BARTLETT

ENGINEERING CALCULATION

Calculation Number: ENG-HB-006

Revision Number: 0

Calculation Title: Area Factors for Use with Humboldt Bay Building Surface DCGLs

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1.0 PURPOSE

The purpose of this calculation is to develop area factors (AFs) for use with derived concentration guideline levels (DCGLs) for assessing building surfaces at the Pacific Gas & Electric (PGE) Humboldt Bay nuclear power site. This calculation is a deliverable product specified in the scope of work section in Contract No. GT012 3500895165.

2.0 APPLICABILITY

This calculation addresses only the development of AF values for use with building surface DCGLs for the PGE Humboldt Bay site.

3.0 REFERENCES

3.1 Bartlett Engineering Procedure ENG-AP-02, *Verification of Software Operability*

3.2 *User's Manual for RESRAD-Build Version 3.0*, June 2003 (ANL/EAD/03-1)

3.3 Bartlett Engineering Calculation ENG-HB-002, *RESRAD-Build Input Parameter Sensitivity Analysis*

3.4 Bartlett Engineering Calculation ENG-HB-004, *Humboldt Bay Building Surface Derived Concentration Guideline Levels*

3.5 NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Rev.1 , August 2000

4.0 METHOD OF CALCULATION

The operability of the RESRAD-Build code was verified on each computer used for code executions in accordance with Bartlett Engineering procedure ENG-AP-02, *Verification of Software Operability* [ref. 3.1]. The RESRAD-Build user's manual [ref. 3.2] provided guidance for code operation.

Version 3.5 of the RESRAD-Build code was used to perform a parameter sensitivity analysis [ref. 3.3] and to calculate building surface DCGL values [ref 3.4]. To maintain consistency with the approached used in those calculations, RESRAD-Build version 3.5 was also used in the development of area factors for use with the building surface DCGLS.

Area factors permit assessments of small areas of elevated activity. By definition, an AF is the magnitude by which the residual radioactivity in a small area of elevated activity can exceed the $DCGL_w$ while maintaining compliance with the release criterion [ref. 3.5]. Typically, a $DCGL_w$ value is adjusted by an area factor that is appropriate for the given area of elevated contamination. The resulting adjusted DCGL value is referred to as $DCGL_{EMC}$, where EMC stands for elevated measurement comparison. $DCGL_{EMC}$ values are obtained from the following relationship:

$DCGL_w * AF = DCGL_{EMC}$

where the AF value is specific for the area of the elevated contamination.

The model used for AFs is similar to that used in the development of building surface $DCGL_w$ values. However, only one source is modeled, instead of the six sources considered in calculating the building surface $DCGL_w$ values. The receptor is located at the source midpoint

at a distance of 1 meter. All other input parameters and assumed active exposure pathways are the same as those in the building surface DCGL calculation [ref. 3.4].

Elevated measurement comparisons (i.e., assessments of residual activity greater than the DCGL value) are likely to occur only in Class 1 areas. Accordingly, the recommended limit to the size of a Class 1 structure, 100 m^2 [ref. 3.5], was set as the upper bound for sizes used to develop AFs. AF based on ten area sizes were calculated: 100m^2, 50m^2, 10m^2, 8m^2, 6m^2, 5m^2, 4m^2, 3m^2, 2m^2, 1m^2.

RESRAD-Build version 3.5 code runs were performed for each area size and each radionuclides-of-concern (ROC) for the Humboldt Bay site. The development of AFs followed the steps outlined below.

1. RESRAD-Build calculations of the doses associated with each area size for each radionuclide.
2. Calculation of the AF value by determining the ratio of the doses associated with an area of 100m^2 ($dose_{100}$) to the doses for the various area sizes ($dose_i$): $dose_{100}/dose_i$.
3. Generation of tables and graphs to present AF values.

5.0 ASSUMPTIONS AND INPUT

5.1 Assumptions

5.1.1 With the exception of the number of sources and area size input, all assumptions regarding input parameters and active exposure pathways were the same as those used in the sensitivity analysis [ref. 3.3] and in the DCGL calculations [ref. 3.4].

5.1.2 The following radionuclides are assumed the only radionuclides-of-concern (ROCs) for the Humboldt Bay site: Am-241, C-14, Cm243/244/245/246, Co-60, Cs-137, Eu-152, Eu-154, H-3, I-129, Nb-94, Ni-59, Ni-63, Np-237, Pu-238/239/240/241, Sr-90, and Tc-99.

5.1.3 The areas used to develop AF values are bounded by the recommended maximum size for a Class 1 structure, 100 m^2 [ref 3.5]. Area sizes assumed in this calculation are m^2) are 100 m^2, 50 m^2, 10 m^2, 8 m^2, 6 m^2, 5 m^2, 4 m^2, 3 m^2, 2 m^2, and 1 m^2.

5.1.4 The receptor dose point was assumed at 1m above the center of the various area sources, which were located at the center of the room and directly under the receptor.

5.2 Input

5.2.1 Values used as input for the RESRAD-Build parameters were the same as those used in the calculation of the building surface DCGLs [ref. 3.4]. Table 1 summarizes the input values for all input parameters.

5.2.2 The location of the receptor was the center of the floor. The dose point was set at a height of 1m. On the x, y, and z-axes, the locations were 4.24m, 2.82m,1.0m, respectively, which is the same location used in the calculation of the building surface DCGLs [ref. 3.4] and in the sensitivity analysis [ref. 3.3]. The various sized sources were automatically placed under the receptor when the area input value was entered.

6.0 CALCULATIONS AND RESULTS

6.1 Using the assumptions described in section 5.0 and the input values shown in Table 1, RESRAD-Build code executions were made for each ROC and various source areas. The sizes for the various area sources were 100m^2, 50m^2, 10m^2, 8m^2, 6m^2, 5m^2, 4m^2, 3m^2, 2m^2, and 1m^2.

6.2 Table 2 summarizes the RESRAD-Build dose results for the various area sizes by ROC.

6.3 Table 3 shows the AF values for each area size by ROC. The AF values were calculated as follows:

$$AF = dose_{100}/dose_i$$

where, $dose_{100}$ = dose associated with 100 m^2, and $dose_i$ = dose area size of interest (i = 100m^2, 50m^2, 10m^2, 8m^2, 6m^2, 5m^2, 4m^2, 3m^2, 2m^2, and 1m^2).

6.4 Figures 1, 2, 3, and 4 graphically display the area factors.

Table 1: RESRAD-Build Input Parameter Values for Area Factors					
Parameter	Type[a]	Nuclide	Treatment[b]	Value	Reference Source
Exposure Duration (d)	B	All	D	365.25	NUREG/CR-5512, Vol.3,section 5.2.1
Indoor Fraction	B	All	D	0.267	NUREG/CR-5512, Vol.3,section 5.2.2.9
Evaluation Time (y)	P	All	D	1, 5 (1, 5, 10, 25, 50, 100 for Pu-241)	Use of 1y provides doses at t=0y and t=1y; multiple input applied to verify time of peak dose
Number of Rooms	P	All	D	1	NUREG/CR-5512
Deposition Velocity (m/s)	P	Am-241, Cm-243, Cm-244, Cm-245, Cm-246, Np-237, Pu-238, Pu-239, Pu-240, and Pu-241	D	1.5179E-05	50th percentile value
		C-14, Co-60, Cs-137, Eu-152, Eu-154, H-3, I-129, Nb-94, Ni-59, Ni-63, Sr-90, and Tc-99	D	4.78217E-04	75th percentile value
Resuspension Rate (s^{-1})	P	Am-241, Cm-243, Cm-244, Np-237, Pu-238, Pu-239, Pu-240, and Pu-241	D	1.79444E-08	50th percentile value
		C-14, Cm-245, Cm-246, Co-60, Cs-137, Eu-152, Eu-154, H-3, I-129, Nb-94, Ni-59, Ni-63, Sr-90, and Tc-99	D	6.70403E-10	25th percentile value
Air Exchange Rate for Room (h^{-1})	P	All	D	8.35789E-01	25th percentile value
Room Area (m^2)	P	All	D	47.77	Humboldt Bay-specific data (General Office Building)
Room Height (m)	P	All	D	2.49	Humboldt Bay-specific data (General Office Building)
Time Fraction	B	All	D	1	NUREG/CR-5512
Inhalation Rate (m^3/d)	M	All	D	45.6	Conservative inhalation rate for moderate to heavy activities - NUREG/CR-6697, Attachment C, section 5.1; NUREG/CR-5512, vol. 3, section 5.3.4
Indirect Ingestion Rate (m^2/h)	B	All	D	0.0001	NUREG/CR6755

Table 1: RESRAD-Build Input Parameter Values for Area Factors					
Parameter	Type[a]	Nuclide	Treatment[b]	Value	Reference Source
Receptor Location	B	All	D	4.24, 2.82,1.0	NUREG/CR-5512; site-specific room dimensions (General Office Building)
Shielding Thickness (cm)	P	All	D	0	Site-specific model-no shielding assumed
Shielding Density (g/cm^3)	P	All	D	2.4	RESRAD-Build default value for concrete – not used in DCGL calculations
Shielding Material	P	All	D	concrete	Default input – not used in DCGL calculations
Number of Sources	P	All		1	Various size areas
External Dose Conversion Factor, (mrem/y per pCi/cm^2)	M	All	D	RESRAD-Build Library	FGR12
Air Submersion Dose Conversion Factor, (mrem/y per pCi/m^3)	M	All	D	RESRAD-Build Library	FGR12
Inhalation Dose Conversion Factor, (mrem/pCi)	M	All	D	RESRAD-Build Library	FGR11
Ingestionl Dose Conversion Factor, (mrem/pCi)	M	All	D	RESRAD-Build Library	FGR11
Source 1: Floor					
Type	P	All		area	NUREG/CR-5512
Direction	P	All		Z	NUREG/CR-5512
Location of Center of Source: x,y,z (m)	P	All	D	4.24, 2.82, 0.0	site-specific data – center of floor based on dimensions for General Office Building room
Source length X-axis (m)	P	All	D	8.47	Not used in calculations
Source length Y-axis (m)	P	All	D	5.64	Not used in calculations
Area (m^2)	P	All	D	100, 50, 10, 8, 6, 5, 4, 3, 2, 1	Recommended size for Class 1 structure used as upper limit for area source size
Air Fraction	B	H-3 All others	D	1.0 0.07	NUREG/CR-6697, Att. C Section 8.6
Direct Ingestion (h^{-1})	B	All	D	9.32E-7	NUREG/CR6755, A.3.3

Table 1: RESRAD-Build Input Parameter Values for Area Factors

Parameter	Type[a]	Nuclide	Treatment[b]	Value	Reference Source
Removable Fraction	P	All	D	0.1	NUREG-1727, Table C.7.1; NUREG/CR-6755, section 3.5
Time for Source Removal (d)	P	C-14, Co-60, Cs-137, Eu-152, Eu-154, I-129, and Nb-94	D	52695.2	75th percentile value
		Sr-90 and Tc-99	D	33056.9	50th percentile value
		Am-241, Cm-243, Cm-244, Cm-245, Cm-246, H-3, Ni-59, Ni-63, Np-237, Pu-238, Pu-239, Pu-240, and Pu-241	D	18249.3	25Th percentile value
Radionuclide Concentration (pCi/m^2)	P	All	D	1.0	-

[a] P = physical, B = behavioral, M = metabolic; (see NUREG/CR-6697, Attachment B, Table 4.)
[b] D = deterministic

Table 2: RESRAD-Build Results

	Annual Dose (mrem) from 1 pCi/m^2:										
(m^2)	Am-241	C-14	Cm-243	Cm-244	Cm-245	Cm-246	Co-60	Cs-137	Eu-152	Eu-154	H-3
1	1.14E-06	4.91E-10	8.56E-07	6.03E-07	3.78E-06	1.91E-06	1.79E-06	4.60E-07	8.91E-07	9.44E-07	1.81E-11
2	2.27E-06	9.79E-10	1.69E-06	1.21E-06	6.98E-06	3.65E-06	3.20E-06	8.22E-07	1.59E-06	1.68E-06	3.63E-11
3	3.39E-06	1.46E-09	2.51E-06	1.81E-06	9.82E-06	5.27E-06	4.35E-06	1.12E-06	2.16E-06	2.29E-06	5.44E-11
4	4.51E-06	1.95E-09	3.32E-06	2.41E-06	1.24E-05	6.83E-06	5.33E-06	1.38E-06	2.65E-06	2.81E-06	7.25E-11
5	5.63E-06	2.43E-09	4.12E-06	3.01E-06	1.48E-05	8.32E-06	6.18E-06	1.60E-06	3.07E-06	3.26E-06	9.07E-11
6	6.75E-06	2.91E-09	4.91E-06	3.61E-06	1.70E-05	9.77E-06	6.93E-06	1.80E-06	3.45E-06	3.65E-06	1.09E-10
8	8.98E-06	3.87E-09	6.49E-06	4.82E-06	2.12E-05	1.26E-05	8.22E-06	2.14E-06	4.09E-06	4.33E-06	1.45E-10
10	1.12E-05	4.83E-09	8.06E-06	6.02E-06	2.50E-05	1.53E-05	9.30E-06	2.43E-06	4.62E-06	4.90E-06	1.81E-10
50	5.55E-05	2.39E-08	3.87E-05	3.01E-05	8.38E-05	6.42E-05	1.85E-05	5.14E-06	9.18E-06	9.74E-06	9.07E-10
100	1.11E-04	4.76E-08	7.65E-05	6.02E-05	1.47E-04	1.22E-04	2.31E-05	6.76E-06	1.14E-05	1.21E-05	1.81E-09
	Annual Dose (mrem) from 1 pCi/m^2:										
(m^2)	I-129	Nb-94	Ni-59	Ni-63	Np-237	Pu-238	Pu-239	Pu-240	Pu-241	Sr-90	Tc-99
1	1.02E-07	1.26E-06	5.29E-11	1.37E-10	1.54E-06	9.70E-07	1.07E-06	1.07E-06	2.35E-08	3.84E-08	4.04E-10
2	1.95E-07	2.25E-06	1.06E-10	2.75E-10	3.04E-06	1.94E-06	2.15E-06	2.15E-06	4.69E-08	7.58E-08	7.94E-10
3	2.83E-07	3.06E-06	1.59E-10	4.12E-10	4.51E-06	2.91E-06	3.22E-06	3.22E-06	7.02E-08	1.13E-07	1.18E-09
4	3.67E-07	3.75E-06	2.12E-10	5.49E-10	5.97E-06	3.87E-06	4.29E-06	4.29E-06	9.35E-08	1.49E-07	1.55E-09
5	4.49E-07	4.35E-06	2.65E-10	6.87E-10	7.41E-06	4.84E-06	5.36E-06	5.36E-06	1.17E-07	1.85E-07	1.92E-09
6	5.28E-07	4.88E-06	3.17E-10	8.24E-10	8.83E-06	5.81E-06	6.43E-06	6.43E-06	1.40E-07	2.21E-07	2.29E-09
8	6.82E-07	5.78E-06	4.23E-10	1.10E-09	1.17E-05	7.74E-06	8.58E-06	8.58E-06	1.86E-07	2.92E-07	3.02E-09
10	8.31E-07	6.54E-06	5.29E-10	1.37E-09	1.45E-05	9.68E-06	1.07E-05	1.07E-05	2.33E-07	3.62E-07	3.74E-09
50	3.48E-06	1.30E-05	2.65E-09	6.87E-09	6.93E-05	4.84E-05	5.36E-05	5.36E-05	1.16E-06	1.74E-06	1.77E-08
100	6.61E-06	1.61E-05	5.29E-09	1.37E-08	1.37E-04	9.68E-05	1.07E-04	1.07E-04	2.31E-06	3.44E-06	3.50E-08

