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Date: December 13, 2018  
Witness(es): Various

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**PACIFIC GAS AND ELECTRIC COMPANY**

**2018 NUCLEAR DECOMMISSIONING COST TRIENNIAL PROCEEDING**

**PREPARED TESTIMONY**  
**ATTACHMENTS SUPPORTING CHAPTER 9**

**VOLUME 5**

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PACIFIC GAS AND ELECTRIC COMPANY  
2018 NUCLEAR DECOMMISSIONING COST TRIENNIAL PROCEEDING  
PREPARED TESTIMONY

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**PACIFIC GAS AND ELECTRIC COMPANY**  
**CHAPTER 9**  
**ATTACHMENT A**  
**HUMBOLDT BAY POWER PLANT**  
**UNIT 3 COMPLETED PROJECTS REVIEW**

**The Humboldt Bay Power Plant Unit 3  
Completed Projects Review for  
2015-2018**

(Submitted as part of HBPP 2018 NDCTP)



Title:		2018 NDCTP Completed Projects Review for Humboldt Bay Power Plant Unit 3 2015 - 2018			
Revision Signatures					
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Shaina L. Mason		12/05/2018		12/05/2018	
Prepared by		Date		Approved by	
Steven K. Shelanskey		12/05/2018			
Checked by		Date			
Status	Rev. #	Date	Prepared By	Pages	Description of Changes
Issued	0	12/05/18	S. Callihan S. Mason	All	New

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## ACRONYMS

ALARA	As Low As Reasonably Achievable (radiological term for keeping dose low)
AC	Air Conditioner / Air Conditioning
ACM	Asbestos-Containing Material
AED	Automated External Defibrillator
ARO	Asset Retirement Obligations
ASO	Armed Security Officer
BGS	Below Ground Surface
BMP	Best Management Practice
CAC	Certified Asbestos Consultant
Cal/OSHA	California Occupational Safety and Health Administration
CAP	Corrective Action Program
CCC	California Coastal Commission
CCW	Closed Cooling Water
CDFW	California Department of Fish & Wildlife
CDP	Coastal Development Permit
CFR	Code of Federal Regulations
CLSM	Controlled Low-Strength Material
CO <sub>2</sub>	Carbon Dioxide
CO	Carbon Monoxide
CPUC	California Public Utilities Commission
CSM	Cutter Soil Mix
CW	Civil Works
CWA	Contract Work Authorization
CWC	Civil Works Contractor
CWP	Civil Works Project
D&D	Demolition and Disposal
DAW	Dry Active Waste
DCGL	Derived Concentration Guidelines
DCN	Design Change Notification
DCPP	Diablo Canyon Power Plant
DOE	Department of Energy
DOR	Designer of Record
DOT	Department of Transportation
DRM	Decommissioning Corporate Risk Management Program
DTSC	Department of Toxic Substance Control
EHT	Effluent Hold Tank
EORM	Enterprise and Operational Risk Management
EPC	Engineering, Procurement and Construction
ERF	Emergency Response Facility
ESCP	Erosion & Sediment Control Program
FIXS	Filtration and Ion Exchange System
FS	Feasibility Study
FSAR	Final Safety Analysis Report
FSR	Final Site Restoration
FSS	Final Status Survey
GARDIAN	Gamma Radiation Detection and In-Container Analysis

gpm	Gallons-Per-Minute
GTCC	Greater Than Class C
GWTS	Groundwater Treatment System
H <sub>2</sub> S	Hydrogen Sulfide
HBFD	Humboldt Bay Fire Department
HBGS	Humboldt Bay Generation Station
HBPP	Humboldt Bay Power Plant
HDPE	High-Density Polyethylene
HEPA	High-Efficiency Particulate Air
HLRWV	High-Level Radwaste Vault
HMA	Hot Mix Asphalt
HMS	Hot Machine Shop
HVAC	Heating, Ventilation and Air Conditioning
IH	Industrial Hygiene/Hygienist
IM	Intermodal
IMRAW	Interim Measures Removal Action Work Plan
IP	Industrial Packaging
ISFSI	Independent Spent Fuel Storage Installation
ISOCS	In-Situ Object Counting System
IWP	Incremental Work Package
LC24	Load Center 24
LLRW	Low-Level Radwaste
LLRWB	Low-Level Radwaste Building
LRW	Liquid Radwaste
LRWB	Liquid Radwaste Building
LTP	License Termination Plan
LTS	License Termination Survey
MARSAME	Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MLLW	Mean Lower Low Water
MPEF	Main Plant Exhaust Fan
NCRWQCB	North Coast Regional Water Quality Control Board
NDCTP	Nuclear Decommissioning Cost Triennial Proceedings
NFSV	New Fuel Storage Vault
NO	Nitric Oxide
NO <sub>2</sub>	Nitrogen Dioxide
NPDES	National Pollution Discharge Elimination System
NRC	Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act
O&M	Operations and Maintenance
OAD	Open-Air Demolition
ODCM	Offsite Dose Calculation Manual
OSHA	Occupational Safety and Health Administration
PCBs	Polychlorinated Biphenyls
pCi/g	Picocuries-Per-Gram
PE	Project Engineer
PERP	Portable Equipment Registration Program
PG&E	Pacific Gas & Electric
PM	Project Manager
PMO	Project Management Oversight (or Organization)

POD	Plan-of-the-Day
POND	Plan-of-the-Next-Day
PPE	Personal Protective Equipment
PTS	Pretreatment System
PWP	Project Waste Plan
QA/QC	Quality Assurance/Quality Control
QSP	Qualified SWPPP Practitioner
RCA	Radiological Controlled Area
RCRA	Resource Conservation and Recovery Act
REMP	Radiological Environmental Monitoring Plan
RFB	Refuel Building
RFI	Request for Information
RMS	Records Management System
RP	Radiation Protection
RPV	Reactor Pressure Vessel
SAFSTOR	Safe Storage
SAMS	Site Alarm Monitoring System
SAP	Systems, Applications & Products (a German software accounting system)
SAS	Security Alarm Station
SCA	Surface Contamination Area
SES	Security Electronics System
SF	Safety Factor
SFP	Spent Fuel Pool
SME	Subject Matter Expert
SMF	Soil Management Facility
SNF	Spent Nuclear Fuel
SO <sub>2</sub>	Sulfur Dioxide
SOE	Shoring of Excavation/Support of Excavation
SOX	The Sarbanes-Oxley Act of 2002 or Sarbanes-Oxley
SPAMS	Stack Particulate Alpha Monitoring Systems
SRWB	Solid Radwaste Building
SSC	Systems, Structures and Components
SWPPP	Storm Water Pollution Prevention Plan
TBDT	Turbine Building Drain Tank
USACE	US Army Corps of Engineers
VBS	Vehicle Barrier System
WAC	Waste Acceptance Criteria
WBS	Work Breakdown Structure
WCP	Work Control Program
WHT	Waste Holding Tank
WMF	Waste Management Facility
WP	Work Package
WRT	Waste Receiving Tank
WWF	Welded Wire Fabric

## **EXECUTIVE SUMMARY**

Pacific Gas and Electric Company (PG&E) has prepared this site-specific Decommissioning Completed Projects Review for decommissioning the Humboldt Bay Power Plant (HBPP) Unit 3. The report describes work completed and the costs during the period from 2015 through 2018 required to support license termination of HBPP Unit 3. This review also includes activities and costs associated with the operation of the Independent Spent Fuel Storage Installation (ISFSI). The total cost presented for review during this period to decommission Humboldt Unit 3 is \$400.2M. Previously presented and approved decommissioning costs total \$486.9M. The associated Decommissioning Cost Estimate report describes an anticipated \$199.4M in remaining activities to be completed, subject to future reasonableness review. The total approved decommissioning budget for HBPP Unit 3 in the 2015 NDCTP is \$1,095.4M.

For the \$400.2M costs presented for reasonableness review in this filing, the costs in the blue line categories shown in subsequent tables are less than the corresponding budgets previously approved for those categories.

Table I- 1, Completed Projects Approved Cost Estimate to Actual Costs (2012-2014)

A 2012 NDCTP CPUC Filing	B 2012-2014 Approved 2012 NDCTP Estimate		C Amount Spent Presented for Reasonableness			G Previously Presented and Approved	H Spent Remaining for Future Reasonableness Review	Delta C (F+G-H)
	Base	Nominal	D 2012-2014 <sup>1</sup>		F Total			
			2012-2014 <sup>1</sup>	2015-2018				
	378,802,217	398,622,050	34,289,776	-	34,289,776	227,153,626	7,630,505	129,548,143
1 General Staffing	66,879,786	69,938,306	-	-	-	66,432,824	7,630,505	(4,125,023)
License Termination Survey	7,149,598	7,487,619	-	-	-	-	7,630,505	(142,886)
Overall Project/Civil Works Oversight	59,730,188	62,450,687	-	-	-	66,432,824	-	(3,982,137)
2 Remediation of Plant Systems	51,287,467	53,421,149	41,535	-	41,535	43,748,081	-	9,631,534
Direct Labor	32,716,722	34,022,032	41,535	-	41,535	31,823,080	-	2,157,417
Liquid Radwaste Removal	6,938,936	7,320,409	-	-	-	4,282,774	-	3,037,635
Tools and Equipment	11,631,810	12,078,709	-	-	-	7,642,227	-	4,436,482
3 Site Infrastructure	2,251,887	2,343,226	-	-	-	4,935,540	-	(2,592,314)
4 Specific Project Costs	72,184,834	75,643,003	9,783,021	-	9,783,021	27,282,792	-	38,577,191
Reactor Vessel Removal	15,896,279	16,530,248	-	-	-	15,263,911	-	1,266,337
Turbine Building Demolition	14,370,353	14,940,563	-	-	-	12,018,881	-	2,921,682
Civil Works	41,918,202	44,172,193	9,783,021	-	9,783,021	-	-	34,389,172
Nuclear Facilities	41,376,133	43,601,017	9,656,521	-	9,656,521	-	-	33,944,496
Office Facilities	542,069	571,176	126,501	-	126,501	-	-	444,676
5 Waste Disposal (Excludes Cansons / Cansons)	50,762,743	53,876,290	5,494,905	-	5,494,905	46,507,268	-	1,874,117
Labor (Packaging and Handling)	11,512,031	12,241,660	-	-	-	10,874,350	-	1,367,310
Third Party Disposal Sites	36,620,246	38,850,851	5,494,905	-	5,494,905	31,867,488	-	1,488,459
Waste Handling Buildings	2,630,466	2,783,779	-	-	-	3,765,480	-	(881,651)
6 Small Value Contracts	20,925,024	27,720,352	37,924	-	37,924	21,575,040	-	6,115,400
Small Dollar Vendor	7,186,457	7,454,061	37,924	-	37,924	2,680,883	-	4,735,254
Specialty Contracts	19,638,567	20,265,292	-	-	-	18,895,065	-	1,390,227
7 Spent Fuel Management	13,450,356	14,154,252	-	-	-	14,270,307	-	(125,145)
Security (PG&E)	10,126,024	10,690,990	-	-	-	11,235,555	-	(544,565)
ISFSI O&M	1,525,843	1,593,444	-	-	-	1,632,172	-	(38,729)
ISFSI Staffing / Engineering / Specialty Contracts	1,727,246	1,795,538	-	-	-	1,089,192	-	706,346
ISFSI Infrastructure Expense	-	-	-	-	-	77,231	-	(77,231)
NRC Fees	71,243	74,280	-	-	-	245,246	-	(170,966)
9 Cansons	65,245,822	69,346,787	9,194,034	-	9,194,034	-	-	60,152,753
Field Work (Civil Works Contract)	58,556,128	61,976,019	9,194,034	-	9,194,034	-	-	52,781,985
Slurry Wall/CSM Wall	58,556,128	61,976,019	9,194,034	-	9,194,034	-	-	52,781,985
Waste Disposal	4,883,412	5,380,589	-	-	-	-	-	5,380,589
Packaging / Material Handling	1,806,283	1,990,179	-	-	-	-	-	1,990,179
10 Cansons	23,704,100	25,642,441	8,379,236	-	8,379,236	-	-	17,263,205
Canal Removal	12,580,790	13,386,673	8,379,236	-	8,379,236	-	-	5,007,437
Canal Disposal	11,123,310	12,255,768	-	-	-	-	-	12,255,768
11 Common Site Support	5,720,750	5,995,251	1,159,807	-	1,159,807	2,391,776	-	2,443,668
Relocation of Trailer City	2,542,000	2,688,812	888,774	-	888,774	-	-	1,800,039
Groundwater Treatment System Ops	761,474	792,786	271,033	-	271,033	14	-	521,739
Groundwater Treatment System	2,417,276	2,513,653	-	-	-	2,391,763	-	121,890
12 EPC	489,447	521,993	199,315	-	199,315	-	-	322,678
EPC Services	489,447	521,993	199,315	-	199,315	-	-	322,678
Other Services - Training	-	-	-	-	-	-	-	-

Note: 1. Small Value Contracts Spend Includes \$3,149 for 2011 costs that were not sent through reasonableness review in 2015

Table I- 1, Completed Projects Approved Cost Estimate to Actual above identifies the flow of the Completed Projects Review discussion. The outline begins with a discussion of General Staffing (Section 1) and concludes with a review of Engineering, Procurement and Construction (EPC) costs (Section 12). The table also contains the financial information from the 2012-2014 time period.

Table I- 2, Completed Projects Approved Cost Estimate to Actual Costs (2015-2018)

A 2015 NDCTP CPUC Filing	B 2015-2018 Approved 2015 NDCTP Est mate		C Amount Spent Presented for Reasonableness			G Previously Presented and Approved	H Spent Remaining for Future Reasonableness Review	Delta C-(F+G+H)
	Base <sup>1</sup>	Nomina <sup>2</sup>	2012-2014	2015-2018				
				2015-2018	Total			
	415,768,624	443,560,039		365,887,901	365,887,901	5,254,094	34,301,629	38,116,416
1 General Staffing	34,643,447	36,475,856		28,138,098	28,138,098		6,020,138	2,317,621
License Termination Survey	6,296,058	6,641,393						621,255
Overall Project/Chil Works Oversight	28,347,388	29,834,463		28,138,098	28,138,098			1,696,365
2 Remainder of Plant Systems	5,104,925	5,263,992		4,587,091	4,587,091			696,901
Direct Labor	2,743,043	2,860,330		2,655,329	2,655,329			205,000
Radiation Protection	2,743,043	2,860,330		2,655,329	2,655,329			205,000
Tools & Equipment	2,361,882	2,423,662		1,931,762	1,931,762			491,900
RP Tools & Equipment	2,361,882	2,423,662		1,931,762	1,931,762			491,900
4 Specific Project Costs	103,968,390	110,194,042		68,792,685	68,792,685	1,720,205	28,281,491	11,399,661
Reactor Vessel Removal	1,693,007	1,739,108		(736)	(736)	1,720,205		19,639
Civil Works	102,494,605	108,683,615		68,886,219	68,886,219			11,515,905
Nuclear Facilities Demolition	60,161,115	62,821,873		66,293,695	66,293,695			(3,471,822)
Administration Services	40,814,849	43,029,349		42,437,915	42,437,915			391,435
Restricted Area Prep	5,547,472	5,673,442		6,171,599	6,171,599			(496,138)
Refueling Building	8,304,579	8,496,126		9,170,035	9,170,035			(673,909)
Units 1, 2 and 3 Circulating Water Lines	2,722,521	2,785,325		6,612,272	6,612,272			(3,826,947)
Upper Yard Demolition	1,238,993	1,267,574		957,170	957,170			310,405
Temporary Facilities	1,532,701	1,568,057		944,705	944,705			623,352
Offices & Facilities Demolition	1,865,978	2,041,690		2,101,145	2,101,145			(59,454)
Final Site Restoration	37,253,866	40,412,905					28,281,491	12,131,414
Other Services/Letter of Credit	3,213,846	3,407,147		491,379	491,379			2,915,768
Disallowed Scope	(219,222)	(228,681)		(92,788)	(92,788)			(135,893)
5 Waste Disposal (Excludes Caisson / Canals)	34,822,844	38,799,614		35,229,131	35,229,131	3,533,889		36,594
Third Party Disposal	32,601,773	36,485,244		35,229,131	35,229,131	1,293,653		(37,540)
Labor Packaging and Handling	2,221,071	2,314,370				2,240,236		74,134
6 Small Value Contracts	12,960,489	13,562,375		11,017,677	11,017,677			2,544,697
Small Dollar Vendors	1,750,345	1,846,866		1,723,266	1,723,266			123,600
Small Dollar Vendors	1,750,345	1,846,866		1,723,266	1,723,266			123,600
Specialty Contracts	11,210,144	11,715,509		9,294,412	9,294,412			2,421,097
Environmental Contracts	1,041,989	1,121,875		1,512,840	1,512,840			(390,866)
Permitting	302,000	322,857		983,518	983,518			(680,661)
Specialty Consultants	9,866,156	10,270,777		6,798,054	6,798,054			3,472,724
7 Spent Fuel Management	35,352,832	37,793,062		27,714,733	27,714,733			10,020,348
Security (PG&E)	24,152,470	25,910,839		21,937,592	21,937,592			3,973,248
ISFSI Operate & Maintain	2,180,894	2,316,519		1,912,651	1,912,651			403,868
ISFSI Staffing / Engineering / Specialty Contracts	3,346,908	3,517,087		1,877,811	1,877,811			1,639,276
ISFSI Infrastructure Expenses	5,490,000	5,792,821		1,812,492	1,812,492			3,980,328
NRC Fees	192,559	197,816		174,187	174,187			23,630
8 Caisson	111,677,601	141,915,900		141,816,081	141,816,081			115,508
Field Work (Civil Works Contracts)	77,189,053	81,405,385		80,613,876	80,613,876			791,509
Caisson	61,833,344	65,359,258		68,261,967	68,261,967			(2,902,708)
Slurry Wall/CSM Wall	12,641,528	13,211,889		10,575,080	10,575,080			2,636,809
Dewatering	2,714,181	2,834,238		1,776,830	1,776,830			1,057,408
Project Staffing	17,643,186	18,869,164		13,231,648	13,231,648			5,637,516
Waste Disposal	23,313,034	26,205,862		35,092,897	35,092,897			(8,887,035)
License Termination Survey	4,189,848	4,486,368		5,398,254	5,398,254			(811,887)
Tools & Equipment	1,253,937	1,301,563		763,662	763,662			537,901
Other	9,089,943	9,663,248		6,715,743	6,715,743			2,947,505
RP Discrete	1,338,207	1,425,435		1,498,091	1,498,091			(72,654)
Specialty Contracts	6,887,232	7,312,073		4,990,147	4,990,147			2,321,926
Specialty Contracts	5,274,446	5,586,229		3,988,979	3,988,979			1,597,250
Environmental Contracts	1,250,386	1,340,034		921,147	921,147			418,887
Specialty Permitting	362,400	385,810		80,020	80,020			305,790
Small Dollar Vendor	864,504	925,740		227,505	227,505			698,235
Small Dollar Vendor	864,504	925,740		227,505	227,505			698,235
10-Canals	44,242,713	46,962,455		38,670,562	38,670,562			8,291,873
Canal Removal	32,582,306	33,939,883		32,095,069	32,095,069			1,844,814
Canal Disposal	11,660,406	13,022,572		6,575,493	6,575,493			6,447,079
11 Common Site Support	1,725,005	1,883,437		1,270,370	1,270,370			563,068
Relocation of Trailer City	1,398,085	1,497,542		928,129	928,129			569,412
Groundwater Treatment System Ops	34,579	35,303		35,303	35,303			0
Groundwater Treatment System	292,342	300,592		306,937	306,937			(6,345)
12-EPC	10,270,378	10,781,616		8,651,473	8,651,473			2,130,143
EPC Services	9,588,908	10,059,383		7,339,041	7,339,041			2,720,342
Other Services - Training	681,470	722,233		1,312,432	1,312,432			(590,200)

Notes:

1. HBPP decommissioning estimated cost to complete approved in D-17-05-020 with contingency allocated to each category as authorized through AL 5203-E effective Mar 23, 2017
2. Amount of authorized expenditures escalated to nominal dollars in the year planned to spend Jan 1, 2015 through Dec 31, 2018. Includes complete budget for all CWC scope of work.
3. Reactor Vessel Removal has a credit of \$736 due to late invoice credit.

Table I- 2, Completed Projects Approved Cost Estimate to Actual Costs above contains the financial information for the 2015-2018 time period.

The 2015-2018 costs include actual costs incurred from January 1, 2015 through August 31, 2018 and forecasted costs from September 1, 2018 through December 31, 2018. A true up for actual costs from September 1, 2018 through December 31, 2018 will be provided in 2019.

Table I- 3, Completed Projects Status

Scope of Work Categories that Close Out in 2018 NDCTP	Scope of Work Categories that Remain Open in 2018 NDCTP to Support Final Site Restoration
2 Remainder of Plant Systems	1 General Staffing
4 Specific Project Costs	6 Small Value Contracts
5 - Waste Disposal (Excludes Caisson / Canals)	7 Spent Fuel Management
9 Caisson	
10-Canals	
11 - Common Site Support	
12-EPC	

## 1 GENERAL STAFFING

This General Staffing section reports on the headcount and associated costs of staffing. It contains two subsections; the first is a breakdown by department and the second is by program.

The cost of staffing (labor) was a significant portion of the overall costs of the Humboldt Bay Power Plant (HBPP) Unit 3 Decommissioning Project. The cost of direct labor for performance of work and the cost of overhead labor that supported the direct labor force, contributed to total labor costs. Staffing comparisons are depicted in Table 1-1, General Staffing.

**Table 1-1, General Staffing**

2015 NDCTP ID		Approved NDCTP Estimate		Amount Spent Presented for Reasonableness			Previously Presented and Approved	Remaining For Future Reasonableness Review
		Base	Nominal	2012-2014	2015-2018	Total		
E.4.1	General Staffing	101,523,233	106,414,162		28,138,098	28,138,098	66,432,824	13,650,642
E.4.1.2	2012 NDCTP CPUC Filing	66,879,786	69,938,306				66,432,824	7,630,505
	General Staffing	66,879,786	69,938,306	-	-	-	66,432,824	7,630,505
	License Termination Survey	7,149,598	7,487,619	-	-	-	-	7,630,505
	Overall Project/Civil Works Oversight	59,730,188	62,450,687	-	-	-	66,432,824	-
	2015 NDCTP CPUC Filing	34,643,447	36,475,856		28,138,098	28,138,098		6,020,138
	General Staffing	34,643,447	36,475,856		28,138,098	28,138,098	-	6,020,138
E.4.1.1.1	License Termination Survey	6,296,058	6,641,393	-	-	-	-	6,020,138
	Overall Project/Civil Works Oversight	28,347,388	29,834,463	-	28,138,098	28,138,098	-	-

Actual costs during 2015 through 2018 for General Staffing Overall Project/Civil Works Oversight were \$28.1M compared to the approved cost estimate of \$29.8M. License Termination Staffing is not being presented for reasonableness review in this NDCTP.

The right people were selected for the tasks at hand to ensure that decommissioning was completed safely and in an efficient, cost-effective manner. It also ensured that they were aligned with Project Management’s expectations for success. Pacific Gas & Electric’s (PG&E) entire team recognized the importance of effective horizontal and vertical communication in the organization to ensure that expectations were understood. This was especially needed when considering the highly-variable environment of this decommissioning project.

Being a leading utility in the United States, PG&E established site-level objectives to support the HBPP Decommissioning Organization with Executed Goals and Planned Principles that aligned with the company’s Mission, Vision and Culture Expectations. These Corporate goals evolved during the nine-year decommissioning project.

### PG&E’s Mission

- To safely and reliably deliver affordable and clean energy to our customers and communities every single day, while building the energy network of tomorrow.

### PG&E’s Vision

- With a sustainable energy future as our North Star, we will meet the challenge of climate change, while providing affordable energy for all customers.

### PG&E’s Culture



- We put safety first.
- We are accountable. We act with integrity, transparency and humility.
- We are here to serve our customers.
- We embrace change, innovation and continuous improvement.
- We value diversity and inclusion. We speak up, listen up and follow up.
- We succeed through collaboration and partnership. We are one team.

By ensuring this decommissioning project was safely completed in a cost-effective and in an environmentally-compliant manner, HBPP Management aligned itself with PG&E's Corporate goals. With the completion of the Civil Works (CW) scope, Unit 3's former site was fully restored to its agreed-to end state, per the approved permit conditions. Returning the site to the agreed habitat conditions with applicable permitting agencies ensured PG&E Corporate that resources were appropriately provided for future end-state periodic follow-up reviews, so they could meet PG&E's North Star - a sustainable energy future with a minimal level of resources.

A commitment to its customers, employees, community and the environment led to PG&E's decision to retain the responsibility to identify, monitor and mitigate identified risks related to this decommissioning. As a result, PG&E decided to identify and procure a successful, well-vetted bidder to perform the balance of the decommissioning, while retaining oversight and monitoring functions to ensure the project was completed as safely as possible. To further reinforce PG&E's commitment to safety and excellence, the company committed to the California Public Utilities Commission (CPUC) to take the following actions:

- PG&E's procurement process examined disciplinary policies as part of each contractor's safety qualification.
- The procurement process examined putting a high value on each contractor's policies regarding prescription drugs and drug testing as part of the contractor's safety qualifications.
- The formal safety training and safety certifications of each contractor's proposed Site Safety Officers were evaluated before they were accepted in that role during the bid process.
- When significant changes to the work methods that were agreed upon during the bidding process were proposed, PG&E conducted a risk assessment on the new process, including a discussion of additional hazards and risks, necessary mitigation and potential costs.
- The roles and responsibilities of all PG&E on-site representatives were clearly defined in writing and communicated to all on-site project staff and contractors.
- To foster continuous training improvements of new representatives, PG&E captured the lessons learned through the Corrective Action Program (CAP).
- Procurement employed a third party specializing in assessing contractors' safety programs and validating and tracking contractors' safety and insurance data.

The HBPP Site Vision was to *"complete the decommissioning of HBPP in a manner that established a benchmark for the nuclear industry,"* which fully aligned with the Corporate culture statement for PG&E. HBPP put an extreme focus on safety, embraced innovative methods and strove for continuous improvement. HBPP was accountable and acted with integrity, transparency and humility. Only through transparency and humility could Project Management acknowledge, learn from and correct any issues that might hinder their vision.



Through close integration with the Civil Works Contractor (CWC), PG&E developed a cohesive team during the multi-phase HBPP Decommissioning Project. PG&E has chosen to use the experience and expertise developed at HBPP by reassigning key members to develop plans for the upcoming decommissioning of Diablo Canyon Power Plant (DCPP).

Maintaining and improving PG&E's standing in the Humboldt County community was critical when HBPP became one of the most prominent employers in the area. Decommissioning goals at HBPP emphasized representing stakeholders' business interests, relationships and reputations. The entire HBPP Team developed shared mutual values that addressed PG&E's Corporate Vision, Goals and Strategies as decommissioning progressed.

The HBPP Decommissioning Project developed and implemented the following goals and objectives:

- Safety - Safety was the core of our culture at Humboldt Bay.
- Decommissioning Excellence - This was the benchmark for decommissioning projects. We completed the Humboldt Bay decommissioning safely and efficiently, with minimized effects to the public and environment through controlled worker hazard exposure.
- Teamwork - We worked together as a team, acted with integrity and communicated openly and honestly.

The workforce demonstrated commitment by developing a key initiative. The primary initiative at HBPP was promoted in our safety culture. Rather than set any long-term "Fewer Accidents" or "No Accident" goal, the workforce adopted a "Plus 1" approach to safety, based on a focused safe work environment, repeating that same focus every day. This meant that the "Plus 1" way of thinking did not aim at an "end goal." It was crucial to make safety a priority every day and in every action. Safety was and is the core of the culture at Humboldt Bay. Every employee was empowered and expected to contribute to the safe work environment, aligning with PG&E's Corporate culture goal of inclusion. They were urged to speak up, listen up and follow up whenever there was an issue.

Transitioning from the self-perform phase to contractor-perform phase in 2014 to 2015, was a major transition for the HBPP Management group, leading to the establishment of an Oversight Team, who monitored the CWC's work performance. HBPP retained this function to ensure that the CWC took on the HBPP safety culture, supported the safety vision and performed the project work safely and efficiently.

Management first made sure that the vision of the Project Team and PG&E Management was understood. Initial employee training sessions presented what Management valued and what was expected of all new employees. In addition, current employees attended regular meetings in which values and expectations were discussed. The meetings decreased in frequency as the workforce matured and demonstrated excellence. Visual aids were placed in common areas to reinforce focus on successes and goals. Employee-led voluntary lunchtime training sessions and Project Management Institute materials were made available to aid personnel in obtaining Project Management Professional Certification and continued education credits. Radiation Protection (RP) offered training to staff every two weeks, in addition to offering a formal certification course. Senior Management attended scheduling meetings, Plan-of-the-Day (POD) meetings and Plan-of-the-Next Day (POND) meetings.

Communication was key to aligning the entire HBPP Team with the project's vision. Before major project changes or evolutions began, they were announced and briefed to stakeholders. Examples of such evolutions were the transition to the CWC, downgrading of the Radiological Controlled Area (RCA) and moving into the Final Status Survey (FSS).

The HBPP Oversight Team's ability to understand schedule constraints and relate them to physical actions taken in the field firmly established ownership and buy-in that contributed to the success of this project. Buy-in was particularly important when having a workforce composed of local hires, operators, utility workers and organizations with varied exposure to project control tools. Production increased over time, with commensurate safety improvements and environmental stewardship, which proved the value of the time and effort invested. The pride and accountability instilled in each team member established our "one team" approach.

### **1.1 Overall Project**

Effective management of the project cost was contingent on control of labor force and staffing requirements. As the work to be performed changed, the labor force had to change with it. A staffing plan identified expected changes and adapted strategies to address the transitions in a safe and effective manner.

HBPP Site Management developed a staffing plan for each period through the end of 2018. The staffing plan included ramp-up, ramp-down, durations, funding sources and the number of staff needed to complete each function associated with the project.

Anticipated work determined the need for appropriate levels of personnel. When workload increased, staffing to successfully create pre-project plans and implement plans required a staffing increase. During the HBPP Unit 3 Plant System Removal Phase, the work scope was dynamic, with substantial uncertainty. However, the CW phase work scope had less uncertainty and provided opportunity to more thoroughly define a contract work scope. As CW's work was completed and the project moved into FSS, the needs were limited to only a small number of staff to meet license termination commitments to the Nuclear Regulatory Commission (NRC).

HBPP Site Management routinely reviewed staffing needs and tracked actual expenditures against expected expenditures. By developing a staffing plan very early in the project and by frequently reviewing and updating needs against actuals, HBPP Site Management optimized staffing levels. As a result, actual staffing expenditures remained well within acceptable margins of predicted values.

Staffing costs included fixed overhead, which was those costs incurred for maintaining staff who were assigned to Management, Safety, Facility Maintenance, Licensing Support, Procurement and Finance. Fixed overhead was job functions that were needed regardless of the status and progress of the decommissioning. It also included direct and discrete labor, which were the staffing costs for personnel who directly supported schedule progress with engineered plans, development of Work Packages (WP) and permits.

These overhead costs were classified as Project Management Oversight (PMO) costs. PMO costs were split among active projects, based on how much time and effort was spent on them. When active projects were shifted in the schedule, PMO costs were redistributed to follow the work.

Staffing costs were also split between the base scope and Reactor Caisson support, based on the amount of work being performed. Field activity staffing levels were split between these scopes, using the ratios in Table 1-2, Overhead Staffing Division Between Base Scope and Caisson Scope.

**Table 1-2, Overhead Staffing Division Between Base Scope and Caisson Scope**

Over-head Split	2015				2016				2017				2018			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Base %	100	100	65	65	50	50	50	50	50	50	50	50	50	50	100	100
Caisson%	0	0	35	35	50	50	50	50	50	50	50	50	50	50	0	0

### 1.1.1 Department Staffing

#### 1.1.1.1 Site Management Team

PG&E recruited a highly-experienced and specialized group of skilled managers with strong technical backgrounds, as discussed in the 2015 Nuclear Decommissioning Cost Triennial Proceedings (NDCTP) filing.

The overarching criteria considered when selecting the Management Team were:

- Technical excellence;
- Team compatibility;
- Safety culture background;
- Project management, demolition and risk mitigation experience;
- Ability to interface with the public and community;
- Prior nuclear credentials or experience; and
- Prior environmental or waste background experience.

Additional considerations in hiring the Management Team varied based on the position. Necessity, and in some cases regulatory requirements, dictated the budget.

Staffing during the planning and self-perform stages required stronger resources for planning, work control and RP. As work was completed, a shift towards FSS and environmental concerns took place. As HBPP moved into Final Site Restoration (FSR), PG&E focused its oversight as necessary. The Management organization at that time was well-suited to oversee site restoration.

#### Senior Director of Nuclear Decommissioning

The Senior Director of Nuclear Decommissioning was responsible for oversight of the entire decommissioning and site restoration. The Director's primary concerns were the safety of employees, implementation of work processes, disposal of wastes and control of the budgets to

complete the entire project. The Director worked collaboratively with a wide variety of groups to safely and efficiently execute the mission. These groups included, but were not limited to:

- Internal stakeholders (e.g., RP, Safety, Security, Quality Verification groups);
- External stakeholders (e.g., interested state and federal regulators, other utilities that were preparing to decommission facilities); and
- Local community groups (e.g., Citizen’s Advisory Board or “CAB”).

#### Decommissioning Manager

The Decommissioning Manager provided management and supervision of the day-to-day activities of the Finance, Litigation and Project Controls groups; oversight of remaining self-perform work field activities; and oversight of the contractors and contracts for Civil Works Projects (CWP). This position was primarily responsible for cost and schedule baselines and managing the line-of-business interests for PG&E. This position was released in 2017, and residual responsibilities were spread to the Environmental Manager, Site Closure Manager, Business Analysts and contracted Projects Controls Team.

PG&E reduced direct reports, as their specific specialties were no longer needed. The Engineering Manager was released in 2015, the RP Manager was released in 2016, and the Deputy Director was released in 2017. Any residual responsibilities were assumed by either the Site Closure Manager or the Environmental Manager.

#### Site Closure Manager

The Site Closure Manager took on the remaining responsibilities of the Engineering Manager and the RP Manager.

The Site Closure Manager supervised the Count Room, CAP, Records Management, Training, FSS and the remaining RP staff. Specific activities included: managing and supervising the day-to-day activities of the FSS and Count Room employees; coordinating activities with NRC as required for the License Termination Plan (LTP); developing and implementing the “Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual” (MARSAME) and the “Multi-Agency Radiation Survey and Site Investigation Manual” (MARSSIM); FSS packages for disposition of waste; providing radiological analysis support to RP, Environmental, Radwaste, FSS and LTP; coordinating Quality Assurance/Quality Control (QA/QC) with outside laboratories; coordinating the Radiological Environmental Monitoring Plan (REMP) sampling for HBPP; the FSR plans; and other duties as requested by HBPP’s Director for Decommissioning.

#### Environmental Manager

The Environmental Manager assumed the remaining responsibilities of the Deputy Director’s role when the position was vacated in March 2017.

The Environmental Manager supervised the Environmental, Remediation and Waste organizations, while maintaining some responsibilities for remnants of the Engineering organization, including day-to-day supervision of Fire Protection and Safety. This approach aimed to put focus on key project priorities as the site transitioned.

Staff ramp-down was laid out in the “Staffing Plan” to ensure there was focus on controlling project cost and schedule through continued oversight of the CWC. This was while also releasing resources that were brought in for specific phases of work.

Civil Works Contractor (CWC) (Reference Section 9.1.11, CWC Project Staffing)

In mid-2014, the field work portion of the CW phase of the project began. HBPP Site Management continued to exercise the same approach for managing the project and worked cooperatively with the CWC to instill these same values. As the CWC became more familiar with the established practices HBPP Management had implemented on the site, the responsibility for managing several areas formerly managed directly by HBPP Site Management was transferred to the CWC including:

- Training;
- Site maintenance;
- Work control;
- Remediation activities; and
- Project execution planning and field execution.

The transfer of responsibility for the functions listed above facilitated the HBPP staff transition from an execution role to an oversight role.

#### 1.1.1.2 Decommissioning Organization

The Decommissioning Organization was responsible for performing cost control, budget control and procurement functions. The organization was also tasked with oversight, identification and control of project transitions and work.

The Decommissioning Organization interfaced directly with the CWC and oversaw associated field activities.

Central to the project and led by a highly-experienced Project Manager (PM), the Decommissioning Organization began its activities when PG&E decided to transition from a Safe Storage (SAFSTOR) mode into full decommissioning. The Decommissioning Organization was responsible for planning, executing and tracking the progress of the decommissioning of HBPP Unit 3, as well as its funding. To accomplish these activities, the Decommissioning Organization assembled a team of very experienced professionals. This team planned the decommissioning from start to finish. The makeup of the Decommissioning Organization changed as the workload declined. The final organization was composed of functional teams including:

- Field Work and Oversight;
- Business, Financial and Project Analysis; and
- CWP Oversight.

##### 1.1.1.2.1 Field Work and Oversight

The Field Work and Oversight functional group oversaw the execution of day-to-day decommissioning project tasks, as directed by the Decommissioning Manager. The Decommissioning Manager was responsible for overall project planning and execution, while

the Deputy Director oversaw the field execution of the CW Contract. HBPP retained these functions to ensure that the CWC took on the HBPP safety culture, supported the safety vision and performed project work safely and efficiently. The Deputy Director developed a five-person team of highly-experienced nuclear and decommissioning personnel, who were embedded in CW as professionals in their field and took oversight of their work as fundamentally important to finishing the project within scope and schedule and without safety violations.

#### 1.1.1.2.2 **Financial**

The Business, Financial and Project Analysis groups were responsible for tracking and validating expenses against budgets, contractual requirements and regulatory requirements. The Sarbanes-Oxley Act of 2002 (Pub. L. 107-204, 116 Stat. 745, enacted July 30, 2002), more commonly called Sarbanes-Oxley or SOX, is a federal law that sets new or expanded requirements for US public company boards, management and public accounting firms. The bill covers responsibilities of a public corporation's board of directors, adds criminal penalties for certain misconduct and requires the Securities and Exchange Commission to create regulations to define how public corporations are to comply with the law.

As a result of SOX, top Management was required to certify that they were "responsible for establishing and maintaining internal controls" and "have designed such internal controls to ensure that material information relating to the company and its consolidated subsidiaries is made known to such officers by others within those entities, particularly during the period in which the periodic reports are being prepared."

SOX testing was required every quarter by the PG&E FSS Business Process Group, beginning in the 2<sup>nd</sup> Quarter of 2014. This testing was a review of transactions that were paid after the monthly close of business.

To ensure the continued accuracy and completeness of the company's financial statements and US Securities and Exchange Commission filings, PG&E was required to update the Asset Retirement Obligations (ARO) on a quarterly basis.

Requests for HBPP Decommissioning Trust disbursements were prepared each month for costs that were paid to PG&E employees, contractors and vendors during the period of the request. Because disbursements were requested for costs when actually paid, a significant review of transactions in the PG&E accounting system, or Systems, Applications & Products (SAP), was completed each month to remove transactions that had been posted, but not paid. The completed report, with the requested amount of reimbursement, was submitted to the Asset Accounting Department for review and approval. The Asset Accounting Department prepared a Withdrawal Certificate to the Nuclear Decommissioning Trust Trustee, requesting reimbursement of the funds from the qualified trust to PG&E.

Staffing to support SOX testing, ARO updates and trust fund documentation underwent a ramp-down as the workload subsided; however, a reduced level of staffing will persist until the project is completed.

#### 1.1.1.2.3 **DOE Litigation Specialist**

Enacted by Congress, the Nuclear Waste Policy Act of 1982 (NWPAA), required the Department of Energy (DOE) to establish repositories for the disposal of radioactive waste. The NWPAA



initially provided for the selection of two permanent repository sites, with the initial site being limited to a capacity of 70,000 metric tons.

Under the NWPA, utilities that own nuclear plants are assessed a user fee on every kilowatt-hour the plant generates in exchange for the government's contractual commitment to accept commercially spent fuel for disposal. The government was slated to begin accepting spent fuel on January 31, 1998. The DOE failed to meet this date and has yet to receive any spent fuel. The DOE and the affected utilities have been engaged in litigation ever since the DOE failed to meet its obligations.

When work was suspended at the Yucca Mountain Repository, the DOE breached its contractual agreement with PG&E. PG&E reached a settlement agreement with the DOE in 2012. Per the agreement, yearly claims are submitted to the DOE. DOE Litigation staff is responsible for preparing and submitting DCP and HBPP's yearly DOE claims. Prior to submittal, they analyze expenses for appropriateness to the claims and then collect, justify and prepare backup documentation of those expenses. They remove any charges disallowed from previous claims and provide assurance that transactions for the claim were paid by PG&E within the specified period. Backup documentation includes detailed analytic spreadsheets of DCP and HBPP's financials to fulfill DOE's settlement agreement guidelines.

Proceeds of the DCP and HBPP claim submittals are returned to customers in accordance with the procedures adopted in the General Rate Case.

Under the current settlement agreement with the DOE, PG&E has submitted seven yearly claims to date, with the most recent submitted in October 2018. Six claims have been submitted to the DOE for the period of January 2011 through May 2017 for \$145.6M and was awarded \$142.6 for a recovery of 97.9 percent. The current claim for the period of June 2017 through May 2018 in the amount of \$25.0M is pending review.

PG&E has been issued an extension to the settlement agreement, from the Department of Justice, to continue the annual claim process through December 31, 2019 for the delay in DOE's acceptance of spent fuel waste.

The DOE Litigation Specialist and support staff are the positions within the Decommissioning Organization that will remain in place throughout the Independent Spent Fuel Storage Installation (ISFSI) Operations phase, final transfer of spent nuclear fuel and Greater Than Class 'C' (GTCC) wastes to the DOE and final ISFSI decommissioning and site restoration.

#### 1.1.1.2.4 **Project Controls and Business Analyst**

Project Controls functions were assigned to the Business Analyst, Project Controls Analyst and the Invoice Coordinator. They were responsible for monitoring the decommissioning project's performance.

Various teams, supported by the Business Analyst, were assembled to track, monitor and control project costs. First, a Work Breakdown Structure (WBS) was established, using the approved 2009 NDCTP cost study, and was divided into eight cost categories to measure cost performance as the project evolved. HBPP Management tracked performance to keep leadership informed of trends and deviations.

The PMO and Business Analyst were responsible for supporting government- and trust fund-related filings. This included annual Advice Letters to the CPUC, NDCTP filings and NRC assurance of funding reports. The PMO was involved in supporting all aspects of project management pertaining to cost and schedule. Examples of such aspects were purchase requisitions, vendor invoice review, contract performance tracking, risk and opportunity analysis and contract closure.

To help support project goals, all major vendor invoices were reviewed and tracked. It was imperative to maintain a consistent accounting system to support the CPUC filing and ensure accurate budget tracking.

The role of the Business Analyst was updated as needed to provide accurate information in support of annual Advice Letters, NDCTP and various other CPUC-related reporting requirements.

The Business Analyst was an integral part of staffing analysis and forecasting. Each department manager notified the Business Analyst of any unexpected change in staffing or long-term leave of absence that affected cost.

The Business Analyst and department managers met monthly to review the most recent staffing plans to suit the project's needs. From discussions made in these meetings and from regular communications, results were used to formulate costs, which were then compared to original plans and budgets. This reinforcement provided drive and focus to maintain an optimal staffing plan.

Financial updates provided to the Management Team allowed for review and evaluation of project finances, were used for department-level evaluation and reviewed with each manager. Department costs were outlined as they pertained to the monthly CPUC budget. The costs were also compared to the budgets by year, to highlight trends that could be utilized for forecasting future costs and predicting the effect on the project. The forecasts were often referenced when deciding the overall trend of planned expenditures. These forecasts helped dictate whether adjustments would be made to align more closely with the original plan or be altered to further deviate from it. Vendor invoices were received daily, reviewed for appropriateness and then categorized so they could be entered into the accounting system. Each invoice was categorized in accordance with the system approved in the NDCTP. Invoices pertaining to large contracts were tracked in a separate database structure to ease identification of spending trends, for comparison of contracts to actual performance and to provide other useful insights, as requested.

Invoice Coordinators processed invoices, so they could be validated and paid in accordance with contract terms. They confirmed that invoices and associated documents had been uploaded to the Electronic Documentation Routing System (EDRS) and assigned the invoices to appropriate reviewers and approvers. In addition, Invoice Coordinators were responsible for ensuring that invoicing issues were resolved and that the resolution was documented. Their reviews identified issues to ensure the issue or item had not been previously identified and resolved, determined if the issue or item required formal resolution and ensured that the desired resolution or concern was clearly worded.



#### 1.1.1.2.5 **Contract Administrator and Contract Technical Representatives**

PG&E used contracted support extensively during the HBPP demolition project. Most of the contracted support worked directly for PG&E in a staff-augmentation role for the self-perform portion of the demolition project. Several major definable features of work warranted contracts dedicated to completion of the grouped demolition tasks, the Turbine Building demolition and the CW portion of Unit 3 demolition.

To manage these larger scopes of work, PG&E set up a Contract Management Team to execute administration of the technical contract. Using lessons learned from the demolition of Units 1 and 2, staff with prior HBPP site experience provided the Contract Management Team with insight for WP review from HBPP departments, including RP, FSS, Strategic Waste Management, Safety, Environmental, Engineering and Procurement (Contract Management), prior to issuance. This helped ensure compliance with HBPP procedures and coordination with interfacing decommissioning activities.

For existing staff at HBPP, the CW contract resulted in their roles shifting from execution to oversight. Along with a Management Team, the Senior Director developed an oversight plan to provide direction for HBPP staff during this transition. The primary driver in this oversight plan was clarification of role changes. The focus shifted from performing the execution function to assessing the risks to PG&E that work methods described by the CWC imposed, and subsequently working with the CWC to minimize those risks.

The early efforts by the CWC to meet contractual requirements and develop WPs compliant with established HBPP protocols and CWC requirements were a challenge. The Field and Administrative Contract Technical Representatives orchestrated a major effort, called the "Field Initiative," to push past this initial challenge. The goal was to provide site-specific knowledge directly from HBPP Subject Matter Experts (SME), who would support the CW staff, so that WPs could be developed in a manner that provided compliance with both HBPP's and the CWC's safety culture. The effort was considered successful in achieving the targeted work start date.

The CW Contract Administration staff was selected based on expertise in nuclear-related activities, experience with existing HBPP decommissioning activities and anticipated support requirements. The initially-planned staffing level was higher to accommodate the early surge of submittals by contractors to satisfy contractual requirements that established working procedures and a foundation for future work.

#### 1.1.1.3 **Engineering**

The Engineering function for decommissioning was embedded in the Plant Director's organization. During the self-perform phase of decommissioning, the Engineering functional area was responsible for: developing, reviewing and approving drawings, calculations, WPs and other documents; evaluating non-conformance of licensed components for engineering implications; assisting with development of workflow plans; revising engineering procedures and programs; field engineering; and developing rigging and heavy-lift plans.

When work shifted from self-perform to CW contracts, the need for a full engineering department was eliminated. HBPP retained the appropriate external SMEs to facilitate review of engineering and work plans. Ramp-down continues as HBPP approaches FSR.

As HBPP became a CWP, the work control process also transitioned. A new procedure, HBAP C-17, Work Control Process for Civil Works Projects, was developed for use by the primary CWC. The new procedure focused on ensuring that CWP work was clearly defined, thoroughly reviewed, totally transparent and within safety, contractual and regulatory requirements. HBAP C-17 facilitated communication with the CWC to ensure that work plans submitted by contractors met requirements so they could be reviewed and approved.

#### 1.1.1.4 Radiation Protection (RP)

The RP organization primarily implemented the requirements of Title 10 of the Code of Federal Regulations (CFR) §20 (10 CFR §20) (Standards for Protection Against Radiation). The organization contributed significantly to implementation of the REMP and compliance with 40 CFR §190 (Environmental Radiation Protection Standards for Nuclear Power Operations), Unit 3 Technical Specifications and 10 CFR §19 (Notices, Instructions and Reports to Workers: Inspection and Investigations). For decommissioning sites, the RP program was perhaps the major focus area of NRC oversight, particularly once nuclear spent fuel had been transferred to dry cask storage.

The RP organization retained a core group of both professional and technician-level staff with prior experience in decommissioning. The three principal leaders of the RP Department - the RP Manager, the Site Closure Manager and the Senior RP Consulting Engineer - led the RP organization during the demolition phase. These leaders manage the team of RP technicians described in Section [2.1.2](#).

In addition to the experienced staff of technicians recruited for the project, local personnel were hired primarily as support labor to RP. As the project progressed and radiological hazards decreased, locally-hired technicians advanced to assume roles in RP, Count Room and FSS organizations. Hiring local personnel reduced HBPP's per diem budget, while providing a stable workforce and injecting money into the local economy.

The RP organization began the triennium with approximately seventeen positions performing assigned duties in the following functional areas:

- Dosimetry and RP Records Management Team;
- RP Instrumentation Maintenance and Calibration Team;
- RP Engineering Team;
- Radioactive Materials Control Team;
- RP Operations Team;
- RP Radiologically-Restricted Area Access Control; and
- SAFSTOR Radiological Monitoring Team.

As radioactive materials (source term) were removed and sent for disposal, associated radiological hazard and risk were steadily reduced. Reduction in source term and risk reduced the staffing needed to monitor and control radiological hazard and risk. Staffing levels have slowly ramped down over the remaining balance of decommissioning.

HBPP radiological decommissioning ended with the lowest man-REM dose of any commercial nuclear Demolition and Disposal (D&D) project in the United States; a noteworthy achievement given the initial levels of alpha contamination.

### **1.1.2 Program Staffing**

Programs are those activities that are required by regulation, license, or the company in order to ensure that decommissioning is accomplished safely and efficiently. While there were many such programs established at HBPP, programs that had the most financial impact included implementation of the CAP, Enterprise Risk, Work Control, Project Safety and Environmental Compliance Processes at HBPP. Project Safety encompassed components (occupational, industrial, radiological, environmental and systems) of the HBPP Decommissioning Project's Safety and Safety Risk Management Processes and Procedure Manual Programs. Many of these programs persisted through decommissioning.

#### **1.1.2.1 Safety Program**

The Safety Program was adopted by the CWC for the day-to-day responsibility of field work safety. The success of the HBPP Decommissioning Occupational and Industrial Safety Program continued in the CWPs of the decommissioning. The prudent measures taken by HBPP to make this a safe work environment for its workers and nearby surrounding public community were effectively adopted by the CWC. HBPP retained safety professionals for oversight and for coordinating with the CWC in perusing work documents and changes to procedures. The decommissioning safety culture continually encouraged a questioning attitude and allowed workers to bring up concerns and think outside the box in order to work safer. Without the adoption of the existing safety culture, starting a new, strong safety culture would have been more challenging.

The Civil Works phase of the decommissioning has a project safety record of no Occupational Safety and Health Administration (OSHA) lost-time injuries for more than five years and almost no recordable injuries (only two in five plus years), after having performed significantly challenging excavation and demolition work, much of which involved "First of Its Kind" evolutions. This accomplishment was evidence of a safety culture, work ethic and continued focus on safe work practices, which was expected by PG&E and CW Management. During the CW phase, the CWC was recognized by the National Safety Council and received the Green Cross for Safety medal. This award is presented to organizations that have distinguished themselves through outstanding safety leadership with a commitment to safety by building successful partnerships to save lives and prevent injuries. The PG&E Decommissioning Team received the PG&E Safety Awards by earning the Shermer L. Sibley Award six times in 2008, 2009, 2010, 2015, 2016 and 2018, and was a runner up in 2017. The Sibley Award is the most prestigious safety award a PG&E organization can earn in recognition of their safety achievements. NRC regulators recognized this achievement and routinely recommended national and world nuclear industry companies use HBPP as the benchmark standard in accomplishing decommissioning safety with lowest dose to workers.

#### **1.1.2.2 Corrective Action Program (CAP)**

HBPP's 10 CFR §50 License required that PG&E develop and maintain a Corrective Action Program (CAP) that was compliant with NRC regulations. At HBPP, PG&E utilized a function within the SAP enterprise risk management software known as "SAP Notifications" to identify, track and resolve issues potentially requiring corrective action. Every worker at HBPP had access to SAP Notifications, either directly or through their supervisor.

The CAP was used to identify performance and safety issues. An experienced coordinator was retained throughout the decommissioning process. The CAP Coordinator recognized adverse trends and CAP performance issues. HBPP Management was involved when there was potential for adverse trends, regulatory violations, regulatory reporting, or expenditure of resources to conduct cause analysis.

The success of this program within the nuclear part of the company has prompted PG&E as a whole to adopt a CAP for its entire organization, structured similarly to the NRC-required program.

### **1.1.2.3 Enterprise and Operational Risk Management (EORM)**

In support of PG&E's Corporate Risk Management Vision and Strategy, the HBPP Decommissioning Manager oversaw the PG&E Decommissioning Corporate Risk Management Program (DRM). This entailed implementation of the Enterprise and Operational Risk Management (EORM) Program. The Decommissioning Manager ensured that the DRM process complied with EORM requirements applicable to the decommissioning project. The Decommissioning Manager further ensured that any identified high-risk items were addressed at the EORM level and that the required risk data form was entered into the EORM database (ECTS-Risk).

At the project level, the HBPP Decommissioning Project Team developed and implemented an effective EORM. The DRM provided for systematic evaluation and management of decommissioning work process and work process activity risk elements. It provided a methodology for identifying, evaluating, assessing, mitigating, tracking and reviewing decommissioning work processes and activities that posed a potential risk to the public, the employees, or to the company. The DRM process integrated Management, Safety, Engineering, SMEs and workers into the process of risk identification, evaluation, response planning, monitoring, periodic review and reassessment.

DRM successfully integrated the essential elements of several available risk management resources into a coherent and productive Risk Management Process. Those resources included the DRM, the existing HBPP EORM, HBPP Industrial and Occupational Safety Programs, HBPP RAD Safety, Environmental Safety, Systems Safety, Engineering and SMEs. This integrated process resulted in outstanding safety performance and demonstrable risk reduction throughout the decommissioning process. The DRM Team facilitated several major design and process changes, which proved to be beneficial to the project's safe and environmentally sound production performance.

HBPP achieved lower health and safety residual risk levels than anticipated for facility decommissioning, utility decommissioning, waste transportation and Caisson removal activities.

### **1.1.2.4 Work Control Program (WCP)**

The Work Control Program (WCP) for PG&E's self-perform work was defined in Humboldt Bay Administrative Procedure HBAP C-45, Work Control Process. This procedure met regulatory requirements and brought together site programs, requirements and decommissioning strategy to provide detailed instructions for execution of physical field work. The program's primary objective was to assure work was performed safely, while keeping exposure As Low as

Reasonably Achievable (ALARA). This included creating no adverse impact to the public or to the environment.

A new procedure, HBAP C-17, Work Control Process for Civil Works Projects, was developed for use by the primary CWC. HBAP C-17 also contained necessary regulatory elements and site programs that ensured a safe and effective decommissioning. It laid out the interface between PG&E and the CWC, which ensured that work plans met contract requirements. PG&E accomplished this with review and approval of contractor submittals. HBAP C-17 was revised as the project moved through the CW phase to FSS and NRC's eventual approval of the site's license termination.

All site work was conducted under the HBAP C-17 WCP. HBAP C-45 was also necessary to complete remaining self-perform work.

Work Planners with specialized training and decommissioning experience were a key element of the WCP. They created WPs using a systematic planning process while documenting coordination between affected organizations, to ensure safe and compliant decommissioning. The Planners' decommissioning experience provided valuable insight and Best Management Practice (BMP) methods. Their input proved to be invaluable to planning strategies, decommissioning sequencing and preparation work.

Work planning took a wide range of programs, regulations, organizations and concurrent work activities into account when developing WPs that were ready for craft to execute in the field. Comprehensive plans that incorporated experiences and expertise from the broad knowledge base available at HBPP, provided assurance that critical program elements were captured.

A wide range of positive effects were realized from the WCP at HBPP, such as an excellent safety and exposure record and international recognition as an industry leader for decommissioning.

The HBPP Unit 3 Decommissioning Project was continually challenged with unique features and issues, due to the age of the facility, radiological conditions, operating history, small site footprint, competing projects, area weather and close proximity to operating generation units. These challenges required innovation and at times, first-of-their-kind work evolutions. Close coordination was required with multiple government agencies, site organizations, operating facilities and active site equipment operations. Some of the challenges included:

- Innovative and first-of-its-kind Cutter Soil Mix (CSM) wall for the Caisson removal required consideration of significant risks, such as fire and earthquake hazards;
- Complex design of a restricted space ventilation system for Caisson removal that used computer models to address personnel air quality and heavy-equipment exhaust;
- Quick revision to increase the capacity of the Groundwater Treatment System (GWTS) to handle predicted El Nino weather patterns and increased rainfall, while maintaining the system in operable condition;
- The coastal interface to the Discharge Canal required extensive coordination with the Corps of Engineers, California Coastal Commission (CCC) and other local and state permitting agencies;
- Unique design of a hanging staircase for Caisson entry and exit that could manage changing excavation elevations; and



- FSR drainage and runoff properties to ensure wetland areas are properly restored and meet permitted requirements.

Work Planners created WPs containing detailed instructions, drawings and procedures necessary for Craft to execute work safely and effectively. Support organizations were engaged during the planning process to ensure proper controls and permits were addressed and that necessary resources, equipment and materials were staged. Engineers provided technical evaluations and design changes in support of work plans.

Work Planners created WPs early enough to allow for accelerated scheduling, while also being engaged in the execution of work. They conducted transfer-of-knowledge tailboards to provide Craft with overall planning strategy and the methodology used to develop it. This was effective to build teamwork, reduce field changes and engage Craft knowledge. As decommissioning work proceeded, Craft aided the Planners in resolving complications arising from unknown conditions and configurations. Both groups were involved in problem-solving and work plan modification, as needed. All experience and insight gained was incorporated into work plan development, work-in-progress and in the closeout of projects and tasks completed. This cooperation contributed to the decommissioning successes.

Work control training was provided to decommissioning personnel as part of their required training profile. The training was an overview of the entire planning process, from conceptual planning through package completion. It described WP development and review, transfer-of-knowledge meetings between Planners and Job Supervisors, management and control of the packages in the field and final work verification and closure.

The need for Work Planners persisted throughout most of the decommissioning project. As the CWP work was completed, work planning efforts lessened with completion of work scope. The Work Planning organization was subsequently ramped down.

#### **1.1.2.5 Procedure Updates**

Procedure Writers were integrated into the WCP to develop and revise procedures, which were an integral part of WP planning and execution. Approved procedures and engineering documents provided detailed instructions for many of the repetitive or complex tasks performed during decommissioning activities. Procedures were necessary to comply with the NRC License Basis requirements for implementing a QA/QC Plan, Fire Loss Protection and Prevention Program, Emergency Plan and a Security Plan. Procedures detailed processes used to evaluate work that could affect the License Basis and implemented administrative controls for Record-keeping, Document Control, Organization Structure, Training and Qualifications, Design Control and many other programs.

At the start of decommissioning, there were more than seven hundred mature HBPP Unit 3 procedures required for maintaining Unit 3 in SAFSTOR status and assuring safe storage of spent fuel and radioactive waste. This number did not include the procedures used by support organizations, such as DCPD for regulatory services, quality assurance, procurement, records, laboratory testing and calibrations. As the radioactive waste source term was reduced during decommissioning and the project moved nearer to FSR, the number of procedures was reduced, with additional procedures slated for cancellation or consolidation at the completion of the NRC 10 CFR §50 License Termination.

The hierarchal structure of HBPP Unit 3 procedures conformed to regulatory requirements and nuclear industry standards. It was a top-down structure, which began with the NRC-issued 10 CFR §50 License for possession of special nuclear material previously used to operate the nuclear reactor. The License invoked various programs that comprised the Licensing Basis. Changes to the Licensing Basis were subject to review and approval by the NRC. The Licensing Basis documents contained commitments to regulations, regulatory guidance and industry standards, which were implemented through various procedures. The conditions of the License, the Licensing Basis and the implementing procedures were subject to administrative controls, NRC inspections and independent quality assurance audits.

Some revisions to the License Basis were significant milestones during decommissioning, that had extensive impact on site organizations, associated programs and numerous implementing procedures. These types of changes were carefully planned, coordinated and executed within defined implementation periods that considered completion of cross-discipline reviews, approvals, training and qualification updates.

One significant License Basis revision was the scaling back of the Site Emergency Plan as the project source term was reduced to Open-Air Demolition (OAD) levels. It was implemented after transitioning to a stand-alone ISFSI and the permanent shutdown of both the main plant exhaust system and gaseous effluent monitoring system. This change resulted in the cancellation of numerous procedures and the reduction of the quality classifications for many others.

Procedures were continuously changed as other decommissioning milestones were met. They changed to reflect the decommissioning status, organizational changes and reduced radiological hazards. The effects of burdensome procedures were weighed against the burden of revising procedures, to find an efficient balance between the two concerns. Additional procedure revisions will be completed after NRC released HBPP's 10 CFR §50 License.

The Procedures group included Procedure Writers with nuclear experience, who were responsible for managing the procedure change process and the Document Control group, who were responsible for making sure that only the most current procedure revisions were used, as well as word processing, revision tracking and record retention. The Procedures group sponsored License Basis changes and coordinated their implementation. Procedure Writers participated in the WCP to develop and revise decommissioning procedures vital to the project. Decommissioning procedures also provided detailed instructions for unique and first-of-their-kind activities, and for repetitive or complex tasks.

Procedure changes initiated by the responsible owner organizations were carefully controlled and reviewed by the Procedures group, to identify and prevent adverse impact on the License Basis or other related programs. Changes had the potential to cause unforeseen conditions or deviation from controls designed to prevent specific possible accidents. Changes were subject to review by Independent Safety Reviewers, whose qualifications included relevant training, skillsets, backgrounds and experience.

Many of the decommissioning activities involved quality-related Systems, Structures and Components (SSC), and quality-related activities governed by the Humboldt Bay Quality Assurance Plan. These quality-related SSC and activities were controlled by quality-related procedures, which invoked regulatory administrative requirements for record-keeping, document

control, organization structure, training and qualifications, design control and other programs. All quality-related SSC and activities were subject to independent quality assurance audits, per regulatory requirements. Quality-Related Programs included:

- RP Controls;
- Effluent Monitoring;
- Radwaste Shipping;
- Site Characterization;
- Fire Loss Protection and Prevention Program;
- Emergency Plan; and
- Offsite Dose Calculation Manual.

The Procedures group ramped down as SSC and procedures were terminated. The responsibility for maintaining procedures has been shifted to remaining staff.

#### 1.1.2.6 Investment Recovery

PMO staff handled investment recovery during the decommissioning of HBPP. As HBPP decommissioning progressed, the quantity and frequency of items considered for investment recovery increased. The CWCs' main involvement in investment recovery was notifying PMO when assets needed removal from HBPP and then providing any skilled labor required for removal. Assets turned over for investment recovery included items in place from Unit 3's operational period, as well as equipment and materials utilized in demolition, remediation and restoration activities.

PG&E staffs an Investment Recovery Department in San Francisco, CA. The Investment Recovery Department normally returns assets to PG&E, with the goal of reducing operating costs. Investment recovery was handled in a slightly different manner for the HBPP Decommissioning Project, because of PG&E's special responsibilities related to the decommissioning trust. Money recovered through the sale of surplus goods was returned to the project to ensure accurate reporting of HBPP's decommissioning costs. This also meant that shipping and selling costs were charged to the project, just as waste disposal or any other direct costs were charged.

Investment recovery at HBPP dispositioned equipment in five ways: transfer; sale; donation-in-kind; salvage; or waste. Surplus assets were evaluated based on many factors and the option giving the most value to HBPP stakeholders and ratepayers was chosen.

Surplus equipment from nuclear demolition projects requires special consideration. In order for surplus equipment to be resold, it must undergo radiological testing and clearing to ensure that it is safe to be released. Consequently, assets generally only leave nuclear decommissioning projects in one of two categories. One category of items is those safe for free release to the public. The second category is for items that must be treated as waste and disposed of at specialized facilities. In the nuclear industry, there can be a third category for surplus equipment. This category is for equipment capable of being turned over to companies that hold certain NRC licenses and are involved in similar types of radiological work. While it is common in the industry for this type of transfer to occur, it was not a viable option for a portion of the equipment used at HBPP, because of specific concerns regarding the presence of alpha contamination.



There was specialized equipment for radiological testing, which presented no risk of alpha contamination and could be released to the public. This equipment can be expensive when purchased new, but the specificity of its function reduces its resale value. This type of used equipment is often purchased by intermediaries, who then sell to other nuclear projects after a substantial markup. For this reason, PG&E determined that in some instances, the best course of action was to turn the equipment directly over to other nuclear sites within California. This meant that ratepayers in California avoided paying for equipment twice. This method also had much lower administrative cost than other disposition options. By transferring some of the items, PMO sought to give maximum benefit to the ratepayers of California.

Auctions are the method commonly used when selling investment recovery assets. While auctions are a viable option for certain types of equipment with a known value on the open market, they also bring risk. The main risk is that the net income from the sale could end up being negative after costs are accounted for. Associated costs are administrative, skilled labor to move equipment off site, auction fees, commissions and shipping costs. With this in mind, PMO only considered auctions when it could be ascertained with a great deal of certainty that they were the best option.

Offering assets for the cost of freight can be the most cost-effective measure when an asset is extremely large and/or heavy. Transportation costs for large items can sometimes be more than an item is worth. As with testing equipment, the specialized nature of some types of large equipment makes their resale value low. Some companies that supplied materials and equipment purchased their goods back from HBPP for the cost of shipping, thereby providing HBPP with large savings in labor and disposal costs.

Donating fully-functional and safe assets to government and non-profit community organizations helped accomplish the PG&E goal of “serving our customers.” These donations were referred to as “donations-in-kind.” The majority of costs resulting from the donations were transportation- and labor-related. Some of these assets would likely have ended up being scrapped, were it not for their being donated. By coordinating with local businesses that donated labor and transportation services, HBPP was able to cost-effectively make a positive impact in the community. Successful donations included the gift of several trailers to a homeless outreach organization, a metal footbridge to a local city and scientific equipment to a state university.

Salvage was considered in cases when equipment could not be transferred, sold or donated. The salvage value of raw materials offset freight costs to bring the lowest cost option for disposing of assets. The final option in investment recovery is the disposal of assets as waste. While an asset could be within the requirements for free release to the public according to RP testing, California regulations regarding materials originating from nuclear sites during demolition prevented their disposal at lower-cost facilities within the state. Before an asset was sent out as waste, every other option was evaluated and/or attempted. This was generally the most expensive method and was avoided if possible.

## **1.2 License Termination Survey (LTS) (Site Closure)**

License Termination Survey in the General Staffing category is not being presented for reasonableness review during the 2018 NDCTP as this scope remains ongoing.

## 2 REMAINDER OF PLANT SYSTEMS

The remainder of plant systems and support of CW was comprised primarily of direct labor costs and the cost of tools and equipment that supported the remaining efforts of the CWC.

**Table 2-1, Remainder of Plant Systems**

2015 NDCTP ID		Approved NDCTP Estimate		Amount Spent Presented for Reasonableness			Previously Presented and Approved
		Base	Nominal	2012-2014	2015-2018	Total	
E.4.2.1	Remainder of Plant Systems	56,392,393	58,705,141	41,535	4,587,091	4,628,626	43,748,081
E.4.2.3	2012 NDCTP CPUC Filing	51,287,467	53,421,149	41,535		41,535	43,748,081
	Direct Labor	32,716,722	34,022,032	41,535	-	41,535	31,823,080
	Direct Labor - Craft	17,889,181	18,570,537	-	-	-	16,116,296
	Direct Labor - Rad Protection	14,827,541	15,451,494	41,535	-	41,535	15,706,784
	Liquid Radwaste Removal	6,938,936	7,320,409				4,282,774
E.4.2.4.2	Tools and Equipment	11,631,810	12,078,709	-	-	-	7,642,227
	2015 NDCTP CPUC Filing	5,104,925	5,283,992		4,587,091	4,587,091	
	Direct Labor	2,743,043	2,860,330	-	2,655,329	2,655,329	-
	Direct Labor - Rad Protection	2,743,043	2,860,330	-	2,655,329	2,655,329	-
	Tools & Equipment	2,361,882	2,423,662	-	1,931,762	1,931,762	-
	Radiation Protection	2,361,882	2,423,662	-	1,931,762	1,931,762	-

Actual costs during 2012 through 2014 presented for reasonableness review for Remainder of Plant Systems were \$41,535. Actual costs during 2015 through 2018 for were \$4.6M compared to the approved cost estimate of \$5.3M.

### 2.1 Direct Labor - Radiation Protection

Table 2-1, Remainder of Plant Systems, highlights the budget for direct labor between the 2012 NDCTP and this 2018 filing.

The HBPP Decommissioning Team remained attentive to the dynamic needs for staffing by routinely reviewing those needs and tracking actual expenditures against expected expenditures. HBPP was able to optimize its staffing level by frequent review of actual staffing needs against the staffing plan. These costs were split between the base scope and Reactor Caisson support, based on the amount of work being performed. Two issues were recognized during this process, which allowed the team to make adjustments to staffing levels.

The first issue involved the RP support needed to safely remove the highly-contaminated and highly-radioactive plant systems, such as the Reactor Pressure Vessel (RPV). Additional staffing was needed to adequately protect the workforce, public and the environment. This need for additional staffing persisted until the end of 2015, when the Refuel Building (RFB) met OAD criteria. Subsequently, a 40-foot section of the building was demolished to grade and the designation of a restricted area, or RCA, was no longer required, which allowed for reduction in staffing.

The second issue involved a reevaluation of the staffing needed to support OAD. During routine review of the work plans, HBPP recognized that the RP support needed for safe Caisson removal and site restoration was less than originally thought and that some of the work was redundant with work assigned to the FSS group. HBPP reduced the forecasted staffing requirements to better optimize and utilize staffing resources.

From the data, the HBPP Team prepared reliable job forecasts, adjusting staffing when needed, managed head count and billing rates to start under the forecasted values, and actively sought opportunities that optimized the safe staffing of this project. The methodology that was developed in the 2012 NDCTP filing to ascertain the staffing costs for RP support proved to be sound; and that methodology was retained through the 2015 NDCTP and for this 2018 NDCTP filing.

### **2.1.1 Craft**

Self-perform work was completed and there are no further costs associated with this section. These costs were closed out in the 2015 NDCTP Completed Projects Report.

### **2.1.2 Radiation Protection**

Throughout the decommissioning, the focus and purpose of the RP organization was the protection of the workforce, public and environment from potential deleterious effects of exposure to radioactive materials and ionizing radiation. The RP organization accomplished its mission through a combination of monitoring, measuring and controlling radioactive materials and access to those materials.

The RP organization was divided into several functional areas. RP Technicians provided all required RP functions and RP Deconners maintained cleanliness and prevented contamination from spreading throughout the plant and to workers required to be in contaminated areas. These combined teams of RP Technicians and RP Deconners provided all required job coverage, including performing routine and special surveys, manning the radiological control points for each of the processes and activities and ensuring that radiological dose and contamination remained in a controlled environment.

HBPP RP rules and practices were established in accordance with NRC regulations and PG&E Company Policy, which provided for the safety of HBPP workers occupationally exposed to radiation. Thus, it was of utmost importance that all HBPP RP rules be strictly adhered to by all individuals while in an HBPP RCA. All radiation workers occupationally exposed to radiation at HBPP were required by the NRC to have a basic knowledge of the risk associated with their radiation exposure. Each radiation worker understood how to apply radiation protection principles and precautions to maintain personal exposure to levels that were ALARA. In addition, individuals working in an RCA were expected to conduct themselves in such a manner as to minimize any occupational risks to themselves or others, using practicable means.

The number of Technicians assigned to any particular job was generally based on the complexity - the more activities taking place which could affect radiological controls, the more sets of hands and eyes were required. To maintain the required controls associated with the levels of HBPP alpha contamination, most job coverage activities needed a minimum of two RP Technicians and two RP Deconners. In some of the larger activities (e.g., RPV removal and Spent Fuel Pool [SFP] work), the job could at times require as many as four RP Technicians and four RP Deconners. The specific number on these teams changed as the course of the specific tasks and radiological conditions changed.

There were several reasons that job coverage required more than one RP Technician or one RP Deconner - the need to maintain constant oversight of radiation levels, the multiple job responsibilities of RP Deconners and the nature of the work itself. Given that radioactivity can

only be “seen” (detected) with a meter, it was easy for workers to challenge boundaries. At times, boundaries were largely conceptual or dictated by policy and practice and were less obvious than simpler measures such as posting and other barriers. Because workers must focus on completing the task at hand, the role of RP was one of oversight and restraint; which could have easily become compromised when members of the RP Team became focused necessarily on specific tasks, such as conducting a survey, or when a Technician was required to leave the job area (e.g., to obtain supplies).

RP Deconners were used throughout the project for more than just RP-specific functions. They often served in the roles of laborer or utility worker. While this versatility was useful, it required more personnel in the field to ensure that laborer and utility worker tasks did not compromise the importance of RP functions. Furthermore, much of what RP Deconners did was of such a nature that two or more workers were required for certain portions of an overall evolution (e.g., wrapping and securing a large contaminated object in plastic sheeting).

### Work Scopes

The radiologically-significant work that was ongoing at the beginning of 2015 included SFP cleanup and removal. Both evolutions contained higher levels of risks from radioactivity and therefore, required higher RP Technician staffing levels in order to adequately monitor, measure and control the risks. RP began the period with thirteen RP Technicians and RP Deconners. As the quantity of radioactive materials and therefore, levels of radiation and contamination were reduced, the required amount of RP oversight was also reduced. Beginning in mid-2015, RP staffing levels began a gradual ramp-down, with a corresponding reduction in associated costs.

By the end of 2015, the SFP project was completed and the facility entered into the controlled OAD portion of the decommissioning. The radiological focus shifted from intense, high-level radiological work to a lower level of radiological intensity associated with canal remediation, Caisson removal, circulating water pipe removal, building removal and leading in to FSR. All of the projects still had a potential for encountering radioactive materials and required monitoring, measuring and control. While it was understood that much of OAD would occur at a time when the operational RP program was reduced in force, residual radiological concerns continued to exist that required RP attention.

Prior to OAD, HBPP performed radiological surveys and provided the results to the CWC. During OAD, radiological controls were required of embedded piping, because the material was considered radiologically-regulated. The CWC was directed to minimize excavation of contaminated piping and areas during the rainy season. The alpha contamination and airborne prevention methods proven to be most effective for the radiological source term included surface coatings, which affixed contamination to surfaces during demolition to prevent contamination migration; and water sprays at the point of demolition, to prevent spread of small particle dust that was generated. Access to demolition surfaces was limited by ensuring demolition personnel were positioned inside of excavating equipment and by limiting personnel access to potentially-contaminated debris piles.

RP engineering controls were approved by the HBPP Radiological Management Team and utilized during controlled OAD activities, including:

- Water misting from portable power-washing units, consisting of spray units, which were mounted directly on the arm of the hydraulic excavator during demolition activities, similar to units used during the Turbine Building foundation demolition;
- Water misting from portable “snow maker” or “fog cannon” machines, which could spray water mist into the work area with a variable water flow rate;
- Decontamination of surfaces, components and equipment when OAD activities were shut down for breaks or decontamination periods;
- Application of spray fixative (including latex paint, special encapsulates designed for contamination and spray glues to bind the contamination) on areas that were of concern, to mitigate the spread of any potential contamination; and
- Localized ventilation such as High-Efficiency Particulate Air (HEPA) filters.

The project work plans for the Caisson demolition scope of work were developed by the CWC’s Engineering group. RP and waste controls were incorporated into the work plans to meet the necessary radiological engineering controls and exception requirements, as well as waste segregation requirements. Work Planners were provided with the tracking SAP Notification, which included all of the RFB areas and listed the RP requirements and Rad Engineering controls for each area. The RFB Team worked directly with the Engineering Team to ensure that all of the RP and waste requirements were in place, fully understood and practical for execution of OAD.

The most prominent residual radiological concerns involved excavations planned in the East Yard and the Caisson.

#### East Yard Excavation

There were two Liquid Radwaste (LRW) lines buried in the East Yard. One was an abandoned radwaste line, which discharged into the circulating water discharge; and the other was a tank area drain line, which traveled under the road to the Discharge Canal. During plant operations, the radwaste line was used to move LRW from the LRW building to the discharge canal through the circulating water system. The drain line was contaminated due to an earlier spill from a radwaste tank into the drain system. The drain went directly to the discharge canal. There were quantities of radioactive contamination still in those lines, which required careful monitoring and handling to avoid unintentionally spreading contamination during removal. Additionally, in the east yard was the off-gas tunnel that was highly contaminated due to spill during operations and SAFSTOR.

#### Caisson Excavation

The Caisson’s surfaces and accessible embedded piping were either decontaminated or removed in preparation for excavation. However, there were areas where the residual contamination could not be removed safely or cost effectively in advance of Caisson removal. RP monitoring, measuring and control were required during Caisson excavation and removal. Areas of concern which required RP Technician support included embedded pipe commodities, drywell-activated core region, suppression chamber removal and the removal of bulk plate steel and beams:



- Embedded pipe included pipes that were simply piping stubs or complete floor drain systems. Embedded pipe was removed by mechanical means with the use of hydraulic excavators equipped with large hammers and shear attachments. Pipe embedded within concrete and rebar mats was removed intact to the greatest extent possible. However, 100-percent intact removal was not achievable. RP Technicians monitored, measured and controlled contaminated materials during removal, segregation and packaging of piping and surrounding materials, which included soil and gravel layers discovered outside the Caisson walls during excavation.
- The activated core region located within the bio-shield was located from approximately the -20-foot elevation to approximately the -30-foot elevation and was a heavily-reinforced concrete wall, sandwiched between the 5/8-inch thick drywell liner and the 3/16-inch thick stainless steel suppression chamber liner. These materials were found to be activated during plant operations and were separated for disposal. These materials were removed by mechanical means, with the use of hydraulic excavators equipped with large hammers and shear attachments. RP Technicians monitored, measured and controlled the activated materials during removal, segregation and packaging.
- The suppression chamber was narrowed to the east and west end walls of the chamber. Along these walls were large, wide-flange structural beams. These beams contained highly-contaminated debris, which was remediated to the extent possible and coated with fixative. Within the east and west chamber, there were legacy baffle plates discovered nestled between two of these beams. These interior beams were also remediated to the extent possible. However, not all areas were fully remediated to the OAD limits stated in RCP-2G. The exception process was followed and was approved by the HBPP Radiological Management Team for OAD.
- The plates and beams were removed whole during the demolition process under controlled OAD. The west baffle plates were secured to one another and removed together, limiting the spread of any contamination that was present. Due to access restrictions, the baffle plates located in the east chamber were fastened to each other during OAD. Extreme care was taken during the removal process to ensure personnel safety and to limit the spread of contamination. The waste was segregated, packaged and sent to the appropriate disposal site.

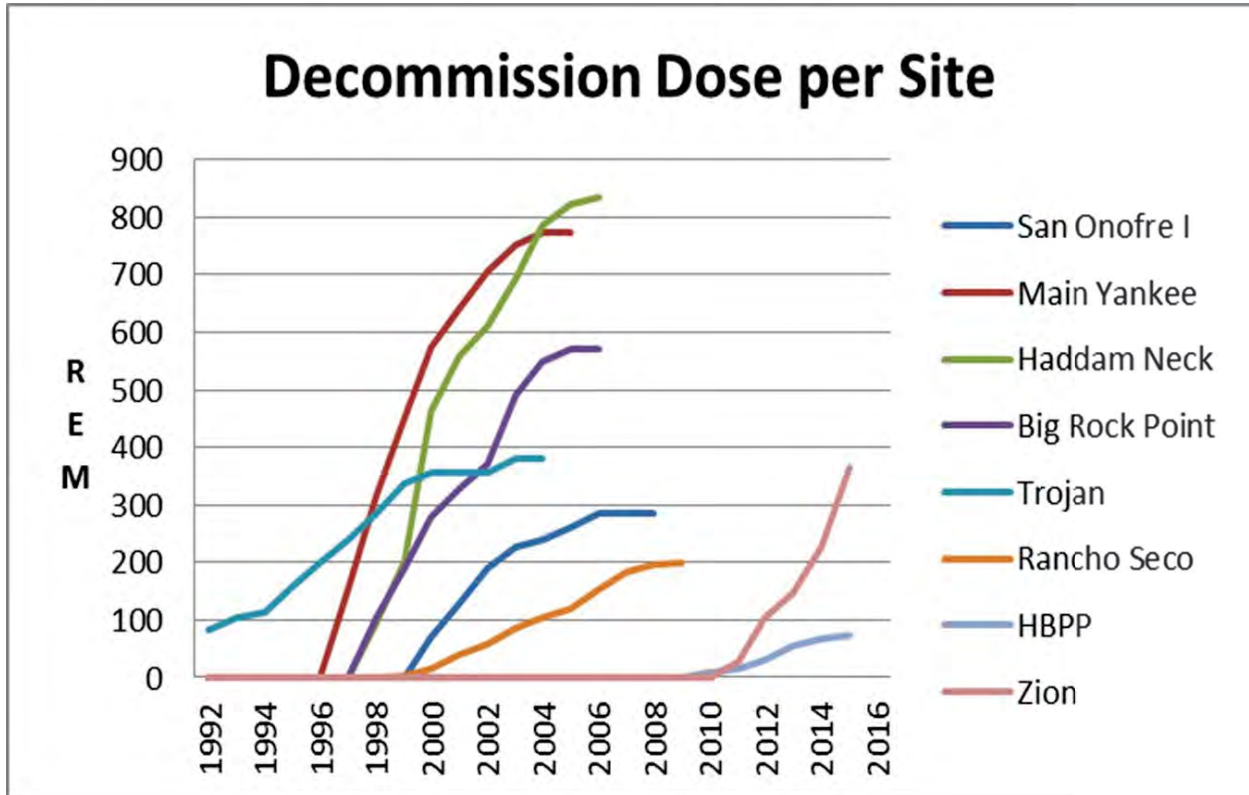
Upon completion of removal of contaminated material, HBPP RP and Environmental staff took confirmation samples. The chemical confirmatory sampling included total petroleum hydrocarbons, polycyclic aromatic hydrocarbons, Polychlorinated Biphenyls (PCBs), metals and Toxic Control Leaching Procedure and Solubility Threshold Limit Concentration testing. FSS sample and survey results took two weeks and disposition radiation surveys took two days. Control of excavated areas was maintained until sample and survey results were returned. Based on results of radiation samples and surveys and chemical sampling, no additional excavation of areas was required to achieve sufficient levels of cleanliness.

During OAD, all tools and equipment used in the area was surveyed for radiological contamination at the end of each shift, prior to removal from the area, after any suspected contamination issue and after completion of excavation of known contaminated areas and piping.

## Dose Summary

The RP team approach to HBPP decommissioning, coupled with the amount of time HBPP spent in SAFSTOR status prior to starting decommissioning, resulted in a significantly-reduced ALARA dose to the decommissioning workers than was reported at other prior decommissioned sites, as shown in Figure 2-1, Decommissioning Dose per Site.

Figure 2-1, Decommissioning Dose per Site



## 2.2 Tools & Equipment

Typical tools and equipment purchased to support the decommissioning project included many general tools of varying sizes, such as wrenches, hammers, screwdrivers and drills, as well as electrical equipment, carpentry materials, various cutting equipment, replacement blades, pipe fitting tools and PPE. Most small tools and equipment were kept in tool cribs in order to maintain control of the inventory and to control potential contamination issues.

This work was assumed by the CWC when PG&E turned the tool program over in 2015 and it included all costs through the remainder of the CWC contract. A separate procurement group under PG&E remained in place to purchase contamination-control provisions, various lab supplies, contamination detection instrumentation and other specialty-customized materials required during the decommissioning.



### 2.2.1 Health Physics Supplies/RP Tools and Equipment

Radiological tools and supplies consisted of an adequate variety and supply of materials for radiation and contamination detection, isolation, controls, health physics supplies in support of decommissioning and the typical hand tools and Personal Protective Equipment (PPE) inventories specific to decontamination tasks. This included calibrated instrumentation; calibration services; instrumentation maintenance; waste-handling materials and storage; contamination-control devices; various signage and boundary materials; and sampling supplies.

PG&E continued to realize cost savings from the used radiation detection equipment obtained from the Rancho Seco Nuclear Power Plant decommissioning project. As instrumentation aged or was damaged from infield work, legacy parts were utilized from the used Rancho Seco instrument batch to refurbish and maintain an ample supply of functioning instrumentation required to monitor remediation and decommissioning activities, thus reducing the need to purchase replacement equipment.

PG&E was also able to reduce costs by reusing existing tools and equipment from completed projects by repurposing and modifying the tools for future work. For example; the underwater personnel radiation remote monitoring equipment was originally utilized for personnel radiation monitoring in uncertain radiation dose fields during underwater dive operations of the SFP liner removal project. The remote readout technologies, along with other compatible legacy components were repurposed to help track and monitor potential radiation levels inside excavator cabs and areas of concern during subsequent Caisson excavation. Data collected from this equipment was used for tracking and trending purposes to ensure that radiation doses were maintained ALARA and well below regulatory occupational radiation exposure limits.

As decommissioning lessons were learned, PG&E determined a few key changes to strategy, which resulted in optimizing RP tools and equipment. Two significant items were the Gamma Radiation Detection and In-Container Analysis (GARDIAN) system for reuse of soils on site and the OAD process.

The GARDIAN system is a series of sensitive radiation detection instruments designed to survey large volumes of containerized waste or homogeneous material for the presence of radioactivity. The GARDIAN system is discussed in detail in Section 4.1.1.6.2.

OAD allowed for the rapid, controlled demolition of structures and removal of large volumes of waste materials for disposal. OAD is discussed in detail in Section 4.1.1.3.

As HBPP remediation and decommissioning progressed, the RP organization studied potential radiological impacts. Radiological air sampling and contamination survey data was collected for a case study on the interior of the Liquid Radwaste Building (LRWB) during demolition. The building layout provided a controlled environment to test demolition methods, engineering controls of typical demolition methods and to study the dispersion of radioactive materials, under an enclosure with a monitored effluent pathway. The data was analyzed and compared with data from Connecticut Yankee decommissioning to develop a threshold level of residual radiological activity, which could be left affixed to surfaces during the demolition process. The calculated threshold level would not challenge regulatory limits, increase dispersion pathways of radiological materials, or increase radiological risk to workers and members of the public.

Decontamination of the structures below the established limit allowed excavators to perform OAD without implementing costly engineering controls, such as containment, glovebox or HEPA ventilation. Confirmatory monitoring and sampling were performed during OAD and no anomalies were identified.

To meet OAD threshold levels, radiological safety required encapsulation of some contaminated surfaces such as walls and floors, as well as the inside of embedded piping and components. The RP organization continued to research and implement new, effective cost-saving methods, such as the use of off-the-shelf alternatives to encapsulate, which met the Waste Acceptance Criteria (WAC) for the waste disposal site.

Encapsulation of contaminated surfaces and decontamination of the structures below the established threshold also reduced the number of contaminated work areas. Contaminated area entries required personnel to don a disposable anti-contamination suit, booties and gloves for each entry. The reduction in size and numbers of these areas resulted in a safer and less stressful work environment for employees, greater work efficiency during the demolition process, reduced PPE costs and reduced waste disposal volume, resulting in a cost savings for waste disposal.

Additional cost savings was realized in reducing the time and tooling required to decontaminate low-level radioactive materials found on surfaces prior to commencing Caisson demolition. Subsequent data collected post-OAD implementation, confirmed sufficient protection of workers and public by limiting inhalation pathways in work areas and by controlling potential doses to members of the public.

### **2.2.2 Tool Cribs**

A tool crib is generally a 20-foot steel container, plywood shed or a dedicated room in a building. At HBPP, the RCA Tool Crib was located in the HMS until it was demolished. The purpose of tool cribs was to provide, maintain and control the necessary hand tools and personnel safety equipment required for workers to perform daily field activities. Tool cribs were staffed to ensure that adequate tools in safe working order were available when needed. Staff also conducted inspections, maintenance and distribution of necessary safety equipment. Two tool cribs were established early in the project, one located within the RCA to service potentially radiologically-contaminated tools, and one outside of the RCA, dedicated to non-radiological work activities.

The tool cribs were managed by the same Union Craftsmen to ensure a seamless transition was in place to maintain continuity throughout the lifecycle of the project. This management of the tool cribs was scheduled to continue through the completion of decommissioning activities.

