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HUMBOLDT BAY

INDEPENDENT SPENT FUEL STORAGE INSTALLATION

ENVIRONMENTAL REPORT

PG&E

PACIFIC GAS AND ELECTRIC COMPANY

HUMBOLDT BAY
INDEPENDENT SPENT FUEL STORAGE INSTALLATION
LICENSE APPLICATION
ENVIRONMENTAL REPORT
SAFETY ANALYSIS REPORT

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LIST OF CURRENT PAGES

Page No.	Rev.
CONTENTS	
i	
ii	
GLOSSARY	
1	
2	
3	
4	
5	
6	
7	
CHAPTER 1	
i	
1.1-1	
1.2-1	
1.3-1	
1.3-2	
1.4-1	
1.5-1	
CHAPTER 2	
I	
ii	
iii	
iv	
v	
vi	
vii	
viii	
2.1-1	
2.2-1	
2.2-2	
2.2-3	
2.2-4	
2.2-5	
2.2-6	

Page No.	Rev.
2.2-7	
2.3-1	
2.3-2	
2.3-3	
2.3-4	
2.3-5	
2.3-6	
2.3-7	
2.3-8	
2.3-9	
2.3-10	
2.3-11	
2.3-12	
2.3-13	
2.3-14	
2.3-15	
2.3-16	
2.3-17	
2.3-18	
2.3-19	
2.3-20	
2.3-21	
2.3-22	
2.3-23	
2.3-24	
2.3-25	
2.3-26	
2.3-27	
2.4-1	
2.4-2	
2.4-3	
2.4-4	
2.4-5	
2.4-6	
2.4-7	
2.4-8	
2.5-1	
2.5-2	
2.5-3	
2.5-4	
2.5-5	
2.5-6	

Page No.	Rev.
2.5-7	
2.5-8	
2.5-9	
2.5-10	
2.5-11	
2.5-12	
2.5-13	
2.5-14	
2.5-15	
2.5-16	
2.5-17	
2.5-18	
2.5-19	
2.6-1	
2.6-2	
2.7-1	
2.7-2	
2.7-3	
2.7-4	
2.7-5	
2.7-6	
2.8-1	
2.8-2	
2.8-3	
2.8-4	
2.9-1	
2.9-2	
2.9-3	
2.9-4	
2.9-6	
2.9-6	
2.9-7	
2.9-8	
2.9-9	
2.9-10	
2.9-11	
2.10-1	
2.10-2	
2.10-3	
Table 2.2-1	
Table 2.2-2	
Table 2.2-3	

LIST OF CURRENT PAGES

LIST OF CURRENT PAGES

LIST OF CURRENT PAGES

HUMBOLDT BAY ISFSI
ENVIRONMENTAL REPORT

CONTENTS

HUMBOLDT BAY ISFSI
ENVIRONMENTAL REPORT

CONTENTS

GLOSSARY

A glossary of most of the terms and acronyms used in this environmental report, including their frequently used variations, is presented in this section as an aid to readers and reviewers.

Accident Events means events that are considered to occur infrequently, if ever, during the lifetime of the facility. Natural phenomena, such as earthquakes, tornadoes, floods, and tsunami, are considered to be accident events.

ALARA means as low as is reasonably achievable.

ADE means annual dose equivalent.

APCD means Air Pollution Control District.

AREOR means Annual Radiological Environmental Operating Report.

Best Management Practices (BMPs) means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of "waters of the United States." BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Boral is a generic term to denote an aluminum-boron carbide cermet manufactured in accordance with U.S. Patent No. 4027377. The individual material supplier may use another trade name to refer to the same product.

CAL OSHA means California Occupational Safety and Health Administration.

Cask Transporter (or Transporter) is a U-shaped tracked vehicle used for lifting, handling, and onsite transport of loaded casks.

CCC means California Coastal Commission

CDFG means California Department of Fish and Game.

CDP means coastal development permit.

CEDE means committed effective dose equivalent.

CEQA means California Environmental Quality Act.

CFR means Code of Federal Regulations.

GLOSSARY

CoC means a certificate of compliance issued by the NRC that approves the design of a spent fuel storage cask design in accordance with Subpart L of 10 CFR 72.

Confinement Boundary means the outline formed by the sealed, cylindrical enclosure of the multi-purpose canister (MPC) shell welded to a solid baseplate, a lid welded around the top circumference of the shell wall, the port cover plates welded to the lid, and the closure ring welded to the lid and MPC shell providing the redundant sealing.

Confinement System means the MPC that encloses and confines the spent nuclear fuel during storage.