Table 3: Building Surface Area Factors by Radionuclide and Area Size

(m²)	Area Factor Values:										
	Am-241	C-14	Cm-243	Cm-244	Cm-245	Cm-246	Co-60	Cs-137	Eu-152	Eu-154	H-3
1	9.7E+01	9.7E+01	8.9E+01	1.0E+02	3.9E+01	6.4E+01	1.3E+01	1.5E+01	1.3E+01	1.3E+01	1.0E+02
2	4.9E+01	4.9E+01	4.5E+01	5.0E+01	2.1E+01	3.3E+01	7.2E+00	8.2E+00	7.2E+00	7.2E+00	5.0E+01
3	3.3E+01	3.3E+01	3.0E+01	3.3E+01	1.5E+01	2.3E+01	5.3E+00	6.0E+00	5.3E+00	5.3E+00	3.3E+01
4	2.5E+01	2.4E+01	2.3E+01	2.5E+01	1.2E+01	1.8E+01	4.3E+00	4.9E+00	4.3E+00	4.3E+00	2.5E+01
5	2.0E+01	2.0E+01	1.9E+01	2.0E+01	9.9E+00	1.5E+01	3.7E+00	4.2E+00	3.7E+00	3.7E+00	2.0E+01
6	1.6E+01	1.6E+01	1.6E+01	1.7E+01	8.6E+00	1.2E+01	3.3E+00	3.8E+00	3.3E+00	3.3E+00	1.7E+01
8	1.2E+01	1.2E+01	1.2E+01	1.2E+01	6.9E+00	9.7E+00	2.8E+00	3.2E+00	2.8E+00	2.8E+00	1.2E+01
10	9.9E+00	9.9E+00	9.5E+00	1.0E+01	5.9E+00	8.0E+00	2.5E+00	2.8E+00	2.5E+00	2.5E+00	1.0E+01
50	2.0E+00	2.0E+00	2.0E+00	2.0E+00	1.8E+00	1.9E+00	1.2E+00	1.3E+00	1.2E+00	1.2E+00	2.0E+00
100	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00
(m²)	Area Factor Values:										
	I-129	Nb-94	Ni-59	Ni-63	Np-237	Pu-238	Pu-239	Pu-240	Pu-241	Sr-90	Tc-99
1	6.5E+01	1.3E+01	1.0E+02	1.0E+02	8.9E+01	1.0E+02	1.0E+02	1.0E+02	9.8E+01	9.0E+01	8.7E+01
2	3.4E+01	7.2E+00	5.0E+01	5.0E+01	4.5E+01	5.0E+01	5.0E+01	5.0E+01	4.9E+01	4.5E+01	4.4E+01
3	2.3E+01	5.3E+00	3.3E+01	3.3E+01	3.0E+01	3.3E+01	3.3E+01	3.3E+01	3.3E+01	3.0E+01	3.0E+01
4	1.8E+01	4.3E+00	2.5E+01	2.5E+01	2.3E+01	2.5E+01	2.5E+01	2.5E+01	2.5E+01	2.3E+01	2.3E+01
5	1.5E+01	3.7E+00	2.0E+01	2.0E+01	1.8E+01	2.0E+01	2.0E+01	2.0E+01	2.0E+01	1.9E+01	1.8E+01
6	1.3E+01	3.3E+00	1.7E+01	1.7E+01	1.6E+01	1.7E+01	1.7E+01	1.7E+01	1.7E+01	1.6E+01	1.5E+01
8	9.7E+00	2.8E+00	1.3E+01	1.2E+01	1.2E+01	1.3E+01	1.2E+01	1.2E+01	1.2E+01	1.2E+01	1.2E+01
10	8.0E+00	2.5E+00	1.0E+01	1.0E+01	9.4E+00	1.0E+01	1.0E+01	1.0E+01	9.9E+00	9.5E+00	9.4E+00
50	1.9E+00	1.2E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00	2.0E+00
100	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

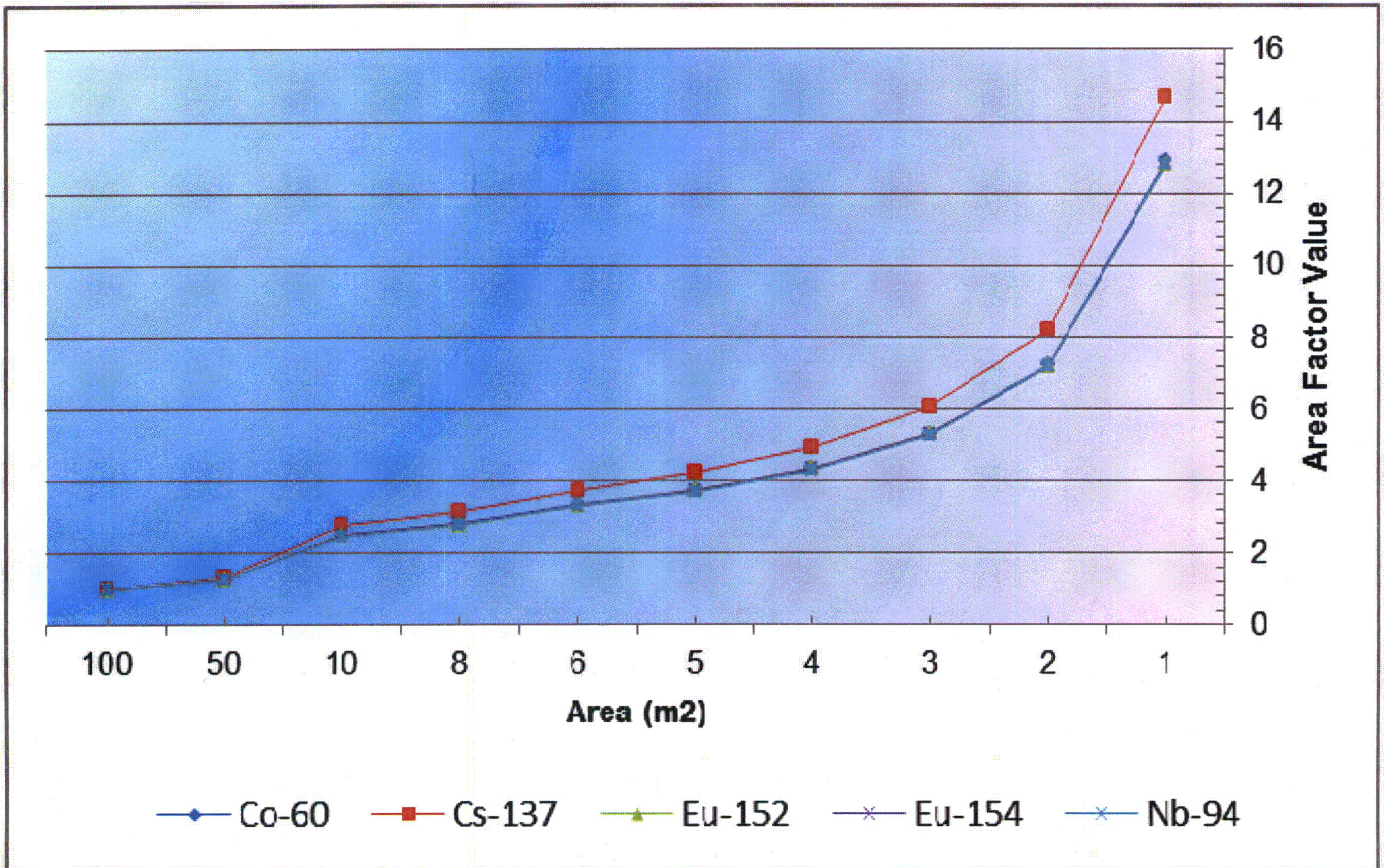

Figure 1: Building Surface Area Factors for C0-60, Cs-137, Eu-152,154, and Nb-94

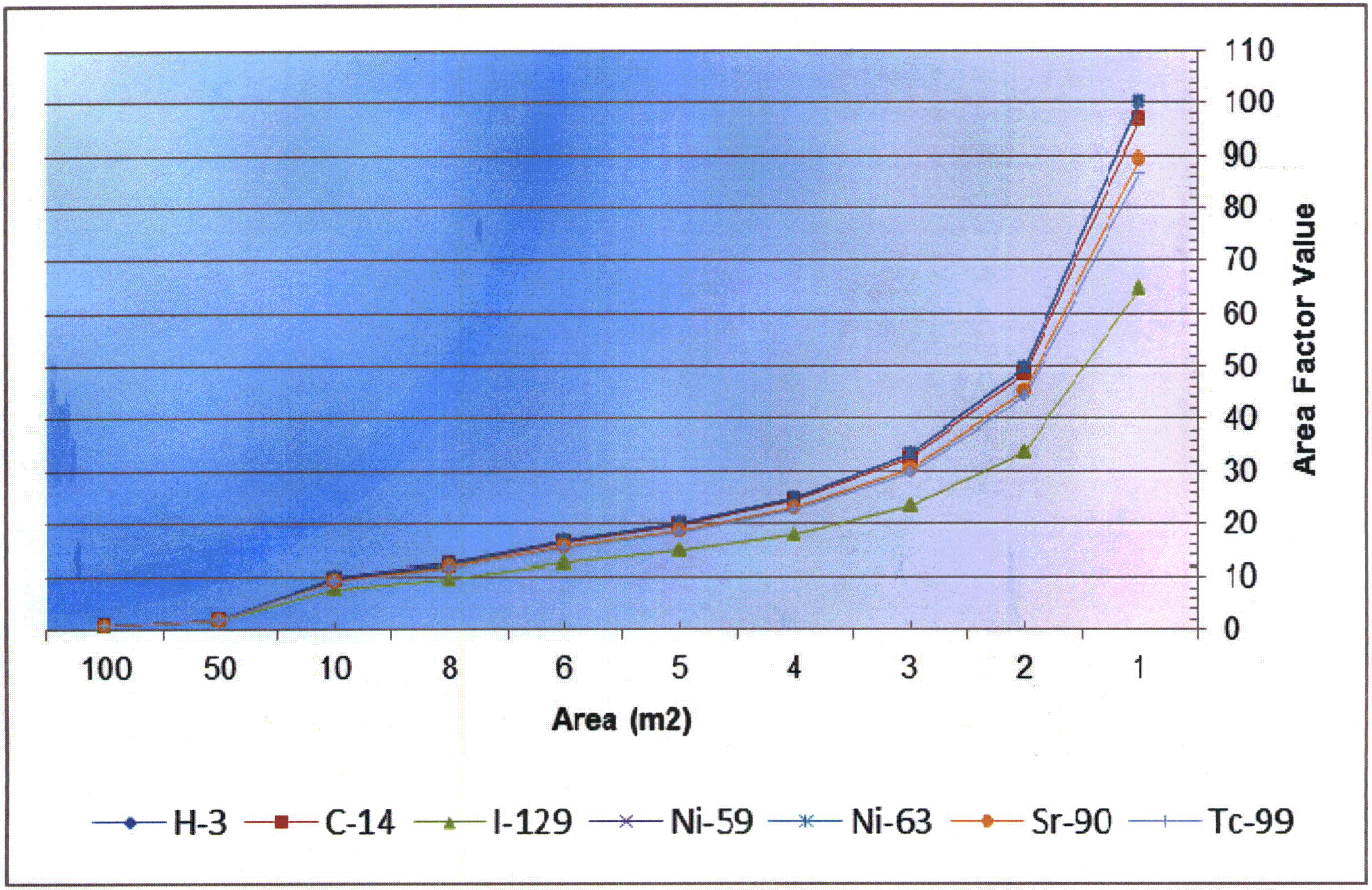

Figure 2: Building Surface Area Factors for H-3, C-14, I-129, Ni-59, 63, Sr-90, and Tc-99

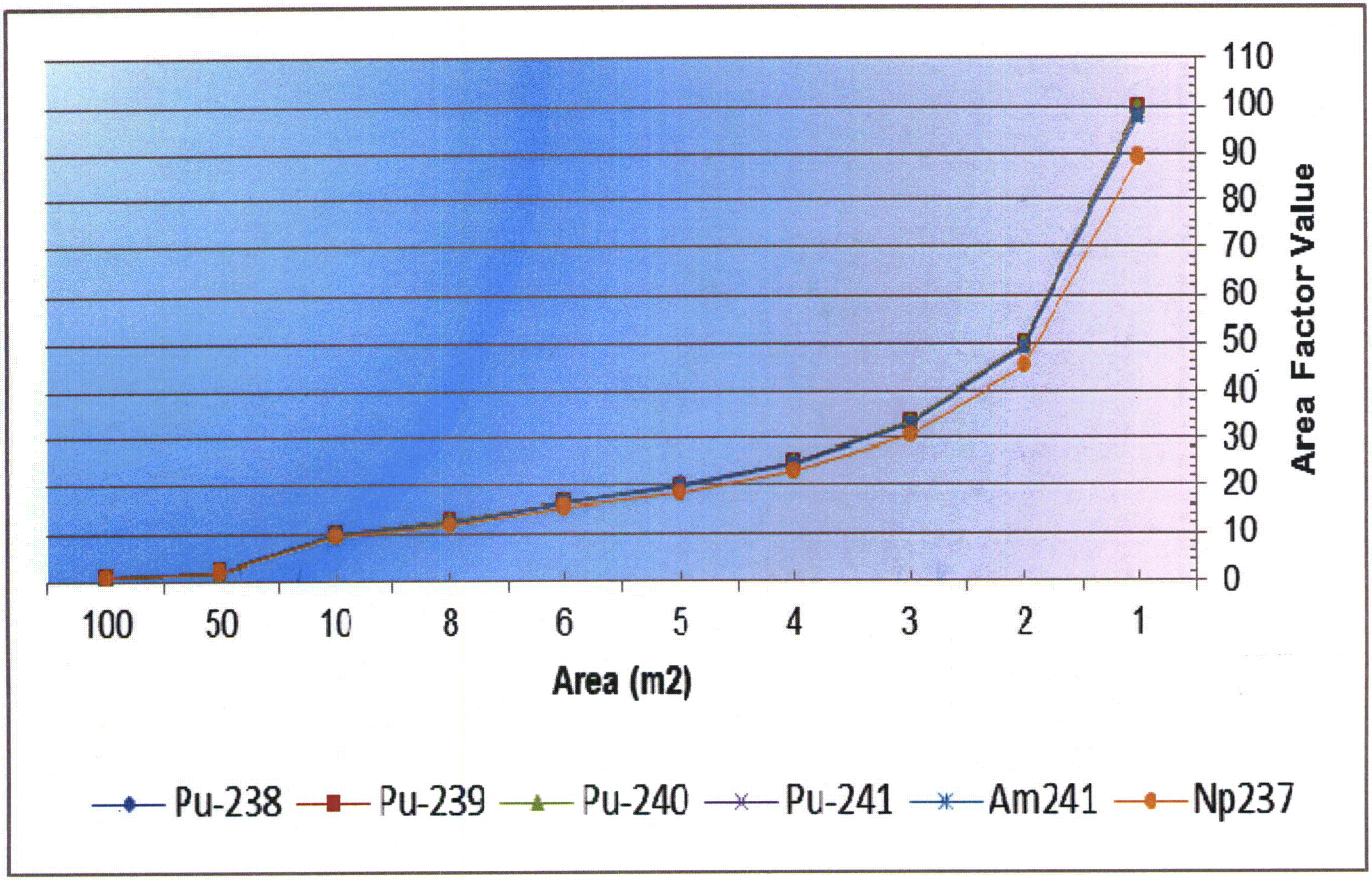

Figure 3: Building Surface Area Factors for Pu-238, 239, 240, 241, AM-241, and Np-237

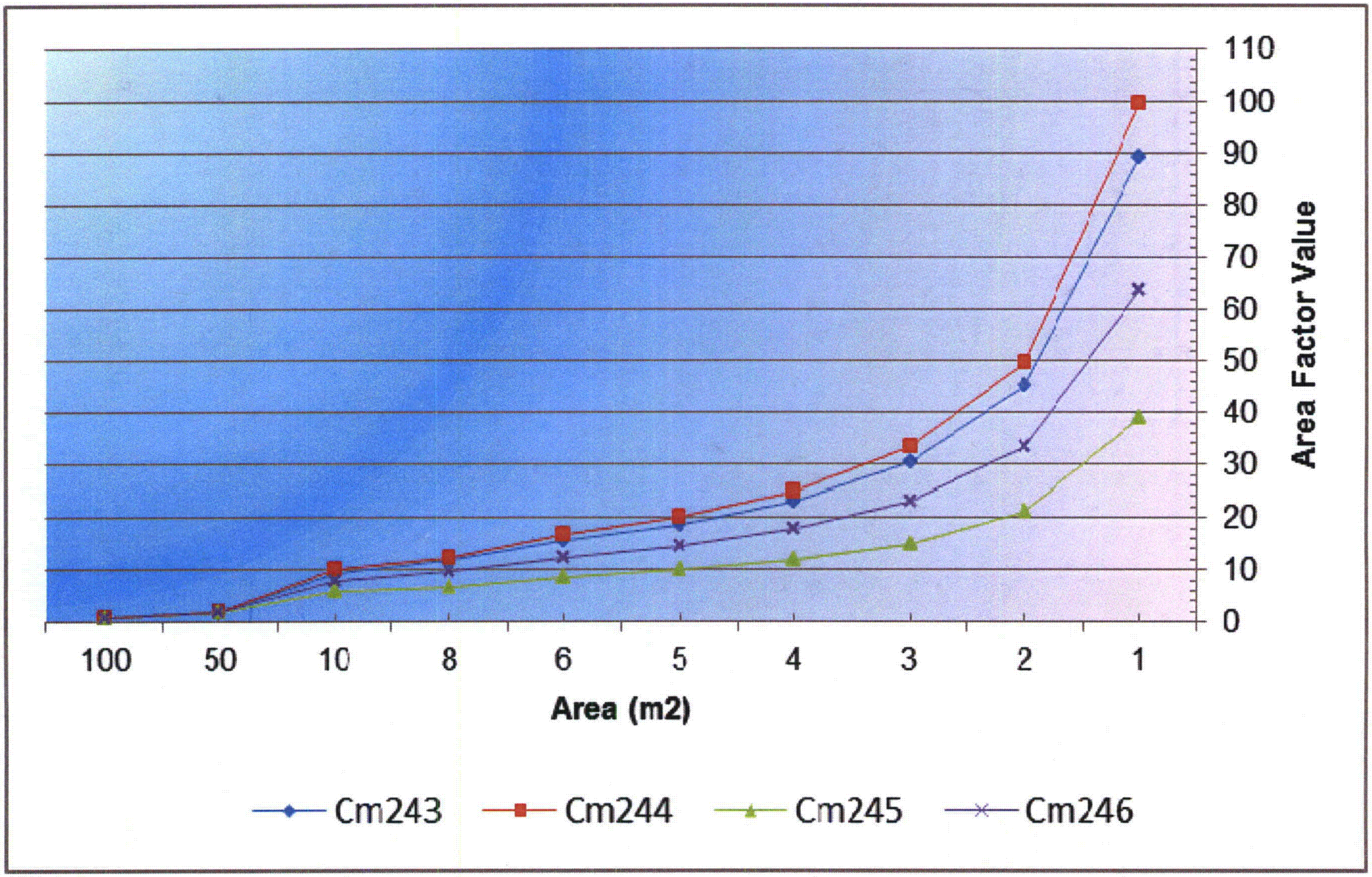

Figure 4: Building Surface Area Factors for Cm-243, 244, 245, and 246

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7. UPDATE OF SITE-SPECIFIC DECOMMISSIONING COSTS

7.1. Introduction

In accordance with 10 CFR 50.82(a)(9)(ii)(F) (Reference 7-1) and Regulatory Guide (RG) 1.179, "Standard Format and Content of License Termination Plans for Nuclear Power Reactors," (Reference 7-2) the site-specific cost estimate and funding plans are provided in this chapter. RG 1.179 provides guidance with respect to the information to be presented.