Warehousing of incoming equipment and material was managed with a dedicated crew that included Procurement. As materials were received by common carrier or delivery service, they were distributed to the tool crib Attendants or Laborers.

The tool crib and rigging loft located inside the RCA were closed and removed during the fourth quarter of 2015. As the station approached down-posting the RCA in preparation for OAD of the Reactor Building, a process was established to evaluate the radiological condition of the tools and equipment inside the RCA. By the very nature of the usage of the tools and

equipment, fixed contamination became the overarching concern and the majority of the tools and equipment used during decommissioning were not in condition to be free released.

Ultimately, contaminated tools and equipment were discarded as waste. Approximately 90 percent of the tooling was discarded due to fixed contamination. Virtually 100 percent of the rigging was discarded, as the rigging could not be easily confirmed as radiologically clean. The rigging material was largely woven nylon slings and braided steel cable, both of which provided crevices that easily trapped potentially radioactive particles. Detection and removal of deeply-embedded radioactivity is very difficult and therefore, it was more cost effective to dispose of the rigging than to attempt to clean and release it. It was not possible to place a wire rope or nylon sling in a SAMS unit, which was the only possible means to meet free-release criteria. The balance of the radiologically-cleared tooling was placed in the tool crib outside of the RCA for general use on the project.

### **2.2.3 Tool Crib Scope of Work**

Control of the tool cribs was initially done with one Attendant stationed in each of the tool cribs, to maintain the inventories, new purchases, damaged tools and equipment and repairs, if practical. In addition to issuing, returning and maintaining the tools and equipment, the Attendants were required to maintain minimums and maximums for consumable commodities, such as gloves, saw blades and drill bits. Generally, the tool cribs were manned with no more than two persons; however, at times there was need to add staff to support annual inventories and rigging inspections.

The types of tooling and equipment maintained by the tool cribs generally included the following:

- Decontamination equipment;
- Pipe-cutting equipment;
- Power tools valued under \$500.00;
- Carpentry tools;
- Cement and masonry tools;
- Rigging and hoisting equipment;
- Portable generators;
- Safety equipment;
- Tool consumables (e.g., bits and blades); and
- Hand tools.

As the project began the transition to larger heavy equipment, the Tool Crib staff was reduced to one Attendant managing both tool cribs, until elimination of the RCA Tool Crib. Again, as the project evolved over time, the need for tool cribs was evaluated. The Tool Crib continued to be a necessary control point for small tools and supplies. As demolition progressed, the project further reduced the resources necessary to maintain tool cribs by designating a Labor person, who was assigned to both perform field work and to control the distribution of tools and supplies, as required.

### 3 SITE INFRASTRUCTURE

This category was completed and approved in the 2015 NDCTP filing for completed work. There are no additional costs associated with this category.

### 4 SPECIFIC PROJECT COSTS

**Table 4-1, Specific Project Costs**

2015 NDCTP ID		Approved NDCTP Estimates		Amount Spent Presented for Reasonableness			Previously Presented and Approved
		Base	Nominal	2012-2014	2015-2018	Total	
E.4.4	Specific Project Costs	176,153,224	185,837,045	9,783,021	68,792,685	78,575,706	29,002,996
E.4.4.1	2012 NDCTP CPUC Filing	72,184,834	75,643,003	9,783,021	-	9,783,021	27,282,792
E.4.4.1.1	Reactor Vessel Removal	15,896,279	16,530,248	-	-	-	15,263,911
E.4.4.1.2	Turbine Building Demolition	14,370,353	14,940,563	-	-	-	12,018,881
	Civil Works	41,918,202	44,172,193	9,783,021	-	9,783,021	-
	Nuclear Facilities	41,376,133	43,601,017	9,656,521	-	9,656,521	-
	Office Facilities	542,069	571,176	126,501	-	126,501	-
	2015 NDCTP CPUC Filing	103,968,390	110,194,042	-	68,792,685	68,792,685	1,720,205
	Reactor Vessel Removal <sup>1</sup>	1,693,007	1,739,108	-	(736)	(736)	1,720,205
	Civil Works	102,494,605	108,683,615	-	68,886,219	68,886,219	-
	Nuclear Facilities Demolition	60,161,115	62,821,873	-	66,293,695	66,293,695	-
	Administration Services	40,814,849	43,029,349	-	42,437,915	42,437,915	-
	Restricted Area Prep	5,547,472	5,675,442	-	6,171,599	6,171,599	-
	Refueling Building	8,304,579	8,496,126	-	9,170,035	9,170,035	-
	Units 1, 2 and 3 Circulating Water Lines	2,722,521	2,785,325	-	6,612,272	6,612,272	-
	Upper Yard Demolition	1,238,993	1,267,574	-	957,170	957,170	-
	Temporary Facilities	1,532,701	1,568,057	-	944,705	944,705	-
	Offices & Facilities Demolition	1,865,978	2,041,690	-	2,101,145	2,101,145	-
	Final Site Restoration	37,253,566	40,412,905	-	-	-	-
	Other Services/Letter of Credit	3,213,946	3,407,147	-	491,379	491,379	-
	Other Services	2,191,230	2,363,250	-	345,631	345,631	-
	Letter of Credit	1,022,717	1,043,897	-	145,748	145,748	-
	Disallowed Scope	(219,222)	(228,681)	-	(92,798)	(92,798)	-

1. Reactor Vessel Removal has a credit of \$736 due to late invoice credit.

Actual costs during 2012 through 2014 presented for review in Specific Project Costs were \$9.8M. Actual costs 2015 through 2018 were \$68.8M compared to the approved cost estimate of \$108.7M. Included in the approved cost estimate for 2015 through 2018 is \$40.4M in FSR scope for which actual costs are not being presented for reasonableness review in this NDCTP.

The Completed Projects Review Specific Project Costs are divided into three sub-sections:

- 4.1 Civil Works
  - 4.1.1 Nuclear Facilities
  - 4.1.2 Office Facilities
  - 4.1.3 Other Services

#### 4.1 Civil Works Contract

Team-building between multiple contractor agencies

PG&E is a proponent of a one-team approach to project execution and to that end, promoted team-building between all prime and subcontractors. All stakeholders owned the successes and failures of project execution. One of the effective strategies was to share talent and resources among construction groups. For example, the CSM contractor assimilated some of the CWC's labor and skilled craft resources into their batch plant operations and construction

equipment operations. This blended work crew integrated PG&E's rigorous safety culture with the CSM contractor's talent and helped them become familiar with site policies and practices.

Another example was combining PG&E's Oversight engineering resources with the CWC's engineering organization. This had the desired result of reducing the iterative review and approval process for design documents and encouraged collaborative development of designs and engineering products.

#### **4.1.1 Nuclear Facilities Demolition**

This scope was comprised of a number of large demolition projects and facilities removal performed by the CWC. These projects being presented for reasonableness review total \$9.8 million during 2012-2014 and \$68.9 million during 2015-2018.

Nuclear Facilities was comprised of Restricted Area Preparations; Refueling Building demolition; Units 1, 2 and 3 Circulating Water Lines removal; Upper Yard Demolition; and Temporary Facilities removal. These areas are described in detail in the following subsections.

Demolition equipment shared among site projects included:

- Various cranes, man-lifts, long-reach excavators, standard excavator with bucket/thumb attachment, concrete hammers and crushers for demolition;
- Backhoes, front-end loaders, dump trucks, Intermodals (IM) and B25 boxes (based on access to space and confinement) for waste-loading; and
- Mist sprayers, water trucks, power washers and monsoon foggers for maintaining dust control.

Other processes required the use of forklifts; drum rollers; air compressors; skid steers, including their various attachments; fuel; lubricants; and service trucks with welders.

##### **4.1.1.1 Administration Services**

Administration Services describes project overhead staffing and fixed costs incurred by the CWC including indirect costs, which could not be directly assigned to specific decommissioning activities. Examples of these costs; trailer rentals; van transportation, including rentals and fuel; housekeeping activities, including tree services, bottled water services, lawn care and landscaping, garbage services; Management travel; incidental expenses; and subsistence.

##### **4.1.1.2 Restricted Area Prep**

Three demolition projects, the Turbine Building, the LRWB and the Security Alarm Station (SAS) Building, comprised the area surrounding the RFB and Caisson. Their removal, and the removal of the underground utilities in the vicinity, was a precursor to starting the underground demolition of the RFB, the SFP and the Caisson.

###### **4.1.1.2.1 Turbine Building Concrete Demolition**

The Turbine Building was located adjacent to and south of the Reactor Building and housed the steam turbine connected to a generator with its condenser, heat exchangers and other auxiliary equipment integral to the operation of the generating facility. All components were removed during the self-perform phase of the project, leaving the structure and embedded pipe for the

CWC removal phase. The Turbine Building foundation was partially demolished in 2014-2015. The below-grade foundation was temporarily left in place. Removal of the foundation and Caisson was planned for concurrent execution, as the area would have been within the slurry wall containment to allow for dry removal.

The underground structure was a heavily-reinforced concrete structure that sat on top of creosote foundation piles driven into the soil. The 7,391-square foot, irregularly-shaped basement housed the Condensate Demineralizer Room, condenser pit, condensate pumps, bearing cooling water tank and instrumentation vaults. Some walls were up to 30 inches thick and the floor varied from 3 feet, to nearly 10 feet thick at equipment pads/pedestals. The seal oil, reactor feed pump and hydrogen yard concrete pads were also at grade level.

Between completion of the above-ground demolition in August 2013, and the beginning of foundation demolition in April 2015, the area was used for equipment and material laydown. The final backfill and FSS was completed in March 2016.

#### Scope of Work

Initially, the Turbine Building foundation was within the perimeter of the slurry wall and was scheduled for removal with the Caisson. When the slurry wall approach was changed to the CSM wall, the Turbine Building foundation fell outside of the CSM wall excavation area. Consequently, a change to the excavation plan was needed to address the deep foundation pile removal below the Turbine Building foundation, outside the water cutoff wall. After much study and calculation, Engineering prepared a Design Change Notification (DCN), which imposed a limitation on the number of open holes from pile removal were allowed at any given time, with the requirement that each group of holes had to be filled with a cement slurry mix before another group of piles could be removed. Additionally, the plan required the installation of sumps and pumps to help manage the subsurface water that emerged as the piles were pulled out.

This scope of work included removal of below-grade pedestal structures, timber foundation piles, imbedded utilities, drains and intake and discharge piping up to 54 inches in diameter. Removal processes required that these oversized foundations, numerous deep piles and contaminated utilities were not similar to a typical building foundation. The WP Planner and Job Supervisor carefully laid out a 3-phase plan, which minimized disruption of surrounding activities and integrated with the concurrent CSM pre-trenching and installation.

The scope of work exceeded a typical subsurface removal activity. A geotechnical engineer was engaged to perform an "Excavation, Dewatering and Construction Engineering Analysis," due to the depth of excavations, presence of groundwater and types of soil. This analysis provided the CWC with a technical approach for excavation sequencing, stability and groundwater and surface water control.

Critical path work sequencing was a priority and necessitated a phased approach of field implementation. Significant portions of the foundation were an impediment to beginning and completing the CSM wall installation.

#### Actual Work Performed



Initial demolition of the northwest foundation walls created the starting location of the CSM wall in this area and facilitated the construction of a long ramp of the proper slope from the Unit 2 fossil footprint down into the excavation area. Work boundaries were established and all the required safety precautions for demolition were put in place. This work was considered OAD, utilizing established radiological and silica control (misterters). Due to its location inside the RCA, the area required RP support for access control and for monitoring specific areas of the demolition where imbedded piping and utilities still remained.

Phase A and B walls (see Figure 4-1) were removed using typical concrete demolition and sizing equipment. Many of the below-grade walls were no deeper than 10 feet. The pedestals that served as foundations for the turbine and pumps were as large as cars and required the largest available excavators with hydraulic hammers, concrete processors, shear and bucket/thumb attachments. The thickness of concrete and the size of rebar required caution and detailed attention from the workers during the material segregation process.

The RFB railway door air-operated controls were mounted on a wall inside the Turbine Building structure. This wall was planned to be demolished as part of the Turbine Building scope, so Engineering prepared a DCN to relocate the door control assembly inside the RFB, as continued operation of this RFB door was required. The large assembly of air-actuated valves and levers was not in a modern cabinet configuration; rather the instrument piping and associated equipment covered an area of the wall approximately 6 feet wide by 8 feet high. The new location and operation was streamlined from the original configuration.

The Condensate Demineralizer Room and its commodities, along with the Reactor feed pump pad and north section of the Turbine Building foundation, were removed in Phases A and B. This included expanding the work area approximately 6 feet into the Unit 2 pad area and into the Hot Machine Shop (HMS) area to ensure all underground commodities were removed.

The Anion Cation Room, within the Condensate Demineralizer Room extending from the RFB, had legacy resin spills, which incurred during plant operation and SAFSTOR. The floor consisted of a multi-section cantilevered concrete slab. The joints in the slab were a radiological area of special concern. An attempt was made for remediation of this area; however, the seam of the slab was large enough that when the historical resin spills occurred, some resin traveled down the cracks. Remediation activities were halted at 2 feet into the concrete floor. The area was still showing dose rate limits that exceeded the procedural requirements for OAD. The floor was removed in pieces as large as possible to mitigate the spread of contamination. The Waste Management group maintained segregation and characterized it as a single homogenized pile with direct-load operations into IM waste containers. Following removal of the radiological area of special concern and adjacent Off Gas Tunnel excavation, the area received radiological confirmation from the FSS group and backfill was completed in March 2016.

Phase C was implemented to incorporate the installation of a sheet pile wall to support heavy load removal from the RFB and still allow excavation in Phase A. Placement of the sheet pile wall was required to isolate the subgrade east foundation wall and associated underground vaults for later removal. This coordination allowed continued installation of the CSM wall, simultaneously with Turbine Building demolition activities.



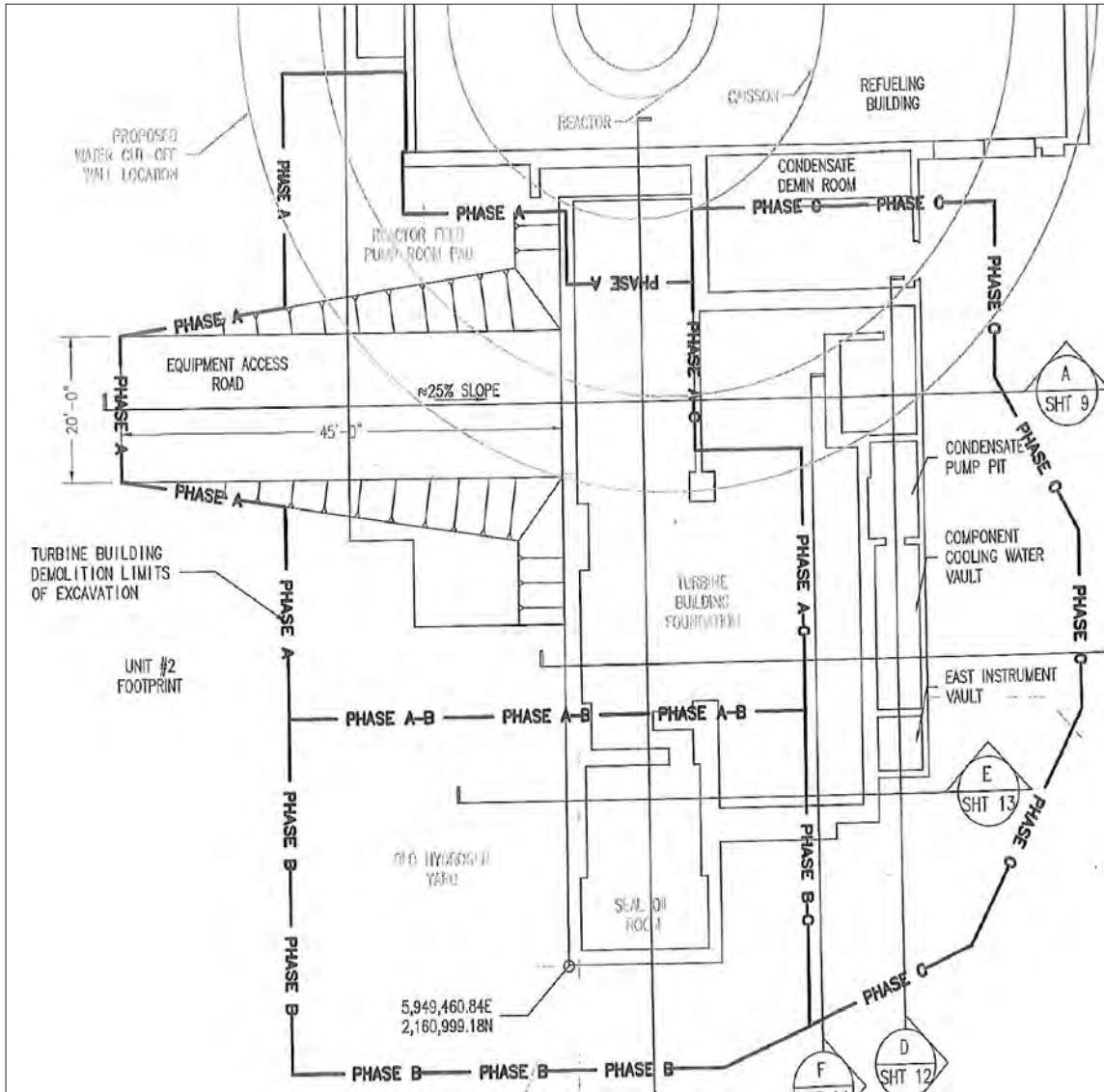
As the foundation walls and floor were removed, the 179 timber foundation piles could be extracted. These piles were removed in phases as areas of concrete were removed. Soils were removed around the piles to about 3 feet below the pile tops. A steel pipe sleeve was then driven down the length of the pile to break the suction action of the wet clay. Then a large crane with vibratory hammer removal device was attached to the top of the pile and the pile removed, followed by removal of the sleeve. The process was intentionally slow and methodical to ensure worker and environmental safety. The single most productive day removed 27 piles. Difficulties encountered during pile removal included heavy rains, equipment breakdowns and encounters with contaminants, which would usually require moving equipment to other areas while corrective actions were developed and executed.

Asbestos-Containing Material (ACM) transite pipe in various locations stalled excavation to allow for its removal. The affected areas were isolated and posted to restrict access. A qualified team of ACM removal specialists had to be mobilized, and their equipment and enclosures sometimes forced crews working nearby to relocate to other work faces until the areas were down-posted.

At the elbow locations of the cooling water piping, there were deep thrust blocks to remove, which were approximately 20 feet below grade. This design presented challenges to Engineering for maintaining safe personnel access. The removal of up to 54-inch diameter pipe sections proved challenging to reach at this depth and required the equipment to descend within its reach. This descent was accomplished using earth-compacted steps and removal of rubble via bucket transfer to dump trucks.

Once heavy loads from the RFB were removed, the sheet pile wall and remaining concrete structures were removed and Turbine Building foundation demolition was complete.

Figure 4-1, Phase A and B Walls



Hazardous Material Removal

The CWC's Project Waste Plan (PWP) included the expected hazardous waste to be generated. The plan included characterization, packaging and storage. There was a known oil drain line running in the foundation of the seal oil room to the north end of the basement. It was carefully removed and disposed of as hazardous waste. Transite pipe was expected and removed with appropriate ACM-Certified Asbestos Technicians. Radiological contamination and other hazardous material such as chromated water, potentially remained from Unit 3's operational period. As a precaution for this and other contaminant risks, all embedded drain lines were cleaned and grouted. A 3-inch diesel fuel line was considered full and treated as such until removed and disposed of. RP identified contaminated areas that had to be properly packaged for disposal. This waste determination was based on historical knowledge, radiological surveys and direct sampling.

## Waste Management

Remediation surveys were performed nearly daily, followed by FSS, as phases were completed. Water from excavations, piling holes and precipitation was checked for radiological contamination and if it was cleared, it was handled through the GWTS system. No radiologically-impacted groundwater was found during this phase of the demolition.

Excavated soil was frequently checked by RP to determine appropriate type of waste containers. Waste Management would then direct packaging, shipment scheduling, the logistics of containers and packages to and from work faces, waste profiling, shipment preparation and manifest documentation before turning the waste over to PG&E for shipping. Refer to Section 5.5.1.

## Equipment

Equipment used for the demolition work included:

- Excavators fitted with a 12,000-pound hydraulic hammer with other configurations, including a concrete processor, shear and bucket/thumb attachment;
- 10-cubic yard and 30-cubic yard dump trucks;
- Backhoe;
- Bobcat loader;
- All-terrain forklift for general support;
- Backfill compaction equipment;
- Man-lifts;
- Water misting equipment; and
- 270-ton crane and vibratory head for removal of wood piles.

Mobile equipment was provided by local rental companies and the CWC.

Numerous mobilizations and subdivided backfilling operations were required with the phased strategy. The phased approach affected WP performance; however, the decisions were justified by CWC Project Management given the alternate, substantially higher cost of standby time for the CSM wall installation resources and downstream critical path schedule impacts, thereby offsetting potential total project cost and schedule impacts.

### 4.1.1.2.2 Liquid Radwaste Building (LRWB)

The LRWB was located on the HBPP site to the north of the RFB. The LRWB was connected to the RFB by an underground tunnel, which supplied all required instrumentation, piping and original ventilation to the concrete structures and tanks for operation. The LRWB contained a radwaste sump, trench and access to the Off Gas Tunnel, which connected many of the plant's radwaste systems. During HBPP's operational period and while in SAFSTOR, all Turbine Building and RFB plant waste systems and associated drains were sent to the LRW system for processing and final disposition.

The LRWB housed 8 tanks:

- 3 Waste Receiving Tanks (WRT);
- 2 Waste Holding Tanks (WHT);

- 2 concentrated waste tanks; and
- 1 resin disposal tank.

A concentrator, demineralizer, filters, pumps and their associated piping connected the eight tanks into one integrated system. During operation and SAFSTOR, this system processed radioactive wastewater for release, collected radioactive byproducts on filter media and demineralized the water as it passed through resins. The resins and filters were collected, packaged and disposed of at offsite waste facilities.

Most of the LRWB's interior components were removed during the PG&E self-perform phase of the project, before the CWC began work. This work was evaluated and approved in the 2015 NDCTP. The LRW processing function of the system was replaced by a Filtration and Ion Exchange System (FIXS).

The FIXS was installed in July 2013 and was operational by August 2013. Its installation costs were reviewed for reasonableness in the 2015 NDCTP. The FIXS was a temporary LRW processing system that replaced the outdated existing LRW system. Because the SFP would need to be drained once work in the SFP was completed, the FIXS was designed to handle a once-through process and only required recirculation if needed to meet the final processing requirements. The FIXS was a modularized, component-based system consisting of pumps, hoses, valve manifolds, pre-filters, carbon filtration beds and ion exchangers. The system was required to treat system leakage and rainwater in-leakage, to meet Offsite Dose Calculation Manual (ODCM) discharge requirements. The FIXS was provided by a vendor as a modular, temporary system. All components were installed on wheeled skids and interconnected by hoses. The system was successfully used to treat LRW and ultimately, to process all remaining water in the SFP as it was drained for the last time. The system was removed from service and disposed of under CW.

The original LRWB had an open-air layout, which consisted of a concrete slab featuring drains and trenches for control of liquids. The LRWB had a heavily-reinforced concrete foundation built into a hillside. It measured 96 feet long by 44 feet wide and covered 4,400 square feet in total. The concrete walls were up to 3 feet thick and the slab was up to 3.5 feet thick. The thickest sections of the foundation were beneath the interior walls and the radiation waste tanks. The foundation was also supported by concrete piers, installed as part of the original structural design. The thicker reinforced walls and ceiling housed the demineralizer, concentrator, two concentrated waste tanks and the resin disposal tank. Each of these tanks was in its own vault, which was built into the structure for shielding. The partially-enclosed section of the structure housed the pumps, associated piping and filter systems. The remaining footprint of the LRWB was exposed to the atmosphere. The exposed footprint included three WRTs, two WHTs, and associated piping for those tanks.

A metal enclosure was installed around the LRWB during SAFSTOR to provide containment, weather protection and contamination control of the LRW systems and concrete structures. Ventilation to the metal enclosure was supplied by the Main Plant Exhaust Fan (MPEF). The metal enclosure was a one-story, six-bay, pre-engineered rigid-frame steel structure with metal roofing and metal siding. The footprint of the metal enclosure covered the footprint of the LRWB. Because it was built into the hillside, the metal enclosure had an eave height of 16 feet above grade at the north wall and an eave height of 34 feet above grade at the south wall.

Demolition to the interior of the LRWB started in January 2015 and finished with removal of the exterior conduit and lighting in July 2015. Demolition of the metal enclosure started at the end of July 2015 and finished in August 2015. The building foundation and buttress walls were kept in place as a retaining structure for the Upper Yard. These retaining walls and the foundation were planned for removal in mid-2018. However, the Project Team recognized that most means of contamination control would be demobilized by the scheduled 2018 demolition. The removal schedule was reassessed after review of critical path resources, equipment needs and concerns regarding potential contamination beneath the building. After this reassessment, the concrete structure demolition was rescheduled for 2016. Demolition of the LRWB's concrete structures started in May 2016. Subgrade excavation, soil remediation under the foundation and backfill was completed in August 2016, two years ahead of baseline schedule. Rescheduling this activity allowed for avoidance of costs associated with twice remobilizing RP resources needed to assure the radiological safety of the workforce and environment during wall and foundation demolition.

### Scope of Work

The scope of work for the LRWB included removal of the steel structure and any remaining components down to the slab at El. +12. The concrete building's structural features included external buttress walls on the east and west elevations and a retaining wall on the north elevation, all of which remained in place until removal as part of the subgrade demolition. Similarly, the internal vault walls, which were an integral part of the ground support system provided by the north wall, remained in place until subgrade demolition. Active demolition in adjacent areas had the potential to impact contaminated LRWB systems and components. To enhance the safety margin, some additional work, such as protecting and isolating the Off-Gas Tunnel connecting the LRWB to the RFB, was performed.

### Field Work

Through review of previous work performed in the LRWB, a review of historical radiological surveys and by performing detailed radiological surveys to confirm the current status of the building and systems, RP confirmed that radiological remediation was required. Therefore, the LRWB was maintained under localized negative-pressure ventilation to minimize the spread of radiological contaminants to the environment during work activities. The primary radiological concern was for alpha contamination. Alpha contamination within the LRWB was directly related to site historic fuel failures and collection of operational waste and its processing during operation and SAFSTOR. Personnel were required to use high-efficiency respiratory protection to prevent inhalation of contamination. They were also required to wear lapel samplers to track and monitor any potential internal uptakes. RP utilized smear surveys to detect area contamination levels prior to working in an area and during the demolition process. RP then utilized smear surveys to ensure the area was clean once the activity was completed. Alpha continuous-air monitors were used to provide real-time contamination coverage wherever work was to occur.

The CWC worked with the RP group to establish an access control area. This area was for entry and exit of the building and was needed to provide safe egress for personnel without hindering demolition of the internal structure. A C-van was placed and sealed to the upper northwest corner of the LRWB to create RP access control, a PPE change area, an entry and



exit point to the contaminated area and an RP monitoring station. Cameras placed inside the building fed video monitors in the C-van, which allowed RP personnel and others to remotely observe work activities. Remote monitoring limited the number of personnel exposed to a hazardous environment. As a further safety measure, an emergency exit area was established on the lower section of the building.

The RP group monitored the satellite ventilation system, demolition and disposal activities during field work. For this task, the RP Team included from two to four RP Technicians, three to five RP Deconners and an RP Supervisor. This extra monitoring was necessary so the collected data would demonstrate the effectiveness of RP control methods used and to confirm that the OAD criteria were met.

RP staff continuously tracked the hazards and controls for alpha contamination. The negative-pressure work involved radiological site-specific training for the Demolition Team. During LRWB demolition, standard industry alpha contamination control methods were tested. The alpha contamination and airborne prevention methods that were proven to be most effective for our radiological source term included surface coatings, which affix contamination to surfaces during demolition to prevent contamination migration; and water sprays at the point of demolition, to prevent spread of small particle dust generated by knocking down at the point of generation. Access to demolition surfaces was also limited by ensuring demolition personnel be positioned inside of excavating equipment and limiting personnel access to potentially-contaminated debris piles. These same methods were implemented and utilized during OAD in the next two scopes of work, RFB and Caisson demolition. To ensure safe work practices were followed, the crew was required to perform dry runs for loading, hoisting and removing debris bags from the building. Building entry required the use of specific protective gear and respirators for all individuals, as determined by RP.

The Craft group included Equipment Operators, Spotters, Drivers, RP Technicians and Supervisors. This group normally consisted of fifteen team members on average. Specific tasks required Carpenters and Electrical personnel, in addition to the normal crew. Ongoing daily activities included:

- Setting and resetting fall protection/personnel barriers;
- Cleaning equipment and radiologically clearing material for removal from the RCA;
- Installation of steel plates over openings;
- Machine inspections and repairs;
- Repetitive change-out of shears, blades and buckets;
- Collecting and redirecting hoses;
- Loading out structural steel, ensuring no damage to the IM;
- RP load-out of waste into IMs, filter counting and cleaning; and
- Proper housekeeping to prevent slips, trips and falls at the end of shift each evening and as conditions changed.

Other routine activities included:

- Removing conduit and service lines, power cords and lighting;
- Reconfiguring temporary fence panels and concrete ecology blocks as needed;
- Disconnecting temporary power to LRWB at panel Load Center 24 (LC24); and

- RP controls, including setup, maintenance and removal of step-off pads, placement of plastic sheeting for contamination controls, control of radiological boundaries and various other support needs required by procedure and Field Technicians.

#### Interior Concrete Demolition

The LRWB and the waste it contained were radiologically characterized prior to demolition. Characterization was accomplished by performance of detailed chemical and radiological surveys, including measuring fixed and loose surface contamination and performing bore sampling to identify interstitial contamination. Survey results indicated that internal building components required special RP controls during the demolition process to ensure personnel safety and prevent environmental radiological release. The primary sources of hazard were contaminated sumps and embedded drain pipes, which were removed throughout the building footprint.

The LRWB required extensive decontamination of the interior concrete walls and floor surfaces prior to OAD. Based on contamination levels in the area, the most robust engineering controls were required for remediation (in most cases, a negative ventilation package-controlled area). These controls required HEPA ventilation, tents, glove bags, enclosures, application of fixative, wetting, decontamination, remediation and packaging. Because the LRWB connection to the main plant exhaust system was removed during the SAS demolition, an alternative method was needed to create a negative-pressure work area. Local HEPA filtration units were installed and used to capture dust and maintain the negative-pressure work environment. All air exiting the building, including demolition equipment exhaust fumes, had to pass through HEPA filtration units. Area examples are the WRTs and WHTs, RP work station/filter vault area and tank pedestals.

In preparation for decontamination and demolition, the CWC removed all exposed piping, equipment, furnishings and components that interfered with access to structural surfaces of floors, walls and ceilings. Surface decontamination included the wet wipe method for loose surface contamination and the mechanical shaving method of concrete surfaces for fixed contamination. Additionally, fixative agents were applied within the building interior, encapsulating remediated surfaces to ensure any remaining radiological contamination would not become airborne.

In addition to radiological concerns, several other hazards were identified in the LRWB, including lead, asbestos, PCBs and mercury. Specific attention utilizing site hazardous waste control procedures were used to identify, prepare, remove and dispose of these materials. Removal of structural coatings of lead-containing and asbestos materials required the use of specially-qualified personnel and the establishment of special control areas suited to the particular hazard or hazards. Potential for PCBs and mercury was of concern, specifically in sump areas and drains during interior preparation and removal work.

Removal of surface contaminants posed unique safety and environmental concerns. The most effective removal process, rubbleing, also generated substantial airborne hazards. After evaluation of the risks, benefits and costs of the process and hazard mitigation techniques, Management decided to proceed with the rubbleing process and use water misting and HEPA filtration to mitigate airborne hazards. Various types of water spray techniques were used to control airborne contaminants (such as concrete silica-laden dust) and to prevent rapid clogging



of HEPA filters, which would require multiple air filter change-outs. Although effective, application of this control process was labor-intensive. Too little water created an unacceptable airborne dust hazard with the potential for overloading the HEPA filtration units. Too much water clogged the HEPA filters, making it difficult to maintain building negative atmospheric confines. Water misters and garden sprayers delivered the appropriate volume of water, but required the applicator to work too close to the operating demolition equipment. Use of pressure washers resolved some of these issues. It was necessary in this process to collect the water that migrated into the floor trenches and sumps. This water was pumped to totes, decanted and reused to manage the volume. While this process was an impediment to a sustained pace of demolition work, the combination of the surface rubbing process with the hazard mitigation techniques provided the most cost-effective decontamination method, with enhanced personnel and environmental safety margins.

Water accumulation in contaminated areas and the spread of contamination was a concern during decontamination. Radiological boundaries and entry controls were changed frequently during demolition of interior walls to optimize water collection and contamination control. Challenges encountered with effective solutions served to provide lessons learned, which were then applied to the much more complex RFB demolition. For example, large specialized water misters were utilized and resolved most of the previously-described difficulties, resulting in a successful method of use for future OAD work.

The LRWB interior concrete removal required large excavators with metal-cutting shears, a concrete breaker and bucket/thumb attachment. Interior concrete demolition was conducted methodically from top to bottom, bay-by-bay, beginning with the Radwaste Demineralizer Room, followed by the Radwaste Concentrator Room and Pump Room. Access into the Concentrated Waste Tank and Resin Disposal Tank Rooms required breaching through 3.5-foot thick walls, enabling the removal of contaminated concrete tank pads. Contaminated sumps and embedded drain pipes were also removed throughout the building footprint.

The LRWB was an enclosed environment, requiring specific planning and equipment modifications to direct combustion-fired equipment exhaust fumes out of the building. Appropriately-sized machines capable of maneuvering within the tight workspace were selected and the exhaust manifolds were modified, using flexible ducting routed to the building exterior. Due to the potential for alpha contamination (as determined by RP sampling) in this dusty environment, it was impossible to adequately clean exterior and interior surfaces of the specific equipment to meet the free-release requirement from the RCA. As a result of the embedded contamination, it became necessary to purchase two excavators from the contractor. The high levels of dust generated during concrete decontamination and processing required substantial manpower to decontaminate the I-beams and horizontal surfaces of the ceiling and other hard-to-reach areas inside the steel building. Man-lifts were used to get the Deconner Team and RP personnel safely to these coated locations for final building release.

Processing of demolition debris was consistently challenging, due to the building's configuration and radiological controls, which required conducting multiple handling and stockpiling activities within a constricted workspace. Concrete debris was loaded into 4-foot by 4-foot by 3-foot nylon bags lifted via an overhead crane, and then staged on the upper floor. Upon radiological evaluation, waste bags were loaded onto carts and transferred out of the building. Ultimately, the nylon waste bags were loaded into IMs for disposal. This required extensive coordination, communication and support from multiple groups to perform the work.

## Exterior Steel Structure Demolition

Final interior cleaning and RP surveys confirmed that the LRWB met the criteria to be released to OAD. Structural steel demolition was accomplished using conventional demolition methods. There were several obstructions within close proximity to the LRWB, including active electrical distribution panels, dewatering sumps and equipment exclusion zones protecting the hillside retaining wall. Installation of protective measures and equipment operation within this limited space was time-intensive. Steel removal required large excavators equipped with metal-cutting shears and bucket/thumb attachments. Initial demolition began on the west end, demolishing the structure methodically bay-by-bay. Multiple excavators were employed throughout the demolition process, ensuring positive control of building components. Components were processed and loaded into IMs for disposal off site.

## Subgrade Demolition

Subgrade demolition of the LRWB was rescheduled earlier in the decommissioning to leverage the availability of the RP group and survey equipment. The RP group and their equipment were scheduled to be demobilized prior to the start of subgrade demolition. There was a risk that undetected contamination existed below the demolition zone. Earlier demolition facilitated sampling to identify any subgrade contaminants while full RP support was still available to handle this type of contamination control. Samples taken from the soils prior to the demolition at the northeast corner of the foundation showed a much lesser degree of contamination than originally anticipated. Had higher levels of contamination been present in some of these areas, special controls for collection and segregation of the materials would have been required. The potential costs of remobilization and a second de-mobilization were avoided by completing the subgrade demolition while RP resources were still on site. Additionally, moving the concrete LRWB structure D&D earlier in the schedule provided a laydown and staging area used during early Caisson removal project activities taking place.

During the metal building demolition, protection was established around the 12KV at LC24, which supplied decommissioning site power. Damage to LC24 from flying debris could have shut down all project activities until it was repaired and placed back in service. LC24 was located immediately west and above the LRWB foundation. A geotechnical evaluation of slope stability was performed, which identified additional stability requirements. The load center was restrained using straps and construction blocks and tying it back temporarily, to relieve the weight it would impose on the 1:1 (100 percent) slope at 45 degrees created to access the LRWB grade elevation and provide the requisite stability for LC24.

Rubble load-out started after the final section of the wall and upper support piers were removed. During slab removal, RP provided close observation to ensure the embedded piping and areas of concern on the slab were segregated properly for waste load-out.

Extensive preparation was required for processing waste materials at the location. Material generated at the worksite was separated and the steel and concrete loaded into separate trucks or IMs. This effort was time-consuming, requiring crews to separate rebar from concrete in preparation for its transport to waste-handling buildings and ultimately, off site as waste in most cases. Soils removed during demolition were also loaded into trucks. During demolition of subgrade materials, each truck of soil had to be driven through the GARDIAN system to determine if it could be reused, or if had to be disposed of as waste.

Concurrently with LRWB slab removal, North and Upper Yard excavation work was taking place. Excavation in the non-cohesive type of soil present on site required a slope ratio of 1.5 feet horizontal length for every 1 foot in vertical height 1.5:1 (66.7 percent) slope at 33 degrees. Inspections by an excavation-competent person took place each day and after rain events. If needed, repairs were made to the slope.

Water intruded into the work zone and excavation areas during demolition. The sources of water were groundwater, rain and the spray used for concrete dust controls. Any water that accumulated in the excavation areas was removed to maintain a good working surface. The water was pumped to storage tanks for eventual treatment.

Subgrade demolition work was planned concurrently with FSS, with surveys of the excavated area being performed prior to backfilling any excavations. Utilizing an excavator, the LRWB concrete piers had to be partially dug from the ground and then removed. Before the holes could be backfilled, FSS soil samples were taken and evaluated. This included environmental sampling and RP walkover surveys. Use of the 50-ton crane and carry deck cranes with ISOCS was required to complete the FSS survey in areas not safely accessible to personnel. As an additional cost-saving measure, during the backfill and grading process, sumps and pumps were installed to help with future groundwater controls, which would be needed during the Caisson removal process, thus avoiding re-digging and rework for groundwater control system installation.

Each backfill layer in the area of the LRWB, North Yard and Upper Yard required compaction testing. Once the backfill process was completed, the area was covered with BMPs and a block retaining system to control water runoff, keeping as much water as possible away from the future Caisson work area.

#### 4.1.1.2.3 SAS (Security Alarm Station)

The SAS was located just north of the RFB and south of the LRWB, inside the RCA. The SAS facility was originally built as a hydrogen recombiner vault to reduce radiation emissions leaving the stack of the HBPP Unit 3 nuclear facility. This vault was built prior to the 1976 refueling outage and was to be tested as operational prior to the restart after the refueling outage. The vault housed an extra off gas particulate filter, charcoal retention tanks and heat exchangers, which would have required thick shielding once in service. Because the plant was not restarted, the vault was never placed in service and remained a clean area within the RCA. After the World Trade Center attacks in September 2001 brought on new security regulations, the vault became the logical location for a hardened SAS. The Security Team relocated from the SAS to the ISFSI upon relocation of the spent fuel from the SFP in 2008. During the self-perform portion of decommissioning, the SAS stored miscellaneous radiological monitoring equipment utilized by RP.

The SAS was a 30-foot by 30-foot heavily-reinforced concrete superstructure, with support section below grade. The superstructure consisted of a roof, walls and floors as thick as 2 feet 9 inches. Below grade, the SAS consisted of walls that were up to 3 feet thick, with a 2-foot thick floor slab. The SAS was 8 feet 6 inches above ground and extended down below grade 10 feet 6 inches. Access to the structure was through an entry at El. +12 opening into a stairwell down to the main floor of the structure at El. +3.5. At El. +3.5, the east wall provided access into a pipe tunnel. Mounted along the west side of the SAS were obsolete electrical

conduits, a control panel and two active security cameras. On the north side of the SAS, the available space was restricted, as only about 5 feet of clearance existed between the planned south edge of the CSM wall and the SAS. The interior of the structure included a vestibule on the ground floor and both a large and a small room, hallway and storage on the lower floor.

The SAS was connected to the plant ventilation system through the Off Gas Tunnel. The southwest corner was within a few feet of the MPEF foundation and associated ventilation ducting and filter bank. These ventilation components were quality-related and needed to stay in operation until the RFB was cleared for OAD. The LRWB ventilation duct was routed over the top of the SAS and was removed prior to demolition of the building.

The scope of SAS demolition work was to safely remove the SAS structure, both above and below grade. The SAS demolition work was split into two separate evolutions, Above-Grade Demolition and Below-Grade Demolition, which were separated by five months. This phased approach was implemented to enable more effective coordination with other demolition activities, specifically, pre-trenching related to the CSM installation.

#### Above-Grade Demolition Scope

The work plan for demolition of the SAS was to raze the above-ground portion and prepare the area to support the heavy equipment to be used for the CSM wall pre-trenching and installation activities. The concrete rubble from above-grade demolition was placed into the SAS lower level as a temporary fill. The remaining voids were filled with flowable fill, or reusable fill from the site.

The demolition followed standard demolition practices, with the majority of the work being performed using an excavator fitted with either a hydraulic breaker (hammer) or a concrete processor. This work required close monitoring of the MPEF, which was operating in close proximity to the building on other projects.

The above-grade work scope included the following key elements:

- Verifying Freon removal from Air Conditioning (AC) systems by certified, qualified AC technicians;
- Performing Class I asbestos abatement on four duct seals, utilizing the room as the enclosure, and two roof penetrations, utilizing a mini enclosure on the roof;
- Demolishing all conduits, pipes, rails, ducts and other miscellaneous equipment from the SAS exterior;
- Installing protection for active systems adjacent to the SAS, including the MPEF and Stack Particulate Alpha Monitoring Systems (SPAMS);
- Constructing a scaffold structure and screen placed in service to protect personnel and equipment;
- Installing water-resistant protective covers for the Access Tunnel;
- Removing the vent duct from the MPEF system to the LRWB;
- Removing all remaining commodities from the interior of the building;
- Segregating coated concrete for characterization, packaging and shipping;
- Segregating uncoated concrete for use as temporary backfill; and
- Backfilling subsurface SAS with material mentioned above.

#### Hazardous Waste Removal

Prior to the CWC executing demolition activities, PG&E removed wastes such as mercury-vapor lamps, mercury switches and PCB sources, as well as asbestos-containing ceiling tile from the SAS. However, four duct seals inside the lower structure near the ceiling and two roof penetrations required Class I asbestos abatement by the CWC. Paint on walls and floors inside the SAS was found to contain levels of hazardous constituents. Remaining below-grade stairways, ladders and other components not considered hazardous or contaminated were not removed with the above-grade SAS; rather they were left in place and demolished in place as part of the SAS below-grade demolition.

Coated concrete was segregated and characterized through paint sampling, then packaged and shipped off site to an appropriate waste facility. Any uncoated concrete (roof and upper sections of the SAS walls) was rubblized and used as temporary backfill.

#### RP, Craft and Waste Support

The daily SAS Demolition crew typically consisted of a Field Work Supervisor, Equipment Operators, Laborers, Asbestos Abatement Personnel, Safety and Industrial Hygiene Specialists, Environmental Specialists, RP Technicians, Waste Disposal Personnel, and Electricians. Specialized mechanical subcontractors for draining Freon from the building Heating, Ventilation and Air Conditioning (HVAC) units were utilized as required. Crew size ranged from four to twelve personnel, depending upon the day and task.

#### Above-Grade Demolition Field Work

Above-grade work of the SAS began in September 2014 and was completed on schedule in October 2014. Initial work started by removal of any remaining universal waste and congested commodities from inside the building. Some commodities required special planning. For example, an AC was slated for removal. To remove the AC unit, the Freon and the compressor oil were removed from the unit by a local HVAC specialty contractor. The oil was turned over to the plant Waste Team for storage and eventual proper disposal.

The SAS roof coating contained non-friable ACM, which was remediated by the same specialty abatement contractor who was used for removal of the Phase 1 asbestos coating on the outside of the RFB. Additionally, the specialty abatement contractor remediated four wall penetrations and two roof penetrations that contained ACM. Utilizing this abatement contractor for both the SAS and the RFB projects produced a savings as a result of one less mobilization and demobilization effort. Scaffolding support had to be provided for the abatement work and for removal of some of the other overhead commodities.

After hazard remediation was completed, the remaining interior components were removed. Subsequently, the building was configured with cold and dark power and the remaining RP equipment and existing sump pump were removed. Next, the exterior conduit, boxes, ductwork and other outer components were removed. Two steel barrier plates were installed to segregate the SAS from the pipe tunnel. The steel barrier plates and their associated structural steel and anchors were heavy and required rigging attachments and chain falls to maneuver into the tunnels for installation. Once in place, the plates served as a seal to the valve gallery and the pipe tunnel adjacent to SAS. Additionally, the plates served as a retention barrier when filling the below-grade SAS with rubble and a concrete slurry mix. The conduits, piping and ductwork were demolished from the SAS interior. The 14-inch vent duct between the MPEF system and LRWB was then removed.



Emergency egress for personnel was maintained out of the RFB from the escape hatch next to the main plant exhaust stack by placing a scaffold with plywood cover, providing a walkway for personnel to exit. The escape hatch was immediately south by just a few feet of the SAS above-grade structure. Egress via the escape hatch needed to be maintained during the SAS above-grade demolition. To accomplish this, a scaffold with plywood cover was erected so personnel could safely use the escape, if needed. The RFB north airlock exit pathway was shut down during the rubble process, requiring establishment of a second exit path for personnel. The Engineering and Safety Teams utilized an existing containment building, which was used for material removal during tunnel and valve gallery work, as the second exit path from the RFB. Scaffold crews erected a scaffold stair tower in the tunnel area, allowing personnel to exit the building through this temporary facility, until safe passage was restored following completion of above-grade demolition.

Because the MPEF was still needed for RFB work, the SAS needed to be removed without interrupting operation of the MPEF. A tall, rigid debris curtain was erected around two sides of the building to protect the MPEF and personnel from concrete debris during roof and wall demolition. Building robust debris netting took a scaffold team approximately two weeks to erect. Plywood was added to 8 feet high for additional protection for MPEF. The scaffold configuration supporting the debris net protected the RFB MPEF duct work, MPEF, HEPA filters, instrumentation, SPAMS Infrastructure, SPAMS monitoring skid and associated tubing and instrumentation from flying debris. Frequent maintenance of the netting was required during demolition to ensure protection of the plant's sensitive operating equipment, as well as to ensure safety for personnel around this demolition area. Through well-coordinated communications and diligence of the crews, the complete removal of the SAS in such close proximity to the MPEF was executed without operational interruptions.

Concrete removal required a large excavator with metal-cutting shears, a concrete breaker and bucket/thumb attachment. Use of a second excavator with attached bucket loaded debris into IMs or dump trucks. A skid steer kept the area cleared of small debris and mud. The southwest corner of the building was left standing until the end to protect the adjacent MPEF. The remaining rubble process was handled slowly and meticulously so the MPEF and its foundation would not be compromised. Final removal of the section near the MPEF involved carefully pulling the corner wall over into the SAS footprint, instead of using the breaker attachment on the excavator. Engineering personnel monitored the base of the MPEF for movement during this iteration and there were no incidents.

The above-grade demolition of the roof, interior and exterior walls took three weeks to remove the very thick concrete and heavy reinforcement. It required considerable size reduction of rubble to separate the steel and concrete debris. Closely-spaced, large-diameter rebar took extra time to cut and place into IMs for disposal. Dust control required use of hand-held pressure washers and large misting machines elevated above the work utilizing man-lifts. The man-lifts were also used to monitor projectile patterns during demolition. Work stoppages were ordered when debris patterns approached the top of the safety net. Demolition processes were then modified to enhance the safety margins around the netting.

During the rubble process, roof and wall concrete was allowed to fall into the lower level of the building. Approximately 200 cubic yards of concrete rubble were produced by the demolition of the above-grade structure. This concrete rubble was used as fill within the SAS footprint, to provide a stable working surface for the area prior to below-grade demolition. Resulting voids

were filled with flowable concrete fill. Utilizing the rubble as fill reduced costs by precluding the use of temporary imported backfill material. Only uncoated concrete was used as fill for the SAS. Any concrete that tested positive for contaminants was characterized, packaged and shipped off site to the appropriate disposal facility. The lower-level SAS (below grade) was left in place, capped with a slurry mix and remained until the slurry wall pre-trenching critical path work was completed north of the SAS.

### SAS Below-Grade Demolition

Once the slurry wall pre-trenching critical path work was completed north of the SAS footprint, the SAS below-grade work commenced. Work began in March 2015 and was completed in April 2015, concurrent with the planned North Yard work in April 2015. Planned tasks included removal of surface and subsurface commodities and backfill. The CWC analyzed the work schedule and determined the planned productivity of the SAS below-grade work could be optimized by utilizing crews in adjacent work areas performing other work, without affecting the scheduled critical path. The overall duration of the SAS below-grade work was reduced, therefore minimizing planned mobilizations, planned demobilizations, crew production time and equipment rental time.

Demolition followed standard practices as above-grade demolition, with the majority of the work being performed using an excavator fitted with either a hydraulic breaker (hammer) or a concrete processor.

Specifics of the below-grade work included the following key elements in addition to those listed for the above-grade work plan:

- Excavation of concrete rubble and slurry from above-ground demolition;
- Demolition of sub-structure walls;
- Leaving a section of the SAS southwest corner to support the MPEF;
- Establishment of an equipment exclusion zone during excavation; and
- Assurance that structural backfill was installed to support the remaining portion of the SAS foundation, prior to removing the equipment exclusion zone.

The slurry fill that was used to cap the area during above-grade demolition was easily removed, then below-grade walls and rubble from above-grade demolition was removed, using similar equipment as described in the above-grade demolition. When a depth of approximately 6 feet was reached, pumps and sump areas were put in place to remove the existing rain and groundwater collected in the area. These pumps remained active throughout the rubbing process.

To ensure the MPEF foundation was adequately supported, the lower SAS removal had to be completed in phases. Engineered slopes were graded in place, creating a safe work path, to ensure the MPEF and foundations would not collapse into the excavation, protecting both the equipment and personnel working in the space below. The southwest corner was again left until the end of the removal process. Pre-existing sheet piles adjacent to the MPEF foundation provided additional support during demolition while the MPEF was still in service.

Close coordination between Field Supervisors and the Phase 2 RFB Scaffold Team was needed (performing concurrent work activities for the RFB abatement) to complete backfill of the excavation on which the RFB scaffold erection was dependent. As a result of excellent



coordination during backfill, the space needed by the RFB Scaffold crew was made available, keeping the RFB near-critical path activity on track. This effort was challenging due to congestion, with limited available area for movement of needed equipment and IMs. Additionally, a concerted effort was made to optimize the location of the RCA boundary so IMs could be staged for loading excavation debris.

## Equipment

Equipment used for the demolition work included:

- Excavator fitted with a 12,000-pound hydraulic hammer; with other configurations including a concrete processor, shear and bucket/thumb attachment;
- 10-cubic yard dump truck;
- Backhoe;
- Bobcat loader;
- All-terrain forklift for general support;
- Man-lift;
- Water misting equipment; and
- 90-ton crane for intermittent support of vent duct and HVAC removal.

Mobile equipment was provided by local rental companies and the CWC.

### 4.1.1.3 Refueling Building

The RFB was a rectangular concrete structure constructed over the Caisson. It was approximately 100 feet long by 45 feet wide by 45 feet tall and constructed of reinforced concrete. The structure served as the ventilation and containment envelope for the SFP and Caisson support systems. It also served as secondary containment for the reactor. MPEF and components were attached to the RFB. The MPEF system provided the required negative ventilation for the RFB and Caisson and originally discharged to a ventilation stack. The main portion of the stack was removed during SAFESTOR operations. The stack base was located immediately north of the RFB.

The initial commodities removal and area hazard remediation of the RFB was performed during the self-perform phase of decommissioning. The HBPP Team turned over the balance of RFB demolition to the CWC in June 2014. The remaining tasks to prepare the RFB for OAD included drywell systems remediation and removal, MPEF components remediation and removal, plant stack base demolition, overhead crane removal and asbestos abatement of the exterior. Above-grade RFB demolition immediately followed RFB preparation.

Completion of RFB removal was accomplished in two phases, RFB Preparation and RFB Demolition.

#### RFB Preparation for OAD

This work included the necessary activities to prepare the interior of the RFB and Caisson ventilation envelope for OAD, including a complete SSC characterization for radiological and environmental hazards. Once the characterization was complete, systems that did not meet the required OAD criteria were removed, remediated, or placed in a configuration that met the OAD criteria established by the PG&E RP Program. Additional preparation activities included

removal of exterior asbestos-containing coating and roof membrane, and partial dismantling and preparation for removal of the overhead crane.

Preparation of the RFB and Caisson for OAD required a team of experts performing an in-depth review of the legacy SSC that were left in the RFB and Caisson. The team was comprised of the RPV PM, RPV Project Engineer (PE), industry experts in radiological decontamination and characterization (from several other United States and United Kingdom decommissioning projects), and experienced Technicians. The RPV PM and PE were chosen for their professional expertise and site-specific knowledge. These two individuals were part of the PG&E self-perform project and were intimately familiar with the remaining SSC.

The physical work of characterization was performed using a systematic, level-by-level approach. All rooms and areas within the RFB and Caisson proper were examined, including remaining piping, penetrations, embedded pipes and concrete surfaces. Radiological data such as surface contamination concentrations and gamma and beta dose rates were analyzed, reviewed and assessed. The results were documented and submitted to the Project Team to determine whether removal or remediation was needed.

An HBPP procedure for OAD governed the radiological limits for OAD. The procedure included calculations based on the site-specific radionuclide distribution. These calculations provided a dose rate at the site boundary, which was compared to NRC regulations for site boundary dose rates. The calculated values were used to determine the subsequent course of action. Possible actions were removal, remediation, or no action.

The Project Team used the data and criteria to develop a list of SSC that had to be removed or remediated to meet OAD criteria. Many systems, such as embedded floor drains, could not be removed without affecting the structural stability of the RFB and Caisson. The team successfully employed the industry standard remediation techniques involving paints, epoxies, glues and foams as surface coatings. These techniques affix contamination to surfaces to prevent contamination migration during demolition. This allowed for successful remediation of non-removable SSC, bringing the RFB and Caisson to OAD status.

Other safety hazards were addressed during the preparation phase. For example, lead shielding from the adjoining Demineralizer Building had to be carefully removed and the electrical panel CDP-7 was relocated, due to exterior asbestos abatement scaffold erection. The Project Team also utilized specialty subcontractors to effectively abate and remove any accessible hazardous materials, which were discovered during the characterization process. Materials removed were packaged, then shipped for disposal.

While the physical work was being performed, the Waste Team evaluated data collected by the Characterization Team. The data was analyzed to ensure that WAC of the planned disposal locations would be met without risk of a non-compliant shipment. The Project Team, Waste Team and the HBPP Team worked jointly to ensure the end result of OAD would be within acceptable risk limits for personnel and radiological safety, and also for regulatory compliance. The Project Team developed a demolition guidance document that was used to create the detailed demolition work plans for the Caisson. The document included areas of high radiological and environmental risk, and processes for the demolition and mitigation of the associated risk. The document also defined how the remaining radiological waste would be segregated and packaged during the Caisson demolition.

## Asbestos Remediation

The exterior paint coating on the RFB was found to contain asbestos above the criteria allowable for OAD. The team hired an independent Certified Asbestos Consultant (CAC) to characterize the RFB to complete a sampling campaign. The CAC identified ACM, PCBs and California Administrative Manual (CAM) 17 metals. CAM 17 metals identifies the metals above and beyond the Federal Resource Conservation and Recovery Act (RCRA) list that must be analyzed.

Cold and dark power conduit and power panels on the exterior of the RFB were relocated. The building exterior was coated with an ACM material that had to be removed from the seismic columns and the wall of the building prior to demolition. Test results showed that the ACM coating was not present behind the seismic columns, indicating that the coating was placed on the building after column installation.

In advance of RFB wall demolition, the team conducted an extensive study and approval process for asbestos abatement methodology to be used on the RFB walls. The work required erection of a sizable engineered scaffold structure on the exterior walls of the RFB, which was shrink-wrapped to establish negative-pressure asbestos containment on the building exterior, allowing for the RFB rhino coating to be removed. To ensure schedule adherence, pre-trenching was expedited in this specific location. In turn, this required a resequencing of preparatory excavations, backfilling and soil compaction at the asbestos abatement scaffold footprint location within the RCA. Resequencing of these major excavation efforts maintained an optimal progression of decommissioning work. The changes demanded the full attention of a dedicated Design and Planning Team to plan, integrate and execute the work. Incremental work plans were developed to build scaffolding while abatement plans were being developed.

A Class II enclosure was erected to contain the approximately 10,000-square foot surface area in a negative-air-pressure envelope to prevent airborne escape of particles. Scaffolding was erected on all four sides to the top of the RFB, then completely covered with a shrink-wrap fabric. Using a double layer of 12-mil sheeting and berm on the ground, a water filtration system was installed to recycle the water and trap contaminants and debris during the ACM removal process. The Field Team verified that the ground was level, allowed for full operation of rail bay doors for continuing work in the RFB, and maintained unrestricted access to the two airlocks.

A specialty abatement contractor was engaged to perform the asbestos remediation. The contractor operated under State of California regulations and HBPP Site Specific Abatement Procedures. Licensed personnel were required to wear a Powered Air Purifying Respirator (PAPR), OREX outer garment, booties and gloves. They removed the paint using an approved chemical and pressure wash. The remaining ACM in difficult-to-reach locations was removed by mechanical means. The specialty contractor then applied an encapsulant to lock down any remaining contaminants. RP and Waste Management directed disposal of materials, tools, tanks, asbestos and filters, as described in the PWP. Scaffolding was then disassembled.

The roof of the RFB was also found to contain ACM. The mastic used to seal layers of flat rolled roofing was known to contain non-friable asbestos. Test results identified the multilayered bituminous rolled roofing to be non-friable ACM and of the waste designation "non-hazardous asbestos waste." The ACM was impregnated in the asphalt roofing material and therefore, an

enclosure was not required. The stair tower from the paint removal project was retained for access and egress. A crane loaded waste bags directly from the roof to IMs.

Additional preparation included removal of universal waste, fixative application and preparation of the bridge crane for demolition. Fluids were drained, contamination was removed, and a pulling harness was installed on the bridge crane for its future controlled drop. The active service air and water supply systems were then abandoned. The Cold and Dark circuits were incrementally de-energized as preparatory activities advanced and electrical needs decreased.

#### Hazardous Material Removal

During the self-perform portion of the decommissioning, the HBPP Team removed most of the hazardous wastes, such as mercury-vapor lamps, mercury switches, asbestos insulation and lead-containing materials. During Caisson OAD characterization activities, additional materials were identified throughout the RFB, Caisson, stack base and MPEF components. These materials were characterized and removed by a licensed subcontractor.

#### Specific RFB Systems and Areas

The RFB contained systems and areas of special interest during the preparation phase. In particular, the MPEF, drywell region and plant stack base required focused attention.

The MPEF components included main suction fan, inlet fan, control dampers, exhaust stack, main HEPA filtration bank, exterior hard ventilation ducting and supporting foundations for these components. Preparation activities included a complete SSC characterization for radiological and environmental hazards. Once the characterization was complete, systems that did not meet the required OAD criteria were either removed, remediated, or placed in a configuration that met the intent of the OAD criteria established by the HBPP RP program. Once hazardous materials were removed or fixed in place and the structure met the OAD criteria, the structure was demolished to grade.

The drywell region work included the removal of the remainder of the contaminated piping systems located within the drywell of the Caisson. The systems were directly associated with the function of the RPV (e.g., primary cooling water, instrumentation lines, sample nozzle piping and ventilation). Access to the drywell required use of the Reactor Containment Building's 15-ton crane and a man-basket. The team worked out of the basket, utilizing the RFB crane with attached chain hoist to remove the remaining contaminated components.

The plant stack base work included the removal of as-left stack base and components. The stack base concrete structure extended 20 feet above grade and 15 feet below grade and previously housed the gas treatment system components. The Gas Treatment System components, which included all its hard piping and duct work, were removed during self-perform, as reported in the 2015 NDCTP Attachment B, Completed Activities Report. Activities included a complete SSC characterization for radiological and environmental hazards. Once the characterization was complete, the team successfully employed the industry-standard remediation techniques involving paints, epoxies, glues and foams as surface coatings, which affix contamination to surfaces for demolition to prevent contamination migration, allowing for successful remediation. The structure met the OAD criteria, allowing the structure to be demolished to grade. Below-grade structure and components were removed later by OAD excavation.

## RFB Open-Air Demolition (OAD)

After the RFB preparation was well underway, the guidance document for RFB and Caisson OAD was completed. The scope of OAD included above-grade demolition of the RFB to the working surface grade located inside the Unit 3 footprint. The expected waste to be generated from this demolition included approximately 850 cubic yards of concrete rubble, 700 cubic yards of soil, 6 steel pilings and 133,000 pounds of rebar and steel.

In order to accommodate the critical path CSM preparation, the MPEF and the RFB east 40 feet were selected as the starting point of the RFB OAD. A demolition contractor familiar with demolition of radiologically-contaminated structures was selected to begin the OAD. The contractor was able to employ the necessary practices governed by the demolition guidance documents, utilizing the specialized demolition equipment discussed earlier, to successfully demolish the MPEF and the east 40 feet of the RFB in October 2015. The data gathered during the preparation phase and initial OAD was used to update Project Work Plans to include the required characterization data and lessons learned. As expected with an OAD determination, the OAD was executed without personnel injury or uptake of any radiological material. Waste was downsized as needed and packaged per direction of Waste Management.

The remainder of the RFB and the stack base were demolished, using the same techniques as on the RFB east 40 feet and the MPEF. This demolition work was also executed without personnel injury or uptake of any radiological material. Waste was downsized and packaged by Waste packaging personnel. The SFP was filled with concrete rubble to create a working surface in the structure, so heavy equipment could operate over the pool area during future Caisson removal. Concrete rubble was used, as it was in the immediate proximity and saved the hauling expense of other fill materials.

Removal of the overhead 74,000-pound bridge crane could have been a time-consuming piece-by-piece overhead cut and lower operation, but for an engineering design that planned a careful and controlled drop of the entire assembly. It was performed flawlessly, providing a much safer means of removal and saving considerable crew time.

Miscellaneous excavation included removal of the Off Gas Tunnel and other below-grade structures and piping systems, rigging and removal of 70-foot long steel piles encountered under the slab. A rigging plan and a large crane had to be obtained for these piles.

## Labor and Equipment

The preparation and demolition crews consisted of a Field Work Supervisor, Equipment Operators, Laborers, Asbestos Abatement personnel, Safety and Industrial Hygiene/Hygienist (IH) Specialists, Environmental Specialists, RP Technicians, Waste Disposal personnel and Electricians on a daily basis. Crew size ranged from six to eighteen personnel, depending upon the day and task.

The equipment used for the RFB preparation and OAD varied with the task at hand. The interior scopes of some work required materials and components to be sectioned and removed manually with hand-held tools, due to the confined areas located throughout the Caisson structure. Piping systems were removed by non-sparking methods, due to radiological contamination, and then packaged such that the components could be safely transported from the Caisson interior. For larger exterior components and the concrete structures themselves,



large industrial demolition equipment was utilized. This equipment included standard and high-reach 40-ton to 50-ton excavators, fitted with a 12,000-pound hydraulic hammer. Other configurations for the excavators included concrete processors, concrete and metal-cutting shears and standard bucket/thumb attachments. Additional equipment utilized included 10-yard trucks, a backhoe, a skid steer loader, an all-terrain forklift for general support, power washer/misters, a service truck and a man-lift. Mobile equipment was procured from local rental companies and the CWC.

### Specific Challenges

The OAD preparation activities were challenging, due to limited access to areas of the Caisson interior itself. At the start of preparation activities, many areas were still categorized as Surface Contamination Area (SCA). Remediation of these SCAs required the workforce to be in full radiological PPE, while still performing SSC removal. This included ventilation duct components, preparation of the overhead crane for removal, any remaining access shaft and drywell components and electrical cabling. Upon complete removal of the SSC, the Caisson was free of SCAs, providing a clean environment for OAD.

Seismic retrofit steel added in the 1970s was removed in a bay-by-bay sequence. The CWC was directed to track seismic retrofit removal expenses separately. These costs have been directly borne by PG&E, since the CPUC did not allow recovery of the original costs of this retrofit.

The MPEF demolition had unique challenges, due to its close proximity to the CSM wall installation project at the time. Demolition crews worked in a congested area between the CSM project and the plant stack base. Nonetheless, work was performed safely and without any incident of damage to surrounding work faces.

As with the MPEF, the plant stack base and the RFB demolition were performed during the CSM wall installation. Work execution was sequenced such that other work areas were minimally impacted. Also, the RFB was the tallest building on site to be demolished during CW performance. This brought with it additional challenges for space and safety clearance areas. Work was performed safely and without any incident or damage to surrounding work faces.

### Schedule

The RFB preparation work began in June 2015, after the completion of the RPV removal project and Phase 2 of the RFB demolition, which was completed in August 2016. During this time frame, the following activities were completed: interior preparation (September 2015), MPEF demolition (October 2015); and the first 40 feet of the RFB (started October 2015 and completed November 2015).

#### 4.1.1.3.1 Spent Fuel Pool (SFP) Liner

The SFP was located inside the RFB. The top of the pool was at floor level, or El. +12. Unlike newer power plants, this pool did not have a connecting fuel transfer canal to the reactor area. An overhead crane and shielded containment cask were used to transfer fuel assemblies between the reactor and the SFP.

The SFP was the holding area for used nuclear fuel bundles. During refueling outages, fuel assemblies were moved to the SFP for wet storage. The SFP water provided an excellent



shielding barrier, as well as cooling for storing used fuel assemblies. At one time, the SFP also contained damaged fuel assemblies accumulated during operation of the plant. In addition, substantial amounts of dispersed activated metals, which came from performing segmentation of reactor vessel internals during demolition activities, accumulated in the SFP. The highly-contaminated nature of the SFP was an RP concern during the SFP cleanup process, particularly considering the potential for personnel internal contamination from the uptake of alpha contamination from the surfaces of the pool.

The SFP was originally coated with carboline to prevent leaks and prevent contamination of the underlying concrete. After a number of cracks developed in the concrete during operations, a stainless steel liner was installed over the concrete pool floor and walls in the early 1960s. The liner was made from 10-gauge stainless steel sheet for the walls, 1/4-inch stainless steel plate for the floors and attached with stainless steel studs.

PCBs and lead were identified in the specification for the carboline pool coating system. A sample was taken through the SFP liner to obtain characterization data. The findings indicated the carboline coating:

- Was negative for asbestos;
- Contained 4.1 ppm of PCBs; and
- Contained lead.

The presence of PCBs and lead required the complete removal of the carboline coating as a critical part of the SFP demolition.

#### Scope of Work

The scope of the SFP liner project included draining the SFP, removing the SFP liner, remediating the carboline coating, scabbling, and sealing the remaining concrete surfaces. This project was necessary to allow OAD of the RFB. Initial work began in August 2014, with removal of the Tri-Nuke filter, hoses and demineralizer, interspersed with various mechanical and civil interferences. Work was completed in September 2015.

In addition to liner removal and surface remediation, the project scope included removal and disposal of the following commodities:

- 60 filter cartridges;
- The Tri-nuke filter;
- Fuel elevator;
- Demineralizer vessel;
- Demineralizer column;
- SFP ventilation header; and
- SFP bridge.

The SFP liner removal and concrete remediation was originally planned to be completed dry after the final draining of the SFP. The CWC presented an alternate wet method for liner removal by keeping the SFP full of water to retain the shielding benefits, while utilizing qualified underwater commercial divers and special cutting and coating equipment. The dry removal process would have required delaying the draining of the SFP until after the installation of the CSM wall to control groundwater in-leakage into the working area inside the SFP. Additionally,

the later SFP work would have resulted in scheduling conflicts, which would have delayed beginning demolition of the RFB. Using the underwater removal approach allowed the liner to be removed simultaneously with other critical path activities in the RFB, thus eliminating the SFP liner project from the critical path. Wet removal saved schedule time by allowing two activities to proceed concurrently - reactor vessel segmentation and SFP liner removal.

The wet approach resulted in a safer working environment for the crews by both reducing radiation exposures and by eliminating physical stresses incurred by wearing Power Air Purifying Respirators for the dry-work scenario. Underwater remediation and sealing of the SFP reduced the estimated person-rem exposure to personnel by eight-person-rem, keeping with PG&E's ALARA practices.

#### Field Work

Field work began with removal of loose commodities, ventilation header and other structural components and the refueling bridge from over the pool (including downsizing for packaging and disposal). These activities took one month to complete. Field work proceeded in conjunction with the RPV segmentation. The two projects shared equipment and space (e.g., 75-ton crane and rail bay for laydown and load-out of materials). To help alleviate crowding, a third crew, the Dive Team who had been working in the same area, moved to another work location for two weeks to plug the three Discharge Canal lines, in order to isolate the canal from the plant.

After the SFP bridge was removed, the divers mobilized in the RFB. Mobilization and SFP commodity removal took several weeks and included installing a diving access platform and establishing the RP contamination control area for the divers' access area. The diving support equipment included:

- A diver platform;
- Diver dry suits;
- Temporary dry suit storage;
- Diver air supply;
- Underwater dosimetry equipment;
- Water filtration system;
- SFP liner cutting and rigging equipment;
- Scabbling and chipping tools;
- Underwater video and audio monitoring system and associated equipment;
- Liner waste packaging materials; and
- A diver de-contamination area.

Divers started in-pool work on day shift and transitioned to night shift later in the project to prevent interferences with the critical path activities of the RPV segmentation project. Segmenting the RPV, removing building components and performing decontamination and remediation proceeded uninterrupted on the day shift, while diving activities occurred on night shift. The split enhanced the cost and schedule performance of both projects. Both projects were able to proceed uninterrupted and undisturbed by the other.

The routine process for getting the diver into the pool started with the dive assistant (a stand-by diver) preparing the dry suit, while the diver donned a thermal under suit. The assistant then

helped the diver don the dry suit and attach the dive helmet, including communication, video and air supply lines. Due to restricted vision of the dive helmet, the assistant escorted the diver to the entry platform for pool entry. After duration of approximately 2 hours, the diver exited the pool. Upon exiting the pool, the diver was rinsed down with demineralized water, scanned by RP personnel and assisted with helmet and suit removal. At this point, the assistant and diver reversed rolls to repeat the process of re-entering the pool.

SFP liner removal was initiated by filling the SFP with clean water to the normal operating level. Divers segmented the stainless steel liner using small, waterproof and hand-held tools. The three primary tools used for segmenting the liner were an underwater circular saw, a pneumatic band saw and an underwater torch. A floating in-pool hoist system with racks located in the SFP assisted the segmenting operation. The floating hoist also doubled as a fume hood, catching any contaminants that rose to the surface in the air bubbles. The air and contaminants were then run through a HEPA filtration unit.

Divers cut the SFP steel liner into 5-foot by 9-foot segments, using a cutting torch and circular saw and laying the segments on the bottom of the pool. Once on the bottom of the pool, the segments were further reduced in size to fit specialized removal racks fabricated specifically to hold the SFP liner segments. Loaded racks weighing approximately 4,000 pounds were surveyed for hot spots and then removed from the SFP. Once out of the pool, the racks were surveyed again to ensure they met shipping criteria, placed into B-25 grout boxes and moved outside the SFP to the rail bay. They were then prepared for shipment to the designated waste disposal site.

Following removal of the stainless steel liner, the diving specialty contractor and RP performed a comprehensive underwater radiological survey of the concrete SFP walls and floor, using remote dose rate meters. They identified several areas of elevated activity on the walls and floor. These areas were remediated by removal of the carboline coating and any associated radiologically-contaminated concrete. Small hand tools were used (diamond grinding and chisel work) to remove the higher radiation spots from the concrete walls underwater. A specific area of concern was the cask pit sump area, which had elevated dose rates. Additional remediation by scabbling the concrete up to ½ inch deep was necessary in this area.

After the elevated activity areas were remediated, the rest of the carboline coating was removed and a fixative applied underwater by the diving specialty contractor. The fixative was a product that has been used extensively to coat fuel pools around the world. The fixative performed a dual role, fixing loose surface contamination and providing a barrier to mitigate the in-leakage of groundwater into the SFP. Final coating of the SFP walls and floor took several weeks to complete.

The SFP was drained after the fixative cured. The water from the SFP, approximately 100,000 gallons, was processed through the FIXS for offsite shipment and disposal. Coordination of transfer of the water to the FIXS Effluent Hold Tank (EHT) was required to maintain the processing rate within the capacity of the FIXS, EHT and transport trucks within their respective capacities. The EHT was limited to 20,000 gallons and each of the two transport trucks only held approximately 5,000 gallons. The availability of only two trailers limited shipments to two per week, resulting in a processing capacity of just 10,000 gallons of SFP per week. The shipment effort was the limiting activity and resulted in extending the duration of this project.

The FIXS and the RFB ventilation system were maintained in operable condition in accordance with HBPP procedures throughout the performance of the SFP liner demolition.

During and following the drain-down of the SFP, RP personnel conducted verification surveys for loose surface contamination of the coated concrete SFP liner walls and floor. At each stage of the SFP drain-down, the RP group, using a man-basket, would enter the drained portion of the pool to perform surveys. During this time, the divers were again diverted to the Discharge Canal (this time for six weeks) to commence work on the outfall pipe plugging, until they were needed for ACM component removal. By diverting the divers to alternate work, the CWC optimized their workload with other tasks as available and avoided unnecessary demobilization and remobilization costs and activities.

Once the SFP was dry, additional fixative coating was applied in areas where loose residual surface contamination was identified in the SFP. There was some minor decontamination required in the areas where underwater pipe had penetrated the SFP walls. This piping was the source of much of the remaining radiological contamination, specifically the bottom drain line, which contained high alpha contamination levels. The drain line was pumped dry and filled with 13 gallons of PVA-based synthetic glue-like filler and a final foam cap. It was then painted pink (indication for the RP Team that it was a concern area for OAD), similar to other areas in the Caisson that may have had higher levels of expected contamination, which could not be remediated during normal decommissioning, due to limited access.

In addition to radiological contamination, there were ACM components in the pool that needed to be removed (e.g., valve gaskets). Rather than mobilizing a new ACM abatement specialty contractor, the CWC decided to utilize the already-mobilized diving specialty contractor, who was asbestos-certified. The Dive Team and the RP group returned to the drained SFP to set up a glove bag configuration to remove the ACM gaskets from the flanges located on the SFP wall (e.g., SFP recirculation return lines). Once completed, the Dive Team demobilized their equipment, with RP surveying and free-releasing it as allowed. Some of the divers' suits could not be free-released and had to be disposed of in accordance with the PWP.

#### RP, Craft and Waste Support

The RP group monitored demolition and disposal process activities. Any work in the SFP required extra RP Deconner support, due to the potential alpha airborne release from materials coming out of the SFP. Requirements for additional decontamination processes were established per the Radiological Work Permit (RWP) and Special Work Permit (SWP) for work in the SFP. The RP Team included two RP Technicians and four RP Deconners, as well as an RP Supervisor.

The Craft support group typically consisted of eight team members and included Equipment Operators, Spotters, Level 3 Riggers and Supervisors. Carpenters and Electrical personnel were used during support tasks. The SFP Liner Removal Project Team also included the diving specialty contractor, consisting of a Dive Master (Supervisor) and four divers. The team included support from CWC Supervision, Safety, QC and Engineering during its night shift portion of the project.

Waste supplied B-25 grout boxes IMs, bags and waste containers and ensured proper packaging prior to accepting the container from the RFB for disposal.

#### 4.1.1.4 Units 1, 2 and 3 Cooling Waterlines

In addition to HBPP Unit 3, which operated through 1976, HBPP Units 1 and 2 fossil-fueled steam boiler plants provided electricity to Humboldt County from 1956 through 2010. All three units utilized a “once-through” circulating water system, using saltwater from Humboldt Bay to cool the unit condensers.

The Units 1, 2 and 3 circulating cooling water lines were located underground between the Intake Canal structure and the Discharge Canal structure. The pipes ranged in depth from approximately 8 feet Below Ground Surface (BGS) to 20 feet BGS.

The circulating cooling water lines needed to be surveyed and found radiologically “clean” to meet the NRC standards for clean-up of a decommissioning nuclear site for release of the 10 CFR §50 License. While early consideration was given to leaving the pipes in place, interior surfaces were found to be too difficult to clean and survey; and the history of radiologically-contaminated water spills into the storm drain system and subsequently into the Intake Canal led to the decision to remove the pipes.

Units 1 and 2 intake cooling lines consisted of two 30-inch, reinforced-concrete pipes each. Unit 3 intake pipes consisted of two reinforced-concrete pipes, 39 inches in diameter. Units 1 and 2 discharge lines each consisted of one 42-inch reinforced-concrete pipe. Unit 3 discharge pipe consisted of one 54-inch reinforced-concrete pipe. Removal of all lines took place in the same extensive excavation to preclude rework of the area. Cost of work was allocated by one-third / two-thirds between the Nuclear Decommissioning Trust Fund and Fossil Decommissioning Funds.

##### Scope of Work

The scope of work included the demolition and removal of the circulating cooling water piping for Units 1, 2 and 3, between the Intake Canal structure and Discharge Canal headwall. A portion of the Unit 1 discharge was located under the Maintenance area of Building 5. Approximately 100 feet of discharge piping from Units 1, 2 and 3 was under the Humboldt Bay Generation Station (HBGS) fence and boundary. Large concrete thrust blocks associated with the circulation cooling water system were removed during this project.

Early coordination and planning between HBPP and HBGS were necessary to resolve potential conflicts with various shared commodities. Of paramount importance was the determination of how to safely remove circulation water pipes entering and exiting HBGS property in close proximity to operating equipment.

Additional modifications to the work area had to be performed before and during the demolition. Switchyard fencing reconfiguration, storm drain rerouting, new sewer force main and modification to the HBGS fire water line were completed with the support of Engineering and Planning.

##### Schedule

Removal of the circulating water lines was scheduled to begin in January 2017 and be completed by November 2017. Coordinating this scope of work with the HBGS presented schedule challenges and required changes which resulted in a short delay at the start of this project. The overall decommissioning critical path at the time of this work was Caisson removal.



The two projects were competing for limited resources, specifically, traffic on site, GARDIAN usage and dump truck availability. This was resolved by coordinating the Caisson soil removal with the circulating water lines soil removal.

A WP was developed and transferred to field personnel for a work start date in February 2017. Final backfill and compaction of the project was completed in May 2018.

Actual Work Performed:

The scope of work included:

- Removing shallow underground commodities;
- Abating and removing transite pipe;
- Relocating sewer line;
- Removing contaminated drain line;
- Relocating and installing temporary fencing;
- Installing shoring system;
- Removing Units 1, 2 & 3 intake and discharge circulating cooling water lines;
- Demolishing the remaining portion of the deep Discharge Canal headwall;
- Removing circulation water piping anchor blocks;
- Performing FSS; and
- Backfilling and compacting the area to final grades.

A portion of the discharge circulating water piping traversed beneath the HBGS boundary. To remove this section of piping, it was necessary to remove a section of fence, reroute a portion of the HBGS sewer line and temporarily isolate a portion of the HBGS fire line. Additionally, it was necessary to reroute the storm drains and the GWTS supply piping. The HBGS security camera and light pole had to remain in service during the circulating cooling line removal work, so temporary above-ground electrical wiring was installed to maintain service during this field work.

The general sequence of work performed was completion of biological and cultural resource surveys, installation of required BMs, excavation and removal of shallow commodities, temporary backfill, installation of engineered sheet pile shoring system and excavation and demolition of the intake and discharge piping. After the piping and soils were removed, environmental and radiological sampling and surveys were performed to ensure the areas were clean and met the Interim Measures Removal Action Work Plan (IMRAW) and NRC requirements for backfill. Using the radiologically and environmentally clean soil from the excavation after passing it through the GARDIAN system, the excavation areas were backfilled in 8-inch to 12-inch lifts. Afterwards, the shoring was removed and the site was brought back to final grade.

The scope of work for the circulating water piping removal was completed in four major phases. Phase A:

This phase was split into two sub-phases, A.1 and A.2. Phase A.1 included the demolition and removal of the shallow intake piping for Units 1 and 2 and a portion of Unit 3. Phase A.1 demolished and removed approximately 1000 linear feet of reinforced-concrete pipe and its associated thrust blocks. The intake pipes were located approximately 8 feet BGS. The southern edge of the excavation adjacent to the switchyard required the existing switchyard



fence to be removed and a temporary fence installed. A shoring system was not required for this section of pipe removal. Phase A.2 demolished approximately 380 linear feet of reinforced-concrete pipe and its associated thrust blocks. This section was deeper than Phase A.1, at approximately 20 feet BGS. A combination of sloping and benching excavation methods was used in this area. These methods required more soil removal, but saved resources by avoiding sheet pile installation. Phase A excavations included the removal of approximately 4,254 cubic yards of soil.

#### Phase B:

This phase included the demolition of approximately 400 linear feet of reinforced-concrete pipe and its associated thrust blocks for Units 1, 2 and 3. These pipes were approximately 20 feet BGS, which required an engineered shoring system (sheet pile) to reach the proper depth and minimize groundwater intrusion. Shallow commodity removal was performed prior to sheet pile installation. Phase B excavations included the removal of approximately 2,784 cubic yards of soil.

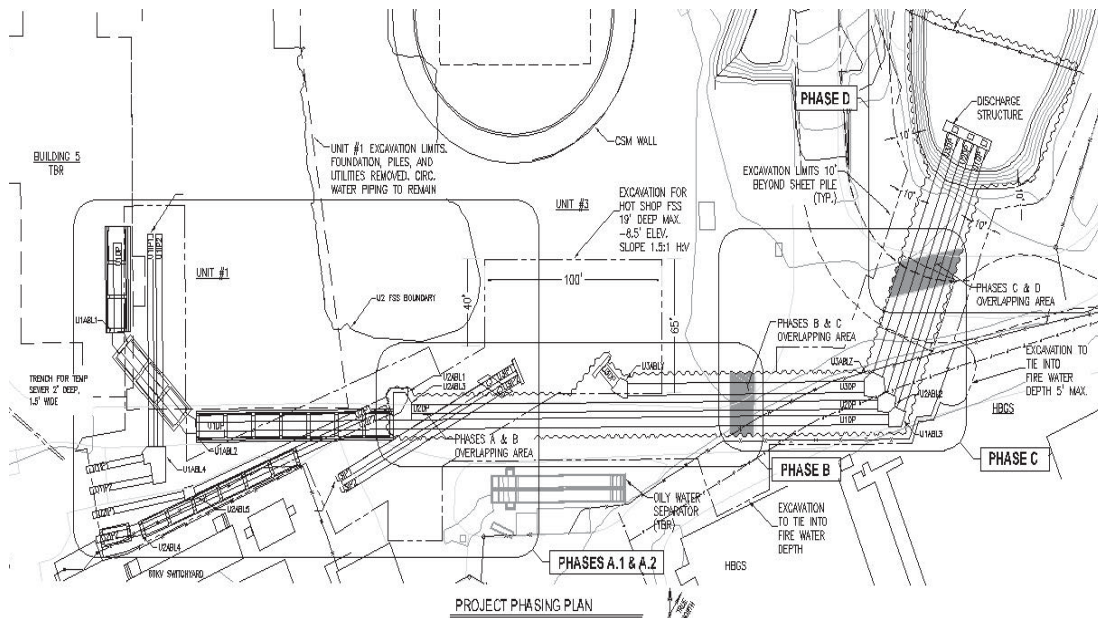
#### Phase C:

This phase included the demolition and removal of approximately 350 linear feet of reinforced-concrete pipe and its associated thrust blocks. The pipes were approximately 20 feet BGS, which required an engineered shoring system (sheet pile) to reach the proper depth and minimize groundwater intrusion. Shallow commodity removal was performed and the area was backfilled prior to sheet pile installation. Phases B and C encroached on the HBGS footprint and required a substantial amount of coordination to minimize impact to operations. Engineering performed analyses of soils near the operating power plant and determined no concrete or equipment were at risk from sheet pile installation vibrations. Pre-auguring the pile locations lessened the vibrations and supported driving the sheet piles. Vibration monitoring was conducted to assure HBGS Plant Operators that shoring installation vibrations were within the parameters of equipment in their plant. Continuous operation of HBGS is a requirement for maintaining system grid stability. Phase C excavations included the removal of approximately 3,221 cubic yards of soil.

#### Phase D:

This phase included the demolition and removal of approximately 250 linear feet of reinforced-concrete pipe and its associated thrust blocks. The pipes were approximately 20 feet BGS, which required an engineered shoring system (sheet pile) to reach the proper depth and minimize groundwater intrusion. This section also included a 4-inch clay discharge pipe that was known to be radiologically contaminated. This pipe ran from the LRWB to the Discharge Canal. Phase D excavations included the removal of approximately 4,830 cubic yards of soil.

**Figure 4-2, Circulation Water Line Removal Phases**



Included in the removal of the discharge pipes at the south end of the canal was the remnant headwall (See Section 10.1.2.6, Discharge Canal Remediation). Due to the depth of excavation required to remove this remnant headwall, this activity was deferred from the Discharge Canal remediation work to coincide with the circulating water discharge pipe removal effort as a means to optimize mobilization of equipment and shoring system. The upper few feet of the headwall were removed under the Discharge Canal project. The circulating water pipes were embedded in this headwall at such a depth that safely removing them at that time without an engineered shoring design was not possible. Working the remnant headwall with the circulating cooling water piping allowed efficient use of the deep shoring needed and required only one mobilization effort of the equipment. This also prevented the need to close Decom Road, which would have had unacceptable impacts to the schedule at that time. This road closure issue was later resolved by installation of a new road at the north end of the Discharge Canal.

The crew for this project included Equipment Operators, Laborers, Specialty Asbestos-Qualified and trained Individuals, RP, FSS, Environmental, etc. Additionally, a CWC specialty contractor was utilized for the installation and removal of the sheet piles.

The depth of circulating water piping between 8 feet and 20 feet BGS resulted in groundwater intrusion and constant in-flow water from an underground spring near the Discharge Canal headworks, facilitating a constant need to dewater the excavations to complete the work. Excavations were dewatered by submersible pumps daily, conveying water to the GWTS.

Waste streams for this work included asphalt, potentially contaminated soil, PVC piping, steel pipe, transite pipe, reinforced-concrete pipe rubble, rebar and creosote-treated timber. The materials were delivered to waste-handling facilities, packaged and disposed of.

#### Equipment

Construction equipment for this project included typical excavation and backfill equipment, such as excavators, dump trucks, drum rollers for compaction and hydraulic hammers for demolition

of the concrete piping and thrust blocks. Specialty equipment included an RTG25 pile driver, a 275-ton crane and a 60-ton crane to support pile driving, a large forklift, etc.

#### Hazardous Material Removal

Between 3 feet and 6 feet BGS, numerous transite piping runs were removed to facilitate the demolition of the circulating water piping. This pipe was typically used for electrical conduits needed for plant operations to run electrical lines from the oily water separator, sewer lift station, and relay building. Transite piping is an asbestos-containing material, which required specialty crews trained and qualified for its removal, packaging and disposal.

During the removal of the deep structure Discharge Canal headwall, a section of creosote-treated piles and redwood shoring was discovered along the deep portion of the Unit 3 discharge pipe. It is assumed that this shoring system was constructed when the Unit 3 discharge pipe was originally installed and left in place afterwards. Removal of the pile and shoring was not included in the original scope.

#### Cost Impacts

This project was originally estimated anticipating the ability to survey and leave in place some of the underground circulating piping. In addition, the piping to be removed was estimated using trench boxes on individual pipes. Site experience with the difficulties in cleaning and surveying reinforced-concrete pipe and the schedule impacts of removing one line at a time led to the decision to use sheet pile as the Shoring of Excavation/Support of Excavation (SOE) and completely remove all the circulating water piping.