Controlled Area (or Owner-Controlled Area) means the area, outside the restricted area but inside the site boundary, for which access to can be limited by PG&E.

Cooling Time for a spent fuel assembly is the time between its discharge from the reactor (reactor shutdown) and the time the spent fuel assembly is loaded into the MPC.

CWHR means the California Wildlife Habitat Relationships Program.

CZLUD means coastal zone land use ordinance.

dB(A) means decibels (on the A-weighted scale).

DBE means design basis earthquake.

DCSS means dry cask storage system.

Damaged Fuel Assembly is a fuel assembly with known or suspected cladding defects, as determined by review of records, greater than pinhole leaks or hairline cracks; empty fuel rod locations that are not replaced with dummy fuel rods; or those that cannot be handled by normal means. Fuel assemblies that cannot be handled by normal means due to fuel cladding damage are considered fuel debris.

Damaged Fuel Container (or Damaged Fuel Canister or DFC) means a specially designed enclosure for damaged fuel or fuel debris that permits gaseous and liquid media to escape from the container to the MPC while minimizing dispersal of gross particulates. The damaged fuel container/canister (DFC) features a lifting location that is suitable for remote handling of a loaded or unloaded DFC.

HBPP DSAR means the HBPP Defueled Safety Analysis Report for HBPP Unit 3 SAFSTOR 10 CFR Part 50 license.

DE means design earthquake.

GLOSSARY

DHS means Department of Health Services.

Humboldt Bay ISFSI (or ISFSI) means the total Humboldt Bay storage and includes the HI-STAR HB System, transporter, storage vault, and ancillary equipment.

DOE means the US Department of Energy.

EIR means environmental impact report.

ER means environmental report

Enclosure Vessel (EV) means the pressure vessel defined by the cylindrical shell, baseplate, port cover plates, lid, and closure ring that provides confinement for the helium gas contained within the MPC. The enclosure vessel and the fuel basket together constitute the MPC.

Forced Helium Dehydration (or FHD) is one of the two possible drying systems used to dry the inside of the MPC and can be used to backfill the MPC with the inert gas (helium).

FSAR means final safety analysis report.

Fuel Basket means a honeycombed structural weldment with square openings that can accept a fuel assembly of the type for which it is designed.

Fuel Debris is a subset of damaged fuel, and refers to ruptured fuel rods, severed rods, loose fuel pellets, or fuel assemblies with known or suspected defects that cannot be handled by normal means due to fuel cladding damage.

GET means general employee training

HI-STAR HB Overpack (or Loaded Overpack or Storage Cask) means the cask that receives and contains the sealed MPCs (containing spent nuclear fuel) for final storage in the storage vault. It provides the gamma and neutron shielding, missile protection, and protection against natural phenomena and accidents for the MPC.

HI-STAR HB System consists of, for the Humboldt Bay ISFSI, the Holtec International MPC, and HI-STAR HB cask.

Holtite is a trademarked Holtec International neutron shield material.

HBPP means Humboldt Bay Power Plant

GLOSSARY

Important to Safety (ITS) means a function or condition required to store spent nuclear fuel safely; to prevent damage to spent nuclear fuel during handling and storage; and to provide reasonable assurance that spent nuclear fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public. This definition is used to classify structures, systems, and components of the ISFSI as important to safety (ITS) or not important to safety (NITS).

Independent Spent Fuel Storage Installation (ISFSI) means a facility designed, constructed, and licensed for the interim storage of spent nuclear fuel and other radioactive materials associated with spent fuel storage in accordance with 10 CFR 72. For Humboldt Bay, this term is clarified to mean the total storage system and includes the HI-STAR HB System, transporter, storage vault, and ancillary equipment.

Insolation means incident solar radiation.

Intact Fuel Assembly is defined as a fuel assembly without known or suspected cladding defects greater than pinhole leaks and hairline cracks, and which can be handled by normal means. Partial fuel assemblies, that is fuel assemblies from which fuel rods are missing, shall not be classified as intact fuel assemblies unless dummy fuel rods are used to displace an amount of water greater than or equal to that displaced by the original fuel rod(s).

Keystone Species means a species capable of having a major influence on community structure, often in excess of that expected from its relative abundance.

LAR means license amendment request.

LDE means lens dose equivalent.

License Life means the duration that the HI-STAR HB System and the Humboldt Bay ISFSI are authorized by virtue of certification by the US NRC.

Maximum Reactivity means the highest possible k-effective including bias, uncertainties, and calculational statistics evaluated for the worst-case combination of fuel basket manufacturing tolerances.