The License Termination Plan (LTP) must provide an estimate of the remaining decommissioning costs, and compare the estimated costs with the present funds set aside for decommissioning. The financial assurance instrument required per 10 CFR 50.75 must be funded to the amount of the cost estimate. If there is a deficit in present funding, the LTP must indicate the means for ensuring adequate funds to complete the decommissioning.

The decommissioning cost estimate includes an evaluation of the following cost elements:

- Cost assumptions used, including a contingency factor
- Major decommissioning activities and tasks
- Unit cost factors
- Estimated costs of decontamination and removal of equipment and structures
- Estimated costs of waste disposal, including applicable disposal site surcharges and transportation costs
- Estimated final survey costs
- Estimated total costs

The cost estimate should focus on the remaining work, detailed activity by activity. The cost estimates should be based on credible engineering assumptions that are related to all major remaining decommissioning activities and tasks. The cost estimate should include the cost of the remediation action being evaluated, the cost of transportation and disposal of the waste generated by the action, and other costs that are appropriate for the specific case.

Pacific Gas and Electric (PG&E) owns a 100 percent undivided interest in Humboldt Bay Power Plant (HBPP), Unit 3, and provides financial assurance for decommissioning through the use of an external sinking fund.

7.1.1. History

PG&E placed the plant in a long-term storage and monitoring condition known as SAFSTOR. During this period, the plant was maintained to ensure the integrity of its safety systems and to ensure that the health and safety of the public, environment, and work force were protected. Several cost studies were performed between 1978 and 2009. PG&E hired a specialty consultant, TLG Services, Inc., to prepare the updated 2001 SAFSTOR Decommissioning Study to the original that was issued in 1997. The decommissioning cost study and subsequent studies by TLG provided PG&E with sufficient information to prepare the financial planning documents for decommissioning, as required by the Nuclear Regulatory Commission (NRC). The cost studies provided estimates that were based on detailed studies of the unique features of the facility and accounted for lessons learned at other facilities that had undergone similar decommissionings. These estimates were not detailed engineering documents, but were financial analyses prepared in advance of the detailed engineering that would be required to carry out the decommissioning. The 2009 cost study was approved by the California Public Utilities Commission (CPUC) in the 2009 Nuclear Decommissioning Cost Triennial Proceeding (NDCTP) (Reference 7-4).

As HBPP, Unit 3, Decommissioning transitions from the Plant System Removal Phase (where work scope was dynamic with significant uncertainty) to the Civil Works Projects Phase (where work scope is well defined), the remaining decommissioning work has been analyzed and then described in major, well-defined, Civil Works Projects. These Civil Works Projects include Turbine Building Demolition, Nuclear Facilities Demolition and Excavation, Intake and Discharge Canal Remediation, Office Facility Demobilization, Reactor Caisson and Foundation Piles Removal and Final Site Restoration. Detailed bid specifications were developed for each project and then bids were solicited from multiple vendors. The use of competitively bid, cost plus with fixed fee contracts assures PG&E that the costs are fully understood and provides for some financial risk mitigation.

7.2. Decommissioning Cost Estimate

7.2.1. Cost Estimate Description and Methodology

PG&E formed an interdisciplinary and broad-based subject matter expert team to develop and vet 15 technical specifications accompanied by 10 administrative specifications. The specifications developed by this technically focused group defined the requirements and criteria to complete the remainder of the

decommissioning at HBPP Unit 3, including a plan for final site restoration. The Specifications Development Team met every week for 12 months and a Long Term Strategy Team met every week for 7 months developing the Level 1 Long Term Schedule and Exit Strategy. The effort resulted in a document known as the Decommissioning Capstone Document (Reference 7-5).

Three bids were received from leading industry/reputable companies for all four discrete civil works projects. One additional bid was received for canal remediation only. The four projects are; (1) Intake and Discharge Canal Remediation, (2) Nuclear Facilities Demolition and Excavations; Office Facility Demobilization, (3) and Final Site Restoration.

PG&E identified potential issues associated with the reactor caisson. To gain a better understanding of the alternatives to resolve radiological issues associated with the caisson, PG&E commissioned an engineering feasibility study. The study, known as the Kiewit HBPP Caisson Feasibility Study (Reference 7-6), evaluated methods, risks, schedules, and costs for removal of the caisson. After PG&E evaluated the technical issues associated with remediation and in-place abandonment versus removal, management determined that the only viable solution was complete excavation and removal of the caisson.

In addition to the cost of civil works, PG&E will incur overhead costs associated with oversight of the civil works projects, safety monitoring, ongoing engineering work, and control of the site. Those costs are captured in the staffing plan. As a result, PG&E has prepared a site-specific Decommissioning Project Report (DPR) (Reference 7-7) to identify the cost and schedule to complete decommissioning and license termination of HBPP, Unit 3. The DPR incorporates the site-specific decommissioning tasks and detailed plans that have been identified as a result of the ongoing implementation of the decommissioning effort. The remaining cost to decommission HBPP, Unit 3, including a 10 percent to 25 percent line item contingency applied to remaining work (depending on the degree of difficulty), is estimated to be approximately $982.4 million (2011 dollars).

7.2.2. *Summary of the Site Specific Decommissioning Cost Estimate*

Site-specific cost estimates were prepared for PG&E prior to commencing decommissioning of the HBPP, Unit 3, facility. The estimates were based on the unique features of the facility and previous studies, and accounted for lessons learned at other facilities that had undergone similar decommissionings. As PG&E identified efficiencies and discovered issues that affected work

processes, and therefore costs, changes to implementation methodologies were researched, planned, and reviewed by management. With system dismantling work underway, PG&E has not updated the previous cost studies; rather this current estimate reflects forecasts that have been developed from engineering studies and/or actual contractor bids. This estimate update incorporates the site specific and special tasks that have been prescribed or implemented as a result of the ongoing decommissioning planning. The basis of the estimate and the sources of information, methodology, site-specific considerations, assumptions, and total costs are described in this section. PG&E currently estimates that the cost to complete remaining decommissioning work at HBPP, Unit 3, is $727.6 million (including ISFSI) including contingency.[1] The total cost of decommissioning Humboldt, Unit 3, is $982.4 million. This represents an increase from the CPUC approved forecast in the 2009 NDCTP of $499.8 million (in 2008 dollars) for decommissioning HBPP Unit 3.

The principal drivers of the projected cost increase are unforeseen changes in the scope of work to be performed and the large amount of infrastructure upgrades needed to perform the work. In its previous cost studies, PG&E had specifically assumed that the reactor caisson and associated structures 3 feet and more below grade level would remain in place. In late 2011, PG&E was able to obtain access to one portion of the bioshield wall surrounding the reactor vessel. Laboratory testing revealed that there was greater neutron activation than had been predicted. PG&E now believes that it has no viable alternative but to remove the entire reactor caisson containment structure. After a detailed feasibility study, PG&E has determined that this new scope of work will be approximately $192 million, including contingency.

Additionally, stakeholder involvement within Humboldt County, and state and local regulatory requirements, the probability is high that PG&E will ultimately be required to mitigate the final restoration state of the project to a more stringent standard than previously assumed under NRC regulations. PG&E has changed its previous assumption and assumed lower values of residual radioactive material. This change in scope particularly affects the remediation of the intake and discharge canals, which, with associated soil removal and disposal, is estimated to be approximately $47 million, including contingency. It is PG&E's judgment that moving to the more rigorous standard now will not only result in more complete remediation, but will also result in lower costs than those associated with regulatory uncertainty, delay, and potential

[1] Unless specifically stated otherwise, dollars used herein are in 2011 dollars.

litigation. Site support and groundwater treatment costs for the caisson and canal are $6.2 million,

Table 7-1 provides a summary of remaining decommissioning costs (from December 2013) in Year 2011 Dollars. The total does not reflect the costs of maintaining the ISFSI, as that area is under a 10 CFR 72 license. Bolded totals are the cost category group totals.

Table 7-1 Summary of Remaining Decommissioning Costs in Year 2011 Dollars (thousands of dollars)

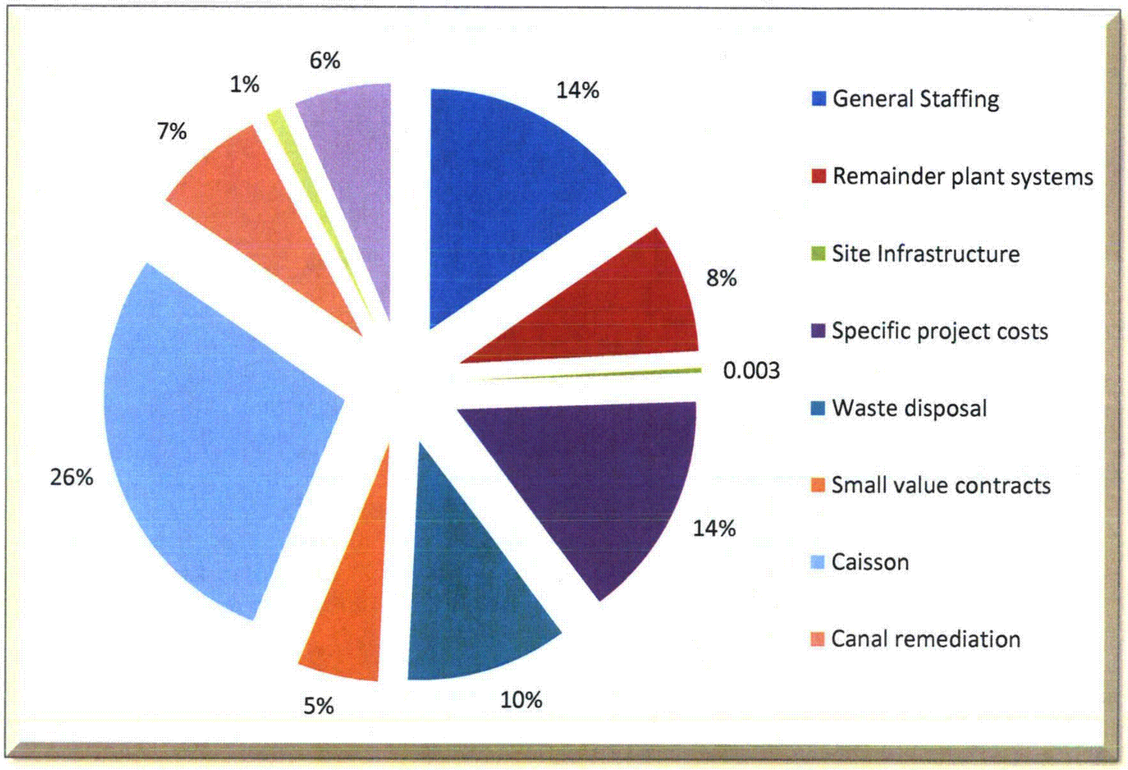
Cost Category	Amount
General Staffing (Excludes Caisson)	**100,167**
Overall Project	87,002
License Termination Survey (Excludes Caisson)	13,166
Remainder of Plant Systems	**56,693**
Direct Labor	32,814
Craft	17,748
Radiation Protection	15,066
Liquid Radwaste System	6,659
Tools & Equipment	17,220
Common Tools	3,771
Rad Protection	12,628
Glove Bags	821
Site Infrastructure	**2,074**
Specific Project Costs (Excludes Disposal / Caisson / Canal)	**104,254**
Reactor Vessel Removal	15,368
Turbine Bldg Demolition	14,307
Other Civil Works	74,579
Waste Disposal (Excludes Caisson / Canals)	**74,011**
Labor (Packaging and Handling)	18,994
Third Party Disposal Sites	52,315
Waste Handling Building	2,701
Small Value Contracts	**36,042**

Cost Category	Amount
Small Dollar Vendors	10,751
Specialty Contracts	25,291
Contingency(Excludes Caisson / Canals)	**41,216**
Subtotal Base	**419,793**
Caisson	**191,627**
Field Work	78,000
Packaging / Material Handling	12,932
Project Staffing	22,126
Waste Disposal	24,037
License Termination Survey	6,168
Tools and Supplies	2,346
Other	4,238
Caisson Contingency	41,780
Canal Remediation	**47,408**
Removal	21,000
Disposal	20,224
Canal Contingency	6,184
Common Site Support - Caisson and Canals	**6,196**
Relocation of Trailer City	2,542
Groundwater Treatment	2,893
Groundwater Treatment System Operation	761
Subtotal Caisson / Canal / GWTS	**245,230**
TOTAL	**665,023**

7.3. Decommissioning Funding Plan

The recent additional scope (e.g., caisson removal and canal remediation) of decommissioning activities significantly increase the estimated cost of HBPP decommissioning. PG&E recently filed an application with the CPUC requesting approval of the 2012 NDTCP (Reference 7-8) revised cost estimates and authorization to recover the increased decommissioning funds in the nuclear decommissioning charge paid by PG&E's customers.

Figure 7-1 Summary of Remaining Decommissioning Costs Percentages



7.4. References

7-1 U.S. Code of Federal Regulations, Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities, Section 82—Termination of License"

7-2 U.S. Nuclear Regulatory Commission, Regulatory Guide 1.179, "Standard Format and Content of License Termination Plans for Nuclear Power Reactors," January 1999

7-3 "Decommissioning Project Report for the Humboldt Bay Power Plant, Unit 3," 2012–2024, December 2012

7-4 "Nuclear Decommissioning Cost Triennial Proceeding," 2009

7-5 "HBPP Decommissioning Capstone Document," June 2012

7-6 "Kiewit HBPP Caisson Feasibility Study," October 2012

7-7 "HBPP Decommissioning Project Report," December 2012

7-8 "Nuclear Decommissioning Cost Triennial Proceeding," 2012

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8. SUPPLEMENT TO THE ENVIRONMENTAL REPORT

8.1 Introduction and Purpose

8.1.1 Purpose

The purpose of this chapter of the License Termination Plan (LTP) is to update the environmental report for Humboldt Bay Power Plant (HBPP) with new information and significant environmental changes associated with the site's decommissioning and license termination activities. Therefore, this chapter becomes a supplement to the "Environmental Report for decommissioning" (Reference (8-7). This chapter of the LTP is prepared pursuant to 10 CFR 51.53(d) and 10 CFR 50.82(a)(9)(ii)(G).