After the decision was made to proceed in this manner, difficulties arose regarding the availability of sheet pile. In February 2017, a major storm with significant rain caused a breach in the main and emergency spillways at Oroville, CA. Due to the significance of this emergency situation, major supplies of steel materials, including sheet pile, were being diverted to repair the dam. This created a shortage of supplies in the western US and delayed delivery of the materials.

During installation of sheet piles, ground conditions were discovered to be more difficult than anticipated. The lower clay layer was very tight, necessitating extensive pre-drilling to drive the 56-foot sheets to refusal in the clay layer, as required in the shoring design. The RTG25 sheet pile driver was also equipped with a drill rig. Utilizing the RTG25, the Operator drilled a series of holes spaced along the alignment of the sheet piles. This process facilitated easier sheet-pile driving and reduced disruptive vibration to the nearby HBGS. Pre-drilling the holes extended the original sheet pile installation schedule, but reduced the time to drive the sheet piles to the required depth.

The oily water separator was a defined feature of work requiring removal. Its location next to the circulating cooling lines made removal simultaneously with one of the adjacent phases of work practical but extended the duration of the circulating cooling water piping project. The work included above-grade commodities, four deep pits, piping and concrete rubble. The demolition occurred in the summer of 2017. All debris was deemed by Waste Management to be hauled off site as waste.

The location of the circulating water piping required substantial coordination with other projects. A section of piping south of the Discharge Canal headwall was located under a major

throughway for waste streams from the Caisson excavation project to the Soil Management Facility (SMF) tents. Work crews were required to construct an alternate truck route to facilitate these other critical path projects. A bypass road was constructed at the north end of the Discharge Canal to allow the crew to complete substantial excavations at the south. This required installation and compaction of a 20-foot wide road base.

The 6-inch main pipeline that was used to transfer water from other excavations to the GWTS was originally routed across the Phase D area and required rerouting around the area to facilitate the excavation.

#### **4.1.1.5 Upper Yard Demolition**

The Upper Yard was a 20,000-square foot area, covered in asphalt at the north side of the site, midway between the ISFSI and the Discharge Canal. It was bounded by the south wall of the LRWB and east to the RCA Way (road), on the north by the temporary tent, (Building 44), and to the west from the northwest corner of the LRWB to the Building 26 Paint Shop. Buildings within the Upper Yard included the Low-Level Radwaste Building (LLRWB), the Solid Radwaste Building (SRWB), the underground High-Level Radwaste Vault (HLRWV) and some of the temporary office and support structures for the decommissioning work. The entire area was paved over with asphalt and used for various storage needs until the beginning of demolition.

##### **4.1.1.5.1 Scope of Work**

There were four distinct projects within the Upper Yard scheduled as individual projects, with each one having typical mobilization and demobilization activities, specific crews and equipment. As the demolition schedule approached, the close proximity of the LLRWB and the SRWB foundation slabs, the HLRWV and the underground utilities provided CW an opportunity to combine the four projects into one operation. The CWC evaluated the timing for the work in that area and chose to use a single Lead Supervisor, crew and demolition equipment, which could be shared as one project. Thus, the four WPs were directed by one Supervisor and Field Engineer concurrently, which enhanced efficiency in execution.

The 2015 NDCTP filing projected the removal of the LLRWB and SRWB structures in 2015 and the removal of their foundations in 2016, in concert with Upper Yard removal. Removing these two foundations in coordination with the Upper Yard removal allowed for the mobilization of equipment, work crews and the Hazardous Abatement Team once instead of twice. The two above-grade structures, the LLRWB and the SRWB, were removed first to provide a laydown area and storage space. The building foundations were removed during excavation and underground utility removal.

##### **4.1.1.5.1.1 Low-Level Radwaste Building (LLRWB)**

The LLRWB was a one-story, 36-foot by 16-foot, grout-filled cinderblock structure, divided into two sections with sliding steel doors, which provided shielding for radiological equipment and waste. Having a steel deck, flat roof and an internal fire water sprinkler system, it sat on a reinforced-concrete slab.

The LLRWB was used during operation and SAFSTOR for temporary storage of items that needed minimal radiation shielding. In most instances, waste barrels or spent resin vessels were placed in the building until the accumulation was sufficient for a shipment to an offsite

waste facility. The partition separating the two sections of the building allowed for storage of waste and equipment of different hazard types, which met regulated storage requirements. The LLRWB interior demolition started in March 2015, with the removal of any hazardous components (i.e., mercury-vapor lights and asbestos wall coatings, etc.). The structure demolition was completed in April 2015.

#### **4.1.1.5.1.2 Solid Radwaste Building (SRWB)**

The SRWB was a pre-engineered metal building sitting on a 6-inch level slab. The building was approximately 2,700 square feet and was built for handling and storage of solid radwaste. The waste was sorted by classification. When sufficient waste within a classification had accumulated, it was packaged, surveyed and shipped to an offsite waste facility. The building contained two bay doors to the outside and one interior roll-up door separating the two bays of the building. Unlike most of the other buildings on site, this was of newer construction and no lead paint was expected nor found. The minimal amount of hazardous components, conduit and piping that remained in the building were removed in early June 2015. Demolition was complete in June 2015.

#### **4.1.1.5.1.3 High-Level Radwaste Vault (HLRWV)**

The HLRWV was within the RCA, between the LLRWB and the LRWB. There were various conduits and piping in and around the HLRWV, and an abandoned 12-inch steel natural gas line running across the top of one of the concrete footings. The HLRWV was built to house solid, high-level radwaste in a 1,200-cubic foot pit. The HLRWV was 22 feet long by 11 feet wide by 8 feet deep, with a concrete cover over each of three internal chambers. The three chambers were used to segregate low-level from high-level solids. The walls, slab and roof were 12 inches thick. The internal equipment was removed and the walls and floor were cleaned and sealed in late 2015. Demolition was completed in April 2016.

#### **4.1.1.5.1.4 Upper Yard Below Grade**

The Upper Yard below grade included fire water lines, a storm drain, abandoned well water line, various conduits, abandoned gas line and various floor drain lines from buildings and the HLRWV. Active systems left behind had to be protected, including two monitoring wells and a communication conduit buried alongside RCA Way.

#### **4.1.1.5.2 Field Work**

Early in 2015, the two above-grade structures, the LLRWB and the SRWB, were demolished to the ground. The slab for each building was left in place to provide laydown space until subgrade demolition took place.

The LLRWB demolition included removal of the transite board demountable partitions, designated as Class II materials. Mercury-vapor lights, mercury switches and PCBs were removed by qualified remediation specialists and approved for disposal by the CWC's IH. Disposal was in compliance with the approved PWP. A specialty asbestos abatement contractor was engaged for the transite panel removal.

During hazardous material removal, potential friable asbestos was discovered between transite panels. The work was stopped and the building was sealed. Inspection and samples were



taken by the IH. The abatement was completed by a specialty asbestos abatement contractor in March 2015.

Demolition of the LLRWB followed standard demolition practices, with the majority of the work being performed using an excavator fitted with either a hydraulic breaker (hammer) or a concrete processor. Separation of concrete and rebar was required before wall debris was loaded into IMs for disposal.

The SRWB commodity removal phase of work included a detailed radiological survey of the entire building, including the rafters and drains, to support the waste and building characterization. Since this building housed solid wastes stored in appropriate containers, there was very little remediation to perform. Hazards abated during interior prep work were mercury switches and mercury-vapor and fluorescent lighting. Remediation debris was loaded into suitable containers. The loaded containers were transferred from the work area and consolidated into larger waste containers for removal from the site. Existing in the building was a 2 ½-ton overhead trolley hoist and rail. A man-lift was brought into the SRWB to drain oil from the hoist gearbox and assist in its removal. Though not in this scope of work, prior to demolition of the SRWB, the remaining nearby Rubb tent was protected from flying debris by a temporary barrier built to withstand impact. As a precaution, personnel were evacuated from the tent during the SRWB metal wall removal. The building was then demolished, utilizing large excavators equipped with metal-cutting shears and bucket/thumb attachments. Initial demolition began on the east end, demolishing the structure methodically bay-by-bay. Multiple excavators were employed throughout the demolition process, ensuring positive control of building components.

In order to prepare for the HLRWV demolition, the lids were removed from the HLRWV and the chambers were emptied of high-level contaminants, including stainless steel liner pans and a drum of waste. RP characterized the walls and floor. The drain line under the HLRWV was found to be radiologically contaminated, as were the soils around it. RP assisted with samples, then plugged the drain. Remaining radiological spots of concern were remediated or fixed and permission was given for OAD.

Once the buildings and slabs were removed, excavation and removal of the remaining underground utilities were required. Upper Yard asphalt was removed and the soils were tested by RP, followed by removal of the below-grade commodities.

Subgrade commodity removal included the fire water main (part of which was transite pipe) and standpipe riser removal, which were performed simultaneously. A portion of the storm water drain line was abandoned and removed. A sump and pump were installed to pump storm water. Conduits from load center and building-to-building were checked live/dead/live and removed as encountered. A 4-inch radwaste clay drain line from the corner of the LRWB out to the road was removed. A 12-inch natural gas line, which was found to have asbestos-containing wrap, was removed in 10-foot sections. RCA Way had to be kept clean using a skid steer and road sweeper to prevent the spread of mud. The Storm Water Pollution Prevention Plan (SWPPP) crew maintained BMPs to prevent sediment runoff.

ACM in this area included transite water lines, a transite fire water line, transite drain lines and other ACM-coated piping. This required a large amount of machine and labor time to be spent



on careful removal, sizing, wrapping and loading into double-lined containers. ACM commodities were abated using an asbestos abatement specialty contractor.

Low levels of arsenic were identified at three locations in previous surveys of the Upper Yard, along the RCA Way roadway at the east side of the yard. These areas were remediated and the wastes disposed of following the direction of environmental specialists.

Prior to the start of the HLRWV demolition, the HLRWV and nearby LRWB foundation were evaluated for ground pressure of demolition equipment against the remaining below-grade walls for both structures. A key feature of the LRWB foundation was an integral retaining wall supporting the Upper Yard slope. As equipment was working on the north side of the LRWB foundation, a concern was identified that the retaining wall integrity would be diminished and potentially lead to slope failure. In addition, as demolition began on the HLRWV, the structural integrity and ability to support heavy equipment on the surrounding soils were reduced. Engineering evaluations were performed on both underground features to provide setback distance for equipment expected to approach those areas. An OSHA engineering survey was also performed to evaluate the sequence of demolition and its potential for a premature collapse of a wall or beam. To keep heavy equipment from affecting nearby below-grade walls, crews placed safe work zone flagging around the areas, which designated two offset zones.

Demolition of the HLRWV began in April 2016, as a continuation of the subgrade commodities removal. The soil surrounding the sides of the HLRWV was removed and then the sides and bottom of the HLRWV were demolished, using an excavator fitted with either a hydraulic breaker (hammer) or a concrete processor. The drain line from the floor of the HLRWV to the LRWB was a deep feature, asbestos-containing 4-inch diameter transite pipe with radioactive contaminants interior to the pipe. Contaminated soils under the pipe were processed for disposal. Separation of concrete and rebar was required. The three HLRWV lids, stainless steel liner drain pans, and concrete walls and floor were loaded into IMs for disposal.

The CWC coordinated removal of the LRWB north foundation wall with grading of the south portion of the Upper Yard to ensure proper water runoff and to provide a safe 1.5:1 slope. As soils were tested, some went to reuse storage areas and the remaining soils were loaded into IMs for disposal. RP marked areas that required remediation. The steep embankment north and east of the LRWB was included in this demolition, which also included removing the shotcrete and soils to provide an even slope down to the CSM work area.

An FSS was performed over all areas where commodities were removed.

Equipment was shared among other demolition projects, as well as among Upper Yard projects. Examples of shared equipment included:

- Excavators equipped with bucket/thumb attachments, concrete hammers and crushers;
- Front-end loader;
- Forklifts;
- Dozer;
- Skid steer;
- Mist sprayers, including a monsoon mister;
- Water truck;
- Fuel/lube truck; and

- Service truck with welder.

#### 4.1.1.5.3 **RP, Craft & Waste Support**

The crew associated with this work scope spanned from three, to approximately sixteen personnel on the busiest days. The Craft group included Equipment Operators, Spotters, Drivers, Laborers, RP Technicians and Supervisors. A PG&E Gas Service Crew was on site to clear the 12-inch gas line for removal. Electrical support was needed for clearing power and moving pumps.

The Waste Department supplied IMs, waste containers and scales and ensured proper packaging prior to taking delivery. RP was on site daily and on call for specific tasks.

Ongoing daily activities included setting and resetting personnel barriers, cleaning equipment, scanning material and equipment and moving it from the RCA to clean areas. Crews loaded out asphalt, concrete, soils and pipe in IMs and dump trucks; performed machine inspections; and performed mechanical repairs and repetitive change-outs of shears, blades and buckets. As machinery moved in and out of the RCA, crews collected and redirected hoses and cleaned tracks and tires. Loading out large-diameter rebar steel was a challenge in preventing damage to IMs. Proper housekeeping was performed during each shift to meet safety and environmental requirements.

#### 4.1.1.6 **Temporary Facilities**

The activities discussed in this section were performed to support Soil Management decommissioning functions. SMF tents served to keep soils controlled and aided in containment of water draining from the soils, which could have potentially released contaminants. Mixing and loading were performed under cover. Installation of the GARDIAN system allowed scanning and detection of the radioactive content of soil, and eventually concrete, to assist in classification of the material. Without the GARDIAN system, soils would have had to be spread out in 6-inch lifts and manually scanned via walkover survey, a major challenge due to the confines of the small worksite. Power pole relocation eliminated potential electrical hazards to excavation equipment.

##### 4.1.1.6.1 **SMF Tent Installation**

Soils excavated from the Caisson removal project, circulating water line removal and other site excavations could not be stockpiled in the open, due to potential turbidity increases and contaminant releases, which could occur during storm water runoff events. Several types of covered structures were evaluated and the most cost-effective was a slab on grade with a fabric-over-steel structure, having large doors at either end. The slab was designed to support the weight of soils and heavy equipment. Large doors at either end provided effective airflow, which assisted with soil drying processes and offered the ability to move end-loaders and dump trucks through the tent structures.

Each structure provided a 200-foot by 100-foot external footprint, which encompassed nearly 20,000 square feet. The size and dimensions required engineering for structural footings, slab, tent structures and coverings, including drainage water management and an electrical power supply. The best location for the tents was determined to be in the area that previously housed office trailers for decommissioning, which was at the far eastern end of the site. Refer to

Section 4.1.2, Offices and Facilities Demolition. This location was selected because of its close proximity to the Discharge Canal, circulating cooling water piping and Caisson excavation.

The tents were located parallel to each other with a 10-foot separation. Environmental, building and grading permits similar to building a permanent structure were obtained. The steel supports and roof structures endured rigorous engineering analysis, in light of the seismic building code, the North Coast 100-Year Storm Requirements and personnel safety. A local consulting civil engineering firm was engaged to design the concrete footings, slab and curb. The structures were designed by the supplier and approved by local building authorities. PG&E Engineering completed the DCN for electrical supply and interior lighting. A land surveyor performed the layout and the final elevation certificate for flood insurance.

Rigging plans were created and approved, which required the use of a crane to bring the heavy roll of fabric up and over the 38-foot high truss structures. Man-lifts and other equipment were used for spreading and attaching the tent fabric to the frames and for mounting large door frames to the structures.

Physical work on construction of the tents began in May 2014 and was completed in November 2014.

SMF 1 tent was used for soils with some radiological activity and SMF 2 tent was used for “clean” soil. Water drained from the soils was collected in a below-grade tank at the east end of each building and pumped to portable totes. Water from radiologically-impacted soil was collected and shipped off site for treatment, as required. After sampling, water from the “clean” soil was transported to the GWTS for treatment.

#### 4.1.1.6.2 **GARDIAN System Installation**

Once the decision was made to remove the Caisson, a more robust bulk surveying system needed to be considered. Caisson removal created a large volume of soils, which would become waste material if it could not be reused on site. The GARDIAN system supported efforts to classify material for reuse (if it met the applicable DCGL requirements), instead of waste, which was disposed of at a high cost. Rather than purchasing new material, reuse material could be utilized on the site to backfill areas when removing Caisson components or other site excavations. The GARDIAN system was used for the large amounts of excavated soil on nearly the entire site. These soil quantities were placed in varying-sized dump trucks, each requiring its own calibration, settings and run-time based on container size and material composition of the soil in the container for final disposition. Bulk scanning of truckload quantities for radiological activity reduced labor hours for RP and the FSS. The alternative survey method was to use the ISOCS system and walkover surveys to release site soils for FSS. The ISOCS system was labor-intensive for bulk soil surveys. Both these processes were used during decommissioning and FSS release of site areas. However, the GARDIAN reduced RP and FSS labor costs and shortened the time to perform soil assays, since the entirety of material in a surveyed container could be assayed at once.

The GARDIAN assay system included two semi-trailers, which housed and provided support system equipment and instrumentation, as well as providing a transportation means for the temporarily-leased equipment. The main assay trailer was 53 feet long by 8.5 feet wide and the support trailer was 46 feet long. Installed in both trailers were detector tracks and towers, which were used to position the High-Purity Germanium Detectors at correct spacing and height.

These detectors required cooling by liquid nitrogen for proper operation and were adjustable for various sizes of trucks and containers. The main assay trailer included an assay office/control room for the system.

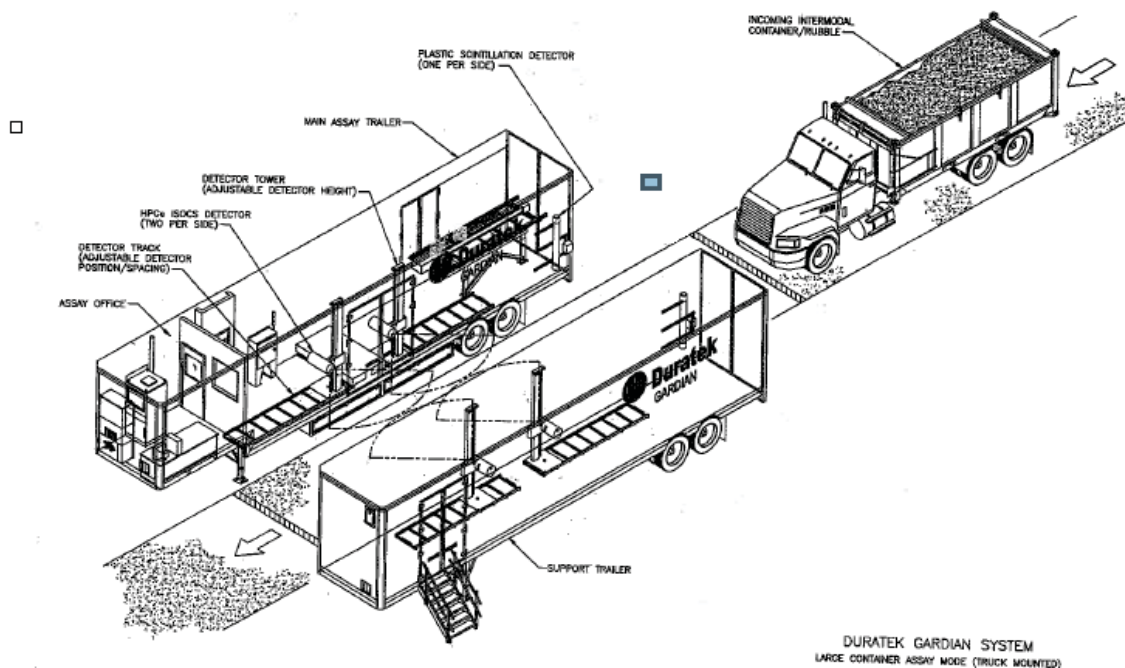
The spacing of the two trailers allowed approximately 2 feet of clearance on either side of a typical 8-foot wide load. An in-ground calibrated truck scale was installed between the two detector trailers, allowing the load to be weighed as required before the scanning process started. Power, communication and liquid nitrogen were also supplied to the trailers. In addition to supplying the utilities to the site, a pad area of approximately 60 feet by 45 feet was excavated, leveled and surfaced. Stairs and a landing were added by site Carpenters, providing safe access to the trailers and operating systems.

The installation area was chosen for traffic control and low-radiation background activity. The tight confines of the small site played a key role in the location of this equipment and required detailed traffic control plans as the materials were moved around the site. This system was at the far west end of the Owner Controlled Area (OCA), directly in front of Gate C. This became the main entry and exit site for waste and material shipments. The GARDIAN design and detector locations and orientations were selected to simplify the operation, in support of an efficient and reliable means of assaying large volumes of waste material, including concrete rubble. This was an industry-accepted tool and was used at near-capacity on days of excavation and waste packaging.

To survey a dump truck with a load or mounted container, the truck drove slowly between the system trailers to allow a scan of the load by the scintillation detectors. After the truck's load cleared the detectors, the truck stopped in a pre-designated position between the trailers to allow a fixed-position assay, using ISOCS to qualify and quantify gamma emitting nuclides present in the load. Total scan time for this process varied by truck volume but averaged about seventeen minutes per 10-cubic yard truck.

The start-up of the system was performed by a qualified vendor, who could supply the necessary Validation and Verification of System. This vendor trained on-site personnel to operate and maintain the GARDIAN. The system required scheduled calibration and testing during its operation at HBPP.

**Figure 4-3, GARDIAN Mobile Assay System**



## Second System

The CWC's Waste Manager foresaw a pinch point approaching, when more than thirty trucks per day were going to cross the GARDIAN. Thirty trucks would consume over 8.5 hours of scan time, thus slowing the movement of soils around the site and risking schedule delays while waiting for the equipment to become available for use. The increased number of trucks requiring scanning was based on scheduled active excavations that would be taking place at the same time. Specific work taking place included canal, circulating water line removal, Caisson removal and the beginning of the FSR area modification, all creating excavated soils, which needed to go through the GARDIAN system. A second GARDIAN system was ordered and installed to reduce potential delays in moving soils. The truck waiting times had increased even before the second system was ready, thereby justifying its acquisition.

Possible locations were discussed for the second GARDIAN, which was intended to help with site efficiencies and traffic controls. This included a well-thought-out plan, placing the second system at the far east end of the site near the Discharge Canal, where considerable quantities of soils were being processed. Space limitations and active field work taking place at time of installation effectively eliminated all possible locations, except in the area next to the first system. De-staffing allowed for the removal of an office trailer, and the installation of the second GARDIAN took its location with its layout similar, and parallel to the first one. Required office staff was relocated to both on- and offsite locations to accommodate this change.

GARDIAN 1 was installed in October 2014 and the second unit was installed in July 2016.



## Metrics

The Count Room had the responsibility of monitoring and recording the daily operations of the systems. The maximum capacity of one system was thirty-two trucks per day. This maximum was reached a number of times before the second system became operational. The height of operations saw more than sixty-four trucks per day on extended-hour days.

### 4.1.1.6.3 Power Pole Relocation

A 12kV powerline running generally around the perimeter of the project served the HBPP site. At the east end in the Discharge Canal area, some of the poles and cable interfered with the safe operation of high-reach excavation equipment working the CSM stockpiles in the canal. Eventual site restoration called for removing some of these poles and lines. This project served a dual purpose of clearing unneeded distribution lines and making for a safer workspace above the canal stockpile.

PG&E's Distribution Line Department performed the majority of the work, with coordination among Engineering and Planners. The Line Division prepared work instructions and the CWC prepared a document with guidelines for supporting PG&E's work with labor, supervision, RP and waste coverage.

As this was the only power supply line to the site, coordination of a site-wide power outage was necessary. Critical path work was supported by generators and the schedule minimized interruption to field work by scheduling the required site power outage over a weekend. A list of safe work steps was written to protect workers and those on site not directly involved. Once verifications were performed, one new pole was placed near SMF 1 and five poles were removed.

The CCC permit did not need to be revised, due to an exception under the "Electric Utilities" section. A guy wire had to be placed in a sensitive area but was exempt due to compliance with the restrictions given in agency guidelines.

The new alignment ran from the existing pole at the southeast corner of SMF 1, to one new pole near the southwest corner of the tent. From there, it fed over to the modified pole at the GWTS and then over the canal to the remaining pole at southeast corner of the northeast laydown area.

### Actual Work Performed

With support from site personnel and supervision, the crew from PG&E dug and set new poles and attached cabling in early February 2016. The second day included drilling guy anchor holes and recabling the GWTS pole and northeast laydown area poles. Soils were removed and stockpiled, checked by RP and disposed of at their direction. Poles that were removed and one transformer were free-released from the site. The PG&E crew took these components back to the PG&E equipment yard.

The power outage, removal of old cable, restringing of new cable where needed, and modification of the pole at the GWTS to allow cable to be hung higher over the canal area, were accomplished during weekend work. After power was restored to the site, the Clearance



Coordinator powered up the various load centers. By performing this work on a weekend, there was no impact to scheduled work at the site.

This work allowed the realignment of the 12kV line away from the south end of the Discharge Canal, where extensive excavation work was performed. It also cleared poles from the northeast laydown area, so that abatement work could proceed and the final site grading contours could be established. This configuration was not the end state, as more work was required. This was a necessary interim measure. Other electrical work will be performed during Final Site Restoration.

#### 4.1.1.6.4 SMF Tent Foundation Removal and Demobilization

Complete removal of the SMF was required to place the site in final configuration, which included the start of FSR, wetland establishment, FSS and NRC §50 License Termination.

The first SMF tent to be removed had stored and processed soils that were not radiologically contaminated. Once the characterization survey of the fabric and frame was performed, they were removed by high-reach excavators and man-lifts. Tent fabric and structure had to be disposed of as waste. The concrete slab and footings were surveyed and abated if necessary, broken up by conventional demolition means and taken to the processor to be rubblized for Caisson fill material.

The soils under the tent were sampled for radiological and chemical contamination, then underwent minor grading to bring them level with the surrounding area.

The second SMF was removed later in the same fashion with no incidents. The grounds were then available for reconfiguration, per FSR requirements.

A sewer lift station had been added in this general area to support numerous offices. Due to its proximity, it was removed at the time of removal of the second SMF facility. The remaining piping was also removed and disposed of.

#### 4.1.2 Offices and Facilities Demolition

Multiple offices and service buildings were located around the site to support decommissioning. Many of these were temporary office complexes or single trailers. Others were pre-existing metal or concrete block buildings and served multiple purposes. Of approximately forty structures, the majority were mobile office trailers. These have been systematically removed as the project de-staffs.

For buildings other than trailers, Engineering-related activities included sequencing of demolition, structural stability evaluation, planning the excavation geometry and specifying required controls to ensure personnel safety. An OSHA-mandated engineering survey required review of available drawings, a visual survey of the building and a structural assessment of the inherent stability to withstand failure during demolition.

The following work items were common to almost every building and performed before removal of the structures:

- Obtain Humboldt County Demolition Permit;

- Submit a National Emissions Standards for Hazardous Air Pollutants (NESHAP) notification to the North Coast Unified Air Management District (Air Board);
- Remove CWC and PG&E commodities from the structure;
- Remove universal and electronic waste (e-waste) from the area and dispose of in accordance with the PWP;
- Identify potential hazardous wastes and planned remediation;
- Mark excavation extents and area utilities according to approved excavation permit;
- Establish area RP and FSS controls where necessary;
- Erect barricades and signage to define and control access to the demolition area;
- Erect debris curtains and netted fencing to protect adjacent work areas from projectiles;
- Place spill kits and eyewash stations in the work area;
- Mobilize waste containers to the work area, per the PWP;
- Permanently de-energize and air gap electrical, air, water and other energy sources;
- Implement storm water BMPs, per the Erosion & Sediment Control Program (ESCP);
- Perform waste characterization sampling, as directed by CWC or PG&E Environmental Departments;
- Perform B clearance of the area, which sometimes included a bird nesting survey;
- Properly abandon nearby wells, standpipes, vaults and conduits as prescribed.

Dust suppression, barricades and shielding of nearby buildings or utilities and other methods described above in Section 4.1.1 were deployed for the safety of workers during demolition. Similar equipment such as end-loaders, excavators and dump trucks were also used to demolish the buildings described below, while most office trailers were simply towed from the site by specialty vendors after utility disconnects were made.

### **Building 8 - Security Building**

The Security Building was added to the site in 1976, and originally used for training. This building was a reinforced-concrete block, single-story structure, measuring 32 feet by 16 feet. Because of its ideal location at the end of the main site entry road, it was used as a security checkpoint. It was a hub for communications equipment, underground electrical raceways, antennas and video monitoring, as well as for issuing PPE to visitors. It continued as a Security building until its demolition in 2018. Like other block buildings from this era, it required asbestos abatement and other precautions and preparations as mentioned in the Common Operations bulleted list.

### **Building 10 - Assembly Building**

This modest building, erected in the early 1960s during HBPP Unit 3 construction, served a number of roles over the course of five decades. Originally a construction office, it became a gathering spot for visitors and meetings with offsite vendors and interested parties. During the decommissioning years, it also served as a conference room, as well as training class space. This conventionally stick-framed building, 82 feet by 29 feet., was on concrete spread perimeter footings.

During the Intake Canal restoration in 2017, the building and parking lot were removed, so the area could be used for soils and equipment laydown. By that time, training had been transferred to an offsite facility, so this building could be removed.

Debris netting was installed to protect two nearby office trailers and workers accessing the Parking Lot B laydown area. Protection was also provided for the active sewer system. The utilities were air-gapped and removed, and the building was demolished and removed as waste. Cleared concrete was taken off site for recycling. Work started in February 2017, with building demolition completion in March 2017, and the building water supply line termination completed in May of that same year.

(Note: Trailer 10A was an owned trailer and is addressed in Section 4.1.3, Other Services.)

### **Building 10B - Warehouse Office Trailer**

Previously located in Parking Lot B, this trailer was used by procurement, issuing and material receiving personnel. Delivery trucks had only this one option upon entering the site to drop off tools, materials and heavy equipment. A small cloth-covered frame structure nearby served as a temporary receiving and storage site until work groups picked up their respective materials. Tools were often distributed to the hot and cold tool rooms, or to a permanent warehouse that was originally adjacent to the Machine Shop in Building 5.

In early 2016, this small office trailer was moved to the new receiving area at Gate C entrance to accommodate the Intake Canal project.

### **Temporary Warehouse (Tent)**

A temporary tent structure, 30 feet long by 24 feet wide by 32 feet high, was erected near the entrance to the site in approximately 2013, for receiving deliveries and temporary storage of tools and materials until they could be picked up by the craft. The Warehouseman and Procurement were nearby in Trailer 10B. In 2018, the tent was removed and disposed of as waste.

### **Building 13A - Fossil Decommissioning Office Trailer**

This trailer was first brought in to house the staff performing the demolition of the two fossil power units located next to Unit 3. After the completion of fossil plant demolition in 2011, a portal monitoring system was set up for inbound and outgoing waste vehicles, with the monitoring system installed in and operated from the trailer. When that system was taken out of service in 2015, the PG&E Safety Team and the CWC Safety and Industrial Health personnel moved into the trailer. In 2016, that trailer was needed for ISFSI Security Management personnel, who remained there until removal of the trailer. The demolition crew abandoned the utilities and the lessee removed the leased trailer in 2018.

### **Building 13B - Waste Management Office Trailer**

This trailer was delivered in 2013 for the use of the CWC's Waste Management personnel. When there was office space available closer to their Waste Management Facility (WMF), the support personnel moved to a different location and the CWC Radiation Protection (RP) group moved in. As the RP group was de-staffed, CWC's labor supplier moved to this trailer.

The demolition crew abandoned the utilities and the lessee removed the double-wide trailer late in 2018, after the labor supplier personnel were de-staffed or moved to other quarters.

### **Building 13C - Prime Subcontractor's Office Trailer**

This trailer was a double-wide that was brought on site in 2013 for use by the CWC's labor supplier for their offices and Craft break room. They occupied it until mid-2016, when the second GARDIAN system was installed in that location. The trailer was removed by the leasing company in 2016.

### **Hydrogen Storage Building (Unnumbered Building)**

Another of the original buildings from HBPP, it was known as the "Gas and Oil Storage House." It was located to the north of the Unit 1 pad area. The structure was built of reinforced-concrete blocks on a concrete pad. It was 22 feet by 10 feet by one story high, set into a hillside with load-bearing sloped soils on three sides. The roof was a steel pan deck with an ACM non-friable coating.

The building housed miscellaneous construction materials, tools and legacy accumulation. Once removed, demolition followed the common operations explained in opening paragraphs of 4.1.2. Additionally, the roof required scaffold handrails built around the perimeter for worker safety during abatement of mastic and built-up insulation. After demolition and disposal, backfill was placed, compacted and graded to match the surrounding hillside.

### **Trailer 20 - Operations**

Active HBPP Unit 3 systems were still in use during the CWC phase of decommissioning, including the FIXS, Fire Water and SPAMS, etc. This required plant operators until the RFB ventilation system was no longer needed. When Trailer 18, Trailer 20 and the adjoining Conex needed to be removed, resident personnel were either de-staffed or relocated to other office facilities.

The two above Trailers, 18 and 20, along with two 20-foot Conex units, numbered 20 and 34, were removed in sequence during 2016 to make way for grading the area to approximate final site contours. The underground utilities were removed and the area was then used for storage of water tanks and materials.

Conex 34 originally housed calibration source material, a controlled item under NRC regulations, which remained inside the RCA until ready to move off site. This Conex, also known as a "sea-land container," was then used by job supervisors on nearby work, including RFB demolition, and was the last of the 4 Conex units to be removed.

### **Building 21 - Hazardous Waste Storage**

The metal Hazardous Waste Storage Building, approximately 30 feet by 22 feet, was located near the Discharge Canal. It was built in 1987, during SAFSTOR and had been used for storage of packaged wastes, such as hazardous waste materials prepared for monthly and annual shipments. It was eventually converted to storage use and then for personnel and supervisors working on nearby projects, such as the Discharge Canal and SMF. It did not contain asbestos, but was built on a concrete slab and footings, which required excavation and backfill. It was removed in 2018 and subsequently disposed of as waste.

### **Building 26 - Painting and Sandblasting Building**

Building 26 was originally built to house the Paint crew and their equipment and to serve as a paint booth. A compressor building was added to the original building for sand blasting and

storage. After the Paint Team was released, the building was converted to a multipurpose radiologically-controlled, ventilated building. It was demolished and disposed of as waste in 2018.

#### **Building 44 - Rubb Tent and Foundation in NE Area**

Building 44 was a temporary tent provided by DCPD to HBPP in 2010. DCPD avoided disposal costs and at the same time, HBPP acquired the tent for the minimal cost of relocating and installing the tent. Similar to the WMF tents, Tent 44 was smaller in scale, measuring 88 feet by 60 feet, and was used primarily for a 90-day hazardous waste accumulation area and the Waste packaging facility. Carpenters also used this tent as their workshop.

The demolition work for removal of the tent included abandonment of utilities and dismantling the fabric, steel and concrete structure. The excavation of asphalt and soil facilitated SCA and FSS surveys. It was outside the RCA, near the north central fence along Bay View Road. Waste characterization sampling was performed, which consisted of MARSAME surveys of the above-ground structure and materials by PG&E RP. Survey results concluded that the building concrete was suitable for reuse on site. The concrete was then placed in the stockpile.

The CWC provided man-lifts for access during Building 44 demolition. The fabric skin was removed, followed by the steel framing. This was disposed of as waste.

#### **Miscellaneous Structures and Systems**

Throughout SAFSTOR and subsequent decommissioning, there were approximately a dozen portable buildings that were used for various purposes, including guard shack, pump house, fire hose station, original portal monitor, smoke break shed and other similar functions. None of these portable buildings had utility connections or permanent foundations and they were removed as required to support decommissioning activities.

Facilities that were removed throughout the decommissioning process included the abandoned domestic water, sewer and power distribution systems. Natural-flow drainage swales, ditches and ponds were incorporated as needed for storm water control leading into the start of FSR.

#### **4.1.3 Other Services/Letter of Credit**

PG&E incurred costs for other services and captured those costs in a category called "Other Services." This category included work scope and services that were added to the CWC's contract.

##### **4.1.3.1 Scope of Work**

Though originally written for waste support, the initial Contract Work Authorization (CWA) was amended and specified providing the technically-qualified labor and equipment. PG&E determined it was more cost effective to allocate some work to the CWC for performance by CWC personnel, and to contracted groups with specific expertise, using their specialized equipment. PG&E recognized the need for these additional services not covered in the project's technical specifications. These services included:

- Asbestos Abatement - The CWA provided technically-qualified labor and equipment needed to perform asbestos abatement on the RFB roof and Building 5. Activities included the removal of approximately 5,000 cubic feet of ACM roofing and the removal of Building 5's interior and exterior asbestos. Additional scope included erecting a Class II decontamination area, installing temporary power, installing a fall-protection guardrail barrier and establishing an asbestos-regulated area and rigging-exclusion zone.
- PG&E-Owned Trailer Removal - The CWA provided technically-qualified labor and equipment to remove PG&E-owned trailers that were not identified for demolition or removal from HBPP by the CW Contract. This included Trailers 9, 10A, 12-1, 12-2, 12-3, 12-4, 12-6, 12-7, 18, 22, 25 and 35. The CWC prepped these trailers for removal and/or demolition as requested, including: removal of furniture, equipment and appliances; cleaning; disconnecting services from them; and surveying them for release. Note: this does not include trailers that were removed in Section 11.1, Trailer City Demolition.

#### Equipment

Equipment used for some of the preceding work scope included forklifts, man-lifts, scissor lifts, trailer, service trucks, a 275-ton crane, air filtration system, excavator, dump trucks and hand tools.

#### 4.1.3.2 Letter of Credit

The Letter of Credit from the CWC was a guarantee of performance specifying that in the event of default, PG&E may present the letter to the issuing bank and draw the face amount set forth in the letter of credit. These costs are associated with the CWC bank fees charged by the bank for the open liability on their resources. The original approved budget for the Letter of Credit was based upon an estimate provided by the CWC. The actual bank fees costs were considerably less.

### 5 WASTE DISPOSAL COSTS (Excludes Caisson / Canals)

The HBPP Unit 3 decommissioning and demolition CWP involved several work faces, which generated debris from nuclear plant demolition. The debris was managed for offsite disposal or reused on site. The CWC developed a management program to manage wastes in accordance with PG&E's contract specifications, using PG&E's already-established Safety, Risk, Waste Reduction, Quality Control, Waste Management and Radiological Protection Programs. PG&E staff provided oversight to the CWC's Waste Management group to ensure CWC adherence to state and federal regulatory requirements and on-site waste management practices. The Waste Management group also provided direction in logistical areas, such as scheduling, WAC, waste accumulation, packaging, loading and shipping.



**Table 5-1, Waste Disposal**

2015 NDCTP ID		Approved NDCTP Estimates		Amount Spent Presented for Reasonableness			Previously Presented and Approved
		Base	Nominal	2012-2014	2015-2018	Total	
E.4.5	Waste Disposal (Excludes Caisson / Canals)	85,585,587	92,675,904	5,494,905	35,229,131	40,724,036	50,041,157
E.4.5.1	2012 NDCTP CPUC Filing	50,762,743	53,876,290	5,494,905	-	5,494,905	46,507,268
E.4.5.1.1	Labor (Packaging and Handling)	11,512,031	12,241,660	-	-	-	10,874,350
E.4.5.1.2	Third Party Disposal Sites	36,620,246	38,850,851	5,494,905	-	5,494,905	31,867,488
E.4.5.1.3	Waste Handling Building	2,630,466	2,783,779	-	-	-	3,765,430
E.4.5.1	2015 NDCTP CPUC Filing	34,822,844	38,799,614	-	35,229,131	35,229,131	3,533,889
	Third Party Disposal	32,601,773	36,485,244	-	35,229,131	35,229,131	1,293,653
	Labor Packaging and Handling	2,221,071	2,314,370	-	-	-	2,240,236

Actual costs during 2012 through 2014 presented for review for Waste Disposal were \$5.5M. Actual costs 2015 through 2018 were \$35.2M compared to the approved cost estimate of \$38.8M.

During decommissioning planning, waste transport and disposal costs were anticipated to be a significant expense associated with the CWP. These costs were reflected in PG&E's preliminary estimates of waste generation used to establish the waste budget. Initial volumes of waste soils and debris during the start of the CWC's work in 2014, indicated higher-than-estimated volumes of waste requiring disposal. CWC and the Waste Management Team developed methods of waste reduction, utilizing early segregation of material by separating clean from contaminated material. This reduced material requiring offsite disposal, while increasing materials allowed to be reused on site. These methods included early segregation of clean and contaminated waste streams and averaging the radionuclide concentration, to send a minimal amount of material with higher activity to Clive, UT in order to avoid higher disposal costs. By utilizing multiple waste disposal facilities, HBPP was able to find the safest methods and realize the lowest costs for waste disposal for a given type or class of waste. This is explained in more detail in Sections 5.5, Areas of Waste Generation, and 5.11, Cost Avoidance, Savings and Process Improvements.

The performance goal for the CWP was to safely, efficiently and cost-effectively manage waste, while protecting or mitigating the effects to the environment. The waste removal process was complete when the areas were released after meeting the license termination conditions and the DCGL. In addition to removal of waste, the performance goal included the disposition of equipment and tools (i.e., heavy equipment, IMs or waste containers and excess materials or supplies) and submittal of shipping and waste disposal documents to PG&E Document Control for retention as retrievable records.

### 5.1 Waste Management Staffing

The CWC maintained a staff of waste management professionals known as the Waste Management group. Members of this group specialized in radioactive and hazardous waste management and reported to the CWC Waste Manager, who was responsible for managing the preparation of waste leaving the CWP. Waste Management duties included preparing waste material for suitable load-out, waste handling, packaging of waste for disposal and preparation and certification of required shipping papers and notifications. These responsibilities spanned the requirements of state and federal hazardous waste management regulations, including: Federal TSCA and RCRA; California Code of Regulations (22 CCR); California Health and Safety Code (HSC, Division 20, Chapter 6.5); the NRC Waste Management Regulations;

Federal (49 CFR); and State Highway Transportation Regulations. Additionally, this group interfaced with transportation and disposal vendors to ensure PG&E service needs were met and that vendors met PG&E Management expectations for safely by implementing various laws, regulations and requirements.

Waste Management staffing was structured to optimally support efficient packaging, handling and transporting waste to disposal sites. The CWC provided physical labor and supervision to support Waste Management activities for the CWP. Staffing levels fluctuated commensurate with the volume of waste being handled and natural attrition of staff. As a rule, staff members lost due to natural attrition were not replaced. Supervisory oversight occasionally identified the need for additional staff. For example, when the project selected 10 cubic yard bags for packaging some waste material, a resultant workflow analysis identified the need for additional staff members.

## **5.2 Waste Determination**

Waste determination was the process where material type, origin and risk factors were evaluated to determine the disposition of materials for on-site reuse, asset recovery, or characterization for waste disposal. Each type of demolition debris was evaluated differently based on the type of material.

The soil waste evaluation was a four-step process. If the material failed any one of the four following criteria, it was determined to be waste and was disposed of appropriately:

- Are the concentrations of radioisotopes in the material less than DCGL limits?
- Are the levels of contaminants in the material less than the limits specified in the IMRAW?
- Has Engineering determined the material is structurally suitable for reuse and backfill?
- Is the volume of debris in the soil less than 5 percent by volume?

For demolition debris that included concrete, rebar, structural steel, asphalt and grubbing, the evaluation process was three steps. Meeting on-site criteria, material eligible for reuse was based on:

- The origin of the material;
- The radiological release criteria for the debris; and
- The cost of processing.

The goal was to minimize the volume of material determined to be waste to the extent it could be performed safely and be compliant with state and federal regulations.

## **5.3 Waste Acceptance Criteria (WAC)**

WAC established the minimum requirements for classes of waste destined for a radioactive waste disposal site. Requirements were intended to facilitate handling and provide protection of the health and safety of CWP and PG&E personnel and disposal facilities. Some disposal sites had additional requirements that exceeded the minimums listed below:

- Waste must not be packaged for disposal in cardboard or fiberboard boxes.
- Small quantities of liquid waste must be solidified or packaged in sufficient absorbent material to absorb twice the volume of the liquid.

- Bulk waste water must be shipped in tanker trucks.
- Solid waste-containing liquid shall contain as little free-standing and noncorrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1 percent of the volume.
- Waste must not be readily capable of detonation, explosive decomposition, reaction at normal pressures and temperatures, or of explosive reaction with water.
- Waste must not contain or be capable of generating quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling, or disposing of the waste.
- Waste must not be pyrophoric. Pyrophoric materials contained in waste shall be treated, prepared and packaged to be nonflammable.
- Waste containing hazardous, biological, pathogenic, or infectious material must be treated to reduce to the maximum extent practicable the potential hazard from the non-radiological materials.

Stability requirements were intended to ensure waste did not structurally degrade and affect the overall stability of the disposal site through slumping, collapse, or other failure of the disposal unit, thereby leading to water infiltration. Stability was also a factor in limiting exposure to an inadvertent intruder, since it provides a recognizable and non-dispersible waste. Specific requirements for stability included:

- Waste must have structural stability. A structurally-stable waste form will generally maintain its physical dimensions and its form under expected disposal conditions such as: weight of overburden and compaction equipment; the presence of moisture and/or microbial activity; and internal factors, such as radiation effects and chemical changes. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal.
- Notwithstanding the provisions in 10 CFR §61.56(a) (2) and (3), liquid wastes, or wastes containing liquid, must be converted into a form that contains as little free-standing and noncorrosive liquid as is reasonably achievable; but in no case, shall the liquid exceed 1 percent of the volume of the waste when the waste is in a disposal container designed to ensure stability, or 0.5 percent of the volume of the waste for waste processed to a stable form.
- Void spaces within the waste and between the waste and its package must be reduced to the extent practicable.

CWP Waste Management activities were oriented to ensure the waste acceptance criteria were met, thereby minimizing waste processing costs. Wastes not meeting the above criteria incurred additional costs with further processing on site, offsite processing at a processor for subsequent shipment to disposal, or processing by the waste disposal site.

#### **5.4 Waste Packaging and Handling**

Within the CWC's scope of work, the commodities, equipment, demolition debris and soil designated as waste were packaged and shipped to disposal facilities. The majority of the radiologically-impacted material was shipped to Grand View, Idaho (Grand View), Clive, Utah (Clive) and Andrews, Texas (Andrews). A portion of non-radioactive material that could not be reused was shipped to Beatty, Nevada (Beatty).

Two large tents, designated as SMF-1 and SMF-2, were constructed to manage bulk waste materials generated from the CWP. The SMFs allowed for wet soils, sediments and waste material to be dried out prior to loading containers. The SMFs allowed waste to be processed (stockpiled, crushed, conditioned, processed and packaged into containers for transport) throughout the year to meet transport schedules, regardless of inclement weather conditions. Maintaining a set schedule allowed for consistently level staffing and minimal impact to the HBPP decommissioning schedule. The advantage of using the SMFs was reduced costs associated with waste-handling operations. See Section 4.1.1.6.1.

Additional savings were realized with the use of stockpile locations, which provided a suitable location for risk-reducing processes such as rubblizing concrete. Rubblizing the waste provided greater stability once loaded and reduced the chance of damage to shipping containers. The Andrews disposal facility offered a reduced disposal cost for concrete that had already been size-reduced. Cost avoidance and other processes to realize savings are discussed in Section 5.11.

## **5.5 Areas of Waste Generation**

The PWP identified the type of waste and the area in which it was generated.

Table 5-2, Actual Shipments, shows the waste volumes from each area and where they were disposed according to their waste classification.

**Table 5-2, Actual Shipments**

2018 NDCTP Waste Actuals	Total Shipments (2014)	Waste Weight (bs) (2014)	Waste Volume (ft3) (2014)	Total Shipments (2015)	Waste Weight (lbs) (2015)	Waste Volume (ft3) (2015)	Total Shipments (2016)	Waste Weight (lbs) (2016)	Waste Volume (ft3) (2016)	Total Shipments (2017)	Waste Weight (bs) (2017)	Waste Volume (ft3) (2017)	Total Shipments (2018)	Waste Weight (lbs) (2018)	Waste Volume (ft3) (2018)
<b>Clive</b>	<b>39.00</b>	<b>574,339</b>	<b>15,429.7</b>	<b>68.00</b>	<b>1,707,667</b>	<b>20,860.2</b>	<b>59.00</b>	<b>1,872,357</b>	<b>18,025.5</b>	<b>33.00</b>	<b>1,078,930</b>	<b>9,165.00</b>	<b>1.00</b>	<b>32,320</b>	<b>432.0</b>
Caisson	1.78	26,189	703.6	15.06	378,105	4,618.8	4.78	151,824	1,461.6	33.00	1,078,930	9,165.00	1.00	32,320	432.0
Canal	0.00	0	0.0	0.00	0	0.0	54.22	1,720,533	16,563.9	0.00	0	0.00	0.00	0	0.0
Canal Shipment	37.22	548,150	14,726.1	52.94	1,329,562	16,241.4	0.00	0	0.0	0.00	0	0.00	0.00	0	0.0
<b>Oak Ridge</b>	<b>16.00</b>	<b>132,391</b>	<b>12,623.0</b>	<b>12.00</b>	<b>128,820</b>	<b>10,445.5</b>	<b>0.00</b>	<b>0</b>	<b>0.0</b>	<b>2.00</b>	<b>21,528</b>	<b>127.00</b>	<b>0.00</b>	<b>0</b>	<b>0.0</b>
Caisson	0.00	0	0.0	1.54	16,532	1,340.5	0.00	0	0.0	0.00	0	0.00	0.00	0	0.0
Canal	0.00	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00	0	0.00	0.00	0	0.0
Canal Shipment	16.00	132,391	12,623.0	10.46	112,288	9,105.0	0.00	0	0.0	2.00	21,528	127.00	0.00	0	0.0
<b>Richland, Gainesville</b>	<b>4.00</b>	<b>2,554</b>	<b>103.0</b>	<b>0.00</b>	<b>0</b>	<b>0.0</b>	<b>1.00</b>	<b>3,300</b>	<b>450.0</b>	<b>0.00</b>	<b>0</b>	<b>0.00</b>	<b>1.00</b>	<b>3,300</b>	<b>450.0</b>
Caisson	0.00	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00	0	0.00	0.00	0	0.0
Canal	0.00	0	0.0	0.00	0	0.0	0.00	0	0.0	0.00	0	0.00	0.00	0	0.0
Canal Shipment	4.00	2,554	103.0	0.00	0	0.0	1.00	3,300	450.0	0.00	0	0.00	1.00	3,300	450.0
<b>Andrews</b>	<b>2.00</b>	<b>9,650</b>	<b>165.0</b>	<b>21.00</b>	<b>3,400,000</b>	<b>36,720.0</b>	<b>108.00</b>	<b>20,598,840</b>	<b>222,220.0</b>	<b>372.00</b>	<b>67,528,910</b>	<b>705,699.00</b>	<b>76.00</b>	<b>12,699,660</b>	<b>130,801.0</b>
Caisson	0.00	0	0.0	20.40	3,303,156	35,674.1	9.74	1,858,486	20,049.3	295.85	53,705,095	561,235.65	50.78	8,485,915	87,401.2
Canal	0.00	0	0.0	0.00	0	0.0	17.42	3,322,206	35,839.9	4.37	793,923	8,296.75	16.40	2,740,991	28,231.0
Canal Shipment	2.00	9,650	165.0	0.60	96,844	1,045.9	80.84	15,418,149	166,330.8	71.78	13,029,893	136,166.80	8.81	1,472,754	15,168.7
<b>Grand View, Beatty</b>	<b>384.00</b>	<b>12,406,844</b>	<b>118,419.0</b>	<b>832.00</b>	<b>27,809,746</b>	<b>283,498.0</b>	<b>682.00</b>	<b>23,231,176</b>	<b>226,046.0</b>	<b>386.00</b>	<b>13,146,402</b>	<b>146,289.50</b>	<b>739.00</b>	<b>25,664,993</b>	<b>298,300.0</b>
Caisson	2.97	96,084	917.1	471.74	15,768,103	160,743.1	76.36	2,600,953	25,308.0	161.64	5,505,051	61,258.68	49.85	1,453,224	21,136.2
Canal	0.00	0	0.0	143.62	4,800,437	48,936.6	154.03	5,246,674	51,051.6	37.60	1,280,598	14,250.14	17.81	519,178	7,551.1
Canal Shipment	381.03	12,310,760	117,501.9	216.64	7,241,206	73,818.3	451.62	15,383,549	149,686.3	186.76	6,360,753	70,780.69	671.00	23,692,592	269,613.0
<b>Totals</b>	<b>445.00</b>	<b>13,125,778</b>	<b>146,739.7</b>	<b>933.00</b>	<b>33,046,233</b>	<b>351,523.7</b>	<b>850.00</b>	<b>45,705,673</b>	<b>466,741.5</b>	<b>793.00</b>	<b>81,775,770</b>	<b>861,280.50</b>	<b>817.00</b>	<b>38,400,273</b>	<b>429,983.0</b>
2018 NDCTP Total Actual Waste Weight (lbs)	212,053,727		2015 NDCTP Waste Estimated Weight (lbs)		133,888,123										

Caisson waste disposal is discussed in Section [9.3](#) and Canals waste is discussed in Section [10.2](#).

### 5.5.1 Nuclear Facilities Waste Generation

The majority of waste generated from early nuclear facilities demolition was direct-loaded into Industrial Packaging (IP) IMs, thus avoiding the rehandling of materials. Waste soil was added to maximize efficiency for each shipment. As the rate of waste generation increased, Waste personnel determined that hauling waste into the SMFs for processing to meet acceptance criteria allowed demolition work to progress at an increased rate, with no impact on the CWP schedule. Most of waste generated was comprised of soil, concrete, steel and small amounts of other construction debris like metal, wood and plastics.

### 5.6 Waste Disposal Facilities

PG&E used available waste disposal options to mitigate risk safely, compliantly, efficiently and in a cost-effective manner, including disposal options at Andrews, Texas and Clive, and an approved exemption to dispose Low-Level Radwaste (LLRW) at a disposal site in Grand View. Noncompliant waste (waste not meeting disposal criteria) was transported to processors in Richland, Washington, Oak Ridge Tennessee, or Gainesville, Florida, to ensure the waste was treated or processed to meet WAC at a disposal facility.

The WAC threshold for disposal of radiologically-contaminated soils and demolition debris in Grand View was isotope-specific. In most cases, waste was shipped to Grand View under the exemption containing very low levels of measurable radioactivity and was also exempt under Department of Transportation (DOT) Regulation (49 CFR §173.436). Waste with greater concentrations of radioactive material was shipped to the Clive disposal facility as Class A waste.

PG&E used radioactive waste disposal options in Andrews, Clive and Grand View and non-radioactive waste disposal options in Beatty. PG&E and the Waste Management group used its suite of waste processors and disposal facilities to optimize waste disposal to safely maximize risk reduction, while minimizing cost to achieve the best value. Waste exceeding the very restrictive Grand View waste acceptance criteria and not warranting the costlier disposal at

Clive, was shipped to the RCRA Part B cell at Andrews. Having three radioactive waste disposal options allowed PG&E to make the most cost-effective decisions on waste disposal.

**5.7 Low-Level Radioactive Water Shipments**

Radioactive water shipments were identified during project risk evaluation as a high-risk activity for PG&E, due to the potential adverse impacts of environmental releases during loading and transportation activities. Water was transported in tanker trucks off site for disposal, following termination of the site’s operating discharge permit held with the NCRWQCB in 2013, which allowed liquid radwaste discharge to the Discharge Canal.

Forty-four water tanker shipments of radioactive liquid were completed over a four-year period. The water shipments included 1,800,534 pounds, or 28,792 cubic feet of liquid containing small amounts of Cs-137 radioactivity. Despite the greater risk of transporting liquid on the highway in tankers, water shipments to Grand View were completed safely without adverse incident.

In 2018, the NCRWQCB established the requirement that discharges could not contain any radiological constituent. This requirement did not factor in the presence of naturally-occurring radioactive material or radioactive materials at de minimis levels. PG&E sampled process water to determine if water for discharge met permissible chemical and radioactive constituents. The sampling identified the existence of naturally-occurring (background) radioactivity, thereby preventing discharge to the Humboldt Community Service District System. The process water was collected and disposed of appropriately. Water tanker shipments were performed per the following table:

**Table 5-3 Spent Fuel Pool Water Tanker Shipments Breakdown**

No. of Shipments	Year	Weight lbs	Volume ft <sup>3</sup>	Cs-137 mCi
10	2014	416094	6637	2.37E-02
27	2015	1095060	17547	4.58E-02
5	2016	212100	3399	1.46E-02
2	2017	77280	1209	1.09E-03
44	-	1800534	28792	8.52E-02

**5.8 Waste Shipments**

Selection and use of containers was unique to each type of waste being packaged. The waste’s physical, chemical and radiological characteristics were accounted for when choosing packaging. (See Table 5-1, Waste Disposal)

To accommodate for the various sizes and configurations of wastes, the following shipping containers were used:

- IP-1
- IP-2
- SeaVan or Sealand, also known as ISO container
- Custom-made IP-1, IP-2, Type A containers (e.g., the Lower Reactor Head box)



- Type A B-25 container (one-time use containers)
- 30-gallon drums (one-time use containers)
- 55-gallon drums (one-time use containers)
- 85-gallon or 110-gallon over-pack drums (one-time use containers)
- Specialty bags and miscellaneous packages that met DOT specifications for shipment

Each package used for Class 7 (radioactive) materials was designed to be physically and chemically compatible with the material being shipped. Drums and other small containers in a workplace accumulation were labeled with their contents, including hazardous properties and physical state.

### **5.9 Waste Shipment Vehicle Inspections**

The Waste Management group utilized procedures, work instructions and plans to perform functions related to radioactive waste shipments from the CWP, including DOT vehicle inspections performed or verified for each inbound and outbound shipment, and review of driver endorsements and medical status. PG&E staff also performed oversight on a statistical sampling of waste shipments leaving the CWP. This process of conducting waste activities in accordance with written plans and procedures, periodic and random oversight by PG&E and verification of credentials, ensured the project risk associated with transport and disposal was minimized.

### **5.10 Container Optimization**

DOT regulations stated that the gross weight limit of a loaded truck for the configurations used for waste transportation may not exceed 80,000 pounds. Based on tare weight of the truck, the Waste Management group determined that the gross weight of a loaded IM could exceed 43,000 pounds. Approximately 270 cubic feet to 300 cubic feet of soil or concrete waste would equal a shipment of 43,000 pounds. Hence, the vast majority of shipments reached capacity based on weight. Optimizing waste loading was challenging, but was the most economical method for disposal. PG&E incentivized the CWC by setting a goal to load waste containers to 97 percent of capacity, based on either the weight or the volume. Portable weight scales were situated near work locations during demolition and excavation activities. IM containers were placed on the scales while they were being filled, allowing workers to maximize or optimize waste loading. Containers loaded with sheet metal, siding, piping and rebar waste were often full based on volume, but light on weight, due to the amount of void space within the container. In order to maintain high-shipment optimization, the Waste Management group added suitable waste to bring the weight up to capacity. The project reduced the total number of IM shipments by topping off metal debris IMs with soil to increase the total weight.

In 2014, waste was loaded into IMs at an average of 90 percent of the loading capacity. With the use of scales and improved loading practices, the Waste Management group was able to optimize IM loading. In 2015 through 2017, IMs were loaded to over 97 percent load capacity.

The Waste Management group continued to maximize the amount of waste per shipment by implementing the bag campaign. In 2016, HBPP shifted methods of loading and shipping waste materials from direct loading in the field, to using a staging facility known as the SMF for staging and loading shipments. This change occurred in part due to acquiring a disposal facility at Andrews. This waste facility had the ability to receive IP-1 bags via railcars, thus allowing

HBPP to ship more material per shipment and at a reduced cost. This method of shipping allowed HBPP to replace the IMs with IP-1 bags for soil or crushed concrete. Shipments no longer had to account for the tare weight of the IM.

The CWP waste shipment estimates assumed an average shipment contained a net weight of 32,000 pounds of waste. The Waste Management group's loading optimization proved more waste could be shipped on each actual shipment. To track waste volumes against waste estimates, an IM equivalency method of tracking was adopted, reflecting one waste shipment as equal to 32,000 pounds. By improving IM loading strategies and switching to bags, the Waste Management group reduced the number of shipments required to travel to disposal sites.

### **5.11 Cost Avoidance, Savings and Process Improvements**

In addition to using the most cost effective site for disposal (see Section 5.6), the Waste Management group continuously reviewed waste management practices and process improvements that provided risk reduction and cost savings, provided the improvements still held safety as the project's highest priority. During the CWP, waste generation, management, handling, processing and ultimately disposal, were the critical elements in the process of removing the above- and below-grade structures and impacted soil.

Safe, cost-effective waste management practices were important to the success of the CWP. Therefore, waste activities were evaluated for risk mitigation and cost savings, resulting in numerous improvements, as the following examples demonstrate:

- To prevent payment of vendor billing errors caused by waste weights, shipping distances and demurrage durations being improperly transcribed from shipping papers to the billing system, PG&E staff routinely checked the billing details against shipping records to ensure any errors were corrected before payment.
- Much of the CWP hazardous waste, such as waste oils, used batteries and spent paint and solvents, were generated in relatively small quantities. Regulations required that hazardous waste be accumulated on site for no more than ninety days. Rather than contract with a disposal vendor to ship a few containers of hazardous waste every few months, CWP and PG&E staff participated in a PG&E program that coordinated collection of small quantities of hazardous waste at multiple PG&E locations. This program resulted in greater utilization of each truck transporting waste and resulted in fewer trucks carrying hazardous waste on California highways. Hazardous waste shipments were scheduled approximately every quarter to ensure regulatory time limits were not exceeded.
- Prior to completing the HBPP sewer lift station upgrades, some waste waters from outside the RCA were collected in totes and/or drums and analyzed for chemical and radiological constituents. The Environmental Coordinator reviewed the analytical results and if they indicated the water was a candidate for disposal to the sewer, the water was transferred to a bulk tank and the accumulated water was pumped into a tanker truck and transported to a publicly-owned treatment works. Following sewer lift station upgrades, waste water was collected in a bulk tank near the sewer discharge point. When approved for disposal to the sewer, the water was discharged directly to the sewer, with concurrence of the local services district. This process reduced truck traffic at the CWP and on public highways and reduced waste disposal costs.

- PG&E terminated discharge of industrial waste water from HBPP under a National Pollution Discharge Elimination System (NPDES) permit on December 23, 2013. Following termination of discharges, PG&E utilized NRC Exemption #3 to transport 37 shipments of industrial waste water containing low levels of radioactivity to an offsite disposal site in Grand View. Although tanker truck transport of contaminated industrial waste water was a risk, HBPP decommissioning sought the benefit of replacing the discharge of waste water to the environment with safe, compliant disposal in a Class 2 landfill.
- Depending on the type of waste and radiological levels, PG&E established multiple transport and disposal pathways to three different radwaste disposal facilities. This “toolbox” approach of multiple disposal options gave the Waste Management group choices on minimizing transportation risks and waste disposal costs. For example, radwaste with the very lowest activity and radiological concentration was transported by truck to Grand View for disposal. The higher-activity waste, and consequently the most expensive waste disposal option, was transported by truck to Clive. Based on risk mitigation (reduced truck highway miles) and cost reduction, PG&E entered into an agreement for a third disposal option for intermediate-activity waste at Andrews. This option included packaging waste in soft-sided IP-1 bags, trucking the waste bags to Redding, California and transloading the waste into gondola rail cars for rail transport to Texas. This approach allowed flexibility in selecting disposal options and eliminated over 2,000,000 truck miles during the life of the CWP. In addition, thirty-six IMs were shipped to Andrews, which otherwise would have been disposed to Clive, saving the CWP \$1.8M.
- PG&E implemented a process for categorizing waste to achieve compliance with the NRC exemption for shipment of radwaste to Grand View to ensure the aggregate of waste shipments remained below 15 pCi/g Cs-137. In most cases, these radwaste shipments were DOT-exempt as well. There were over 250 radwaste shipments sent to Grand View, which would have otherwise been disposed to Clive if not for this process. This process included verifying the aggregate Cs-137 concentration of radwaste shipments to Grand View remained well below 15 pCi/g, the average dose for each waste package remained below 100 uR/hr and no single measurement was above 500 uR/hr.
- The Waste Management group improved waste packaging methods and identified ways to optimize loading waste containers by weight and by volume. For example, earlier in the HBPP decommissioning, Turbine Building metal siding, sheet metal and roofing, and steel and rebar were loaded into IMs until the waste containers were 100 percent full, based on volume. Consequently, the net waste weight in the container was only 12,000 pounds to 20,000 pounds of waste. The CWC developed packaging methods that loaded metal waste first, then the container was optimized by weight and the voids in the container were filled with soil and concrete debris to a gross weight of 43,000 pounds, until the IMs were full, based on both volume and waste weight. This method reduced the total number of waste containers being shipped for disposal.
- The CWC segregated concrete from outside the RCA that was released by RP to an offsite processor. A total of 17,372,175 pounds, or 5,537 cubic yards (473 end dump loads) of reuse concrete was returned to the CWP. This reuse of concrete avoided the cost for disposal and import of backfill material.

- Mixed waste was more difficult to dispose of, as it was dependent on specific hazardous materials and the levels of radioactivity. Disposal sites varied in their ability to accept mixed waste based on the specific mix of waste. Based on the content of the mixed waste and the processor determination of the waste that had to meet its WAC for the specific facility, processors in Florida and Tennessee were used for mixed, more complex wastes. If the radioactivity was low enough to meet Grand View WAC, these wastes were shipped direct to Grand View for disposal.
- Based on dose profile and issues with chimney-cutting equipment, careful coordination and characterization of the reactor chimney was needed. After the most active section had been cut away, a shipping container similar to that used for spent fuel racks was built. Light-weight grout was used, allowing the chimney to be shipped and disposed of as Class A waste, rather than the more expensive Class C waste.
- Addition of the SMF allowed for switching from a direct-loading campaign to a collect and stockpile campaign. This allowed for staging, drying and size reducing and reduced the number of machines needed for loading within the field.
- A soft-side bag was used for shipping the large secondary waste components to Grand View, which eliminated the need for size reduction. The emergency condenser with asbestos insulation was shipped in an IP-1 bag, eliminating the risk and cost associated with asbestos removal. Soft-side bags were evaluated for shipping soils to disposal sites. A filled bag of soil weighed 20,000 pounds and two bags could be shipped in a single truck. This allowed 40,000 pounds of waste to be shipped, compared to 32,000 to 35,000 pounds in an IM, due to not having to include the tare weight of the IM. This eliminated one waste shipment for every five shipments.

Dry Active Waste (DAW), including paper, plastic, empty containers, materials, supplies, PPE, rubber, PVC and wood, was sent to a waste processor for size reduction and void space minimization prior to disposal. Due to radioactivity levels, this waste stream was sent to Tennessee for processing and then sent to disposal in Utah. As demolition progressed, the radioactive source term at the CWP was reduced and personnel determined some DAW could be sent to Grand View for direct burial at a reduced disposal cost. In addition, an alternate processor closer to the CWP was identified for processing DAW at a reduced rate.

#### Concentration Averaging

Wastes intended for radioactive waste disposal facilities were required to be classified on an activity-per-weight basis in accordance with 10 CFR §61. The NRC developed guidance in a document titled "The Branch Technical Position on Concentration Averaging." This position paper allows generators of radioactive waste to average lower-activity material and higher-activity material from the same source, to establish an average activity over multiple items being disposed of in one package.

HBPP utilized this method when generating waste filters, such as the Tri-Nuke Filters used for removing radioactivity from liquids. Calculations were performed and dose rates were established for cutoff limits for the filters.

Prior to the RPV internals project, this method was utilized for mostly filtration used in removing radioactivity associated with the SFP and other water processing systems. Once the RPV internal project commenced, it became more difficult to apply this strategy, due to the additional filters required and radiation exposure to individuals handling the waste. Filters were utilized

longer and more radioactivity was introduced to the filtration systems. This resulted in disposal at a Class B and a Class C facility, but also meant that fewer filters were used.

After the RPV internals project, a different type of filter was utilized, called a Solid Collection Filter, which was specially designed to hold more material with more mass, which in turn could be disposed as Class A waste at lower cost.

## 5.12 Waste Minimization

As the Waste Management group had to accommodate for large quantities of unforeseen waste and be consistent with initial estimates, they minimized waste where possible.

PG&E and CWC provided annual training to remind workers of the importance of characterizing and classifying waste and waste minimization. Packaging materials such as cardboard boxes, foam packing and plastic wrap were removed prior to taking materials into a potentially-contaminated area.

- The CWC utilized a tool crib within the RCA or RMA to issue and return tools and routine equipment for use within the RCAs. This minimized the number of new or clean tools that were contaminated and subsequently disposed of as waste.
- Lead metal was used in such items as shielding, bolts and pipe joints. If these materials were destined for disposal, they would be subject to full hazardous waste disposal requirements; however, there was regulatory relief for waste generators who managed the lead through recycling. Rather than sending radioactively-contaminated lead or non-radioactively-contaminated lead for disposal, the material was sent to either a processor for recycling or a recycling facility. This approach reduced disposal fees, minimized waste going into landfills and ensured valuable resources remained available for use.
- Specific radiologically-contaminated imbedded drain locations and concrete seams were closely observed by RP. The potential existed for mercury to migrate to these drain locations and concrete seams, or within the lab area where discarded mercury-containing components were stored. The Waste group wanted to ensure the combination of radioactive contamination and elemental mercury did not become a mixed waste. Special identification and handling of these locations were addressed during CWC work to successfully minimize quantities of mixed waste shipped for processing and disposal, reducing the overall costs of waste disposal.
- The CWP maintained flammable-chemical storage cabinets at key locations. Workers were encouraged to utilize the existing inventory of partially-consumed product from these cabinets prior to opening new containers. This method reduced the number of partially-consumed containers of chemical products in the waste stream.
- As part of the demolition process, water was applied through a mister or power washer to reduce dust particles in the air. For the LRWB, several hundred gallons of water were generated from the dust suppression process. Rather than supply new domestic water to the misters, the water was collected in the building's utility trench, pumped into totes, then reused through the misters and power washers.
- Where practical, the CWP used the GARDIAN system to screen excavated soil for reuse on site. The screening criteria at less than 5 pCi/g Cs-137 (and no Europium or other gamma emitters) ensured the soil deemed reusable on site remained conservatively below the regulatory license termination limit of 7.0 pCi/g Cs-137. Using this system to



screen excavated soils, approximately 70,900 cubic yards of soil from various excavations across the CWP was stockpiled and used to fill in the Caisson and circulating water piping excavations. Sending this soil off site for radioactive disposal would have cost about \$70M in disposal fees. In addition, reusing the soil eliminated the need to purchase imported fill for excavated areas. Most of the CSM wall spoils were determined to be reusable. Most of the soil between the CSM wall and the concrete Caisson structure was successfully screened for reuse. Soil 1 foot around the circulating water pipes was established as radioactive waste, because of its proximity to the concrete piping. However, after repeated surveys of the soil at or below background at 6 uR/hr, the soil was screened through the GARDIAN for reuse. In this manner, a portion of the excavated soil was saved for reuse and continued disposal of soil as waste was avoided.

- Building or structure concrete from nonradioactive areas was surveyed and sampled by RP for release off site for stockpiling, size reduction, and eventual reuse on site as fill material.

## **6 SMALL VALUE CONTRACTS**

The Small Value Contracts category includes Small Dollar Vendors and Specialty Contracts, which fell outside major scopes of work. Specialty contractors generally performed functions unique to the decommissioning project, while Small Dollar Vendors provided mostly generic services for office and facilities maintenance.

Examples of goods and essential services that were procured as Small Value Contracts were specialty printing services, communication services, NRC fees, environmental sampling analysis, emergency planning fees and internet technical services. RP monitoring and equipment programs were also procured to support ALARA requirements and provide oversight staffing with information they needed to support the team in the field. Vendors were engaged for such services as: moving and storage services provided by a local company to haul between the HBPP site, offsite offices and an offsite warehouse; calibration services for equipment, tools and lab instruments; office supplies; document shredding services; mobile facility rentals; badging equipment; and MRU rental.

Specialty consultants provided support, skills and knowledge unique to decommissioning activities. Consultants provided guidance to help the project conform to local, state and federal regulations. This included guidance on the equipment, packaging, transportation and accepted practices for waste disposal. They also supplied the organization with project management suggestions, bid specification support and permitting support (on site and off site).



**Table 6-1, Small Value Contracts**

2015 NDCTP ID		Approved NDCTP Estimates		Amount Spent Presented for Reasonableness			Previously Presented and Approved
		Base	Nominal	2012-2014 <sup>1</sup>	2015-2018	Total	
E.4.6	Small Value Contracts	39,785,514	41,301,727	37,924	11,017,677	11,055,601	21,575,949
E.4.6.1	2012 NDCTP CPUC Filing	26,825,024	27,739,352	37,924		37,924	21,575,949
E.4.6.1.1	Small Dollar Vendor	7,186,457	7,454,061	37,924	-	37,924	2,680,883
E.4.6.1.2	Specialty Contracts	19,638,567	20,285,292	-	-	-	18,895,065
E.4.6.2	2015 NDCTP CPUC Filing	12,960,489	13,562,375		11,017,677	11,017,677	
E.4.6.2.1	Small Dollar Vendors	1,750,345	1,846,866	-	1,723,266	1,723,266	-
E.4.6.2.2	Specialty Contracts	11,210,144	11,715,509	-	9,294,412	9,294,412	-
	Environmental Contracts	1,041,989	1,121,875	-	1,512,840	1,512,840	-
	Permitting	302,000	322,857	-	983,518	983,518	-
	Specialty Consultants	9,866,156	10,270,777	-	6,798,054	6,798,054	-

1. Includes \$3K in 2011 Actuals not sent through Reasonableness Review in 2015 filing

Actual costs during 2012 through 2014 presented for review in Small Value Contracts were \$37,924. Actual costs 2015 through 2018 were \$11.0M compared to the approved cost estimate of \$13.6M.

## 6.1 2012 NDCTP CPUC Filing

### 6.1.1 Small Dollar Vendors

For the period 2009 through 2014, Small Dollar Vendors spent \$37,924 for services of pay-per-click printing services. These services were not included in the previous Completed Projects Review claim, because they were to support CWP. Therefore, these costs are included in the 2018 Reasonableness Review.

## 6.2 2015 NDCTP CPUC Filing

### 6.2.1 Small Dollar Vendors

After the self-perform phase was completed and the majority of the work turned over to the CWC, PG&E still needed some vendors under its direction and control. These costs were split between the base scope and Reactor Caisson support, based on the amount of work being performed. Some vendors had functions that were strictly dedicated to support PG&E's commitment to the NRC for safe decommissioning. Other vendors had roles that supported PG&E's role as manager of the CWC and similar staff support functions for which a full-time position was not warranted. Some examples follow:

#### EPRI Membership

This membership allowed PG&E to participate in the Electric Power Research Institute Remediation and Decommissioning Technology Program from 2016 through 2018. Dissemination of our experiences to a clearing house of D&D technology was extraordinarily helpful to utilities planning their decommissioning strategies. It also offered PG&E a knowledge base to glean techniques and lessons learned from other decommissioning projects for use in its own planning and execution.

#### Fire Extinguisher Services

PG&E maintained a fleet of its own fire extinguishers separately from the CWC inventory. A cost savings was realized in using the same vendor for CWC services and the on-site Safety

Manager could do the rounds on a once-per-month service cycle and cover all the units. Fire extinguishers were inspected to ensure they were accessible and would operate properly in the event of an emergency. Fire extinguisher inspections were required by OSHA regulations and HBPP policy.

#### Aerial Mapping Services

Periodic feature and contour mapping services were performed. All visible structures associated with the site were mapped and aerially triangulated via survey control for accuracy. Roads, fences, sidewalks, parking lots and hydrography, as well as contours of land and waterways were also shown. This data proved helpful for planning, forecasting, logistics, presentations, reporting agencies and as an aid for construction and demolition activities.

#### Environmental and RP Sample Analysis Services

PG&E utilized offsite laboratories to support the following decommissioning activities:

Environmental Chemistry - Analysis of samples for asbestos, lead, chrome-6, PCBs, herbicides, metals, mercury, volatile and semi-volatile organics and other constituents, to ensure compliance with various state and federal regulations, such as the National Emission Standards for Hazardous Air Pollutants, the North Coast Unified Air Quality Management District, NPDES, the SWPPP and RCRA.

Radiochemistry – Advanced analysis of samples for hard-to-detect radionuclides, which was beyond the capabilities of the on-site laboratory, laboratory and laboratory technical services cross-check samples, and radio-bioassay analysis. Non-radiological and low-level radiologically-impacted environmental samples were sent to offsite laboratories when necessary. Environmental samples that also contained low-level radiological activity were sent to labs with a radiological materials license, therefore limiting the selection of available facilities that could provide the needed services.

#### Telecommunication Services

Telecommunication Services supported personnel relocation to the offsite facility and numerous moves between offices on the worksite. Services included the setup of communication, provision of IT infrastructure and maintenance. Area PG&E IT support was integral to supporting employees and contractors with access to and equipment for phone service and network connections.

#### Emergency Responders Coverage

In lieu of employing a full-time permanent emergency response staff solely for HBPP, the local Humboldt Bay Fire Joint Powers Authority was contracted to provide immediate response for rescue operations. The monthly stipend ensured 24 hours a day, 7 days per week, 365 days per year response and included regularly-scheduled drills with ambulance and Law Enforcement participation.

#### Environmental/Biological Study and Surveys for Proposed Sidewalk

A walking path that was a CDP requirement along one side of King Salmon Avenue for pedestrian safety was provided. During decommissioning and into the start of FSR, activities increased vehicle and pedestrian traffic to that area. The PG&E provided a pedestrian path

from US 101 to Parking Lot C entrance. The contractor considered wetlands, geography, topographic survey and special-status plant survey to meet the required permitting criteria to construct the path.

Other Small Dollar Vendor contracts included:

- Badging equipment and supplies;
- Bottled water, floor mat and PPE laundry services and trash/recycling;
- Computer software, hardware, license and maintenance;
- Routine maintenance and repair services of Count Room and other HVAC systems;
- Document shredding services;
- Electronic dosimeter calibration services;
- Equipment and tool calibration services, including scales;
- FSS silt sampling of Intake Canal;
- Lock and alarm components installation and monitoring;
- Office supplies;
- Office trailer rental;
- Mobile respirator unit rental;
- Moving and storage services;
- PPE;
- Printer supplies and paper;
- Proactive office assessment (Human Performance and Ergonomics);
- Project printing services; and
- Water and sewer services.

### **6.2.2 Specialty Contracts**

Specialty Contract costs were split between the base scope and Reactor Caisson support, based on the amount of work being performed. A variety of specialty contractors performed the following decommissioning-specific tasks:

#### **NRC Licensing and Inspection Fees**

NRC fees during the period were for individual time spent by headquarters personnel to review and process specific items. Examples of such items included an Emergency Plan Revision, an LTP Amendment, a partial site release, a records exemption request, several FSS reports and associated NRC project management for these items. Additionally, there were fees for time and travel associated with nine inspections performed at HBPP by regional inspectors out of NRC Region 4.

- NRC reviewed the LTP Amendment. NRC costs were associated with review of the LTP Amendment Request, issuance of Requests for Additional Information and development of a License Amendment approving the Amended LTP.
- NRC performed reviews of the Site Emergency Plan Amendment Revisions. NRC costs were associated with on-site inspection time at HBPP, plus time to develop and issue an Inspection Report.
- NRC consultant Oak Ridge Institute for Science and Education performed confirmatory surveys and analyses of FSS activities originally performed by PG&E. NRC costs were

associated with on-site inspection time at HBPP, plus time to develop and issue an Inspection Report.

- NRC reviewed the Annual Decommissioning Funding Report. NRC costs were associated with review of the report.
- NRC reviewed and performed inspections for the Partial Site Release Request submitted by PG&E. NRC costs were associated with on-site inspection time at HBPP, plus time to develop and issue an Inspection Report.
- NRC performed various routine project management inspections on decommissioning activities. NRC costs were associated with on-site inspection time at HBPP, plus time to develop and issue Inspection Reports.
- NRC headquarters and regional staffs participated in routine periodic communications on site status and potential opportunities for independent confirmatory surveys.

#### Chemical Analysis Sampling Services

PG&E continued to engage the services of a testing lab for RP Sample Analysis, Environmental Sample Analysis, Safety Sample Analysis and FSS Sample Analysis. While some testing could be performed on site in the Count Room, certain testing had to be performed or confirmed by an independent laboratory.

#### Drilling and Well Installation

The contractor monitored groundwater conditions in the area surrounding Unit 3 during CSM wall construction and future decommissioning activities, by installing six additional depth-discrete monitoring wells. These new wells were spatially distributed between the remaining Radiological Environmental Monitoring Plan wells in both the intermediate and deep water-bearing zones beneath the site. Three of the wells were constructed as intermediate-screened wells and three were constructed as deep-screened wells.

#### Certified Asbestos Consultant

The Certified Asbestos Consultant (CAC) monitors the Work Site during the removal of asbestos materials, supports post-Work visual inspections and air sampling tests, and validates that an area or facility is within regulatory limits for asbestos clearance thresholds prior to demolition.

#### SWPPP Services and Support

This contractor provides all necessary labor, materials, and equipment needed to perform on-site Environmental Support Services and SWPPP for HBPP, including clean-up, disposal, labeling, and proper storage of hazardous waste and hazardous materials; monitoring of Soil Stockpiles; General Site Housekeeping; repair or replace of Fencing and Signage around Environmentally Sensitive areas; filling and replacement of sandbags as necessary; tarping of uncovered construction materials; pick up of Abandoned Construction Materials for recycling; repair of unavoidable impacts due to Decommissioning Activities; monitoring of multiple Waste and Waste Bins; and seed and straw bare ground as deemed necessary.

#### Sample Analysis for RP, Environmental, Safety, FSS and SAFSTOR

Various labs were contracted to perform chemical and radiological sampling and analysis of samples provided by PG&E. HBPP identified types of analysis needed, sensitivity, frequency

and reporting requirements. Most of these costs were related to radiological waste characterization, which provided the basis for informed decisions as to where and how to package and deliver waste to its final destination.

Final Site Closure characterization required hard-to-detect isotopes documentation, which could not be performed by the on-site laboratory.

Environmental sampling included detection of lead, PCBs, asbestos, etc. These samples included strict chain of custody handling and paperwork and reports back to PG&E.

#### Industrial Security Services

Unrelated to ISFSI Security, unarmed officers from a national security services company allowed only authorized personnel and visitors to enter the gates at HBPP, and provided emergency support as necessary. In addition to providing clearance paperwork and PPE for visitors, they performed visual ID checks of badges for personnel entering the facility and kept in radio contact with supervision to coordinate the arrival of delivery trucks and waste transport vehicles. They controlled the Main Gate and SAMS, took delivery of small packages, coordinated early/late arrivals, allowed access for weekend workers, processed vehicular traffic, surveilled ingress/egress routes and fences, patrolled parking lots, issued janitorial keys, issued and logged loaner badges and housed a first aid kit and Automated External Defibrillator (AED).

#### NDCTP Subject Matter Expert (SME) Support

Consultants and contractors provided SME writing advice and review of documents being prepared for the NDCTP filings. They prepared write-ups for the Completed Projects Review, researched historical information, developed technical briefings, responded to Requests for Information (RFI), prepared expert witnesses, provided management review of deliverables prior to submittal and performed variance analysis reports as requested. Other services performed included preparation of detailed descriptions and funding justification for completed projects, site staffing plan expense updates with justifications, updating or preparing additional subsections of the DPR, prudency reviews and other duties as requested by PG&E's Technical Coordinator or their delegates.

#### Civil Works Contractor (CWC) Administrator:

The CWC Administrator conducted and coordinated reviews of submittals for the CWC Master Service Agreement for contract compliance and SME review and comment. These duties included: pre-screening submittals for completeness and contract compliance; distribution of submittals to qualified SMEs for comment; receiving and screening comments received from reviewers for compliance with the most recent approved revision of "Submittal Review Desk Guide;" and preparation and technical assessment of reviewer comments to summarize key takeaways and general trends of comments. The CWC Administrator was also required to perform review and approval for CWC invoices to ensure the contractor was working prudently and work performed was billed appropriately. Additionally, the CWC Administrator provided leadership to the Document Control Specialist to ensure proper records retention in accordance with the most recent approved revision of HBAP E-1 and other applicable policies, procedures and desk guides.

#### Demolition and Decommissioning Consulting Services

This service Consultant provided professional expertise services of D&D specialists. They provided oversight of CW demolition activities; identified safety and/or technical issues for resolution; ensured procedural and work control compliance; attended daily meetings and safety tailboards; prepared daily reports; performed field observations; and examined schedule impacts and delays, crew sizes and equipment usage. This Consultant also participated in the Management Observation Program, reviewed contractors' monthly invoices, identified negative trends for resolution and fostered effective working relationships and teaming approaches.

#### Licensing Support Consultant

The Licensing Support Consultant provided full-time licensing support to the FSS Team. Duties in this capacity included providing monthly reports for required periodic surveillance surveys of previously-surveyed areas. This Consultant also provided:

- Bi-weekly reports for tracking and routing procedure changes, LTP changes, technical basis documents, final status reports and any other applicable documents in the review process;
- Monthly interdepartmental reports of program status and ongoing projects and activities;
- Assembled documentation packages of final status reports for NRC submittal;
- Date-controlled copies of the LTP between submittals to the NRC;
- Proofreading and editing of the LTP and Final Status Reports;
- The preparation and submittal of licensing documents, ensuring their delivery in a timely manner and in accordance with PG&E procedures and processes;
- Review of Site Closure group records for completeness and transfer of same to the Records Management System (RMS) on a monthly, quarterly and annual basis;
- Tracked and scheduled training for FSS Engineers, FSS Technicians and contractors supporting FSS-related work; and
- Supported administrative needs of the department by scheduling meeting rooms, routing inquiries, budgeting assistance, scanning materials, resolving office equipment problems, maintaining supplies, etc.

#### Communication Consulting Services

In 2014, the HBPP Decommissioning Project entered the CWP phase, which required increased external communication and coordination. A Communications Consultant supported the HBPP Management Team in its effort to engage with the local community, permitting agencies and other key stakeholders in a proactive, strategic and credible manner.

#### Senior Project Controls Consultant

This Consultant provided multiple personnel to perform master invoice reconciliations, broke down costs from CWC to match SAP order numbers, attended weekly Waste Management meetings, monitored the waste-loading process, compared the waste-tracking log to shipment costs invoiced, wrote variance reports and provided general oversight of the waste-handling process as a client representative.

#### Schedule and Costing Support

PG&E sought the ability to forecast projected schedules and costs for an unbiased comparison with the CWC reports. A consultant was hired to provide the implementation, layout



development and design of reporting documentation and training for project-scheduling software. Training was implemented for SAP transaction users and administrators on site. Training included: business intelligence, including development of standard and custom forms and reports; training and module object development; Contract Management Interface (CMI) implementation, including initial design; custom architecture; and on-site training.

#### Waste Planning and Field Oversight Specialist

This Specialist was an SME on waste-handling issues and assisted the CWC in aligning with state and federal regulatory shipping constraints. This Specialist also assisted in nuclear decommissioning planning and execution oversight, including waste handling. The Specialist also: observed CWC work activities; identified safety and/or technical issues for resolution; prepared daily reports of field observations, accomplished tasks, concerns and schedule impacts; participated in PG&E's Management Observation Program; reviewed monthly invoices; and identified negative trends for resolution.

#### Hazardous Waste, Environmental Compliance Oversight and Transportation Services

Costs for this category included transport and disposal of various hazardous wastes associated with ongoing decommissioning efforts. Hazardous wastes and recyclable materials included used oil, oily debris, mercury, lead, batteries, bulbs, PCB ballasts, universal wastes and e-wastes. Hazardous wastes were picked up on a routine quarterly basis to comply with the RCRA and California's 90-day waste accumulation regulations.

Additional environmental support was contracted for the FSS silt sampling at the Intake Canal. This support involved a boat, sampling equipment and an emergency response plan for in-water work.

#### Regulatory Affairs Specialist

The Regulatory Affairs Specialist was hired for insight, review and evaluation of status reports, regulatory affairs meetings with the NRC and submittals related to licensing. The Specialist coordinated on-site inspections by NRC, facilitated FSS sampling with the Oak Ridge Associated Universities (ORAU) group, gave presentations at NRC public meetings, updated License Basis Documents and participated in Community Advisory Board meetings.

#### CWC Support

The CWC provided earned-value metrics, project controls support personnel, report-writer personnel and supported PG&E with CPUC reporting requirements. The CWC also assisted in abandoning the existing wells, in accordance with county regulations.

