______________ _______________________________

Name Signature

___ _______________________ _____/_____/_____

Title Mo / Day / Year

Financial Certification

"I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or the persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for making false statements or representations to the Department, including the possibility of fines for criminal violations."

___Karin King_____________________ _______________________________

Name Signature

_______________________________ _____/_____/_____

Title Mo / Day / Year