LTP, Chapter 8, documents an assessment of the environmental effects of decommissioning the HBPP, Unit 3. The assessment determined that the environmental effects from decommissioning HBPP, Unit 3, are minimal, and no adverse effects are outside the bounds of NUREG-0586, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities Supplement 1 Regarding the Decommissioning of Nuclear Power Reactors" (FGEIS; Reference 8-1).

Additionally, the conclusions contained in the "Project Description and Coastal Resource Assessment – Humboldt Bay Power Plant Decommissioning and Demolition of Fossil Units 1 and 2 and Nuclear Unit 3" (Reference 8-2), used as the original basis for the decommissioning environmental assessment of radiological and nonradiological effects of decommissioning, are still valid and are summarized in this chapter of the LTP.

The information contained in this chapter generally follows the guidance in Nuclear Regulatory Commission (NRC) Regulatory Guide 1.179, "Standard Format and Content of License Termination Plans for Nuclear Power Reactors" (Reference 8-3), and NUREG-1700, "Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans" (Reference 8-4). Guidance contained in the FGEIS also was used during preparation of this chapter, as well as the Coastal Resource Assessment prepared by Pacific Gas and Electric Company (PG&E) in 2009. The contents of this chapter have also been reviewed against the appropriate sections of NUREG-1757, "Consolidated NMSS Decommissioning Guidance Decommissioning Process for Materials Licensees" (Reference 8-5).

Much of the information in this chapter has also been provided to the NRC in other forms including the "Humboldt Bay Independent Spent Fuel Storage Installation (ISFSI) Environmental Report" (Reference 8-6).

8.1.2 Background

PG&E is currently in the process of full decommissioning and 10 CFR 50 license termination for its nuclear facility at the 143-acre site in Humboldt County, California (Figure 8-1). HBPP formerly consisted of five electric

generation units, including Nuclear Unit 3 that ceased operation in 1976. Units 1 and 2, which have been demolished and removed to grade, were conventional 52 and 53 megawatt (MW)-electric units that were capable of operating primarily on natural gas with fuel oil as a backup fuel source. Two gas turbines, rated at 15 MW-electric each, were located near the Unit 3 structures and also have been removed.

The site has been repowered. The Humboldt Bay Generating Station (HBGS) consists of 10 reciprocating engines (Model 18V50DF, manufactured by Wärtsilä) with 163 MW total output from 10 combined cycle engines. HBGS will normally run on natural gas with ultra-low sulfur diesel as its backup fuel. All generating units, as well as the plant site, are owned by PG&E (Figure 8-2).

PG&E is the holder of the Unit 3 Facility License No. DPR-7. Unit 3 was granted a construction permit by the Atomic Energy Commission (AEC) on October 17, 1960, and construction began in November 1960. The AEC issued Provisional Operating License No. DPR-7 for Unit 3 in August 1962. Unit 3 achieved initial criticality on February 16, 1963, and began commercial operation in August 1963. The rated electrical generation capacity of the Unit 3 generator was 65 MWs.

8.1.3 Environmental Effects of Decommissioning

A description of both the radiological and nonradiological environmental effects of decommissioning is provided in Section 8.5. Radiological impacts reviewed include evaluations of occupational and public doses, decommissioning accidents, low-level waste generation, transportation and disposal, and adherence to radiological criteria for license termination.

The nonradiological effects include potential impacts governed by federal, state, and local regulations. PG&E used the FGEIS as guidance in evaluating the nonradiological effects of decommissioning.

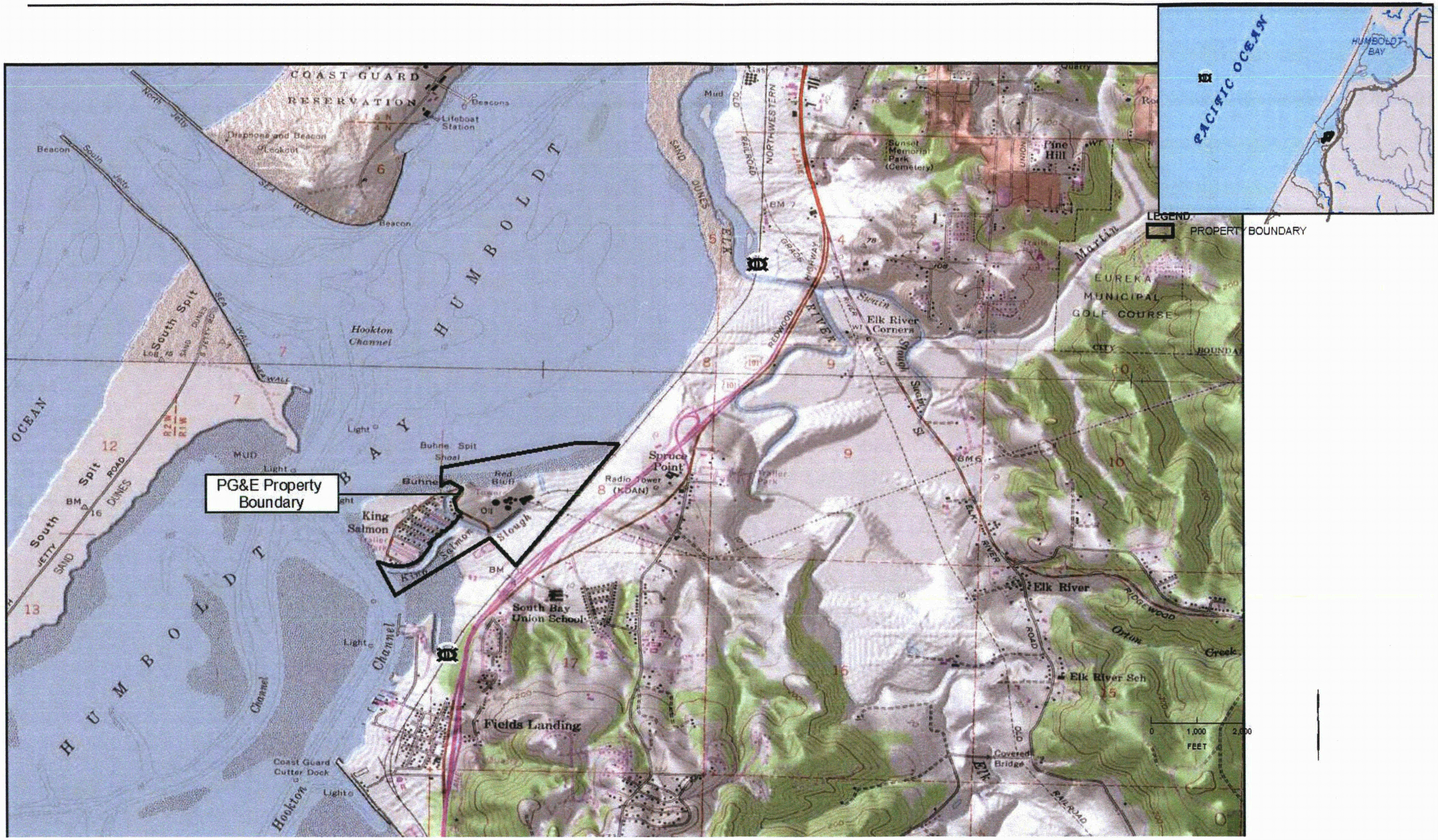


FIGURE 8-1 LOCATION MAP

Humboldt Bay Power Plant License Termination Plan
PG&E Humboldt Bay Power Plant Eureka, California

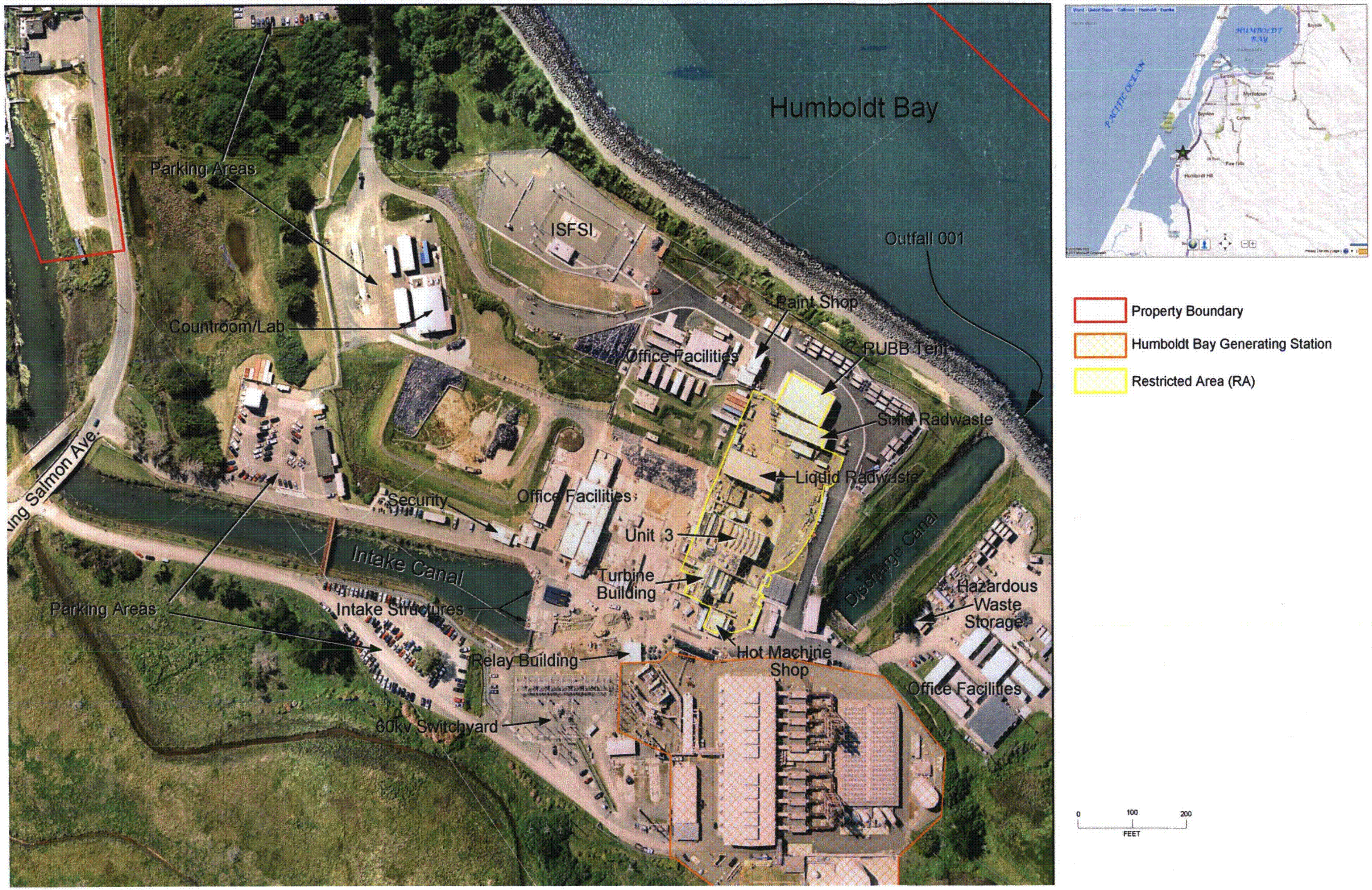


FIGURE 8-2 SITE FEATURES
Humboldt Bay Power Plant License Termination Plan
PG&E Humboldt Bay Power Plant Eureka, California

8.2 Site Description after Termination of the License

This section summarizes the final condition of the site at the conclusion of dismantlement and license termination activities. Chapter 3 of this LTP provides a more detailed description of the final site condition. The impacts of these activities are discussed in Section 8.5.

A main objective of the decommissioning project is to restore the land formerly occupied by Unit 3 to conditions that allow for continued industrial uses of the site. It is unlikely that the HBPP site will be used for any purpose other than an industrial site; however, PG&E has chosen the conservative approach of remediating and surveying to the resident farmer scenario to allow for unrestricted release of the site upon termination of the 10 CFR 50 license.

Chapter 5 of this LTP, "Final Status Survey Plan," describes the contents of the final status survey report.

Clean-up of residual radiological contamination associated with the historical power production and other operations since Unit 3 shutdown (SAFSTOR) is the primary objective for the project. On the basis of current efforts to characterize nonradiological contaminants, such as petroleum products, solvents, and heavy metals, the site soil and groundwater quality is typical of an established industrial power plant. No imminent threats to human health or the environment due to radiological or nonradiological constituents have been identified, although additional assessments during decommissioning are ongoing.

The NRC is the lead agency over radioactive impacts and waste (such as spent nuclear fuel or byproduct materials, radioactive debris and media). The Department of Toxic Substances Control (DTSC) also may assert jurisdiction over final site remediation standards as necessary to achieve full regulatory closure of the site. PG&E is currently working with the DTSC to ensure that proposed actions to remediate radiological and nonradiological impacts are consistent with any final remedial actions to be approved by DTSC.

The Unit 3 license termination is expected in 2019. The spent nuclear fuel and the greater than Class C (GTCC) waste will remain in storage at the Independent Spent Fuel Storage Installation (ISFSI) (licensed under 10 CFR 72) until the Department of Energy transfers this waste to a federal repository.

8.3 Post-shutdown Decommissioning Activities Report

In February 1998, PG&E issued a Post Shutdown Decommissioning Activities Report (PSDAR), in accordance with 10 CFR 50.82. The PSDAR provides a description of planned decommissioning activities, a schedule for their accomplishment, an estimate of expected decommissioning costs, and the reasons for concluding that the environmental impacts associated with site-specific decommissioning activities will comply with 10 CFR 50.82(a)(6)(ii). PG&E intends to decommission HBPP in accordance with the SAFSTOR

option found acceptable to the NRC in the FGEIS. PG&E revises the PSDAR as necessary in accordance with the requirements of 10 CFR 50.82. PG&E anticipates submitting Revision 4 of the PSDAR in June 2013, which includes an updated schedule and cost estimate as well as discussion of environmental impacts.

Chapter 3 of this LTP, Identification of Remaining Site Decommissioning Activities, identifies the major dismantlement and decontamination activities that are scheduled to be completed prior to license termination and site release.

8.4 Humboldt Bay Power Plant Site Environmental Setting and Description

The "Environmental Report for HBPP Decommissioning" (Reference 8-7), was submitted with the original HBPP SAFSTOR application. This document has been updated with information from the Humboldt Bay ISFSI Environmental Report (Reference 8-6), the Coastal Resource Assessment (Reference 8-2) and other source documents. PG&E reviewed the environmental reports and the guidance contained in the FGEIS to determine what new information needs to be included in this chapter of the LTP.

8.4.1 Geography and Demography

8.4.1.1 Site Location and Description

The HBPP site is located on the northern California coast in Humboldt County, situated between the western slopes of the Coast Range and Humboldt Bay, along the Pacific Ocean. The site is approximately 250 miles north of San Francisco and approximately 3 miles southwest of the City of Eureka.

The HBPP site is located on a small peninsula known as Buhne Point, nominally at 12 feet above mean lower low water (MLLW).

Land use surrounding the site and Humboldt Bay is mainly rural residential and agriculture, and includes a mixture of open space, commercial uses, and industry. The only access to the site is via U.S. Highway 101 onto King Salmon Avenue, which also serves the community of King Salmon on the western part of the peninsula. A more detailed description of the plant site is located in Section 1.1.2 of Chapter 1 of this LTP.

8.4.1.2 Population

Detailed population statistics are presented in Chapter 1, Section 1.1.3, of this LTP.

8.4.1.3 Site Access, Land, and Water Use

The project site is accessible via King Salmon Avenue, off U.S. Highway 101. U.S. Highway 101, which is a north-south freeway immediately east of the project area. King Salmon Avenue is a county-maintained road between U.S. Highway 101 and the community of King Salmon. It is also the main access road to the entrance of HBPP (Figure 8-2). King Salmon Avenue is lightly traveled by passenger cars and trucks. Heavy trucks are limited to those associated with plant operation.

The power plant site is on land zoned as coastal dependent industrial with combining district designations for coastal resource dependent, flood hazard, and coastal wetland. The project site is currently used for industrial purposes (electricity production and distribution). The majority of the project is in an unincorporated area within Humboldt County's jurisdiction. The City of Eureka's sphere of influence extends west and south of the project site, and the city considers land within this designated area as land that may be annexed to the city in the future.

Although Humboldt County has a certified Local Coastal Program, the HBPP site is within the retained jurisdiction of the California Coastal Commission (CCC).

Property owned by the City of Eureka surrounding the HBPP is zoned as coastal agriculture. An existing public trail, included as part of the California Coastal Trail system, is located on the north and western side of the HBPP site along Humboldt Bay.