The CWC provided a full-time on-site Senior Field Scientist to assist the Environmental Coordinator with day-to-day environmental record-keeping, task coordination, maintaining the RMS schedule log of reports, plans, agency correspondence, site visits and permitting action item dates. The CWC worked with PG&E's Senior Environmental Scientist on waste manifests, analytical information, waste profiles and generation of reports for PCBs, source reduction and toxic-release inventory.

PG&E provided reimbursement to the CWC for on-site leased trailers. The CWC later removed the leased trailer and other trailers, using a flatbed trailer and truck.

### Decision Log

The contractor monitored performance and compiled documentation related to supporting PG&E's obligations with respect to maintaining a Decision Log.

### Technical Editing and Writing

Several Technical Writers supported development of documents, including permitting requests from agencies and government submittals, on an as-needed basis. It was important to have documents professionally reviewed and edited before submittal to ensure proper grammar and content. Technical editors responded to RFIs, incorporated comments from Management and legal reviewers and developed documentation to support PG&E's NDCTP CPUC filing.

### Final Site Restoration (FSR) Planning

FSR planning included plans for restoration of specific land areas to functioning wetlands, establishing final grade and surfacing of roads and industrial use areas and potential land improvements needed to support ongoing industrial operations at the site. Planning also included remedial actions contained in a DTSC Remedial Action Plan, as necessary to restore the site to industrial uses.

The FSR plan established the final end-use of the site after decommissioning. A permitting plan for the restoration provided a road map for obtaining permits and authorizations needed to support development of the selected end use.

### On-Site Medical Services

HBPP Care On-Site Services provided oversight and support of occupational injury and illness programs. As an emphasis on worker safety, this service was provided to ensure site personnel were promptly evaluated and treated or sent off site as necessary, to address any injury or worker health issue. These services included training, consultation, technical support, physician services, quality assurance and monitoring of the program and medical liability coverages. The contractor also provided: monthly management services for care on site; PG&E's on-site Medical Care Specialist via remote access, including the provision of professional medical attention twenty-four hours a day, seven days a week, three hundred sixty-five days a year; and consultations for occupational illnesses and injuries, minor first aid services and emergency evaluation.

### Emergent On-Site Engineering Support

A contractor was procured to provide on-site Engineering support as needed, at the direction of the PG&E Engineering staff, and to provide fast turnaround to address emergent Engineering issues in support of Unit 3 Decommissioning.

### Legal Representation/Support

Legal Services provided support to PG&E in dealings with the CPUC, DOE, CCC and other agencies.

### On-Site Part-Time Decommissioning Consultant

This Technical Specialist provided SME expertise on the operating history and critical equipment locations and maintained a systems database, server maintenance and

programming. This consultant also managed Plant Records logs, the Management Observation System, the drawings database, procedures and the RFI system, in addition to providing support to various departments.

#### Permitting and Permitting Assistance

The decommissioning process was regulated by numerous local, state and federal agencies. Regulatory permitting and associated fees are a necessary component of decommissioning a nuclear facility and some will be ongoing for a number of years. This element includes certain agency permitting fees and assistance by outside contractors for services including: FSR outside service contracts covering permitting assistance and support of HBPP's submittal of FSR permits to regulatory agencies; CCC-Coastal Development review and permitting of Caisson removal and various restoration projects; Humboldt County development permits; and State of California hazardous substance fees.

#### ISIP V3 Maintenance

Annual maintenance and support of the Intersection Safety Implementation Plan (ISIP), Version 3, which included programming support to correct defects and errors and to implement minor modifications to Program Code Updates of DOT and NRC regulations for waste shipment of low-level radioactive waste management. This involved the ISIP that ensured roads and intersections along the haul path to the three disposal sites were not deficient for this type of transportation. Finding alternative travel paths and monitoring road closure conditions was a challenge, due to the region's limited access to principal arterial highways.

#### Independent Assessment of Waste-Handling Logistics and Spoils Management

An independent assessment for HBPP waste-handling and spoils management was performed, including on-site observation of plant operations, employees, equipment and procedures and interviews with relevant personnel. The purpose of the assessment was to identify deficiencies and limitations of waste handling and management practices and provide recommendations for corrective actions. As a result of the recommendations of the independent assessment, improvements were made to waste processing, as discussed in Section 5, WASTE DISPOSAL COSTS.

#### Remedial Action Consultant

The Remedial Action Consultant was assigned to review the initial FSR plan and suggest any remedial action needed. The review focused on restoring land areas to functioning wetlands, establishing final grade and surfacing of roads and industrial use areas, potential land improvements needed to support ongoing operations of ISFSI and HBGS and ensuring compliance with the DTSC Remedial Action Plan. The CWC assumed the duties of FSR planning and permitting. Remedial action included long-term monitoring and permitting requirements of the land areas designated for sensitive environmental set-asides.

#### Miscellaneous Services

Miscellaneous specialty services necessary to support the project on an ongoing basis, included:

- SAMS (offsite)

- Administrative support services, including document control and drafting
- Information Technology for computers, network, phones and their servicing
- Hydrologic Impact Study and support
- Risk Assessment and Risk Management consultation
- Environmental Coordinator, support and training services
- Hazardous Materials business plan
- REMP analysis
- Aerial mapping of HBPP (not included in professional flyover contract)
- Turnover of Shepard calibration source
- Transmission support
- Field oversight for CW
- FSR for PG&E
- Oracle P6 System, support and training
- IT infrastructure consultant
- ACM and lead-sampling of Buildings 5, 6, 7 and 8
- Address special permitting conditions for “as-left” CSM wall
- Consultant-examined waste transport supplier fleet safety
- Decommissioning Financial Consultant
- Digitizing film records and drawings
- Employee Concerns Investigator
- Excavation and Penetration Permit reviews
- Fence repairs and installation
- Grounding of 60kV switchyard for work nearby
- Independent analysis of two estimates of bio-shield wall activated concrete volume
- MARSSIM training course hosted on site
- Office machines, supplies, equipment and furniture
- RP personnel to support work in the field
- Separation of HBPP from ISFSI
- SME engineering review of two high-profile demolition work plans
- SME to assess alternative technology approach to Caisson removal

## **7 SPENT FUEL MANAGEMENT**

### **Background**

An ISFSI is a facility designed and constructed for the interim storage of SNF and reactor-related solid waste that is GTCC radioactive material. Owners of nuclear facilities around the nation will continue to store their SNF on site in ISFSIs until the DOE commences picking it up for storage at either a permanent or an interim repository site.

HBPP’s spent fuel is safely stored on site in an underground series of HI-STAR MPC-HB canisters. They are surrounded by security fencing and heavily guarded, in conformance with NRC regulations. The ISFSI will continue to operate until all spent fuel and GTCC material stored had been transferred to the DOE. After the transfer process is complete, the ISFSI will be decommissioned and the ISFSI 10 CFR §72 license terminated when the NRC determines that the site has been remediated in accordance with an LTP.

Until that time, PG&E continues to incur security, as well as O&M costs, associated with the ISFSI. PG&E continues to maintain the various local and federal permits required for the ISFSI, including the CDP.

For information on the claim against the DOE for the delay in SNF pickup, see Section 1.1.1.2.3, DOE Litigation Specialist.

### CPUC Review of Spent Fuel Costs

In the 2015 NDCTP, the CPUC accepted PG&E's proposal that due to the recurring and long-term nature of these costs, they be reviewed for reasonableness in each NDCTP, rather than waiting until final ISFSI site decommissioning.

### Comparison of Actual to Forecast Costs

Table 7-1, Spent Fuel Management for 2015 NDCTP Filing, provides ISFSI Security and Operating Costs consisting of 5 WBS elements:

1. Security
2. ISFSI O&M Costs
3. ISFSI Staffing, Engineering and Specialty Contracts
4. ISFSI Infrastructure Expense
5. NRC permits and fees

**Table 7-1, Spent Fuel Management for 2015 NDCTP Filing**

2015 NDCTP ID		Approved NDCTP Estimates		Amount Spent Presented for Reasonableness			Previously Presented and Approved
		Base	Nominal	2012-2014	2015-2018	Total	
E.4.7	Spent Fuel Management	48,803,188	51,889,334		27,714,733	27,714,733	14,279,397
E.4.7.2	2012 NDCTP CPUC Filing	13,450,356	14,154,252				14,279,397
E.4.7.2.1	Security (PG&E)	10,126,024	10,690,990	-	-	-	11,235,555
E.4.7.2.2	ISFSI O&M	1,525,843	1,593,444	-	-	-	1,632,172
E.4.7.2.3	ISFSI Staffing / Engineering / Specialty Contracts	1,727,246	1,795,538	-	-	-	1,089,192
E.4.7.2.4	ISFSI Infrastructure Expense	-	-	-	-	-	77,231
E.4.7.2.5	NRC Fees	71,243	74,280	-	-	-	245,246
	<b>2015 NDCTP Spent Fuel Management</b>	<b>35,352,832</b>	<b>37,735,082</b>		<b>27,714,733</b>	<b>27,714,733</b>	
	Security (PG&E)	24,152,470	25,910,839	-	21,937,592	21,937,592	-
	ISFSI Operate & Maintain	2,180,894	2,316,519	-	1,912,651	1,912,651	-
	ISFSI Staffing / Engineering / Specialty Contracts	3,346,908	3,517,087	-	1,877,811	1,877,811	-
	ISFSI Infrastructure Expenses	5,490,000	5,792,821	-	1,812,492	1,812,492	-
	NRC Fees	182,559	197,816	-	174,187	174,187	-

Actual costs during 2015 through 2018 for Spent Fuel Management were \$27.7M compared to the approved cost estimate of \$37.7M.

### 7.1 Security Staff Costs

For the period covered by this NDCTP, the ISFSI Security staff was responsible for guarding the spent fuel in accordance with the 10 CFR §72 license. Other duties Security personnel were responsible for included maintaining the ISFSI facility, security training, procedure writing, ISFSI licensing and access authorization. The ISFSI Security Unit, including ISFSI Specialists, were responsible for the safe and secure storage of three hundred and ninety spent fuel assemblies. The fuel assemblies occupied five casks; and one cask contained GTCC waste from the

decommissioned HBPP Unit 3. PG&E ISFSI Specialists, who functioned as Armed Security Officers (ASO), were trained and qualified in accordance with the Guard Training Plan (HB ISFSI Training and Qualification Plan) and the ISFSI Final Safety Analysis Report (FSAR). They conducted 24-hour surveillance of the storage casks and complied with NRC security requirements as specified in NRC orders and the NRC-approved Physical Security Plan. In addition to conducting patrols and searches, ISFSI Specialists' duties included verifying that personnel and activities within the ISFSI were authorized. The important functions and elements they provided demonstrated compliance with the ISFSI security commitments in the FSAR.

ISFSI Shift Managers (ISMs) were responsible for supervising Officers and shift activities and implementing the site's Emergency Plan. They were required to qualify as ASOs and have the ability and authority to revise nuclear quality and department-level procedures.

ASOs were required to enter issues into the CAP for resolution. They were responsible for operations, emergency response, security reporting to the NRC, declaration of Emergency Action Levels pursuant to the HB Emergency Plan, and immediate action in response to emergencies.

For the 2015 through 2018 period, Security staff costs were \$21.9M.

## **7.2 ISFSI Operations and Maintenance (O&M) Costs**

Effective and efficient management of ISFSI O&M functions incorporated safety and compliance measures necessary to meet NRC requirements. Key contributing activities and elements of ISFSI O&M totals during the period 2015 through 2018, included overhead, procedure revision, communications enhancements for continued compliance with NRC standards, engineering services, guard booth enhancements, required improvements to the Vehicle Barrier System (VBS), and ISFSI Team training.

For the 2015 through 2018 period, ISFSI O&M costs were \$1.9M, compared to the projected expenditure of \$2.3M. The underrun was attributable to a delay in upgrading the ISFSI security system to allow coordination with DCPD to standardize system operations. There was a scheduling adjustment, which moved the HBPP training tracking system into the next triennial filing period as it transitioned to a Quality Database. Further decreasing costs, a weapons simulation system was delayed until after the HBPP decommissioning cleared the needed space.

Overhead costs to maintain the ISFSI included: mandatory PPE for Security Officers; physical, auditory and psychological testing to support Fitness-for-Duty requirements; uniform supplies; arms and ammunition; radio and cellular equipment and service; specialty training; office supplies; and facility cleaning, maintenance and services.

Engineering Services and Support covered outside engineering services for HBPP ISFSI to perform work assigned by PG&E's Engineering Manager. All work was done in accordance with PG&E procedures. Work included level-of-effort support and specific work for processing field drawings and to prepare products such as analyses, reports, design changes, technical evaluations and sketches.



The VBS that was used to control vehicle access to the ISFSI was refurbished to like-new condition. A contractor moved the unit off site, where it was stripped, painted and its decals, plug covers, hinges and hydraulic fluid were replaced. The work was necessary, because the refurbished barrier was incorporated into the latest ISFSI VBS modification. The VBS modification was completed to address a recommendation from the NRC during HB ISFSI's most recent security inspection in August 2014.

An outdated guard booth was removed and replaced with a new bullet-resistant booth, because of concerns stemming from several industrial security-related incidents at HBPP, such as several tears being made in cyclone fencing and the attempted theft of the portable light stanchion located at Gate C.

HB ISFSI entered into a service agreement with the original installer of the Security Electronics System (SES). The agreement was for three years, included software support and made provisions for semi-annual planned maintenance on hardware and software. For assistance in the event of an SES failure, a 24-hour IT phone support hotline was also made available through this agreement.

To prepare and submit a report to the permittee and the CCC, a local environmental engineering firm was hired to perform an annual topographic survey of the bluff slope and adjacent shoreline. Previously-established guidelines had called for a five-year report and directed actions, which would have to be taken if a two-foot or greater movement was detected. If movement outside the decided threshold was detected, then annual surveys would continue beyond the five years. However, the last of the annual surveys was completed in 2017, and the determination was that the slope was within tolerance. As a result, another slope stability survey is not required until 2022.

A portion of the Pan/Tilt/Zoom (PTZ) cameras were replaced, due to failure from age and wear. These PTZ cameras were used for security surveillance activities and required search activities.

A specific mobile testing device was procured for regular testing of the Perimeter Intrusion Detection System (PIDS). It was purchased at the recommendation of an NRC inspector, who performed a security inspection in August 2014. The mobile testing device provided for consistent and repeatable testing of the PIDS.

Two contraband detection and identification systems were purchased to ensure continued effectiveness in screening for potential explosive materials. The previous units used radioactive components to detect contraband and required special care and handling. It was decided that the old units would be sent to DCP. The new units contained no radioactive components. Thus, HB ISFSI, being a stand-alone entity, would not need to bear the responsibility of additional and unnecessary radioactive sources.

A specialty contractor was hired to revise O&M procedures in a four-phase approach. In Phase 1, existing procedures were evaluated against proposed templates and a protocol was established to address shared procedures that contained both NRC §50 and NRC §72 requirements. Phase 2 created a §72 Procedure Set, edited the current HBAP E-4 procedure to transform it into an ISFSI equivalent E-4, drafted an O&M procedure set of scopes and titles to be reviewed and approved by the Nuclear Security Director, drafted a set of O&M procedures conforming to the §72 format, and prepared the history records and License Basis Impact Evaluation (LBIE) screens for approval. Phase 3 involved preparing a training presentation for

staff and affected groups. Phase 4 created a new QA plan that was compatible with the needs of HBPP's ISFSI after the §50 License was terminated.

Dues were paid to the Users Group of the canister manufacturer for continual owner's information and updates regarding maintenance and upkeep. Subscribing to the Users Group allowed participation in semi-annual conferences, where owners of the storage systems meet to collaborate and learn BMPs, bring common technical issues to the manufacturer's attention, share incidental operating experience learned from deploying the systems at respective plant sites and share aging management practices for ISFSI SSC. The Users Group uses conferences as an opportunity to receive technical training directly from the cask system designer. Training topics are on varied aspects of the storage system (e.g., thermal, shielding, criticality, canister processing and license renewal), to build greater understanding of the technology and specific governing regulations amongst the users.

A radio communications company provided replacement equipment and services for existing two-way radios as needed. During this time, twenty-six hand-held radios were replaced. Communication costs included an annual service plan for a satellite communications system to provide fail-proof ability to keep in touch with authorities if conventional networks were down.

The Emergency Response Facility (ERF) is an offsite trailer that houses the means to remotely manage an emergency if Management or Emergency coordinators cannot reach the site or need to evacuate the site. It was an upgrade to prevent communications loss during any ISFSI events. Some of the costs explained herein pertain to the ERF. The ERF will remain in service to respond to any potential HB ISFSI emergencies after the HBPP decommissioning is complete.

Smaller value items to support ISFSI O&M included cleaning services, locksmith services, electrical hardware and supplies, mechanical hardware and supplies, maintenance of the Uninterruptible Power Supply (UPS), relay panel replacements, brush clearing, computer and monitors replacement, a smart board for the conference room, television programming, attentiveness aids, gun range training expenses, cell phone accessories, employee screening services and office supplies.

Permitting fees were paid for the annual CCC's CDP #E-5-001 for monitoring bluff conditions.

Telepresence web conference equipment was installed to facilitate conferences with offsite support organizations that were located primarily at DCP and other PG&E Corporate locations. These conferences included, but were not limited to, HB ISFSI Relicensing meetings, Planning meetings, Quality and Improvement meetings, CAP meetings, Procedure Validations and PG&E Corporate CAP Implementation meetings.

A new sidewalk was installed along the inside perimeter of the HB ISFSI Security Area. The sidewalk was installed to improve the safety of a regularly-traversed path on non-compacted rounded gravel. The graveled area was not originally designed to be a walking surface and was uneven and difficult to traverse. Prior to the installation of the sidewalk, ISFSI personnel had to walk this route to complete their required daily activities, which presented a safety and security hazard in the dark and in inclement weather.

A new set of K-rail barriers, which later comprised a portion of the VBS, were installed on the south side of the HB ISFSI. They were installed to improve safety for ISFSI personnel

performing vehicle inspections, as well as to improve VBS bollards and credited natural terrain. An NRC inspector stated during the August 2014 security inspection, that the bollards and vegetated slope on the south side of the ISFSI may not meet all the desired barrier requirements. The K-rails addressed this concern, directly aligning and complying with NRC barrier requirements. Furthermore, unlike the bollarded areas, the area around the installed K-rails was not a safety hazard for HB ISFSI personnel during wet and dark conditions.

Two 40-foot storage containers were obtained for the storage of HBPP ISFSI required supplies. The HB ISFSI previously depended on several storage locations that were scheduled to be removed as part of the HBPP decommissioning. The HBPP ISFSI installed the two storage containers within the HB ISFSI area. One of the storage containers was utilized for required emergency supplies, based on the HBPP Emergency Plan (Licensing Basis Document). The second storage container was utilized for the storage of tools and equipment, based on HBPP ISFSI O&M activities. Both these containers were also used for protection from inclement weather while conducting security searches. Other than the Primary Alarm Station, the HBPP ISFSI did not have any permanent structures to protect staff from the elements when conducting searches.

### **7.3 ISFSI Staffing / Engineering / Specialty Contracts**

ISFSI staffing costs were those non-Security personnel assigned to support the O&M of the ISFSI. Engineering and specialty contracts costs supported discrete, well-defined missions at the ISFSI. For the 2015 through 2018 period, ISFSI Staffing, Engineering and Specialty Contracts costs were \$1.9M, compared to the projected expenditure of \$3.5M, an underrun of 47 percent. This underrun was attributable to the delay of certain ISFSI infrastructure projects as well as a decrease in the level of specialty engineering contracts.

The communication system between the Humboldt County Sheriff's Office and HBPP Security was upgraded to maintain a level of communication that met NRC requirements.

A procedure specialist was enlisted to coordinate and assist in revising ISFSI procedures to establish its independence from the Unit 3 Decommissioning Project.

A consultant was hired to assist in developing technical briefings, responding to RFIs and assembling backup documentation for completed projects review and the decommissioning project report.

The CWC was enlisted to provide Coastal Access Trail repairs and maintenance in accordance with requirements outlined in the CDP.

An electrical engineering firm supported troubleshooting of electrical and electronic equipment, wrote work instructions for repair or installation, performed quality receipt inspections and performed post-modification testing. This firm also spent two weeks assisting with the turnover of the ISFSI Engineering support to Diablo Canyon Power Plant Engineering.

The annual Independent Management Review (IMR) was also performed by a specialist in ISFSI and nuclear plant reporting. The product included interviews with Management staff, incorporation of comments and issuing a final report in accordance with the Humboldt Bay Quality Assurance Program.

A local general engineering firm had an annual agreement to support ISFSI engineering requirements, including relicensing assistance, ISP-511 inspection records and procedure rewriting, Alkali-Silica Reaction (ASR) concrete evaluation, corrosive soils sampling plan development and execution, VBS design and maintenance support, annual ISFSI concrete inspection and other support activities requirements.

A QA SME was responsible for strengthening the ISFSI Team on regulatory requirements and implementing industry BMPs for quality-related items. The SME also coordinated with the ISFSI Team on establishing quality methodologies, developing training to expand knowledge and assisting with implementing practices to improve the quality culture.

An SME in the Access Authorization Program was hired to perform an independent peer review and evaluation of the Program, to assess compliance with PG&E programs and procedures, with Nuclear Energy Institute's (NEI) implementation guidance and with peer utility sites.

A specialty contractor performed technical analyses to facilitate the license renewal of the ISFSI site-specific license Phase II with the NRC.

#### **7.4 ISFSI Infrastructure Expenses**

For the 2015 through 2018 period, ISFSI Infrastructure Expenses costs were \$1.8M, compared to the projected expenditure of \$5.8M, an underrun of 69 percent. This underrun was attributable to the ISFSI infrastructure projects not being started in the year planned.

An ISFSI monitoring sump was previously abandoned during construction of the Portal Monitor Road. The 4-inch drain line from the sump needed a future access point, as well as drainage system evaluation and environmental soil sampling outside the ISFSI protected area. The on-site CWC did the civil work and a CWC environmental consultant performed the hand borings and soil analysis.

Site support was provided by the CWC performing decommissioning of HBPP, and included manpower, operators and equipment such as forklifts and cranes, when needed. This equipment was required for periodic maintenance troubleshooting of security systems; support from Electrical Engineering; utilization of forklifts for K-rail movement; moving and installation of storage containers; support during the ISFSI Relicensing Lid Lift Activities; movement of the VBS for refurbishment; removal and replacement of Building 11 AC unit; and removal of riprap on the slope to identify HB ISFSI drain pipe terminus, etc.

One of the existing consulting companies was engaged to prepare the ISFSI licensing renewal plan and participate in NRC and other industry activities. They assembled ISFSI monitoring results and operating experience, prepared an Aging Management Program (AMP) gap assessment, issued seven Time-Limited Aging Analysis (TLAA) Evaluation Reports, prepared presentation and supporting documents to hold a License Renewal Pre-Application Meeting and other activities as directed by the PG&E Technical Coordinator.

This same consultant also prepared and conducted a license renewal-lead inspection and finalized the inspection package as part of the submittal for the license renewal of the HB ISFSI site-specific license.

The provider of nuclear waste storage canisters (aka casks) was engaged to answer various inquiries from ISFSI Management, including relief device, rupture disks and torque values.

## 7.5 NRC Permits and Fees

For the 2015 through 2018 period, NRC Permits and Fees were \$174K, compared to the projected expenditure of \$183K.

The NRC is statutorily required by Congress to recover most of its budget authority through fees assessed to licensees. Most of these costs were for the triennial inspection of the site and the ensuing written reports, examining the "Assurance of Funding" letter, Emergency Plan review and Security Plan review, a records exemption request, reviewing the Decommissioning Funding Plan and Background Security L Clearance checks. These were performed in 2015 through 2017. The time billed was approximately 184 hours, at the current NRC labor rate of \$268 per hour.

## 8 SECTION INTENTIONALLY OMITTED

## 9 CAISSON

A Caisson is defined as a water-tight structure used as a foundation, or to carry out work underwater. Caissons have been used for centuries as building foundations and occasionally as structures housing activities such as garages and pump stations. In the case of HBPP Unit 3, the Caisson was a first-of-its-kind structure to house a nuclear containment structure, pressure suppression chamber, bio-shield wall surrounding an RPV and nuclear steam supply system below grade. The advantages of this structure included additional radiological shielding and because the structure was below grade, external pressure provided by the soils would assist with suppression in the event of an accident.

Normal seismic activity over the years created non-structural fissures in the Caisson walls and compromised the water tightness of the Caisson structure, resulting in groundwater in-leakage and potential migration paths out of the structure for radioactive material. As a result, PG&E committed to excavation and removal of the below-grade Reactor Caisson structure as part of the decommissioning project, to assure that all reasonable efforts would be employed to assess and remove legacy radiological contaminants from the soil below the site's power block structures. The technical issues that drove the final decisions regarding removal of the Caisson included the inaccessibility of sample locations to measure neutron activation products within the Caisson structure, as well as the inability to verify that internal residual radioactive contamination levels would meet final site release criteria.

**Table 9-1, Caisson**

2015 NDCTP ID		Approved NDCTP Estimates		Amount Spent Presented for Reasonableness		
		Base	Nominal	2012-2014	2015-2018	Total
E.4.5	Caisson	197,923,424	211,278,376	9,194,034	141,816,081	151,010,115
E.4.5.2	2012 NDCTP CPUC Filing	65,245,822	69,346,787	9,194,034		9,194,034
	Field Work (Civil Works Contract)	58,556,128	61,976,019	9,194,034	-	9,194,034
	Slurry Wall/CSM Wall	58,556,128	61,976,019	9,194,034	-	9,194,034
	Waste Disposal	4,883,412	5,380,589			
	Packaging / Material Handling	1,806,283	1,990,179			
	2015 NDCTP CPUC Filing	132,677,602	141,931,590		141,816,081	141,816,081
	Field Work (Civil Works Contract)	77,189,053	81,405,385	-	80,613,876	80,613,876
	Caisson	61,833,344	65,359,258	-	68,261,967	68,261,967
	Slurry Wall/CSM Wall	12,641,528	13,211,889	-	10,575,080	10,575,080
	Dewatering	2,714,181	2,834,238	-	1,776,830	1,776,830
	Project Staffing	17,643,186	18,869,164	-	13,231,648	13,231,648
	Waste Disposal	23,313,034	26,205,862	-	35,092,897	35,092,897
	License Termination Survey	4,189,348	4,486,368	-	5,398,254	5,398,254
	Tools & Equipment	1,253,037	1,301,563	-	763,662	763,662
	Other	9,089,943	9,663,248	-	6,715,743	6,715,743
	RP Discrete	1,338,207	1,425,435	-	1,498,091	1,498,091
	Specialty Contracts	6,887,232	7,312,073	-	4,990,147	4,990,147
	Specialty Contracts	5,274,446	5,586,229	-	3,988,979	3,988,979
	Environmental Contracts	1,250,386	1,340,034	-	921,147	921,147
	Specialty Permitting	362,400	385,810	-	80,020	80,020
	Small Dollar Vendor	864,504	925,740	-	227,505	227,505
	Small Dollar Vendor	864,504	925,740	-	227,505	227,505

Actual costs during 2012 through 2014 presented for review for Caisson were \$9.2M. Actual costs 2015 through 2018 were \$141.8M compared to the approved cost estimate of \$141.9M.

## 9.1 Field Work

In the 2012 NDCTP, the CPUC approved PG&E's planned method to remove the entire Caisson based on a 2012 Caisson Removal Feasibility Study (FS) by a specialty contractor. In the 2015 NDCTP, the CPUC approved PG&E's revised estimate, which was based on a methodology change for removal.

It was clear that removing the underground Caisson required a means to isolate the work area from the groundwater to work at the depths identified. Prior to and over the lifespan of the plant, numerous geological studies were conducted that identified site stratigraphy. This stratigraphy identified a contiguous dense clay layer designated as the Unit F Clay, which extended across the entire site at roughly 165 feet BGS. Site hydrology studies indicated that due to relatively low permeability, the clay layer could be used to form the bottom of a water-isolation structure.

Isolation of the Caisson for removal required SOE and water cutoff structures. These features allowed for a dewatered excavation of the cylindrical Caisson structure that housed the below-grade reactor vessel, operating components and the SFP. Multiple designs were considered and evaluated and ultimately, PG&E and the CWC decided to install a multi-feature CSM wall.

PG&E worked with industry experts to develop a conceptual design and compile a cost estimate, utilizing the results of the 2012 Caisson Removal Feasibility Study. The conceptual approach included installation of a cement-bentonite water cutoff wall. The original CW contract



endorsed this conceptual approach and PG&E directed the CWC to evaluate and implement the concept. The CWC's detailed analysis and evaluation found technical implementation issues with the conceptual design, which precluded its practical implementation at HBPP. Many alternative options were developed and analyzed. PG&E and the CWC worked together to agree on a final design, the CSM wall.

The scope for Caisson field work included designing shoring and the cutoff wall, pre-trenching, installing the CSM wall, dewatering, excavating and removing the Caisson and backfilling. CSM wall design, pre-trenching and CSM installation are discussed in the following subsections. Dewatering and Caisson removal are discussed in Sections [9.1.9](#) and [9.1.10](#).

### **9.1.1 Feasibility Study (FS) and Design Approach**

Prior to issuing the CW bid documents, PG&E contracted an FS to determine what methods would be required to remove the underground Caisson structure. The 2012 FS provided a "proof of concept" level analysis and plans for the Caisson excavation and demolition, consisting of the following SOE elements:

- Cement bentonite slurry wall to minimize groundwater infiltration, supporting a dry excavation;
- Sloped soil nail wall for support of the upper excavation; and
- Sheet pile wall and ring beam shoring system for support of the lower excavation.

The FS considered lateral movement of the studied excavation system and potential settlements resulting from the installation of the system, with particular attention to the adjacent HBGS.

The CW contract originally proposed to use the October 2012 HBPP Caisson Removal Feasibility Study approach to install cement-bentonite, backfilling a slurry wall trench excavated to an average depth of 170 feet and tied into the Unit F clay layer, which was found to be located up to 181 feet below grade. The FS approach for SOE included the installation of a 90-foot diameter shoring system with eight separate levels of ring beam steel reinforcement deep shoring components to El. -79 feet. Once the Unit 3 Caisson and tremie pad concrete were removed and FSS was completed, the shaft was to be backfilled to +12 feet elevation in lifts. As backfilling operations progressed, ring steel reinforcement was to be removed.

### **9.1.2 Evaluation of Alternative Industry Technologies**

The original concepts for Caisson removal were suspected to be technically flawed, leading the CWC to evaluate a number of alternative methodologies and technologies to accomplish their work scopes. Within the realm of regulatory mandates, PG&E was supportive of the CWC's attempts at innovation and optimization of work execution. PG&E's supportive oversight was a positive influence by promoting issue resolution, utilizing a risk cause and consequence approach that provided feedback quickly to the CWC Team.

The CWC presented numerous options to the HBPP Management Team, studying and vetting alternate technologies and viable execution sequencing. This time- and labor-intensive effort eventually paid off with a streamlined execution strategy, which contributed to maintaining the overall decommissioning schedule of the project previously filed. The end result was the

optimal execution of the work scope and space, in many cases allowing concurrent work activities on multiple work fronts.

The primary industry technologies and methods considered for use at HBPP were Slurry Wall, Soil Nail Wall, Freeze Wall, Sheet Pile, Ring Reinforcement and the CSM Wall.

#### **9.1.2.1 Slurry Wall**

Slurry wall technology generally involves construction of an underground barrier cutoff wall with structural and/or low-permeability characteristics. Specialized equipment, including long-reach excavators, clamshell buckets and hydromills, are typically used to construct a slurry wall. A trench is excavated to a required depth and filled with a mixture of bentonite and water in engineered proportions to achieve the design function. During excavation, the trench is filled with a slurry of bentonite and soil to prevent the excavation from collapsing. The slurry is displaced by the bentonite wall material, which is tremied into the trench in a start-to-finish, continuous operation. The displaced natural soils from the installation process must be managed as spoils. This approach was in the CW bid specification and part of the CWC cost estimate. A nationally recognized industry leader in design and installation of slurry walls was consulted for the cutoff wall and dewatering aspect of the FS. The CWC subsequently subcontracted this design and installation to advance the slurry wall design and installation planning.

For the decommissioning project, the slurry wall had a singular function: a non-structural wall to minimize groundwater inflow to the Caisson excavation, allowing dewatering within its alignment, resulting in dry demolition and removal. The deep excavation also required a structural shoring wall to prevent collapse of the excavation walls.

PG&E sponsored a slurry wall operation tour for key project personnel to one of the specialty company's large-scale, in-progress slurry wall projects in Rocanville, SK, Canada. The strategy was to gain insight to construction issues, challenges and/or success aspects of this specialized technology. The Rocanville project was a miles-long cutoff wall to surround a potash mine tailings site to prevent salts from migrating into the drinking water source of the surrounding area.

#### **9.1.2.2 Soil Nail Wall**

Soil nail walls are patterned steel reinforcing tendons anchored (grouted) in the earth and mechanically connected with a concrete grout face (shotcrete) to produce a coherent support matrix. Soil nail walls are widely used in the construction industry to provide permanent slope stabilization and earth retention in deep excavations. They are engineered systems, allowing safe slope stabilization for steep excavations and embankments and are widely used on highways, railroads and deep structural foundations.

The FS proposed a soil nail wall as a key element for the Caisson excavation and removal. The technology is prevalent for specific applications and there are several recognized specialty contractors, who could have installed the nail wall. A successful nail wall installation requires specific soil characteristics and sufficient space to achieve the desired result.

### 9.1.2.3 Freeze Wall Technology

Early decommissioning feasibility studies suggested use of an industry-specialized freeze wall technology and industry-standard sheet piling to achieve a deep, dry excavation. This would involve installation of a deep piping grid similar to a radiator, through which liquid coolant circulates continuously. This approach was considered, but rejected due to the enormous cost for a functional installation at the scale required for Caisson removal. Additionally, the use of a freeze wall concept applied to brackish groundwater would challenge the ability to freeze the water.

### 9.1.2.4 Sheet pile

Sheet pile walls are widely used in construction for excavation shoring and dewatering applications. Sheet piles are formed structural steel sections with interlocking edges. The sections are installed in sequence to form continuous wall sections. The maximum section length is approximately 100 feet, and highway transportation permitting in northern California restricts trucking load lengths at approximately 60 feet. Welding sections together on site, end-to-end to achieve the longer section length needed to reach the F Clay layer, was deemed impractical when compared to other methods of excavation stabilization. The FS proposed sheet piling to provide excavation shoring from approximately El. -30 feet to El. -74 feet, with a soil nail wall providing reinforcement from El. +12 to El. -30. The FS also included a concept to install cast-in-place concrete ring beams at approximately 10-foot vertical spacing on the inside face of the sheet pile wall to provide lateral support to the steel sheet pile wall. The sheet pile length limitation would have required a 42-foot deep excavated bench surface to support the sheet pile installation equipment. Additionally, the refusal depth had been found to be approximately 52 feet in the dense clay mixture. To drive sheets deeper than 52 feet would have required out-sized thickness and very large specialized equipment.

As an alternative to the concrete reinforcement ring concept, multiple steel rings were also considered as the sheet pile reinforcement. It was determined the concrete was more feasible from an installation and cost standpoint. Under this scenario, the SOE would require removal of the ring reinforcement and the sheet pile. Although the sheet pile could be removed after backfilling was complete, ring removal would have to progress from within the excavation as it was completed. This would have posed unacceptable safety risks to workers inside the excavation and was therefore rejected as an option.

### 9.1.2.5 CSM Wall

CSM is a method for constructing cutoff walls, earth retaining walls and foundation elements by which self-hardening slurry is mixed with native soil, using a modified trench cutter technique. The CSM method provided groundwater control comparable to that of a slurry wall. Mixing soil in place and using it in the resulting slurry wall is estimated to decrease the spoil volume compared to traditional slurry walls, allowing stockpile areas to be minimized. The method uses in-situ soil as a construction material. This operation can use either a cable-hung CSM hydromill or a fixed-mast hydromill. The cutter head and mixing wheels in a cable-hung hydromill are suspended by cables and susceptible to drift, influenced by soil density and random rocks and cobbles in the gravel stratum below grade. The fixed-mast CSM hydromill has an advantage over the cable-hung hydromill in that the cutting heads are mounted to a rigid bar (mast) and can be hydraulically adjusted for verticality via computer control.

Before starting the cutter operation, the mud pump of the hydromill cutter head is fully submerged in the bentonite slurry. The cutter head is then positioned along the proper X and Y axis of the trench. The mixing tool is driven into the ground at a continuous rate. The soil matrix is broken up by the cutting wheels and at the same time, a fluid is pumped to the nozzles set between the cutting wheels, where it is mixed thoroughly with the loosened soil.

A water/bentonite clay mix is pumped to nozzles set in the cutting wheels, where it is mixed thoroughly with the loosened soil. After reaching the wall's design depth, the cutting/mixing tool is slowly extracted while binding agent is continuously added. The components of the binding agent commonly used in the construction of CSM panels are cement and water. A portion of the in-situ soil is incorporated into the mixture, and the excess soil is ejected from the process. Homogenization of the fluidized soil mixture with the binding agent is accomplished in situ by the rotation of the wheels of the drill rig. One panel at a time is installed, either continuously in a row, or in case of sequencing issues, the rig can be moved to a different location and it can pick up where it left off.

If a circular shoring design is used, the external water pressures cause a uniform circular compression load by design, being stronger than the imbalanced load imposed by the perimeter wall (slurry wall) cutoff recommended in the FS.

### **9.1.3 Design Development**

During the slurry wall design phase, the slurry wall contractors continued to revise the planned installation approach. In the course of design development, the slurry wall contractor expressed concern that tight vertical tolerances could only be met with great effort, potentially affecting cost and schedule. The slurry wall contractor ultimately proposed a combined clamshell bucket and hydromill approach to install slurry wall panels and continued planning that approach.

The CWC was concerned that the perimeter slurry wall and the proposed deep shoring components were analyzed as separate components, rather than collectively as a system. These concerns were compounded after observing slurry wall operations at the project in Rocanville, SK. The team observed overspray that would cause difficulties in complying with environmental regulations, due to the proximity of the wetlands surrounding HBPP, as well as having the potential to impact HBGS operations. The CWC expressed concerns regarding the slurry wall contractor's ability to control verticality and the technology's increased difficulty in addressing cross-contamination concerns and environmental SWPPP requirements at HBPP.

The CWC and PG&E reevaluated the design approach outlined in the original proposal and in the awarded CW contract. As the CWC further developed design plans, an option to complete the perimeter wall with CSM technology was developed. A specialty contractor described the CSM process as a modified trench-cutter technique, to be used for both perimeter groundwater cutoff and for Caisson demolition SOE.

The contractor proposed several variations for three key support elements:

- The perimeter cutoff wall (slurry wall);
- The dewatering well system; and
- The Caisson SOE shoring system.

The CWC decided to initiate a parallel path with a CSM specialty contractor, who was retained to analyze the FS approach and previously-identified options. The analyses confirmed that the perimeter slurry wall and deep shoring option in the FS would only work if the slurry wall was more than 100 feet from the deep shoring. This distance was needed to reinforce the slurry wall against external hydrostatic water pressure. If the slurry wall was installed less than 100 feet from the SOE, there would be risk of hydrostatic buckling. However, because of existing site space constraints, the slurry wall could not be moved from the location identified in the FS. Additionally, a thorough analysis of the slurry wall FS by independent engineering companies determined that the system would not have stayed within the available footprint within the proposed alignment of the slurry wall.

The CSM contractor evaluated and confirmed that hydrostatic pressures at depth were too great to allow installed CSM shoring to be removed as the excavation was backfilled to the surface. The CSM specialty contractor also determined a circular wall configuration was necessary to withstand the external water pressure compression loading. CSM alternatives that did not include ring steel were considered. Ultimately, PG&E received state regulatory confirmation that CSM materials could remain in place. The CSM approach also offered construction flexibility not offered by the slurry wall approach. Because the CSM wall was constructed by overlapping individually mixed and cured panels, installation could be completed panel-by-panel. This type of installation was not sequence-specific, so CSM equipment could be moved as other demolition activities required space, specifically the RFB and the LRWB demolition. In contrast, the slurry wall approach required continuous installation once started, requiring the demolition of the RFB and the LRWB, as well as extensive site grading before slurry wall construction could commence.

A geotechnical investigation of the new footprint for the CSM approach was necessary to complete the final design. This investigation defined the tie-in Unit F clay layer 10 feet higher in this area than in the slurry wall footprint.

PG&E also considered the proposal to apply the CSM method in lieu of a slurry wall. The CSM method would provide groundwater control that was equal to or better than the slurry wall, and the specialty contractor's experience showed that the CSM method was equally cost-effective and environmentally advantageous. Mixing soil in place and using it in the resulting CSM wall was thought to decrease the spoil volume, as compared to traditional slurry walls, thereby allowing stockpile areas to be minimized.

The CWC and PG&E ultimately selected a final design, including installation of a 110-foot diameter, by 13-foot thick CSM SOE system, consisting of five concentric, overlapping rings (containing no ring steel), with the outside ring tied into the Unit F clay layer. Figure 9-1, CSM Wall Vertical Configuration, shows the CSM wall vertical configuration relative to the Caisson and the Unit F Clay layer. Figure 9-2, CSM Wall Footprint, shows the CSM wall footprint relative to other buildings.



Figure 9-1, CSM Wall Vertical Configuration

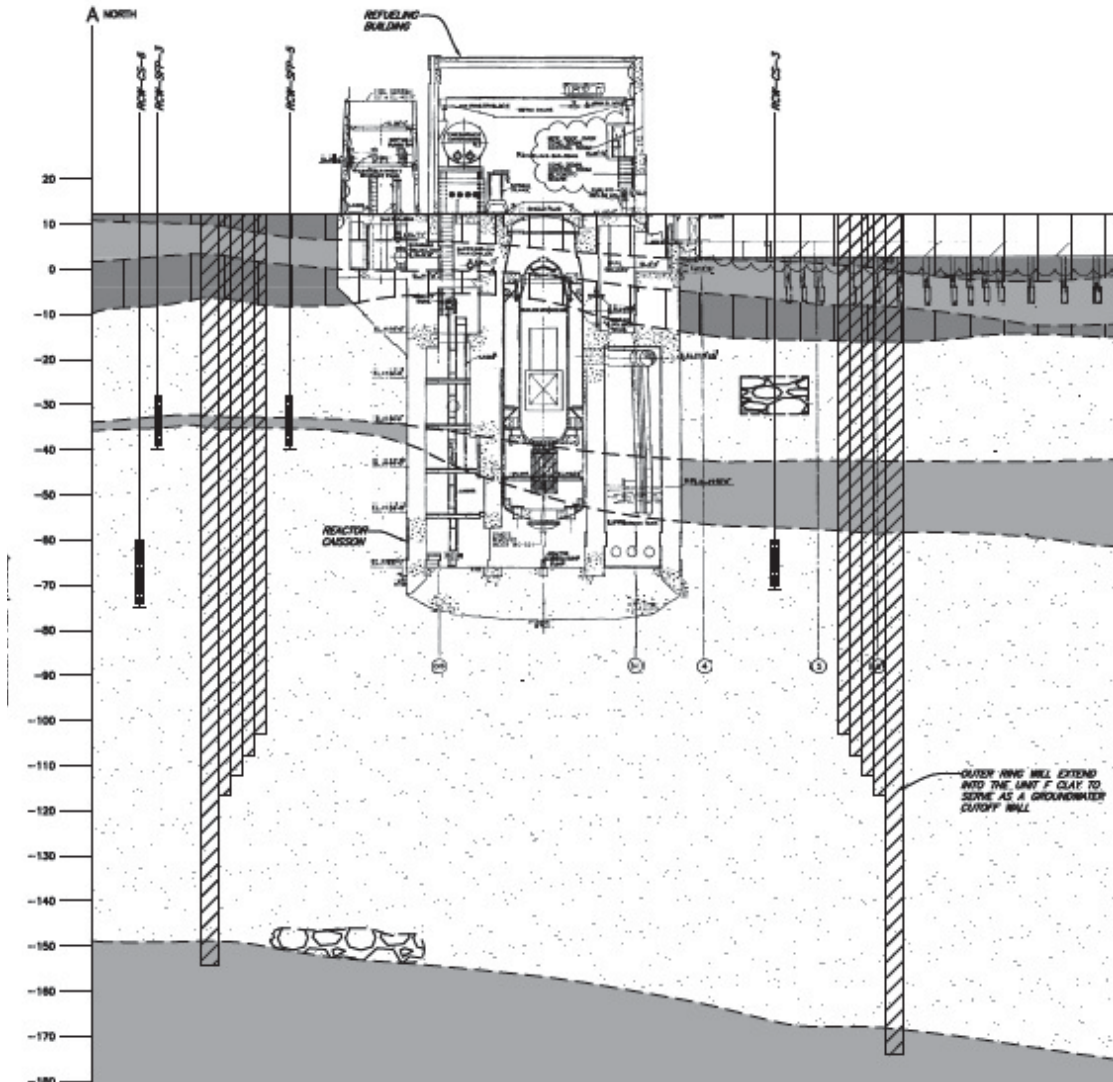
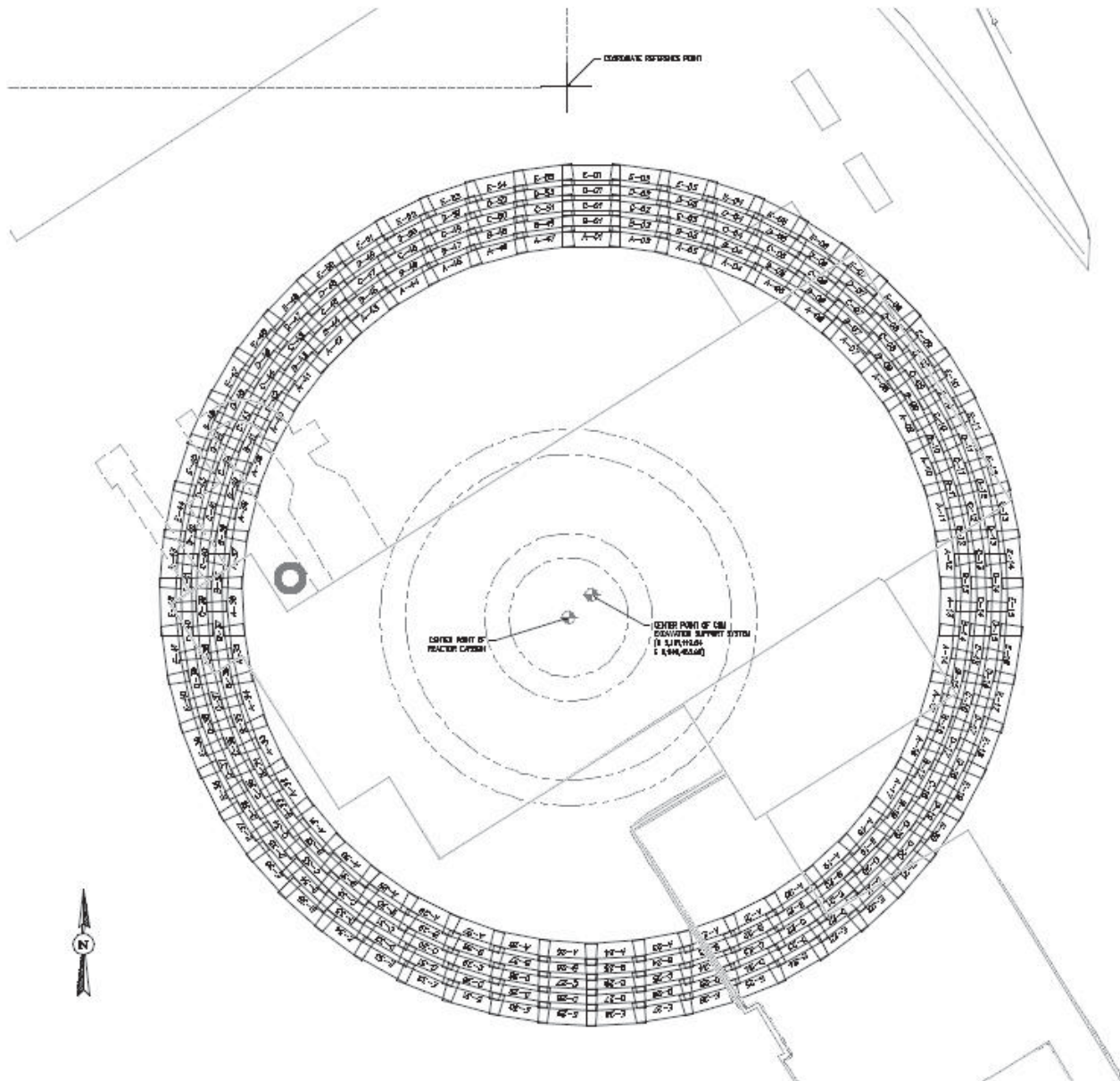


Figure 9-2, CSM Wall Footprint, shows the CSM wall footprint relative to the Caisson and other structures.



Figure 9-2, CSM Wall Footprint



**Table 9-2, Comparison of the Slurry Wall to CSM Wall Designs**

	Slurry Wall Conceptual Design	CSM Final Design
<b>Shape</b>	Coffin-shaped	Circular
<b>Installation</b>	Continuous from start to finish	Panel-by-panel with sequence flexibility
<b>SOE</b>	<ul style="list-style-type: none"> <li>sloped soil nail wall for support of the upper excavation; and</li> <li>sheet pile wall and ring beam shoring system for support of the lower excavation</li> <li>must be at least 100 feet from slurry wall</li> <li>SOE removed during backfill</li> </ul>	<ul style="list-style-type: none"> <li>CSM concentric overlapping rings</li> <li>uniform circular compression load by design</li> <li>SOE left in place</li> </ul>
<b>Water Cutoff</b>	<ul style="list-style-type: none"> <li>Cement bentonite slurry extending to the Unit F Clay layer</li> <li>Comparable water cutoff to that of CSM wall technology</li> </ul>	<ul style="list-style-type: none"> <li>self-hardening bentonite and cement slurry mixed with native soil</li> <li>comparable water cutoff to that of slurry wall technology</li> </ul>
<b>Thickness</b>	Approximately 5 feet	Approximately 13 feet
<b>Spoils</b>	All soil excavated during slurry wall construction to be treated as spoils	A portion of soil is mixed with slurry, resulting in less spoil volume than the slurry wall design
<b>Equipment</b>	<ul style="list-style-type: none"> <li>Long-reach excavator</li> <li>Clamshell</li> <li>Hydromill</li> </ul>	<ul style="list-style-type: none"> <li>Hydromill</li> </ul>
<b>Site Footprint</b>	<ul style="list-style-type: none"> <li>676 lineal feet</li> <li>28,500 square feet encompassed area</li> </ul>	<ul style="list-style-type: none"> <li>430 lineal feet</li> <li>9,500 square feet encompassed area</li> </ul>
<b>Depth for Water Cutoff</b>	Approximate average 170 feet	Approximate average 165 feet
<b>Dewatering</b>	<ul style="list-style-type: none"> <li>Approximately 2.9 million cubic feet</li> <li>Four dewatering wells</li> <li>Maintain dry excavation by dewatering at 50 gpm</li> </ul>	<ul style="list-style-type: none"> <li>Approximately 1 million cubic feet</li> <li>four dewatering wells</li> <li>Maintain dry excavation by dewatering at 20 gpm</li> </ul>
<b>Environmental Impacts</b>	<ul style="list-style-type: none"> <li>Clamshell operation would require more BMPs and spoils controls</li> <li>Higher volume of water used during installation process (not recycled)</li> </ul>	<ul style="list-style-type: none"> <li>Spoils and slurry remain inside trench</li> <li>Most water used during installation process is recycled</li> </ul>
<b>Schedule Impacts</b>	<ul style="list-style-type: none"> <li>The RFB, Turbine Building foundation, and the LRWB demolition needed to be complete prior to start of slurry wall</li> </ul>	<ul style="list-style-type: none"> <li>The RFB, the LRWB and portions of the Turbine Building foundation demolition could occur simultaneously with CSM installation</li> </ul>
<b>Personnel Safety</b>	More man hours required inside the excavation to support ring steel construction and ring steel removal as backfill was completed inside the excavation	More man hours required during construction but fewer hours required inside the excavation

As can be summarized from this chart, the key advantages to the CSM wall as compared to the Slurry wall are:

- Smaller footprint;
- SOE left in place;
- Smaller quantity of spoils;
- Smaller volume for dewatering requirement;
- Less water used in installation;
- More flexible installation schedule, which allowed for multiple projects to be occurring at the same time and shorter overall schedule duration; and
- Fit within site footprint.

#### 9.1.3.1 PG&E Vetting of the Final Design

The HBPP project provided oversight to vet seismic criteria and design integration of the water cutoff wall with the deep shoring of the excavation cutoff wall system. Early in the design phase, Project Teams from HBPP and the primary contractor visited two sites to benchmark the project and to evaluate appropriate means and methods for similar work to be performed at HBPP. Appropriate independent oversight was implemented by HBPP through its SMEs.

HBPP made use of its SMEs, Engineering and Consultant staff to assess, evaluate and document positions on significant technical issues. This ensured alternatives were being addressed and any alternate approaches were appropriately evaluated.

During the development of the design, HBPP Risk Analyst met with the Project Team to provide an overview of the PG&E risk comparison initiative, explaining its importance and specifics of the Caisson removal project.

Key technical benefits of the CSM wall design, which were discussed at this meeting and later realized upon construction, were:

- The integration of the water cutoff wall with the deep shoring validated the final design configuration of the dual-feature system. Use of a single specialty contractor instead of two, required only one learning curve with respect to embracing work safety on site.
- The 13-foot CSM wall design did not rely on ring beams. Although more man-hours were spent installing the CSM, fewer man-hours were spent inside the excavation, which reduced risk to personnel.
- The combined circular deep shoring and cutoff wall system reduced the quantity of deep drilling work, as compared to the originally-planned coffin-shaped slurry wall. For the combined system, approximately 430 feet of wall extended down to the Unit F clay layer, and for the full perimeter wall (slurry wall) alignment, 676 feet of wall extended to the Unit F clay layer, saving approximately 246 feet of wall installation.
- Groundwater isolation was limited to the circular CSM shaft geometry and focused on only dewatering the Caisson for removal, reducing the overall volume of water requiring management (and potentially treatment), as compared to the coffin-shaped slurry wall design.

#### 9.1.3.1.1 **Benchmarking**

In 2012, key decommissioning project personnel benchmarked the slurry wall technology at a large-scale, in-progress slurry wall project. A specialty company in Rocanville, SK, Canada, was in charge of the project. The HBPP strategy was to gain insight into construction issues, challenges and/or success aspects of this specialized technology. The Rocanville project was a miles-long cutoff wall to surround a potash mine tailings site to prevent salts from migrating into the drinking water source of the surrounding area. The project had excellent safety records and was accomplishing its mission for wall installation successfully. Based on the results of the benchmarking trip, in-depth investigation of the technology, and a comparison of the technology to the HBPP needs the FS performed in 2012, the initial recommendation was to proceed with the slurry wall technology at HBPP.

As the detailed on-site vetting of the final wall design proceeded, technical issues were identified, which caused Management to reconsider the slurry wall option. The CSM wall technology was considered as one of the alternatives. A CSM contractor invited the Decommissioning Management Team to witness one of their CSM wall projects in Los Angeles, California.

In September 2014, HBPP key personnel took a site tour of the CSM operation for the LA Metro Expo line extension in Los Angeles. The specialty company had two mixing rigs drilling panels 98 feet deep for rectangular SOE walls for the launch of TBMs and support of traffic decking across Crenshaw Boulevard. Prior to starting production, the specialty company had successfully mixed test panels to a depth of 120 feet, which was about the limit of the two drilling machines available at the time. Bigger rigs that could reach 140 feet to maybe 160 feet were available, if needed.

On one side of the street, the drill rig was set up to drill between the tracks (not a conventional configuration), due to site constraints caused by traffic and sidewalk configurations. On the opposite side of the street, the rig was drilling sideways (conventionally), which allowed the full weight of the counterweight to counteract any lurching of the drill string. The mixing plant was setup down the street from the drills (about 700 feet to 1000 feet of pumping for fresh slurry) and was surprisingly operating very quietly. A sieve shaker and a centrifugal cyclone were used to separate fines sucked up with vacuum trucks and produced relatively clean spoils. The vacuum trucks were staged right at the mixing operation to suck up slurry spoils from the cutting action and kept the site clean and tidy.

The specialty contractor effectively and efficiently installed a CSM wall along a busy thoroughfare corridor. The cleanliness of the operation was immediately evident to the HBPP Team and the CSM contractor's ability to operate their equipment without closing the street to vehicular and pedestrian traffic bode well for the similar active, space-constricted footprint at HBPP. The HBPP Team recommended further research into the CSM wall technology as an alternative to the slurry wall.

#### 9.1.3.1.2 **Management Review**

The CWC petitioned HBPP Management for approval to change the FS approach for water cutoff from oblong slurry wall technology to circular CSM wall technology. The CWC examined ten different water cutoff and shoring wall configurations and presented details of three with

advantages and disadvantages to each. After several vetting iterations, which involved input from PG&E Corporate SMEs and outside SMEs, HBPP agreed to the five-concentric-ring, circular, combined water cutoff and excavation shoring wall configuration.

This vetting iteration was accomplished by a large number of question/answer submittals back and forth to the CWC, requiring personnel resources to address and provide resolution. This led to three key support elements, including the perimeter cutoff wall, the dewatering well system and the Caisson deep shoring and cutoff wall system. The proposed alternatives brought many enhancements to the design and to integration of the work to be executed. Contractor personnel presented their ideas to HBPP Management. They evaluated the proposed approach, benchmarked the change against other similar projects in the country and vetted the proposed change with the project risk profile. Based on safety and schedule enhancements, HBPP ultimately accepted the CWC's proposal.

#### 9.1.3.1.3 Risk Assessment and Management

Risk identification, assessment and mitigation is an effective management tool on any project and PG&E used this process to facilitate project decisions. The process involved grading the likeliness of occurrence, the magnitude of the impact to the project costs and listing the prescribed measures to mitigate the occurrence and/or severity.

One substantial risk to the CSM wall approach was equipment size. There was no existing fixed-mast CSM equipment capable of reaching the required depth of 170 feet necessary to key into the Unit F clay layer for water cutoff, while remaining within design vertical tolerance. The CSM contractor was familiar with and had used BG-40 fixed-mast hydromills to install CSM walls to a depth of 130 feet on other projects. They proposed to use a BG-40 model for part of the CSM wall installation. The equipment manufacturer also advised the CSM contractor that a mast could be designed and fabricated, and one of their BG-50 machines could support the mast required to install panels to approximately 170 feet deep. The equipment manufacturer advised the CSM contractor that a BG-50 machine could also be fabricated with an extended rigid Kelly Bar mast and shipped to meet the CWC's schedule requirements.

The lead time for design, production and shipping was approximately eight months, and the scheduled start date for the CSM wall was about eight and one-half months out, pressing a decision to procure the BG-50 to comply with the project's baseline completion schedule.

Another risk for the CSM wall installation was the uncertainty of accurate panel alignment at a 170-foot depth. With a cable-hung CSM hydromill, the cutter head and mixing wheels are suspended by cables and susceptible to drift influenced by soil density and random rocks and cobbles in the gravel stratum below grade. The proposed fixed-mast CSM hydromill had a clear advantage over the cable-hung hydromill in that the cutting heads were mounted to a rigid bar (mast) and could be hydraulically adjusted for verticality via computer control.

#### 9.1.3.2 Final Design

The CSM wall was a cylindrical cementitious structure encircling the Reactor Caisson to allow excavation in nearly dry conditions. The CSM wall was constructed by in-situ mixing of native soils, bentonite and cement in two hundred and fifty-five individual overlapping rectangular panels, forming five concentric rings. The CSM rings were installed to specific design depths, allowing for excavation to a depth of 96 feet.



The inside ring had a diameter of 110 feet and was centered near the Unit 3 reactor Caisson. The elevation at the highest point of the wall was EL. +9.5. The inside ring extended to a depth of 106 feet. The depths of the three adjacent rings increased by 4 feet for each successive ring. The fifth ring was the outer-most ring and in addition to supporting the inner rings, it also served as a deep shoring and a groundwater cutoff ring, keyed into the Unit F clay layer. The outer ring's depths varied around the wall, based on the geotechnical boring investigation, with the deepest depth at 173 feet. A water cutoff wall keyed into the Unit F geological clay layer, formed a "contained" structure, allowing for removal of the groundwater inside the CSM wall via conventional dewatering wells. A cross section of the ring structure is shown in Figure 9-3, Cross Section of CSM Installation.

As installed, each of the five rings was nominally 3.2-foot thick, but the panels were overlapped, which reduced the overall wall thickness to approximately 13 feet throughout. The bottom of the Reactor Caisson structure was approximately 80 feet BGS and the bottom of the inner shoring ring was approximately 106 feet BGS. Each successive shoring ring stair-stepped down in 4-foot increments, to a depth of 118 feet.

Technical challenges to the coffin-shaped wall configuration and physical challenges to installation of the slurry wall paved the way to the round wall configuration within the original slurry wall alignment. The area encompassed by the original slurry wall proposal was 28,500 square feet. In contrast, the final design for the circular CSM wall encompassed 9,500 square feet. This was of considerable savings in time and material, which gave more room for other decommissioning field work, while allowing just enough room to efficiently remove the Caisson.

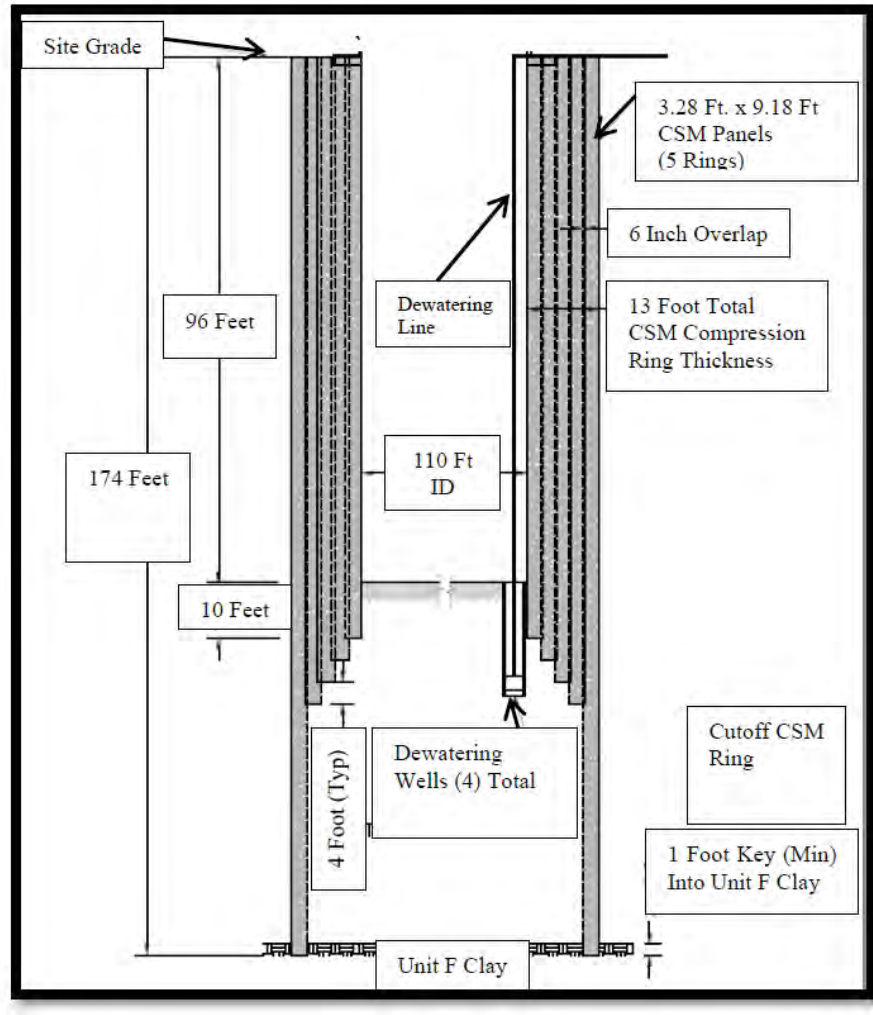
Four 126-foot deep dewatering wells located inside the deep shoring system allowed for dewatering, providing for dry excavation of deep structures. Four open-tube piezometers were installed inside the CSM deep shoring and cutoff wall and four vibrating-wire piezometers were installed outside to monitor groundwater during excavation and backfill operations. Additionally, four inclinometers were installed outside the CSM deep shoring and cutoff wall system to monitor mass ground movement.

At approximately a 170-foot depth, the CSM wall installation was a first-of-its-kind installation next to an environmentally-sensitive bay front. Overcoming the myriad challenges of emergent issues and the coordination of numerous support task activities required the skills of many different professionals.

Challenges included weather conditions (unusually large amounts of rainfall), close proximity to an operating power station and demanding regulatory permit conditions. A significant number of dissimilar work activities performed by multiple contractors on the small, congested work face footprint provided both technical and safety challenges. The project was completed without any lost-time injuries, only minor first-aid incidents and no environmental violations.



**Figure 9-3, Cross Section of CSM Installation**



Site Grade surrounding CSM= El. 9.5.

A top view of the panels comprising the ring structure is shown in Figure 9-2, CSM Wall Footprint.

#### **9.1.4 CSM Technical Specification**

The CW contract required the CWC to prepare the final design, develop an implementation plan, develop specifications, prepare work plans and complete all work for slurry wall construction. Additionally, the CWC was required to determine the actual construction method and excavation sequence for all primary and secondary panels.

With the technology change from slurry wall to CSM walls, a technical specification was needed. The CWC developed the initial specification in collaboration with the CSM specialty contractor and Designer of Record (DOR), based on similar CSM project specifications previously used in the construction of CSM projects throughout California. Elements of the slurry wall specification were adopted for the outermost ring of the CSM wall, considered the cutoff wall.

#### 9.1.4.1 Safety Requirements

PG&E's primary focus is on worker safety. To maximize safety margins, HBPP requested a Safety Factor (SF) of 3 on the final wall strength in the CSM wall specification. The design also considered an evaluation of a hundred-year seismic event during the Caisson demolition and excavation. DOR calculations for hydrostatic forces outside the wall outlined the CSM compressive strength requirements for an SF of 3 per depth of excavation. Specifically, strength requirements increased from the upper elevations as the depth increased. Based on the assumption that the CSM panels were homogenous, the specification aligned with the strength required at the greatest depth of excavation.

In order to achieve a SF of 3, the design CSM mix above El. -94 required an average a compressive strength of 1,000 psi (measured in 56-day cured wet grab samples taken during installation). Soil mix below El. -94 has no strength requirement and served only to block water flow. Average compressive strengths less than 1,000 psi are acceptable above an excavation depth of 96 feet, so long as the actual strength meets the required strength at depth.

The specification required that a minimum of 75 percent of individual cylinders tested for strength must meet or exceed the design strength. The specification allowed for 25 percent of the samples to be lower than the design strength, so long as the overall average met or exceeded 1,000 psi.

The initial specification also included criteria for panel verticality, panel overlap and alignment. PG&E consulted with several structural and seismic engineering SMEs for consensus on the predicted design strength of the CSM wall and the overall specification criteria. All parties agreed with the initial specification and the project moved forward with installation.

The specification required wet grab sample tests of each panel at the time of installation, to assure panel strengths met the design strength requirements. Although samples were tested at 7-, 14-, 28-, 56-, 112- and 224-days cure time, the panel strength was based on 56-day cure time. Sampling test results indicated that initial panels were not as strong as anticipated. These panels were generally located in the western half of the circular CSM wall alignment. The DOR altered the mix design with increased cement content to improve the strength of the panels, which was allowed by the specification. Additionally, part of the altered mix design was a change in admixture flocculent, to stiffen the very wet excavation spoils.

Final wet grab sample test results at 56 days failed to meet the 75 percent criterion. The DOR evaluated the increasing strength requirements over the depth of the CSM wall. In October 2016, the technical specification was revised to move from absolute 1,000 psi average sample strength to a strength requirement by depth necessary to achieve a SF of 3 (based on 10 psi per foot of depth). The specification retained the initial 75 percent / 25 percent pass/fail criteria, allowing for deviation from this acceptance criteria with DOR approval.

The DOR and the CSM specialty contractor initiated a vertical core boring operation at their own expense to verify the compressive strength of the wall. The compressive strength test results of the vertical cores proved inconclusive, due to several issues encountered during core recovery, including:

- Inability to guide the core drill head;
- Loose particles scoring the outer edges of the core samples; and

- Difficulty in recovering core samples due to depth.

As a result, the DOR proposed a horizontal core boring operation from within the excavation as the Caisson demolition progressed. This allowed for shorter cores, which alleviated the guidance and recovery issues associated with the long vertical core sampling method. In addition, due to the horizontal core orientation, a larger sample size was obtained, with each sample containing representative samples from several individual panels. Horizontal drilling was performed at 10-foot depth intervals for the first 60 feet of the excavation. When a 60-foot depth was reached, the results of the program were assessed by the DOR to determine if additional SOE was needed. Based on the results of the program, the DOR determined that additional reinforcement was in fact needed to sustain the targeted SF of 3.

Based on test results and DOR evaluation, a 12-inch thick layer of 4,000 psi shotcrete, starting at the 50-foot depth and continuing to the bottom of the excavation, was installed. A joint approval among the DOR, CSM specialty contractor and HBPP was reached, which allowed the excavation to proceed past a depth of 50 feet with the shotcrete reinforcement.

#### **9.1.4.2 CSM Panel Verticality and Overlap**

The initial specification had tight verticality and panel overlap criteria. Initially, panels had a 9-inch maximum allowable circumferential vertical deviation. A 3D engineering model comprised of actual installation data for the water cutoff wall, was reviewed by the DOR, the CWC and the CSM specialty contractor. They jointly determined that overlap was not necessary to meet design intent, so long as no apparent void existed between panels.

The revised specification amended the 9-inch circumferential deviation criteria for all panels to a maximum 12-inch allowable deviation. Additionally, the initial specification required a minimum 12-inch overlap between panels. 2D engineering models comprised of actual installation data for panel overlap were reviewed after installation of each panel. The DOR reviewed and approved all cases of panel verticality and overlap that did not meet the revised specification.

Verticality and overlaps meeting the design intent for the water cutoff wall were confirmed with the successful groundwater drawdown test inside the CSM wall. During the drawdown test, the groundwater level inside the CSM wall was brought down approximately 30 feet and allowed to recover. Groundwater recovery water levels were monitored over several days. Recovery inside the CSM occurred at a rate of approximately 20 gallons-per-minute (gpm), which was close to the theoretical inflow value, based on specified permeability and assuming a full-length seal of the outer CSM ring panels and a complete tie-in to Unit F clay.

#### **9.1.5 CSM Wall Installation**

The CSM wall installation baseline milestone start date was June 2015 and the scheduled completion was April 2016. Multiple additional required support tasks, such as installation of a distribution power panel, additional Baker tanks, seismic restraints for cement and sand silos, pushed the actual start date to July 2015. The installation took about twelve months and ended in June 2016.

Field work was interrupted for several weeks when the east end of the RFB was being demolished. The CSM panel installation work was challenged by the presence of a demolition exclusion zone for personnel safety. Additionally, panel installation could not proceed until the

east side of the RFB was completely demolished and underground commodities removed within the CSM footprint.

#### 9.1.5.1 Pre-Trenching

Throughout the HBPP footprint, there were numerous known shallow commodities that needed to be removed to meet decommissioning and FSS requirements. These included electrical conduits, domestic water lines, fire lines and waste and storm water drain lines. In addition to commodities, in some areas there was known subgrade contamination that needed to be removed prior to FSS. Pre-trenching and excavation were used to remove known shallow commodities and remediate any radiological contamination within the areas in the slurry wall or the CSM wall footprint.

Pre-trenching was among the early field activities started. Pre-trenching progressed as originally planned in support of a coffin-shaped slurry wall. Since the commodity removal associated with pre-trenching would be required regardless of the methods used for Caisson removal, overall project schedule time was preserved by targeting the slurry wall footprint for pre-trenching prior to finalizing the CSM wall design.

Pre-trenching work proceeded on the Unit 2 slab footprint while the CWC was fully engaged investigating alternate technologies. The Unit 2 slab area was the only area outside the RCA within the slurry wall footprint. After this area was pre-trenched to the RCA boundary, project focus shifted to working inside the RCA. This required meticulous planning and coordination to facilitate ongoing decommissioning preparation activities with minimal disruption, including major demolition and excavation work within the small, fenced-in RCA.

There were several distinct scopes of work ongoing within the RCA, including: reactor vessel segmentation; preparation of the RFB for OAD; asbestos abatement on the RFB outer walls; decommissioning of the LRWB; equipment and systems; geotechnical borings; and groundwater/storm water management. Each of these individual projects had multi-disciplined workforces who passed through Access Control on the east end of the RCA. The only logical available area within the RCA conducive to pre-trenching was the northwest corner of the RCA. Above-grade demolition and subgrade excavations began at this location. Demolition of the SAS was required in order to complete pre-trenching.

Interference between the RFB and the circular CSM wall alignment required field work and schedule balance so work could be completed safely. As a result, in addition to the previously-completed pre-trenching activities, it was necessary to demolish and remove the east 40-foot section of the RFB to allow for pre-trenching, underground utility removal and FSS activities.

#### 9.1.5.2 CSM Installation

Before construction began, the Planning Department developed two Incremental Work Packages (IWP), which allowed field work to get started before the final design was complete for primary WPs. One IWP was for advance work on electrical, water supply and grading of the area. The second IWP allowed for access road construction. This field work enhanced the schedule by getting ancillary activities completed while waiting for the final approved WP and equipment.

During panel installation, the hydromill cutter head wheels pulverized and ejected the soil matrix and injected bentonite and water on the down stroke. Once the cutter wheels reached the

bottom of the designated panel installation depth, cement soil slurry was injected as the cutter head was withdrawn. The ejected backflow of excavated soil from the rig was pumped to a de-sanding plant, where the sand was separated from the mixture. The remaining soils were pumped to a mixing chamber to be mixed with cement slurry, which was then pumped back to the rig. In order to support a steady supply of bentonite, water slurry and cement soil slurry, a batch plant needed to be installed prior to hydromill mobilization.

A batch plant was assembled and installed on the Unit 1 footprint at the west end of the fossil power block to support operation of the BG-40 fixed-mast hydromill. This batch plant had several 20,000-gallon capacity mobile tanks connected in series in order to efficiently recycle water and help meet the 30,000 gallons-per-day water demand. The plant also had two silos for cement storage and large hoppers for bentonite. After the second hydromill arrived on site, a second identical batch plant was installed.

The CSM subcontractor was to provide a generator to power the batch plant. After considering the airborne emissions over this length of time and the safety aspects of refueling often or placing a diesel fuel tank, it was decided the batch plant would operate on a 600-amp power supply provided by PG&E. The Engineering Department prepared a design change to supply power from the site's LC24 and used the generator for backup during power loss. PG&E incurred costs for the generator for actual hours operated.

Operation of the batch plant required careful control, mixing and monitoring of raw materials to maintain the specified mix design. This required a steady delivery rotation of cement trucks contracted and supplied by local vendors during drilling operations.

A large de-sanding unit was also operated adjacent to the first batch plant. The de-sander separated sand from the slurry, which was then pumped back to the rig. It also reclaimed water from the wet excavation spoils, optimizing water consumption. Multiple dump trucks and loaders operated between the de-sander unit and CSM wall, clearing the installation site of wet excavation spoils. The southwest corner of the site was congested with materials and parts stockpiles, moving and stationary equipment and personnel. This required the use of Spotters and clear communications continuously throughout the day.

The original de-sanding unit did not have the capacity to process spoils from both machines. When the second hydromill machine was brought on site, an additional portable centrifugal de-sanding unit was added, as planned.

The operational work phase requirements associated with the installation of the CSM deep shoring and cutoff wall system panels included:

- Mobilization of equipment;
- Dewatering well and instrumentation installation;
- CSM materials;
- CSM mix design;
- CSM wall excavation and construction, slurry mixing, placement and testing, backfill mixing and placement;
- CSM wall QC testing;
- As-built documentation;
- Excavated material handling;
- Protection of the completed panel; and
- Demobilization.

Field work included simultaneous operation of many types of equipment, including:



- Hydromills;
- Batch plant tanks, pumps and associated equipment;
- Long-reach excavators;
- Standard excavators equipped with bucket/thumb attachments, concrete hammers and crushers;
- Waste support equipment including backhoes and front-end loader, dump trucks, IMs and B25 boxes (used based on access to the space and confinement);
- Dust control equipment including water trucks, power washers and dust collection for the batch plant silos;
- Forklifts, air compressors, skid steers and their various attachments, fuel, lube and service trucks with welders;
- Various cranes, as needed; and
- Man-lifts, as needed.

With CSM mobilization and pre-trenching complete on the southwest area of the footprint, panel installation began. At the start of the CSM wall installation, the ongoing pre-trenching excavation was progressing on the opposite side of the RFB. This was also a schedule-critical, equipment and labor-intensive effort with excavators, hoe-rams and processors working to clear underground utilities and related contamination.

Panels were installed in a “leap-frog” type sequence. Within a ring, after installation of the first panel, the third panel in the pattern was installed and the middle panel within the pattern was installed last. This methodology was also applied for rings, with the innermost ring panels installed first, then the middle ring and/or outer ring, then lastly, the second and/or fourth ring. The sequence was frequently interrupted to facilitate other field work activities such as RFB demolition, which required relocating the CSM drilling equipment so that panel installation could continue in a different area without schedule interruption.

### 9.1.5.3 Specific Challenges

The CWC experienced construction challenges associated with large crane erection, electrical load center start-up, preparation of the BG-40 and BG-50 hydromill rig engineered working surfaces, and systemization and start-up of the bentonite/cement batch plant, all of which contributed to a one-month delay to the CSM installation start. The CWC and the CSM contractor were confident the delay could be recovered. Working longer days and on weekends focused on the schedule directly related to critical path activities.

#### 9.1.5.3.1 CSM Spoils and Waste Handling

The project needed to identify an on-site location for stockpiling CSM spoils. The Discharge Canal had the required volumetric capacity and truck transportation to the canal would be minimally disruptive to other decommissioning activities. A study was performed by the CWC PM to pump the spoils to the canal, but the logistics of crossing paths with projects, roads and work faces made this option unviable. As such, the Discharge Canal was chosen as the designated the CSM spoils collection and stockpile location, with spoils trucked to the canal.

One hundred percent of the excavated spoils had to be radiologically surveyed to confirm the material was under the threshold limit for reuse on site. The GARDIAN was used to survey approximately 3,600 truckloads of CSM spoils, with each truckload requiring 10 minutes to scan.



Each truckload made a circuitous route, filling at the de-sanding unit, going through the GARDIAN on the west side of the site, going on to the Discharge Canal on the east side of the site for offloading, then returning to the de-sander.

Spoils handling was complicated by the unusual consistency of excavated clay, making dewatering inefficient. The planned location for spoils stockpiling in the Discharge Canal required a low-moisture content of spoils in order to allow for stable sloping. The CSM spoils were much wetter than anticipated, and prolonged soil-drying made handling tedious. Due to the strict site regulations for turbidity (BMPs) in site runoff water, any mud falling from the truck had to be immediately cleaned up to minimize silt runoff. The trucks were fitted with troughs at the underside of their gates to catch the dripping mud. The troughs were moderately successful, but road cleanup was an ongoing, labor-intensive effort. The trucks were hosed down at the end of each offloading to minimize mud buildup and inadvertent dropping of mud on the site's paved perimeter roads. As buildup on the roads was observed, a vacuum/sweeper unit would clean the roads as necessary to ensure environmental compliance was maintained.

The drilling contractor tested a mix design that included a polymer, which helped remove the water from the excess clay and fines in the CSM drilling spoils. It was injected into the slurry stream before entering the centrifuge, where the solids were separated from the slurry and the treated water was recycled into the process water for the CSM. The leftover solids, along with spoils from de-clumper and de-sander equipment, were collected and run through the GARDIAN system and stored for reuse or sent to waste, depending on GARDIAN results. Initial cured, wet grab sample compressive-strength results indicated higher cement content was required and as a result, the mix design was modified. The introduction of additional cement caused plugging of the pump, fittings and hose. Introduction of the polymer into the mix design had an added benefit of creating the optimum mixture, preventing excess machine maintenance and downtime on an already tight schedule.

Even with the added polymers, the wetness and consistency made it difficult to spread the soil for drying in the Discharge Canal. An above-average seasonal rainfall total exacerbated the difficulties of soil stockpiling. Spoil stabilization included adding bulk lime, importing dry topsoil and adding alternative flocculants to the drilling fluid. The additional additives increased spoil volume at the Discharge Canal. Geotechnical engineering evaluations were completed to ensure the stockpile was appropriately sloped to safely handle possible seismic events.

The actual volume of excavated spoils exceeded the CSM contractor's original estimate. This unanticipated extra volume, combined with drying products added post-excavation, created extra management and handling of spoils material. This became its own complex, labor-intensive and technically-demanding project.

#### 9.1.5.3.2 Technical Challenges

Even though this CSM wall process was proven on numerous projects, the panel depth and number of adjacent rings was a first-of-its-kind iteration. Challenges arose during the first week of full production runs. Some of those challenges included:

- Water flow control not working as planned;
- Equipment hoses and de-sander leakage;
- Fine particles plugging equipment;

- Construction of additional temporary spoil ponds for excess materials that the canal could not accept at the time;
- General shake-out of the large CSM equipment mechanical issues; and
- Working within the small confines of the HBPP footprint.

During a typical shift, the CSM contractor encountered many unexpected equipment issues and repairs. Typical challenges encountered included repair and maintenance of the hydromill on-board computers, compressors and similar equipment, cutter wheels, blade replacement and repairs, centrifuge pump stops and unscheduled maintenance of many components. In most cases, the challenges were mitigated by completing maintenance and repairs to the equipment after the normal work shift was over, to prepare for the next day's work. Excavation challenges were generally tied to removing an unknown sub-grade sheet pile and rebar from 1960s-era construction, and the occurrence of plugged nozzles on hydromills, due to soil characteristics.

#### 9.1.5.3.3 **Weather**

Winter rains, unusually high tides and a high-water table resulted in cave-ins at 3 panels. The pre-trenched ditch had to be fortified at the three panels with nearly 200 cubic yards of low-strength concrete mix pumped in place.

Weather delays caused by high winds, lightning, flooding and heavy rains were frequent winter interruptions to production. This also increased the amount of water that had to be treated and temporary pumps were utilized to remove the excess water.

#### 9.1.5.3.4 **Water Cutoff Wall Key to Unit F Clay**

During installation of the water cutoff panels, several panels were identified as not being keyed into the clay layer as planned and laid out in the specification. The CSM contractor self-disclosed the error and developed a plan to remediate the issue. Some of the short panels were remixed, causing schedule delays. Realizing an opportunity to lessen schedule impacts, the team decided to extend some as-yet uninstalled adjacent shoring panels to the Unit F clay. This effort helped the CSM contractor meet their commitment to key all water cutoff wall panels into the clay layer.

#### 9.1.5.3.5 **Installation Efficiency**

The original estimated duration was based on production rates of 0.8 short panels per day for the BG-40 and 0.5 deep panels per day for the BG-50. These initial rates were expected to increase with site-specific experience. Due to the project challenges discussed in previous sections, the initial production rates continued longer than anticipated and the CWC projected a mid-July finish, about three and one-half months beyond the baseline scheduled finish date. Installation production rates improved dramatically over the last third of the 255 total panels. By the time the wall was completed, the installation rate had increased to about 1.5 per day for the BG-40 and 1 per day for the BG-50, cutting one month from the projected mid-July finish.

#### 9.1.5.3.6 **Concurrent Field Work**

To optimize the critical path, the CWC performed several distinct, but related work activities simultaneously. These activities included pre-trenching, CSM installation and preparation of the RFB for demolition. As part of the RFB demolition preparation, the asbestos abatement

specialty contractor erected an extensive negative-air enclosure on a scaffold frame encircling the RFB. The frame further reduced the available footprint for the CSM and pre-trenching operations. The abatement crew had to cross the CSM alignment work face several times each shift to access their work zone. This required careful planning and coordination between work crews to allow work on several faces to proceed safely, without personnel being struck by moving equipment.

While these activities were working at the center of the RCA, several other activities were ongoing around the site, including:

- LRWB demolition;
- Excavations;
- CSM spoils management within the Discharge Canal footprint;
- GWTS operation and maintenance;
- Excavation spoils management at the two SMF tents; and
- Waste container management and offsite shipping activities at the WMF.

These major work efforts shared the limited-site roadways. Complex coordination efforts were performed to keep operations productively working. The necessity of re-prioritizing work activities at the various locations was at times disruptive to the normal workflow of noncritical path singular tasks, but necessary to support critical path.

#### **9.1.6 Functional Adequacy**

Prior to commencing Caisson excavation, it was necessary to demonstrate the installed CSM wall met the design and that the water cutoff wall performed as needed to support a dry excavation. Additionally, the compressive strength of the shoring wall needed to be validated to ensure an SF of 3 for safe excavation.

##### **9.1.6.1 Wall Strength Assessment**

As described in Section 9.1.4.1, the Horizontal Core Bore Sample Program was executed as excavation progressed, collecting additional CSM compressive strength data. This data was evaluated by the PE responsible for shoring design. From the data, the PE determined the necessity and extent of shotcrete shoring, equipment positioning and allowance to proceed to the next level of the excavation for the Caisson removal process. The PE's recommendations were submitted to the CWC and made available to PG&E for review and approval.

The initial horizontal core bore sample compressive strength test results verified that the upper elevation of the CSM wall was less than the design target of 1,000 psi. During a seismic event, the forces exerted upon the CSM wall would be strongest near the upper elevations. As this value was used in the seismic evaluation, the DOR and the CSM specialty subcontractor determined that additional reinforcement was needed to maintain the SF of 3. To achieve the required SF of 3, a 6-inch layer of shotcrete was applied with welded wire mesh reinforcement to the top 20 feet of the CSM wall from inside the excavation. This shotcrete and welded wire mesh work was performed at the CSM specialty contractor's expense, with the CWC providing support.

After review of the CSM wall seismic force calculations, PG&E's outside SMEs recommended an additional 10 feet of welded wire mesh to be rock-bolted to the interior of the CSM wall below

the shotcrete. This provided an additional level of protection, should there be a seismic event resulting in spalling of CSM material. Because this recommendation and decision to install the mesh was made by PG&E and PG&E SMEs, this was at PG&E's cost.

PG&E's SMEs, the CWC, the DOR and the CSM specialty contractor were confident that the addition of the upper and lower shotcrete applications and the wire mesh maintained the required SF throughout the depth of the excavation. This expert confidence and measured approach allowed PG&E to authorize the excavation to proceed. Final resolution of wall strength concerns resulted in the safe and successful excavation and removal of the Caisson (Section 9.1.10, Caisson Removal).

#### **9.1.6.2 Dewatering and Instrumentation**

Successful dewatering inside the CSM wall was crucial for a dry excavation. The dewatering system inside the CSM deep shoring and cutoff wall consisted of four deep wells with individually-controlled 7.5 HP submersible electric pumps. Each pump had the capacity to operate at a flow rate of up to 80 gpm, which totaled a maximum design flow rate of 320 gpm at full flow. Eight piezometers were installed to measure the performance of the system, to ensure it met the design requirements and to track water levels during excavation operations. Four of the piezometers were located inside the CSM wall and four were located outside of the structure. Additionally, four inclinometers were installed around the perimeter of CSM wall to monitor for soil movement as the excavation progressed. No appreciable soil movement was detected throughout the excavation.

A dewatering acceptance test was performed on the system to verify the cutoff wall met specification for in-flux of groundwater. The water level at the time of the test was at El. +5 feet above mean sea level. The dewatering system was designed to be capable of maintaining the water level within the CSM structure at El. -90 feet, 15 feet below the bottom of the Reactor Caisson and 5 feet below the maximum design excavation depth. The dewatering drawdown test was performed between July 6, 2016 and July 14, 2016. During the test, the water level was lowered from El. +4 feet to El. -28 feet. Once the wells were shut off, actual recharge measured was at a rate of 19 gpm, indicating a successful overlap of panels and that key into the deep Unit F clay layer was achieved.