MLLW means Mean Lower Low Water

Moderate Burnup Fuel is a spent fuel assembly with an average burnup less than or equal to 45,000 MWD/MTU.

MTU means metric tons of uranium.

GLOSSARY

Multi-Purpose Canister (MPC) means the sealed canister that consists of a honeycombed fuel basket contained in a cylindrical canister shell that is welded to a baseplate, lid with welded port cover plates, and closure ring. The MPC is the confinement boundary for storage conditions.

MWD/MTU means megawatt-days per metric ton of uranium.

NEPA means the National Environmental Policy Act of 1969 including any amendments thereto.

Neutron Shielding means a material used to thermalize and capture neutrons emanating from the radioactive spent nuclear fuel.

NFPA means National Fire Protection Association.

NPDES means national pollutant discharge elimination system.

NRC means the US Nuclear Regulatory Commission.

NRHP means National Register of Historic Places.

NWPA means the Nuclear Waste Policy Act of 1982 and any amendments thereto.

PFSF means Private Fuel Storage Facility.

PFSLLC means Private Fuel Storage Limited Liability Corporation.

PMF means probable maximum flood.

Protected Area (or ISFSI Protected Area) means the area within the storage vault.

Reactivity is used synonymously with effective neutron multiplication factor or k-effective.

RFB means Refueling Building

REMP means radiological environmental monitoring program.

Restricted Area means the area within the fence circumscribing the storage vault, access to which is limited by PG&E for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials.

GLOSSARY

Restricted Area Fence means the fence that circumscribes the storage vault. It is located to ensure the dose rate at this boundary will be less than 2 mrem/hr in compliance with 10 CFR 20 requirements. This is also the security area fence.

RWQCB means Regional Water Quality Control Board.

SAR means safety analysis report.

SDE means shallow dose equivalent.

Security Area Fence is is also called the restricted area fence.

SFP means spent fuel pool.

SNF or Spent Fuel means spent nuclear fuel. Per 10 CFR 72.3, spent fuel includes the special nuclear material, byproduct material, source material, and other radioactive materials associated with fuel assemblies.

SSC means structures, systems, and components.

TEDE means total effective dose equivalent.

Thermosiphon is the term used to describe the buoyancy-driven natural convection circulation of helium within the MPC fuel basket.

TLD means thermoluminescent dosimeters.

TODE means total organ dose equivalent.

Transport route means the route to be used by the cask transporter for onsite transfer of the loaded HI-STAR HB cask from the RFB via the oil supply road to the ISFSI storage vault.

USGS means the US Geological Survey.

UTM means Universal Transverse Mecator and is used to define topographic locations in metric coordinates.

Vacuum drying system is one of the two possible drying systems used to dry both the inside of the MPC and Overpack water annulus.

χ/Q means site-specific atmospheric dispersion factors used in radiological dose calculations for normal and accidental releases.

GLOSSARY

ZPA means zero period acceleration.

ZR means any-zirconium-based fuel cladding material authorized for use in a commercial nuclear power plant reactor.

HUMBOLDT BAY ISFSI
ENVIRONMENTAL REPORT

CHAPTER 1

PROPOSED ACTIVITIES

CONTENTS

CHAPTER 1

PROPOSED ACTIVITIES

This chapter provides background information on the Humboldt Bay Power Plant (HBPP), the need for the Independent Spent Fuel Storage Installation (ISFSI), and the schedule for licensing and constructing the Humboldt Bay ISFSI. Some of the information in this Environmental Report (ER) pertaining to HBPP and the Humboldt Bay ISFSI site was taken from HBPP Defueled Safety Analysis Report (Reference 1). Other documents that are on file with the Nuclear Regulatory Commission (NRC) and referenced throughout this ER are listed in Section 1.5.

1.1 BACKGROUND

HBPP consists of five electric generation units. Unit 3, a boiling water reactor, operated for approximately 13 years before being shut down for refueling in July 1976. The reactor has remained inactive since that time. Units 1 and 2 are co-located conventional 53 megawatt-electric (MWe) units capable of operating on fuel oil or natural gas. Unit 3 is located in a separate building, but is adjacent to Unit 2. There are also two gas turbines, rated at 15 MWe each, located in the vicinity of the Units 1, 2, and 3 structures. The four generating units, as well as the plant site, are owned by the Pacific Gas and Electric (PG&E) Company.