Recreational opportunities within Humboldt Bay are numerous and include boating, fishing, camping, swimming and bird watching. The following designated recreational areas are located in Humboldt Bay, within a 3-mile radius of the project site: Samoa Dunes Recreation Area, South Spit, Fields Landing County Park, Humboldt Bay National Wildlife Refuge, and Elk River Wildlife Area (Figure 8-3).

None of the areas on which decommissioning activities will occur is used for agricultural production. Prime agricultural land is located within 1 mile of the HBGS within the Elk River Valley. More details on land usage are provided in Chapter 1 of this LTP. A detailed description of the site water supply is provided in Chapter 1.

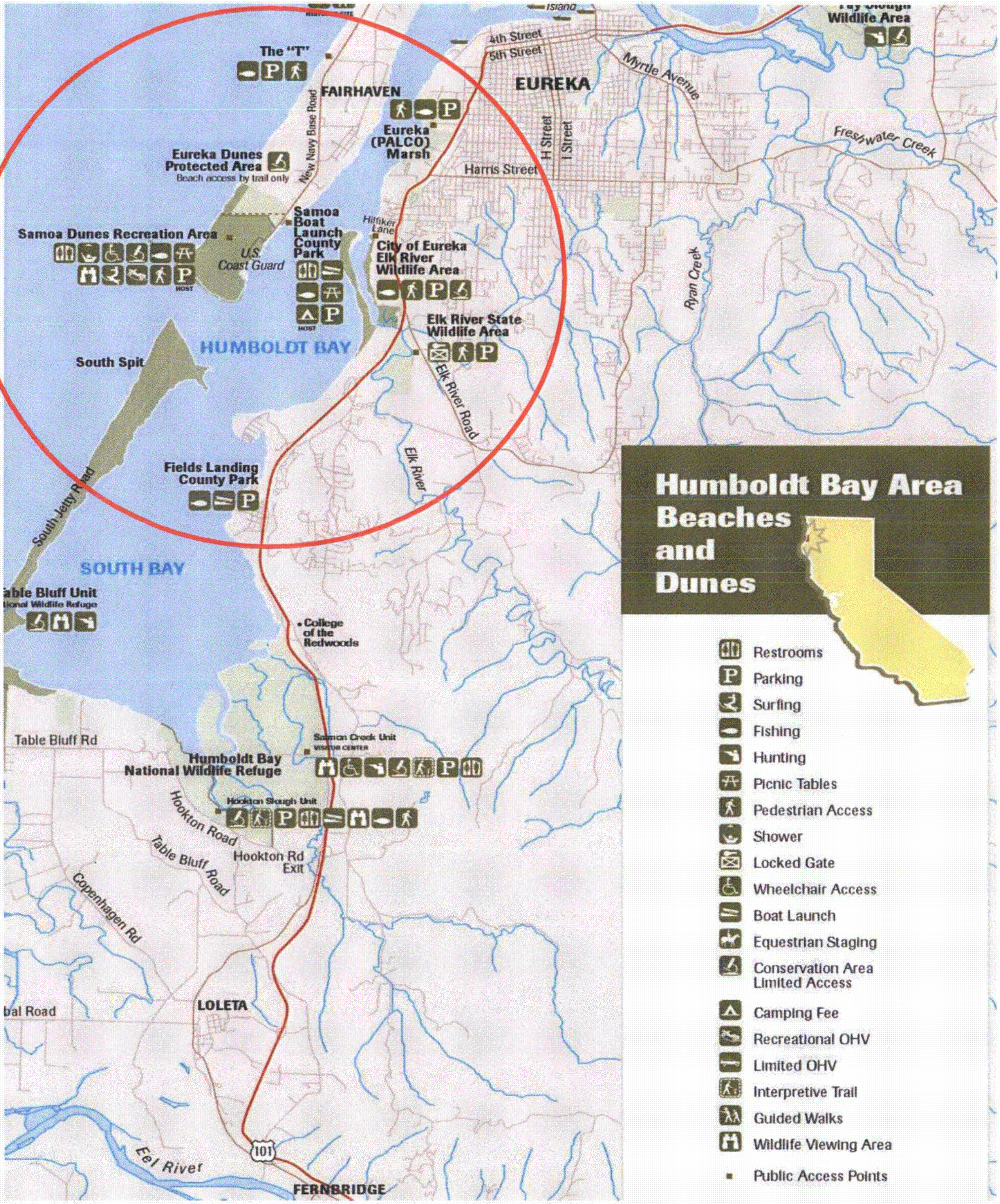
8.4.2 Climate

8.4.2.1 General Climatology

The climate of the greater Humboldt Bay region, including Eureka and the immediate coastal strip where the project site is located, is characterized as Mediterranean. Summers have little or no rainfall, and low overcast and fog clouds are frequently observed. The dry season, extending from May through September, contributes only 10 percent of the average annual precipitation. Winters are wet, with frequent passage of Pacific storms, and temperatures are mild. The rainy season generally falls between November and March, and yields approximately 75 percent of the annual precipitation, with an average annual rainfall of 39.57 inches as measured at Eureka (Reference 8-9). The average annual temperature is 51°F, with the warmest months from July to September and the coldest months from December to February (Reference 8-9). The transitional months of April and October contribute the balance of the annual precipitation.

The area surrounding the HBPP site is influenced by the coastal mountain ranges (hills). The hills of influence extend from Washington State to near San Francisco. The coastal range of interest surrounding HBPP begins with Patrick's Point, 30 miles to the north, then extends to the southeast, then to the southwest, ending in Cape Mendocino, 23 miles from the site. The tops of these hills range from 1,500 to 2,500 feet, with the highest point (Kings Peak) reaching 4,087 feet, 40 miles directly south of Eureka. These hills create a rain shadow and shelter the region from heavier rainfall and temperature extremes (Reference 8-9).

The ring of hills surrounding the area also contributes to the marine effects in the summer. Sea surface temperatures average 55 to 57°F in the summer, and this strongly influences air temperature. Extensive fog and low clouds are a frequent occurrence during the summer. The fog and low stratus clouds usually retreat offshore in the late morning and early afternoon, and return at night. The marine layer of the atmosphere is typically 800 to 1,500 feet thick. There are periods when the day-to-night cycle is broken and the entire area remains under continuous low clouds and fog for days. Table 8-1 provides the monthly averages for heavy fog events for the HBPP area (Reference 8-9).



ES123010062534RDD
SOURCE: FRIENDS OF THE DUNES, 2002 (Reference 8-8)

FIGURE 8-3 RECREATIONAL OPPORTUNITIES

Humboldt Bay Power Plant License Termination Plan
PG&E Humboldt Bay Power Plant Eureka, California

8.4.2.2 *Extreme Winds*

The wind direction and speeds in Eureka are governed by the seasonal location of the Pacific high-pressure system and the low-pressure systems that bring the winter storms to the northwest coast. For approximately three quarters of the year, the region experiences prevailing winds from the north to northwest as the semi-permanent high pressure settles over the Pacific Ocean to the west of Eureka. During the winter, the winds are generally from the south to the southeast as the weather is largely influenced by low-pressure systems that originate in the Gulf of Alaska. Table 8-2 shows the directional distribution based on data from the period 1905 through 1996 (Reference 8-9).

Table 8-1 Monthly Average Heavy Fog Events at Eureka

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heavy Fog[a]	4	3	2	2	1	2	3	5	8	9	7	4

[a]Visibility less than 0.25 mile.

Table 8-2 Wind Direction Distribution (1905 through 1996)

Wind Direction From	Annual Percentage
North	32.42
Northeast	2.29
East	5.05
Southeast	14.83
South	13.42
Southwest	9.48
West	6.47
Northwest	16.03
All others	<1.00

The lack of an easterly wind component is caused by the hills surrounding the region blocking the east winds from reaching the coast. When east winds do occur, they occur in the late night or early morning and are due to downslope flows from the surrounding hills. Eureka's highest daily wind speed is

38.2 miles per hour (mph) for the 24-hour period on April 29, 1915. The highest peak gust is 69 mph and was recorded twice in 1981. The first highest peak gust occurred on January 21, 1981, and the second on November 13, 1981. Table 8-3 shows peak gusts recorded at Eureka between 1887 and 1996, for each month of the year. The 50-year return period for a 1-minute average wind speed is 58 mph. The 50-year wind gust speed is expected to be 71 mph (Reference 8-10). Table 8-4 provides the monthly and annual average speeds for a 54-year period through 2001 (Reference 8-11).

Table 8-3 Peak Wind Gusts Recorded at Eureka between 1887 and 1996

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Peak Gust (mph)	69	60	60	62	60	60	60	42	50	50	69	60
Year	1981	1902	1898	1915	1894	1899	1897	1918	1914	1924	1981	1982

Table 8-4 Average Wind Speeds – Monthly and Annual for Eureka (through 2001)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
6.9	7.2	7.6	8.0	7.9	7.4	6.8	5.8	5.5	5.6	6.0	6.4	6.8

Source: Reference 8-11.

The distribution of wind shows 24.3 percent offshore, 57 percent onshore, and 18.7 percent light and variable winds during an average year. The prevailing wind direction is from the north. The greatest variance (as measured by the distribution of the standard deviation) is observed during the wet season. The lowest variance occurs during the dry season (Reference 8-7).

The high variance on wind speed occurs predominantly with the wind from the south, and the lowest variance on wind speed occurs predominantly with the wind from the northwest to northeast sectors (Reference 8-7).

8.4.2.3 Tornados

The Eureka area has rarely experienced tornadoes. Over the period from 1950 through 2004, one tornado was recorded in Humboldt County, California. It occurred on March 29, 1958, at 3:40 p.m. It was classified as an F2 (Fujita scale F0 – F6)

tornado with winds in the 113- to 157-mph range. Property damage was estimated at $3,000 (Reference 8-12). The minimum return period for an F2 tornado is once in 4,000 years at any location in the United States (Reference 8-13) and is expected to be much longer for this area of California.

8.4.2.4 Tropical Storms and Hurricanes

A discussion of tropical storms and hurricanes is not applicable to HBPP because they are not known to have occurred in the area.

8.4.2.5 Precipitation Extremes

The rainy season, generally November through March, accounts for approximately 75 percent of the average annual rainfall of 39.57 inches for the Eureka area. December (7.12 inches) and January (6.86 inches) receive the largest total average accumulations of precipitation. The largest single monthly total precipitation accumulation was 23.31 inches during December 2002. The highest annual total occurred for the year 1983, with a total of 67.21 inches (Reference 8-14). The 1-day highest total precipitation occurred on December 27, 2002, and measured 6.79 inches (Reference 8-15). The average number of days during the year that produces greater than 0.01 inch of rain is 121, but of those 121 days, only 8 days average greater than 1.00 inch. Table 8-5 provides the average annual precipitation by month and the maximum total accumulation of precipitation by month for this same period (Reference 8-16).

Table 8-5 Average Monthly Precipitation and Maximum Monthly Precipitation for Eureka from 1948 to 2006

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average (inches)	6.86	5.32	5.31	3.00	1.69	0.65	0.13	0.34	0.76	2.66	5.73	7.12
Maximum (inches)	13.92	13.95	11.18	11.25	6.05	3.08	1.13	3.42	3.35	13.04	16.58	23.31
Year	1969	1998	1995	2003	1960	2005	1991	1983	1977	1950	1973	2002
Source: Reference 8-16.												

During the 5-month dry season, May through September, there is an average of just 3.57 inches accumulation of precipitation.

July is the lowest month, averaging only 0.13 inch of precipitation (Reference 8-16).

The 39.57-inch average precipitation is among the lowest in the northwestern California coastal areas. This is due to the rain shadow effect of the surrounding hills and the minimal uplift along the immediate west-facing beaches.

8.4.2.6 *Snow and Ice Storms*

Snowfall totals are very low for the Eureka area. The average total snowfall is only 0.3 inch for an entire year. December, January, and February average 0.1 inch of snowfall per month, and the rest of the months of the year average 0.0 inches. The largest annual snowfall recorded for 1948 to 2006 was 3.5 inches, which occurred during 1972 and again in 1989 (Reference 8-14). Using records dating back before 1948, snowfall annual averages were reported as less than 1.0 inch. In 1907, record snows were produced as follows:

- Daily maximum 3.4 inches January 13, 1907
- Maximum storm total 5.9 inches January 12-15, 1907
- Monthly maximum 6.9 inches January 1907 (Reference 8-15)

Snowstorms have minimal impact on the Eureka area, as do ice storms. No further consideration of snow and ice is warranted.

8.4.2.7 *Thunderstorms*

The average number of thunderstorms in the Eureka area was determined to be four per year (Reference 8-16). The thunderstorm frequency is approximately one per month during the wet season (November to March). Damaging hailstorms rarely occur in northern California. The effects of thunderstorms and their accompanying lightning strikes and hailstorms are very small in the HBPP area.

8.4.2.8 *Restrictive Dilution Conditions (Inversions)*

Two types of thermal inversions occur in the HBPP area. Both types of inversion affect the vertical depth of the atmosphere through which pollutants can be mixed. Vertical air movement is important in spreading pollutants through a thicker layer of air. Horizontal air movement is important in spreading pollutants over a wider area. Upward dispersion of pollutants

is hindered wherever the atmosphere is stable, that is, where warm air overlies cooler air below (Reference 8-17).

The first type of thermal inversion, radiation inversion, occurs when the ground cools by thermal radiation, causing a cool air layer near the surface of the ground to extend upward several hundred feet. Radiation inversion in Humboldt County is found in the night and early morning almost daily, but is more prominent from late fall to early spring when there is less sunlight and it is cooler. Radiation inversions tend to last longer into the morning during the winter months than in the summer (Reference 8-17).

The second type of thermal inversion, subsidence inversion, is caused by downward moving air aloft, which is common in the area of high pressure along and off the coast. The air warms at a rate of 5.5°F per 1,000 feet as it descends. Thus, it arrives at a lower height warmer than the air just below and limits the vertical mixing of air. Subsidence inversion often affects a large area and is more common during the summer months. This type of inversion, which occurs from late spring through the early fall, can be very strong and shallow given the cooling of the lower layers from the cool ocean water (Reference 8-17).

The effect of the numerous inversions found to occur in the HBPP area negatively contributes to the air quality. The North Coast Unified Air Quality Management District (NCUAQMD) consists of the three counties of Humboldt, Del Norte, and Trinity. All three counties in the NCUAQMD are currently classified as nonattainment for the California Ambient Air Quality Standards for particulate matter less than 10 microns in aerodynamic diameter (PM_{10}). The main air contamination emission sources in Humboldt County release particulates from ongoing processes such as lumber mill activities (Reference 8-17). By comparison, the impact of the decommissioning of HBPP on the air quality of Humboldt County is expected to be small and of short duration, as discussed in Section 8.5.

8.4.3 Geology and Seismology

8.4.3.1 Geology

Geology is described in Section 6.2.2 of the LTP.

8.4.3.2 Seismology

The HBPP is located in the Coast Ranges Physiographic/Tectonic Province and is within a highly active seismic region that has experienced numerous earthquakes. The geology of the region around the site is very complex, reflecting geologically rapid processes driven by recent (that is, last 10,000 years) tectonics and rapid erosion. The site lies within the Eel River sedimentary basin. The sediments in the basin are young and generally not well cemented, and have been dramatically deformed by tectonics driven by the Cascadia Subduction Zone as it extends from offshore to onshore in the Eureka area. The resulting geologic structures of this zone in the Humboldt Bay region are dominated by north-northwest-trending compressional structures, some of which are reactivated faults that formed during earlier phases of plate convergence that have affected the region since the Late Jurassic. The Mad River Fault Zone and the Little Salmon Fault Zone are major reverse faults that pass near the site. They are active with multiple movements documented during the past 10,000 years.

The HBPP lies within the Little Salmon Fault Zone. The zone has a total length of 59 miles, including offshore traces. The Little Salmon Fault Zone is part of the Little Salmon Fault system of active folds and reverse faults that extends from its intersection with the freshwater fault/Coastal Belt thrust near Bridgeville, northwest to its intersection with the Thompson Ridge Fault off the coast of southern Oregon. The fault system trends parallel to the deformation front associated with the leading edge of the Cascadia Subduction Zone and the Little Salmon fault system is considered to be the southern end of the subduction zone. Four traces of the Little Salmon Fault Zone are mapped near the HBPP site. These include two primary fault traces, the Little Salmon and Bay Entrance Faults, and two subsidiary faults that are in the hanging wall of the Bay Entrance Fault. The subsidiary faults are the Buhne Point Fault and the Discharge Canal Fault.