#### **9.1.7 Demobilization**

Due to the unfamiliarity with the rigor associated with a licensed nuclear facility, demobilizing the CSM equipment and its support components was underestimated by the CSM specialty contractor in the original schedule. From the last panel insertion in June 2016, to the last day on site in September 2016, demobilization took approximately fifty working days. The demobilization effort required steam-cleaning, removing the temporary electrical supply, arranging and preparing for loading and RP free release of all equipment and components used in the process of installing the CSM panels. The equipment cleaned included tanks, hoses, batch plant, pumps and valves. Equipment, tools and components that were cleared by RP were sent off site. Dismantling the two large hydromills required detailed support from several work groups, and required the assistance of a support crane, man-lifts, forklifts and numerous flatbed tractor-trailer rigs, plus considerable crew time.

One specific challenge encountered during the cleaning process was neutralizing the pH of the rinse waters from cleaning of the tanks used for the batch plant. A specialty contractor with a

hazardous waste treatment permit was required, as the pH of this water was in the hazardous waste range (pH>12). This process took several weeks. The tanks used in the batch plant operation contained residual amounts of sludge accumulated in the bottoms and on the sides of the tanks. Cleanup of this sludge required an entire crew working under permit-required confined space. This laborious and time-consuming process also involved the use of equipment, such as jackhammers to loosen the sludge and a vacuum truck to remove it once loosened. Each tank took up to a week to clean and demobilize.

Recovering the unused cement and bentonite from the silos required use of a reclaiming device to transfer it to trucks for transport off site.

### **9.1.8 Slurry Wall Concept**

The slurry wall design approach was replaced with the CSM wall final design (Section 9.1.1); however, during development of the final CSM wall approach, pre-trenching continued as scheduled in a manner supporting the slurry wall configuration.

#### **9.1.8.1 Hot Machine Shop (HMS) Above-Ground Demolition**

The HMS was located inside the RCA, along the southeast perimeter, in close proximity to Access Control, the RFB rail bay east exit path and Turbine Building foundation. The south wall of the HMS was an active barrier and control for the RCA.

The HMS was the first civil demolition structure processed and removed by the CWC. The building was a 1,250-square foot, reinforced-block, single-story structure on a 6-inch thick, reinforced-concrete floor slab on spread footings, with asbestos in the exterior wall coatings and a flat steel roof. Historically, the HMS was used for maintenance of radiologically-contaminated components. An attached calibration room contained two pit casings, 12 inches in diameter and 26 feet deep, with poured-lead shielding. The footprint for subgrade excavation planned 6,800 square feet and up to 20 feet deep for removal of portions of circulating water lines, thrust blocks and other abandoned piping.

##### **9.1.8.1.1 Above-Ground Demolition Field Work**

Removal of the HMS was integral to the pre-trenching excavation project for the slurry/CSM wall. In order to install an underground water cutoff wall around the Caisson, underground utilities were required to be removed in the path of the wall, as were buildings. The scope for the HMS removal included both above-grade and below-grade obstructions. The CWC began field work for above-ground demolition in May 2014. Work included installing and maintaining storm water runoff controls and adherence to all radiological controls, per the PG&E RP Program. A particular challenge was maintaining Gate 13 (located immediately to the east of the HMS) access to RCA, which reduced the west side working area considerably.

Above-ground demolition was completed in September 2014. Field work for below-ground pre-trenching followed in October 2014 and was completed in March 2015. See Section 9.1.5.1 for additional information on pre-trenching activity.

The CWC established a phased approach and planned two comprehensive definable scopes of work to complete the requirements within the specifications for "Above-Ground Demolition of an RCA Structure and Removal of Subgrade Structures, Utilities and Contaminated Soil." Following the CWC development of a PG&E-approved work plan, required permits were



obtained and notifications made for demolition, grading and hazardous material removal. Fully-trained and certified asbestos workers were assigned to this effort.

An Asbestos Abatement Plan was developed to address the complexity of removing Rhinocoat on the building exterior and the significant future asbestos removal at the site. The HMS remediation was the initial use of the plan. After the initial incongruities were resolved, the plan became very useful for the balance of the CWC's work.

Removal of asbestos was a highly-regulated work activity and local, state and federal regulations followed. The minimum training required for some of the work was a 32-hour Asbestos Hazard Emergency Response Act (AHERA) course. The respirators, dress, boundary rules and the regulated work area rigor was beyond what most construction crews encounter.

The initial approach to asbestos abatement was to scrape off the paint on the outside of the building. The asbestos-containing paint was to be collected in an abatement area setup outside the HMS. This removal process was determined to be ineffective and too time-consuming. Alternative processes, such as chemical strippers were tried; however, the heavy Rhinocoat was too thick to adequately respond. Ultimately, the CWC determined that removing the paint from the rough Concrete Masonry Unit (CMU) exterior was not cost-effective, so a different approach was adopted. An encapsulant was chosen, which came with new controls imposed by the CAC. Ground cover and air monitoring were assembled, and a clear waste disposal path was created.

In addition to the asbestos coatings, the concrete blocks had been exposed to radiological contamination and therefore, were not able to be free-released. The combination of asbestos wastes and radiological contamination created a mixed waste stream that adversely impacted disposal costs. With the difficulty experienced in removing the coating on this surface, an evaluation was performed, comparing the cost to continue efforts to remove the coating to the increased cost of mixed waste disposal. Since the coating was non-friable, a decision was made to remove only loose flaking paint and then spray Asbestos Bonding Compound encapsulant before demolition. Strict controls were still needed in the work area to ensure proper enclosure, to restrict access to only trained personnel and to perform a daily clean-up of the remnant block debris and paint chips. A revised PWP was prepared and the WP was revised to reflect this direction. Air quality monitoring equipment assessed the operation and determined there were no instances of airborne asbestos.

Interior demolition preparation was performed by the CWC. The work scope included removal of universal and hazardous waste materials associated with mercury-vapor lighting, overhead crane oils and asbestos gasket materials. Removal of these materials and the contaminated floor slab, including embedded piping and steel plating, was performed by mechanical means under negative air pressure and other radiological controls.

To reduce the risk to personnel during removal of the floor slab, the CWC utilized a specially-designed remote-controlled demolition robot fitted with a breaker and optional bucket/thumb attachment. The robot was electrically operated to avoid exhaust fume hazards and costly filtration systems. The roof and walls had to stay intact while removing embedded piping, contaminated floor slabs and various components. Debris was removed from the building through an air-blockage curtain installed in the place of the roll-up door.

Asbestos-containing items that required additional controls and trained technicians to remove included an overhead crane, gaskets in explosion-proof lighting, roofing membrane and some of the piping. The calibration room served as the RP clean room for dress-out. A specialty



contractor skilled in concrete saw-cutting was brought on site to cut an opening between the office and clean room, so a doorway could be created as an access port.

Prior to final preparation of the footprint for demolition, several actions were necessary, including confirmation from CACs regarding the exterior condition of the building, removal of interior contaminated rubble, radiological verification by RP and confirmation that active systems had been isolated or de-energized. Preparation of the footprint for demolition included removal of the roof-mounted HVAC unit, an 18-foot safety perimeter with debris netting, carpeting near the building to catch coating fragments and water-misting protective controls.

Barricades were moved in and out as necessary to protect workers, sometimes blocking D-Com Avenue. BMPs were closely monitored and moved/repared as necessary. Drainage was reconfigured and inlets protected as the site changed. The RCA boundary was temporarily expanded when needed to support OAD.

Structure demolition was completed in compliance with regulations and without any safety incidents. The typical equipment used included excavators equipped with bucket/thumb attachments, skid steer, water misting, dump trucks, fork lifts and similar demolition tools.

#### 9.1.8.1.2 **Below-Grade Demolition Field Work**

Once the above-ground demolition was completed, the next phase of the HMS removal was the underground commodity removal, including the two 26-foot deep pit casings (for storing a nuclear calibration source) and cooling water lines running under and near the building. The high groundwater table for the site and the presence of tidally-driven water in the circulating cooling water lines presented a unique challenge for the excavation. The cooling lines were still open to both the Intake and Discharge Canals and required plugging of piping up- and downstream. On the upstream side, installation of controlled low-strength concrete slurry was used to stop in-leakage from in and around the pipes entering the excavation. Commercial divers were engaged to plug the three cooling water lines at outfall to the Discharge Canal with rubber bladders, to prevent water encroaching downstream into the HMS excavation.

The deep-pit casings, a cooling water piping thrust block and cooling water piping in the vicinity of the deep excavation were removed.

The open subgrade excavation received environmental clearance sampling confirming no chemical contaminants remained, and a remediation turnover program provided PG&E FSS personnel with confirmation of the subgrade condition.

FSS utilized ISOCS and soil sampling for radiological confirmation that the deepest grade had reached acceptable levels of remediation and backfill could commence. Since overlapping excavations were still to take place by CWC, FSS for side walls and other shallow grades of the excavation was deferred to enhance schedule and cost-efficiency.

As the excavation was expanded to the north and west, the footprint was backfilled with a deep layer of controlled low-strength slurry material for water cutoff from the upstream cooling water piping. This slurry also acted a preventative measure for future excavations at the Turbine Building foundation footprint and East Yard of the RCA, and imported base rock was compacted within specification to original site grade.

#### 9.1.8.1.3 **RP, Craft and Waste Support**

Per HBPP procedure, the RP group monitored the demolition and disposal process activities utilizing survey and monitoring equipment, including air monitoring equipment. RP &

Decommissioning Technicians were present at all times, checking the items being removed and the people doing the work. They worked alongside Waste Technicians to ensure proper packaging and waste streams were utilized. Equipment Operators, Laborers, Riggers, Carpenters and Electricians, as well as hazardous material removal personnel, worked safely with no incidents, no unmonitored radiological releases and no unplanned exposures.

Waste packaging supplied IMs, bags and waste containers and ensured proper packaging prior to taking possession of the containers.

### **9.1.8.2 Pre-Trenching**

Removal of the Caisson required a deep excavation to well below the surrounding water table. A water cutoff feature (e.g., slurry wall) and a pumping system were required to temporarily stop groundwater from continually flooding the excavation area during Caisson removal. To provide unhindered access for the equipment needed to install the cutoff wall, surface and subsurface physical obstructions and utilities along the construction path were removed in an effort known as pre-trenching.

Pre-trenching consisted of removal of obstructions in an area approximately 20 feet wide by whatever depth utilities were encountered, typically less than 15 feet to 20 feet. Included in the effort was removal of surface contamination and underground utility features, including piping, electrical conduit and shallow foundations in the overall footprint areas of the former Unit 2, Unit 3, HMS, North Yard, East Yard and Turbine Building foundation.

#### **9.1.8.2.1 Chronology of Field Work and Water Cutoff Design Optimization**

In October 2012 the FS endorsement of a slurry wall as a cutoff structure was incorporated into the CW contract. The initial cutoff concept was a wall approximately 684 feet in perimeter distance by 3 feet wide by 180 feet deep. The slurry wall design and vetting were completed in August 2013 and encompassed a large coffin shaped outline for the overall footprint, including the Caisson, RFB and entire Turbine Building foundation.

HBPP Decommissioning Management recognized that the utility and contamination removal pre-trenching effort was necessary, regardless of the final cutoff wall technology implemented. Pre-trenching field work began in May 2014 at the HMS and the south end of the Turbine Building foundation, based on the initial water cutoff slurry wall path. This avoided costly delays and preserved schedule and critical path time.

In November 2014 the CSM structural shoring system for Caisson removal was finalized as a circular wall approximately 110 feet in diameter by 13 feet thick by 125 feet deep, that was to be installed around the Caisson. The CSM wall design is discussed in Section 9.1.3.

Also in November 2014, value engineering was performed to revise the water cutoff concept to take advantage of the structural CSM wall. The revised water cutoff concept extended the depth of the outermost 3-foot thickness of the structural CSM wall, to a depth of approximately 173 feet. The revised water cutoff concept reduced the clearance path length required for pre-trenching by 35 percent. It also shifted the field work execution schedule for the Turbine Building foundation removal into the pre-trenching sequence.

#### 9.1.8.2.2 **Scope of Work**

Pre-trenching activities were performed to clear underground structures and utility features (e.g., pipes, drainage, concrete foundation and electrical raceways) from the planned path for temporary water cutoff (deep CSM Wall panels) and temporary excavation shoring structures (e.g., sheet pile). Pre-trenching was a preparatory step to enable removal of the RFB foundation, the Reactor Caisson and the SFP. Areas affected by pre-trenching activities included:

- Turbine Building Foundation;
- HMS - Above Grade;
- HMS - Below Grade;
- Unit 2 - West Yard;
- North Yard; and
- East Yard.

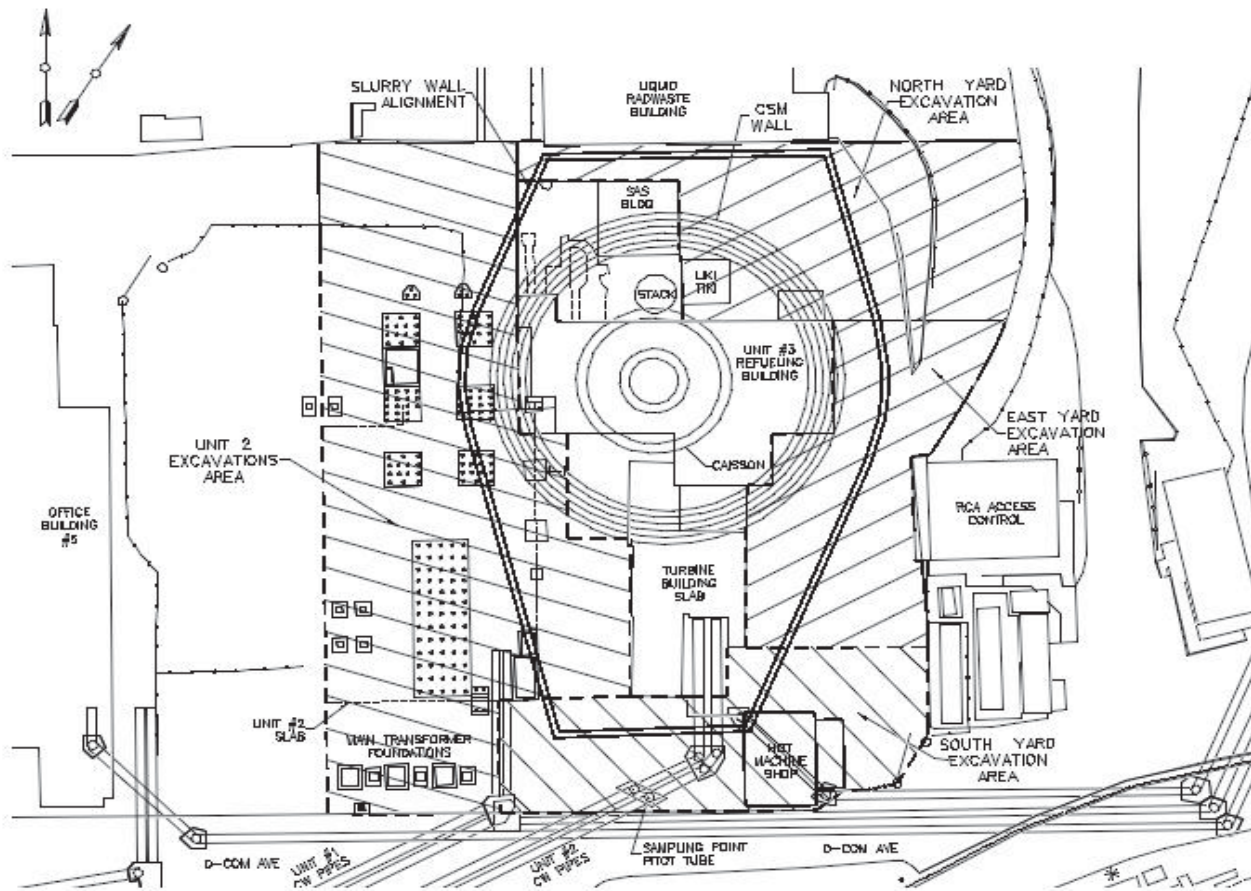
Pre-trenching work started with the HMS and south portion of the Turbine Building. Work progressed generally in a clockwise direction. The HMS work was followed by the Fossil Unit 2 concrete foundations and timber piles. This slab area demolition was required to support critical path of the CSM wall pre-trenching and CSM wall installation, the North Yard; north of the Reactor Building and finished with the area east of the Reactor Building. Work also crossed over the Turbine Building foundation, along the path of CSM wall, south of Reactor Building.

Pre-trenching also included general area excavation to a depth that would verify removal of potentially radiologically-impacted surface soils and to verify radiological acceptance of the subsurface just outside the trench-excavated footprint. Areas within the footprint were verified by core sampling down to and below the depth of the Caisson, to ensure the final left-behind CSM wall met radiological release criteria. Excavation to a depth of 6 feet or greater occurred where required, to remove radiologically-impacted soils and utilities.

Several projects in adjacent areas were identified, which would either impact pre-trenching or would be impacted by pre-trenching. These included the MPEF, Stack Base, SAS, Propane Engine Generator (PEG) Room, SPAMS and the LRWB, plus the contaminated underground piping and pipe chase. To optimize safety and efficiency of affected projects, work was combined to work concurrently in areas adjacent to the water cutoff path. This avoided crews returning to duplicate work in areas already having been excavated.

Figure 9-4, Pre-Trenching Areas (Hatched), shows the various areas impacted by pre-trenching activities.

Figure 9-4, Pre-Trenching Areas (Hatched)



Pre-trenching activities included the labor, materials and equipment to:

- Isolate and reroute utility energy (all areas);
- Remove abandoned piping and drainage conduits (all areas);
- Remove Off Gas Tunnels (North Yard and East Yard);
- Remove concrete foundation pads (all areas);
- Remove abandoned railroad rails and bedding (East Yard);
- Remove contaminated soils (all areas);
- Sample and analyze soils to verify chemical and radiological status (all areas);
- Plug Units 1, 2 and 3 cooling water lines to the Discharge Canal;
- Plan the balance of field work (all areas); and
- Maintain reporting for work progress (all areas).

Several major obstructions were identified during planning for pre-trenching. Examples of obstructions addressed included the concrete foundations and timber piles from the Fossil Unit 2 footprint, abandoned railway bed and tracks, underground off gas duct from the Reactor Building, Tunnels and contaminated utilities.

#### 9.1.8.2.3 Demolition Equipment

Equipment used during pre-trenching was shared among other demolition projects on site. The equipment included:

- Cranes (275-ton, 90-ton, 65-ton, etc.);
- Man-lifts;
- Excavators equipped with bucket/thumb attachments, concrete hammers and crushers;
- Front-end loader;
- Dump trucks;
- Skid steer;
- IMs and B25 boxes;
- Mist sprayer and water truck;
- Power washer and Monsoon fogger;
- Fuel/Lube truck and service truck with welder;
- Hand and power tools; and
- Specialized asbestos abatement equipment and material.

#### 9.1.8.2.4 Hazardous Materials Removal

Several types of hazardous materials were identified for which remediation was required, including ACM, radiologically-contaminated piping, creosote-soaked timber and lead paint-chip-impacted soils.

The ACM identified was predominantly transite utility water and fire water piping. Trained asbestos abatement personnel were used to address segmentation, removal and packaging. Removal was an arduous process, which was performed in muddy conditions and included dress-out in full PPE, double gloves and full-face respirators. The physical stress and discomfort encountered by the workforce required more personnel breaks than normal work.

Former radiological waste lines were removed from portions of the work area. The radiological controls included surveys, sampling, encapsulation of contaminated components, double wrap and seal and a full dress-out similar to that imposed upon the Asbestos Abatement Team.

Creosote-impregnated and coated timber piles were removed and managed in several areas beneath concrete foundation pile caps.

In the Fossil Unit 2 area, lead paint-chip-impacted soil was encountered, as well as residual hydrocarbons in lube lines and underground equipment vaults (i.e., concrete sumps).

All remediation efforts were planned in advance, and actively controlled and the waste streams were managed in accordance with the existing waste disposal plans.

#### 9.1.8.2.5 Execution of Pre-Trenching

Pre-trenching work was the first facility demolition work performed under the CW Contract. The scope included the HMS and areas to the south of the Turbine Building that were performed prior to the changed design for Caisson water cutoff feature. The Turbine Building foundation removal became critical path when CSM wall technology for the water cutoff replaced the slurry wall approach. The CSM wall footprint was reduced in size and shape relative to the original



slurry wall approach. The planned path of the CSM Wall cut through the area occupied by the Turbine Building's foundation. This led to the Turbine Building foundation being removed earlier than originally planned.

HBPP Decommissioning had initiated a Risk Management process to identify and mitigate potential safety risks during the Caisson removal project. The Risk Management Process identified a potential water source of in-leakage from the Discharge Canal. To reduce the chance of groundwater crossing between the Caisson/Turbine Building Area and the Discharge Canal, pipe plugs were installed at the Discharge Canal headworks, inside Units 1, 2 and 3 cooling water lines as a part of the pre-trenching project. The necessity of this work became obvious once the work started, as the Discharge Canal water would have drained into the excavation as soon as it became lower than the cooling water lines.

#### **9.1.8.2.6 Specific Challenges**

The project experienced several challenges that led to a heightened focus on safety, schedule revisions and increased costs. Key among the challenges was dealing with a large volume of water from extreme winter storms and issues additionally identified below.

##### **9.1.8.2.6.1 Water**

The pre-trenching schedule spanned two rainy (winter) seasons, which required significant storm water/groundwater management coordination to enable work to progress. Further, the second rainy season was unusually wet with substantial increases above the normal amount of seasonal rainfall and involved significant flooding in the local community. The increased water volume required water pumping and treatment of the water from the excavations at least daily. Some weekend coverage was also needed to ensure a workable excavation on the following workday.

Due to the limited size of the project site there was insufficient footprint to construct bulk storm water holding ponds. Temporary tanks were used for water holding at the excavation worksites with water pumped to PTS/GWTS. The PTS and GWTS are described in Section 11.2, Groundwater Treatment System.

##### **9.1.8.2.6.2 Projectile Hazards**

Concrete slabs, foundations and structures that were removed during pre-trenching were rubblized, using heavy equipment with hydraulic rams and cutters. Projectile hazards from intense, thick concrete battering had to be controlled with netting/shielding/plywood and stand-off distances, due to their proximity to adjacent work areas. Equipment arrangements and positions were altered and personnel schedules and travel paths were revised to further increase the personnel safety margins.

##### **9.1.8.2.6.3 North Yard**

North Yard pre-trenching was complicated by multiple contaminated pipe tunnels. While removing contaminated pipe, some small thrust blocks were removed, which were not on the drawings. Intense RP involvement was required during removal of waste lines known to be highly-contaminated. An electrical duct bank running diagonally from the LRWB to the RFB was a path for liquid contamination from a historical resin spill to follow. Evaluation and control of



the hazards associated with each of these were carefully completed and took more time than originally estimated. (Thrust blocks were large concrete blocks located at bends in the pipe installed to absorb potential turning forces of the liquid in the pipe and prevent pipe separation.)

Heavy winter rains impacted personnel effectiveness and safety while working outside, as well as installed equipment, such as pumps and electrical distribution components and mobile equipment such as excavators and trucks. As a result, many pumps, including their electrical supplies, suction lines and discharge lines, had to be moved or rerouted. Engineering developed and executed several DCNs to move drain inlets that were considered operating systems. Additionally, the ESCP and grading permits had to be frequently updated, due to water impact issues.

The FIXS discharge line was relocated to allow excavation in the North Yard area. Engineering had to prepare a Field Change to a PG&E DCN to accomplish this task.

Other hazards were discovered that required special attention. For example, various transite fire and domestic water lines had to be removed by asbestos-trained personnel. Totes had to be employed to empty suspect water from various locations for testing, which was a slower, more costly process than direct pumping to frack tanks. A number of unexpected conduits, transite pipes, 2.5-inch pipe and corrugated pipe were unearthed and were hand-dug within a contaminated area. Environmental and RP personnel were frequently needed at the site for checking excavations.

A change in transportation routes from west to east was proposed to facilitate a faster way of getting waste out of the North Yard. The change was approved, and the necessary grading and fence realignment performed.

Limited space precluded free movement of the excavator at times. The spoils had to be transferred from the bucket of the excavator into the bucket of the end-loader, which then transferred them to dump trucks. All departing trucks had to be scanned at their tires, Drivers fitted with dosimetry and accompanied by Spotters.

#### **9.1.8.2.6.4 Unit 2 Slab Area**

A portion of the Unit 2 slab removal costs for activities that were not associated with fossil decommissioning was allocated in support of CSM wall installation and pre-trenching activities. Several hazards were addressed in the Unit 2 slab area, including a contaminated storm drain, ACM, lead-contaminated soils and old timber piles.

The contaminated storm drain line required additional remediation, due to a historical spill from the condensate storage tank during operation. Increased disposal soil waste volumes occurred, due to unexpected radiologically-contaminated soils and concrete. Engineering developed special DCNs to ensure storm water control was maintained during the remediation.

#### **9.1.8.2.6.5 East Yard Area**

The east 40 feet of the RFB was to be demolished to make way for the CSM wall, which drove the East Yard excavation to stay on critical path. While below-grade utilities were not as dense as the North Yard, there were steel and timber piles, whose removal proved more difficult than some other areas. The steel piles required installation of welded caps to provide a grip for

rigging. Upwelling of groundwater occurred because of the holes created when the piles were extracted. Cement slurry was pumped into these holes so that work was not slowed by in-leaking groundwater. This was common to all piling removals. These piles were removed prior to the start of RFB demolition and removal of the Off Gas Tunnel.

The East Yard scope of work included several areas of known radiological contamination. These areas included a 4-inch clay LRW discharge pipe and a contaminated railroad track bed. During excavation, RP surveys revealed higher levels of radiological contamination than anticipated. The higher levels of radiological activity changed the required disposal destination.

#### **9.1.8.2.6.6 Hot Machine Shop (HMS)**

The HMS was the first below-grade CWP. Inter-disciplinary meetings were conducted to ensure a safe and efficient start to the work. As expected, as the team gained a level of comfort in executing the work and using the processes and procedures, the first-time execution of field work took longer than the average time for similar work. The asbestos CACs and Environmental designees erred on the side of caution, which was the safest approach for a first iteration work such as removal of lead contaminants and the first exposure to transite pipes. A Class 1 enclosure to remove drain lines was dictated and erected after training was completed.

The very deep Closed Cooling Water (CCW) thrust blocks were identified for removal at some point. Since the pre-trenching excavation was open, the CWC determined that it was optimal timing to go down to approximately 16 feet below grade to remove them during pre-trenching, rather than backfill and return later for a second round of excavation and backfill.

Additional DCNs for drainage were developed prior to the start of pre-trenching during the fall of 2014, to address the expected amount of storm water runoff and groundwater. Water from winter storms that flowed from the Upper Yard challenged pumping and holding tank capacities. Ensuing water accumulations in the excavations caused the removed soils to be wet. Wet soils were blended with drier material to meet waste disposal criteria. Excavations were pumped out at least daily and required attention on some weekends to ensure a workable excavation for the following workday.

Deep excavation and removal of wood piles and CCW thrust blocks extended to the south edge of the excavation, close to the edge of Decom Road. Changing conditions due to winter rains caused the ground to slough under the road. An active 6-inch transite fire line running under and parallel to the road was damaged by weight of heavy equipment, in conjunction with reduced soil support of the line. Soils were then added to provide adequate slope to support the road, extending HMS excavation duration.

#### **9.1.8.2.6.7 Manpower**

The team size for this work ranged from five to twelve personnel, based on the work at hand. The Craft group was normally comprised on average of seven team members, including Equipment Operators, Spotters, Drivers, RP Technicians and Supervisors. Additional Carpenters and Electrical personnel were called in during specific tasks, as needed.

The Waste group supplied IMs, waste containers and scales and ensured proper packaging prior to taking delivery.

Ongoing daily activities included setting and resetting Garlock barriers; cleaning equipment; clearing material and equipment from the RCA area to the clean area; installing steel plates over openings; loading out waste in IMs; filter counts and cleaning; machine inspections; mechanical repairs; repetitive change-out of shears, blades and buckets; collecting and redirecting hoses; loading out large-diameter rebar steel in such a way as to prevent damage to the IMs; and proper housekeeping to prevent slips, trips and falls, as conditions changed each evening.

Project Controls included counting and recording loaded boxes and containers, equipment on site and hours used, personnel hours, QC oversight, change orders and quantities of removed soils and concrete, etc.

### **9.1.9 Caisson Dewatering**

As part of the support planning process for Caisson removal, a dewatering method was developed to allow the excavation and removal of the Caisson structure in a relatively dry environment. The Caisson structure was surrounded by a CSM deep shoring and cutoff wall earth retention system. A dewatering system was installed within the boundary of the CSM wall, which incorporated geotechnical instrumentation placed in individual wells to monitor groundwater level and soil movement.

The water was managed mainly for groundwater within the structure and served a secondary function for storm water and dust control process water.

The system included four dewatering wells and four piezometer wells that were located inside the CSM wall and required careful observation during the excavation process to prevent damage by excavation equipment.

#### **9.1.9.1 Dewatering System Installation**

The CWC engaged a contractor to install the CSM wall, who also installed the dewatering pumps and monitoring wells. Four well holes 30 inches in diameter were drilled to approximately 110 feet below sea level. Each had HDPE casings and an 80 gpm pump, set at EL. -103. The monitoring wells drilled were 6 inches in diameter at EL.-107 and included the monitoring instrumentation. The pump and monitoring wells were installed with the required permits and following Humboldt County regulations.

#### **9.1.9.2 Dewatering System Operations**

The pumping system received power from a 480v panel located at the northwest corner of the Caisson work area that was fed by LC24, which was supported by a backup generator. All the work regarding powering the dewatering system was performed by the Electrical Team, using design documents at the direction of the Electrical Engineering staff.

After demolition of the RFB and the commencement of Caisson demolition, the excavation groundwater levels were maintained based on current excavation level. As excavation began, the level was maintained at least 10 feet below the current excavation level. Three of the wells were active and one was maintained as a backup. The system operated as designed.

Piezometers installed in dedicated wells tracked groundwater levels. The piezometer monitoring systems included four wells installed inside the excavation and four wells outside the excavation. Piezometer outputs were reviewed and recorded twice a week.

Initial testing and operation of the system showed continuous in-flow of approximately 17 gpm. This historical knowledge of water in-flow provided guidance on how to keep water at the desired levels. Pumping rates were established and the pumps were run for 3 minutes at a time, in 13-minute intervals. The system's four pump discharge pipes connected to a header that emptied into a series of holding tanks, which then pumped directly to the GWTS, utilizing a control valve configuration and operating process. This was a small amount of water compared to the capacity of the GWTS, and at no time did the water pose a challenge.

Small portable pumps were deployed inside the excavation as necessary. They were channeled to the dewatering well casings to handle small seepages, rain water and dust control system runoff.

Tracking the daily operation of the system included contingencies for rain events and seismic activity, etc. Four geotechnical inclinometers located around the perimeter of the CSM wall monitored below-ground lateral movements of the soil mass and CSM wall. They functioned as designed. No surprises or anomalies were detected during the Caisson removal.

Five surface survey points were installed at the HBGS site to monitor for settlement during excavation and backfill. Data from the various readings was used to watch for and identify trends. No unacceptable movement was recorded at any of the measuring sites.

#### **9.1.9.3 Dewatering System Removal**

Per County of Humboldt Division of Environmental Health permit requirements, the four monitoring well pumps and casings down to the bottom of the excavation were removed. This required cutting the upper sections of the pump casing, sludge sediment removal from the pump lower casing and pump removal, including its instrumentation for operation. One of the wells was found to be significantly radiologically contaminated and in addition to removal of the pump and instrumentation, flushing of the contamination was required to meet final license termination radiological criteria. During this process, RP controls were established to insure any potential radioactive materials were captured and disposed of properly. Once the wells and pumps were removed and RP cleared the area, the backfilling process started. See Section 9.1.10.7.

#### **9.1.10 Caisson Removal**

The Caisson was a reinforced-concrete, below-grade structure, which served to house the reactor vessel and supporting operational equipment. The purpose of this structure was to keep the high-water table at bay, as well as to provide a below-grade shell to house Unit 3's support systems and equipment, while retaining the surrounding soils in place. From a nuclear safety perspective, this served as additional radiological shielding and suppression in the event of an accident.

The lower 58.5 feet of the Caisson was a heavily-reinforced 60-foot diameter, circular concrete structure with 4-foot thick walls. The upper portion of the Caisson was a rectangular structure, 50 feet wide (N-S) by 52 feet deep (E-W), and it extended from El. -14 to El. +12.

The Caisson was originally constructed with an open base, using six lift sections. Each lift was from 7.5 feet to 18 feet in height. As each lift was constructed on top of the previous section, the cylindrical structure was sunk in place under its own weight. This was possible with the assistance of a water-jetted cutting shoe. The lift construction and sinking process was repeated until the final exterior walls and interior bio-shield of the Caisson were sunk to the desired depth of El. -72.5. At this point, the interior of the Caisson was fully excavated and the base was sealed using tremie concrete. During installation, the exterior structure, interior wing walls and bio-shield were tied together with large-diameter rebar. The construction methods used resulted in a structure that functioned as a single integrated below-grade system.

On the east side of the Caisson, a series of box structures measuring 50 feet long by 20 feet wide was constructed. These were for the SFP, as well as the vaults previously housing the Turbine Building Drain Tank (TBDT) and New Fuel Storage Vault (NFSV). These structures were keyed into the upper portion of the Caisson on its east side. The bottom of the SFP cask pit was on top of native soil, with four steel 'H' piles, which were driven at an angle adjacent to the lower cylindrical portion of the Caisson structure. Sheet piles also were found in the following locations: north side of the SFP; east side of the SFP and TBDT vault; and south side of the TBDT vault. Additionally, piles were found on the north, east and south sides of the SFP cask pit. These structures were poured in place following the sinking of the main Caisson structure. Concrete walls around the exterior of the SFP, NFSV and TBDT vault extended to the full depth of those structures and were 3 feet thick.

#### 9.1.10.1 Scope of Work

Caisson demolition and backfill included the removal of the Unit 3 deep foundation Caisson structure and its underlying tremie pad. Hazardous, nonhazardous and radiologically-contaminated materials were removed during the demolition. Examples of such materials included concrete slabs, subgrade structures, embedded piping, soils, piling and debris. CWC work plans included a description of minimizing dose ALARA and specific guidance on minimizing waste generation. When excavation and demolition activities were completed, the excavation was backfilled to within 10 feet of grade, using self-compacting material. Traditional mechanical compaction methods were used for the top 10 feet of fill, which brought the area to grade.

Caisson demolition work also included: the operation of a dewatering system; the monitoring of geotechnical instrumentation systems; installation of a surface railing safety system and barrier system at working surface to protect workers; installation of a personnel access system; and installation of an excavation ventilation system.

Additional demolition and backfill activities included measures to:

- Perform mobilization and demobilization of work areas supporting different project phases, such as excavation, demolition and backfilling of the excavation;
- Perform pre-coordination walk-downs, verifications and notifications to supporting work groups;
- Perform and implement general supporting activities, including RP controls, scaffold-building, stair tower installation, clearances, installation of ventilation, fire and fall protections systems and general requirements for hot work;



- Perform waste-handling activities, including stockpile area prep, material load-out from excavation, IM/truck loading, on-site materials transport, stockpile area management and implementation/maintenance of BMPs at stockpiles;
- Perform repair and maintenance activities as issues are identified through a condition report and SAP program, specifically for CSM wall and dewatering well repair/maintenance, truck and equipment maintenance and required actions to take in the event an active system (fire, ventilation, power, etc.) required repair/maintenance work;
- Obtain Humboldt County Permits for grading, demolition and implementation of an approved ESCP, as an amendment to the site SWPPP;
- Implement storm water BMPs, in accordance with the ESCP;
- Complete required daily start check items prior to performing excavation activities, including assignment of a Top Lander, functional and configuration checks for ventilation and fire systems, inspection of scaffold stair tower and man-baskets, check vertical control and review MRI sheets, conveyance of Engineering and RP requirements, CSM and Dewatering well inspections and geotechnical instrument checks, daily waste coordination, verification of adequate lighting and communication checks. (All required checks were documented in a Daily Start Checklist, which was completed prior to performing excavation/demolition work.);
- Complete required daily shift closure check items prior to leaving the work area for the day; verify lighting, power, ventilation and fire systems are turned off, work area lockdown at the end of shift, daily excavation log and geotechnical instruments completed and returned to QC. (All required Daily Shift Closure Checklist were completed prior to leaving the work area for the day.);
- Implement HBPP site permit requirements, including Excavation Permit, Concrete Penetration Permit Waiver, Hot Work Permit and other permits as required;
- Support RP and Environmental monitoring at the excavation site to screen soil, construction debris and other demolition waste;
- Manage water associated with the excavation activities, including storm water, groundwater and dust control process water;
- Spill response measures, including placement of absorbent products where required for petroleum contamination;
- Place barricades, barriers and signs as required for excavation safety;
- Mitigate areas specified in the WP;
- Provide detailed sequence for removal of the activated concrete region of the bio-shield/drywell;
- Collect required geotechnical instrumentation and survey data;
- Support the required as-built excavation measurements as documented in daily log sheets; and
- Establish access point to control access into the area of excavation. Access point had entry logs and entrant tag board to document personnel access into and out of the excavation area.

#### 9.1.10.2 Risk Assessment

In the months leading up to the Caisson excavation work, in-depth risk reviews of planned Caisson activities were conducted that produced the Risk Register, which was used for the



duration of the Caisson Project. The development of this document was reviewed at weekly meetings between CWC and HBPP Oversight, to ensure all WP activities were addressed prior to issuing the initial document to commence the field work. After work was initiated, coordination between the Caisson SME and HBPP Oversight continued to ensure the Risk Register was updated upon addition(s) of new Caisson activities and the crews were updated on these concerns. Several items covered in the Risk Register included, but were not limited to:

- RP protection and coordination;
- Falling debris;
- Loading out material by means of a teledipper or muck bucket;
- Noise;
- PPE for various scopes of work;
- Shotcrete application;
- Horizontal core boring;
- CSM wall loading;
- Emergency extraction of personnel;
- Confined space and hazardous atmospheres;
- Fire protection measures; and
- Excavation rescue plans and coordination with local authorities.

Upon review of a specific risk item, this register helped in the development of most of the Activity Hazard Analysis (AHA) for the project. The two documents worked hand-in-hand to allow field personnel a visual perspective of the task prior to beginning the work. The Risk Register proved to be a proactive tool in identifying any concerns prior to performing the work, and in turn, helped mitigate the potential risks associated with a given task.

The hiring of two degreed mining engineers for Project Management and CWC SME aided the development of plans that culminated in no OSHA- recordable events or lost-time injuries and only two first-aid cases. This Caisson and its removal was a first-of-its-kind project and held several unknowns. Utilizing CWC professional work experience, along with outside SME technical support, the identified risks and unknowns were mitigated.

Phase I is identified as the portion of the exaction from El. +12 to El. -20. Phase II began with the region known as the activated concrete, an area approximately 10 feet in height. The plan was to carefully remove the concrete in this area and prevent it from falling into the drywell. After that successful operation was complete, Phase III was authorized, taking the excavation to completion and removing the tremie concrete at the base of the Caisson.

### 9.1.10.3 Work Performed

#### Impermeable Layer Installation

As discussed in Section 9.1.5.1, Pre-Trenching, prior to installation of the CSM wall, an activity called pre-trenching was conducted to clear subsurface utilities and structures. Once obstructions were cleared, FSS was conducted and the area was backfilled to facilitate the CSM installation. Due to potential risk of contamination during Caisson removal, an impermeable layer was installed around the CSM. Its construction included the placement of approximately 1,100 cubic yards of Controlled Low-Strength Material (CLSM), 2,500 cubic yards of aggregate, storm water collection basins and utility conduits to supply temporary utilities during Caisson

excavation. A rubber liner was installed to cover the completed CLSM foundation and create a waterproof barrier. The final working surface was finished with a gravel base to ensure proper water drainage into the storm water collection basins.

Additional ancillary foundations and support equipment listed below were also installed in support of Caisson demolition and backfill activities:

- Stair tower foundation and 8 K-Rails counterweight elements of ingress/egress;
- A safety barrier at the top side edge of the CSM wall, consisting of 178-foot eco blocks;
- Ventilation system foundations, fan, ducts, filter banks and ring header;
- Installed temporary electric and water utilities for excavation activities;
- Set up work areas for load-out, cranes, crane mats, material processing, debris bull pens, IM loading scales, truck load-out, tool laydown and storage; and
- Configured groundwater EHT, dewatering pumps plumbed to the EHT and powered necessary temporary equipment.

### Dewatering System Operation

The Caisson dewatering system was operated to lower groundwater levels within the CSM deep shoring and allowed for demolition of the Unit 3 Caisson in the dry. See Section 9.1.9 for a full description.

### Stair Tower Installation

An approximate 100-foot tall hanging scaffold stair tower was designed and installed incrementally within the CSM wall. The stair tower was supported by cantilevered steel beams, which were counterweighted with concrete barrier rails. They were braced to the existing shoring wall to support seismic loading requirements. As the excavation progressed, additional sections were added in 20-foot increments to provide safe access to and egress from the excavation.

### CSM Core Plan

As discussed in Section 9.1.4.1, Safety Requirements, the CWC developed a horizontal core testing plan to verify the integrity of the CSM wall. The plan called for horizontal core samples that were 6 inches in diameter and drilled up to 10 feet into the CSM wall. These were taken at 10 locations at El. 0 feet, and repeated at each 10-foot depth increment. This added up to 60 total horizontal core holes. Additionally, at each 10-foot elevation interval, a set of core holes was shifted approximately one panel length of 9.9 feet clockwise from the location of the previous set. Pulling from multiple locations along different vertical alignments increased the reliability of the test.

### Shotcrete Installation

Additional CSM shoring strength was provided by dowels, Welded Wire Fabric (WWF) and shotcrete. A layer of WWF and 6 inches of shotcrete were installed on the first 20 feet of the shaft to meet seismic and surcharge demands. An additional 10 feet of WWF, along with two rows of rock bolts, were installed below the shotcrete to mitigate spalling.

No shotcrete lining was installed from El. -20 feet to El. -44 feet. It was anticipated that this section of CSM wall met all strength requirements and it was confirmed by the results of the horizontal core testing performed.

Horizontal core sampling showed there was less than anticipated strength at a depth of approximately 51 feet. Because of this, dowels, WWF and 12 inches of shotcrete lining were installed at a depth of 51 feet and below. Soil was excavated 4 to 6 feet at a time and the shotcrete liner was installed in 4 to 6-foot lifts. Once the Reactor Caisson's concrete was demolished and the shotcrete liner met required compressive strength specifications, the excavation progressed.

### Caisson Demolition

Caisson demolition and excavation was broken into 3 phases. Each phase was completed with the use of hydraulic excavators equipped with large concrete breakers, metal-cutting shears, and concrete processors. During the first phase, the upper portion of the Caisson, including the RFB slab from El. +12 to El. -20, as well as the exterior Caisson walls in the El. -20 to El. -30, were removed and the area excavated.

The second phase involved removing and segregating the Activated Region of the drywell (which was the interior ring of the Caisson) from the remaining portions of the structure below El. -30. The Activated Regions of the drywell were within El. -20 to El. -30.

The third and final phase was to remove the remainder of the Caisson and the adjacent soils, which extended from an El. of -30 to approximately El. -84.

Excavation began from El. +9.5 and proceeded in approximately 4-foot lifts. First, soils between the concrete structure and the CSM wall were removed from around the exterior of the Caisson. Following removal of the soils, the concrete structure was demolished down to the current soil elevation. This process was repeated until the entire structure, as well as the surrounding soils, were removed. The concrete debris generated from these activities was used to fill void spaces within the structure, which provided additional working surface for demolition equipment.

The initial phase of Caisson demolition activities was performed with the excavation equipment setup around the top of the CSM wall and the former SFP. The SFP had previously been backfilled with demolition debris generated during the RFB demolition. More working space within the CSM ring became available as the excavation progressed. This allowed for a makeshift ramp made up of debris, to be used on the east side of the excavation for the remaining demolition equipment to enter the hole during the first 20 feet of excavation. After a depth of 20 feet was reached, excavation equipment was rigged and lowered into the excavation, utilizing a 275-ton support crane. The stair tower, its support beams and first tier of the scaffolding were installed once the excavation reached approximately 5 feet in depth.

Excavation and demolition continued in lifts down to El. -20. All soils and portions of the structure were fully removed down to this elevation. After the El. -20, the demolition process changed slightly to address issues specific to the Activated Region area. The change meant that the removal of the structure was restricted to excavation of soils and the demolition of structure, exempting the interior drywell concrete, interior suppression chamber liner plate and the drywell liner. This restriction was in effect until approximately El. -30 was reached. Following demolition of the exterior structure within this 10-foot elevation range, a 10-foot tall section of the drywell remained, which protruded above the working surface.

At this point, the top layer of soil was utilized as a sacrificial layer at the working surface. This sacrificial layer was used as a barrier layer to prevent Activated Region debris from comingling with the surrounding materials. Demolition of the Activated Region commenced as follows:

- First, the suppression chamber liner plate was stripped from the drywell concrete (concrete and interior drywell liner plate remained in place). The liner was direct-loaded into IM for disposal following removal.
- Next, the activated concrete from the drywell was demolished and direct-loaded into IMs for disposal. During concrete removal, the interior drywell liner plate served to prevent any Activated Region debris from falling into the drywell cavity.
- Following the completion of the activated concrete removal and load-out, the drywell liner plate was removed and direct-loaded for disposal.
- At completion of the drywell liner plate removal, surveys were taken and the sacrificial material layer was disposed of, along with approximately 6 inches of soil and debris below the sacrificial layer.

Upon completion of the Activated Region removal, the remaining 55 feet of the Caisson and surrounding soils were removed in a manner similar to the first 32 feet of the excavation. This continued until the entirety of the structure was fully removed, as well as the base tremie concrete layer. Excavation equipment was removed and an FSS, in accordance with the LTP, was completed. The NRC and consultants from ORAU were present to observe and perform confirmatory surveys during the FSS. Support equipment used for excavation and demolition work was removed from the hole, including dewatering wells, piezometer survey equipment, stair tower and the ventilation ducts and system. The inclinometers located outside the CSM wall were also removed.

#### Waste

Caisson waste included hazardous, nonhazardous and radiologically-contaminated materials. This included concrete slabs, subgrade structures, embedded pipe, soil, pilings and debris. Soil and debris were loaded from the excavation to material bullpens, and later loaded from the bullpens into trucks. Concrete debris was transported to the SMF and shipped out as waste. Soil loads were passed through the GARDIAN and taken to the SMF if contaminated.

#### Reuse Material

Caisson excavation activities generated approximately 17,000 cubic yards of soil, which could be reused. After having passed through the GARDIAN, reusable soil was taken to the Discharge Canal to be stockpiled. Prior to removal, Caisson excavated spoils reused as backfill were chemically tested, per IMRAW requirements.

### 9.1.10.4 Challenges

#### Inclement Weather

If wind velocities reached 30 mph or greater, work in the excavation ceased until conditions improved. This was due to dependence on crane-operated man-baskets for secondary access and egress. For wind conditions of 20 mph or greater, the cranes' working radii would be reduced to account for the required reduction in crane capacities. Additionally, thunderstorms capable of producing lightning strikes would cease Caisson excavation activities.

#### Waste Minimization

See Section 5.12 for discussion on Waste Minimization.

#### Caisson Excavation Safety

A fueling location was established prior to the start of work, which included a combustible exclusion zone. The combustible exclusion zone was delineated and posted with required "No Smoking" signage. Any hot work or other activity having potential to produce an ignition source was suspended prior to the fuel truck entering the area. Numerous 20-pound ABC dry chemical fire extinguishers were staged within the fueling area and on the fuel truck. Spill kits and eye wash stations were staged and readily available for use in the event of a spill during fueling operations.

The fuel truck gained access to the fueling location with approval from the Job Supervisor. Fuel trucks maintained a safe predetermined distance from the CSM wall and were backed into position with the use of a Spotter. Fueling hoses were equipped with an approved dispensing

nozzle. Temporary Garlock and concrete barriers protected the fuel handler from the leading edge of the excavation.

As the excavation descended, a 1-1/4 inch rigid rubber fuel line was affixed to the CSM wall. This fuel line ran from the top of the excavation to the below-grade working surface. This reduced the chances of a spill by preventing the need to lower and raise a fueling hose into and out of the excavation. As an additional safety measure, the Driver of the fuel truck supplying the rigid rubber fuel line would remain at the rear of the truck, where three shut-off valves were located that could be closed off during an emergency. During refueling, fuel flow would be closed off at the truck when the last equipment to be filled was three quarters full. This allowed remaining fuel within the length of the rigid line to drain into the tank. Additionally, workers always maintained radio contact utilizing three-way communications throughout fueling operations.

#### Confined Space and Hazardous Atmosphere

Habitability in the Caisson was reliant on a combination of source reduction, design ventilation, and portable gas monitoring. Source reduction was achieved by utilizing only approved and inspected Environmental Protection Agency (EPA) Tier-4 equipment.

The ventilation system was designed to provide twenty-one Air Changes/Hour (ACH) in the first 10 feet of elevation above the working surface and ten ACH in the first 20 feet of elevation above the working surface. These ventilation capacities were far greater than needed to ensure a reduction in all regulated contaminants below published Action Limits, Permissible Exposure Limits and Ceiling Limits. With the combination of source reduction and designed ventilation, the atmosphere inside the Caisson excavation was well below the 25 ppm Cal/OSHA PEL for carbon monoxide (CO) and the 0.2 ppm ACGIH limit for nitrogen dioxide (NO<sub>2</sub>).

Industrial Scientific IBRID MX6 multi-gas detectors were used for portable gas monitoring. The portable gas monitors provided measurements for oxygen (O<sub>2</sub>), hydrogen sulfide (H<sub>2</sub>S), CO, NO<sub>2</sub> and combustible gas (LEL). The monitors could either be staged at the working surface or be worn on the worker's person. The excavation was tested to ensure a clear atmosphere prior to entry each workday.

#### Analysis of Equipment Loads During Demolition, Caisson -14 Floor

It was deemed beneficial for demolition equipment to be staged on the debris supported by the floor at elevation -14 feet. Equipment exclusion areas were identified in a structural analysis of the Caisson provided by Engineering. This analysis also allowed specific engineering mitigation guidance to be developed prior to encountering hazard zones. Exclusion areas such as the SFP, NFSV and Reactor drywell required backfilling prior to working surface access. Some additional areas of concern included the East Suppression Chamber, West Suppression Chamber and the Reactor Caisson stairway. These areas were surgically demolished and backfilled to provide a continuous safe working surface.

#### Equipment Restrictions

Equipment was not allowed near the excavation edge unless specific documentation was provided by the DOR for the CSM wall. A surcharge calculation was performed by the DOR to verify that any proposed equipment placements at the top of the excavation were acceptable.



Supplementary positioning of large construction equipment and crane mat positioning on or near the CSM wall were evaluated on an individual case basis.

#### **9.1.10.5 Measures to Ensure Personnel Safety**

The following are examples of how the Project endeavored to ensure the safety of our personnel while in the excavation. Many of these measures were instituted during the risk analysis and assessment exercise that produced the Risk Register.

##### **Means of Access and Egress for Caisson Excavation Personnel**

Cal/OSHA requirements for occupied excavations required that there be a primary and secondary means of access to and egress from the excavation for it to be classified as a non-confined space. Primary access and egress means were provided by a hanging stair tower scaffold. The secondary means were by suspended personnel platforms rigged from a crane. This combination of systems was determined to provide versatility, modularity and practicality in adapting to the changing excavation depth.

##### **Caisson Excavation Fire Protection Plan**

The best approach to provide fire protection within the shoring system was to eliminate the potential for fire. Due to the work being performed and the equipment used, there remained a residual risk of fire even after implementing engineering and administrative controls to meet regulatory requirements. The following measures were implemented to reduce the risk of fire.

##### **Limiting Ignition Sources**

Ignition sources within the shoring system were either eliminated or limited within reason. There were certain functions such as welding, cutting or grinding, which were required in support of demolition work or the maintenance of equipment. While performing those activities, Hot Work Permit requirements found in the procedure were strictly adhered to. This procedure was directed by the Job Supervisor and followed by the work crew performing the work and included a fire watch.

##### **Limiting Flammable/Combustible Loading**

No fuel storage was permitted within the excavation. Fuel was only delivered as needed, in accordance with the equipment fueling procedure. This ensured that the equipment only received the necessary amounts of fuel and that a strict fueling procedure was followed.

All chemicals used in the excavation were thoroughly reviewed by the Safety and Environmental Departments, to ensure that substances with flammable properties were limited to a safe quantity in support of the work activity. More stable substitutes were considered for certain volatile materials. Any chemicals introduced into the excavation received prior approval and their quantities were tracked by the "Top Lander." The Top Lander was a safety professional dedicated to stay at the edge of the Caisson, directing and monitoring any activities that might interfere with personnel safety. They were relieved only by another trained individual.

Housekeeping was a major factor in fire prevention and safety. Debris was not allowed to accumulate near primary walking paths or emergency egress routes. This would allow for unimpeded exit from the excavation in the event of fire. Equipment or goods packaged in

combustible material was not allowed within the shoring system. Spill kits were staged inside the excavation to facilitate quick and timely response for spill cleanup.

#### Site Fire Protection Measures

An emergency equipment cabinet containing safety equipment and fire extinguishers was staged in the excavation. Equipment included an AED, large trauma and first aid kit, eyewash station, stokes basket and eight 20-pound ABC fire extinguishers. The cabinet had engineered rigging points installed so it could be lifted to support different work elevations as the excavation progressed.

All workers were trained in prevention requirements and fire-extinguishing techniques covered in the “Qualification and Training Requirements of Fire Loss Prevention Personnel,” procedures. Supervisors verified qualifications to ensure that workers were documented and maintained status. The Engineering Department developed a site access map for Humboldt Bay Fire Department (HBFD), which showed the preferred access route, primary and secondary hydrant locations and a rescue laydown area. The HBPP Safety Department performed simulated drills with the HBFD and surrounding mutual-aid fire departments.

#### Caisson Excavation Rescue Plan

Exhaustive efforts were made to eliminate potential hazards that could result in injury or illness. Work planning for the Caisson removal identified numerous hazards and initiated mitigating measures to eliminate hazards prior to commencing work. However, several potential hazards still existed and included the following:

- Traumatic injuries resulting from strikes by moving equipment, flying debris or from falls;
- Medical emergencies such as heart attacks, heat stress or diabetic episodes;
- Hazardous atmospheres created by CO or toxic smoke from a fire;
- Seismic events resulting in failure of the stair tower and crane with personnel platform;
- Catastrophic failure of the CSM wall; and
- Flooding within the CSM wall.

In the event of an on-site emergency, the “Site Emergency Plan” would be followed. The site emergency phone numbers from a plant phone and from a cell or non-plant phone would be used to contact the ISFSI Shift Manager to make the emergency notification and initiate the appropriate response.

#### On-Site Rescue Measures

Self-rescue was the primary means of rescue from the shoring system excavation. It was imperative that workers recognize the onset of symptoms and remove themselves from the work area before the condition worsened. Medical conditions included heart attack, heat stress, diabetic episodes, seizures, etc. It would have been considerably easier to have the worker walk out, rather than to extract them using a high-angle rescue. Self-checking and peer-checking were crucial for early identification of a medical emergency. Self-checking, or the acronym STAR (Stop Think Act Review), was the method taught to HBPP workers as a means to assess whether a proposed action was right for the situation and to answer the question, “Am I ready to perform this task?” This was the time a worker would identify if something wasn’t normal and if not, vacate the excavation. Peer-checking was typically a task-based process

where two individuals completed a job as a pair. An individual familiar with the activity may see hazards the worker physically performing the task does not see. This second level of detection was when the worker who is ill fails to identify early symptoms that their peer can detect and can initiate self-rescue. These human performance tools were utilized and discussed every morning as part of the pre-job tailboard that crews were required to attend.

To promote quick assessment and care of workers, all members of the Caisson excavation crew were trained in First Aid, CPR and AED operation. The ability to recognize early signs and symptoms of a medical condition was not only crucial to assisting a worker out of the excavation before conditions worsened, but also in providing any needed emergency care.

#### Personnel Platforms

Two six-person platforms were used as the secondary means of egress from the shoring system excavation. If the scaffold stair tower, which was the primary means of access and egress, was compromised or unstable, the platforms could be used to extricate workers in a timely manner. The platforms were rigged directly to the 65-ton crane hook via the manufactured rigging hardware. The 65-ton personnel platform cranes were operated and maintained in a hot stand-by status at any time crews were in the Caisson excavation.

#### Emergency Escape Breathing Device for Hazardous Atmospheres

Ensuring the existence of a safe condition, the atmosphere was tested and verified it was in compliance with regulatory requirements. Monitors measured the air for O<sub>2</sub> levels, CO, H<sub>2</sub>S and LEL limits. Workers utilized IBRID MX6 multi-gas portable detectors at the work area and within the excavation, or wore them on their person. If atmospheric conditions changed to dangerous levels, the monitor would alarm and the Top Lander would notify the workers inside the excavation to promptly exit.

In the event of fire or hazardous atmosphere within the shoring system, iEvac smoke/fire hoods were available as an escape breathing device. They were to put on so the worker could quickly exit the excavation. The iEvac smoke/fire hoods protected against CO from equipment exhaust, H<sub>2</sub>S from naturally-decaying organic matter, smoke from fire, the 54,000 gallons of ammonia located at HBGS and life-threatening physical hazards, such as radiant heat from fires.

#### Top Lander Emergency Responsibilities

Top Landers were responsible for the safety of workers within the CSM shoring system. They maintained a current log of workers within the excavation at any given time to ensure accountability during an emergency evacuation. The Top Lander position was maintained at any time work was being conducted within the excavation. There was a minimum of two qualified Top Landers at the job site during each shift.

In the event of an emergency, the Top Lander would be responsible for making an evacuation notification to the excavation workers via radio or air horn. The Top Lander would then call the site emergency number to notify the proper response agencies. The role of Top Lander was a designated position that required a Job Performance Measure (JPM) and was tracked in the IQ system.

An example of a response by the Top Lander occurred in early 2017, after a minor earthquake of approximately 3.6 magnitude. The Top Lander notified Supervision and Engineering,

performed a walk around and inspection of the walls and various systems and determined there was no damage. In November 2017, two magnitude 2.5 earthquakes occurred and were not felt by personnel on the site. The Top Lander was instructed that when an earthquake occurs severe enough to cause concern, don't wait for Engineering or Management, but order an immediate evacuation.

#### Humboldt Bay Fire Department (HBFD) Rescue Measures

HBFD was the primary rescue agency for any emergency event on site. HBFD professionals were trained to perform extrications using high-angle rescue techniques. High-angle is the variety of technical rope used to rescue injured or otherwise incapacitated persons on terrain at slopes of 60 degrees or greater, or from the bottom of an excavation like the Caisson removal project. It involves the need to hoist victims from one level to another using ropes, pulleys, harnesses, stokes baskets, or other various hauling devices. The fire department would utilize rigging systems designed to either lower firefighters into the excavation or raise injured workers out. Several planning meetings took place with the HBFD Assistant Chief and Battalion Chief to discuss the scope of work and possible rescue scenarios that could be encountered during all phases of the Caisson removal.

#### On-Site Simulated Drill Involving Mutual-Aid Departments

Simulated drills involving agencies that would respond to an emergency were conducted to test the readiness of rescue plans. The primary rescue would come from the HBFD. It was also important to involve other local fire departments, who have mutual-aid agreements with HBFD. HBPP Security played an active role in all on-site drills. The HBFD Fire Chief's concern was that his resources could be committed to other incidents and not be available for a timely response. Incidents such as large structure fires, wild fires or earthquakes could severely impact capabilities. For this reason, it was necessary to include surrounding departments that could be called to perform rescues. Five departments, coming from Loleta, Fortuna, the local ambulance service, HBPP Security, the Caisson removal work crew and others, participated in on-site drills. There was a drill conducted prior to the start of excavation, followed by additional drills as the excavation progressed.

#### Caisson Ventilation System

Caisson decommissioning required an excavation approximately 110 feet in diameter and 100 feet deep. During the excavation, up to twelve crew members worked within the shoring system. Four pieces of equipment in the 20-ton to 60-ton rating were normally inside the excavation. Due to the operation of motorized diesel equipment, the environment inside the excavation could have contained less than adequate air quality for the workers. A 36,000 cfm exhaust ventilation system was employed to ensure noxious gases and fumes from the equipment exhaust were removed, thereby providing a safe work environment for workers within the excavation.

The ventilation system exhausted air from inside the excavation cavity at sufficient volumes to keep potential contaminants such as CO, CO<sub>2</sub>, NO<sub>2</sub>, NO, SO<sub>2</sub> and diesel particulates at acceptable levels. In addition, air quality monitoring and testing of the environment was continuously performed to ensure worker safety.

During excavation, pockets of radiologically-contaminated soil, embedded piping and concrete had potential to result in low-levels of airborne radioactive contamination. Inside the excavation, airborne radioactivity was monitored for worker safety. Airborne radioactivity monitoring was provided at or near the ventilation exhausts plenum to monitor for ODCM airborne radioactivity compliance. Excavation operations could be shut down if necessary to ensure that airborne radioactivity would not endanger public or worker safety.

#### **9.1.10.6 Demobilization of Caisson Equipment**

The stair tower was demobilized upon completion of excavating the Caisson. This included removing the attached communication lines, equipment fueling lines and emergency response equipment. At this time, the ventilation system was also removed. See Section 9.1.10.8 for information about demolition and excavation equipment removal.

#### **9.1.10.7 Backfill**

After the FSS was completed and support equipment was removed, the CWC backfilled the Caisson using stockpiled materials that had passed all survey criteria. A telestacker (conveyor belt system) was used to transport reuse materials that had been stockpiled at the Discharge Canal into the Caisson. The reuse materials were pushed with a caterpillar to an excavator, that loaded the conveyor system that deposited the materials into the Caisson excavation. Once this stockpile of materials was exhausted, dump trucks were used to continue the filling process of the Caisson excavation to approximately 20 feet below the top. This remaining reuse material was stored on the hillside above the Caisson excavation. This material was leveled with long-reach excavators, then crushed reuse concrete from the site was placed on top, using dump trucks. A bulldozer was placed back into the excavation to level the concrete in preparation for a clay layer to be placed. The clay layer was placed over the crushed concrete, capping it at approximately 10 feet below the top of the Caisson excavation. Geo-Tec fabric was placed over the clay and the remaining 10 feet were compacted. Compaction started with 12-inch lifts, finishing the top 3 feet in 8-inch lifts, until final compaction was met.

The clay layer and Geo-Tec fabric formed a protective pH barrier to prevent the concrete from affecting the existing water table. By utilizing multiple backfill methods (i.e., telestacker, long-reach excavators, caterpillar and compaction equipment), the CWC performed the scope of work ahead of the original forecast. The final 10 feet of backfill material was compacted at a 95 percent compaction rate to fulfill engineering requirements for future parking, road construction and heavy-equipment storage areas.

Demobilization from the Caisson backfill included cleaning, surveying and removing all the equipment used for the backfill process, including the Eco-block barrier installed at the excavation perimeter. It required that the impermeable layer installed to protect areas already in the FSS be removed; the capping off of any sampling wells in the area that could not be done earlier, based on critical path activities; and the FSS of the remaining HMS excavation that was not completed earlier in the project.

#### **9.1.10.8 Equipment**

Demolition and excavation equipment included the following:



- Four excavators of various sizes, fitted with demolition shears, processors, buckets and hammers;
- A dozer, front-end loaders, forklifts and monsoon misters for dust suppression;
- A crane and tele-dipper for lifting debris from the excavation and loading into trucks;
- Two 65-ton cranes and one 275-ton crane;
- A skid steer loader and sinking muck buckets for moving dirt and debris;
- Dump trucks of various sizes and configurations;
- A dedicated pickup truck and UTV; and
- A fuel/lube truck and a welding truck for equipment support.

The equipment was pulled from the deep excavation with approved rigging plans, using a 275-ton crane. Decontamination was performed and the machinery was free released by RP. After decontamination and free release, other remaining support equipment was sent to the recycler or asset recovery (i.e., ventilation components and stair tower).

### **9.1.11 CWC Project Staffing**

#### **9.1.11.1 Program Manager**

The CWC Program Manager created, oversaw and implemented the decommissioning program execution strategy. The Program Manager had oversight of the decommissioning program's purpose and the status of its projects in order to support informed decision-making that ensured program goals were met. The goals were intended to manage cross-project dependencies, which the PMO may not have been able to identify. The Program Manager was tasked with seeking out information from the PMs to identify risks, issues, requirements, designs, or solutions to usefully manage these dependencies.

#### **9.1.11.2 Project Management**

The CWC PMs controlled the time, cost and quality of the decommissioning project. They had many duties, which included: planning and managing schedules for contractors and subcontractors; overseeing project progress; reporting on the progress of project timelines and adjustments; inspecting projects to monitor compliance with regulations, such as building and safety codes; and preparing, negotiating and revising contracts with engineers, consultants, clients, suppliers and subcontractors. The PMs took action to deal with the results of delays, bad weather, or emergencies at the construction site. They conferred with supervisory personnel, owners, contractors and design professionals to discuss and resolve matters such as work procedures, complaints and construction problems.

#### **9.1.11.3 Craft Supervision**

CWC Craft Supervision oversaw and coordinated the activities of Craft workers in the field. They conveyed the scope and expected progression of the job to workers each day and ensured that required materials and supplies were available. They also made sure that decommissioning tasks were assigned to workers with the proper skillsets, as required in the WP. The Supervisor was a liaison for other disciplines to their crew, which ensured that foreseeable hazards were identified, communicated and mitigated. Other duties of Craft Supervisors included: inspecting work to ensure conformance with specifications defined in the WP; allocating work as determined by job size and scope; supervising support Craft assigned to



their WP; selecting large equipment to be used; conducting morning tailboard meetings; performing Job Safety Analysis; serving as the task specific “Competent Person;” and serving as a first responder, if they had the proper training, experience and credentials to so do.

#### **9.1.11.4 Financial and Business Administration**

The Business Administration group was responsible for a variety of project duties. The group was overseen by the CWC Prime Contracts Administrator, who was also responsible for the creation, management and payment of the CWC’s vendor contracts. Other members of the group provided IT Support, Craft Payroll and Warehouse Administration.

#### **9.1.11.5 Project Controls**

The CWC Project Controls group acted as an independent voice for the project. Project Controls provided management tools, which were used as aids in decision-making. Their insights were created with quantitative and qualitative analytical processes that monitored and predicted project variables relating to time, cost and risk. This group aggregated and organized data from these analyses to create useful information for decision-makers. Project Controls were used through all stages of this project, from the initial proposal to post-completion analysis.

Typical tasks included strategy and planning methods to aid PMs in optimizing outcomes; developing, updating and maintaining schedules; cost estimating, cost control and value engineering; Risk Management including the Risk Register and risk assessment; and finally, combining elements of project management methodology that integrate these disciplines within the controls domain and with other project management functions.

#### **9.1.11.6 Engineering**

The CWC Engineering Department was responsible for developing, reviewing and approving drawings, calculations, WPs and field engineering, as well as developing rigging and heavy-lift plans where required.

After final WPs were approved, the CWC Engineering Department began de-staffing. The Department then transitioned from focusing on work plan development to field engineering and FSR. The Department worked with Project Management and Craft Supervision to quickly answer and resolve field construction issues. This kept work progressing in the field without disrupting the decommissioning schedule.

#### **9.1.11.7 Work Control**

The Planning Department, also known as Work Control, was under Engineering and directed by the Lead Work Control Planner. Their staff worked with field supervisors and stakeholders to create a WP that combined all the elements of a particular project. The WP documents contained approximately twenty-four sections, including drawings, calculations, estimates, procedures, check-lists and photographs. The WP was not considered field-ready until reviewed and signatures were received from Safety, Engineering, Operations, Waste, Environmental, the client and Quality Control, among others. Numerous coordination meetings and reviews were held before work was authorized to proceed.

#### 9.1.11.8 Safety

The CWC Safety Department was responsible for monitoring all safety policies in accordance with the site-specific Health and Safety Plan. This involved inspecting the decommissioning site for hazardous conditions and ensuring that Craft were following the guidelines. During their inspections, they were specifically looking for: broken equipment; defective tools and other safety hazards that put workers at risk; proper use of safety gear; proper housekeeping; and ensuring that workers knew how to properly operate equipment. They conducted safety investigations, which meant they interviewed all who were involved in an incident, determined cause and recorded the incident in the CWC Safety database. Lastly, the Safety Department oversaw tracking safety statistics to identify trends and assist Management in taking corrective actions.

#### 9.1.11.9 Document Control

The CWC Document Control Department was responsible for administering document and data management solutions, while keeping a primary focus on document control and the RMS. Throughout the duration of the project, they processed documents through procedural steps mandated by pre-established document control requirements. Examples of such requirements were the document numbering system used, to which signatures were required for certain approvals, etc. The Department received, registered, tracked and monitored documents using industry-standard document management software programs. They maintained databases and produced logs, transmittals and other reports, as required. They initiated and responded to routine correspondence related to document control. At the close of the project, they verified retention requirements and arranged cataloging, packing and long-term storage for records retention.

#### 9.1.11.10 Environmental

The CWC Environmental Department developed and implemented the SWPPP Addendum, Water Management Plan and ensured applicable local, state and federal permits for the HBPP site were being followed. The team installed static BMPs to control water and trained site personal on their duties regarding SWPPP requirements. They prepared and maintained activity logs, which were submitted to PG&E. Sampling activities outlined in work plans were conducted and results obtained and distributed to Management.

#### 9.1.11.11 Waste

The CWC Waste Department managed, packaged and prepared for shipping all radiological and hazardous waste streams during the decommissioning project, in accordance with the Waste Management Plan.

After the majority of radiological waste had left HBPP in the first quarter of 2018, the CWC Waste group was de-staffed to an appropriate level to handle the remaining hazardous and radiological waste. This was a major milestone for the project, because decommissioning waste packaging was a major cost factor.

#### 9.1.11.12 **Quality Assurance**

The CWC Quality Assurance Department developed and implemented the Contractor Quality Control Plan. They carried out inspections and followed all quality-related procedures on site and ensured activities at the site were performed following the approved method statement and inspection test plan. They compiled and submitted daily reports of decommissioning activities on the project.

#### 9.1.11.13 **Field Craft**

CWC Field Craft executed approved WPs, under the supervision of Field Oversight. They operated equipment, created construction aides and took care of site housekeeping. Field Craft was comprised of various disciplines, including Operating Engineers, Laborers, Electricians, Carpenters and Iron Workers. Local union halls provided Field Craft who had the required accreditations and skills to execute their assigned tasks. These skills were learned through on-the-job apprenticeships and classes conducted through local union halls.

#### 9.1.11.14 **PMO**

The CWC PMO included project overhead staffing and indirect costs, which could not be directly assigned to specific decommissioning activities. These costs were: trailer rentals; van transportation, including rentals and fuel; Management travel; Caisson-specific training; incidental expenses; and subsistence.

### 9.2 **Project Staffing**

See Section [1.1](#).

### 9.3 **Waste Disposal**

The upper portions of the RFB were removed prior to excavating the Caisson. Some concrete debris was used within the Caisson and suppression chamber to provide a safe and stable working base for heavy equipment. The EL. +12 to EL. +2 concrete and soil were dispositioned as radwaste, due to contamination. Soil below the EL. +2 was expected to be clean or less contaminated and the Waste Management group reused as much of this soil as possible. Initially, the CWC extracted soil from the area between the Caisson and the CSM wall in 4-foot lifts. Radiologically-impacted concrete and steel and the top 1-foot layer of surrounding soil mixed with concrete debris were removed as waste. The remaining 3 feet of soil were removed and analyzed for reuse on site. However, due to concrete debris from the excavation and comingled material, the soil between the EL. +2 and EL. -6 could not be saved for reuse. Removal techniques and operations improved each lift, resulting in an increased percentage of soil preserved for reuse. As the CWC progressed in Caisson demolition, work performance improved and by mid-June 2017, the CWC had transitioned into 6-foot lifts to maximize the amount of reusable soil.

#### 9.3.1.1 **Soil and Concrete Waste**

Concrete and soil waste materials were taken to the SMF for preparation and packaging. Materials were crushed and sized to adhere to waste disposal facilities' disposal incentives.

Once crushed, the waste material was loaded into IP-1 bags destined to go to Andrews. Other materials were loaded into IP-1 IMs for shipment to Grand View.

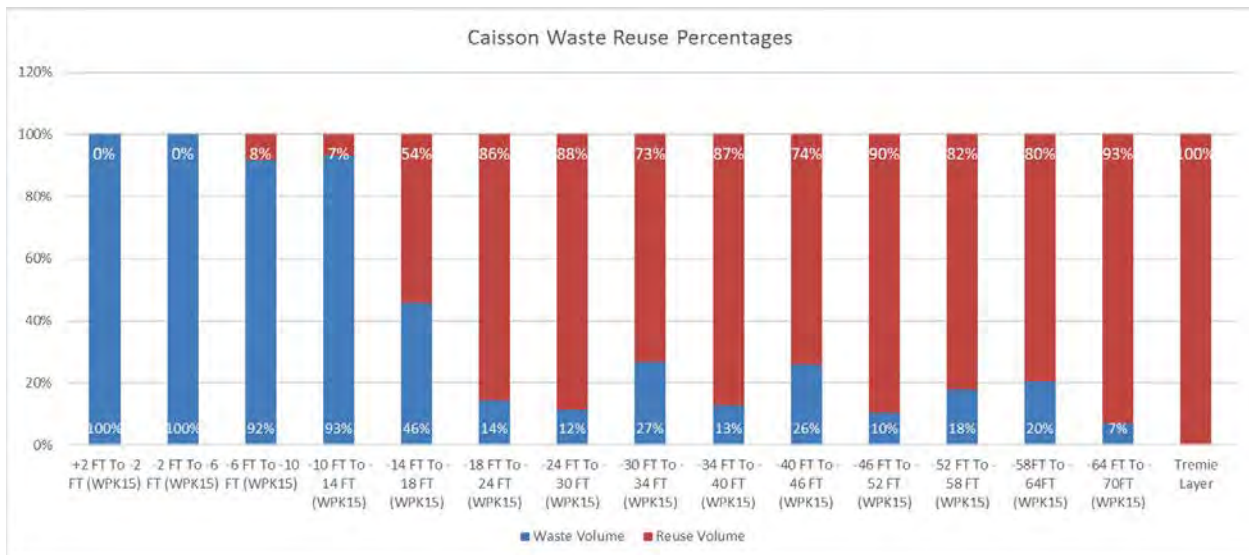
### 9.3.1.2 Soil Reuse

After removal of the 1-foot layer, soil samples were taken to verify the material met soil reuse criteria. The soil was then removed and analyzed in the GARDIAN system (as described in Section 4.1.1.6.2, GARDIAN System Installation). Reuse soil was then deposited in a reuse stockpile or used as backfill on site.

The CWC was tasked to reuse soil from the Caisson excavation as much as possible on site. The waste volume forecast was based on the assumption that 75 percent of the soil from the Caisson excavation could be screened for reuse on site and only 25 percent of the volume would be classified as waste. The screening criteria included routing excavated soil material in dump trucks through the GARDIAN system. The screening criteria required the soil material be below 5 picocuries-per-gram (pCi/g) Cs-137, to ensure the DCGL of 7 pCi/g was not exceeded for 10 CFR §50 License Termination. As shown in Figure 9-5, the CWC initially had difficulty achieving the desired reuse volumes, due to cross-contamination of clean soil with contaminated soil, metal and concrete debris from the demolition process.

Contrary to the original 75 percent reuse estimate, initially 0 percent of the soil was reused. The CWC ultimately developed better methods and processes for protecting the reuse soil and minimizing cross-contamination, thereby increasing the volume of reuse soil. The improved CWC methods, including removal of a sacrificial soil layer, control of material and focused remediation, resulted in an aggregate soil reuse volume of 65 percent. This percentage equates to more than 300,000 cubic feet of waste and a cost avoidance of about seven hundred, thirty-one waste shipments, for a potential cost savings of \$12M in overrun if the reuse percentage had not been improved by the CWC.

**Figure 9-5, Caisson Waste/Reuse Percentages**



### 9.3.1.3 Piping, Structural Steel and Rebar

During Caisson waste planning, a risk evaluation determined that Caisson piping would be disposed of at Clive. A small portion of the structural steel in the Caisson had elevated levels of radiation and was also sent to Clive. Metal waste (piping, structural steel and rebar) was direct-loaded into IMs and sent to Grand View, Andrews and Clive, based on radiological conditions established during the waste categorization process.

## 9.4 License Termination Survey

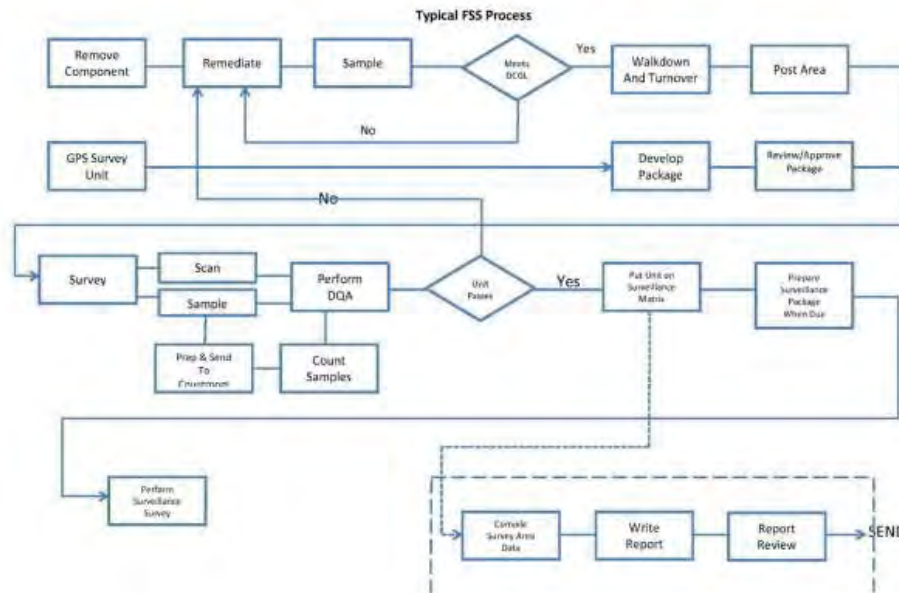
Ensuring the accuracy of site characterization and Historical Site Assessment was the responsibility of the Site Closure organization. The organization was also responsible for maintaining and submitting updates to the LTP. Specific duties pertaining to Caisson decommissioning and remediation activities at HBPP included ensuring that turnover surveys were completed; soils and groundwater Derived Concentration Guidelines (DCGL) for FSS were complied with; surveys were documented; procedures and programs were revised; NRC oversight was coordinated; and reports to the NRC and State of California regulators were produced properly.

The organization was managed by a Site Closure Manager. A lead Project Planner working for this group developed the LTP, which provided the plan for the site to be radiologically cleared and released for unrestricted use. The LTP application was submitted to the NRC as an amendment to the Facility Operating License No. DPR-7 for HBPP, Unit 3. Submittal of an LTP to the NRC for approval was required at least two years in advance of license termination. It provided detailed site characterization; descriptions of remaining dismantlement activities; plans for site remediation; technical data for development of site-specific DCGL; methods for FSS of excavated soils for reuse; detailed plans for the final radiological survey; description of the end state of the site; updated site-specific estimations of the remaining decommissioning costs; and an update to the site environmental report. Based on experience gained from other decommissioned sites, submittal of this plan as early as practical facilitated early end-state decisions and provided increased opportunities for stakeholder involvement.

The LTP was submitted to the NRC in May 2013. NRC requests for additional information on the LTP submittal were addressed and PG&E continued to assist the NRC with the environmental assessment for the LTP to be approved. The LTP was ultimately approved by the NRC in May 2015 and added to the Defueled Safety Analysis Report (DSAR) in November 2016. Its required bi-annual review occurred in February 2018, resulting in Revision 2 of the LTP.



**Figure 9-6, Typical FSS Process**



Because of the similarity between MARSSIM and MARSAME, the FSS group prepared packages and performed surveys to disposition various materials and equipment that were or were not released from the site. Much of this type of work was performed during the demolition of the fossil-fueled units on the HBPP site. However, during Unit 3 decommissioning, there were times when it was beneficial to use the MARSAME process to plan and document surveys. These instances were for specific disposition of items, such as office trailers, major pieces of equipment and building debris. Like MARSSIM surveys, MARSAME surveys are quality records subject to NRC oversight.

#### NRC Oversight of the FSS Process

FSS staff coordinated with the NRC during decommissioning, with the NRC providing independent review of the process. Conference calls occurred on a regular basis and periodic meetings took place to update the NRC on Caisson decommissioning progress and anticipated FSS survey work. It was occasionally requested that split samples be sent to an NRC contractor for independent analysis. Additionally, the NRC contractor was at times present on site, as requested by the NRC, to monitor FSS activities and perform independent measurements of areas being surveyed.

#### Survey Unit Documentation and License Termination

When all survey units within a given larger survey area were completed, relevant documentation was compiled into a submission report to the NRC for review and approval. As a visual aid for the review, site mapping and geospatial representations were overlaid, with sample data to be included in the final area report. Once again, a quality check process was used to validate the



entire area report prior to its submittal to the NRC. Technical FSS staff answered requests for additional information during the NRC review.

A few survey area reports have been submitted for approval to the NRC, to support termination of the 10 CFR §50 License. A final report will be developed once most or all area reports have been submitted to the NRC. Requests for additional information are being addressed during the review of any final survey area packages submitted.

Implementation of this process required the following key staffing positions:

- FSS Consulting Engineer
- FSS Engineer
- FSS Report Writer
- Operations Foreman
- Radiological Control Technician/FSS Technician

Radiological Decontamination Technician/FSS Labor Count Room

The RP organization was originally assigned the responsibility of analyzing radiological samples taken in the field. That responsibility was shifted to the Site Closure organization after major radiological source terms were removed and the main concern became measuring the environmental background levels. The Count Room Supervisor managed the Foremen and Laboratory Technicians to ensure work in the Laboratory was performed safely, correctly and in a timely manner. The Count Room functional area was responsible for: analyzing radiological constituents of work area and environmental samples; calibrating and maintaining instrumentation; evaluating post-decommissioning status relative to DCGL; revising procedures and programs; assisting FSS with ISOCS surveys; operation of the GARDIAN trailers and generating reports to the NRC and State of California regulators.

Final Status Survey Staffing

The FSS was staffed by experienced site termination professionals and technicians. Within the group were individuals with experience from SONGS Unit 1, Yankee Rowe, Fermi 1, Maine Yankee, Connecticut Yankee and various DOE and research reactor and facility decommissioning. In addition to the personnel with experience from other projects, locally-hired personnel, trained and qualified by the RP group, transferred to FSS roles to augment the experienced core group of technicians.

Final Status Survey Consulting Engineer

The FSS Consulting Engineer advised the FSS Supervisor on technical matters regarding the development and operation of the FSS Program. This position was responsible for developing and maintaining procedures, processes, technical basis, license basis and license termination plans and documents. The FSS Consulting Engineer advised Management and staff on how to complete assigned tasks, in addition to providing guidance on how to interact with stakeholders and regulatory agencies.

Final Status Survey Engineer

The FSS Engineer planned and developed survey packages and supporting documentation (i.e., technical position papers, procedures, work instructions and calculations). This position

was responsible for developing and maintaining procedures, processes and plans for executing MARSSIM-compliant implementation strategies to support effective FSS. This included the compilations of data and reports.

#### Final Status Survey Report Writer

The FSS Report Writer prepared and packaged the FSS-related documentation and data required to support license termination. The FSS Report Writer assisted the FSS Engineer(s) and FSS Consulting Engineer in the preparation of survey packages and other FSS program documentation, including regulatory submittals, LTP and Data Quality Analysis reports.

#### Final Status Survey Foreman

The FSS Foreman provided guidance to FSS Technicians. The FSS Foreman provided radiological safety input for planning activities at the site and conferred with cross-departmental Supervision and Management to ensure support of scheduled activities.

#### Final Status Survey Technician

The FSS Technician ensured the project was successfully completed, while maintaining safety as the first priority. Personnel assigned to this position performed radiological surveys and provided that data to FSS Engineers, who would utilize the data to demonstrate the final site clearance criteria was met.

Since the FSS and RP functions were combined, these same Technicians also performed surveys for radiological release of equipment for offsite release, either utilizing a MARSAME survey package or RP procedures where no MARSAME package was deemed necessary.

### **9.5 Tools and Equipment**

Section 2.2.

### **9.6 Other**

The following costs were split between the base scope and Reactor Caisson support, based on the amount of work being performed.

#### **9.6.1 RP Discrete (Direct Labor)**

See Section 2.1

#### **9.6.2 Small Value Contracts**

See Section 6.2.1

#### **9.6.3 Specialty Contracts**

See Section 6.2.2

## **10 CANAL REMEDIATION**

Prior to shutdown of Units 1 and 2 in September 2010 and Unit 3 in 1976, water supplied from Humboldt Bay was used for once-through cooling. Because the canals were also used to cool

Unit 3, they required remediation. There were three canal sections, Fisherman's Channel, the Intake Canal and the Discharge Canal. Sea water from the bay entered Fisherman's Channel, the Intake Canal and the Intake Canal structure, in that order. Approximately one million gallons of water per day were conveyed via the Fisherman's Channel, through the Intake Canal, into the plant and discharged through the Discharge Canal. Inside the Intake structure, the water was filtered through a rotating screen device, then pumped through underground piping into the power unit condensers, then back into the underground piping, and finally into the Discharge Canal through the Discharge Canal intake structure. The water returned to the bay through the Discharge Canal outfall structure.

The canal remediation scope of work included mechanical removal of radiologically- and chemically-contaminated sediment from the Intake and Discharge Canals, demolition of the discharge outfall and levee to Humboldt Bay, demolition of the Intake and Discharge Canal headwork structures, restoration of the levee and Coastal Access Trail along the bay, management and dewatering of contaminated sediments and treatment of water to meet discharge permit requirements.

Remediation of the Intake and Discharge Canals required specific actions, including surveying, water management (water removal and treatment), shoring, asbestos abatement, demolition (Intake and Discharge structures and Discharge Canal outlet), sediment excavation and levee restoration. The end state of this scope of work was removal of clean and contaminated sediment accumulation for both canals and restoration of the levee to separate the Discharge Canal from Humboldt Bay.

**Table 10-1, Canal Remediation**

2015 NDCTP ID		Approved NDCTP Estimates		Amount Spent Presented for Reasonableness		
		Base	Nominal	2012-2014	2015-2018	Total
	Canals	67,946,813	72,604,876	8,379,236	38,670,562	47,049,798
	2012 NDCTP CPUC Filing	23,704,100	25,642,441	8,379,236		8,379,236
	Canal Removal	12,580,790	13,386,673	8,379,236	-	8,379,236
	Canal Disposal	11,123,310	12,255,768	-	-	-
	2015 NDCTP CPUC Filing	44,242,713	46,962,435		38,670,562	38,670,562
	Canal Removal	32,582,306	33,939,883	-	32,095,069	32,095,069
	Canal Disposal	11,660,406	13,022,552	-	6,575,493	6,575,493

Actual costs during 2012 through 2014 for Canal Remediation being presented for review were \$8.4M. Actual costs 2015 through 2018 were \$38.7M compared to the approved cost estimate of \$47.0M.

A considerable amount of work was required to prepare the two canals for remediation, including installation of a water PTS (See Section 11.2.1), construction of temporary paved roads and a paved laydown area, installation of temporary power and other associated tasks. Canal Disposal was underspent relative to the approved 2015 estimate due to unexpected results of radiological surveys of the 3-foot thick clay liner in the Discharge Canal. Originally, the entire 3 foot depth of the clay layer was planned for removal however the RP surveys indicated only the top 6 inches needed to be removed. The result was a major reduction in disposal volume for the clay liner. See Section 10.1.2.6. In addition, only approximately 40% of the Intake Canal concrete structure was removed, resulting in additional disposal savings. See Section 10.1.4.

## 10.1 Canal Remediation

Low levels of radiological and chemical constituents were known to have previously contaminated the Intake and Discharge Canals. Cs-137 was the primary radionuclide of concern. Chemical contaminants included heavy metals and polycyclic aromatic hydrocarbons in the Discharge Canal and total petroleum hydrocarbons (motor oil) in the Intake Canal. The radiological contamination present in the Intake Canal was due to an event around 1973, when a radiologically-contaminated liquid spill made its way into the North Yard Drain System and ultimately to the Intake Canal, contaminating the area in the northeast corner of the canal near the Intake structure and storm drain outlet.