Based on the analysis of the geologic data from extensive trenching, borehole data, and site mapping, surface-fault rupture does not pose a significant threat to the site. Northern California is a highly active seismic region, and faults near the site have the potential to generate large-magnitude earthquakes. The U.S. Geological Survey has recorded more than 1,200 earthquakes with magnitude greater than 2.0 within 50 miles of the HBPP site between the years of 1974 and 2007. The two largest earthquakes are the only earthquakes that registered a

magnitude greater than 6.5 (one magnitude 7.2 in 1980 and the magnitude 6.7 "Petrolia Earthquake" in 1992) (Reference 8-18). HBPP installed a strong-motion recording network in 1971. Since 1975, the HBPP strong-motion network has recorded six earthquakes with peak horizontal accelerations greater than 0.10g, the greatest of which was the magnitude 5.4 "The Eureka Earthquake" of December 26, 1994, with a reading of 0.55g (Reference 8-19).

On January 9, 2010, the City of Eureka received significant damage from a 6.5 magnitude earthquake centered 20 miles northwest of Ferndale. Damage estimates from this recent earthquake were over $28 million. HBPP, HB-ISFSI, and HBGS experienced minimal damage, and no structural damage was sustained as a result of this event.

Tsunamis are also considered a recognized potential hazard associated with the tectonically active zone along the northwest coast of North America. Historical large-scale earthquakes along the Cascadia Subduction Zone have produced tsunamis that have resulted in minor runups in Humboldt Bay, such as following the 1964 Alaskan earthquake. The offshore bathymetry at Humboldt Bay is smooth and wide, and topographic enhancement of tsunamis is not expected at the site. Using conservative estimates of tsunami runup, the inundation height at the ISFSI site for a M 9 Cascadia subduction zone-generated tsunami would be 21 to 36 feet above MLLW if the tsunami occurred at low tide, or 28 to 43 feet above MLLW if the tsunami occurred at high tide at the site area (Reference 8-19).

8.4.4 Hydrology and Hydrogeology

A detailed discussion of site hydrology and hydrogeology is presented in Chapter 6 of this LTP.

8.4.5 Biota

8.4.5.1 Ecology of the Site

Coastal areas in Humboldt County are part of a complex of dune communities and rocky foothills that evolved in a "fog belt" climate dominated by maritime influences. This entire region is dominated by stands of redwood trees interspersed with areas of coastal prairie. Humboldt County is mostly mountainous except for the level plain that surrounds Humboldt Bay. The coastal mountains extend to the Central Valley. The western half of Humboldt County exhibits representative examples of grassland,

marsh, scrub-shrub, forest, and upland communities in proximity. Gradations of various physical features yield a variety of aquatic and terrestrial microhabitats.

8.4.5.2 Vegetation Patterns at Humboldt Bay Power Plant

Vegetation near the project area primarily consists of disturbed coastal terrace prairie. The site has been disturbed considerably over the operation of HBPP, from initial construction to the ongoing maintenance activities (such as mowing). Most of the species occurring on the site and related project areas are nonnative species, many of which are ruderals (that is, plants that grow in wastelands or disturbed areas). Areas previously cleared of vegetation, such as along the discharge canal, access roads, and parking lots, are dominated by the ruderal species present in the disturbed grassland. The project site is generally not conducive to colonization.

8.4.5.3 Fauna at Humboldt Bay Power Plant

Lists of potential species for the county are extensive. As reported in the HB ISFSI Environmental Report, 71 species of mammals, 32 species of reptiles and amphibians, and more than 250 species of birds may be identified in the vicinity at various times of the year. The majority of birds are common migratory species, residing in the Humboldt Bay area seasonally or for short periods as transients. A limited number of special-status species may occur on or around HBPP.

Near the project area, five special-status species of fish—tidewater goby, Chinook salmon, Coho salmon, steelhead trout, and coastal cutthroat trout—occur or have the potential to occur because of the presence of suitable habitat. Coho and Chinook (King) salmon, and steelhead trout are an important part of the cultural and economic history of the area. Commercial fishing and damming of spawning streams has greatly reduced the reproductive success of the salmon populations. The three species mentioned previously are federally listed species with stringently controlled management strategies intended to protect populations from over-harvesting to numbers below critical reproduction thresholds.

Harbor seals are year-round residents of the Humboldt Bay region. Harbor seals do not have official status as a listed endangered or threatened species, but are protected under the Marine Mammal Protection Act. The seals haul out on tidal flats in areas remote from human activity to rest and bear their young. The Humboldt Bay National Wildlife Refuge in the

southern part of Humboldt Bay is a key breeding and hauling out area used by harbor seals.

The majority of mammals in the vicinity are small and occur in low densities such as mice, rats, voles, and bats. Most prefer wooded areas with access to freshwater and dense cover, neither of which are located onsite. Only a small percentage of mammals, including opossum, various voles, mice, and skunks, are expected to be identified in the area, and virtually none of them on the HBPP site.

8.5 Environmental Effects of Decommissioning

The most significant potential environmental effects of decommissioning activities are associated with radiation exposure, structures demolition, and the disposal of radioactive waste. As described further herein, decommissioning HBPP is anticipated to have a minimal and insignificant adverse environmental impact. Moreover, decommissioning is expected to have significant beneficial impacts, including eliminating the risks associated with a radioactively and nonradioactively contaminated facility.

The adverse effects associated with decommissioning include routine occupational radiation exposure and the commitment of land offsite for radioactive waste disposal. As discussed in the FGEIS, radiation exposure to the public is small, even when accidental airborne radioactive releases are considered. The low-probability, worst-case exposure to an individual from an accident involving a truck transporting radioactive waste to a disposal facility is small.

On the basis of the analysis contained in the FGEIS, PG&E's evaluation of site-specific issues, and the supplemental analysis contained herein, PG&E continues to conclude that Unit 3 decommissioning will be accomplished with no significant adverse environmental impacts.

By implementing the appropriate best management practices (BMP) and mitigating measures to minimize the impacts of decommissioning activities, no unique aspects of the plant or decommissioning techniques will invalidate or alter the following conclusions PG&E made on the basis of the FGEIS:

- Delaying the dismantlement of Unit 3 has resulted in considerable radioactivity decay with resultant reduced potential for significant exposures.
- Potential public and occupational doses are bounded by the FGEIS criteria and have been determined to be insignificant.
- Decommissioning does not constitute an imminent health or safety problem and will generally have a positive environmental impact.

8.5.1 Radiological Effects of Decommissioning

The occupational dose for complete decommissioning of Unit 3 considers; (1) occupational dose received from placing Unit 3 in SAFSTOR and maintaining Unit 3 in SAFSTOR, (2) dose from all occupational activities required for the actual decommissioning of Unit 3 through 2018, and (3) occupational dose due to truck shipments. The occupational dose for Unit 3 decommissioning will meet the regulatory standards in 10 CFR 20 and is, therefore, bounded by the criteria in the FGEIS.

Public dose from decommissioning Unit 3, following 29 years of SAFSTOR, considers direct radiation exposure and exposure due to gaseous and liquid effluents. Direct exposure and effluents in gaseous and liquid discharges are not expected to exceed the design objectives of 10 CFR 50, Appendix I, nor the dose limits in 10 CFR 20 and 40 CFR 190. Therefore, the public dose from Unit 3 decommissioning is bounded by the criteria in the FGEIS.

At the time that HBPP, Unit 3, entered commercial service in 1963, the nuclear fuel assemblies used stainless steel as the fuel rod cladding. The stainless steel-clad fuel experienced gross cladding failures during operation. These failures were severe enough that radioactive materials were released from the cladding and dispersed throughout numerous plant systems, contaminating these systems with alpha emitting radionuclides, such as transuranic elements.

HBPP completed the transition from stainless steel to zircaloy assemblies in 1969. Over the SAFSTOR period, as beta and gamma emitting radionuclides have decayed, alpha has become a more dominant factor in dose contribution. Because alpha causes more severe biological damage when internal exposure occurs, the potential radiological dose consequences are likewise more severe. This issue leads to a unique, plant-specific concern that exists for HBPP decommissioning.

The alpha issue was described in two previous PG&E decommissioning funding assurance report submittals to the NRC: (1) PG&E Letter HBL-03-002, "Decommissioning Funding Reports for Diablo Canyon Power Plant Units 1 and 2 and Humboldt Bay Power Plant, Unit 3," dated March 27, 2003, Enclosure 5 and (2) PG&E Letter HBL-07-002, "Decommissioning Funding Report for Humboldt Bay Power Plant, Unit 3," dated March 30, 2007, Enclosure 3. These enclosures contain cost studies developed by TLG Services, Inc., and state "The extent of the alpha contamination will require additional radiological controls and will reduce the efficiency of component removal activities." HBPP will implement appropriate BMPs and mitigating measures so the alpha

issue will not invalidate NRC expectations nor the conclusions on radiological environmental impacts contained in the FGEIS.

On the basis of the previous discussions, PG&E continues to conclude that Unit 3 decommissioning will be accomplished with no significant adverse environmental impacts, and will be accomplished because of the following factors:

- By implementing appropriate BMPs and mitigating measures to minimize the impacts of decommissioning activities, there are no unique aspects of the plant (including alpha) or decommissioning techniques that would invalidate or alter the conclusions of the FGEIS.
- Delaying the dismantlement of Unit 3 following 23 years of SAFSTOR has resulted in considerable radioactivity decay with resultant reduced external dose rates and lower occupational deep dose equivalent exposure.
- Public and occupational doses are bounded by the FGEIS criteria.
- Radiation dose to the public will be minimal.
- Decommissioning does not constitute an imminent health or safety problem and will generally have a positive environmental impact.

8.5.1.1 Offsite Radiation Exposure and Monitoring

Since 1986, the radiological characteristics of the HBPP site have been evaluated as part of PG&E's SAFSTOR Radiological Environmental Monitoring Program (REMP). PG&E submits annual REMP reports that contain results of both onsite and offsite sampling conducted under the REMP. Annual reports indicate that direct radiation from all sources was below the 40 CFR 190 limits at the HBPP site.

8.5.1.2 Environmental Effects of Accidents and Decommissioning Events

Hazardous materials handling and transportation for the project is regulated and controlled by numerous state, federal, and local agencies. The regulations for handling hazardous materials are sufficiently stringent to render the potential for release to the environment from spill or accidental breach of containment as less than significant. Modern engineering designs for containment and proven BMPs and standards of care will minimize any accidental release of hazardous waste, whether within the project boundary or in transit to a disposal facility. Characterization and disposal planning for radiological hazardous waste removal and transportation has been underway for nearly a decade at HBPP. The following HBPP

decommissioning accidents, as described in the Defueled Safety Analysis Report, Appendix A, were previously analyzed for their impact on the environment:

- Dry active waste (DAW) fires
- Explosion of liquid propane gas (LPG) leaked from front end loaders
- Vacuum filter bag ruptures
- Contamination control envelope ruptures
- Oxyacetylene explosions
- Filter damage from a blasting surge
- Detonation of unused explosives
- Minor transportation accidents
- Severe transportation accidents
- HEPA filter fires
- Loss of HEPA filtration

The FGEIS conclusion on the potential impacts of radiological accidents resulting from decommissioning activities states that, "with mitigation procedures in place, the impacts of radiological accidents are neither detectable nor destabilizing. Therefore, the NRC staff makes the generic conclusion that the impacts of non-spent fuel-related radiological accidents are small." For radiological assessments, impacts are of small significance if the total effective dose equivalent (TEDE) to a member of the public does not exceed the U.S. Environmental Protection Agency 400 Manual protective action threshold of 1 rem, a small fraction of the limit established in 10 CFR 100.

Overall impacts from hazardous materials will not be significant, given the level of preparation, control, and regulation that exists at the site for these types of materials.

8.5.1.3 Storage and Disposal of Low-level Radioactive Waste

Regulations that apply to the transportation of hazardous, mixed-waste, and radioactive material promulgated by the U.S. Department of Transportation are contained in 49 CFR 171-177. NRC regulations related to transportation of low-level waste are contained in 10 CFR 71, "Packaging and Transportation of Radioactive Material." These regulations contain requirements for transport vehicles, maximum radiation levels for packages and vehicles, special packaging requirements, driver training,

vehicle and packaging inspections, marking and labeling of packages, placarding of vehicles, and training of emergency personnel to respond to mishaps. Highway routing restrictions for certain shipments of low-level radioactive waste (LLRW) are also included in U.S. Department of Transportation regulations. NRC regulations contain performance requirements for certain types of transportation packages of radioactive material. In addition, federal and state regulations govern the size and weights of trucks. NRC assumes that equipment, materials, and waste transportation are conducted within applicable regulations.

On the basis of the nuclide concentrations, LLRWs are classified as Class A, Class B, or Class C. Waste above Class C levels is called "greater than Class C" (GTCC). It requires greater confinement disposal and is not suitable for near-surface disposal. HBPP GTCC waste is to be stored in its own container within the ISFSI facility until a geologic repository is available.

Wastewater, solid nonhazardous wastes, and liquid and solid hazardous wastes will be generated during project activities. All solid and liquid wastes generated at the project site must be classified as either hazardous or nonhazardous.

For the demolition of Unit 3, the demolition contractor, PG&E's radiological protection group, and/or PG&E's environmental coordinator will oversee the classification of the waste generated at the project site and will provide information needed to identify the appropriate disposal facility.

PG&E has additionally prepared a waste management plan for Unit 3 decommissioning, which is focused on managing radiological wastes.

Waste generated during the demolition of Unit 3 will fall into one of the following seven categories (All demolition debris from Unit 3 is assumed to be potentially radioactively contaminated and is included in volume estimates listed for regulated wastes):

- Radiologically contaminated waste
- Mixed waste (both radiological and hazardous constituents)
- Nonhazardous construction debris
- Universal waste
- Non-Resource Conservation and Recovery Act (RCRA) hazardous

- RCRA hazardous
- Toxic Substances Control Act-regulated material

An estimated 64,200 m^3 of LLRW will be generated in association with demolition activities for Unit 3. This amount exceeds the waste quantity evaluated in the FGEIS of 18,000 m^3 for a BWR under the SAFSTOR option. This exceedence is primarily caused by three factors:

- The subgrade configuration of the plant and seismicity of the area are believed to have caused additional soil contamination beyond that typically encountered at a BWR.
- The extensive siltation within the discharge canal has added to the projected amount of low-level radioactive waste. and;
- Leakage from the Spent Fuel Pool, volumetric activation of concrete and tritium migration; and the proximity of these to the caisson has driven the decision to completely remove the caisson structure.

The same land usage justification applied in arriving at the FGEIS value was used herein. Since the total quantity of project generated radioactive waste to be disposed of can be accommodated on less than 8 acres of disposal space and since 8 acres is small in comparison with the 143 acres to be released with the termination of the site's 10 CFR 50 license; the overall environmental impact is reduced by performing the decommissioning project.

Additionally, all Unit 3 demolition debris was assumed to be potentially radioactively contaminated for the estimating the volume. The Unit 3 project may result in some generation of clean debris that will be managed similarly to fossil unit (Units 1 and 2) clean debris. All Unit 3 wastes will require intensive screening and characterization.

8.5.1.4 Spent Fuel Storage

PG&E has completed transfer of all spent nuclear fuel to the ISFSI. The storage of spent fuel in casks at the ISFSI is based on an in-ground design that results in no detectable radiation doses to the offsite population. The closest point that an offsite member of the public may access (such as via the public trail) is 53 feet from the ISFSI, and the nearest resident is approximately 800 feet away. Onsite members of the public (security force) are within proximity to the ISFSI vaults and are

also receiving no detectable dose. The multi-purpose canisters are seal-welded and, therefore, are considered leak tight, so that no leakage is expected during normal operation, off-normal conditions, or design basis accidents.

8.5.1.5 Radiological Criteria for License Termination

Chapter 6 of this LTP, "Compliance with the Radiological Criteria for License Termination," provides the methodology for achieving unrestricted release of the HBPP site. Following decommissioning, residual radioactivity will be limited to 25 mrem/year and ALARA from all potential exposure pathways to the average member of the critical group (Resident Farmer).

8.5.2 Nonradiological Effects of Decommissioning

The following subsections provide an assessment of the nonradiological impacts of decommissioning and site release. The planned decommissioning activities were compared against the matrix in Table E-3 of Supplement 1of the FGEIS, to aide in the screening of potential environmental effects.

8.5.2.1 Onsite/Offsite Land Use

The project will be located within the boundary of the existing HBPP in an area used for power generation, and does not conflict with existing onsite uses. Impacts associated with establishing temporary access to the project area also will not affect existing land use.

Prime agricultural land lies about 2,500 feet east of the project site along the Elk River. The decommissioning project will not result in conversion of any prime farmland to nonagricultural use.

8.5.2.2 Water Use

Water usage by HBPP is described in Chapter 1, Section 1.1.4.2.

8.5.2.3 Water Quality

Decommissioning activities already performed include the removal of the intake pumps on the intake channel where HBPP previously drew its cooling water. As a result of the HBGS, PG&E has discontinued the use of the intake cooling water system. Thus, discharge of elevated temperature cooling water to Humboldt Bay has ceased and results in a positive impact on water quality to Humboldt Bay in the area of the existing discharge.

Some of the soil encountered during demolition of Units 1 and 2 is impacted with nonradiological contaminants. That soil was removed to achieve conditions suitable for preparing a laydown area for Unit 3 and, as necessary, to protect groundwater quality. During removal, soil and groundwater analyses were conducted. All soil was handled and, if necessary, transported offsite in accordance with the applicable California State guidance.

During the demolition period, sanitary waste will be collected either in portable toilets supplied by a licensed contractor for collection and disposal of sanitary wastes or be discharged to the existing sanitary sewer system.

In January 2010, PG&E filed an amended report of liquid radioactive waste discharge with the North Coast Regional Water Quality Control Board to authorize continued discharges to the discharge canal following cessation of cooling water from Units 1 and 2. PG&E has monitored the impact that decreasing dilution has had with regard to increasing concentrations of radionuclides in the discharge canal. PG&E continues to evaluate this impact and has determined the impacts can be mitigated to less than significant. Radiological impacts on Humboldt Bay environment are mitigated by the total flow of water from the discharge canal to Humboldt Bay and by the bay dilution factor, which was not previously credited. The Offsite Dose Calculation Manual (OCDM) (Reference 8-20) includes consideration of the nearfield dilution and point of discharge to Humboldt Bay. The comprehensive evaluation of cooling water dilution impacts versus tidal dilution are contained in Humboldt Procedure TBD-208, Revision 0, "Outfall Canal Dilution Factors." There is consideration of the nearfield dilution in the ODCM. Radioactive liquid discharges through this pathway are expected to cease by the end of 2013.

A temporary treatment system has been installed to manage groundwater and surface water associated with excavations, runoff, and other sources.

8.5.2.4 Air Quality

Maximum daily and annual construction emissions were estimated for demolition of Units 1, 2, and 3 utilizing computer codes. Construction equipment emission factors from URBEMIS2007 (Version 9.2.4) and vehicle emission factors from EMFAC2007 (Version 2.3). PM_{10} emissions from soil disturbance were quantified using the grading emission factor in URBEMIS2007 (Version 9.2.4).

Re-entrained road dust emissions were estimated using AP-42[1] (Reference 8-21). Demolition activities for the above grade structures of Units 1 and 2 were expected to occur over a 12- to 14-month period. Table 8-6 shows annual emissions that represent the sum of the 12-month period with the highest emissions. This estimate provides a conservative, worst-case scenario that represents the maximum total emissions expected to occur over a 1-year period during the course of the decommissioning activities. The remaining demolition activities for Unit 3 will occur over approximately 6 years. Emissions associated with Unit 3 demolition are expected to be comparable to the maximum total emissions for Units 1 and 2. Unit 3 demolition and decommissioning emissions associated with Unit 3, like those experienced for Units 1 and 2, will be short term and are not expected to result in an air quality impact. It is expected that demolition equipment will be operated in accordance with manufacturer's specifications, which will prevent increased exhaust emissions caused by engine malfunctions. Furthermore, the decommissioning includes the use of BMP to control fugitive dust during demolition and decommissioning activities. Therefore, demolition activities will not be expected to cause a violation of an air quality standard, and the air quality impact will be less than significant.

Table 8-6 Maximum Daily and Annual Emissions Units 1 and 2

Construction Emissions	Emissions					
	NO_x	CO	VOC	SO_2	PM_{10}	$PM_{2.5}$
Maximum Daily Emissions (pounds per day)	102	46	12	0.1	39	8
Maximum Annual Emissions (tons per year)	10	5	1	0.01	2	0.4

Notes:
The maximum annual emissions represent the 12-month period with the highest emissions. These emissions occur during the Unit 2 demolition.

CO = carbon monoxide
$PM_{2.5}$ = particulate matter less than 2.5 microns in aerodynamic diameter
PM_{10} = particulate matter less than 10 microns in aerodynamic diameter
NO_x = nitrogen oxide

[1]AP-42 is U.S. Environmental Protection Agency's compilation of air pollution emission factors. An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant.

SO_2 = sulfur dioxide
VOC = volatile organic compound

8.5.2.5 *Aquatic Ecology*

Aquatic ecology concerns at the HBPP site are primarily limited to the coastal wetlands described in the following subsections. Decommissioning activities do not require alteration of the natural shoreline and will not result in the substantial alteration of any river or stream. Potential impacts associated with decommissioning are minor because plant water usage and discharge quantities are greatly reduced.

Decommissioning activities will have limited impacts on coastal wetlands that are under jurisdiction of the CCC. Numerous wetlands surveys have been conducted at the site, the extent of wetlands is known, and protection of these wetlands is always a high priority. Some decommissioning activities will have minor impacts on coastal wetland areas, but BMPs and mitigation will minimize the impacts to an insignificant level. PG&E works closely with the CCC to ensure that proper avoidance, minimization, and mitigation are in place for each phase of decommissioning work.

8.5.2.6 *Terrestrial Ecology*

Much of the HBPP site is heavily disturbed, paved, or covered in rock and large riprap. The terrestrial ecology of the site was characterized in the Coastal Resource Assessment (Reference 8-2) prepared by PG&E in 2009, and has been studied significantly over the past decade. As previously mentioned, some decommissioning activities will have minor impacts on terrestrial habitat.

8.5.2.7 *Threatened and Endangered Species*

Surveys for special-status plants were conducted during several site visits to the project area during May and June 2009. No special-status plants were observed onsite, and none with blooming dates outside of the May/June survey window would be expected to occur. One population of Humboldt Bay owl's clover (*Castilleja ambigua* ssp. *humboldtiensis*) was found adjacent to HBPP. Although potential habitat is present in two small tidal salt marshes, no potential habitat is present in the HBPP work area. Similarly, known populations of Point Reyes bird's beak (*Cordylanthus maritimus* ssp. *palustris)* are adjacent to HBPP, but not in the work area.

A California Department of Fish and Game Species of Special Concern may be present at HBPP, the northern red-legged frog (*Rana aurora aurora*) has periodically been observed on and around the project area, and the site does include suitable foraging habitat. The northern red-legged frog is known to occur in a variety of habitats, including freshwater wetlands and brackish areas where the frogs use vegetation for cover and forage.

Site personnel receive instruction on how to gently relocate the frogs and, if necessary, contact the site's wildlife conservation officer for assistance.

Occurrence of the bald eagle *(Haliaeetus leucocephalus)* is unlikely at the project site, with the exception of potential foraging in the discharge canal. No roosting or nesting habitats are onsite. Osprey (*Pandion haliaetus*), double-crested cormorant (*Phalacrocorax auritus*), great egret (*Ardea alba*), California brown pelican (*Pelecanus occidentalis californicus*), and the great blue heron *(Ardea herodias)* have been observed flying and foraging in and around HBPP, but none of the birds has nesting habitat within 1 mile of the site.

Prior to any demolition activities during the breeding/nesting bird season (February through August), a biologist will survey the area for ground-nesting birds (no trees will be affected). If demolition activities occur during nesting season (typically March through August), take of nests and young could occur. To avoid and minimize impacts on nesting birds, nesting substrate for songbirds (taller plants) is proposed to be removed outside of the nesting season (non-nesting season typically September through February) as much as possible before demolition activities begin. A biologist will conduct predemolition surveys and monitor the site as necessary for bird-nesting activities beginning late February prior to site clearing and grading. In accessible areas, nest materials will be removed if no eggs have been laid. If an active nest is found in demolition areas that cannot be postponed, or if a nest is found in construction equipment (occasional when equipment is left undisturbed for a period of time), a biologist will coordinate with California Department of Fish and Game to collect the eggs and young, and deliver them to a wildlife rehabilitation center for rearing and eventual release.

8.5.2.8 Occupational Safety

PG&E personnel, their consultants, and contractors strive to meet the project-specific health, safety, and the environment

(HSE) goals. PG&E has developed and maintains a Code of Safe Practices describing how all employees are expected to conduct themselves on the job. The code is not all-inclusive, but intended as a general foundation to safe behavior. The company's Safety and Health Program Standard Practice, SAFE 1001S, procedures, work processes, and job expectations lay out the specific roles and responsibilities.

The Code of Safe Practices was developed by PG&E in collaboration with the local labor unions. All employees are responsible for reviewing and following the code. In addition to the Code of Safe Practices, site-specific and job-specific training are performed regularly, and health and safety expectations are integral to all work procedures and operations.

HBPP received the Shermer L. Sibley award for safety performance for three consecutive years 2008, 2009, and 2010. It is the highest safety award presented by the PG&E Central Safety Advisory Committee. The award is based on safety performance, including the absence of injuries, a functioning safety committee, in-house safety audits and inspections, housekeeping, and appropriate safety procedures.

The PG&E safety program complies with California Occupational Safety and Health Administration (Cal/OSHA) regulatory requirements and provides the basis for controlling safety during decommissioning activities. Compliance with Cal/OSHA regulations and with the guidance provided to each worker, contractor, and visitor to the site is a top priority of site management and employees.

8.5.2.9 Cost

A detailed discussion of site project costs is presented in Chapter 7 of this LTP.

8.5.2.10 Socioeconomics

There are two primary pathways through which nuclear power plant activities create socioeconomic impacts on the area surrounding the plant. The first is through expenditures in the local community by the plant work force, and direct purchases of goods and services required for plant activities. The second pathway for socioeconomic impact is through the effects on local government tax revenues and services. When a nuclear power plant is closed and decommissioned, most of the socioeconomic impacts will be associated with the plant closure rather than with the decommissioning process.

Impacts caused by closure of the nuclear plant were felt many years ago when the plant was initially shut down. Since that time, numerous jobs have been created by decommissioning activities at the site as well as the construction of the HBGS. It is anticipated that the socioeconomic impact of decommissioning activities will have a net positive impact on the local economy as the decommissioning proceeds through 2019 and a negative impact thereafter.

8.5.2.11 Environmental Justice

Environmental justice considerations are not significant for the decommissioning activities at HBPP beyond those already considered in the FGEIS.

8.5.2.12 Cultural, Historical and Archaeological Resources

California Energy Commission (CEC) staff declared that the entire property consisting of Units 1, 2 and 3 should be considered significant under the California Environmental Quality Act as a historic district. Consequently, the impact of demolition on Units 1, 2, and 3 will be significant, and mitigation will be required.

To mitigate the effects of demolishing Units 1, 2, and 3, a Historic American Building Survey (HABS)/Historic American Engineering Record (HAER) program has been initiated to document the properties individually and as a historic district. The program is being conducted in accordance with HABS/HAER guidelines established by the National Park Service to document historic places. Documentation produced through HABS/HAER, and related programs, constitutes the nation's largest archive of historic architectural, engineering, and landscape documentation. Once this documentation has been completed in accordance with federal standards, mitigation of the effect will have been accomplished.

PG&E submitted the CUL-10 Historic Properties Mitigation Plan for CEC review in August 2009, also a Cultural Monitoring Study is scheduled for completion in May, 2013. PG&E will continue to monitor for and take proactive measures to mitigate any project impacts to cultural, historical and archaeological resources.

8.5.2.13 Aesthetic Issues

Project demolition will be visible from places along public roadways including King Salmon Avenue and U.S. Highway 101 and the shoreline trail; the temporary access roads,

laydown areas, staging areas, and storage areas will likely be most noticeable when seen at close range along a limited segment of King Salmon Avenue. Cars or other vehicles parked at the two remote parking sites will also be visible along King Salmon Avenue. Views will be limited with respect to both duration and visibility, and will be consistent with the past and current industrial nature of the site.

The number of affected shoreline trail viewers and Humboldt Hill viewers is low. Additionally, the views of HBPP from the South Spit and Samoa Peninsula viewpoints are at such a distance that HBPP is not highly visible. Therefore, because of the relatively low use of these recreational areas and the distance of these viewpoints from the site, the resulting aesthetic impact will be minimal.

After the project is complete, the site will be restored to a more natural setting. Restoration of the project site will have a beneficial impact on the aesthetics of the site, after demolition is finished.

8.5.2.14 Noise

The nearest receptors include the following locations:

- King Salmon Community: a small community located less than 0.25 mile south of the project site
- South Bay Elementary School: located approximately 0.25 mile east of the existing facility
- Sea View Mobile Estates: a senior citizens' mobile home park approximately 0.5 mile from the project site

HBGS is a primary contributor to the existing ambient noise at the nearest receptors, particularly at night. During the day, the plant is not discernible from traffic on U.S. Highway 101 at locations east of U.S. Highway 101. The plant is audibly absent local vehicular traffic during both the day and night at King Salmon Dock. Ambient noise levels near the HBPP project site are consistent with routine operation of the power plant.

Demolition activities for Unit 3 are planned to be primarily performed on a flexing schedule with alternating 4-day weeks, at 10 hours per day. One week will run from Monday through Thursday from 7:00 a.m. to 5:30 p.m., and the following week will run from Tuesday through Friday from 7:00 a.m. to 5:30 p.m. Although construction activities associated with the demolition project will be audible from adjacent recreational trails, the decommissioning activities will not significantly

increase ambient noise levels. Occasionally work may need to be performed on weekends or during hours outside the 7:00 a.m. to 5:30 p.m window.

It is expected that heavy construction and demolition activities may be the greatest impacts on ambient noise posed by the decommissioning project. PG&E will inform the potentially affected community members prior to commencement of these work activities.

8.5.2.15 Irretrievable Resources

Irreversible commitments are commitments of resources that cannot be recovered, and irretrievable commitments of resources are those that are lost only for a period of time. The irreversible and irretrievable commitments of resources that are anticipated during the decommissioning process are similar to those that were considered in the FGEIS.

8.5.2.16 Traffic Transportation

Potential traffic impacts primarily result from project staff traveling to and from the site, as opposed to truck traffic. Workers travel to the site at generally the same time in the morning and travel from the site at generally the same time in the evening. Truck traffic associated with hauling project-related materials and waste will be coming and going at different times throughout the day and will have less impact on peak volumes.

Peak traffic volume on affected roads will occur prior to initiation of major project activities associated with the decommissioning project and were associated with the highest contractor activity levels directly related to construction of the HBGS. The HBGS was fully evaluated and was permitted with Traffic Control Plans (TCPs) in place to mitigate potential impacts. Following the construction of the HBGS, traffic volumes have decreased steadily through 2010, with the decreased construction worker demand.

Truck traffic associated with the proposed project is expected to peak in calendar years 2015 and/or 2016 with 100 shipments per month during the peak of caisson demolition and discharge canal and intake canal remediation. This traffic volume is less than traffic associated with workers traveling daily to and from the site.

A TCP will be developed and implemented as necessary to mitigate traffic-related impacts. The North Access Road will allow one-way truck traffic through the site and provide a

0.6-mile controlled staging lane into the site. In addition to mitigating the potential for truck backup on King Salmon Avenue, the North Access Road will significantly decrease the volume of truck traffic through affected intersections by nearly 50 percent.

8.5.2.17 Sub-surface Slurry Wall

In order to isolate and control groundwater within a portion of the Unit 3 footprint, a slurry bentonite wall down to the Unit F clay layer is proposed to be constructed to be consistent with Figure 8-4 and as described in the PG&E HBPP Decommissioning Capstone document (Reference 8-22). The wall will extend to a depth of 185 feet below grade. This is proposed as a method to facilitate the complete removal of the reactor caisson and spent fuel pool (SFP) structural foundations and substructure.

Upon slurry wall completion, dewatering wells or well points will be installed to allow for the removal of groundwater to a level beneath the SFP and, later, the reactor caisson itself. Once in place, the dewatering system must be maintained continuously to keep groundwater levels below the elevation of any active excavations that are part of the nuclear decommissioning subgrade demolition tasks.

In preparation for the installation of the slurry wall, several geotechnical borings were made to verify the top of the so-called "Unit F," which is a thick clay layer at about minus 170 foot elevation. This is necessary to ensure that the slurry wall is designed to "lock" into the impermeable clay, allowing for groundwater control during subgrade work within the slurry wall.