The activity present in the Discharge Canal was due to NRC-licensed low-level liquid radwaste discharges and other operating events during Unit 3 operational periods. The Discharge Canal had been the permitted release point for the LRW system. The canal bottoms were a clay-like mixture. The permitted releases to the canal settled on the bottom and were expected to be retained by the clay particles, concentrating LLRW over time. Initial canal characterization performed in 1998, identified activity at depths of up to 2 feet in accumulated sediment in the canal. After the initial characterization, radioactive discharges continued during SAFSTOR, which were projected to have likely increased the activity present in the sediment. Additionally, heavy silting occurred in the Discharge Canal after the cooling water to the fossil units was shut down, which was thought to place the activity at greater depths.

The NRC required HBPP to demonstrate site mitigation of residual radiological exposure at or below twenty-five (25) millirem per year (ALARA). In 2012, PG&E assumed a "Residential Farmer Scenario" for purposes of calculating exposure, which assumption was approved in the 2012 NDCTP. In 2012, HBPP altered the scope of this project to include demolition of the Intake Canal and Discharge Canal concrete structures, and removal of silt and sediment with excavation extending 6 inches into the walls and bottom of the canal. To meet the Residential Farmer Scenario standard in the near term, PG&E concluded that approximately 24,000 cubic feet of material would need to be removed from the Intake Canal and 160,000 cubic feet removed from the Discharge Canal.

### 10.1.1 Intake and Discharge Canals Remediation Scope of Work

Specific scopes of work for remediation of the Intake and Discharge Canals and restoration of the wetlands and tidal areas included the following:

- Obtain required permits from regulatory agencies to perform the work. The Intake and Discharge Canal permit required that HBPP participate in mitigation efforts to improve the area, provide for marine and aquatic species and provide environmental habitat restoration.
- Install paving for the primary travel paths around SMF1 and 2 and the general staging area at the former Trailer City location.
- Install a water PTS on the input side of the existing GWTS.
- Seine the canals at the start of remediation, to remove and relocate animals and sensitive species.
- Isolate canals from Humboldt Bay influences.
- Dewater the canals and continually manage and dewater sediments and transfer water.

- Mechanically remove clean and radiologically- and chemically-contaminated sediment from the Intake and Discharge Canals.
- Demolish or remove the existing discharge outfall structure, which connected the Discharge Canal to Humboldt Bay and consisted of four 60-foot long, 48-inch diameter asbestos-bonded pipes and concrete structure.
- Demolish the Intake Canal intake structure and Discharge Canal input structures.
- Remove discharge pipes and concrete appurtenances.
- Remove the riprap around the outfall and up to 3 feet of sediment.
- Remediate Discharge Canal impacted riprap within the cofferdam area.
- Conduct remediation with radiological and chemical sampling around the outfall to confirm LTP and chemical remediation requirements were met.
- Restore the levee and Coastal Access Trail along the bay.
- Demolish the Intake Canal structure, which involved removing and disposing of the approximately a 27-foot long by 13-foot wide by 18-foot tall concrete Discharge structure. Recondition the surrounding areas with slope and drainage toward the canal, to prepare for returning the canal to use.
- Excavate contaminated sediment to the clay liner and remove riprap to enable PG&E to conduct License Termination Survey (LTS) in support of its NRC license termination. Excavation beyond the limits set forth in the drawings and specifications to continue as necessary until the DCGL have been met.
- Construct a cofferdam in the Intake Canal east of the walking bridge, surrounding the known area of concern to prevent tidal flow into this portion of the canal.
- Remove contaminated sediment up to a depth of 2 feet below the as-found surveyed bottom of the Intake Canal, with continual dewatering.
- Removal of Intake Canal sediment to establish the former shape.
- Restore and mitigate the Intake and Discharge Canals to the surrounding site areas to meet CDP requirements.
- Implement soil and erosion control measures in work areas, including placement of BMPs to protect against storm water pollution and to protect adjacent wetlands.

The following equipment was used for remediation of the canals:

- Company vehicles (light-duty trucks);
- 350-ton crane;
- 150-ton crane;
- 35-ton crane;
- Hydraulic excavator;
- Wheel loader;
- Backhoe;
- D6 Dozer;
- Motor grader;
- Motor scraper;
- Smooth drum roller;
- 4,000-gallon water truck;
- Double drum compaction rollers;
- Articulated dump trucks;

- Tractor/trailer transfer truck;
- Forklift;
- Aerial lift to perform radiological surveys;
- Pile driver; and
- Numerous motor-driven and electric pumps.

### 10.1.2 Discharge Canal

The Discharge Canal was located on the northern portion of the HBPP property. The Discharge Canal was originally 360 feet long by 20 feet wide, with the bottom at a depth of approximately 7 feet below El. 0 Mean Lower Low Water (MLLW). The embankment height was 12 feet above the MLLW, with the side walls lined with riprap at a slope of 1.5:1. It was surrounded by higher-elevation industrial lands to the west and a temporary construction laydown facility to the east. There were four 48-inch diameter, unscreened outfall pipes connecting the Discharge Canal to Humboldt Bay.

During plant operation, the Discharge Canal was the final ponding location for cooling water from operating units before it entered Humboldt Bay. It was used to allow the temperature of water to normalize and for the settling of potential sediments and contaminants. In addition to sea water, effluent discharges entering the canal included the radwaste discharge and laundry discharge lines, fossil unit settling ponds, storm water, oily water separator and low-volume waste water, consisting of evaporator blow-down water. The chemical contaminants in the effluents included heavy metals and polycyclic aromatic hydrocarbons. Discharge effluents would go directly to the canal. Low-volume waste (oily water separator overflows) and boiler blow-down containing heavy metals were discharged through the settling ponds and a filtration system. Normal releases to the canal allowed some waste compounds to contact the material on the bottom and be retained by the clay particles. Each of these allowed effluents was included as a part of the operating discharge permits for the HBPP site.

Treated water from the liquid radioactive waste processing system was regulated under existing NRC requirements in Appendix B to 10 CFR §20 and 10 CFR §50 Appendix I. These regulations allowed for treated liquid radwaste to be diluted in the cooling water discharge of Units 1, 2 and 3. After Unit 3 was shut down, the discharges of LRW were reduced and there were still large quantities of cooling water from Fossil Units 1 and 2 to dilute the water. After shutdown of the fossil units in 2010, the liquid radioactive effluent discharge was no longer diluted by circulating water and discharges needed to be timed to coincide with high-tide to continue to achieve acceptable dilution ratios. Absent the high flow rates from the power unit cooling discharges, sediment began accumulating in the Discharge Canal. Even with adequate dilution ratios, tidal flows were insufficient to prevent sediment accumulation, leading to the potential for radioactive waste constituents to become trapped in the sediment.

Initial characterization of the sediment in the Discharge Canal in 1998 resulted in several samples with elevated Cs-137 concentrations and activity at depths up to 2 feet in the sediment. After initial characterization, permitted radioactive discharges from the liquid radwaste system continued. This was anticipated to result in a potential increase to the sampled activity in the sediment and silting layer. Sediment samples taken at the time indicated concentrations up to 20 pCi/g (3 times the DCGL) at the south end of the Discharge Canal. As a result of this sampling and the expected continued use of the Discharge Canal as a radioactive liquid effluent



pathway post shutdown, the area of the Discharge Canal was identified in the initial site characterization as Class 1, requiring subsequent remediation and evaluation.

After termination of the flushing cooling water flows from Units 1 and 2, the sediment layer thickened significantly with sand and silt material. The accumulated sediments included naturally occurring materials carried on the ebbing and flowing tides mixed with radioactive chemical contaminants, which had been discharged, a portion of which settled in the canal sediments. Routine discharges of liquid radwaste continued until December 2013. After that, any liquid radwaste was treated and shipped to an offsite facility for disposal. At the time remediation began, the expected condition of the Discharge Canal would be the layer of sediment containing the radioactivity identified during the initial characterization, plus an upper layer of potentially contaminated sediment accumulated in the absence of circulating water flow.

After dewatering the Discharge Canal, the remaining material was semi-liquid in nature. Even after substantial material removal and continual dewatering, access to the canal to complete required surveys by FSS required use of movable planks. The original plan and estimate assumed selective removal of higher-activity-level material from lower-activity-level material.

Prior to installation in the early 1960s, the discharge pipes (four each, 60 feet in length by 48 inches in diameter) to Humboldt Bay were coated with an asbestos-containing coating. The structure that housed the pipes and the soil underneath were treated as ACM, remediated and disposed of accordingly. The CWC removed the piping and concrete to the extent practical, with the remainder surveyed by FSS and left in place. The excavation was backfilled and the sea wall was rebuilt.

After reviewing the appropriate environmental permit conditions, PG&E determined that it was acceptable to leave part of the south end discharge headwall concrete foundation in place.

The CDP included requirements to maintain public access to the Coastal Access Trail. Recognizing that some work required closure of the trail, PG&E agreed to limit trail closure time to one hundred, twenty-seven days. As a result, closure and work activities had to be scheduled around the number of closure days. The CWC designed a temporary Coastal Access Trail to allow safe public access through HBPP during the discharge pipe removal. This temporary reroute enabled Discharge Canal field work to proceed within the closure requirements outlined in the CDP. The work was successfully completed in the fall of 2016.

#### **10.1.2.1 Mobilization and Site Preparation for Discharge Canal Remediation**

Several mobilization activities were required prior to field work. The CWC initiated work in June 2014. To prepare the Discharge Canal for remediation activities, temporary roads were built. The temporary laydown area was prepared and paved. Temporary power was installed at the temporary laydown area to support the PTS and dewatering operations. See Section 11.2 for water treatment discussion. The PTS was installed south of the current GWTS, located in the area formerly known as Trailer City. The CWC completed the preparatory work in August 2014.

#### **10.1.2.2 Grading and Paving**

Before field work could begin, a “cleanable” working surface was constructed for staging of equipment, dewatering spoils and staging materials prior to offsite shipment. To accomplish this, several roads were modified to comply with BMPs.

Grading and paving activities associated with the mobilization and site preparation scope of work included construction of temporary paved roads and construction of a temporary laydown area in Trailer City. Under this scope of work, temporary paved roads were constructed in the temporary laydown area from D-Com Avenue, and from the northern end of the Discharge Canal outlet into the temporary laydown area. Paved roads were necessary to provide a cleanable traffic surface to ensure BMPs; prevent further contamination of subgrade soils; and for heavy truck and equipment traffic. Temporary roads were installed using either existing compacted gravel base or an imported aggregate base. The base was overlain with Hot Mix Asphalt (HMA). A small section of road from the northern end of the Discharge Canal outlet into the temporary laydown area was standard HMA pavement and designed for a minimal amount of truck trips per day over a short duration. The road into the temporary laydown area from D-Com Avenue was constructed of heavy duty HMA pavement, capable of handling 200 large truck vehicle trips per week. The temporary laydown area was constructed of standard HMA pavement. The estimated size of the laydown area was approximately 300 feet by 120 feet.

#### **10.1.2.3 Equipment Mobilization**

When equipment arrived on site, it was moved to one of the temporary staging areas located in the existing Trailer City area and/or off site. Once in the temporary staging area, the equipment was inspected to ensure it was operational, safe and free from foreign material (dirt, mud, etc.). Hoses were inspected for cracks, loose fittings and leaks. Commercial vehicles and trucks were inspected to ensure they passed Level II DOT inspection. Additionally, under the California Air Resources Control Board's (CARB) Airborne Toxic Control Measure, portable equipment with diesel-fueled engines having a rated brake horsepower of 50 and greater  $\geq 50$  bhp were registered as part of the statewide Portable Equipment Registration Program (PERP). Portable equipment such as air compressors, concrete pumps, tub grinders, wood chippers, water pumps, drill rigs, pile drivers, rock drills, abrasive blasters, aggregate screening and crushing plants, concrete batch plants and welders were subject to the PERP requirement (CARB, 2011).

#### **10.1.2.4 Installation of a Water Pretreatment System (PTS)**

Initial dewatering of the lower levels of water in the Discharge Canal resulted in turbidity levels in excess of the maximum turbidity specification for the inlet to the GWTS. In order to meet the maximum turbidity specification for the inlet to the GWTS, additional settling time to reduce particulate loading of the water to reduce turbidity was required. After considering other methods of treatment, the CWC chose to install a temporary passive PTS, consisting of additional tankage and bag filters. The additional tankage in this system allowed for more settling time outside the field work area, thereby reducing the particle loading going into the GWTS.

The PTS was installed adjacent to the Discharge Canal and the existing PG&E GWTS in the Trailer City area. The PTS was designed to settle, filter and convey collected dewatering water, groundwater, and storm water to the existing GWTS, and storm water at a maximum flow rate of 300 gpm to the existing GWTS.

#### **10.1.2.5 Discharge Canal Field Work**

Prior to commencing field work, LRW discharges to the canal had stopped and storm water discharges to the canal were rerouted. Discharge Canal field work commenced August 2014.

The Discharge Canal was isolated from Humboldt Bay tidal waters to remediate the soil and remove asbestos-coated pipes that provided a connection between the Discharge Canal and the bay. Isolation was achieved by installing a sheet-pile coffer dam in the bay just outside the canal discharge pipes, to isolate the discharge pipes and the Discharge Canal from the bay. Once the coffer dam was installed, fish were removed from the canal by Biologists and then the canal was dewatered.

Once dewatered, the riprap, sediment and part of the clay liner were removed. FSS was then performed, allowing the area to be used for staging of radiologically-clean CSM spoils.

#### 10.1.2.5.1 **Coffer Dam Installation and Canal Isolation**

Originally, the canal remediation specialty contractor proposed to install a sheet pile coffer dam, which would have required work from a marine crane barge to install the sheet pile. Steel sheet pile cutoff walls are most commonly used in deep excavations as a method of separation from tidal waters and the excavation area. Sheet pile walls are constructed by driving prefabricated sections of steel panels into the ground. The full wall is formed by connecting the joints of adjacent sheet pile sections in sequential installation. The canal cutoff wall permitted dewatering of the excavation area to allow the construction crews to perform the work in the dry and eliminate potential construction turbidity in the bay.

Equipment on the barge would have been diesel-operated, and controlled by hydraulic systems, which are prone to leakage when worked vigorously. A barge anchoring system consists of four "spuds," 12 inches to 16 inches in diameter and hollow steel tubes that are sunk into the mud each time a relocation is necessary, contributing to silting in the bay.

The original design of the in-water work came from an engineering team experienced in this type of operation. The CWC specialty contractor recommended a change to the design, which represented a substantial cost reduction compared to the original design, by reducing the distance between the sheet pile wall and the shore. This reduced the amount of sheet pile utilized and eliminated the need for a marine barge. The expense of redirecting the Engineer's efforts was offset by labor and equipment savings.

Justification for this change away from a barge-based installation was primarily focused on safety of in-water work versus shore-based installation. The Humboldt Bay inlet is directly across from the plant site, which focuses wave action directly at the plant's shoreline. The location of the original sheet pile was further out in the bay. Bringing the sheet pile wall closer to shore allowed the pile driver to sit safely on a pad staged on the shoreline.

The sheet pile coffer dam was installed using a Rough Terrain Crane staged on an excavated and constructed work pad, located on the levee Coastal Access Trail footprint. Use of a man-lift assisted in the sheet pile driving support to allow for removal of the sheet pile hoisting chain when working over the water. Use of the land-based crane and man-lift proved to be cost effective and provided additional safety margins. Environmental advantages included reduced siltation from daily barge anchoring; reduced in-water work by boats and divers to place longer silt curtain; and no possibility of spilled hydraulic or diesel fuel, which would minimize schedule impacts from shutdown during spill responses.

A turbidity curtain was installed to prevent sediment from flowing into the bay during sheet pile driving process. The Coastal Access Trail was closed for a minimal time, allowing for the initial

work to take place with temporary fencing installed, closing off the trail during initial sheet pile installation and canal dewatering.

A mesh blocking net was used to prevent fish re-entry into the canal. To ensure maximum aquatic species capture, a triple net sweep was conducted. The fish seining and removal effort met the U.S. Fish & Wildlife Service (USFWS) requirements to minimize entrainment of the protected Tidewater Goby larvae. Low pools were hand-netted and fish were relocated by biologists.

After sheet pile installation, electric- and diesel-powered dewatering pumps were utilized for transferring water. Because there were no construction-related impacts to the water inside the Discharge Canal during initial dewatering, the water was pumped into Humboldt Bay. After sediment-disturbing activities began, canal dewatering was directed to the GWTS, which was designed to precipitate out sediments and filter the water to established release criteria. The original dewatering plan for the canal included a secondary dewatering system, consisting of 2 and 6 horsepower pumps and a piping network into the GWTS, for secondary dewatering, which remained in service for the duration of the sediment removal project.

All dewatering processes proceeded as planned, until December 7, 2014, when a storm pounded the sheet pile wall. Despite the wall being of even height with the revetment, the force and height of the waves from the storm resulted in seawater in-leakage into the canal. In-leakage came from over the top of sheet pile and around the sides. In spite of utilizing conventional sheet pile design, the continual wave action produced constant flexing of the sheet pile walls, which created several large leaks in the wall. Two 4-inch diesel-powered pumps, operating at approximately 1600 gpm, were barely able to keep up with the inflow. It was obvious this in-leakage rate was not acceptable and a recovery plan was developed. During the recovery-planning process, the Coastal Access Trail was reopened per permit requirement, and as plans were established to readdress bay isolation from the canal to allow dewatering the canal to proceed and begin the remediation process. Recovery included installation of sump pumps between the sheet pile and the discharge pipes outside of the levee.

Following the storm event which damaged the sheet pile, the CWC decided to reduce costs by demobilizing the sub-contractor and self-performing the remainder of the work.

In-leakage through the coffer dam exceeded the capacity of the GWTS, making the remediation of the interior of the Discharge Canal challenging. The CWC prepared a multi-part plan to reduce water in-leakage by plugging the Discharge Canal pipes with inflatable bladders, placing large cement blocks in front of the plugged pipes, and pouring a cement slurry between the pipes and the cement blocks to adequately seal the area and prevent water in-leakage. Divers prepared the inside of the pipes underwater by removing debris to prevent damage to the bladders. They then installed the bladders in the discharge piping. Additionally, concrete blocks were placed on the south end of the pipe plugs and low-strength concrete to fill the gap between the blocks and bladders was pumped in. Once gross water in-leakage was reduced, remediation of the canal began.

Once the canal was dewatered through the GWTS, RP performed an evaluation of the work areas to determine the need for additional access controls and boundaries. The evaluation was intended to determine whether additional equipment and PPE that came in contact with asbestos or contaminated sediment, concrete, piping or other materials was required. The

contamination levels were found to be lower than expected, as were the levels of hydrocarbons and PCBs. As a result, no special PPE or decontamination procedures were required.

#### 10.1.2.6 Discharge Canal Remediation

Riprap was installed prior to operation of the generating units in the 1960s, to stabilize the embankments. The canal remediation plan required removal of the riprap. Due to potential for contamination, the PWP originally directed shipment of riprap off site, which came at a high cost. As an alternative to disposing the riprap, use of a pressure washer to clean it was considered, but was determined to be unacceptable, due to the inability to clean surfaces with the riprap in place.

The riprap above the normal water table was assumed radiologically clean and was stockpiled for reuse. From the waterline down, the riprap was surveyed using ISOCS. The surveys determined the riprap met the DCGL criteria for reuse. This eliminated costly labor to climb on the banks with frisking equipment, and the safety risk of falling and/or tumbling into the water. However, these surveys only addressed exposed surfaces of the riprap. To ensure the riprap was within release criteria, the riprap from the water line down to bottom of the canal slope was removed using excavators, lifting the rocks individually from the embankment and placing them directly into dump trucks. The trucks were then sent through the GARDIAN system prior to the riprap being placed in storage for possible reuse. All riprap from the Discharge Canal successfully passed through the GARDIAN system, was considered clean and was stockpiled for reuse at some stage in the process of the canal backfill operation or reconstruction of the levee and Coastal Access Trail.

The removal of years of sediment accumulation was performed next. The north half of the canal had the most accumulated sediment, being up to 3 feet in depth at some points. This accumulated sediment accounted for approximately 122,000 cubic feet of the 160,000 cubic feet removed from the entire canal. In addition to the sediment removal, the specification mandated excavation of up to 3 feet of the original clay liner placed in the Canal to minimize groundwater and contain the cooling water. Based on RP surveys, contamination had not penetrated the original clay liner past a 2-inch to 3- inch layer. This was confirmed during the excavation by RP surveys as the clay liner was removed. The actual activity level in silt and sediment during remediation and removal was found to be lower than expected. The Discharge Canal sediment was characterized with a 95 percent upper confidence limit of 2.95 pCi/g Cs-137. The characterization demonstrated that Cs-137 and chemical contamination did not migrate into the lower levels of the clay liner at the bottom of the Discharge Canal. To be conservative, the top 6 inches of clay was removed as assurance that all contamination was addressed.

During excavation, groundwater upwelled in several locations through the exposed clay liner. Even with minimal clay liner removal, several springs in the south end were exposed, causing substantial (180 gpm) in-leakage. In addition, during high tides seawater seeped through the soils of the canal at the north end, requiring additional management efforts by crews. All this in-leakage was treated in the GWTS.

In order to prevent potential spread of contamination in unexcavated material from groundwater intrusion from the exposed springs into the already excavated and surveyed area, a bladder dam was installed near the south end of the Discharge Canal, isolating approximately 20 percent of the southern Discharge Canal area. Once the decision to install a CSM wall in lieu of



the slurry wall was made, the north end of the canal was filled with CSM spoils (Section 9.1). An earthen berm created from CSM spoils was then built against the bladder dam and then built to a higher elevation than the bladder dam as a water intrusion barrier. This new soil accumulation served as a replacement dam allowing the bladder dam to be removed while continuing to protect the completed area from possible contamination. The removal of sediment and topographic surveys was performed in stages, going from north end to the south, followed by FSS and confirmatory chemical sampling.

#### 10.1.2.6.1 Discharge Canal South Headworks Removal

At the south end of Discharge Canal, a headworks structure was planned for removal. This structure enveloped the cooling water lines coming from Units 1, 2 and 3. In addition to the below-grade cooling water lines, a 4-inch diameter liquid radwaste discharge line fixed to the top of concrete the headworks structure was carefully removed before demolition could commence. In order to remove the south headworks structure, riprap and storm drain discharge lines had to be removed, and remaining exposed ends were capped.

The south Discharge area canal headworks removal was a high-risk, difficult work area. In order to remove this concrete monolith, the excavation required a 20-foot deep excavation area. The excavation area was further complicated, due to the presence of a nearby slope of approximately 85 degrees. The recommended maximum slope for the site was 67 degrees. Located at the top of this slope was a roadway, parking lot and office trailer. Removal of the office trailer, handicap parking and some of the road above was evaluated and subsequently performed, resulting in a reduction to an acceptable slope. An access ramp was then built down to the canal bottom and crane mats were placed for the excavator to sit on. The excavator at the bottom of the canal removed material and placed it in a staging location prior to the material being loaded into trucks. A second excavator and dump trucks were staged at the top of the slope to receive the rubble. Personnel access paths, ladders and barricades were placed and maintained as needed.

As previously discussed, springs erupted through the clay liner in the south Discharge Canal work area. Attempts were made to permanently stem the flow from the springs, but were not successful. Sumps were installed to address the water flow from the excavated springs to maintain water levels below the work surface during excavation and backfill. Water in-leakage was processed through the PTS and the GWTS.

A power pole located at the top of the riprap slope, at the southwest corner of the canal, had to be reinforced and carefully worked around. A Spotter was required to be with an excavator at any time it was working within proximity of the line to ensure the required 20 feet clearance.

The CWC conducted an evaluation of the effects of removal of the headworks on nearby infrastructure. It indicated that a change to the scope of work for excavation of the deep headworks structure was necessary. The sloping requirements for safe excavation would have required closure of the adjacent road for several weeks, due to the depth of the excavation required for removal of the deepest portion of the headworks structure. The road provided the only access to west side of site. Closure of the road would have created significant schedule delays in other ongoing projects, which was not acceptable. Construction of a temporary crossing of the canal was also not an option. Alternate shoring means were not acceptable, due to the location of a powerline. As a result, the CWC decided to transfer the deep headworks



structure removal scope to the WP that would eventually remove the circulation water piping later in the project.

The exposed headworks were then removed as far as possible without additional shoring requirements. The rubble was examined by RP and was disposed. The riprap was passed through the GARDIAN for eventual reuse or disposal. A second clay radwaste discharge line and two storm drain lines were cut and removed at the remaining slope and disposed of at the direction of RP and Environmental. After plugging the ends, surveyors marked the location of daylight pipe ends and left them for future removal with circulating water lines.

#### 10.1.2.6.2 Discharge Canal North Headworks Removal

Upon completion of the sediment removal in the Discharge Canal, the CWC was able to address the remaining work of removing the ACM-covered discharge pipes. The tops of these pipes were 3 feet below sea level and with the original sheet pile wall continuing to have substantial leakage, these pipes remained underwater. The specialty contractor could not remove the piping underwater because of the potential for uncontrolled spread of ACM particles. Thus, the CWC needed to isolate and drain this area from the water in-leakage.

Two safety issues needed to be addressed before the pipe removal work could be undertaken. First, a safe work area needed to be established for the crew performing the abatement behind the sheet pile coffer dam. To reduce the flexing of the sheet pile, additional structural support was needed. Second, water in-leakage issues needed to be addressed to ensure a dry work environment. The CWC engaged a marine engineering consultant to evaluate the north end Cofferdam installation and design a system that would fortify the existing sheet pile in the bay. The consultant designed a stiffening system to add to the previously-installed sheet pile, with an internal waler system, and added a southern sheet pile brace for the waler.

Design of the waler system was finalized after extensive review and acceptance by the CWC, HBPP and outside HBPP SMEs. While this system was being fabricated, other work continued in the field, including the spoils delivery from the CSM wall project, removal of riprap and building the laydown area and installation of the south waler support sheet pile. The waler system was installed, abutting the support sheet pile and functioned to reinforce the sheet pile during excavation of the 48-inch discharge pipes. This allowed personnel safe access to the area at the north end of the canal, between the levee and the sheet pile.

After reinforcement of the sheet pile, leakage continued. In order to block in-leakage of sea water, a plastic-wrapped poured-in-place concrete plug was used to seal the wall, as well as isolate the concrete from pH influences on the bay. After installation of the plug, activity completion included:

- Removal of the north headwall;
- Removal of the pipes;
- Addition of approximately 3 feet of fill below the pipes;
- Removal of the temporary trail; and
- Removal of temporary facilities, including laydown area and crane pad.

A temporary fence was installed, redirecting the Coastal Access Trail around the worksite, thereby keeping the trail open to the public during this excavation. This area was remediated

and a new levee and Coastal Access Trail was installed, similar to original one. The levee was the final permanent separation between the bay and the HBPP site.

The installation of the waler system, completion of all other work and removal of the sheet pile wall was limited by a completion date of October 15th, 2016, as that was the last day in 2016 when work in the bay could be conducted. To minimize construction impacts on aquatic species, an annual work window was permitted between June 15 and October 15 each year, referred to informally as the “fish window.” This date was set by the California Department of Fish & Wildlife (CDFW). It was paramount to the project schedule that the north end work be completed by October 15, so as to not be extended to June 2017. All materials were removed and the sheet pile wall was pulled in time to meet that deadline.

#### **10.1.2.6.3 Soil and Erosion Control Measures**

Soil and erosion control measures, including placement of BMPs, were performed in the work areas to protect against storm water pollution and to protect adjacent wetlands. Work was conducted to avoid and minimize impacts to any ecological resources. BMPs for canal activities were installed as described in the SWPPP, including the ESCP. BMPs included the installation of erosion, sediment and dust control measures. BMPs installed during implementation of this scope of work remained and were inspected and maintained daily for the duration of the canal work.

#### **10.1.2.6.4 Specific Challenges**

The project encountered several specific challenges, including wetland protection issues, traffic congestion and a series of severe storms.

The location of preexisting seasonal wetlands adjacent to the Discharge Canal interfered with required canal remediation activities. Wetlands located in this area were under the jurisdiction of the USACE (total 0.14 ha [0.06 ac]) and the CCC (an additional area of 0.04 ha [0.10 ac]). The impact to the wetland was mitigated by optimizing and upgrading a portion of the existing wetland (0.328 ac) that was created in the Buhne Point Preserve as part of HBGS mitigation. This plan by HBPP’s Environmental Manager saved the project from potential violations and more expensive mitigation costs, had the exchange not been accommodated. This exchange also eliminated the need to maintain active biological monitoring of the area until the project was completed, having a positive impact for both schedule and cost. Mitigation of these wetlands allowed elimination of the use of constant Spotters, hard protection from trucks and equipment, frequent BMP freshening and replacement, and would have not likely endured the construction disruption surrounding them.

The Discharge Canal remediation included temporary roads and a traffic control plan. Site coordination of waste transport, hauling riprap and soils through the GARDIAN system, then to a designated storage location for reuse or disposal required timing and coordination with other projects that needed these same GARDIAN survey services was challenging. This coordination required good communications and planning with fully-engaged site teams. Preparation and management of expanded laydown areas with erosion and sediment controls added to the coordination effort.

#### **Storms and Extreme Weather**

Working next to Humboldt Bay, directly across from the mouth to the Pacific Ocean led to some unexpected conditions during king high tides and winter storm waves. A series of storms challenged the Discharge Canal project. These storms, in conjunction with king high tides, passed through the Eureka area in late 2014 and late 2015, carrying high winds of 25 mph to 35 mph, with gusts up to 50 mph. This created strong surf and 15-foot to 18-foot waves, which caused substantial damage to the Coastal Access Trail and the Discharge Canal. The entire canal was filled with an estimated 1.4M gallons of storm and sea water in less than 45 minutes during the 2014 event. With the GWTS capacity at approximately 300 gpm, it took a number of days to process the accumulated water. In addition to the unexpected flood, excavation materials (such as crane mats) used to support excavators and the ramp into the canal required resetting and reconstruction, resulting in substantial setbacks to the canal remediation project. Levee and canal protection barriers were installed to mitigate future potential storm impacts. A modification to the GWTS completed in the fall of 2015, resulted in increased capacity and allowed recovery that was faster than recovery efforts from the previous storms.

On December 11, 2015, another severe storm pounded the north end of the canal. The CWC had been aware of an impending storm and stocked riprap on the north end, inside the Coastal Access Trail boundary, in a manner that was intended to stem the inflow of storm surge and waves. The severity of the storm overran the riprap and again, the canal and surrounding area were flooded.

Recovery operations instituted to dewater the canal once again. Water was pumped to the PTS and GWTS over the course of several days. Additionally, fencing, roads and riprap repairs were performed to get the canal ready to receive additional spoils.

Based on previous storm experience, a temporary rock energy dissipater wall was installed along the south side of the Coastal Access Trail, to divert high seas and direct water away from the canal area, where the spoils from the CSM excavation resided, and to avoid washouts of the CSM Discharge Canal fill material into the bay.

#### 10.1.2.6.5 RP, Craft, and Waste Support

RP personnel monitored demolition and disposal process activities for contamination, utilizing survey and monitoring equipment for soils, riprap, concrete and equipment exiting the canal. The RP Team included two RP Technicians and two RP Deconners, as well as an RP Supervisor.

The Craft group included Equipment Operators, Spotters, Divers, Laborers, Waste Handlers and Supervisors. Carpenters and Electrical personnel had occasional support duties. Laborers provided BMP controls, which were frequently in need of repairs and relocation, due to changing conditions.

The Waste group supplied IMs, bags and waste containers. A higher-than-expected labor effort was added to the processing of soils, due to wetter-than-normal consistency. Lime had to be purchased and intermixed to speed up the drying process. A procedure had to be written for this iteration, and Safety was involved with monitoring the air and working conditions.

FSS for of the Discharge Canal, excluding the southern-most end, was completed prior to loading CSM soils stored for reuse. The FSS for the south end of the Discharge Canal was not completed during the rest of the Discharge Canal project. Part of the south headworks

remaining in the ground was removed during the circulating water pipe removal project. This work was delayed in order to coincide with the removal of concrete and pipes. The FSS of this southern portion of the canal was performed after this removal project.

### **10.1.3 Fisherman's Channel**

The Fisherman's Channel connected Humboldt Bay to the Intake Canal and was owned and maintained by PG&E. PG&E submitted and received approval of the LTP from the NRC. According to the plan, the Fisherman's Channel was considered a single survey area. Characterization sampling was performed to gather enough statistical radionuclide information to develop LTS sampling plans for this area. All characterization data indicated that radioactivity levels in both the bay and Fisherman's Channel were statistically indistinguishable from background.

Because PG&E performed a partial site release of the Fisherman's Channel area after the NRC approved the LTP, an LTS was conducted for that area. The report containing the survey methods was reviewed and submitted to the NRC upon LTP approval. Like the characterization data, LTS results indicated that the levels of contamination were well below the DCGL clearance levels and statistically indistinguishable from background levels. Ownership of the Fisherman's Channel was deeded over to the Humboldt Bay Harbor District.

### **10.1.4 Intake Canal**

The Intake Canal channeled ocean water from the bay via Fisherman's Channel, as a cooling water source for the original fossil power generation units and Unit 3. Intake Canal remediation included removal of the concrete Intake infrastructure at the east end of the Intake Canal, which housed debris bar racks, a screen wash system, isolation gates and cooling water pumps. Some of these components were removed during fossil decommissioning or, in the case of Unit 3, when the unit was placed in SAFSTOR. Next to the Intake structure was an area used to collect canal and sea water debris. The canal led from King Salmon Road to the structure and was 550 feet long by 60 feet wide. Once through the Intake structure, the water was drawn through three pipes to the three operating units for cooling the condensers.

#### **10.1.4.1 Scope of Work**

The original scope of work included the entire removal of the Intake structure, which was comprised of reinforced concrete. The structure was located at the head of the Intake Canal, directly south from Building 5, and directly north of the 60kV switchyard. The structure was comprised of three major "cells," one for each unit. Each cell was about 40 feet long by 20 feet wide by 20 feet deep. For the removal of the structure to take place, a water cutoff structure was required, so the canal area was completely dewatered. Specific remediation of radiological contamination was required to restore the area, in accordance with the CCC restoration requirements and the LTP.

Radiological remediation required removal of legacy radiological soil and debris located on the northern bank of the canal itself and directly west of the Intake structure. Contamination detected in this area was a result of the Unit 3 condensate tank overflow during plant operation. The legacy contamination in the yard drain system eventually migrated to its discharge point at the Intake Canal head structure, resulting in low levels of contamination localized around the

yard drain discharge and into the canal soils. Because of this contamination in the canal area, full radiological release surveys were required to meet FSS release criteria. Environmental remediation was expected, due to long-term inactivity, which could allow hydrocarbons and heavy metals concentrations in the silt.

#### **10.1.4.2 Intake Canal Field Work**

Intake Canal field work began in June 2016. The field work was performed to remove the Intake structure, remove and remediate hazardous materials and remediate identified radiological contaminants.

##### **10.1.4.2.1 Intake Structure Removal**

The first activity for the canal area was to install a water cutoff structure. The original intention was for an industry-standard water bladder dam to be installed. During the planning and permitting process, the engineering analyses determined that the bladder dam would isolate more bank area than was available for remediation. As a result, an industry-standard sheet pile wall was installed instead. The sheet pile wall was installed by a specialty CWC subcontractor, utilizing a large-capacity 330-ton crane with over 100 feet of reach. Just after the installation of the sheet pile wall, a fish relocation process was performed by one of the CWC specialty subcontractors. This process involved seining the area three times and installing a turbidity curtain upstream after seining was complete. Various marine life species were expected, found and appropriately released by the biologists.

Canal work had to be performed in a prescribed time window, dictated by the associated approved permits (i.e., the fish window ensures best habitat recovery and the least amount of damage). See Section 10.1.4.5

Upon completion of the sheet pile wall, the canal was dewatered back to the bay. This process included the use of large-capacity water pumps outfitted with special screens to prevent the loss of marine wildlife. During the pumping of the water, the CWC specialty subcontractor was utilized to relocate the marine wildlife that remained on the “to be dewatered” side of the water cutoff structure. Once the marine wildlife was relocated, final pumping of the water was completed and the next phase of work began.

The original scope of work called for complete removal of the Intake structure. During the work planning process, the CWC worked with HBPP FSS Department on a revised approach. The levels of radiological and chemical contamination were expected to be low. However, because the structure was classified as a class 1 contaminated structure, 100 % survey would be required to leave the structure in place. A plan was developed to clean and survey one of the Intake structure cells, which established that the structure could be down-graded to a class 3, requiring only that amount of survey as was performed in the one cell. After the survey was completed, the NRC was consulted, and the down-grade was approved. Once the survey and down-grade was approved for the structure, only 3 feet below grade of the structure needed to be removed. To allow for the survey, Unit 1 Intake structure was cleaned out by the CWC and surveyed by HBPP FSS Technicians. This approved approach allowed the CWC to leave roughly 60 percent of the structure in place, resulting in a shortening of the schedule for the project. Removal of the fill rock used in the Intake structure during fossil decommissioning took longer than planned, because of 3-inch to 4-inch sized stone.



#### 10.1.4.2.2 Hazardous Material Removal

This scope of work included provisions for removal of chemical contamination, if found during the work activities. The CWC anticipated that there would be some minor areas that would need remediation based on the site history and previous surveys and sampling. An example discovered during sampling was the presence of creosote-coated timbers used as blocking in the Intake structure. Additionally, the walls of the cells had barnacle and similar biological growth, which had to be detached and cleaned for the RP crew to do a thorough scan.

#### 10.1.4.2.3 Radiological Remediation

After the canal was dewatered and the contaminated soils removed, the Remediation Department performed a turnover survey of the entire canal area. The results of this survey provided the necessary bounds of the area for remediation. The as-bounded area was less than the original estimated area. The contaminated soil was removed with a long-reach excavator and transferred to the Waste Department for disposal. Upon completion of the contaminated sediment removal, the HBPP FSS group performed FSS of the entire canal. During the FSS survey the HBPP Environmental group completed a chemical contamination survey. Results of the surveys indicated radiological and chemical clearance criteria were met for the canal.

#### 10.1.4.3 Canal Area Restoration

The CCC canal remediation permit required restoration of the canal area. This restoration included the creation of new wetland areas that were an off-set for the filling in of the Discharge Canal. This new wetland created roughly 1.5 acres of new saltwater wetlands, which were vegetated per the permits with native species identified.

Creation of additional wetland areas expanded into the former Contractor Parking Lot. The parking lot had been utilized by the decommissioning staff during self-perform, early civil activities and the workforce who built the HBGS. Creation of the wetland involved the removal of approximately 6,000 square yards of material. Work crews excavated the area to the grades established by the approved work plans, which were based on the site restoration permits. A portion of the material from the excavated area was used to backfill the remaining Intake structure to meet end-state final grades. The remaining material was transported to the Discharge Canal area, which was the main on-site staging area for reuse soil.

The project time frame was limited by a completion date of October 15, 2016, as that was the last day in 2016 in which work in the bay could be conducted. To minimize construction impacts on aquatic species, an annual work window was permitted between June 15 and October 15 each year, referred to informally as the “fish window.” This date was set by the CDFW. The CWC subcontracted biologists, who reportedly removed approximately 2500 fish comprised of 13 species. Most of them were less than 6 inches long. They were successfully relocated over the course of several days.

Project Management desired to complete the Intake Canal work within the fish window, but this did not occur. The CDFW granted an extension to allow work to continue outside the fish window, due to the Intake Canal’s distance from the bay. This accommodated the removal of sheet pile to take place until October 15, 2016.



Upon completion of the excavation activities, the canal was reflooded. This was achieved by slowly removing sections of the sheet pile wall. This allowed the bay water to slowly reflood the dry canal area and prevented excessive erosion of the newly-excavated and profiled area. The area was then protected by BMPs, until the proper planting season, selected aquatic plant species harvest and replanting could take place for establishing the coastal salt marsh habitat.

Upon completion of the excavation and reflooding, the area was revegetated with coastal plant species and wildlife habitat snag placement. This mixture of fixed object and plant species was specified in the CCC restoration permits. It included a mixture of upland grasses and shrubs, coastal salt marsh habitat, an oyster shell bed and eelgrass beds. This restoration work was performed by a CWC specialized subcontractor, who had local experience for the Humboldt Bay area, as well as established working relationships with local permit governing agencies.

#### **10.1.4.3.1 Equipment**

The CWC performed the structure demolition with industry standard demolition equipment, as listed in Section 10.1.1. A wide variety of equipment and manpower was used during the Intake Canal remediation process. Concrete structure removal work utilized large industrial demolition equipment. This equipment included 40-ton to 50-ton standard-reach excavators fitted with a 12,000-pound hydraulic hammer. Other configurations for the excavators included concrete processors, concrete and metal shears and standard bucket/thumb attachments. Additional equipment utilized included a bulldozer, 10-yard trucks, a backhoe, an all-terrain forklift for general support and a man-lift. The remediation and restoration work utilized some of this same equipment. Additional equipment included long-reach excavation equipment, large-capacity off-highway dump trucks and a large-capacity crane for the installation of the water cutoff structure. Mobile equipment was provided by local rental companies and the CWC.

#### **10.1.4.3.2 Manpower / Crews**

The work crews consisted of a Field Work Supervisor, Equipment Operators, Laborers, specialized sheet pile installation personnel, specialized Fish Relocation Biologist crew, specialized vegetation personnel, Safety and IH specialists, Environmental specialists, FSS Technicians, Waste Disposal personnel and Electricians on a daily basis. Crew size ranged from six to fourteen personnel, depending upon the day and task.

#### **10.1.4.4 Specific Challenges**

The project encountered several challenges, including Intake structure removal, radiological remediation and canal restoration.

##### **10.1.4.4.1 Intake Structure Removal**

The removal of the Intake structure presented many challenges. As this structure had been installed in early 1950s and was located in direct contact with incoming bay water, it was filled with biological growth, which could create a hazardous atmosphere during the decomposition process. Also, due to the construction of the structure, most of the entries made into the structure were classified as confined space entries. Work crews worked closely with the CWC Safety and IH Department to develop and execute safe entry plans and work steps. The physical removal of the biological growths was challenging in the sense that the structure was

~20 feet in height/depth, and primary access was from the bottom of the structure. Physical removal of the biological growth was required prior to surveying. Specialized scaffolding was erected, using long-handled tools and other various techniques, to allow crews safe access to the walls to execute cleaning of the structure. The biological residue was added to the soils and included in shipments to an appropriate waste disposal site.

#### 10.1.4.4.2 Radiological Remediation

In order to perform the required remediation surveys, the canal had to be free of standing water. The installed sheet pile wall was not a 100 percent water-tight structure. By design, sheet pile does not form a perfect seal and some of the interfacing locks on this wall leaked. As identified in the work plan, this leakage was addressed with the installation of a large sump at the base of the sheet pile wall, which captured the water early. This allowed for the remainder of the canal to drain and surveys to progress.

#### 10.1.4.5 Schedule

The project was restricted to working within a fish window. This window of time was established by site restoration permits and limited in-water work to a less than a six-month window, from June to October. This in itself proved challenging. With the uniqueness of this scope of work and the challenges as mentioned, the project extended slightly past October. The CWC originally intended this scope of work to be completed in two separate canal mobilizations, with a combined project duration of twelve-plus months. The CWC Project Team was able to optimize work sequences, reduce demolition time by leaving the majority of the Intake structure in place and complete the required work within a single dewatering cycle in less than 12 months. The project work began in June 2016 and was completed in December 2016. Special permission was received from the permitting agencies to work past the original fish window date of October 2016. This was granted because of the limited amount of impact the remaining work activities would have on the neighboring water habitat areas.

## 10.2 Canal Disposal

Although the Discharge Canal sediment was previously thought to have much higher levels of contamination, upon excavation it was characterized with a 95 percent upper confidence limit of 2.95 pCi/g Cs-137, which is well within the acceptance criteria for exempt waste. Based on measured and surveyed contamination levels in the excavated materials, no Class A waste shipments to an appropriate disposal site were included in the shipping forecast. In addition, the waste volume excavated was less than expected, because the Cs-137 and chemical contamination did not migrate into the lower levels of the sediment or the clay layer at the bottom of the Discharge Canal. The original waste volume estimate was based on a contaminated clay layer of 3 feet along the bottom of the Discharge Canal.

Instead of the original basis of 30,970 pounds, the actual weight of loaded IMs was approximately 32,000 pounds to 35,000. This optimized the IM weight, which further reduced the number of IM shipments. The reduced waste volume, along with the waste shipments being classified as exempt materials for appropriate site disposal, resulted in a cost avoidance. While the original estimate was for 20,499,000 pounds, the actual weight of disposed materials from the Discharge Canal was 18,111,080 pounds.

Originally, the entire Intake structure, which was comprised of reinforced concrete, was planned for removal. However, only the top 3 feet of the structure needed to be removed leaving roughly 60 percent of the structure in place. See [Section 10.1.4.2.1](#). After the canal was dewatered and the contaminated soils removed, the Remediation Department performed a turnover survey of the entire canal area. The results of this survey provided a bounded area that was less than the original estimated area, resulting in a reduction of waste volume for disposal. See [Section 10.1.4.2.3](#).

### 10.2.1 Specific Challenges

Excavated Discharge and Intake Canal soil was unsuitable for packaging and transporting, due to its high water content. The initial plan was to fill fiber dewatering bags with Discharge Canal soil at the work face and allow them to dewater for a period of time. Upon evaluation, this method was changed to utilizing 10-cubic yard dump trucks filled with Discharge Canal mud, transporting it to the SMF and dumping the load on the concrete floor. The drainage was collected and pumped into a holding tank. This process worked and the mud drained fairly well. As the soil drained, it was stacked and allowed to further drain. This process allowed for a more rapid excavation of the Discharge Canal. The soil processing included draining, drying and the addition of lime to chemically react with the water for evaporation. The Environmental Team gained approval from the NCRWQCB and DTSC prior to mixing lime with reuse soils. This process required multiple soil manipulations utilizing heavy equipment. Technicians, Laborers, Equipment Operators and Spotters were required for the processing operation.

The Discharge Canal ACM piping was processed and packaged into IMs. Concrete and incidental rebar were direct-loaded into IMs at the canals.

## 11 COMMON SITE SUPPORT - CAISSON AND CANALS

Table 11-1, Common Site Support

2015 NDCTP ID	Approved NDCTP Estimates		Amount Spent Presented for Reasonableness			Previously Presented and Approved
	Base	Nominal	2012-2014	2015-2018	Total	
<b>Common Site Support</b>	7,445,755	7,828,688	1,159,807	1,270,370	2,430,176	2,391,776
2012 NDCTP CPUC Filing	5,720,750	5,995,251	1,159,807		1,159,807	2,391,776
<b>Common Site Support</b>	5,720,750	5,995,251	1,159,807	-	1,159,807	2,391,776
Relocation of Trailer City	2,542,000	2,688,812	888,774	-	888,774	-
Groundwater Treatment System Ops	761,474	792,786	271,033	-	271,033	14
Groundwater Treatment System	2,417,276	2,513,653	-	-	-	2,391,763
2015 NDCTP CPUC Filing	1,725,005	1,833,437		1,270,370	1,270,370	
<b>Common Site Support</b>	1,725,005	1,833,437	-	1,270,370	1,270,370	-
Relocation of Trailer City	1,398,085	1,497,542	-	928,129	928,129	-
Groundwater Treatment System Ops	34,579	35,303	-	35,303	35,303	-
Groundwater Treatment System	292,342	300,592	-	306,937	306,937	-

Actual costs during 2012 through 2014 for Common Site Support were \$1.2M. Actual costs 2015 through 2018 were \$1.3M compared to the approved cost estimate of \$1.8M.

### 11.1 Relocation of Trailer City

During the construction of the new HBGS facility, PG&E installed a complex of office trailers, known as Trailer City, in an area at the east end of the HBPP Decommissioning Project. It included power distribution, water and sewer systems, as well as communication and internet

services. HBPP assumed occupancy of the trailers after the HBGS was completed. There were twenty-two individual trailers units which were in configurations ranging from single-wide to six-wide. Half of the 3-acre area east of the Discharge Canal was covered by offices, roadways and sidewalks. The remaining area was occupied by the GWTS and used for associated laydown storage.

The area occupied by Trailer City was also needed to accommodate soil remediation, processing, load-out, storage and as a laydown area. Trailers became unoccupied when PG&E reduced its decommissioning staff and the CWC ramped up their staffing for the CW portion of the decommissioning. Much of the staff moved to a rented offsite office location.

Trailer removal was completed in May 2014. Costs incurred after the removal of Trailer City are attributed to rent costs for offsite office facilities. In 2016, PG&E began allocating facility charges according to labor proportions. This resulted in a lower than projected expenditure in this category.

#### **11.1.1 Scope of Work**

Domestic water lines, sewer lines and conduit were capped at appropriate locations 4 inches below grade. Electrical conductors were de-terminated and removed from the conduits all the way back to their power sources. This work was performed under the direction of Engineering staff and final inspections were performed. Trailer City had been erected on fill that covered two retention ponds. That fill and the underground utilities were left in place and removed at a later date and under a separate WP. See Section 4.1.1.6, Temporary Facilities, SMF Tent Foundation Removal, for more details on subgrade removal.

#### **11.1.2 Actual Work Performed**

BMPs for SWPP were installed and maintained. Required permits for demolition and grading were obtained from Humboldt County.

Office machines and furniture were removed and either returned to vendors or reused.

Trailer skirting, stairs and ADA ramps were removed and discarded, unless lessors retained possession. Wood and metal scrap, anchors, porches and piers were either reused, transported to a local recycler, or disposed of in a Class II landfill. Seismic tie downs were saved for reuse, where practical. To prevent unauthorized entry and potential injury, doors were boarded over following completion of interior preparation.

The CWC prepared multiple-trailer configurations for separation by removing roof and floor joining materials.

Utility removal and capping was performed after applicable clearances were issued. PG&E RP Team scanned the trailers and commodities, and then FSS free released the trailers. No contamination was expected and none was found. FSS located each of the utility caps for future removal. These were recorded on as-built drawings for future reference.

Two vendors removed their respective trailers in a planned sequence. Spotters were used as the oversized loads were carefully maneuvered through the site to exit.

Above-ground structures, poles, and a site emergency siren were removed from Trailer City. Telephone and data communication lines were also removed.

The groundwater drainage was left in place and unchanged. The area was rough-graded after trailers were removed. Later WPs to install SMF tents made slight reconfigurations to the drainage system and paved much of that area.

Water trucks and high-pressure sprayers were used for dust control.

Electrical service that had been installed specifically for Trailer City was removed, including a pole-mounted transformer and a secondary distribution panel. The load center was left in place to power the future SMF tents and Building 21. A pipe vault was left in place and was to be removed during the SMF tent project.

The CWC's Waste Manager collected soil samples from spoils that had accumulated during operation of the fossil units. The samples were then analyzed for heavy metals and hydrocarbon products and locations recorded using GPS coordinates.

Sidewalks, parking areas, truck wash station, concrete pads, concrete pedestals and firehose cabinets were removed and discarded. Concrete rubble from this project was stockpiled for disposition by Waste Management. Below-grade settling and detention basins from the plant's operating years were not disturbed during this iteration and were removed during the SMF facility decommissioning WP.

### **11.1.3 Equipment Used**

Typical demolition equipment included a man-lift, small crane, backhoe, excavators, forklifts, dump trucks and end-loader.

### **11.1.4 Hazardous materials removed**

All trailers were inspected for universal hazardous wastes. Universal wastes such as mercury thermostats, fluorescent light bulbs, and electronic wastes had specific disposal requirements for each type. A local environmental testing lab was engaged to sample trailers for hazardous materials and none were identified.

## **11.2 Groundwater Treatment System**

The GWTS was installed by HBPP during the self-perform portion of decommissioning. GWTS was a required system, which had to be installed to meet NPDES permitting criteria. The GWTS was designed for treating site water at a calculated maximum incoming rate of 300 gpm. The design basis did not take into account the volume or in-leakage rate from the Intake and Discharge Canals, since at the time the GWTS design criteria was established, the plan was to dredge the sediment (wet remediation) and leave the canals in place. Safety concerns and reconsideration of the effectiveness of wet remediation led PG&E to select the alternative approach of dry removing canal sediments.

After initial canal dewatering, storm water and groundwater infiltration during sediment removal resulted in high turbidity in residual canal water, which needed to be removed. High-turbidity levels resulted in frequent GWTS shutdowns for settling tank clean-outs. To adapt the GWTS

for the process of dry removing the canals' sediment, a PTS that settles out most solids was deemed the more efficient and less costly alternative to GWTS outages for cleaning.

Costs in this category were for the GWTS specialty vendor and were incurred in 2015. The GWTS is managed by the CWC and is described in Section [11.3](#). GWTS costs are spread amongst the individual CWC projects.

### **11.2.1 Pretreatment System (PTS)**

The PTS was located adjacent to and connected to the GWTS. The system was comprised of the following components:

- Compact gravel pad;
- Electrical power supply;
- PTS unit operations:
  - Primary settling;
  - Particulate filtration; and
  - Secondary Settling.

The primary settling tanks, T1 and T2, were 21,000 gallons over and under open-top weir tanks designed for the separation of entrained solids. Water entered T1 and T2 via satellite collection tanks. T1 and T2 operated in parallel to maximize settling time prior to transfer to the particulate filters and to allow for continuous operation during cleanout of either tank.

As a safety precaution, tank water levels in the influent sections of T1 and T2 were also monitored with high-level switches, which shut down the influent flow and activated an alarm, notifying Site Operations personnel.

Secondary settling was utilized in the event the operator determined additional settling time was required prior to processing the water through the particulate filters, or if T1 or T2 were out of service for maintenance. The secondary setting tanks were also 21,000 gallons over and under open-top weir tanks designed for the separation of solids. During normal operation, water entered the lead secondary setting tank via the secondary settling diversion line and gravity flowed from the lead secondary settling tank to the lag secondary settling tank. Water level within the effluent section of the lag secondary settling tank was measured by a submersible level transmitter. The transmitter sent a signal to the main control panel, which operated a variable frequency drive connected to the secondary settling transfer pump, where it could be combined with the effluent from primary settling prior to entering particulate filtration. Based upon the signal received, the Programmable Logic Controller (PLC) would either speed up or slow down the pump to maintain a constant level in the tank and maximize settling time.

The purpose of particulate filtration was to remove small diameter suspended particulates within primary and secondary settling effluents. Particulate filtration was a dual skid-mounted bag filter combination piped in a parallel configuration. The PTS was added to remove entrained sediment to ensure that the GWTS was not overloaded and shut down, which would affect any scheduled work activities dependent on continuous water removal. Additionally, the PTS T1 and T2 settling tanks provided storage capacity to allow short GWTS outages, while continuing to support work activities.



Twenty-four-hour monitoring of the PTS was maintained while water was being pumped from the excavations. In the event of a leak and/or spill, System Operators were able to isolate leaks or spills by turning off the PTS equipment and/or turning the appropriate valves to the "OFF" position.

### **11.2.2 GWTS Expansion**

The GWTS was originally designed to process up to 300 gpm. The system was not designed to handle the processing needs resultant from dewatering the canals during sediment removal and removing the Caisson entirely. The decommissioning plan changed to include year-around excavation activity, concurrent excavation activity and the complete removal of the Caisson. As a risk mitigation effort to reduce the potential for non-compliant storm water and groundwater discharges, the CWC proposed to effectively double the capacity of the GWTS by adding an additional sand filter, particulate filters and carbon filters. An additional resin tank was added to the original system to provide additional metals removal capacity and redundancy to the system. The original pumps and piping were reconfigured to allow flow rates up to 600 gpm. The additional equipment was initially rented from an outside specialty vendor to test the capacity expansion, and later purchased once the system expansion proved to meet the more demanding processing needs.

Engineering and Planning, Procurement, Scheduling and the installation crews contributed to successfully doubling the GWTS capacity. GWTS expansion was successfully completed and tested to confirm the added capacity worked as planned. It was proven to be a useful expansion, as the system was operated well over 300 gpm on many occasions after the completed expansion.

### **11.2.3 GWTS Final Configuration**

During the fall of 2017, the GWTS was split into two separately-operable 300 gpm systems. The major elements of the 2015 GWTS Expansion were relocated to the top of the hill adjacent to Building 26 and west of the Caisson. The new system location was required to enable remediation of contaminated soil from beneath the original GWTS footprint. The system relocation was also necessary to implement SWPPP BMPs throughout soil disturbing activities of the project. This included operation almost to the end of FSR to meet permit requirements. The original 300 gpm system was operated through the winter of 2017 to 2018, to enable peak treatment capacity when needed. The relocated GWTS and PTS were removed in November 2018.

## **11.3 Groundwater Treatment System Operation**

Costs in this category were for the GWTS specialty vendor and were incurred in 2015. The GWTS Operation scope is managed by the CWC and is described below. GWTS Operations costs are spread amongst the individual CWC projects.

The CWC trained and dedicated a group of individuals to the daily operation of the GWTS. While much of their duties were shared and cross-trained, only Operators could access the programming of the central monitoring station. Due to strict environmental standards imposed by local and state authorities the functioning of the many elements had to be monitored, maintained and managed to an approved procedure.

Every time water was to be transferred from a work face to the GWTS, a decision was made whether to route to the PTS or directly to influent tanks. Factors such as sampling, blending water to manage turbidity and/or pH levels, hold time for turbidity control (settling time) and storage during system maintenance would inform that decision. Once decided, water transfer was monitored and recorded on a daily report.

Examples of decisions made during a transfer included: valve positions at a myriad of locations; filter conditions; flow control; both eyes-on and control room monitoring; gas-powered pump and electric pump coordination; management of an array of hoses, bypass valves and couplings; verifying proper position of hand switches; checking tank level indicators; verifying and adjusting chemical injection systems including acid/caustic supply; sulfuric acid and sodium hydroxide injections and polymers; and pH and turbidity instruments. The overarching safety principle that ensured incidents were prevented was the use of positive 3-way communication during these water transfers.

Field manual operations included: continuously recording conditions and actions on the daily report, including recirculation decisions, chemical injection pump calibrations, chitosan dosage rates and manual backwash activity; and visually monitoring water stream for pH, turbidity and flow via inline displays and comparing them to digital output displays during discharge. Process parameters including pH, turbidity, flows, etc. were recorded on a fifteen-minute basis by the industrial water controller and downloaded daily by the Operator to a local laptop computer. Additionally, this collected data was downloaded monthly and supplied to the QSP for upload to the California Department of Water Resources Storm Water Multiple Application and Report Tracking System (SMARTS). This data was used to further document regulatory compliance of the water discharged to the environment.

Discharge of treated water to the bay could only happen once a list of metrics met the criteria.

Staff worked irregular hours and weekends during higher-than-normal rains to ensure excavations were ready for the next shift's work. Treatment Technicians were required on site anytime the GWTS was in operation.

## **12 ENGINEERING, PROCUREMENT AND CONSTRUCTION (EPC) SERVICES (INCLUDING QUALITY TRAINING)**

EPC was established as a separate cost category in the 2015 NDCTP DCE. It provided a single point of contact to manage a diverse set of vendors and necessary services to support the decommissioning project. Because the CWC was performing most of the work on the site, PG&E transferred the contracted site maintenance activities scope to the CWC. PG&E continued to provide management and oversight. While some of the elements of EPC were anticipated in the 2012 NDCTP and the original CW scope envisioned at the time, PG&E recognized that transferring an additional O&M-type scope to the CWC stood to benefit the project by allowing the CWC to control all activities on site. The CWC would be able to balance resources more effectively than multiple contractors could independently. The EPC work captured the additional support operations necessary to keep HBPP running efficiently and consolidated several scopes of work that fell outside the boundaries of the other CW scope packages.

**Table 12-1, EPC Services**

2015 NDCTP ID		Approved NDCTP Estimates		Amount Spent Presented for Reasonableness			Previously Presented and Approved
		Base	Nominal	2012-2014	2015-2018	Total	
	EPC Services	10,759,825	11,303,609	199,315	8,651,473	8,850,788	
	2012 NDCTP CPUC Filing	489,447	521,993	199,315		199,315	
	EPC Services	489,447	521,993	199,315	-	199,315	-
	EPC Services	489,447	521,993	199,315	-	199,315	-
	Other Services - Training	-	-	-	-	-	-
	2015 NDCTP CPUC Filing	10,270,378	10,781,616		8,651,473	8,651,473	
	EPC Services	10,270,378	10,781,616	-	8,651,473	8,651,473	-
	EPC Services	9,588,908	10,059,383	-	7,339,041	7,339,041	-
	Other Services - Training	681,470	722,233	-	1,312,432	1,312,432	-

Actual costs during 2012 through 2014 for EPC Services were \$199,315. Actual costs 2015 through 2018 were \$8.7M compared to the approved cost estimate of \$10.8M.

### 12.1 Engineering, Procurement and Construction (EPC) Services

PG&E turned over the EPC Services program to the CWC in January 2014. PG&E requested that the CWC assume responsibility to implement the requirements of the approved SWPPP on file with the NCRWQCB. The CWC began providing labor, equipment and materials to maintain site compliance with the SWPPP.

Following the transfer of the SWPPP EPC Scope, PG&E transferred the following EPC Scopes to the CWC in May 2014:

- Housekeeping Activities;
- HBPP Safety Program;
- Warehouse Operations;
- General Site Maintenance and Vendor Oversight; and
- Scheduling Coordination, including a Work Week Manager.

The above scopes were implemented and maintained by the CWC to support the site functions. Changes to the General Site Maintenance Scope in October 2014, added three categories to the EPC operations, including System Operations, Training Coordination/Liaison and Skilled Trades Activities and Light Industrial Support.

#### 12.1.1 SWPPP

The CWC provided craft labor and necessary supervision to perform compliance activities, as required by the SWPPP. The HBPP inventory of BMP materials was turned over to the CWC when it assumed EPC for SWPPP. The CWC managed and maintained the inventories to ensure continued compliance and provided any required equipment to transfer materials to various locations on site. The CWC worked with the contracted QSP daily to ensure continued compliance to requirements set forth in the SWPPP. BMP examples included temporary erosion and sediment control, checking and cleaning drain inlet debris and obstructions and road gutter cleaning and sweeping. Winter storms and above-normal rainfall led to on-site localized flooding, which required extended work hours and elongated work weeks to successfully maintain compliance with water discharge permits.

### 12.1.2 Housekeeping Activities

The CWC performed general housekeeping activities throughout the HBPP site. Housekeeping activities included:

- General site clean-up, such as keeping waste containers closed and remedying misplaced construction rubbish, which had been improperly discarded, blown or dropped to the ground from designated waste containers;
- Breaking down crates and pallets for disposal;
- Staging waste that would not fit into waste disposal containers; and
- Setting up, moving and maintaining desks, shelving, cubicles, cabinetry, file cabinets and other miscellaneous office furniture, as requested.

### 12.1.3 HBPP Safety Program

HBPP turned the site Safety Program over to the CWC. The CWC combined its internal safety program with the HBPP Safety Program. The HBPP Safety Program was previously documented in the 2015 NDCTP Completed Activities Report in Section E.4.1.

Safety Program activities included:

- Project group Safety Meetings;
- Monthly Employee Safety Committee;
- Weekly Safety Supervisor meetings;
- Work Planning meetings;
- Tracking injury/illness data;
- Reporting Safe Work Hours and rewarding Craft for performance;
- Annual Cal/OSHA and OSHA reporting requirements;
- Procedure Development meetings; and
- Maintenance of the HBPP Safety Program.

### 12.1.4 Warehouse Operations

The CWC Warehouse Operations personnel were responsible for:

- Operating the HBPP warehouses;
- Transferring supplies to and from offsite offices;
- Receiving and shipping materials for HBPP;
- Obtaining quotes from various site departments for non-radiological use materials;
- Buying and stocking consumable supplies in the on-site warehouse;
- Maintaining a Min-Max system of radiation protection consumable supplies at an offsite warehouse;
- Coordinating rental of small (size) support equipment, such as light standards; and
- Operating both diesel and electric forklifts (Operators qualified via HBPP forklift training for equipment currently on site, as well as any equipment brought on site by the CWC).

### 12.1.5 General Site Maintenance

The CWC performed HBPP General Site O&M. This support required sufficient staff to respond to repair requests and keep the site in good working condition for a safe work environment.

These services included:

- Installing and maintaining BMPs in accordance with the approved SWPPP amendment and coordinating with PG&E's Environmental Coordinator, as required;
- Testing and certifying backflow preventer assemblies at various site locations;
- Inspecting, testing, verifying certification and performing preventive maintenance as needed for HBPP cranes with a lifting capacity of 6,000 pounds or less;
- Periodic scheduled maintenance activities and field repair services for forklifts, pallet trucks and scissor lifts;
- Fencing materials and services on an as-needed basis;
- Inventorying and cleaning floor mats;
- Providing laundry services for orange visitor vests;
- Periodic maintenance on generators;
- All on-site HVAC repairs and maintenance;
- Janitorial services at HBPP;
- Landscaping and lawn maintenance;
- Locksmith services;
- Pest control services;
- Plumbing services;
- Portable toilet services;
- Tree trimming, tree removal and brush removal services;
- Office waste garbage disposal services;
- Office waste recycling services;
- Steel, aluminum and other recyclable bins and their maintenance and disposal;
- Bottled water delivery services;
- Sump maintenance services;
- Compressed air systems;
- Sewer systems;
- Walkways;
- Site drainage;
- Parking areas and parking area striping;
- Siren systems;
- Water systems;
- Office trailer repairs;
- Light stand rental;
- Fueling of on-site equipment;
- Printing services;
- Relocation of equipment and tools; and
- Rigging/hoisting equipment and inspections.

### 12.1.6 Work Week Schedule Coordination

The CWC provided scheduling and coordination for decommissioning work on site, including input from PG&E and others for work outside the CWC Scope of Work. This EPC activity included:

- Providing schedules on the same day each week for review;
- Utilizing agreed-upon templates for weekly submittal;
- Providing float calculations, baseline variances and critical path in each schedule;
- Providing agreed-upon narratives and reports, such as Earned Value;
- Taking responsibility for running scheduling meetings including:
  - POD
  - POND
- Coordinating scheduled Look Ahead meetings;
- Obtaining PG&E approval for changes to POND activities, using the agreed-upon change form;
- Managing site coordination; and
- Generating weekly Variance reports.

Initially, a dedicated Work Week Manager supported most of the activities for work week schedule coordination. As field work ebbed, that position was eliminated and duties were absorbed by CWC PMs.

For Project Controls budget and schedule responsibilities, see Section 1.1.1.2.4.

### 12.1.7 System Operations and Clearances

The CWC provided System Operations and Clearances personnel responsible for operation of active systems and a Lock-Out/Tag-Out program. System Operations and Clearances activities included:

- Starting and stopping plant equipment;
- Operating valves;
- Responding to alarms;
- Periodic equipment checks;
- Calibration checks;
- Record-keeping and systems monitoring;
- Lock-Out/Tag-Out or clearances;
- Marking of equipment (active or inactive); and
- Preventive maintenance on active ventilation system and air handling in RFB.

System Operation and Clearance services were in accordance with the HBPP QA Program. Systems included:

- RFB ventilation system (decommissioned);
- FIXS (decommissioned);
- Demineralized water (decommissioned);
- Fire water system;



- Domestic water;
- Yard drain system (decommissioned);
- SPAMS (decommissioned);
- SAMS;
- Service air system (decommissioned); and
- Cold and dark electrical power (decommissioned).

#### **12.1.8 Groundwater Treatment System Support**

While the GWTS had a dedicated team of operators, there was occasional need for EPC support during routine maintenance and temporary shutdowns. The CWC allocated GWTS operating costs to the appropriate work scopes for:

- Pumping water from excavations to interim holding tanks;
- Sampling and analysis to determine disposition of the water collected; and
- Pumping of the water to the determined destination, either off site for disposal, to the Public Offsite Treatment Works, or if appropriate, processing through the PTS or directly to the GWTS receiver tank.

A detailed discussion of GWTS is contained in Section 11.2.

#### **12.1.9 Work Requests**

Since taking over EPC in January 2014, the CWC handled work requests to support HBPP work scopes. To enhance program efficiency, a formalized process was developed to replace informal email requests.

Some EPC work requests were relatively minor in nature, such as handling office moves or small repairs to facilities. Bigger tasks were handled as well, such as:

- Moving the Shepherd Source calibration instrument, including modification of space to house the unit;
- Moving RP Instrument Shop from Building 5 to Building 26 (including Personnel Contamination Monitors [PCMs] and SAMS);
- Removing old Machine Shop equipment;
- Decommissioning the Access Control Building and preparing it for removal from the site;
- Removing site air compressor system;
- Repairing the Lift Station; and
- Removing several hazardous trees.

#### **12.1.10 Manpower/Crews**

Although there was not a designated EPC crew, when site maintenance work was needed, noncritical crew members were drawn from other work groups. As project needs demanded, site maintenance work was deferred and crew members returned to critical projects. A single supervisor was designated to be the coordinator for site maintenance efforts.

In general, the only specific challenge was timely completion of the requests for services, since from time-to-time the overall volume of the requests could exceed available manpower. All requests for EPC service were satisfactorily resolved.

## **12.2 Training and Training Coordinator/Liaison Services**

The CWC assumed administrative duties of the HBPP Training Department in 2014, maintaining HBPP's philosophy of implementing an extensive training program and compliance database. This was to ensure worker safety and to comply with Cal/OSHA. The CWC conducted over seven hundred and fifty training classes since assuming program responsibilities under the guidance of PG&E. These training classes were to ensure that the workforce was properly prepared to work on the site as new employees, or to requalify individuals so they could continue their assigned duties.

An offsite office space was used exclusively for training after the planned decommissioning of the on-site training space at HBPP. The training area included a break room, assembly room and staff offices. A shuttle van was available to employees needing transport from the job site to the offsite training space to attend scheduled classes.

The Training Coordinator/Liaison Services were also assigned to the EPC. The services were performed in accordance with the HBPP QA Program. The Training Coordinator:

- Communicated training schedules to PG&E, the CWC and subcontractor personnel;
- Aided personnel in completing the necessary paperwork for training;
- Requested enrollment of personnel into training;
- Ensured that the necessary paperwork was completed and submitted prior to personnel entering training;
- Documented and tracked training status;
- Developed training metrics as necessary to support the CWC reporting requirements;
- Interfaced with PG&E and the CWC; and
- Ensured training courses met regulatory compliance.

**PACIFIC GAS AND ELECTRIC COMPANY**  
**CHAPTER 9**  
**ATTACHMENT B**  
**HUMBOLDT BAY POWER PLANT**  
**UNIT 3 DECOMMISSIONING PICTORIAL SUMMARY**

## **The Humboldt Bay Power Plant Unit 3**

### **HBPP Decommissioning Pictorial Summary**

(Submitted as part of HBPP 2018 NDCTP)



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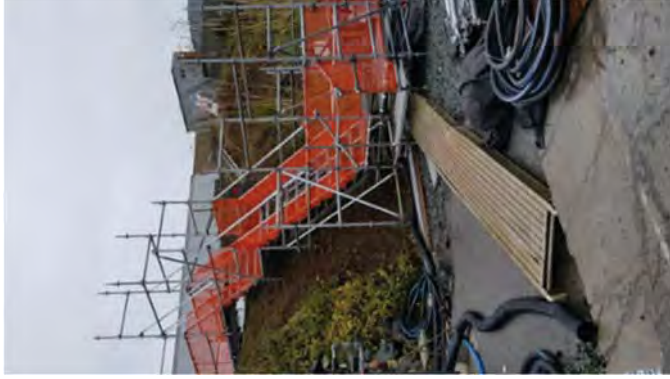
## Project Safety

A "Safety First" philosophy permeates throughout all levels of the decommissioning organization. HBPP and its safety team have been awarded PG&E's prestigious Shermer L. Sibley Award six times in recognition of their performance.

The HBPP Decommissioning project has built a reputation as an industrial and occupational safety leader for its safety program, culture, and performance. Methods were developed at HBPP in pursuit of ALARA radiation exposure that may be applied throughout the industry to reduce worker dose rates.



## Project Safety



Newly established walk paths.



Discharge canal project finishing touches.



## Project Safety

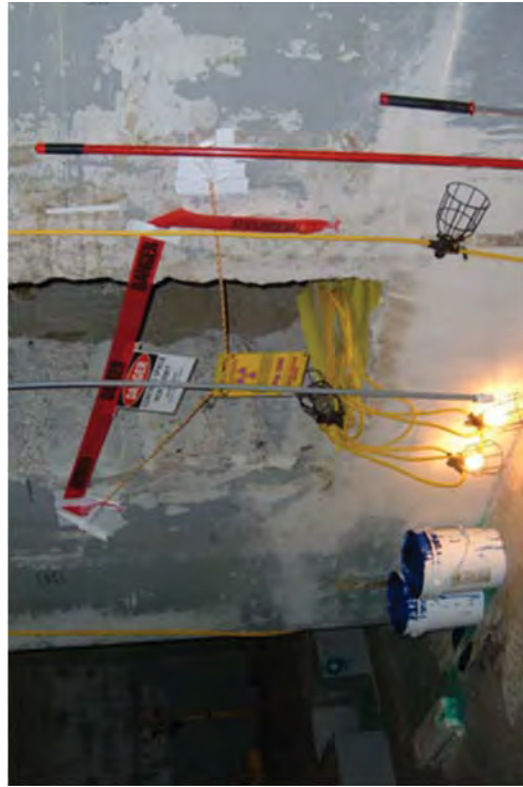


November 8th, 2016 was the date of an HBPP Nuclear Decommissioning Project Milestone. It marked a total of four years of safe days worked without a lost time incident.

## Project Safety



A restricted entry danger zone that requires permission to enter from the Job Supervisor.



Example of a flagged Danger Zone.



A caution area with its required information tag that gives the name of the area's owner and any specific instructions.



## Project Safety



## Project Safety



Performing work on a roof required hand rails, a harness with a tie-off, and hazard warning tags.



Employees prominently wear this badge on their vest to solicit safe work suggestions.



The five year safety milestone at the HBPP Decommissioning Project.



### Project Safety



The spotter for an excavator ensures that a worker does not enter into its swing radius.

### Project Safety



Workers were required to wear personal flotation devices and use a buddy system when working in or near water.



A Two Minute Drill taking place before performing the next step.



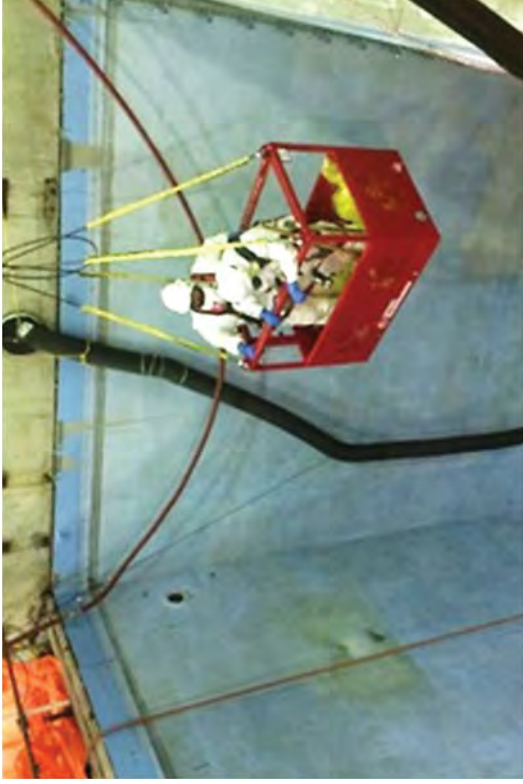
Tag lines were always used and required on lifted loads to prevent unwanted movement.

## Project Safety



A spotter and driver discussing a route and its obstructions. Spotters were a positive addition to the safety program. Eye contact and signals were integral to safely moving equipment on the congested site.

## Project Safety



Man baskets were only allowed and used with strict procedures and inspections. Clean up after liner removal from SFP



Man basket in use for Caisson work. Man baskets were only allowed and used with strict procedures and inspections.



Rigging, ladders and harnesses were inspected monthly. Users also performed daily inspections on their own equipment before use.



**Turbine Building (TB) Foundation**



Excavators staged to remove the TB foundation.

**TB Foundation**



Removing Feed Pump pads.



Removing the Feed Pump slab and footings.



Excavating along the western side of the TB foundation.



**TB Foundation**



Demolishing a 30' foot by 30' foot concrete slab.

**TB Foundation**



Sieving for transite pipe fragments that were found while excavating.



The excavation at a depth of 3 feet below grade at the west end of the TB foundation.



Cleaning up transite pipe debris and loading the ACM into intermodals.



**TB Foundation**



Wrapping 14 feet of 6-inch diameter transite pipe after it was excavated.

**TB Foundation**



Using a small excavator to sort and load TB debris into intermodals.



Loading out concrete from the TB.



ACM is segregated from other materials and monitored by an abatement supervisor.



**TB Foundation**



Any hydraulic leaks are contained and cleaned according to a set process. They were inevitable and caused by constant contact with rebar fragments and other rough surfaces.

**TB Foundation**



Demolishing the TB foundation. Parts of the concrete slab and pedestals were 6 feet thick.



Demolishing the west wall of the TB foundation.



Demolishing the TB foundation.



**TB Foundation**



Pipe that RP directs to be placed by machine directly to an intermodal.

**TB Foundation**



Exposing wooden pilings underneath the TB. A total of twelve wooden pilings were uncovered by the end of this work day.



White paint signifies another pipe in the basement to be exposed and placed whole in an intermodal.



Shearing rebar with hydraulic jaws so that it will fit into intermodals.



**TB Foundation**



RP frisking a bucket of debris before it is loaded.

**TB Foundation**



Dewatering the excavation.



Loading out concrete, rebar, and soil.



An RP technician surveying pipes.



TB Foundation



Demolishing the west instrumentation vault.

TB Foundation



Loading out concrete debris.



Demolishing along the west wall while spraying to mitigate dust.



Using a crane to extract wooden pilings.



### TB Foundation



Using a crane with a pipe drilling attachment to vibrate wooden pilings loose.

### TB Foundation



After they are loosened, the piles can be extracted by conventional means.



Demolishing concrete with cooling water intake lines visible in the foreground.



Pumping CLSM into the holes left after the wooden pilings were extracted.



**TB Foundation**



Staged wooden piling undergoing a soil sampling survey.

**TB Foundation**



Demolishing and loading out debris along the south wall.



Extracting a section of 54-inch inlet pipe from the foundation wall.



Wooden plings marked for extraction.



**TB Foundation**



Grading the west end of the excavation to prepare it for FSS.

**TB Foundation**



Environmental technicians taking samples of the west end excavation area.



RP technicians surveying the west end excavation.



The TB foundation debris pile.



**TB Foundation**



A scale and intermodal set-up to remove and process ACM debris.

**TB Foundation**



Demolishing the west wall.



Loading out ACM required stringent controls to ensure the safety of workers.



RP technicians surveying embedded drain lines while removing the TB floor slab.



**TB Foundation**



Breaking apart the TB floor slab.

**TB Foundation**



Extracting wooden pilings from the TB foundation.



Dewatering the excavation. Wooden pilings can be seen just below the surface of the water.



Extracting wooden pilings.



**TB Foundation**



RP techs performing the FSS on the west end of the TB excavation.

**TB Foundation**



Backfilling of a portion of the central excavation.



RP techs performing the FSS on the central sections of the TB excavation.



The interim backfill of the FSS deep feature excavation.



### TB Foundation



Creating a ramp so that the lower flat areas could be compacted.

### TB Foundation



Backfilling and grading the TB excavation.



Compaction testing an area of the TB backfill.



Backfilling, grading, and compacting the TB excavation.

## LRWB

### Liquid Radwaste Building (LRWB)

To remove the LRWB, its inner concrete structure was demolished down to the walled foundation while its outermost steel structure remained in place. This provided containment to the work area and allowed for proper ventilation while demolishing concrete. These measures were necessary due to the presence of contaminated tank pastels, sumps and hotspots that existed within the concrete.

The steel building was mitigated and demolished after the interior concrete demolition was finished, which left just the LRWB foundation. The foundation served as a retaining wall until the CSM wall was completely installed. It was removed at the same time as other remaining foundations located north of the RFB in the upper yard.



The entry and step off pad to the LRWB.

## LRWB



Personnel performing a PPE dry run in the LRWB before starting demolition work.



LRWB



A fork truck moving a bag which will then be loaded into an intermodal.



Loading a bag into an intermodal.

LRWB



Preparing materials so they could be loaded out.



Materials bagged and ready to be removed from the building.

LRWB



The concentrated waste tank wall opening layout and demolition



LRWB



An excavator loading concrete debris into waste bags.



An excavator demolishing the LRW Concentrator roof and walls.



LRWB

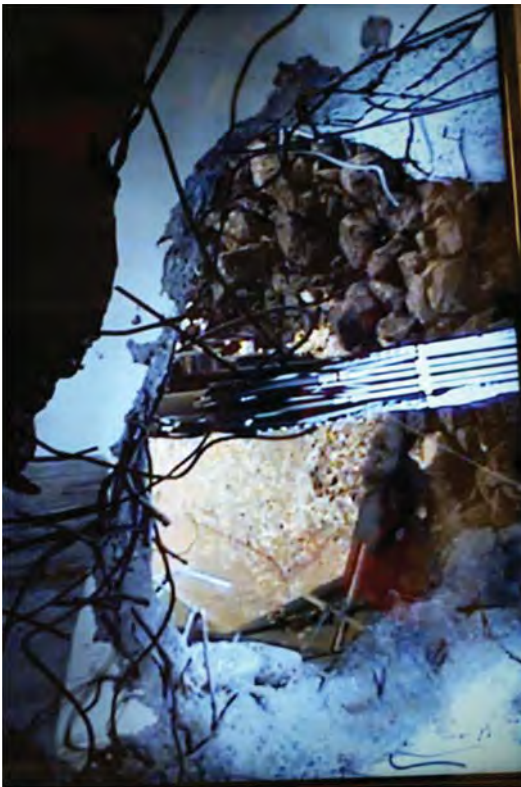


Demolishing the entrance opening to the resin disposal tank.



Decontamination equipment staged before shaving the concentrated waste tank room walls

LRWB



Rebar and jagged concrete that can easily damage a boom's hydraulic lines.



The concentrated waste tank pad was demolished by remotely operated equipment to prevent workers from being exposed to contamination.



LRWB



Scabbling the surfaces of the concentrated waste tank room to remove the most contaminated materials.



The concentrated waste tank after the scabbling was complete.

LRWB



Shaving the walls of the concentrated waste tank room.



An RP technician surveying the concentrated waste tank room.

LRWB



Grouting the LRW sump.



Decontaminating an excavator so that it could be removed from the building.

LRWB



RP technicians surveying the LRW sump.



Removing the LRW sump.



LRWB



Trench grouting.



Decontaminating a second excavator that was used in the LRWB.

LRWB



Removing a decontaminated excavator from the LRWB.



Removing embedded piping.

LRWB



Applying fixative in the LRWB.



The final cleaning in the LRWB.

LRWB



Removing the containment measures from the interior of the LRWB.



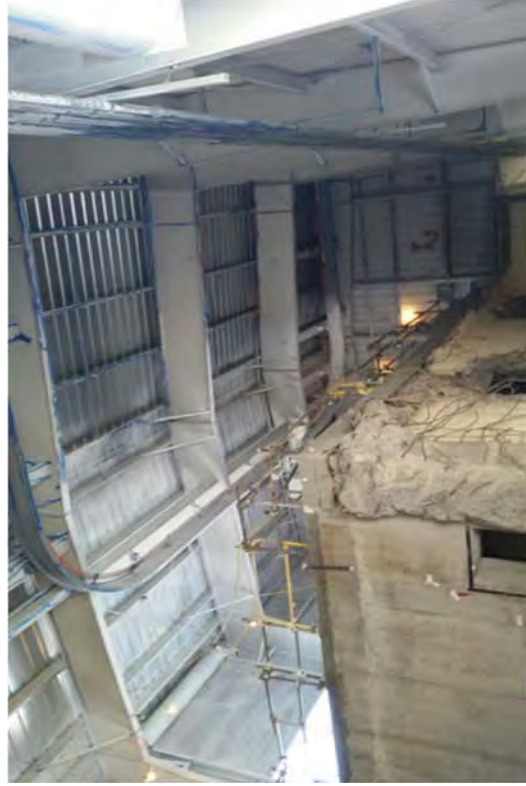
Loading out all commodities and remaining waste from the LRWB.



LRWB



Decommissioning and draining oil from an overhead crane.



Encapsulating the interior of the building a fixative.

LRWB



Decontaminating the interior roof beams of the LRWB.



Decontaminating the West End of the LRWB.

**LRWB**



Protection installed around "LC-24", which was an electrical load center. This load center supplied power for demolition activities



The LRWB after being fully prepared for demolition.



Demolishing the outer metal structure of the LRWB.

**LRWB**



Demolishing the first bay on the East End of the LRWB.



The LRWB steel structure completely down. The excavators are being used to reduce the size of debris so it will fit into intermodal containers.



LRWB



Installing the Concrete processor attachment to an excavator.



Demolishing the above grade portion of the LRWB's structural foundation.

LRWB



LRWB structural steel and siding demolition complete.



LRWB structural steel and siding demolition complete.

LRWB



Demolishing and loading out the LRWB.



Demolishing and loading out the LRWB.

LRWB



Demolishing concrete.



Demolishing the LRWB above grade.



LRWB



Demolishing and loading out the LRWB slab. The transition slope to the upper yard is covered in plastic sheeting.

LRWB



Demolishing and loading out the LRWB slab.



Demolishing and loading out the LRWB slab.



Demolishing, remediating, and loading out the LRWB slab.



LRWB



Backfilling the LRWB footprint.



Backfilling and compacting the LRWB footprint.

LRWB



Remediating a radiological hot spot.



Using the ISOCSS to survey the LRWB subgrade excavation.



## LRWB



The LRWB footprint backfilled, sloped, and graded.



Spreading and compacting a Class II aggregate base layer.

## SAS Above-Grade

This structure was approximately 930 square feet of reinforced concrete with walls that were three feet thick and sat atop a two foot thick slab. The SAS was constructed in 1976 and 1977 to be the recombiner vault but it was never used. It was considered to be a radiologically "clean" building.



Preparing the SAS Building for demolition, including removal of ventilation and power running across the top of the building.



Scaffolding was installed to support a protective netting wall around building.

**SAS Above-Grade**



The access tunnel closed off with approved steel covers.

**SAS Above-Grade**



An excavator equipped with a hammer begins breaking concrete.



The SAS ready for demolition.



The progress of demolishing the SAS after one day work.



### SAS Above-Grade



Using an excavator to hammer the north face of the north wall.

### SAS Above-Grade



Demolishing the south wall with an excavator and the aid of a spotter who provides dust suppression and constant communication regarding projectiles.



Crewmembers cutting any protruding rebar to create a safe passageway.



Lowering internal and external walls while reducing the size of debris.



### SAS Above-Grade



Loading the final debris from the SAS into intermodals.



An excavator using the hammer to soften and penetrate the surface so that CLSM can penetrate after the final load out.



After CLSM was poured to grade

### SAS Below-Grade



SAS below grade structure demolition looking SW towards the MPEF.



West edge of the SAS below grade looking SW to the MPEF foundation slab. The foundation had to be protected and the MPEF had to be kept in operation because it was a critical component in future demolition activities.



**SAS Below-Grade**



Demolishing and excavating SAS below-grade structures. The excavations were dewatered when it was necessary.

**SAS Below-Grade**



Using an excavator to remove rubblized concrete debris.



Sacrificial backfill was used to stabilize the West edge of the SAS excavation because hydraulic hammering on the foundation caused soil sloughing adjacent to the sheet piling.



Placing debris directly into a bucket loader which then took the debris to a waste intermodal.



### SAS Below-Grade



The Off-gas tunnel can be seen on the left of the SAS excavation. The stack is on the immediate edge of the SAS. On the right is the MPEF which is surrounded with protective barriers.

### SAS Below-Grade



Backfilling the SAS.



Backfilling the SAS excavation with a stone fill that was specified by the engineering staff.



Compacting the SAS backfill.



## SAS Below-Grade



Compacting the SAS backfill.



Backfill and SAS below grade demolition complete.

## Spent Fuel Pool SFP Liner

The stainless steel liner of the Spent Fuel Pool (SFP), was removed at the same time as ACM and pipes in the drywell were removed. The two separate crews performing these activities needed to coordinate with each other regarding the use of equipment, such as a 75 ton crane, to complete their tasks. After the liner was removed, the SFP was drained. The SFP was then coated and any ground water in-leakage was repaired prior. Concrete debris from the RFB was used to backfill the SFP so that the it could be removed while excavating the Caisson.



RP surveying the tri-nuke filter assembly and preparing to lift it from the SFP.

**SFP Liner**



Lifting the solids collection filter from the SFP before plugging its drain and moving it to the decontamination and wrapping area.



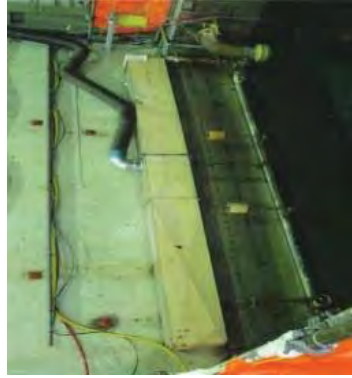
**SFP Liner**



Lifting the first underwater platform scaffolding with a chainfall.



Removing the demineralizer from SFP.



Preparing to remove the vent hood.



Lowering the underwater platform scaffolding into the water.



SFP Liner



The diver waiting for the first fume hood to enter the water before entering the SFP.

SFP Liner



A Diver attaching a hose to the fume hood.



Divers entering the SFP to rig and prepare the liner for removal.



A Diver in the SFP to work on removing the liner.

### SFP Liner

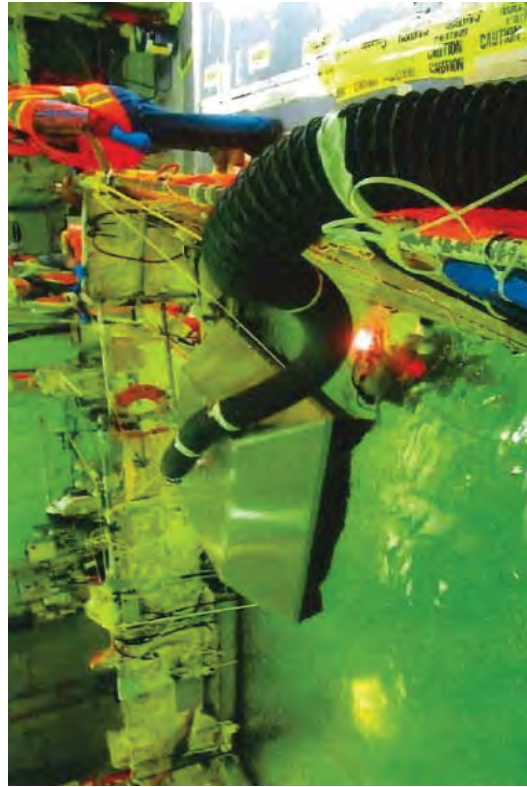


A feed from one of the observation cameras. Remote video monitoring increase overall safety and shortens reaction times emergency situations

### SFP Liner



A Diver cutting the 10 gauge stainless steel liner plate.



A vent hood over the work area capturing the fumes produced when cutting the stainless steel liner.



A Diver exiting the SFP after performing the first cut on the liner.



### SFP Liner



The diver handing the surface tender his tools and equipment.

### SFP Liner



A second diver preparing to enter the SFP and continue cutting the liner. The divers only worked underwater in short shifts to decrease their risk and radiological exposure levels.



Tenders assist the diver in removing the heavy hood and unhook multiple wires and hoses.



A diver giving a debrief regarding the functionality of the equipment used during the dive.

SFP Liner



Removing debris from the SFP that accumulated as a result of the divers' underwater work.

SFP Liner



Removing the fume hood from SFP.



Loading debris from the liner into a lined shipping box.



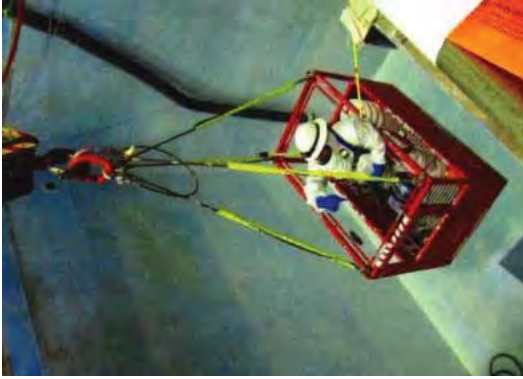
The fume hood packaged for transport.



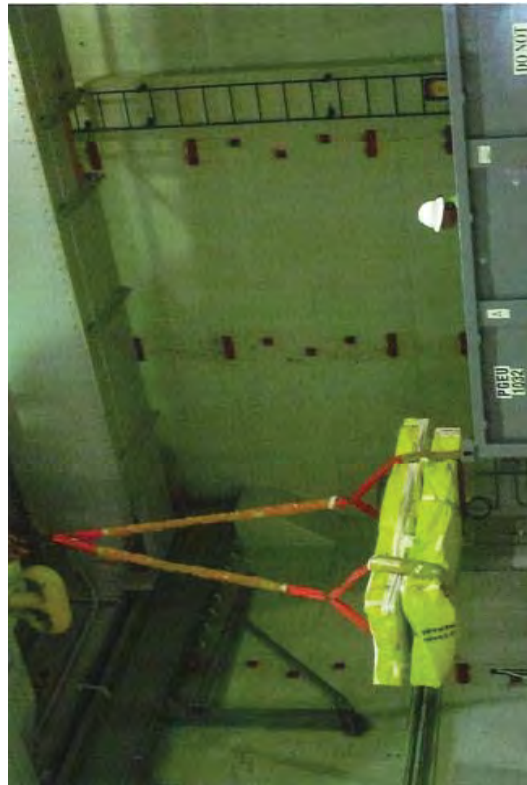
SFP Liner



SFP Liner



RP surveying the SFP walls from an approved man-basket.



Removing the last filter from the SFP before it is drained through the FIXS.



The sump pit in the SFP required additional characterization because it had held highly contaminated waste.



## SFP Liner



Placing rubble from the demolished RFB into the empty SFP.



Debris from the first demolition phase of the RFB was placed into below-grade voids like the SFP.

## Drywell Region

This area was under the main floor level and very tight quarters. There was no way for field engineers or QC to enter the area in full PPE and also take photographs.



HEPA filtration units and air sample units set up by RP technicians for the drywell pipe cutting and removal process.



This is the pipe cutting crew starting the removal process. They descended into the drywell in a man-basket, cut small bore pipe, and were then lifted back up to the +12 EL RFB floor with segments of pipe. At the top, they handed the segments of pipe to RP technicians so that they could be surveyed.



**Drywell Region**



A crew in the man-basket descending into the drywell. The basket and associated rigging was inspected by engineering every workday.

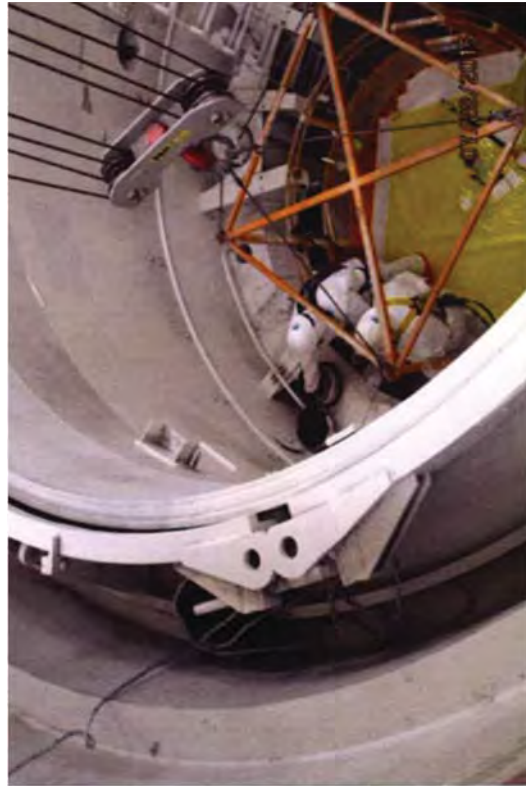
**Drywell Region**



Personnel collecting radiological testing samples from 10" inch pipe and ductwork.



A spent fuel drain pipe was inspected with a borescope camera after being wrapped with a glove bag.



Personnel collecting radiological testing samples from 10" inch pipe and ductwork.



A borescope revealed that the inside of the drain pipe was mildly rusted at its first elbow.

Drywell Region



Removing small bore pipe.

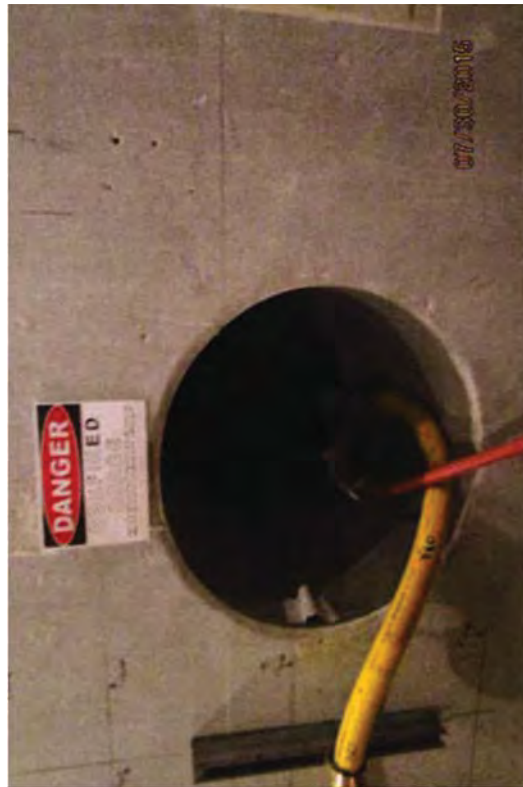


Removing a section of 8-inch feedwater pipe after various lift plans were evaluated.

Drywell Region



1-inch pipe ends being cut and taped.



A confined space in the drywell being surveyed by RP.



Drywell Region



A pipe which needed to be inspected for ACM. The hosing in the foreground supplies the workspaces with proper air ventilation

Drywell Region



Cutting guard pipe at elevation -14' EL.



Setting up equipment to cut the feedwater line.



An enclosure was installed around the guard pipe because it was identified as ACM.

Drywell Region



Cutting the feedwater pipe into manageable sections.



An ACM abatement enclosure.

Drywell Region



Removing the Heat exchanger supply pipe.



Removing the Feedwater pipe.



Drywell Region

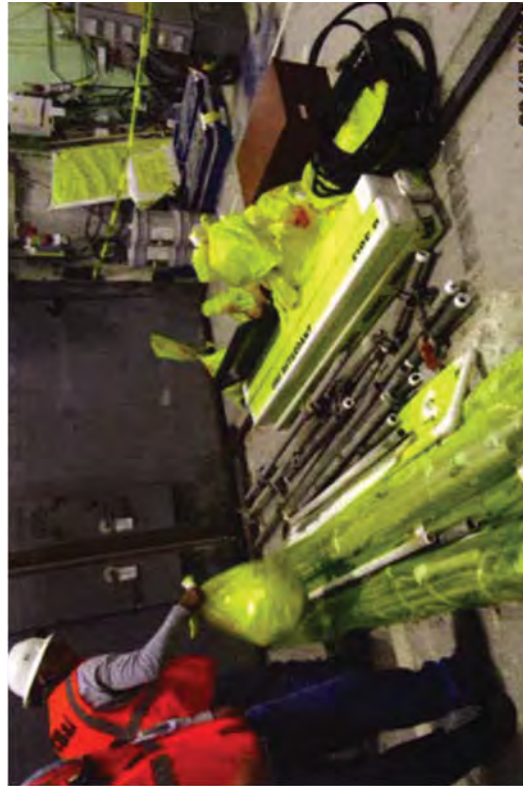


Capping the heat exchanger pipe in the drywell.

Drywell Region



The heat exchanger room cleared out.



Prepared to be loaded out.

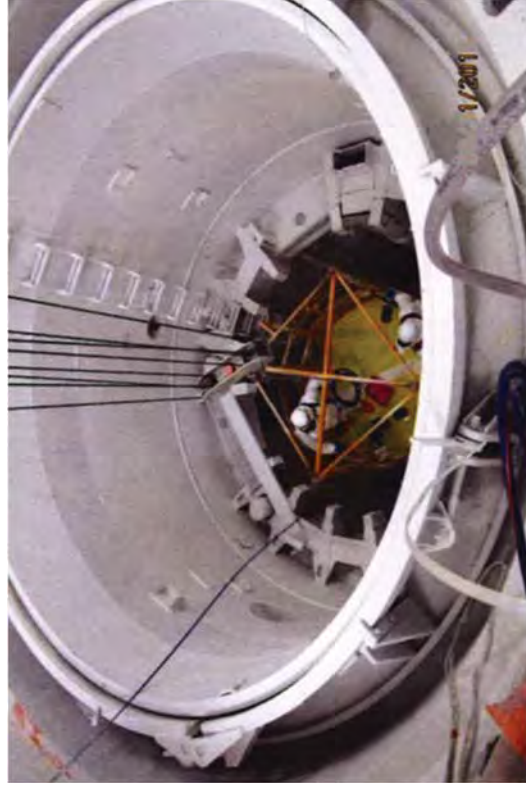


Abatement crew removing the valve gallery lead plug.

Drywell Region



A Pipe in the valve gallery that has been abated of lead.



A crew preparing to paint behind blast shields. Pink paint denotes areas ready for OAD.

Drywell Region



Pipes to that were to stay in-place are identified with tags.



Removing pipe from the valve gallery at -14' EL .



Drywell Region



Waste identified for removal at -66' EL.

Note: At this elevation it was difficult to photograph all work, cleaning, scaffold building, and surveying performed.

Drywell Region



A crew bagging waste from the RCF.

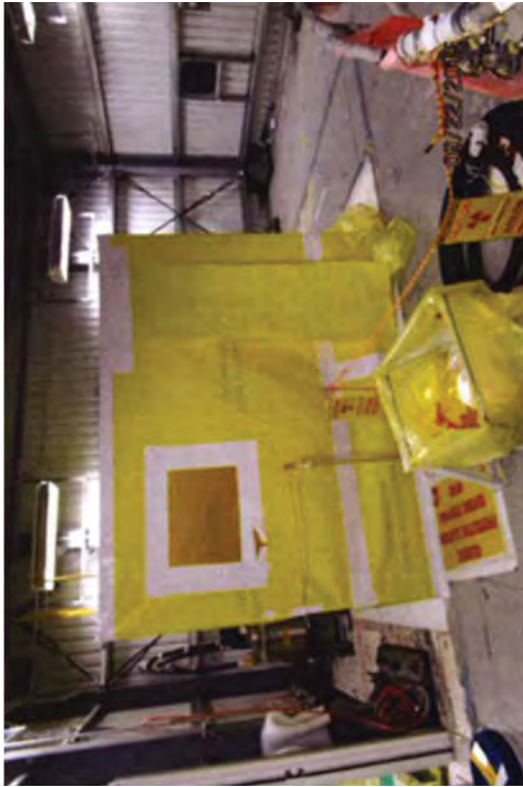


Removing waste via the access shaft using drums.



Areas of contamination marked on the RCF flooring.

Drywell Region



Dismantling a tent enclosure.

Drywell Region



This pipe chase was filled with sand because of limited access to remove the pipe.



A glove bag set-up to survey pipe in the Demineralization Room.



Part of the makeshift chute into the west pipe chase.



### Drywell Region



RP directed that some pipe ends were to be filled with a two-part expanding epoxy foam. The scaffold in this photo is supporting the bulkhead.

### Turbine Building Drain Tank (TBDT)

The TBDT needed to be removed before the OAD of the Turbine Building. The crew used a wire saw to remove the floor of the NFSV located above the TBDT. The TBDT was then wrapped, rigged, removed, loaded in a shipping bag, and secured on a tractor trailer for disposal.



Turbine Building Drain Tank covered for wire saw floor removal of the NFSV.



The last miscellaneous items removed from the underground facilities prepped to be removed from the RFB.



The TBDT removed.

## Asbestos Removal

The ACM exterior coverings of several buildings at HBPP had to be abated before the CWC could demolish them. To begin the process, scaffolding was erected around the buildings and encased in a shrink wrap material. Crews worked methodically and took all of the necessary and required precautions when removing asbestos. The following photos show some of the processes used for asbestos abatement at HBPP.



Shrink wrap containment encasing the scaffolding erected around the RFB.



The RFB after completing asbestos abatement and removing the shrink wrap that encased the scaffolding.

## Asbestos Removal



The RFB with its ACM coating removed and scaffolding removed.



The asbestos abatement process in the reactor drywell inside the RCF.



**Asbestos Removal**



**MPEF**



Removing the MPEF's flexible ductwork.



Stockpiled ACM waste on the roof of the RFB.



Removing HEPA filters from the MPEF.

MPEF



Drilling access holes in vent piping.



Applying fixatives.

MPEF



Removing MPEF HEPA filters.



SPAMS equipment that was salvaged during demolition.





**Plant Stack**



The Stack still remaining.



Demolishing the Stack.

**MPEF**



Demolishing the cable tray and filter box.



Size-reducing metal scrap debris and Demolishing concrete pads to backfill the area so that the CSM can be installed.

Plant Stack



Demolishing the Stack.



Demolishing the Stack.

Plant Stack



A debris pile from the Stack demolition.



Demolishing the Stack Base.



Processing and Loading out Stack material.



RFB Initial Demolition



Demolishing the interior steel railroad bay door.



Beginning the OAD of the RFB.

RFB Initial Demolition



Demolishing the right outer railroad bay door.



Demolishing the left outer railroad bay door.

**RFB Initial Demolition**



Processing the North Wall of the RFB.



Demolishing the RFB while a crane works nearby to install the CSM wall.

**RFB Initial Demolition**



Demolishing the first bay wall of the eastern 40' feet of the RFB.



The RFB during morning inspection.



### RFB Initial Demolition



The northern 40 feet of RFB wall removed to make way for the CSM wall.

### RFB Initial Demolition



Arranging rigging to make the final pull to remove the crane rails.



The 75-Ton trolley crane was pulled off of its rails and to the ground before CSM wall pre-trench work began and water management controls were put in place. The 75-ton crane was then segmented and removed.



Removing the 75-Ton crane from the RFB.

**RFB Initial Demolition**



The 75-Ton crane after its planned and controlled drop from the RFB.

**RFB Initial Demolition**



RP technicians surveying crane beams.



Preparing trolley rails for size reduction.



Processing structural steel to fit intermodals.



**RFB Initial Demolition**



Size-reducing the crane trolley for disposal.



Packaging the 75-Ton crane trolley for disposal.

**RFB Initial Demolition**



75-Ton crane packaged for disposal.



Demolition complete on the eastern 40 feet of the RFB.



Demolishing the RFB slab.



**RFB Initial Demolition**

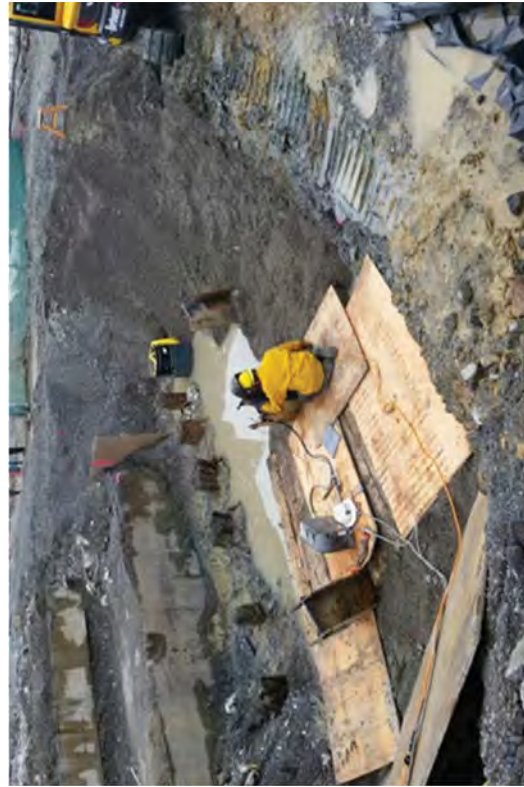


The excavation to remove H-Piles, wooden pilings, and the Off Gas Tunnel.

**RFB Initial Demolition**



Removing H-Piles.



Welding plates onto the H-Piles to aid in removing them.



Hammering wooden pilings.



**RFB Initial Demolition**



Dewatering the excavation.

**RFB Initial Demolition**



Removing the Off-Gas Tunnel.



Removing the Off-Gas Tunnel.



Removing the Off-Gas Tunnel.



**RFB Initial Demolition**



Technicians sampling for FSS.

**RFB**



Preparing to demolish the remaining RFB structure.



Backfilling the RFB Excavation.



RFB



Protective plating was placed over the top of the CSM wall. Protection was also installed on the monitoring wells and their associated equipment.

RFB



Staging the roof trusses within the RFB foot print.



Removing one of two roof trusses.



Demolishing the south wall and crane rail.



RFB



Stockpiled scrap.



Demolishing the trolley crane rail.

RFB



Demolishing the north wall and crane rail.



Ventilation pipe demolition.



RFB



Removing ACM metal.



The RFB wall demolition completed.

RFB



Processing and loading scrap.



Demolishing the RFB roof.

RFB



Processing and size-reducing material.

RFB



The Drywell backfilled and the RFB above grade demolition is complete.



Processing materials and backfilling the Drywell.



The crew celebrating the successful demolition of the RFB, which sat atop the power reactor and was largest, most complex building on the HBPP site.



### Circulating Water Lines Removal



A crew cleaning and preparing a laydown area.

### Circulating Water Lines Removal



The crews laid geotextile fabric, rock, and a base layer before compacting the area to prepare it for sheet piles.



The South Discharge Canal area was prepared and surveyed. Impacted utilities were located in preparation for installing sheet piles.



Inspecting sheet pile installation equipment after it arrived onsite while crews continued re-routing the GWTS.



### Circulating Water Lines Removal



Crews sectioning out the LRW line.

### Circulating Water Lines Removal



Pre-drilling holes for installing sheet pile.



Exposing an abandoned 12 inch gas pipe line.



The abandoned Vortex vault that was dug out and exposed.



### Circulating Water Lines Removal



Crews pre-drilling for a third sheet pile near the south end of the discharge canal.



Crews installing a third sheet pile near the south end of the discharge canal.

### Circulating Water Lines Removal



Crews pre-drilling for the west sheet pile wall.



Removing the abandoned Vortex vault at the discharge canal.



Continuing to pre-drill for the west sheet pile wall.

### Circulating Water Lines Removal



Using a rough terrain crane to install sheet pile.

### Circulating Water Lines Removal



Pre-drilling to install sheet pile.



Using a rough terrain crane to install sheet pile.



Relocating the fence and re-establishing its ground while RP technicians perform surveys.



### Circulating Water Lines Removal



Excavating the HBGS roadway with spotters' assistance while RP technicians survey.

### Circulating Water Lines Removal



A plumbing contractor monitoring the water level for access to HBGS fire line.



Staged sheet piles.



Piping material that was prefabricated for the fire line. A white CW line is marked out. The crew in ditch is obtaining samples for FSS and GPS location.



### Circulating Water Lines Removal



A third load of sheet piles for the day being delivered.

### Circulating Water Lines Removal



Installing sheet piles.



Removing piping and excavating around the RW discharge line.



The OWS control panels' steam cleaning area fence and asphalt removed.



### Circulating Water Lines Removal



Demolishing an electrical pull box in the roadway near the OWS.

### Circulating Water Lines Removal



The headwall removed and showing evidence of some water intrusion.



Deep excavations at the Discharge Canal headwall area.



A hammer being used on the headwall.



**Circulating Water Lines Removal**



A hammer being used on the headwall.

**Circulating Water Lines Removal**



Removing concrete in Area A.



Installing sheet pile in Area C.



Pre-trench activities in Area C.



Circulating Water Lines Removal



Installing sheet pile and a water in Area D.

Circulating Water Lines Removal



Pre-trench activities Area C.



Removing concrete near Building 5 in Area A.



Removing material near the Intake Canal in Area A.

### Circulating Water Lines Removal



Intake piping excavation near the OWS in Area C.

### Circulating Water Lines Removal



A water installed near the Discharge Canal.



Pre-drilling to install piles near HBGS.



A crew continues removing the headwall.



**Circulating Water Lines Removal**



Driving sheet pile in Area C next to HBGS.

**Circulating Water Lines Removal**



FSS being performed on Area D.



Driving sheet pile in Area C next to HBGS.



CLSM pump truck.



**Circulating Water Lines Removal**



Backfilling the excavation after FSS to reduce the in flow of ground water.

**Circulating Water Lines Removal**



Ground water control for the CLSM backfill process.



Pouring CLSM to reduce ground water inflow and allow for soil compaction.



Continuing CLSM backfill.



**Circulating Water Lines Removal**



CLSM backfill completed.

**Circulating Water Lines Removal**



Spreading re-use soils to backfill Area D.



Backfilling Area D with re-use soils.



Removing pipe from Area A.



Circulating Water Lines Removal



Rubbling a concrete thrust block in Area A.

Circulating Water Lines Removal



Backfilled soils in Area D.



Rubbling concrete in Area A.



Installing sheet pile.



**Circulating Water Lines Removal**



Groundwater control in Area D.



Excavating in Area D.

**Circulating Water Lines Removal**



Excavating in Area D.



Removing pipe from Area D.



**Circulating Water Lines Removal**



Commodity and pipe removed from Area A.

**Circulating Water Lines Removal**



Continuing to dig to remove pipe.



Commodity and pipe removed from Area A.



Commodities and piping that has been removed.



Circulating Water Lines Removal



Removing commodities and piping.

Circulating Water Lines Removal



Pre-drilling and setting sheet piles in Area C.



The Area A excavation.



Continuing to excavate and backfill Area D.



**Circulating Water Lines Removal**



Continuing deep excavation.

**Circulating Water Lines Removal**



A 275 ton crane that was mobilized to remove sheet pile from Area D.



Removing commodities and piping.



Removing sheet pile from Area D.

Circulating Water Lines Removal



Relocating the HBGS fence.

Circulating Water Lines Removal



Stabilizing the slope with re-use materials



Relocating the HBGS fence.



The slope after being stabilized.



### Circulating Water Lines Removal



Removing sheet pile.

### Circulating Water Lines Removal



Demolishing the Unit 1 concrete pad to reach underground commodities and Circulating Water Lines.



Removing sheet pile.



Using trench sheeling while demolishing the Unit 1 concrete pad.



**Circulating Water Lines Removal**



Removing and installing sheet pile.

**Circulating Water Lines Removal**



Abandoned electrical wiring and transite pipes being removed from excavation.



Removing Circulating Water Lines and sheet pile from the North end of Area D.



Re-use soil being used to backfill section D.



**Circulating Water Lines Removal**



Loading out soils from the excavated west wing area so that sheet pile on the west side of Area D can be removed.



A water system installed on a sheet pile wall.

**Circulating Water Lines Removal**



A low volume waste sump structure being removed.



Removing Circulating Water Pipe from the Unit 1 pad area.



**Circulating Water Lines Removal**



View from Area A to B.

**Circulating Water Lines Removal**



View from Area C to D.



View from Area B to C.



Performing a radiological survey on Area A.



**Circulating Water Lines Removal**



A water installed on Area C sheet piles.

**Circulating Water Lines Removal**



Backfilling Area A in 12" inch lifts to meet minimum compaction requirements.



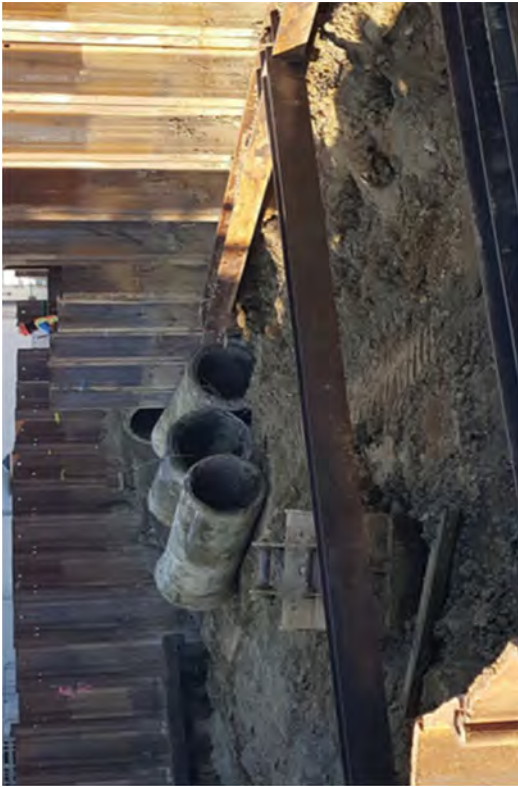
Removing pipe from the deep excavation of Area C.



Area A backfilled.



**Circulating Water Lines Removal**



Pipes removed from Area C.

**Circulating Water Lines Removal**



Surveying the HBGS bank stabilization in Area A.



Backfilling Area D.



Continuing to backfill Area A.



**Circulating Water Lines Removal**



Installing walers in Area C.

**Circulating Water Lines Removal**



Removing shallow commodities and ACM piping in Area B.



Area D after completing the radiological FSS survey.



Area B.



**Circulating Water Lines Removal**



Backfilling Area D.

**Circulating Water Lines Removal**



A crew member performing a compaction test.



After removing soil and pipe from Area D the sheet piles must be removed and the area finished to grade.



Backfilling material into Area D.



**Circulating Water Lines Removal**



Continuing the deep excavation and pipe removal in Area C.

**Circulating Water Lines Removal**



Removing the thrust block from Area C.



Continuing the deep excavation and pipe removal in Area C.



Continuing to remove pipe in Area B.



**Circulating Water Lines Removal**



Radiological FSS being performed on a portion of Area B.

**Circulating Water Lines Removal**



Continuing to remove pipe in Area B.



FSS continues in Area B.



Removing pipe in Area B.



**Circulating Water Lines Removal**



An OWS pipe line to outfall in Area C.



Removing pipe in Area C.

**Circulating Water Lines Removal**



Pipe excavated for removal in Area C.



Pipe excavated for removal in Area C.



**Circulating Water Lines Removal**



Abandoned underground utilities.

**Circulating Water Lines Removal**



Backfilling Area D to Area C.



Removing pipe in Area C.



Backfilling.



Circulating Water Lines Removal



Backfilling.

Circulating Water Lines Removal



Circulating Water Line and thrust blocks.



Compacting backfill.



Demolishing a thrust block.



**Circulating Water Lines Removal**



Removing Pipe.

**Circulating Water Lines Removal**



The sampling vault next to Building 5 alongside Circulating Water lines to the Unit 1 inlet and discharge.



Circulating Water Lines underneath the footprint of Building 5.



Removing Pipe.

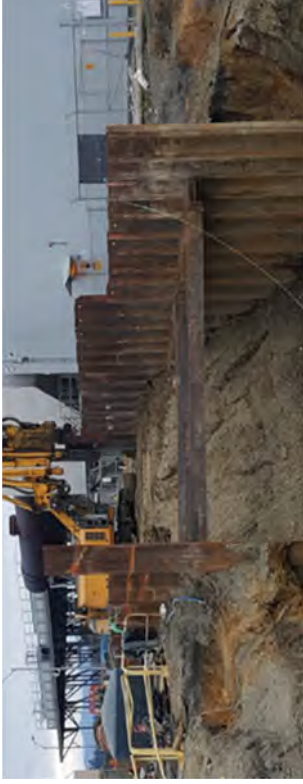


Circulating Water Lines Removal



Backfilling and compacting.

Circulating Water Lines Removal



Backfilling and compacting.



Removing Pipe.



FSS in process.



### Circulating Water Lines Removal



Backfilling with re-use soils

### Circulating Water Lines Removal



Removing Unit 2 piping.



This water must be removed prior to the FSS survey.



The last water section being removed from sheet piles.



Performing FSS and then backfilling.



### Circulating Water Lines Removal



Backfilling and compacting.

### Circulating Water Lines Removal



Humboldt weather.



Backfilling and compacting in trench after FSS complete.



Pumping water from the trench.



Continuing FSS.



### Circulating Water Lines Removal



Removing sheet pile.

### Circulating Water Lines Removal



Compaction testing.



Compacting the top layer as required.



Sheet piles ready to be removed after the are was compacted and the FSS is complete.

**Circulating Water Lines Removal**



Removing sheet pile.

**Circulating Water Lines Removal**



Moving the sheet pile out of the area for so it can be surveyed and released from the site.



Removing sheet pile.



Backfilling and preparing for final compaction.



Circulating Water Lines Removal



Reinstalling the sewer line to HBGS.

Circulating Water Lines Removal



Installing the sewer line.



Area backfilled.



Installing the sewer line.

## Circulating Water Lines Removal



Performing the final connection to the site sewer system.



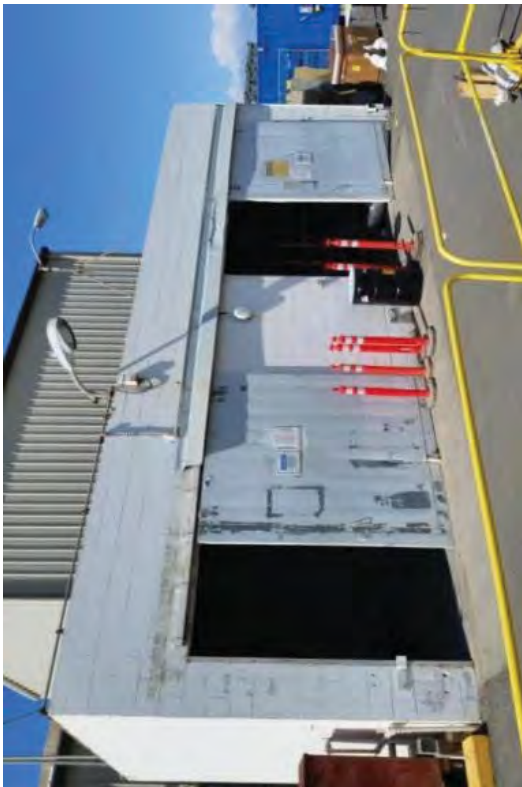
The sewer line trench in the process of being backfilled.



Cleaning up at the end of 2017 after the trench was backfilled.



Low Level Radwaste LLRW) Building

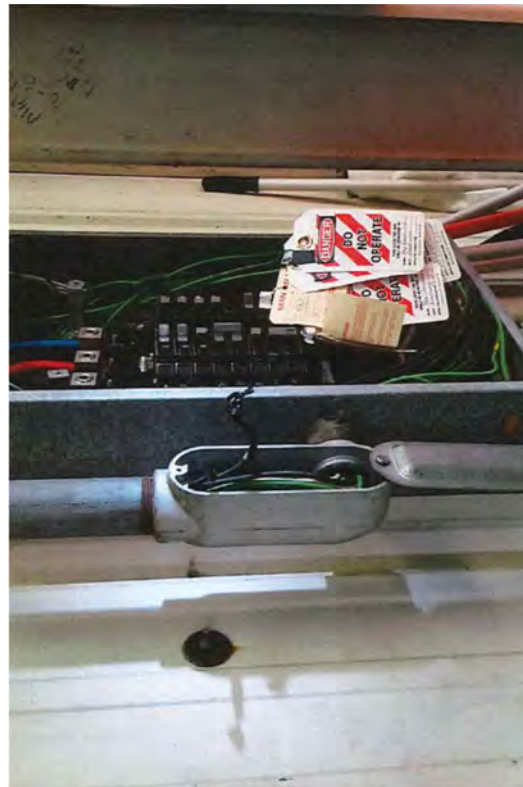


The LLRW Building before starting work.

LLRW Building



LLRW Building electrical air gap after clearance and "Live Dead Live" verification by electricians.



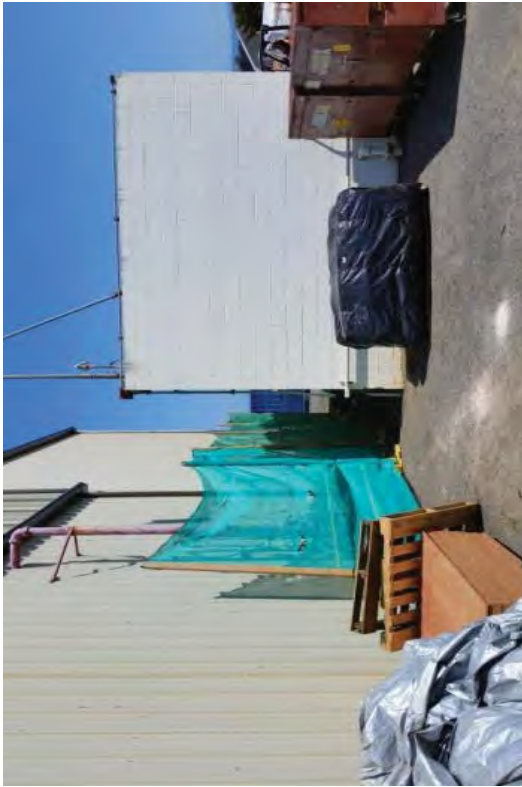
Leads that will be lifted from breaker panel and tested "Live Dead Live".



The LLRW Building set-up for Class I containment for friable asbestos abatement in transite panels.



LLRW Building



A green protective barrier was installed alongside the SRWB.

LLRW Building



Excavators reducing the size of LLRW Building debris.



An excavator demolishing the LLRW Building while a high pressure sprayer is used to control dust.



An excavator cleaning up debris and loading it to intermodals.



LLRW Building



The remaining LLRW Building slab after cleanup.

LLRW Building



Loading out the LLRW Building slab and paving while also removing the SRW Building slab and its associated underground utilities after the building was removed.



A view of the area after the LLRW Building slab, SRW Building, and underground utilities were removed.



Removing ACM pipe that was the upright section of fire line going to the LLRW Building.

### Solid Radwaste Building (SRWB)



The SRWB, which was a steel structure.



Workers evacuated the RUBB tent while demolishing the steel and metal structure of the SRWB because the two structures were so close.

### SRWB



The SRWB was removed from the west to east as planned.



RP characterized and released the entire SRWB for OAD before demolition began.



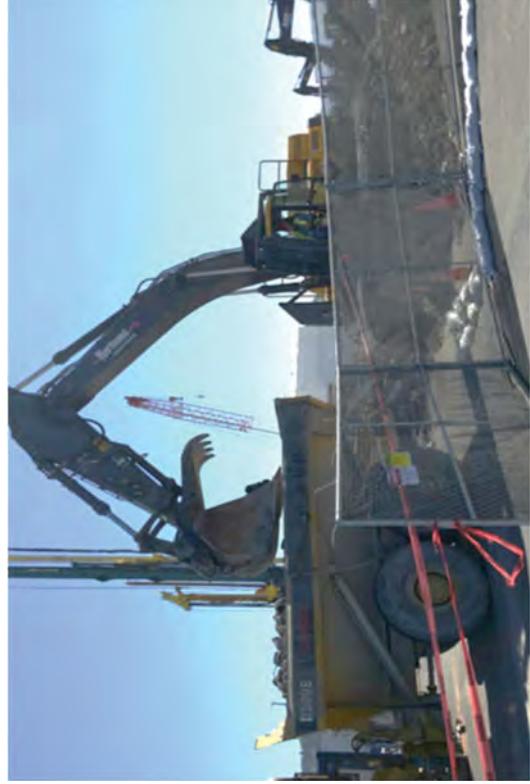
Size-reducing sheet metal and steel so that it could be loaded into an intermodal.



SRWB



Processing SRWB material and debris.



Loading out concrete.

SRWB



Using an excavator equipped with a hydraulic hammer to break apart the SRWB slab.



Processing SRWB concrete and rebar.

SRWB



Removing pipe.



Removing pipe and commodities.

SRWB



Loading out material.



Grading the footprint of the SRWB slab.



**HLV**



Exposing ACM piping. The HLV is seen with a pile of old rail footings on its lid.



Demolishing the HLV.

**SRWB**



Removing soil and final grading.



SRWB removed along with all commodities.



### High Level Vault (HLV)



Demolishing the HLV.

### HLV



Abating ACM pipe and flooded of excavation during winter months.



Demolishing the HLV.



Remediating the area below the HLV slab.



### Soil Management Facility (SMF) Tent Installation



The foundations for the SMF tents were constructed at the former location of Trailer City, which had previously been the location of the Unit 1 and Unit 2 settling ponds.

### SMF Tent Installation



Crews constructing forms for the SMF tent foundations.



Removing the Effluent Pond's concrete wall.



Crews constructing forms for the SMF tent foundations.





### SMF Tent Installation



Filling a soft spot with CLSM after it was more extensively excavated than the immediate area surrounding it.



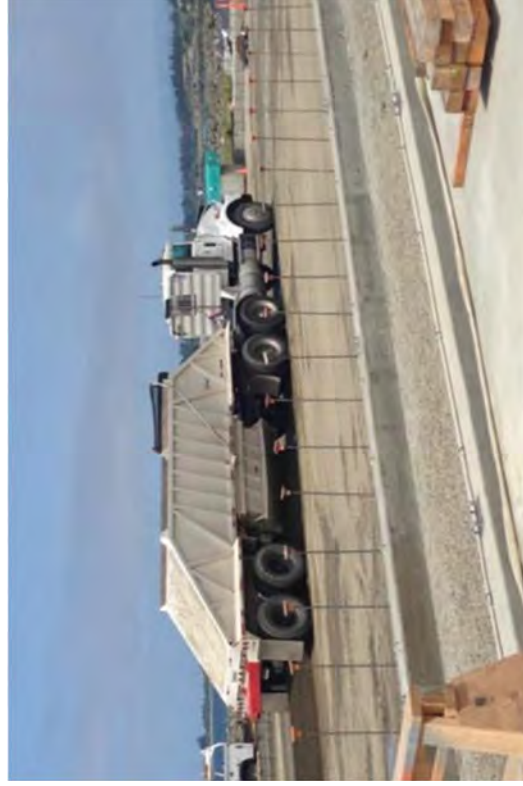
### SMF Tent Installation



Stripping the forms from the foundation and spreading gravel to install the pad and a drain.



Pouring the SMF Tents' foundations.



Placing gravel for the SMF Tent 2 slab after the SMF Tent 1 and Tent 2 foundation and slab for SMF 3 were completed.



### SMF Tent Installation

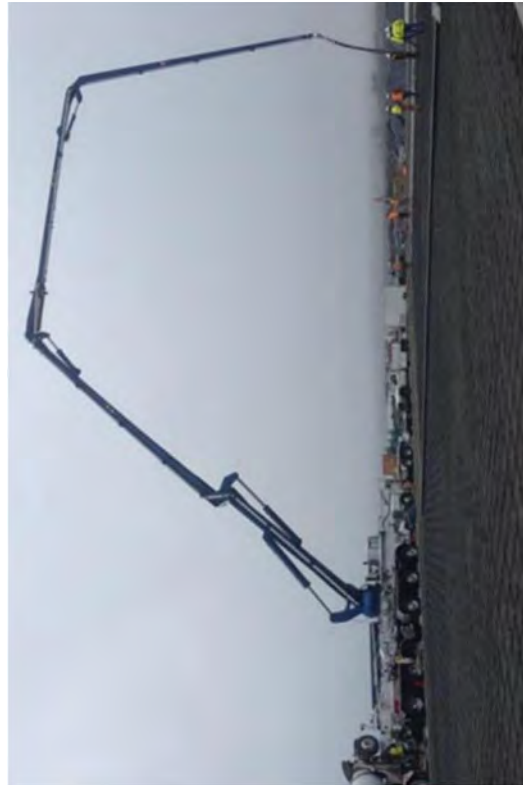


Rebar in place for the SMF Tent 2 slab.

### SMF Tent Installation



Erecting the SMF Tent 1 Structure.



Pouring concrete for the SMF Tent 2 slab.



Erecting the SMF Tent 1 Structure.



### SMF Tent Installation



Installing the gable end with the door opening.

### SMF Tent Installation



The finished interior of an SMF tent with lighting installed.



Fabric stretched and attached



The first soils stored in the SMF.



**SMF Tent Installation**



SMF Tent 1 and Tent 2 which were located on the eastern edge of the HBPPP site.

**SMF Tent Installation**



The SMF Tent 2 tent.



The SMF tents provided a controlled environment and that was large enough for waste hauling trucks to enter and be loaded.



The SMF Tent 1 tent.



## GARDIAN System Installation

The Gamma Radiation Detection and In-Container Analysis (GARDIAN) system allows waste to be assayed while loaded in transport vehicles and containers. The GARDIAN is comprised of two trailers which house detectors, tracks, and towers to precisely position the unit's Purity Germanium Detectors (HPGe). Office and support systems are also located inside the trailers. A scale was installed between the two trailers so that trailers and trucks could be weighed.



The first GARDIAN Trailers that were installed at HBPP.

## GARDIAN



Installing the electrical system for the GARDIAN.



Electricians installing conduit and bridge between the GARDIAN trailers.

**GARDIAN**



Affixing anchors to the GARDIAN trailers.

**GARDIAN**



The first GARDIAN ready for service.



Protective bollards were installed and painted in safety yellow.



**GARDIAN**



The first GARDIAN system in operation.



The first GARDIAN system in operation.



Laying out the area for the second GARDIAN system.

**GARDIAN**



The completed forms with horizontal rebar installed.



Pouring the concrete slab for the scale.



**GARDIAN**



Setting one half of scale in place.

**GARDIAN**



An anchor point for the truck scale.



Both halves of the scale installed, leveled, and anchored down.



Setting the first of two trailers for the second GARDIAN system.

**GARDIAN**



The second trailer added for the second GARDIAN system.

**GARDIAN**



Preparing the exit ramp.



The approach ramp ready for compaction after spreading a base layer of gravel.



To the left of the trailers is the main entrance coming from parking lot C. Gates A and B were closed before the GARDIAN was installed.



## GARDIAN



The center drive-thru area was one of two ways access HBPP. This access point is on the east side of the site.



The view looking forward inside one of the GARDIAN trailers where the hardware and software for scanning trucks is installed. The sensors inside the trailer can be repositioned to accommodate differently sized and shaped vehicles.



The view looking to the rear from inside a GARDIAN trailer.

## Power Pole Relocation



Mobilizing the GC Line and performing preparation activities such as drilling for and installing the pole anchors.



Installing the new power pole.





### Power Pole Relocation



### Power Pole Relocation



The new power line crossing the center of the Discharge Canal to the new pole at the SMF.



Power pole location completed and power restored to site.



Removing the power line that crossed over the south Discharge Canal work area.

**SMF Tent Removal**



The SMF Tent 2 tent ready to be surveyed.



RP technicians surveying the concrete in the SMF Tent 2 tent.

**SMF Tent Removal**



SMF Tent 2 Fabric partially removed.



SMF Tent 2 Fabric removed ready for packaging.



**SMF Tent Removal**



The SMF Tent 2 steel structure ready for demolition.

**SMF Tent Removal**



Processing steel from the SMF Tent 2.



The SMF Tent 2 steel structure on the ground.



Processing steel so it can be surveyed.



**SMF Tent Removal**



Loading the steel into a truck.

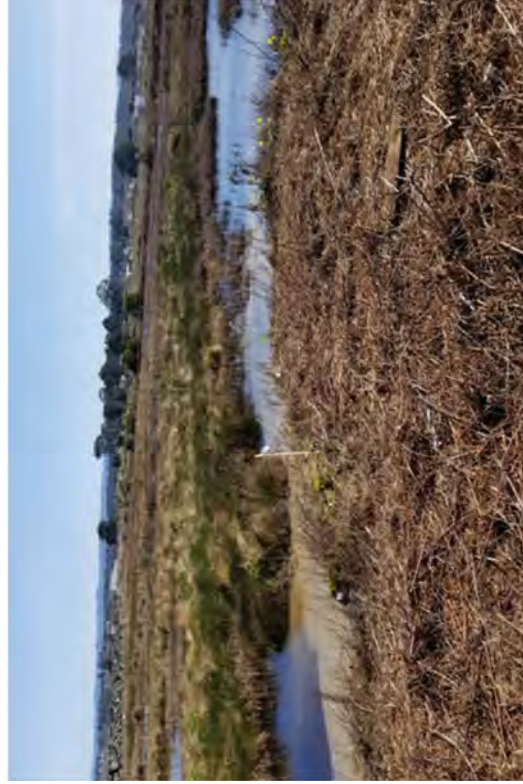


Dewatering the SMF slab to the GWTS.

**SMF Tent Removal**



The location of the SMF tents on the HBPP site.



Pumped storm water and storm water runoff.



**SMF Tent Removal**



Storm whater that needed to be removed.

**SMF Tent Removal**



Stockpiling concrete and rebar from the SMF Tent 2 slab.



Demolishing the SMF Tent 2 slab.





**SMF Tent Removal**



Cleaning out the SMF Tent 1 so that it can be surveyed by RP.



Cleaning out the SMF Tent 1

**SMF Tent Removal**



Size reducing concrete from the SMF Tent 2 slab.



Size reducing concrete from the SMF Tent 2 slab.



SMF Tent Removal



SMF Tent 2 curb footer removal.

SMF Tent Removal



SMF Tent 2 Footer removal.



SMF Tent 2 curb footer removal.



Personnel performing FSS activities on SMF Tent 1.

**SMF Tent Removal**



Processing concrete.

**SMF Tent Removal**



Removing the fabric exterior from SMF Tent 1.



Processing concrete from SMF Tent 2.



Demolishing SMF Tent 1.



**SMF Tent Removal**



Demolishing SMF Tent 1.



RP personnel surveying the steel structure.

**SMF Tent Removal**



Demolishing SMF Tent 1.



Demolishing SMF Tent 1.



**SMF Tent Removal**



Processing concrete from SMF Tent 2.



Processing concrete from SMF Tent 1.

**SMF Tent Removal**



Processing concrete.



Processing concrete.

Office Facilities

Office Facilities



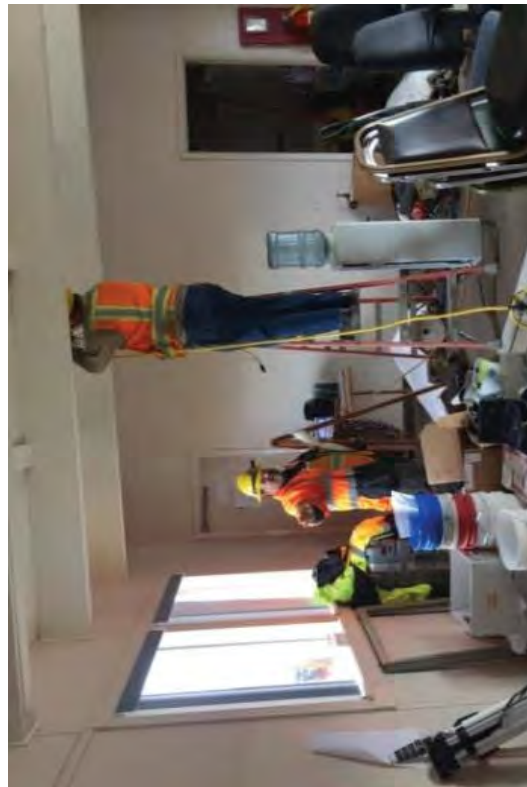
South view of line crew terminated power to Building 1.



Line crew terminating power to Building 1.



West and north view of offices.



Electricians removing lights in offices.



**Office Facilities**



Removing ACM roofing before demolition.

**Office Facilities**



Demolishing the Offices. The "Frog Pond" is in the foreground.



Demolishing the Offices.



Completed Demolishing the Offices.



## Office Facilities



Loading out concrete demolition waste from the Assembly Building to be processed.



The last remaining waste being loaded out.

## Hydrogen Storage Building



Performing asbestos abatement on the roof of Hydrogen storage building.



Performing asbestos abatement on the roof of Hydrogen storage building.



### Hydrogen Storage Building



Performing asbestos abatement on the roof of Hydrogen storage building.



Soil surcharge removal.

### Hydrogen Storage Building



Soil surcharge removal.



Pre-demo.



Building demolition.



### Hydrogen Storage Building



Hydrogen storage building debris.



Foundation demolition.



Grubbing of hillside by old Unit 2 back stairs on hill.

### Hydrogen Storage Building Hillside



Old steps behind Unit 2 in bank removed.



Processing old steps.



### Oily Water Separator (OWS)



The OWS before demolition.

### OWS



Demolishing the OWS raceways.



Hand rails and abandoned control panels removed from the OWS.



Demolishing OWS concrete while using dust mitigation controls.



OWS



Hammering out the north end of the OWS raceway.



Removing the skimmer oil sump from the south end of the OWS raceway.

OWS



Hammering out the OWS raceway.



Removing material from OWS raceway.



OWS



The OWS raceway fully removed and ready for environmental sampling and FSS survey. The LVW sump remains at north end of raceway.

OWS



Pumping ground water out of an OWS raceway excavation.



RP surveying the OWS excavation after the raceways were removed.



Beginning to backfill after FSS of the OWS raceway excavation was completed.



OWS



Rubbing the concrete wash pad.



Removal of the concrete wash pad along with its wooden fencing, area was then sampled by Environmental and surveyed by FSS.

OWS



Backfilling the OWS excavation.



Compacting the OWS excavation backfill.

**Support Trailers**



Trailers prepared to be removed from the site.

**Building 26**



Ventilation removal prep.

**Warehouse Tent Bravo Rd.**



Warehouse tent in Bravo lot prior to demo.



Ventilation removal prep.



Building 26



Fiberglass insulation removal.



Building ready for FSS.

Building 26



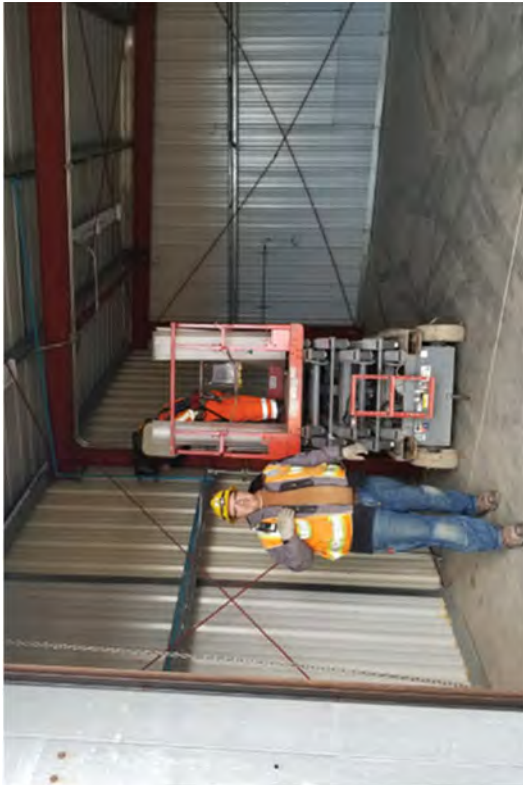
Ventilation system removal.



Final work area cleaning.



Building 26



E-wasted removal.

Building 26



Scrap metal loadout.



Concrete foundation removal.



Building 26



Sidewalk removal.

Building 26



ISOC of gabion baskets.



Concrete loadout.



Environmental sampling.



**Building 26**



Preparing pad for FSS.

**Building 26**



Exercise pad removal.



Wind wall removal.



Exercise pad removal.



**Building 21**



Originally the hazardous waste storage building (Building 21 demolition).

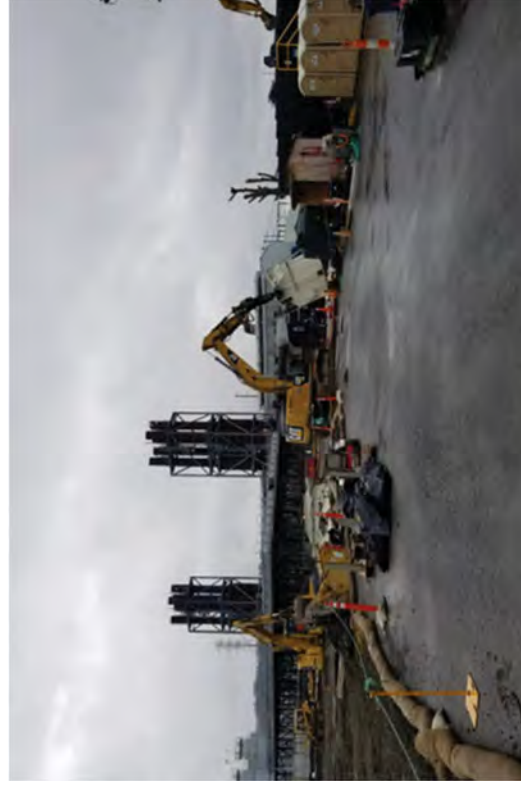
**Building 21**



Building 21 demolition.



Building 21 demolition.



Building 21 demolition.

Building 21



Concrete removal.



Concrete removal, site grading.

Load Center 5 (LC-50)



LC-50 prior to demolition.



LC-50 removal.



LC-50



LC-50 foundation removed.



FSS LC-50 excavation.

LC-50



LC-50 demolition debris.



LC-50 removal.



**Sewer Lift Station at Trailer City**



Removal of sewer lift station at Trailer City.

**Removal of Sewer Lift Station at Trailer City**



Lift Station removed.



Lift station removal.



Lift Station backfill.



## Hot Machine Shop (HMS)

In March 2014 the CWC took custody from PG&E the task to demolish and package the Hot Machine Shop for shipment. The CWC also took over the responsibility for installing and maintaining storm water BMP's for the HMS foot print and its surrounding area in accordance with SWPPP. Excavating the area required approval from PG&E and that the RCA access point east of the HMS be maintained. Cold and dark power was in place for this building as well as its HVAC. To demolish this facility the RCA boundary and additional equipment had to be relocated because the building itself had been used to define the RCA's bounds. Barricades and signage were installed to control pedestrian and vehicular access to this work area.



The HMS as it was turned over to the CWC



The HMS prior to demolition.

## Hot Machine Shop



A crew using hydraulic tooling to break up the floor.



A remotely operated excavator.

Hot Machine Shop



Removing demolished shop slab sections.

Hot Machine Shop



A HMS demolition safety person in a man basket keeping a mist of water on the demolition to control the risk of airborne asbestos and dust. The front of the HMS and CMU block above the overhead garage door opening and the roof deck were removed to provide access to the crane bridge seen on the ground inside the building.



A green asbestos encapsulation coating allowed for OAD of the HMS.



The above grade HMS removed and loaded in intermodals.



**Hot Machine Shop**



Excavating the HMS Below Grade area.

**Hot Machine Shop**



Demolishing thrust block "W". The chase in the foreground contains a section of 39" inch cooling water pipe.



An excavator prepping the HMS trench for FSS and backfilling. The rainy season caused considerable amounts of water runoff to collect in the trench.



An excavation showing a 39" inch cooling water inlet pipe along its west side.



Hot Machine Shop



A section of cooling water pipe that has been sized to fit inside an intermodal.

Hot Machine Shop



Pumping CLSM into a deep hole left after wooden pilings were extracted.



Three wooden pilings after being extracted. They each measured 15 to 20 feet long.



An RP technician surveying a section of the 54 inch discharge line.



**Hot Machine Shop**



Demolishing the 54 inch pipe located north of the thrust block.

**Hot Machine Shop**



Demolishing concrete at the intersection of the Unit 2 slab area.



An excavation that needs to be dewatered. This was a typical accumulation for most mornings.



Removing concrete debris. Remnants of Circulating Water Pipe are visible in the foreground.



Hot Machine Shop



Hand surveying was necessary in certain areas.

Hot Machine Shop



Beginning to backfilling over the CLSM and a layer of geotextile fabric.



FSS suspends the ISOCSS over an area previously occupied by deep discharge water line.



Compacting backfill using the methods of track walking and tamping with bucket.



**Hot Machine Shop**



Preparing to cut off the Circulating Water Pipe in the HMS Trench using CLSM.

**Hot Machine Shop**



The HMS excavation after the Circulating Water Pipe was cutoff with CLSM.



Plugging the Circulating Water Pipe with CLSM allowed backfilling to continue in the HMS Trench.



Backfill completed over CCW piping.



### Hot Machine Shop



Installing geotextile fabric before placing a layer of 3 inch wash rock.

### Hot Machine Shop



The HMS excavation after being graded and compacted.



Placing a 6-inch deep layer of 3-inch wash rock.



Installing a pump in the drainage sump to ready the area for the TB below grade removal.



## Unit 2 Pre-Trench

The Unit 2 slab and its pilings were removed to prepare for the installation of the CSM wall. Soils from this area went to the SMF for re-use, processing, or disposal. Ground water intrusion was continuous while performing this work. All water removed from the excavation was tested and sent to drains or to the GWTS to be discharged.



BMP's installed along the TB foundation's border with Unit 2 in preparation for excavation.

## Unit 2 Pre-Trench



Ready for pre-trench excavation activities to begin at the Unit 2 footprint.



The Unit 2 footprint ready for pre-trench excavation activities to begin.



The initial dig into the Unit 2 slab south of the construction fence. Samples were taken at this time for environmental testing.



Unit 2 Pre-Trench



Engineering staff inspecting some additional piping that was unearthed.

Unit 2 Pre-Trench



This lead exclusion zone was created due to previously known factors.



A drain pipe exposed and prepared for an air gap and plug to be installed.



An XRF meter gathering lead air exposure data.



### Unit 2 Pre-Trench



An Environmental technician prepping an area to be screened with the SRF lead meter.

### Unit 2 Pre-Trench



Delivering and testing a vibratory hammer used to remove wooden pilings.



Positioning the seventh intermodal to be used for lead removal.



The view facing east of wooden pilings that were exposed while excavating lead-containing soils.



### Unit 2 Pre-Trench



Breaking up a 6 foot thick slab with a hydraulic hammer. Rock has been laid down as a base for crane mats.

### Unit 2 Pre-Trench



RP technicians reviewing and taking samples in the wooden piling laydown area.



Loading unit 2 slab debris while the ground is prepared for crane mats.



Removing rubble.



**Unit 2 Pre-Trench**



Demolishing and excavating on the eastern edge of the TB foundation footprint.

**Unit 2 Pre-Trench**



Demolishing at the eastern boundary of Unit 2.



The RCA fence was moved east under the guidance of FSS so that demolition of the TB Foundation could continue.



Loosening wooden pilings.



**Unit 2 Pre-Trench**



A vibratory hammer forcing a pipe sleeve over a wooden piling to free it by breaking the suction created by the dense clay layer.



After the pilings are loosened with the hammer and pipe they can be removed from the ground with lower cost equipment than the large crane.

**Unit 2 Pre-Trench**



Removing an overnight accumulation of groundwater.



Twenty wooden pilings exposed at the center east section



### Unit 2 Pre-Trench



RP technicians scanning and sampling after pilings are extracted.

### Unit 2 Pre-Trench



Pulling wooden pilings after they were freed from the clay.



A vibratory hammer forcing a pipe sleeve over a wooden piling to free it by breaking the suction created by the dense clay layer.



Excavating a 9 foot deep Boiler Blow-off Drum pit.



**Unit 2 Pre-Trench**



Debris from Unit 2 Boiler Blow-off Drum pit.

**Unit 2 Pre-Trench**



Loading an end dump after RP cleared the recyclable concrete stockpile.



Concrete stockpiles were segregated corresponding to the results of sampling and testing by RP staff.



Workers controlling dust using a pressure washer when the excavator hammer is operating.



### Unit 2 Pre-Trench



RP technicians scanning abandoned pipe found in excavation.

### Unit 2 Pre-Trench



Fitting an RP technician with a creosote exposure monitor before the technician handles wooden pilings.



An RP technician scanning an intermodal before it is shipped.



The RP team scanning multiple pilings in the laydown area



**Unit 2 Pre-Trench**



Exposed non-transite pipes that run north toward Unit 1.

**Unit 2 Pre-Trench**



RP technicians using radiological instruments to frisk pipes.



Transite pipe before removal. The steel pipe on the right was chased along the north edge of Unit 2.



Workers removing and sizing steel pipes. Transite pipe is left in the ground so it can be properly removed.



Unit 2 Pre-Trench



Crews cutting steel pipe in the far north end of Unit 2.

Unit 2 Pre-Trench



Transite pipe cut and wrapped for disposal.



Removing cut steel and corrugated pipe from the north portion of Unit 2's footprint.



A crew excavating beneath exposed piping so that it can be cut.



**Unit 2 Pre-Trench**

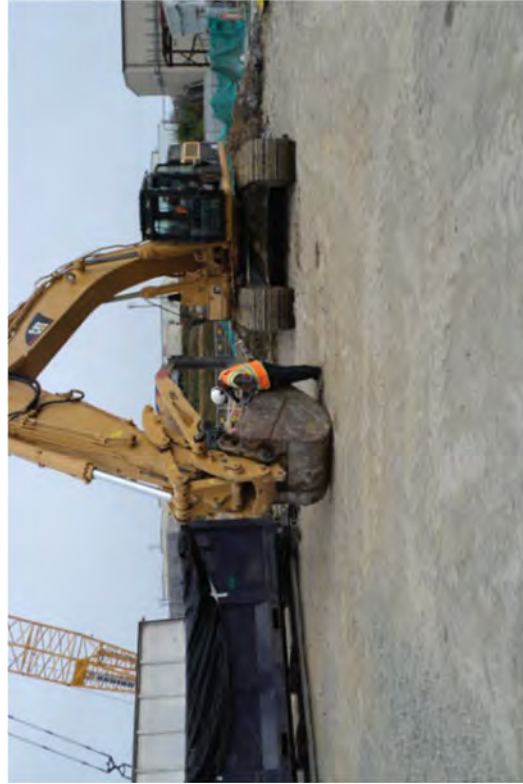


The Unit 2 excavation partially prepared for FSS.

**Unit 2 Pre-Trench**



An ACM crew wrapping a glove bag over a 6 inch pipe to remove mastic tape.



An RP technician taking samples while loading out soil.



The Unit 2 footprint excavation at a depth of approximately 10 feet below grade where deep feature removed.



Unit 2 Pre-Trench



Performing a partial FSS survey on the Unit 2 footprint.



FSS soil sampling.

Unit 2 Pre-Trench



An ACM crew removing transite pipe.





**Unit 2 Pre-Trench**



An FSS crew collecting soil samples.

**Unit 2 Pre-Trench**



Stockpiling material for RP sampling and recycling.



An excavator with a hammer being used to start demolition work on a new area in south central Unit 2.



Backfill equipment arriving at the site, including a sheep's foot roller and dozer.



Unit 2 Pre-Trench



Laying geotextile before backfilling north Unit 2.

Unit 2 Pre-Trench



Using the dozer and sheep's foot roller to backfill.



Beginning to backfill using approved material.



Backfilling the north end.



**Unit 2 Pre-Trench**



Backfill view looking south from RCA.

**Unit 2 Pre-Trench**



The transition to the south central area next to TB foundation.



Backfill completed to be within 16 inches of grade at the north end of Unit 2.



While using dust control measures, rubble is loaded directly into intermodals from the excavation per RP instructions.



### Unit 2 Pre-Trench



Loading soil into intermodal containers for disposal.

### Unit 2 Pre-Trench



Excavating the southeast area of the Unit 2 footprint in preparation for the cutoff wall to be installed.



When FRAC tanks are full of process or rain water they are pumped to a GWTS holding tank.



RP personnel on site and collecting water samples from the Unit 2 FRAC tank. The water was pumped to the GWTS after approval.



### Unit 2 Pre-Trench



A view looking northwest of the ISOCS in operation.

### Unit 2 Pre-Trench



A layer of geotextile material was laid on the flat surface of the FSS area before it was backfilled.



The ISOCS scanning in a low area after it was dewatered.



Operators using a backhoe to deliver fill material into the excavation where a dozer then spreads it.



### Unit 2 Pre-Trench



Placing Class II aggregate over the 0.75-inch fill material.

### Unit 2 Pre-Trench



A corner had to be removed from an extension of the RFB, called the PEG room, because it partially encroached on the CSM footprint.



The Unit 2 footprint ready for CSM cutoff wall installation activities.



Engineering staff gave directions that a steel pipe had to be cut and the concrete thrust block and corner of the PEG room footing had to be removed.



**Unit 2 Pre-Trench**



The excavation next to PEG room ready for FSS evaluation.

**Unit 2 Pre-Trench**



The backfill of this supplemental work area next to the PEG room nearly complete. This completes the portion of CSM Unit 2 pre-trench section.



Using a dozer and smooth roller to compact Class II aggregate.



The North Yard pre-trench had multiple above-ground obstructions.



North Yard Pre-Trench



A modification to the firewater line had to be made before excavation began.

North Yard Pre-Trench



RP tests soil from the bucket for count room.



An excavator mobilized to the North Yard pre-trench area.



Concrete broken in and around the vault at west North Yard.



**North Yard Pre-Trench**



Ferrying a transite pipe to the staging area to be wrapped.

**North Yard Pre-Trench**



This obstruction had to be cut inside an enclosure.



The RP remediation crew locates three radiological hot spots.



A typical accumulation of water in an excavation after substantial rains.



### North Yard Pre-Trench



The top 12" inches of backfill placed for this portion of North Yard.

### North Yard Pre-Trench



Crewmembers cutting bolts from a metal flange which connects transite pipe to a thrust block.



The transite fire line, electrical raceway, and iron 4-inch LRW drain line exposed.



RP collecting samples from corrugated pipe.



North Yard Pre-Trench



A high concentration of transite pipe in a small area which can only be worked by asbestos trained workers.

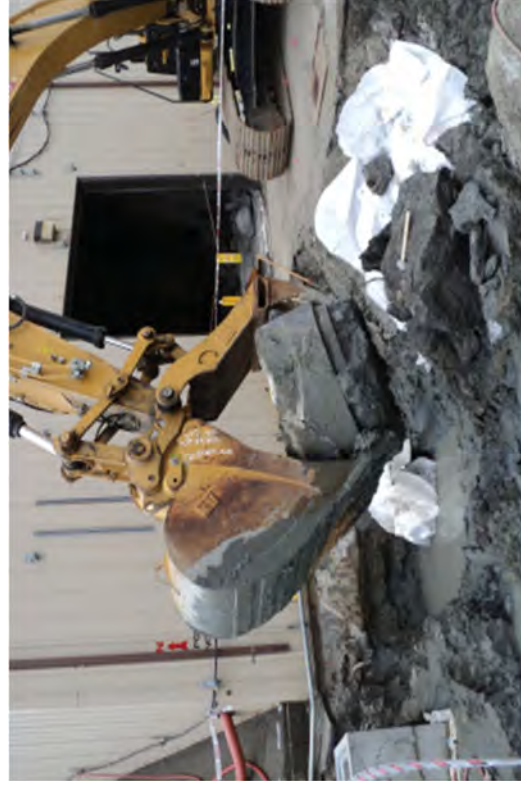
North Yard Pre-Trench



Wrapping transite pipe for disposal.



Demolishing the electrical duct run. The crew is dressed out in PPE due to contaminants and transite pipe in the concrete.



An excavator moving the raceway base to the LRW building where it could be stored and disposed of with the building because of their similar levels of contamination.



### North Yard Pre-Trench



Pieces of raceway concrete were double wrapped due to contamination.

### North Yard Pre-Trench



Workers exposing the raceway and fire line pipe.



This is a collar section containing visible transite pipe that broke off the raceway base connecting to the east-west electrical run.



Gently fracturing the raceway to minimize the risk for projectiles while water is sprayed to mitigate airborne dust.



### North Yard Pre-Trench



Injecting embedded pipes with two-two part epoxy expanding foam as they rest atop supports. Pipes left in place within the raceway were also injected.

### North Yard Pre-Trench



Placing the second section in an intermodal.



An abatement contractor removes the Asbestos warning tapes surrounding a mitigation area.



Injecting two-two part epoxy expanding foam into the raceway that remains in the ground.



### North Yard Pre-Trench



Crewmembers carefully cutting pipe at the LRWB foundation on the northern edge of the North Yard pre-trench area.

### North Yard Pre-Trench



An environmental technician taking samples in the background as RP technicians remediate the area in the foreground.



RP remediation technicians obtained samples.



Continuing RP remediation activities after several rounds of digging and removing soil.



**North Yard Pre-Trench**



RP technicians scanning the excavation after deeper successive cuts. This area was known to have high radiological and heavy metal contamination.

**North Yard Pre-Trench**



Breaking up the condensate storage tank pad.



Backfilling this phase of pre-trench.



Lifting a metal building off of its pad.



**North Yard Pre-Trench**



Preparing the metal building for demolition, size reduction, and loading into an intermodal.

**North Yard Pre-Trench**



Carefully trimming around the offgas tunnel allowed steel plate to be installed later on.



Backfilling this small and technically challenging third area.



Removing rebar and concrete at the east-west tunnel



**North Yard Pre-Trench**



The North-south tunnel partially demolished in the foreground.

**North Yard Pre-Trench**



The fourth North Yard excavation nearly complete.



Debris from the north-south tunnel ready to be loaded out.



This phase of excavation was extended north towards the LRWB.



### North Yard Pre-Trench



Using an excavator to remove soil from around wooden pilings and beginning to expose the LRW tunnel.

### North Yard Pre-Trench



An excavator with a hammer being used to demolish the LRW tunnel floor.



RP technicians scanning the roof tunnel panels.



Using an excavator equipped with a hammer along with a second excavator to create and then remove debris.



**North Yard Pre-Trench**



Starting demolition on the now exposed SAS tunnel.

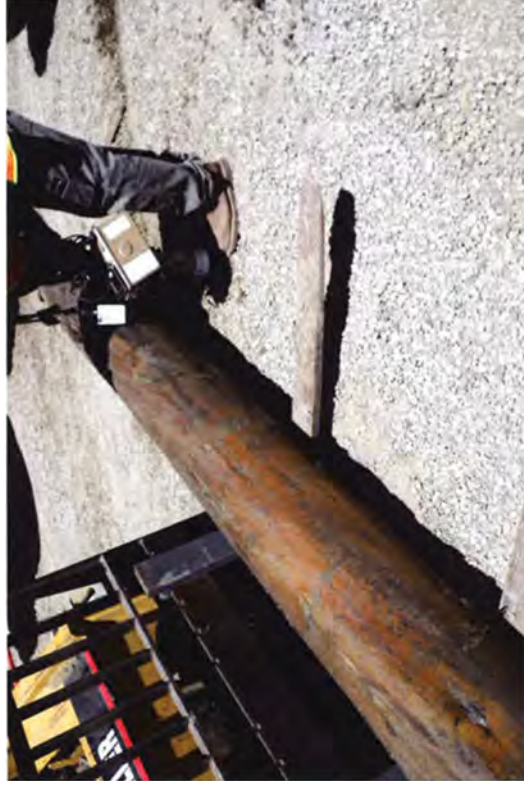
**North Yard Pre-Trench**



Extracting a 19 foot wooden piling.



Backfill material was delivered to create a ramp to access and remove sheet piles and wooden pilings.



An FSS technician was on site to scan each wooden piling and take soil samples.



**North Yard Pre-Trench**



Spreading 1-inch rock over the excavation after a sump and pump were installed.

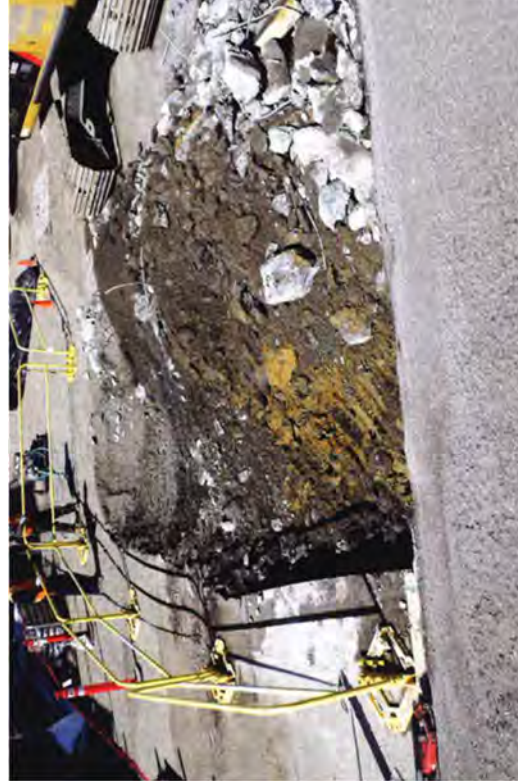
**North Yard Pre-Trench**



The crew compacts a 20 foot zone so that scaffold builders can wrap the RFB building for asbestos remediation.



Surveyors painting marks at the necessary intervals for compaction testing to prepare the area for backfilling.



Beginning to excavate the East section of North Yard.



North Yard Pre-Trench



Crewmembers exposing two contaminated lines. A 4-inch drain line from the LRW can be seen along with an abandoned 2-inch radwaste line.

North Yard Pre-Trench



The remaining section of LRW tunnel exposed.



Plugging the ends of the 2-inch and 4-inch pipes that stay in the ground with two-part epoxy expanding foam. The pipes that will be disposed of are taped. The pipes left in the ground is outside the limits of the excavation and will be removed later.



ACM transite pipe with thrust blocks.



### East Yard Pre-Trench

The East Yard was a small area located immediately east of the RFB between the HMS underground and North Yard excavations. It included the area under the 40 foot section of RFB that had been removed.



Conduit and contaminated piping was uncovered with an excavator along the east edge. The piping was wrapped and all soils were direct loaded into an intermodal. RP and Environmental technicians sampled the soil before the excavation began.



6-inch, 4-inch and 2-inch pipe were found in the RFB footprint in addition to H-piles.

### East Yard Pre-Trench



The ends of H-piles were cut off so that pulling plates could be welded on.



Cutting railroad tracks with a torch.



**East Yard Pre-Trench**



Loading out waste into an intermodal that is sitting on a portable scale.

**East Yard Pre-Trench**



Excavating the East Yard and loading out soil.



Removing the Off-Gas Tunnel.



Environmental technicians collecting soil samples while wooden pilings are being removed in the background.



East Yard Pre-Trench



Vibrating wooden pilings loose from clay so that they can be removed and disposed of. Some wooden pilings in the area were removed at a later stage in decommissioning because they did not interfere with the pre-trench activity.

East Yard Pre-Trench



Beginning to backfill the East Yard.



Performing the post-remediation survey



Performing compaction tests.



East Yard Pre-Trench



Backfilling the TB and East Yard areas.

East Yard Pre-Trench



A concrete slab broken up to be placed into an intermodal.



Resuming the removal of the Off-Gas Tunnel.



Debris created on north edge.



### East Yard Pre-Trench



Using the ISOCS to perform the FSS.

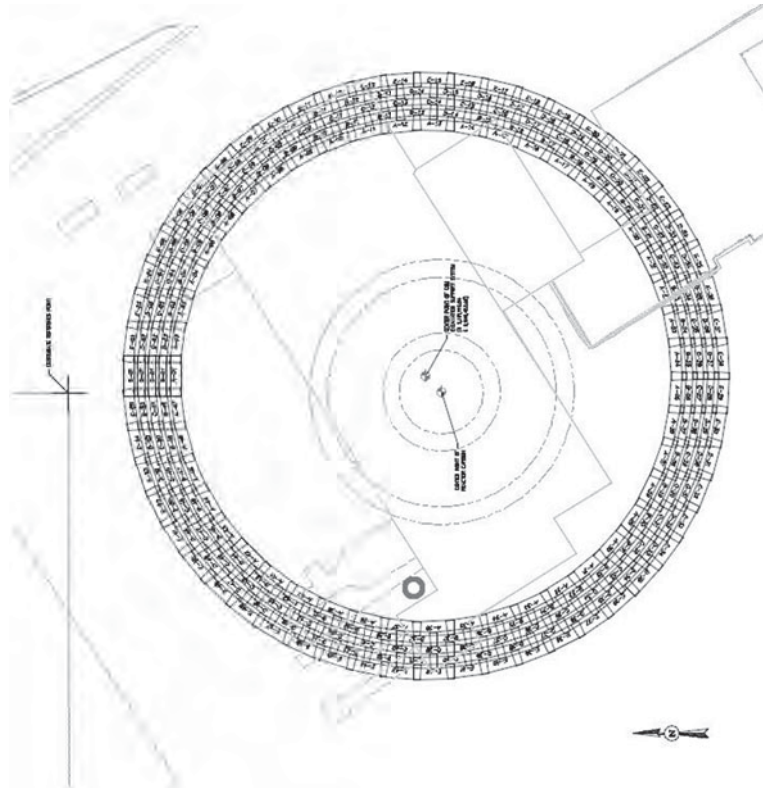


The subgrade at the far east end before being backfilled.

## CSM Wall Installation

All underground commodities were removed during Pre-Trenching for the Cutter Soil Mix (CSM) wall. These included wooden pilings, one third of the RFB, and the MPEF. The pre-trenching cleared a path for the large BG-40 and BG-50 hydromills that were used to install the CSM wall panels.

The five rings of panels that made up the CSM wall were installed in three sections. After the CSM deep water cutoff wall was completed, water was systematically removed from the Caisson area to test its effectiveness. Caisson removal was started only after the area was successfully dewatered.



## CSM Wall Installation



Digging an electrical trench to route powerlines for CSM and CLSM equipment.



Workers installing the powerlines for CSM and CLSM equipment.



**CSM Wall Installation**



The equipment that was used to compact the work surfaces for the large hydromills.

**CSM Wall Installation**



Assembling the BG-40 hydromill onsite.



The work surface for the hydromills ready to be used after it met the required standards.



Workers use a crane to assemble the BG-40.

CSM Wall Installation



Using the BG-40 to begin installing the CSM wall.

CSM Wall Installation



The CSM spoils de-sander.



The CLSM Pond for CSM spoils.



During de-clay operations, a front loader is used loading material into a truck which then transports it to the canal.



### CSM Wall Installation



The North Discharge Canal before it was used to stockpile CSM spoils.

### CSM Wall Installation



Unloading CSM Spoils from GARDIAN into the Canal.



The North Discharge Canal with CSM spoils stockpiled in it.



Unloading wet CSM spoils to the Discharge Canal.



Scanning CSM Spoils with the GARDIAN before stockpiling them in the Canal to be re-used.

**CSM Wall Installation**



Looking north at CSM spoils stockpiled in the Discharge Canal.

**CSM Wall Installation**



Replacing the gear box on the BG-40.



Looking south at excavators being used to manage the stockpile of CSM spoils in the Discharge Canal.



Performing maintenance on the BG-40.



**CSM Wall Installation**



The BG-50 after arriving onsite to be assembled.

**CSM Wall Installation**



Assembling the mast of the BG-50.



Crew members working to assemble the BG-50.



Assembling and installing the cube de-sander.

**CSM Wall Installation**



The BG-40 and BG-50 during the initial phase of panel installation.

**CSM Wall Installation**



Backfilling the pre-trenching excavation in the southeast quadrant.



The BG-40 and BG-50 working in concert in the northeast quadrant.



Setting up the BG-40 in the east yard.



### CSM Wall Installation



Workers setting up the BG-50 in the north yard to continue installing the 'E' Ring of panels.

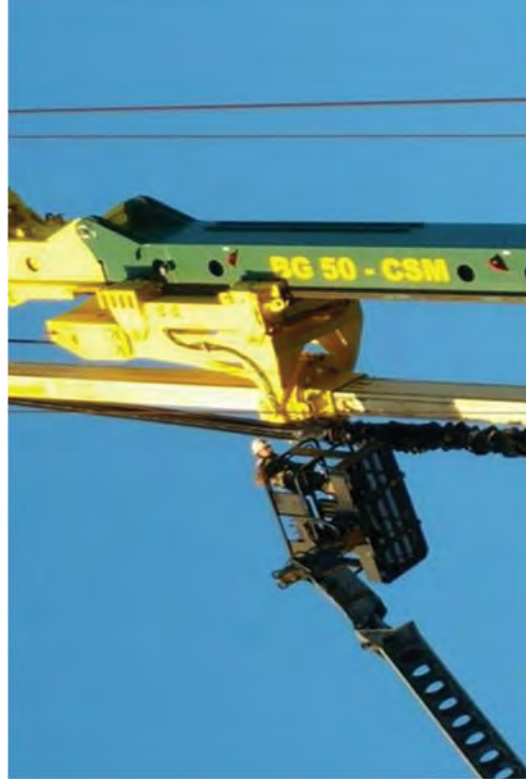
### CSM Wall Installation



Performing maintenance on the BG-50.



Using the hydromills to install CSM panels while circling the Caisson structure in a clockwise direction.



A worker in a man-lift frees a hydraulic line that was hung up due to high winds.

### CSM Wall Installation



Plates are laid out to support the BG-40 while it installs the final panels.

### CSM Wall Installation



Several machines working at one time in this highly congested area.



Navigating and working the equipment in a small area.



Technicians taking a sample from one of the last deep panels.



### CSM Wall Installation



The BG-50 drill head after installing the final CSM panel.

### Caisson Pre-Excavation



Grading and installing a K-rail in the area outside of the CSM wall.



A view of the BG-40 and BG-50 from HBGS.



Excavation for the utility trench and grading so that the impermeable layer could be laid down.

**Caisson Pre-Excavation**



Excavating to +7 EL for impermeable layer surface preparation.

**Caisson Pre-Excavation**



Installing the impermeable layer.



Placing tarping on the LRW hill slope as an SWPPP BMP.



Installing the utility trench.





**Caisson Pre-Excavation**



Pouring CLSM over the impermeable layer in the northwest quadrant.

**Caisson Pre-Excavation**



Installing a liner.



The completed impermeable surface in the northwest quadrant.



Backfilling and grading Class II fill material in the northwest quadrant.

### Caisson Pre-Excavation



The northwest quadrant after being graded and compacted.

### Caisson Pre-Excavation



The southeast quadrant after CLSM was poured.



Starting demolition on the +12' EL Slab.



Demolishing the west end of the +12' EL Slab.



Forms set for the southeast quadrant.



Caisson Pre-Excavation



Preparing rebar and conduit piping for disposal.

Caisson Pre-Excavation



The excavation where the stair tower will be installed.



Demolishing the west end of the +12' EL Slab.



Pouring concrete for the stair tower.



### Caisson Pre-Excavation



The stair tower pad installed and constructing forms to install the ventilation system.

### Caisson Pre-Excavation



Flooding from storm water in the Caisson.



Removing the first 4 feet of soil.



Starting the +12' EL to +8' EL excavation after the slab at +12' EL was fully removed.



Caisson Excavation +12' EL to +8' EL



The CSM wall before installing a layer of shotcrete.

Caisson Excavation +12' EL to +8' EL



Installing wire mesh.



Preparing to install shotcrete.



The CSM wall ready for its first layer of shotcrete.



Caisson Excavation +12' EL to +8' EL



Applying shotcrete.

Caisson Excavation +12' EL to +8' EL



A ventilation fan which was installed to provide fresh air to the excavation.



Installing the shotcrete collar.



A sheet pile wall at west side of excavation which remained from the plant's initial construction.



Caisson Excavation +12' EL to +8' EL



Demolishing concrete below +12' EL.

Caisson Excavation +12' EL to +8' EL



Breaching the West Suppression Chamber.



Accessing the West Suppression Chamber.



Filling the West Suppression Chamber with excavated soil and debris.



Caisson Excavation +12' EL to +8' EL



Exposing the SFP.

Caisson Excavation +12' EL to +8' EL



Loading out material to be scanned with the GARDIAN.



Installing the ventilation ring header pipe.



Soils stockpiled in the Upper Yard for re-use after being scanned with the GARDIAN.



Caisson Excavation +8' EL to -2' EL



Demolishing the SFP.

Caisson Excavation +8' EL to -2' EL



The Caisson removal-site layout in December of 2016.



Clearing the CSM wall to install shotcrete.



Installing an additional 5 feet of dowel and wire mesh for the portion of shotcrete collar.



Caisson Excavation +8' EL to -2' EL



Applying a second layer of shotcrete to the shotcrete collar down to approximately -2' EL.

Caisson Excavation +8' EL to -2' EL



Demolishing the West Suppression Chamber.



Excavating the center of the Caisson and filling the suppression chamber with excavated soils and debris.



Demolishing the Drywell and filling the West Suppression Chamber.



Caisson Excavation +8' EL to -2' EL



Exposing the Drywell.

Caisson Excavation +8' EL to -2' EL



Stockpiling material.



Demolishing the Stack foundation.



Processing and segregating material.



Caisson Excavation +8' EL to -2' EL



Shearing the upper section of the Drywell.

Caisson Excavation -2' EL to -6' EL



Installing the Ventilation system.



Placing a section of Drywell into the bulpden.



Excavating from -2' EL to -6' EL.



Caisson Excavation -2' EL to -6' EL



Segregating debris.

Caisson Excavation -2' EL to -6' EL



The stockpile of re-use soils in the Upper Yard.



Exposing the SFP.



The Caisson removal-site layout on January 6, 2017.



Caisson Excavation -2' EL to -6' EL



The west wall exposed and being preparing to bore the CSM wall to obtain a core sample.

Caisson Excavation -2' EL to -6' EL



Removing sheet piles from the west wall.



Exposing the east wall and preparing to bore the CSM wall to obtain a core sample.



Core sampling in Panel A-10.



Caisson Excavation -2' EL to -6' EL



Loading out the A-10 core sample.