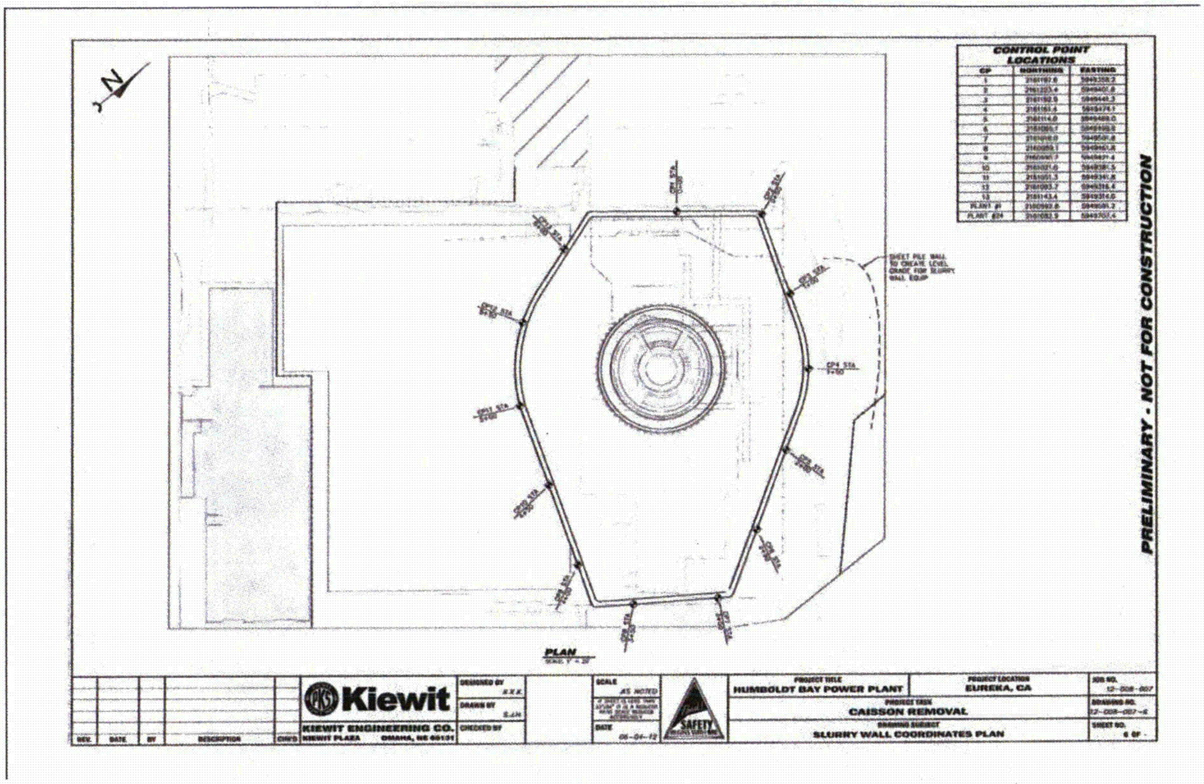


FIGURE 8-4 PROPOSED SLURRY WALL

Humboldt Bay Power Plant License Termination Plan
PG&E Humboldt Bay Power Plant Eureka, California

Removal of the central portion of the reactor caisson will be conducted upon installation of sheet or other piling to act as ground support from the bottom of the SFP, to the bottom of the caisson. Ring beams or other restraint systems installed around the circular piling system will provide structural stability as the excavation proceeds to depth, with the caisson being removed as the site is excavated, in a top-down manner. Upon removal of the reactor caisson, the resulting excavation will be backfilled to the surface, and all removable ground support structures will be removed as part of the project.

The slurry wall itself will be made of radiologically clean material and will remain in place after license termination. The continuing presence of the slurry wall will have minor effect on groundwater flow within the extent of the Unit 3 footprint, and is expected to have a limited impact on site hydrology of the HBPP footprint. This is described in the Assessment of Hydrologic Impacts Associated with Slurry Wall Installation (Reference 8-23).

8.5.2.18 Intake and Discharge Canal Remediation

Work in both the intake and discharge canals will require some sort of water control structure. Remediation of contaminated sediment and soils in a wetland and coastal condition includes installation of a cofferdam or temporary water control structure to prevent influx of water from Humboldt Bay and other water during excavation and FSS activities. These water control structures will remain in place until work is substantially complete and stormwater, groundwater, and liquid from dewatered sediment will be managed through the groundwater treatment facility.

The outfall pipes to the Bay include asbestos-containing materials that will require special handling and disposal. Additionally, the sediments in the canal contain radiological and nonradiological contaminants. Permits and restrictions on work in wetlands will dictate how this remediation work scope is performed. These permit applications, which are yet to be prepared, must be submitted for approval. This scope of work includes 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 structures, restoration of levee and coastal trail along the Bay, management and dewatering of contaminated sediments, and water treatment to meet discharge permit requirements. Removal of approximately 23,600 and 182,400 cubic feet of waste materials from the Intake and Discharge Canals, respectively, is estimated. The removal of the contaminated sediments is expected to have a positive impact on the local environs.

8.5.2.19 Subgrade Pilings beneath Units 1, 2 and 3

PG&E plans to remove subgrade sheet piling and timber pilings beneath Units 1, 2, and 3. This task would occur concurrently with excavations to remove any contaminated soils and/or to remove commodities at the locations and would involve significant subgrade work. While technically feasible, challenges posed by this task include groundwater control, large volumes of soil requiring removal, and ground control around the work area. The removal of the creosote pilings is expected to have a positive impact on the environment.

8.5.2.20 Final Site Restoration

This activity includes development of site grading and drainage, placement of ground cover including vegetation and other

surfacing, road construction and repairs, installation of fencing and site lighting, and other final site development work to achieve the required end state condition for PG&E's future industrial use. This activity includes demolition of remaining miscellaneous structures to support final site restoration plans. The parcel containing the restoration area is approximately 102 acres. The main features of this scope of work include removal of buried asbestos containing materials; demolition of reinforced concrete settling basins, truck ramp, and associated piping; soil excavation, backfilling, and compaction; wetlands construction; finish grading; storm drain system installation; topsoil placement; vegetation establishment; installation of erosion control features; ground cover installation; final surfacing; and removal of portal monitors and truck scales.

The goal of the final site restoration work is to prepare areas of the site for continued use by PG&E operations, including ISFSI security, transmission, substation distribution and the HBGS. Additionally, to compensate for natural resource impacts from the original construction of the HBGS and completion of decommissioning, PG&E is committed to restore specific areas of the site to preconstruction conditions. The final restoration plans for the decommissioned HBPP site will require approval by the CCC.

There are several Coastal Development Permits that establish conditions or require approval of plans for the final restoration of the site. Additionally, certain conditions of the CEC decision on the HBGS Application for Certification establish conditions for final restoration of the HBPP property. Site restoration is considered a positive impact when completed with very minor impact during the restoration process.

8.6 Overview of Regulations Governing Decommissioning Activities and Site Release

8.6.1 Federal Requirements

Federal requirements for decommissioning of the HBPP nuclear site are numerous. Additional requirements from the State of California and other public agencies are also extensive. The following information provides an overall summary of the applicable regulations, but is not intended to be all-inclusive.

8.6.1.1 Nuclear Regulatory Commission

The lead agency for the overall 10 CFR 50 license termination project is the NRC. The NRC has jurisdiction over the handling

and disposition of radiologically contaminated materials associated with decommissioning Unit 3. The NRC also regulates the radiological exposure to decommissioning workers and the members of the public, both on and off of the HBPP site. The NRC has authorized PG&E to commence decommissioning activities in accordance with its PSDAR. The NRC will continue to monitor progress of the project through regular updates of the PSDAR, inspections by regionally based NRC inspectors, and regular correspondence with PG&E.

8.6.1.2 U.S. Environmental Protection Agency

The U.S. Environmental Protection Agency regulations are outlined in Title 40 CFR and apply as follows:

- Part 61 – Asbestos Handling and Removal
- Parts 122 through 125 – National Pollutant Discharge Elimination System
- Part 141 – Safe Drinking Water Standards
- Part 190 – Radiation Protection Standards for Nuclear Power Operations
- Parts 260 through 272 – RCRA
- Part 280 – Underground Storage Tanks
- Part 761 – Polychlorinated Biphenyls (PCBs)
- Parts 129 through 132 – Clean Water Act

8.6.2 State and Local Requirements

8.6.2.1 California Coastal Commission

The CCC has oversight for the decommissioning because the site is located within the coastal zone. In accordance with Section 30600(a) of the California Coastal Act, any person wishing to perform or undertake any development in the coastal zone, in addition to obtaining any other permit required by law from any local government or from any state, regional, or local agency, shall obtain a Coastal Development Permit (CDP).

The decommissioning activities constitute development under Section 30106, which provides in part that development includes "construction, reconstruction, demolition, or alteration of the size of any structure...."

Although Humboldt County has a certified coastal program and is typically the lead agency for issuing a CDP for development in the coastal zone within Humboldt County, the CCC has

retained CDP jurisdiction for the area encompassing the HBPP property. Therefore, the CCC is the lead permitting agency for the CDP. The Energy and Ocean Resources division of the CCC issued the CDP for decommissioning and demolition on December 10, 2009. The CDP process is, by statute, functionally equivalent to the environmental review process required under the California Environmental Quality Act.

8.6.2.2 California Occupational Safety and Health Administration

Worker health and safety protection in California is regulated by Cal/OSHA. These regulations include requirements for respiratory protection, hearing, illumination, scaffolding, crane and rigging safety, chemical usage and release response, and cleanup operations. PG&E, along with their consultants, contractors, and visitors to the site, are required to have appropriate training and equipment to work within the Cal/OSHA guidelines, and are committed to site safety.

8.6.2.3 Regional Water Quality Control Board – National Pollutant Discharge Elimination System Permit and Construction Stormwater Permit

The Regional Water Quality Control Board provides oversight for the decommissioning activities that involve discharge, dewatering, stormwater, or other potential water quality issues.

8.6.2.4 Department of Toxic Substances Control

In accordance with the California Health and Safety Code, Division 20, Chapter 6.65, DTSC has been designated as the state's administering agency responsible for overseeing site investigation and remedial actions. A Voluntary Cleanup Agreement, established pursuant to California Health and Safety Code, Division 20, Chapter 6.8, is anticipated for the project and will determine the regulatory procedure for final site remediation.

Throughout the decommissioning and site remediation process, various documents have been and will continue to be submitted to DTSC for their review and approval. These include an Interim Measures Removal Action Work Plan, approved by DTSC in December 2009, which summarized procedures for handling and disposing of excavated soil generated as a result of decommissioning activities. PG&E will also submit ecological and human health risk assessment reports, and a removal action work plan and/or remedial action plan that will

evaluate remedial options for soil and groundwater and provide details on the selected remedial solution

8.6.2.5 *California Energy Commission*

Although the CEC does not have any direct involvement with the decommissioning, the CEC conducted an environmental review and issued a license for the HBGS adjacent to the project site. Conditions of the CEC license may limit or otherwise affect certain activities associated with decommissioning. Activities that may require coordination with CEC include, but are not limited to, the following:

- Documentation of historical resources within Units 1, 2, and 3
- Any use or expansion of the wetland mitigation areas established for the HBGS project
- Use or modifications to the temporary access road, parking, and laydown areas constructed for the HBGS

Any decommissioning activities that are inconsistent with the conditions of the CEC license for HBGS will not be allowed without approval of the CEC.

8.6.2.6 *Humboldt County*

The Humboldt County building division will require that PG&E secure demolition permits for certain qualifying activities, including dismantling of buildings and other structures. Additionally, any grading involving disturbance of 50 or more cubic yards of soil will require a grading permit from Humboldt County.

8.6.2.7 *City of Eureka*

The HBPP sanitary sewer is connected to the City of Eureka's Elk River Wastewater Treatment Plant. Discharges of process wastewater to the sanitary sewer are prohibited, unless authorized by a pretreatment permit issued by the City of Eureka.

8.6.2.8 *North Coast Unified Air Quality Management District*

NCUAQMD requires notification and subsequent authorization for asbestos work pursuant to 40 CFR 611, Subpart M (National Emission Standards for Hazardous Air Pollutants). Both an asbestos abatement notification and a demolition (renovation) activities submittal may be required for decommissioning.

8.7 Conclusion

Chapter 8 documents an assessment of the environmental effects of decommissioning the HBPP. The assessment has determined that the environmental effects from decommissioning HBPP are being minimized to the extent practicable and no adverse effects are outside the bounds of those described in the FGEIS. Chapter 8 provides supplemental information to the July 1984 Environmental Report.

8.8 References

8-1 U.S. Nuclear Regulatory Commission NUREG-0586, "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities Supplement 1 Regarding the Decommissioning of Nuclear Power Reactors," November 2002.

8-2 Pacific Gas and Electric Company (PG&E), "Project Description and Coastal Resource Assessment – Humboldt Bay Power Plant Decommissioning and Demolition of Fossil Units 1 and 2 and Nuclear Unit 3," August 2009., also amended CDP E-09-010 for the Spent Fuel Pool and Reactor Caisson Removal Project, January 2013.

8-3 U.S. Nuclear Regulatory Commission Regulatory Guide 1.179, "Standard Format and Content of License Termination Plans for Nuclear Power Reactors," January 1999.

8-4 U.S. Nuclear Regulatory Commission NUREG-1700, Revision 1, "Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans," April 2003.

8-5 U.S. Nuclear Regulatory Commission NUREG-1757, Volume 1, Revision 1, "Consolidated NMSS Decommissioning Guidance Decommissioning Process for Materials Licensees," September 2003.

8-6 Pacific Gas and Electric Company (PG&E), "Humboldt Bay Independent Spent Fuel Storage Installation (ISFSI) Environmental Report," December 2003.

8-7 Pacific Gas and Electric Company (PG&E), "Environmental Report for HBPP Decommissioning," July 1984.

8-8 Friends of the Dunes. 2002. Map for Figure 8-3 used with permission. Available at: http://www.friendsofthedunes.org/resources/image/map.pdf.

8-9 Western Regional Climate Center, 2009, "Historical Climate Data Summaries for the Eureka, California Station." Available at: http://www.wrcc.dri.edu/CLIMATEDATA.html. Accessed July 15, 2009.

8-10 Pacific Gas and Electric Company (PG&E), "Final Safety Analysis Report Update – Humboldt Bay Independent Spent Fuel Storage

Installation," Section 2.6.3.3 Rev 0, January 2006, PG&E Letter HIL-06-001, NRC Docket No. 72-27.

8-11 National Oceanic and Atmospheric Administration, "NOAA Recorded Average Wind Speed Data through 2001." Available at: http://www.berner.com/sales/energywindspeed.html. Accessed August 22, 2008.

8-12 Golden Gate Weather Services, "California Tornado Statistics." Available at: http://ggweather.com/ca_tornado2.htm, Accessed August 19, 2008.

8-13 American Meteorological Services, "J3.6 A Hazard Model for Tornado Occurrence in the United States," extended abstract, Cathryn L. Meyer, Harold E. Brooks, and Michael P. Kay, January 2002.

8-14 Western Regional Climate Center, "Eureka WSO City, California Period of Record General Climate Summary – Precipitation." Available at: http://www.wrcc.dri.edu/cgi- bin/cliGCStP.pl?caeure. Accessed August 20, 2008

8-15 National Weather Service, "Eureka, CA – National Weather Service Station Records as of October 2003." Available at: http://www.wrh.noaa.gov/eka/climate/records.php. Accessed August 19, 2008.

8-16 National Weather Service Forecast Office, "Annual Climate Report for Eureka CA for 2007." Available at: http://www.wrh.noaa.gov/eka/climate/getfile.php?pil=claeka. Accessed August 19, 2008.

8-17 Humboldt County, Humboldt 21st Century – General Plan Update, Natural Resources and Hazards Report, Chapter 9, "Air Quality." http://co.humboldt.ca.us/planning/gp/meetings/natl_res/nr_report.asp. Accessed August 21,2008

8-18 U.S. Geological Survey Online Earthquake CaAtlalog, http://quake.geo.berkeley.edu/cnss/catalog-search.html; Accessed 04/04/13.

8-19 Pacific Gas and Electric Company (PG&E), December 2002, Seismic Hazard Assessment for the Humboldt Bay ISFSI Project, Technical Report TR-HBIP-2002-01

8-20 Pacific Gas and Electric Company (PG&E), "SAFSTOR/Decommissioning Offsite Dose Calculation Manual," Revision 22, July 23, 2012

8-21 U.S. Environmental Protection Agency, AP-42, Fifth Edition, Compilation of Air Pollutant Emission Factors, Chapters 13.2.1 and 13.2.2, November 2006

8-22 Humboldt Bay Power Plant Report, Decommissioning Capstone Document, prepared for Pacific Gas and Electric Company (PG&E), June 28, 2012.

8-23 Assessment of Hydrologic Impacts Associated With Slurry Wall Installation, SHN, Consulting Engineers and Geologists, Inc, Eureka, Reference 012125.100, August 15, 2012