Surveying the core sample from Panel A-10.

Caisson Excavation -2' EL to -6' EL



The core sample from Panel A-01.



Panel A-31 core sample.



The Panel A-25 Re-drill core sample.



The core sample from Panel A-25.



Caisson Excavation -2' EL to -6' EL



A Man-Basket pre-lift safety meeting.

Caisson Excavation -2' EL to -6' EL



Installing fill and vent tubes to grout core sampling holes.



A worker entering the Caisson to conduct coring activities.



Completed core hole grout set-up.



Caisson Excavation -2' EL to -6' EL



Demolishing concrete on the north side from -2' EL to -6' EL.

Caisson Excavation -2' EL to -6' EL



Installing the Stair Tower.



Hanging the stair tower assembly and installing flex ducting.



Backfilling the East Suppression Chamber.



Caisson Excavation -6' EL to -10 EL



Demolishing concrete of the Bio shield.

Caisson Excavation -6' EL to -10 EL



Loading out material to the SMF.



Installing debris netting on the stair tower.



Stockpiling material to be loaded out.



Caisson Excavation -6' EL to -10 EL



An engineering technician drilling and preparing anchor-bolt holes.



Filling an anchor bolt hole with epoxy.



Setting an anchor bolt into the CSM wall.

Caisson Excavation -6' EL to -10 EL



Anchor bolt testing.



CSM Wall stair tower anchor bolt testing.



Caisson Excavation -6' EL to -10 EL



CSM Wall stair tower anchor bolt testing.

Caisson Excavation -6' EL to -10 EL



Loading out material.



Loading out soil laden with debris.



Sheet pile left in place after original plant construction on the west side of the excavation.



Caisson Excavation -6' EL to -10 EL

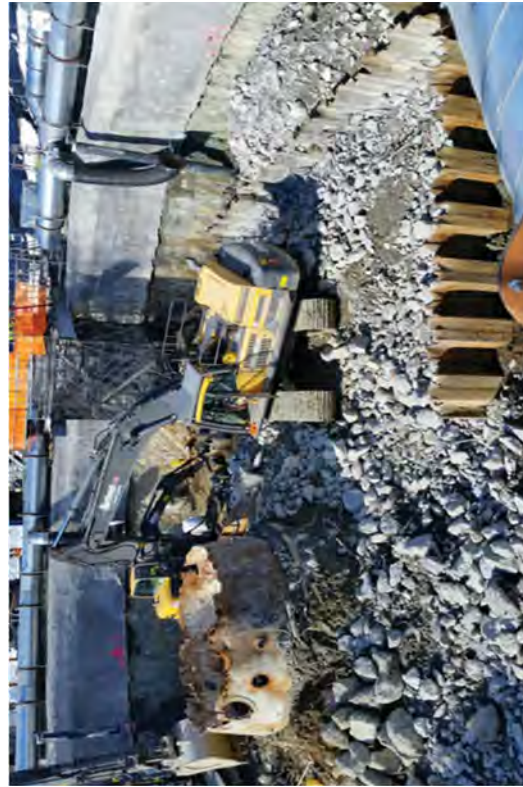


Loading out pipe and rebar.

Caisson Excavation -6' EL to -10 EL



Perforating the Drywell so that it can be removed.



Demolishing concrete.



Removing a section of the Drywell.



Caisson Excavation -6' EL to -10 EL



Stockpiling and loading out material.

Caisson Excavation -6' EL to -10 EL



Processing concrete.



Emergency responders conducting a 'High Angle Rescue' Emergency Drill.



Opening the SW Suppression Chamber.



Caisson Excavation -10' EL to -14' EL



Dewatering the West Suppression Chamber.

Caisson Excavation -10' EL to -14' EL



A section of drywell undergoing lead abatement so that it can be cut by torch.



Demolishing concrete at -10' EL.



Removing the sacrificial layer of material at -10' EL to -14' EL.



Caisson Excavation -10' EL to -14' EL



Loading out material.

Caisson Excavation -10' EL to -14' EL



Cutting a section of Drywell by torch.



Demolishing the SFP.



-10' EL to -14' EL concrete demolition.



Caisson Excavation -10' EL to -14' EL



Exposing the next section of Drywell to be removed.

Caisson Excavation -10' EL to -14' EL



Using an excavator with a shearing attachment to remove a section of Drywell.



Exposing the Drywell and demolishing concrete.



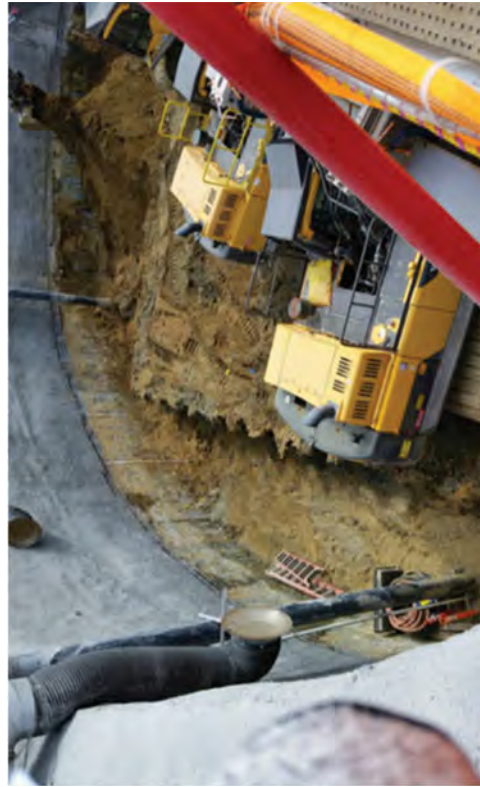
Using an excavator to load out material from the Caisson into a muck bucket.



Caisson Excavation -10' EL to -14' EL



Removing and stockpiling sacrificial material on the east side of the excavation.



The east side with reusable material removed.

Caisson Excavation -14' EL to -18' EL



The north side with reusable material removed.



The -14' EL to -18' EL soil load out complete.

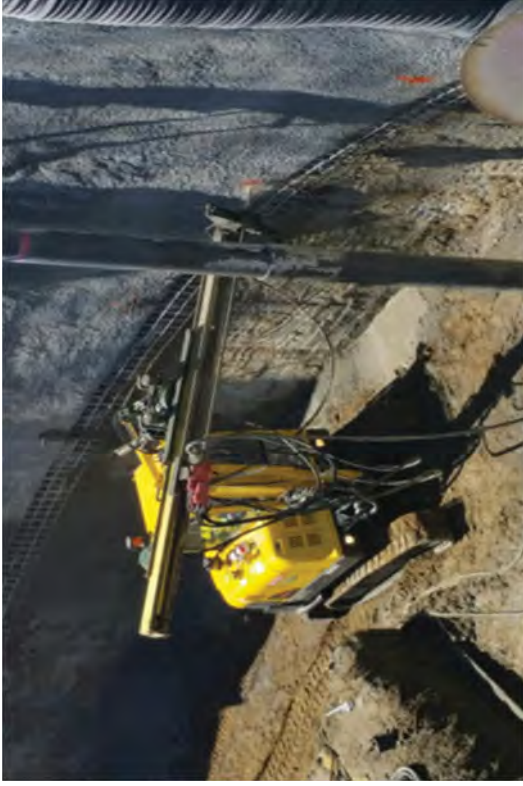


Caisson Excavation -14' EL to -18' EL



Demolishing SFP structural concrete at -14' EL to -18' EL.

Caisson Excavation -14' EL to -18' EL



Installing rock bolts.

Caisson Excavation -14' EL to -18' EL



Demolishing SFP structural concrete at -14' EL to -18' EL.

Caisson Excavation -14' EL to -18' EL



Installing WWF.



Caisson Excavation -14' EL to -18' EL



Removing the drilling rig after it was decontaminated.

Caisson Excavation -14' EL to -18' EL



Engineering staff marking the SFP drain line.



Installed WWF on the west side of the CSM wall.



Removing the SFP drain line.



Caisson Excavation -14' EL to -18' EL



Exposing the East Suppression Chamber Ring Header.

Caisson Excavation -14' EL to -18' EL



Loading metal debris.



Removing the East Suppression Chamber Ring Header.



Demolishing the Ring Header.



Caisson Excavation -14' EL to -18' EL



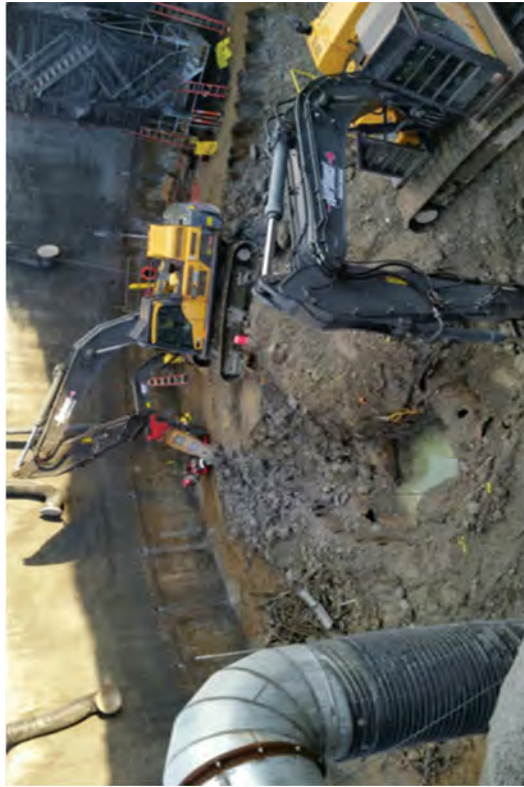
Exposing the West Suppression Chamber Ring Header.

Caisson Excavation -14' EL to -18' EL



Removing Drywell to prepare for the activated region removal activities.

Caisson Excavation -14' EL to -18' EL



Removing the West Suppression Chamber Ring Header.



Loading out the material from the sacrificial layer at -18' EL.



Caisson Excavation -18' EL to -24' EL



Loading out steel and rebar.

Caisson Excavation -18' EL to -24' EL



Excavation re-use soil.



Loading out sacrificial material.



Loading out re-use soil.



Caisson Excavation -18' EL to -24' EL



Stockpiling re-use soils that have been scanned with the GARDIAN.

Caisson Excavation -18' EL to -24' EL



Segregating and stockpiling material.



Exposing an ACM Pipe Chase.



The re-use stockpile.

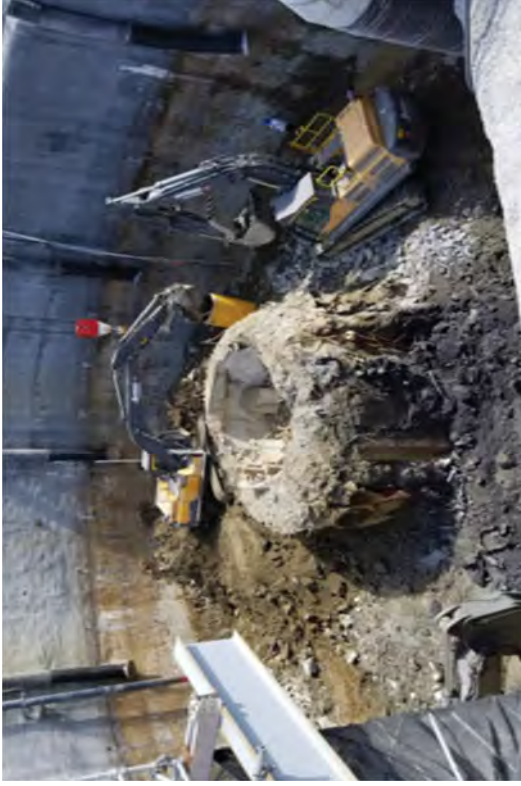


Caisson Excavation -18' EL to -24' EL

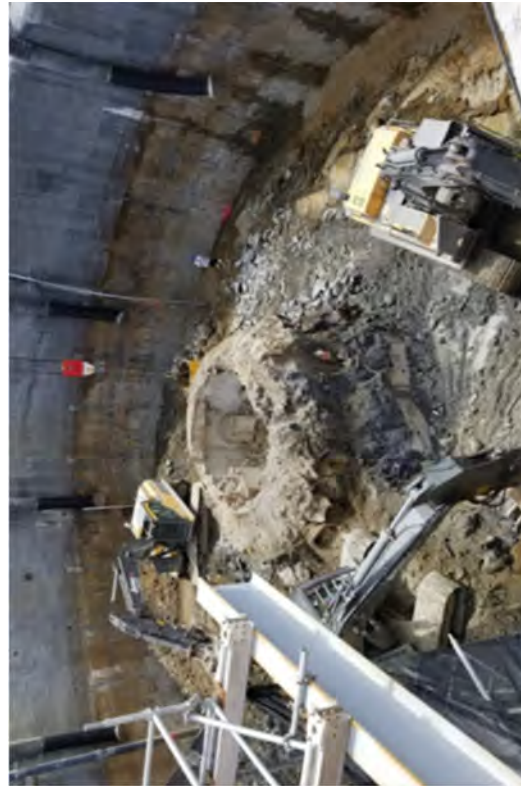


Metal to be loaded out.

Caisson Excavation -24' EL to -30' EL



Demolishing the outer concrete of the Caisson at -24' EL to -30' EL.



Demolishing the outer concrete of the Caisson at -24' EL to -30' EL.



Demolishing the outer concrete of the Caisson at -24' EL to -30' EL.



Caisson Excavation -30' EL to -34' EL



Preparing the excavation so that the activated region can be removed.

Caisson Excavation -30' EL to -34' EL



Spreading reuse material on the Upper Yard Slope stockpile.



Demolishing and loading out the Activated Region.



Demolishing and loading out the Activated Region.



Caisson Excavation -30' EL to -34' EL



Direct loading waste material from the activated region.

Caisson Excavation -30' EL to -34' EL



Demolishing the Drywell.



Demolishing the Activated Region.



Demolishing the Drywell.



Caisson Excavation -30' EL to -34' EL



Removing material from the sacrificial layer at -30' EL.

Caisson Excavation -30' EL to -34' EL



Demolishing concrete from -30' EL to -34' EL.



Removing re-use material at -30' EL to -34' EL.



Exposing the Drywell at -30' EL to -34' EL.



Caisson Excavation-34' EL to -40' EL



Removing soil from -34' EL to -40' EL



Removing soil from -34' EL to -40' EL

Caisson Excavation-34' EL to -40' EL



Loading out material.



Removing soil from -34' EL to -40' EL



Caisson Excavation-34' EL to -40' EL



Removing concrete from -34' EL to -40' EL.



Removing concrete.

Caisson Excavation-34' EL to -40' EL



The re-use stockpile at the Upper Yard.



Loading out re-use material.



Caisson Excavation-34' EL to -40' EL



Demolishing concrete.



Demolishing concrete.

Caisson Excavation-34' EL to -40' EL



Using a much bucket to Lift debris out of the Caisson excavation.



Demolishing concrete.



Caisson Excavation -40' EL to -46' EL



-40' EL to -46' EL reuse soil excavation.

Caisson Excavation -40' EL to -46' EL



Demolishing concrete at -40' EL to -46' EL.



Demolishing concrete at -40' EL to -46' EL.



Loading out debris in the much bucket.

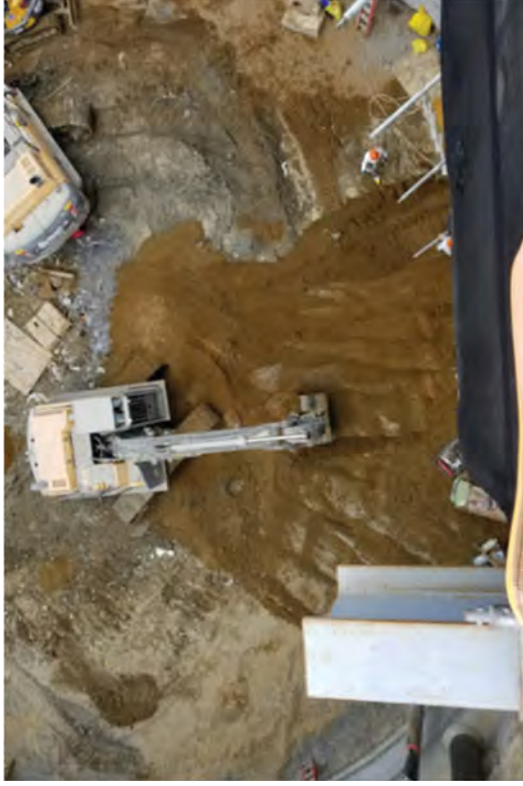


Caisson Excavation -40' EL to -46' EL



Demolishing concrete at -40' EL to -46' EL.

Caisson Excavation -46' EL to -52' EL



Removing material from the sacrificial layer for -46' EL to -52' EL.



Reshaping the upper yard soil stockpile.



Loading out material from the sacrificial layer.

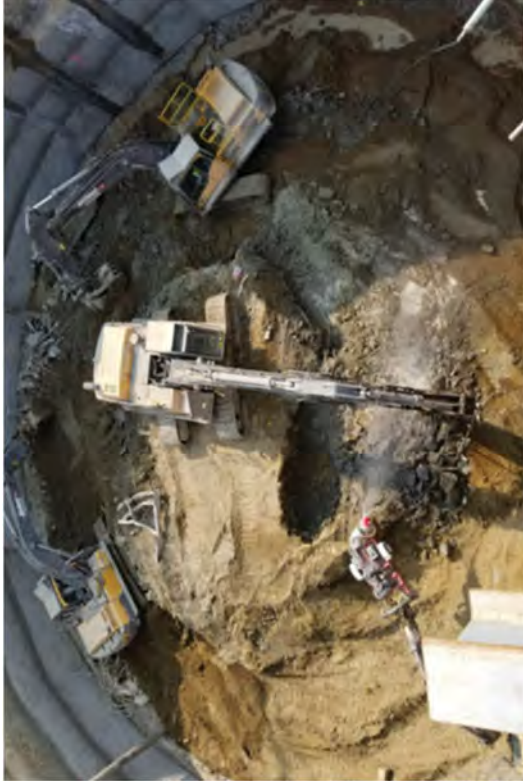


Caisson Excavation -46' EL to -52' EL



Removing re-use soil.

Caisson Excavation -46' EL to -52' EL



Demolishing the Caisson at -46' EL to -52' EL.



Removing re-use soil from -46' EL to -52' EL.



Loading out concrete waste.



Caisson Excavation -46' EL to -52' EL



Exposing Drywell.

Caisson Excavation -46' EL to -52' EL



Demolishing the Caisson at -46' EL to -52' EL.



Demolishing the Caisson at -46' EL to -52' EL.



Removing material from the sacrificial layer at -52' EL.



Caisson Excavation -52' EL to -58' EL



Demolishing concrete at -52' EL to -58' EL.

Caisson Excavation -52' EL to -58' EL



Demolishing concrete at -52' EL to -58' EL.



A new and larger muck bucket.



Stockpiling metals.



Caisson Excavation -52' EL to -58' EL

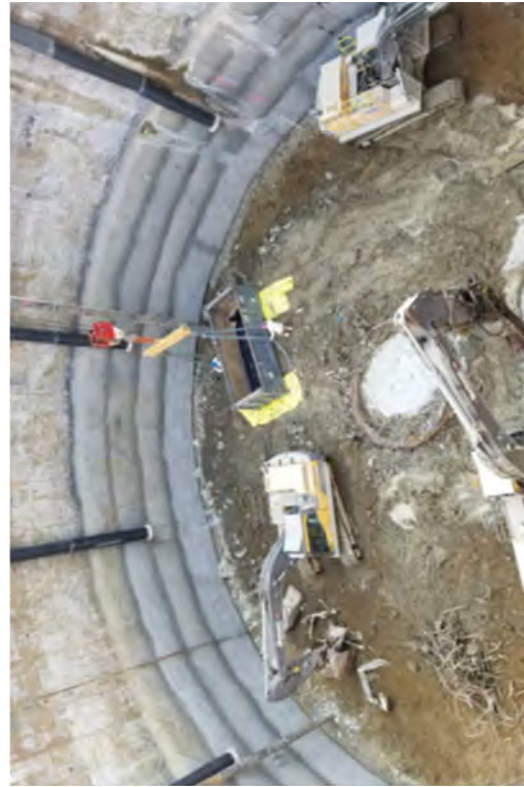


Processing metal.

Caisson Excavation -52' EL to -58' EL



Using an excavator with a hammer to break apart concrete on the interior of the Drywell.



Loading out metal.



Processing the lower Drywell head.

Caisson Excavation -52' EL to -58' EL

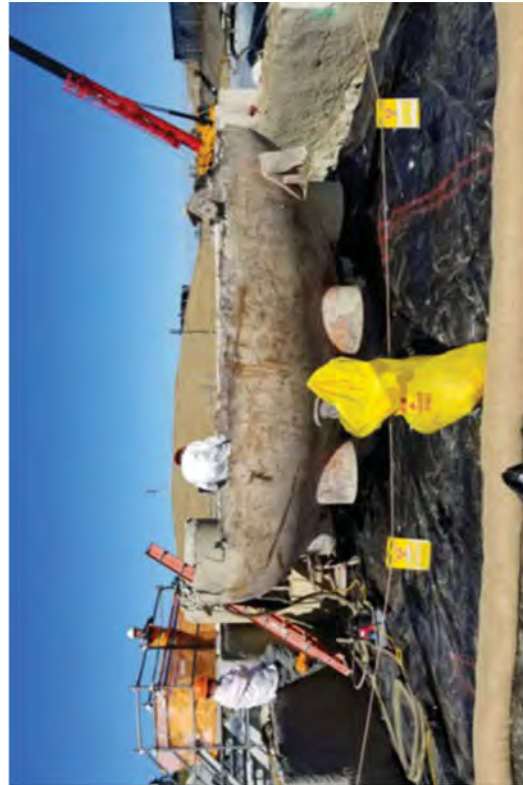


Relocating the lower Drywell head so that it can be processed and downsized.

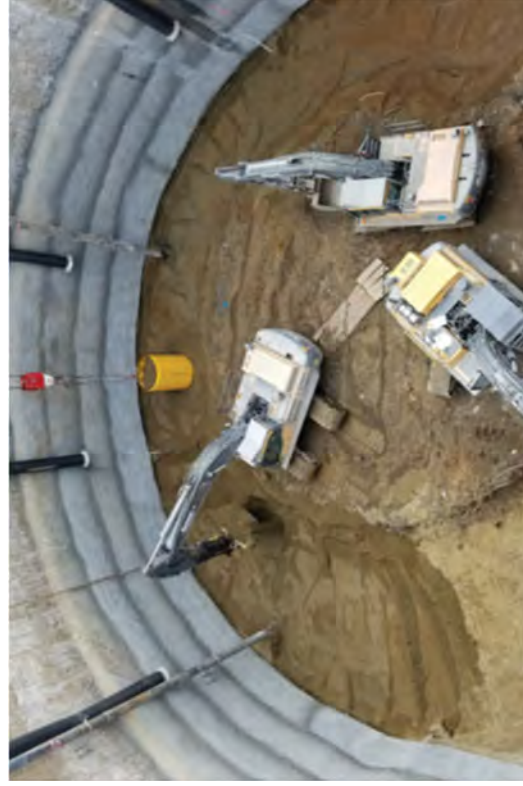
Caisson Excavation -58' EL to -66' EL



Stockpiling sacrificial material.



The Drywell lower head removed from Caisson.



Removing the first cut of reuse material at -58' EL to -59' EL.



Caisson Excavation -58' EL to -66' EL



The lower Drywell head with Paint remover applied so that it can be cut with a torch.

Caisson Excavation -58' EL to -66' EL



Demolishing concrete at -58' EL to -64' EL.



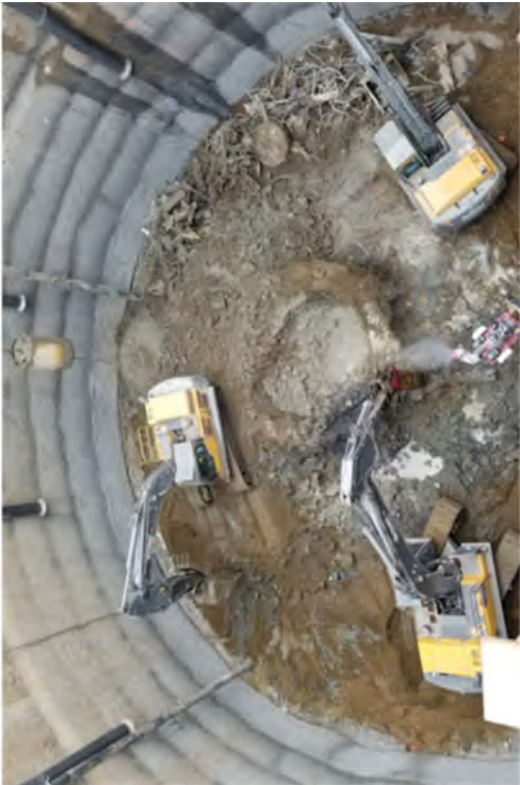
Removing soil for re-use from -60' EL to -66' EL.



Removing concrete from -58' EL to -66' EL.



Caisson Excavation -58' EL to -66' EL



Demolishing concrete at -58' EL to -66' EL with an extra 2 feet approved.

Caisson Excavation -58' EL to -66' EL



Loading out metal debris.



The Lower Drywell head cover.



Removing the caisson floor slab.



Caisson Excavation -58' EL to -66' EL

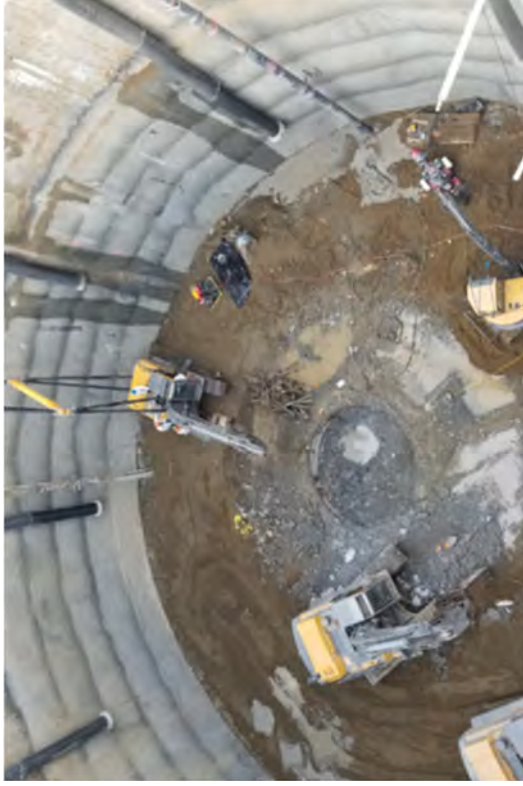


Poeholing the Tremie in an attempt to determine how deep it extends below -66' EL.



The second day of poeholing the Tremie.

Caisson Excavation -58' EL to -66' EL



Rigging up one of the excavators so that it can be removed from the Caisson excavation.



Lifting the excavator out of the Caisson excavation.

**Caisson Excavation**



Decontaminating and surveying the excavator after it was removed from the Caisson excavation.

**Caisson Excavation -66' EL to -70' EL**



Excavating re-use soil at -68' EL.



Excavating the first 1-foot cut of re-use soil.



Excavating re-use soils from beneath the stairway at -70' EL.



Caisson Excavation -66' EL to -70' EL



Exposing original caisson concrete form cutting shoe.



-66' EL to -70' EL concrete demolition.

Caisson Excavation -66' EL to -70' EL



Excavating sacrificial soil surrounding Caisson at -70' EL.



Demolishing concrete at -66' EL to -70' EL.

Caisson Excavation -70' EL to -76' EL



Removing a 1-foot cut of sacrificial material.



Excavating material for re-use at -70' EL to -74' EL.

Caisson Excavation -66' EL to -70' EL



Demolishing concrete at -66' EL to -70' EL.



Shearing apart and loading out steel debris.



Caisson Excavation -70' EL to -76' EL



The Project Director and Deputy Director Inspecting the Caisson Tremie at the working surface.

Caisson Excavation -70' EL to -76' EL



Loading out Tremie concrete in the Muck bucket.



Removing the Tremie from -70' EL to -74' EL.



An excavator equipped with a hydraulic ram/concrete crusher size reducing Tremie concrete in the SMF.



Caisson Excavation -70' EL to -76' EL



Removing Tremie concrete from -70' EL to -76' EL .

Caisson Excavation -70' EL to -76' EL



The area was excavated deeper than -76' EL after the concrete Tremie was removed with the purpose of being the final cleanup and to prepare for survey.



The Tremie completely removed.



Beginning to decontaminate and remove equipment. At the end of 2017 the Caisson structure was fully removed.



**Caisson Pre-Backfill**



Mobilizing the conveyor.



Mobilizing the hopper.

**Caisson Excavation -70' EL to -76' EL**



A Bird's eye view of the Caisson.



The site layout at completion of Caisson removal.



**Caisson Pre-Backfill**



Removing casing from well DW-4.



Stair tower crew exiting the caisson



Grouting wells DW-2 and DW-3.



Scaffold materials being removed from Caisson



### Caisson Backfill



Loading the conveyor system's feed hopper.

### Caisson Backfill



Continuing to backfill the Caisson excavation.



An operator loading reuse soils into the hopper that were transported from storage in the Discharge Canal.



A crew performing repairs on the conveyor system.



**Caisson Backfill**



Backfilling the Caisson.



Backfilling the Caisson.

**Caisson Backfill**



Continuing to backfill the Caisson.



Using an excavator to load the Conveyor.

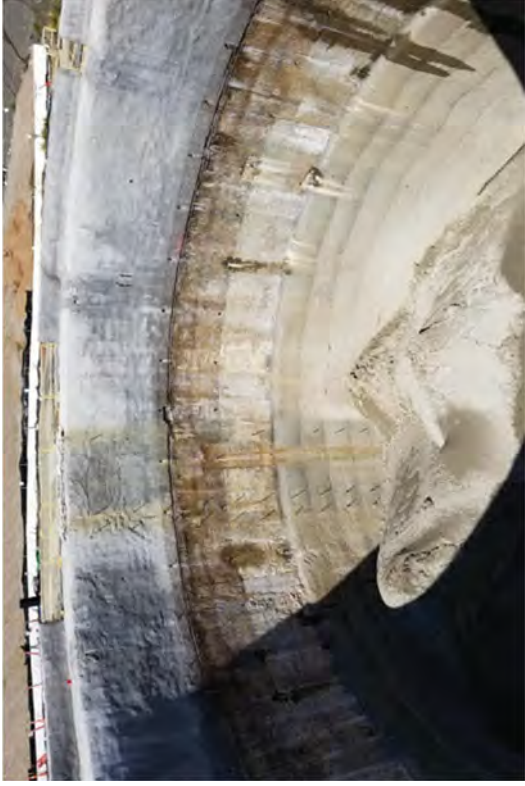


### Caisson Backfill



Removing large rock from conveyor.

### Caisson Backfill



Backfilling the Caisson.



The layout of the Caisson excavation area after demobilizing the removal equipment to allow for remaining backfill operations.



Preparing to transport soils stored in the upper yard for use as backfill material in the Caisson excavation.

### Caisson Backfill



Beginning to backfill the Caisson excavation with reuse soils from the upper yard storage area.

### Caisson Backfill



Backfilling the Caisson excavation.



Backfilling the Caisson excavation .



Transporting backfill.



**Caisson Backfill**



Backfilling the Caisson excavation.



Backfilling the Caisson excavation.

**Caisson Backfill**



Backfilling the Caisson excavation.



Transporting backfill material using a haul truck.



### Caisson Backfill



Backfilling the Caisson excavation.



The Discharge Canal reuse soil stockpile.



Backfilling the Caisson excavation with processed Concrete material after leveling soils inside.

### Caisson Backfill



Concrete back fill progress through 1st day.



Concrete back fill progress through 2nd day.



Caisson Backfill



Caisson Backfill



Concrete backfill completed.



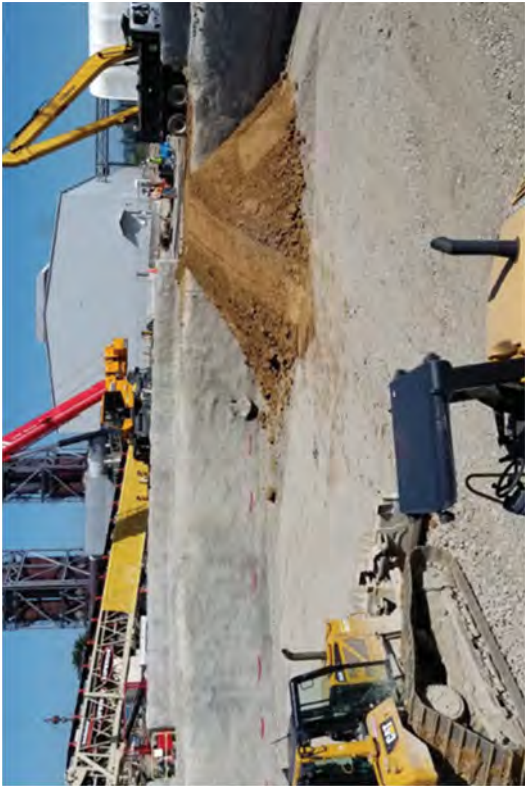
Concrete back fill leveling process



Clay excavation to be used for concrete cap.



**Caisson Backfill**



Clay installation to create a impermeable layer cap on concrete .



Impermeable layer cap being leveled by dozer .

**Caisson Backfill**



Impermeable layer installation



Impermeable layer installation.



Geo-Fabric installation.



Caisson Backfill



Structural backfill -0.5 / 1.5.



Structural backfill -0.5 / 1.5.

Caisson Backfill



Caisson Site Layout.



Structural backfill -0.5 / 1.5.



**Caisson Backfill**



Structural backfill 1.5 / 3.5 elevation.



Structural backfill 1.5 / 3.5 elevation.

**Caisson Backfill**



Backfill 3.5 / 5.5.



Structural backfill 3.5 / 5.5 elevation.



Grade / Compaction 5.5 elevation.



3.5' EL.



Caisson Backfill



Caisson Backfill.

Caisson Backfill



Caisson Backfill.



Completed backfill +9.5 EL. Site grade above sea level.



Grade / Compaction.



Site layout.



Caisson Backfill



CSM wall cleaning (FSS prep).

Caisson Backfill



Eco-Block removal.



3-inch rock removal.



Site layout.



Site layout.



Caisson Backfill



Eco-Block removal.

Caisson Backfill



3 foot CSM breach.



Site layout.



Slurry Cap removal.



15 foot CSM breach.



Backfilling compacting breaches



Intake Canal



Pulling the seaweed boom from the Intake Canal.

Intake Canal



Fish biologists deploying the block net before fish seining later.



Assembling a 330-ton crane. Twenty trucks were needed to deliver its components.



Crew driving sheet piles into the Intake Canal using the 330-ton crane.



Crew driving sheet piles into the Intake Canal using the 330-ton crane.



### Intake Canal



The guide rail for sheet piles in the foreground with the pedestrian bridge in the background.

### Intake Canal



Installing Intake Canal sheet piles.



The crew in the lift attaching the driver to the sheet pile. The yellow boom in the water is a silt curtain.



Installing Intake Canal sheet piles.

Intake Canal

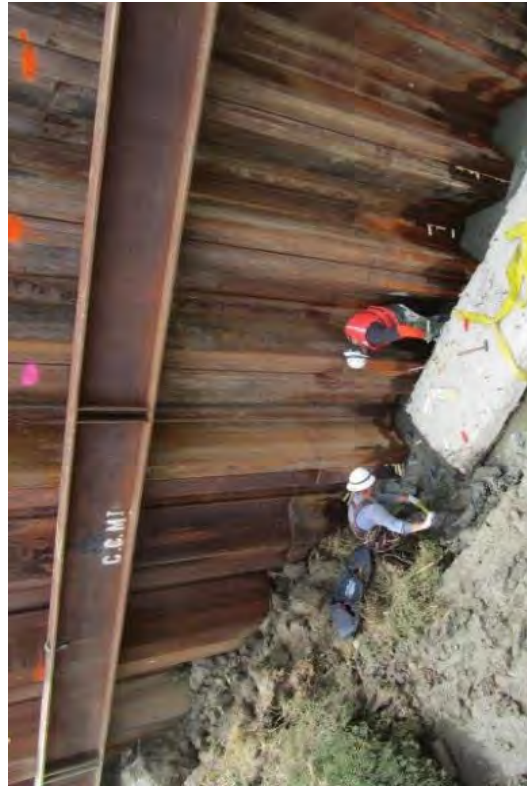


Upstream side of the completed temporary cut-off sheet pile wall.

Intake Canal



Using wood shims.



Finding and filling leaky joints between the piles after the project side of the cut off wall was dewatered.



Fish biologists seining the canal after it is significantly drained.



### Intake Canal



Tidewater goby and salmon were found as was expected.

### Intake Canal



The canal was seined for fish multiple times and followed by a final dip netting.



Water was kept down to allow drying.



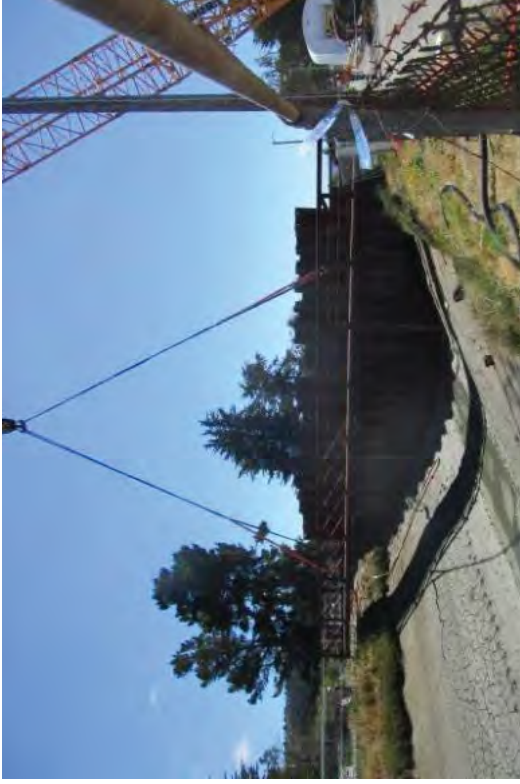
Seining the intake canal for fish. Nearly 500 fish were captured in the first few hours, with most of them being young specimens of several different species. After they were identified they were released on the other side of the coffer dam.

### Intake Canal



Removing riprap from the Intake Canal and transferring it to the SMF.

### Intake Canal



Rigging attached to permanently remove the pedestrian bridge.



After dewatering the Intake Canal, wooden pilings were unexpectedly found to be incorporated into the Intake Structure. The demolition plans were modified to accommodate the treated wood waste.



After it was removed, the footbridge was donated to The City of Ferndale where it is used as a children's pathway in the City Park.



### Intake Canal



A pump was placed at the low point as planned because in-leakage was always expected.

### Intake Canal



Removing soils from in front of the Intake Structure and spreading mud to dry.



A small containment area built to contain water and aid canal drying.



The front of the Intake Structure with gate area. The pumps were used to finish draining the canal and for dewatering from rain.



### Intake Canal



Cells in the Intake Structure were filled with gravel after any pumps, equipment, grating, and piping was removed.



A vacuum hose inside typical cell.

### Intake Canal



A long reach excavator moving canal silt from in front of the intake.



Ramp and crane mats were installed so that an excavator could move into the canal.



Intake Canal



Removing more silt and pumping water.

Intake Canal



Steel plates covered the cells in the Intake Structure. This narrow opening was a gate control access.



Concrete surfaces had to be smooth before RP and FSS could survey them.



Cells were sectioned off with safety railing after being uncovered.



Intake Canal



A pipe exiting a shallow cell.

Intake Canal



Soils from the Intake Canal in the SMF. Lime was added to help stabilize and dry the loose material.



The excavator was set on top of mats to spread the mud and drying canal silt.



Removing a small pedestrian bridge between the headworks and a storage area for the seaweed net.



**Intake Canal**



An Intake Structure cell before removing barnades and surveying the walls.

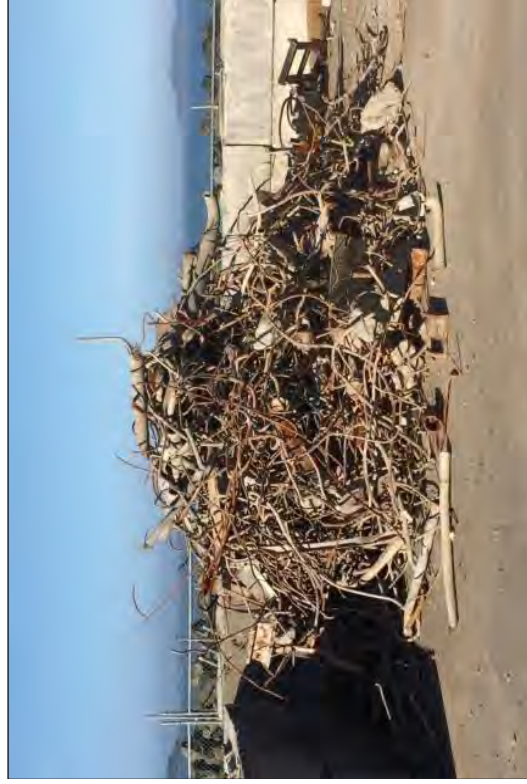
**Intake Canal**



Rubble from earlier days, next to where the small pedestrian walkway bridge was removed.



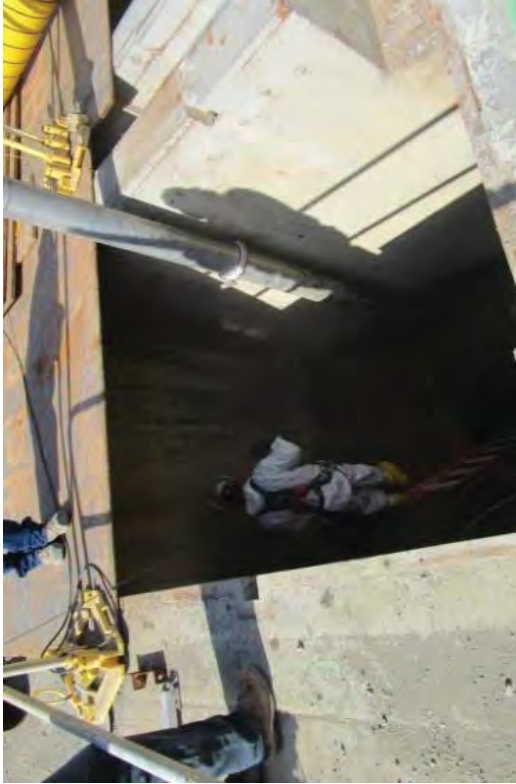
An intake screen that had been left in place.



Stockpiled metal that was separated from the Intake Canal concrete



**Intake Canal**



An RP technician surveying the Unit 1 circulating water pit.

**Intake Canal**



Grading the transition from the parking lot to the Intake Structure.



Grading an access path from the old Parking Lot A to the canal. This area will eventually be one contiguous wetland.



Forming a ditch to direct storm and groundwater to a pump.



Intake Canal



An excavator shaping the area near the Intake Structure before establishing the final grade.



A long reach excavator and dump truck removing gravel from the Unit 2 Intake Structure.

Intake Canal



Demolishing the Unit 3 Intake Structure.



A survey crew staking the planned grades in Alpha lot.



### Intake Canal



Demolishing the Unit 3 Intake Structure. Water is being sprayed to control dust.



Removing the Intake Canal Headworks around the yard drain sump. The headwall, sump, and some surrounding soil was sent to the SMF as waste because of possible contamination. The overburden soil is stockpiled in the south discharge canal to be reused.

### Intake Canal



Demolishing the Unit 1 and 2 Intake Structures.



Loading Intake Structure rubble.



Intake Canal



Dumping Intake Structure rubble.

Intake Canal



The Intake Structure demolition 90% completed. When finished it will be removed to 3 feet below final FSR grade.



Intake Canal structure rubble.



A dozer moving material into the Intake Canal.

Intake Canal



An excavator moving and placing soil at the south end of the canal.



An excavator moving and placing soil at the south end of the canal.

Intake Canal



Excavating the area at the south end of the canal.



Removing the earthen section and preparing to demolish the retaining wall.



### Intake Canal



Rain over the previous weekend made soil removal challenging.

### Intake Canal



Preparing to pull the first pile from the cutoff wall which will allow the water level to equalize on each side.



A crew using excavators to place fill at the east and north sides of intake.



Removing piles after the canal water level equalized.

Intake Canal



SWPPP Controls for turbidity reduction.



The SWPPP team installed plastic sheeting on the exposed soil area.

Intake Canal



Removing the final sheet pile from the cutoff wall.



The Intake Canal before demolition.



## Intake Canal



The Canal after contouring. BMP's are in place and fish nesting features will be added later.

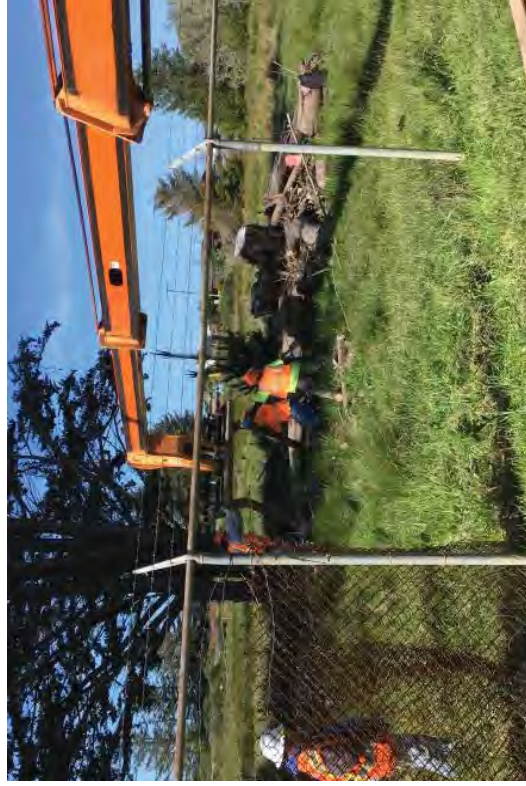


Intake Canal before restoration work.

## Intake Canal



Preparing for restoration planting.



Retrieving debris for Intake Canal.

Intake Canal



Snag features recovered from the site for Intake Canal restoration.

Intake Canal



Anchoring snag features in Intake Canal.



Dump at east side of canal for snag placement.



Placing snag features at the east end of the Intake Canal.



Intake Canal



Jute matting being placed to protect hydro seeding.

Intake Canal



Southeast snag placement.



Small trees planted by a snag feature on the southwest side.



Upland planting on southeast corner.



**Intake Canal**



Upland planting progression on the east side of the canal.

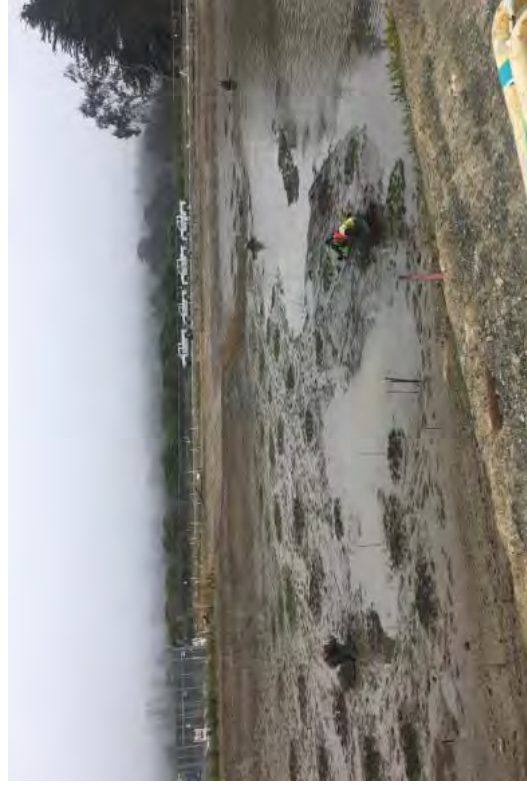
**Intake Canal**



A crew planting eel grass in canal.



Harvesting and planting eel grass from bay in the canal.



A crew planting eel grass in canal.



## Discharge Canal

The Discharge Canal was used to store clean soils generated from the CSM wall installation and other site excavations. All water was pumped out of the canal after divers installed inflatable bladders in its outlets. After removing any riprap and soil that was required, an FSS was performed on the empty canal. After the FSS, the canal was backfilled with the soils that were displaced when installing the CSM wall. High tides and storm waves created many challenges in this area and the decommissioning team responded with insight and innovation.



A diver plugging discharge structure piping at the beginning of Discharge Canal work.



A Diver preparing to enter the Discharge Canal structure to plug the pipe.

## Discharge Canal



Installing a fish blocking net in August of 2014.



The block net installed. Tidal flow is restricted by sandbags placed inside the Discharge Pipes.

Discharge Canal



Re-Routing the storm water discharge line from the canal to the Humboldt Bay.

Discharge Canal



A marine crew repairing Turbidity Curtain.



Using an excavator to install a Turbidity Curtain.



Start of sheet pile installation in waters of Humboldt Bay



Discharge Canal



Installing sheet pile.



Discharge Canal



The installed piles allowed work to progress in the Discharge Canal.



Installing the last sheet pile for the canal in October of 2014.



Dewatering started in the Discharge Canal.

## Discharge Canal



Pumping water from the Discharge Canal into Humboldt Bay. The yellow line is the Silt Curtain.

## Discharge Canal



View looking north at the Discharge Canal after the first dewatering.



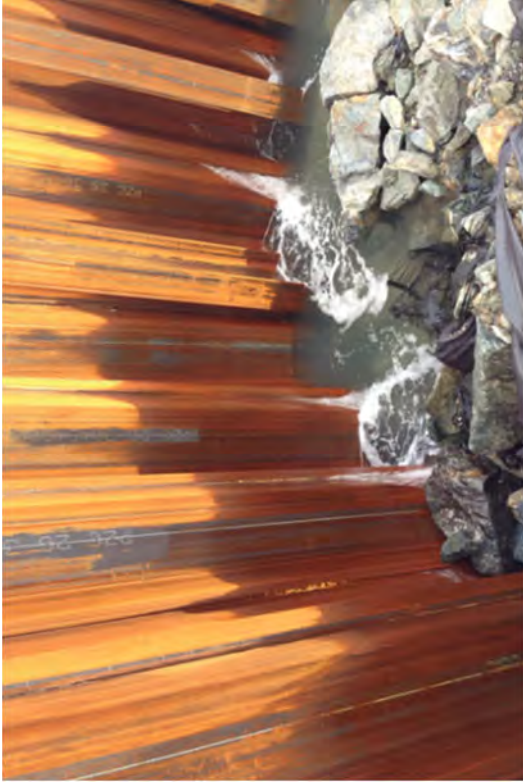
Fisheries biologists surveying the canal and preparing to move fish.



View looking south at the Discharge Canal while its south end is being dewatered and surveyed by biologists.



## Discharge Canal



Leaking sheet pile.

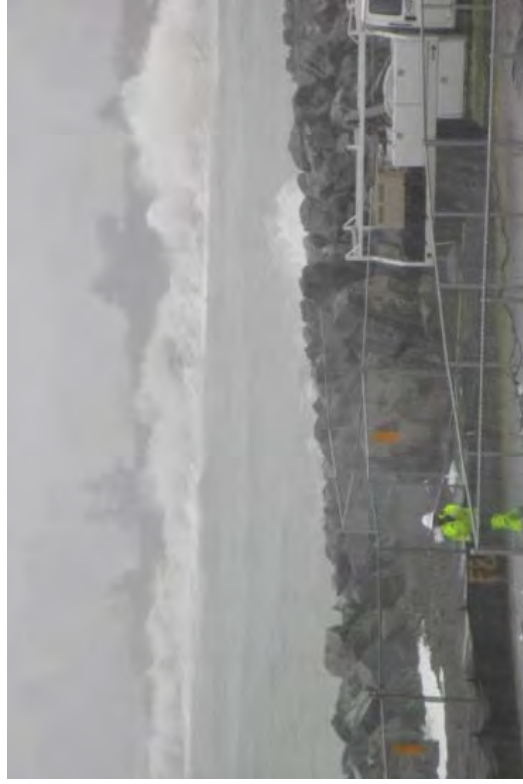
## Discharge Canal



The first excavation in the canal was to uncover four pipes which provided access to install pumps.

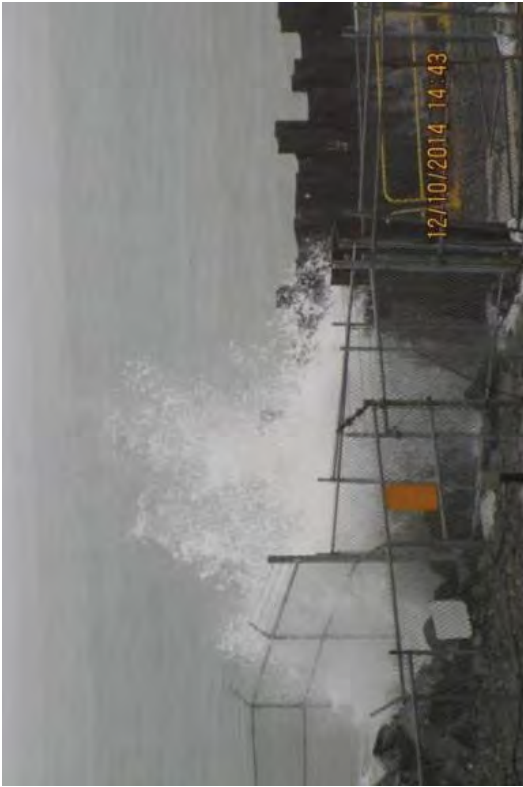


The canal's sheet pile wall suffered a substantial amount of damage during storms in 2014. Strong waves flexed and shifted the piles, which created several large leaks. Two diesel powered pumps operating at roughly 1600 gallons per minute were barely able to keep inflow from accumulating.



Less than a week's worth of canal excavation activities were performed before an uncharacteristically strong winter storm overflowed the sheet piles and sea wall. As a result, the Discharge Canal was filled with water.

Discharge Canal



Discharge Canal



Removing wooden mats for cranes.



Divers installed inflatable bladders to plug the four uncovered concrete outlet pipes and completely close the canal off from the bay. The rubber bladders were 10 feet long and filled with nitrogen.



### Discharge Canal



A small crew assisted and monitored each diver. A second diver was on stand-by whenever there was a diver in the water.

### Discharge Canal



Crane lowering bladder in to discharge canal



A diver entering the water to install the inflatable bladder inside of the Discharge Canal outlet.



A diver moving the bladder towards the discharge pipes.



## Discharge Canal

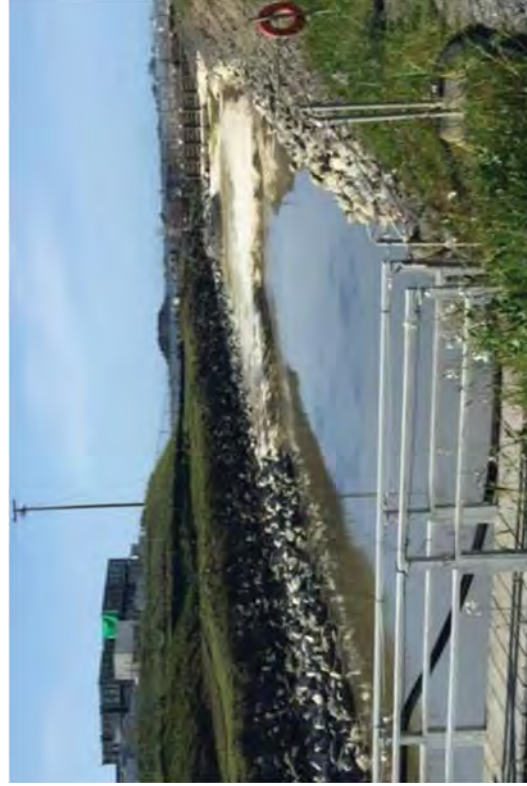


The south end of Discharge Canal was constructed differently and therefore had different challenges.

## Discharge Canal



Continuing to dewater the north end. The black hoses are from the nitrogen rack supporting bladder pressure.



The man bridge used to access the south headworks valves.



Re-excavating the north end. Preparing to install concrete eco blocks and CLSM as a backstop for soils and to help keep out water from the bay.



Discharge Canal



Setting the concrete eco blocks.

Discharge Canal



A pump truck pumping a concrete slurry mix behind the eco blocks. This also plugged the ends of four pipes which measured 48 inches in diameter.



A civil engineer checking to see that the eco blocks are installed properly.



The finished temporary cut-off wall with the sump pump hose in foreground.



### Discharge Canal



Removing riprap from the south bed of drained canal. FSS is being performed on the North end.

### Discharge Canal



Installing reused riprap into the bottom of Canal after it cleared FSS.



The crew kept the canal dewatered so that FSS could take place.



RP using the ISOCS on the north end of canal.



## Discharge Canal



Smoothing the slope and removing the last pieces of riprap from the South east end of the canal.



An aerial view of Discharge Canal and GWTS before winter storms in late 2015.

## Discharge Canal



A bladder dam was installed on the South end of Discharge Canal to control water intrusion from the bay. Soil is stockpiled from the CSM installation behind the bladder dam.



High tide during a storm (El Nino with king tide) pushed waves over the sheet pile wall and into the Discharge Canal in late 2015.



### Discharge Canal



Operators removing excavators from the canal because of the high water levels.

### Discharge Canal



A view of the flooded Discharge Canal after the storm in late 2015.



November 2015 storm waves pushing sea water over the sheet pile wall.



The secondary dam was breached during the storm in late 2015. Crews recovering the bladder from the south end of the canal.



### Discharge Canal



December high tides and storm waves crashing over the sheet pile wall. Note the new riprap structure to keep water out of the canal

### Discharge Canal



A crew cutting the LRW discharge line from the Discharge Canal Headworks



The Discharge Canal again ready for soil stockpiling in January 2016.



Removing the LRW discharge line.

### Discharge Canal



Removing the remaining riprap. Pump boxes with mesh sides are in the water.

### Discharge Canal



An excavator demolishing the Discharge Canal Headworks.



An access ramp to the Headworks for excavators.



Water misting was used during concrete demolition to control airborne silica dust.



### Discharge Canal



Preparing a French drain behind headworks foundation.

### Discharge Canal



There was a constant in-flow of water from a spring and the underground water table.



Placing the sump.



Spreading CSM soils.

### Discharge Canal



CSM soils were received daily for drying and storing.

### Discharge Canal



12kv electrical power lines were rerouted to allow for higher stockpiling.



Beginning the excavation of the NE Laydown Area which will eventually blend into the canal



More area available to spread wet soils.



### Discharge Canal



The area beyond the green rope has cleared FSS. Clean soils were loaded into trucks at this ramp.

### Discharge Canal



A second truck loading station for soils stored in Discharge Canal.



A long reach excavator moving soils at the Discharge Canal.



Removing sheet piles from Bay with covered CSM soils in the foreground.

## Discharge Canal



Stockpiled soils were covered to protect them from the seasonal fall rains.

## Discharge Canal



Installing sheet piles and water supports.



Staged cranes and materials to install sheet piles and a water supports.



Installing sheet piles and water supports.



## Discharge Canal



Part of the east side pre-assembled structural member.

## Discharge Canal



The East and west primary water structure in place.



The south end of the water supports which brace the sheet piles against the force of the waves.



Outrigger pipes distribute the forces on the east shoring.



## Discharge Canal



After the water system was installed the excavation of overburden begins.

## Discharge Canal



RP and asbestos techs surveying the excavation and taking soil samples.



Looking north from sheet piles to where the four discharge pipes originate.



Preparing the working surface in front of the 48-inch discharge outlet pipes.



Discharge Canal



Exposing and removing the first segments of pipe. At this time the bladder bags were still inserted approximately 6 feet into the pipes.

Discharge Canal



The FSS activities were ongoing. For the instrumentation to work properly, any surface water could be no deeper than 1 inch.



Removing concrete rubble and rebar.



Continuing the excavation to expose piping. The pipe came out in scraps, not large sections.



### Discharge Canal



A CLSM plug was installed before backfilling the area

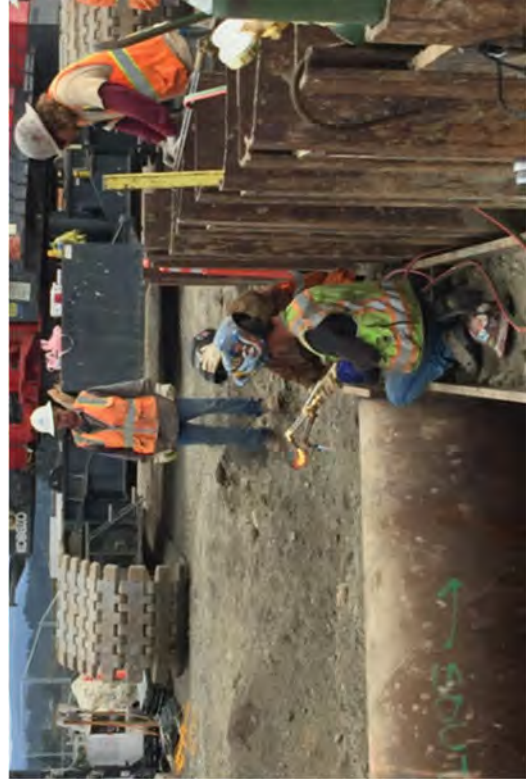
### Discharge Canal



Rigging and preparing to remove the east side water supports.



Continuing to backfill the Discharge Canal. The center water supports have been removed.



A crew cuts a water support to prepare it for removal.

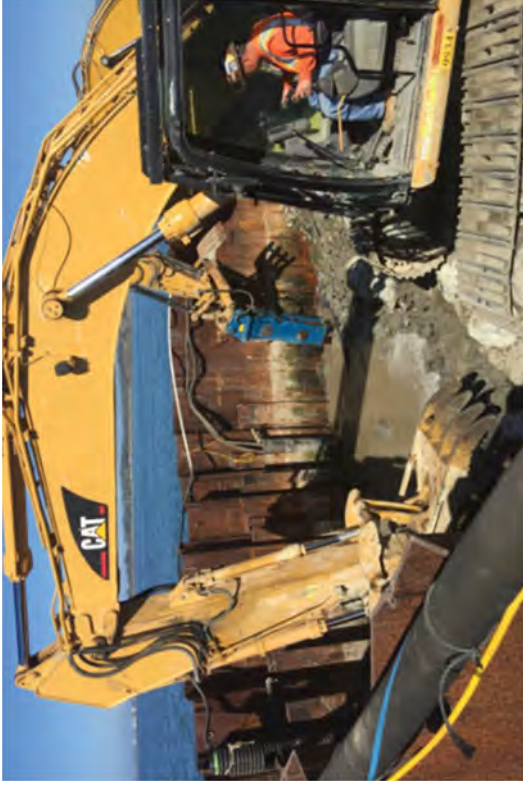


Discharge Canal



Scrap metal debris from the water support system.

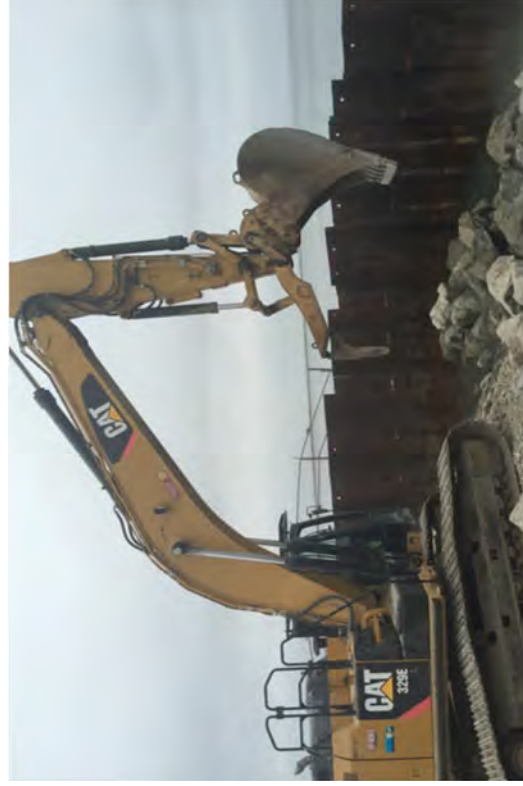
Discharge Canal



Removing the CLSM plug and concrete from the north end.



Removing sheet piles.



Installing riprap.

## Discharge Canal



Performing compaction tests before laying down mats for the crane used to remove sheet piles.



Preparing to remove sheet pile.



Coastal Trail



Sheet pile removed from the Humboldt Bay side of the re-established sea wall.



A loader leveling the Coastal Trail area while an excavator spreads rock to create a swale.

Coastal Trail



Removing sheet pile from the Coastal Trail and Humboldt Bay.



Removing the remaining sheet pile from Humboldt Bay at the Discharge Canal.

### Coastal Trail



Unloading riprap along the Coastal Trail.

### Coastal Trail



A loader leveling the trail and placing riprap around the K-rail.



An excavator building a riprap pile around the K-rail as a secondary wave protection measure.



A crew began digging post holes to reestablish the perimeter fence. The temporary pedestrian trail fence is in the foreground.



Coastal Trail



A view of the restored Coastal Trail at north end of canal after all Discharge Canal work was completed.

Coastal Trail



Closure of the Coastal Trail at HBPP.



The Coastal Trail adjacent to HBPP.



Preparing to reopen the Coastal Trail.

Coastal Trail

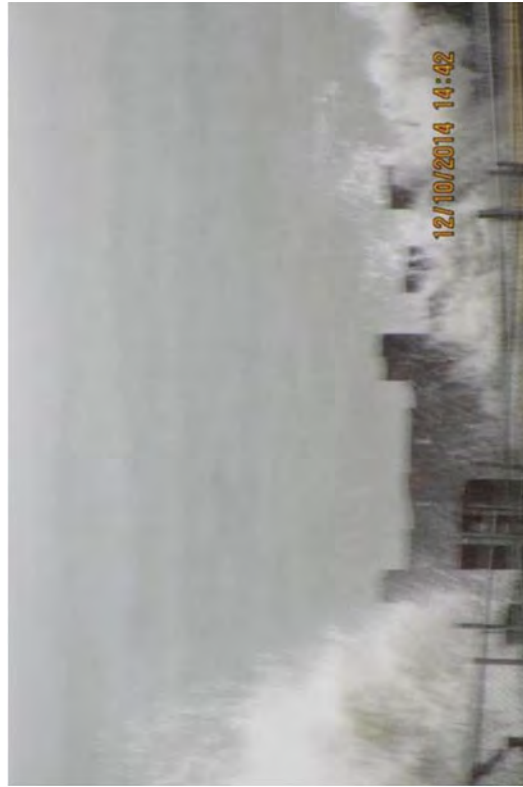


The Coastal Trail opened.

Coastal Trail



Rock washed away from storm.



Coastal Trail hammered by Storm waves and high tides.



Debris on the Coastal Trail from a storm.



Coastal Trail



Installing fencing for a bypass trail while the Discharge Canal outlet pipes were being removed.



Installing the Coastal Trail bypass fence.

Coastal Trail



The temporary fence re-established after a storm.



Fence damage from a storm.



Coastal Trail



Bringing in new rock for the Coastal Trail.



A small front loader spreading and leveling rock for the Coastal Trail.

Coastal Trail



Installing the Coastal Trail bypass fence.



Installing the Coastal Trail bypass fence.



**Coastal Trail**



Looking north from south end of the trail.

**Coastal Trail**



A small front loader spreading and leveling rock for the Coastal Trail.



Bringing in more rock for the North end of the Coastal Trail



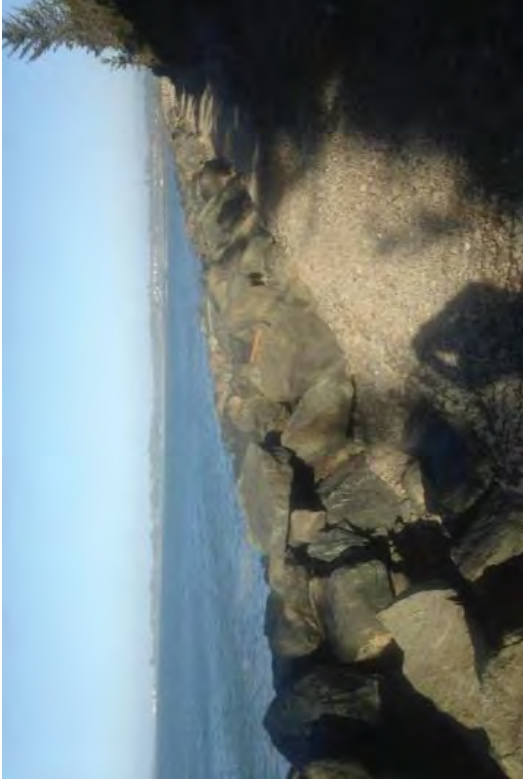
Looking south from middle of the Coastal Trail adjacent to HBPP.

## Coastal Trail



The south end of the Coastal Trail access after it was re-graded.

## Coastal Trail



The trail was leveled with a small front loader once more after the storm.



Waves during a storm pulled gravel away from the trail and back into Humboldt Bay. A plan was created to place a boundary of slightly larger rocks between the gravel trail and the larger riprap.



The Coastal Trail restored at the Discharge Canal.



# Groundwater Treatment System (GWTS)



Initial location of the GWTS.

# GWTS



The original GWTS in place and working.



The GWTS installation.



The Discharge Canal and GWTS area ready for the pretreatment system installation.

GWTS



GWTS storage tanks throughout site.



GWTS storage tanks throughout site.

GWTS



GWTS area prepared and staged for pretreatment system.



Pretreatment system installation to GWTS.



**GWTS**



More GWTS storage tanks throughout site.



The Unit 1 demolition area with holding tanks for ground and storm water.

**GWTS**



GWTS storage tanks throughout site.



An additional GWTS tank installed for the Discharge Canal.



**GWTS**



The GWTS storage tanks were often relocated multiple times.

**GWTS**



New carbon filters for the GWTS installed in July 2015.



Modifying the GWTS to upgrade its capacity.



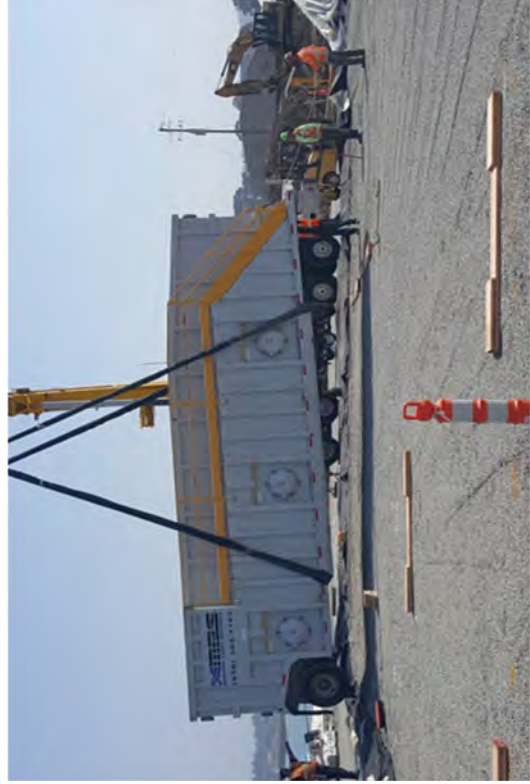
New sand filters for the GWTS.



GWTS



Moving FRAC tanks form the lower GWTS system.



A crane placing the first FRAC tank

GWTS



The new skid for the relocated receiver tank.



A new tank to relocate the receiver tank.

**GWTS**

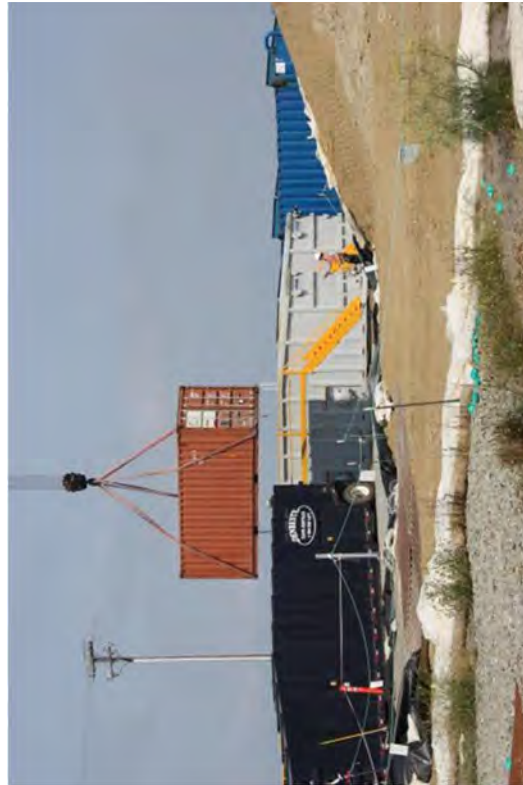


All tanks placed. Four tanks are inside the berm area while the two light blue release tanks are located outside the berm.

**GWTS**



The GWTS 2 control station inside the retention berm area.



Placing the GWTS 2 control station inside the retention berm area.



The GWTS 2 components installed inside berm retention area.



## Waste Management

The following three pages show a typical workday for the waste management crew from their morning meeting to a truck being readied to leave the site.



Every morning meeting starts with a safety message which is then followed with the needs and plan for the day.



The lead shipper prepares waste tracking paperwork and the documents required for the transportation companies involved.

## Waste Management



The Waste team assembles for a Two Minute tailboard and directions for next phase.



Consistent labeling and record keeping is crucial for waste tracking and management.

## Waste Management



The crew preparing soft sided bags of soil for itemizing and loading to truck.



A crew preparing soft sided bags to itemize and load soil onto trucks.

## Waste Management



The yard driver is given paperwork to check trucks through the scale and parking lot.



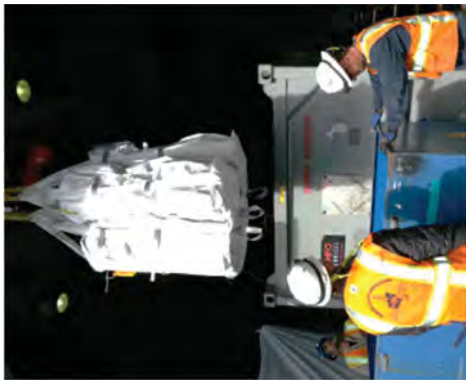
A crewmember verifying that a driver has current copies of all permits.



Turning the paperwork over to the long-haul driver so that the shipment will be properly documented at its destination.



## Waste Management



Loading control rod drive mechanisms from the RFB to SMAC.



Shipment of the FIXS filter and other waste.



Vacuum bags contaminated with lead and asbestos were loaded in a B-25 box for a mixed waste shipment to a processor. This shipment also contained lithium ion batteries and oily debris for processing.

## Waste Management



Loading tanker with water bound for a specialized processing and disposal site.



Wrapped creosote laden wooden pilings are loaded into PSC trucks.



90-day hazardous waste accumulation area in the southeast corner of the RUBB tent.

## Waste Management



Loading a resin vessel.



Demolishing the old truck wash station.

## Waste Management



Drilling activity being supported by Waste Management.



Asbestos Abatement workers were supported by Waste Management while removing transite pipe.



Setting up a boundary, inspecting rigging, and setting up a carry deck crane.



Relocating one SEC shield from the North yard RCA to the count room parking lot.



The wooden boxes were encased in SPS soft bags that were equipped with lifting straps so they could be placed in the IM and removed at the waste facility. The wooden box inserts protected the bags from the sharp edges of the segmented RPV.



**Waste Management**

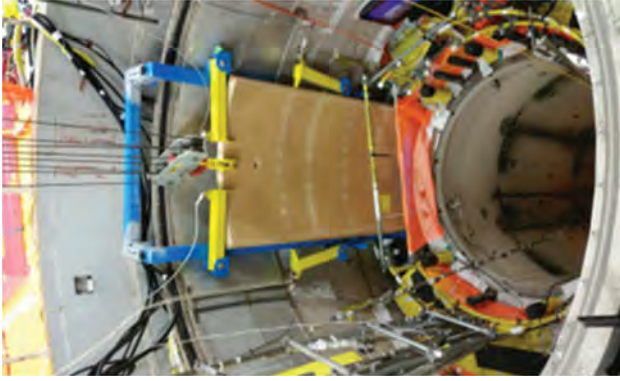


The insulated, soft-sided containers that were used for RPV sections.



RPV insulated packaging.

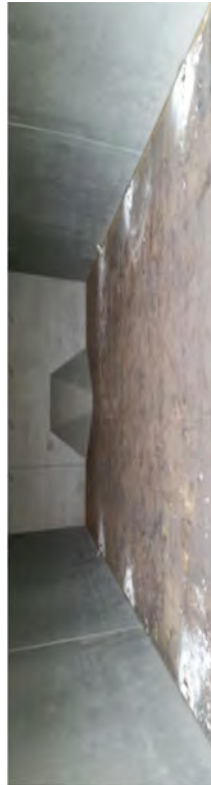
**Waste Management**



A mock-up was required for the safe removal of RPV window segments and the down-ending fixture. The Waste group was closely involved in planning for, removing, and shipping the RPV.



The RPV segment support stand and soft-sided shipping bags.



Concrete Shielding was added to the IM's that transported the segmented RPV.



A mock-up representing the first five RPV shell segments in a loaded position within an IM. A sixth section could be as long as the shipment stayed within weight limits.



A successful dry run of mock-up RPV segment from its containment, to packaging, and then placement in its container.



## Waste Management



Transferring excavated Unit 2 soil with low or no radioactivity to the SMF for potential re-use.



Transferring excavated Unit 2 soil with low or no radioactivity to the SMF for potential re-use.

## Waste Management



An overpacked Mixed Waste shipment headed to a specialized disposal site. Proper identification is affixed to the shipment to indicate the hazards contained in the IM.



Performing the final survey and inspection on a container containing DAW, filters, demineralizer vessel, and resin before it is shipped to a waste facility.





Waste Management



Loading North Yard waste for disposal.

Waste Management



A FRAC Tank in position to drain and dispose SPF water



Loading an IP-2 IM that contains LRWB concrete debris onto a trailer.



A typical 43,000 pound IM shipment of demolition debris.



### Waste Management



A technician applying lock and tamper seals on a tanker shipment of water.

### Waste Management



Loading RPV insulation



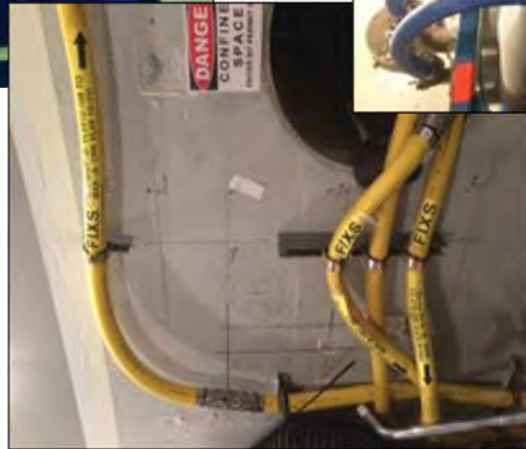
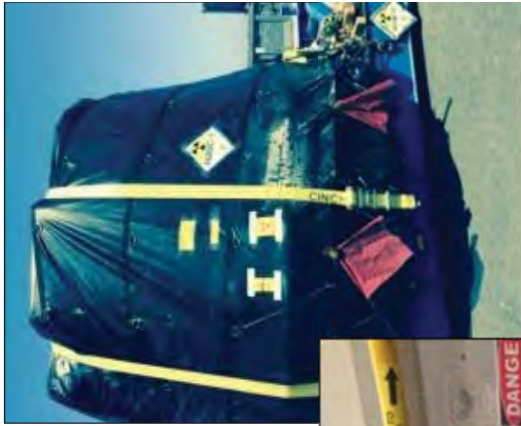
Waste from SMF operations and soil pile management ready to be picked up by Waste Service.



A drop deck trailer to be used for the upper and lower RPV head shipments.

## Waste Management

The RPV upper and lower head.



FIXS components shipped for recycling and specialized processing of their resin and filter media.



## Waste Management



Exposed wooden pilings at the TB were removed and shipped as waste.



Surveying wooden pilings that will be loaded into an IM for disposal.



**Waste Management**



Delivering treated wood waste to the SMF



Loading treated wood waste into an IM with a front loader at the SMF.

**Waste Management**



A Shepard source and calibration machine loaded on a truck and ready to transport.



Receiving five loading frames to support waste bag shipments.

Waste Management



Loading soils into bags at the SMF.



Using a 50 Ton Crane to unload bags of soil waste from metal frames.



Bags filled and staged for loading.

Waste Management



Loading trucks with IP-1 bags for shipment to Redding, CA to be loaded onto Gondola rail car.



Loading trucks with IP-1 bags for shipment to Redding, CA to be loaded onto Gondola rail car.



## Waste Management



The railway facility provided a "yard truck" at the transfer station to move trailers into position for unloading.

## Waste Management



Loading IP-1 bags into a railroad gondola at the railway transfer station.



A liner is installed in each railroad gondola prior to loading.



Loading IP-1 bags into a railroad gondola at the railway transfer station.

**Waste Management**



A loaded railroad gondola.

**Waste Management**



Each Gondola rail car used was rated for 200,000 pounds net weight.



A loaded railroad gondola with the package secured for transport.



GPS units installed on every Railroad Gondola allowed them to be tracked by the waste group and rail company.



## Waste Management



Unloading soft-sided bags at a waste facility so they can be loaded onto a Railroad Gondola.



Unloading soft-sided bags at a waste facility so they can be loaded onto a Railroad Gondola.

## Waste Management



An Inventory of approximately seventy IM's loaded and staged at the WMF.



HEPA vacuums and bags being prepared for processing and disposal.



Weight scales used for weighing waste containers and trucks required periodic calibration and repair.

**Waste Management**



The RFB crane trolley was a wide component and required an oversize permit to ship and dispose of.



The RFB Crane trolley wrapped and ready to be loaded.

**Waste Management**



Structural steel from the RFB prepared for shipment to a waste facility on a flatbed trailer.



Structural steel from the RFB loaded on a flatbed trailer for shipment.



## Waste Management



Maneuvering an empty IM into the Unit 1 and Unit 2 pad area so that it can be set up in the North Yard to load out concrete rubble from the LRWB walls.

## Waste Management



Placing an absorbent in an IM before loading it with concrete and debris.



Heavy equipment in the North Yard must be coordinated to safely load IM's, demolish the LRWB concrete, and install the CSM wall.



An Excavator moving rebar in an IM closer to its door for easier unloading at the disposal site. Other waste is positioned behind the rebar.

## Waste Management



This 3 inch and smaller Backfill material from the North Yard was stored in the SMF because it failed screening through the GARDIAN due to contamination.

## Waste Management



An outbound water tanker headed to a contracted waste processor.



Loading 5 yard bags of LRWB into an IM.



Three dump trucks full of backfill from the North and East Yard staged to be screened through the GARDIAN.



Waste Management



Tanker trailers Containing SFP water staged for release from Gate C to processor.

Waste Management



Workers refurbishing and painting IP-2 IM's.



IP-2 containers that had to be refurbished and verified for integrity due to excessive rust.



Reducing concrete in size for re-use on site.

Waste Management



Re-use concrete was stored with signage denoting PG&E material designation.

Waste Management



GARDIAN System surveying soils.



A liquid tanker loaded with SFP water.



Inside the GARDIAN during a surveying process.



**Waste Management**



Loading dewatering bags with lead impacted waste into an IM for disposal along with liquid in a 30 gallon drum.

**Waste Management**



Monthly environmental waste pickup for non-radioactive HBPP waste streams.



Waste boxes with concrete debris from the LRWB.



Loading waste generated from LRWB demolition.

## Waste Management



A brand new tanker to transport liquids from the SPF for processing arrived at HBPP and was inspected by the waste group.



Team drivers traded positions on the new rig fifty five miles from Arcata, CA.

## Waste Management



An earth mover was used to move soils and debris. Its use helped to reduce truck traffic on site.



A drum containing contaminated mercury.



Beginning to stockpile soil that had been screened for re-use in the Discharge Canal.



### Waste Management



The SMF filled with re-use soils which will be stockpiled in the Discharge Canal.

### Waste Management



Contaminated equipment dispositioned as waste.



Discharge Canal remediation progresses towards FSS so that soils can be stored in the empty canal and re-used to backfill the Caisson excavation at a later date.



Mixing pelletized lime with CSM wall soils with a long reach excavator in the Discharge Canal.

## Waste Management



Two IM's were loaded at 6:30 AM a.m. each morning to coordinate shipments.

## Waste Management



Two processing and storage shields with low levels of radioactive contamination loaded onto a flatbed for disposal along with a man basket that was used in the RFB.



Mixing South Discharge Canal sediment and slurry with the remaining Discharge Canal sediment in SMF. Lime was added to dry and condition it for offsite shipment.



Preparing to return three SEC lids return to their owner on a flatbed truck.



## Waste Management



A returned IMI had this puncture with water dripping from it. It was originally thought to be rust degradation.

## Waste Management



The North Yard excavation ready for its final FSS.



A thorough inspection showed that it was not rust degradation, but the result of a sharp object from the previous load. All IMI's were thoroughly inspected before they were loaded for transport and after they returned.



Moving clean fill material from CSM spoils staged in the Discharge Canal to backfill the North Yard.



### Waste Management



Backfilling Upper Yard

### Waste Management



Soil mounds in SMF grow as Rip-Rap and mud from the Intake Canal are added.



Backfilling the Upper Yard and LRWB excavation



Safely and efficiently coordinating an excavator loading waste bags, dump truck unloading waste from the Upper Yard, and a second excavator conditioning waste for shipment inside the SMF Tent.



### Waste Management



Soil from the Intake Canal. Lime was added to help stabilize the loose, wet material.

### Waste Management



Bags of debris generated from cleaning out the intake structure.



Concrete piles removed from the Discharge Canal outfall structure around the discharge pipes.



Discharge Canal coffer dam debris staged in a waste pile at the SMF.

## Waste Management



Removing TB basement concrete and rebar.

## Waste Management



The first shipments of pallets which enabled soft sided bags at WMF to be transported and stacked.



Processing the sacrificial concrete slurry plug from the Discharge Canal and loading it into bags at the SMF



Staging and storing filled waste bags in the WMF.



## Waste Management



Loading metal from the Intake Canal headworks that was staged in WMF for transfer to and loading into end dumps at Parking Lot B.

## Waste Management



The Caisson excavation was configured so that soft sided IP-1 waste bags could be loaded directly from the work face.



Loading concrete stored in WMF from the Intake Canal for transfer to a processor for re-use.



The first load of soil from the Caisson excavation.



**Waste Management**



Rebar and metal removed from the Caisson excavation which will be loaded into IM's.

**Waste Management**



Size reduced concrete from the bucket crusher being loaded into waste bags.



An IM of steel debris from the RFB and Caisson excavation. Soil will be used to fill the voids in this debris to maximize the weight and volume in the IM.



TB excavation water being pumped to the OWS for settling and processing.



## Waste Management



A tanker for loading drilling slurry, which consists of bentonite and a polymer, for disposal.

## Waste Management



Stockpile of Intake Canal concrete staged for transfer.



Concrete logs from the Discharge Canal coffer Dam which was moved to the SMF and then to this re-use concrete stockpile.



Metal separated from the Intake Canal concrete stockpiles for shipment.

## Waste Management



Ten loads of asphalt which were transferred to the SMF to be loaded into containers for disposal.

## Waste Management



Stockpiles of Intake Canal sediment to be re-used.



A contaminated 17,000 pound, 10-foot wide, 3-inch thick steel seismic impact plate that was removed from the Caisson excavation wrapped in plastic and being prepared for disposal.



Concrete debris is placed in the west suppression chamber to fill the void.



### Waste Management



Upper ring of the drywell located in the bull pen for size reduction and loading into IM's.

### Waste Management



The FSS of upper yard where soils were removed detected some remaining contamination. The RP surveys indicated that an additional 12 inches of material had to be removed.



Moving Caisson excavation soils stored in North Yard to the SMF due to contamination.



Using a secure hold down method for transporting drums in a B-25 box.

**Waste Management**



Storing caisson excavated soil and debris in the SMF because of a small quantity of debris in the waste.

**Waste Management**



Loading soil from the Caisson into bags in SMF.



Five B-25 boxes containing mixed waste drums loaded on a flatbed for transport to a disposal site.



Three loaded bags of concrete debris.



## Waste Management



Excavating lead impacted soil and loading it into soft sided bags.



Demolishing and stockpiling the Unit 1 concrete pad before transferring the concrete for processing.