HBPP Unit 3 received a construction permit on October 17, 1960. Provisional Operating License DPR-7 was issued in August 1962 and commercial operation began in August 1963. On May 17, 1976, the NRC issued an order that required the satisfactory completion of a specified seismic design upgrade and resolution of certain geologic and seismic concerns prior to power operation following the 1976 shutdown. In 1983, PG&E concluded that the seismic modifications and other modifications required (in response to the Three Mile Island accident in 1979) were not economical and opted to decommission the plant. In 1988, the NRC approved the SAFSTOR Plan for Unit 3 and amended the operating license to a possess-but-not-operate license that expires on November 9, 2015.

1.2 NEED FOR THE FACILITY

The Nuclear Waste Policy Act (NWPA) of 1982 as amended, mandated that the Department of Energy (DOE) assume responsibility for the permanent disposal of spent nuclear fuel from the nation's commercial nuclear power plants beginning in January 1998 pending the availability of a permanent DOE repository. Nuclear power plant operators such as Pacific Gas and Electric have been given the responsibility under the NWPA to provide for the interim onsite storage of spent fuel until it is accepted for storage by the DOE. DOE has not met its NWPA mandate to have a repository in operation commencing in January 1998, and no other spent fuel storage facility has been established by DOE. Accordingly, spent fuel stored at Humboldt Bay Power Plant (HBPP) will need to remain at HBPP until a DOE or other facility is available. An Independent Spent Fuel Storage Installation (ISFSI) will facilitate the dismantling of the existing Unit 3 structures, thereby providing for earlier conversion of the Unit 3 site to unrestricted use and termination of the SAFSTOR 10 CFR Part 50 license. Unlike the current wet storage method, dry storage of spent fuel is a passive storage process that does not require extensive operating equipment or personnel to maintain. There are no effluents, liquids or gases, which are produced from the operation of an ISFSI, as compared to the allowable effluents in SAFSTOR.

PG&E has considered several alternative means for continued spent fuel storage at HBPP including continuing the existing wet storage. Based on an overall assessment of operational and safety considerations, and the transportation requirements associated with some of the alternatives, PG&E has concluded that dry cask storage of spent fuel at HBPP is the optimum alternative at this time for providing the necessary storage capacity. In addition, this storage option allows for the early decommissioning of HBPP Unit 3.

1.3 DESCRIPTION OF THE FACILITY

The Independent Spent Fuel Storage Installation (ISFSI) will consist of: an in-ground ISFSI storage vault, an onsite cask transporter, and the dry cask storage system. Pacific Gas and Electric has decided to use the Holtec International HI-STAR dry cask system, as modified for Humboldt Bay Power Plant (HBPP) spent fuel. The Humboldt Bay specific design is referred to as the HI-STAR HB. The HI-STAR HB is a storage and transport cask that provides structural protection and radiation shielding for the multi purpose canister (MPC) (containing the fuel basket and spent fuel). The movement of the HI-STAR HB onsite from the refueling building (RFB) to the ISFSI will be accomplished using a tracked transporter. HBPP will use the transporter developed for the Diablo Canyon Power Plant ISFSI. The HI-STAR HB will also be licensed under 10 CFR Part 71 for transport of the spent fuel offsite to a federal repository.

The ISFSI will be located on the same property as the existing HBPP facility. The ISFSI will be an interim facility consisting of an in-ground concrete structure with storage capacity for six shielded casks, five containing spent nuclear fuel and one containing high-level waste or "Greater than Class C" waste. The spent fuel would be stored there until the Department of Energy (DOE) takes possession of the spent fuel and transports it to a long-term repository.

Licensing of the ISFSI also involves Nuclear Regulatory Commission (NRC) review of a number of site-specific issues. These include the site specific environmental review, geotechnical issues related to the site, natural phenomena, and other site specific matters. Holtec developed a modified HI-STAR overpack and associated MPC for use at Humboldt Bay to accommodate HBPP's shorter length fuel assembly. The modified HI-STAR HB design and associated analyses were performed in accordance with the analytical methodologies previously licensed by the NRC for the HI-STAR 100 System. This license application references the Holtec HI-STAR 100 Final Safety Analysis Report (FSAR) (Reference 2) for description of the generic HI-STAR analyses and certain HI-STORM FSAR (Reference 3) analyses that are applicable to the HI-STAR HB and also provides supplemental analyses for the site specific issues that are applicable to the Humboldt Bay ISFSI site and the HI-STAR HB. PG&E is submitting information on these matters as part of this site specific application and intends that these issues be reviewed and licensed as part of the PG&E site specific 10 CFR 72 license.

In addition to the approval from the NRC under 10 CFR Part 72, other state and local permits and licenses will be required to support the construction and operation of the ISFSI, as discussed in Environmental Report (ER) Chapter 9. With respect to the State of California, PG&E will apply for a Coastal Development Permit (CDP). The CDP application will require an environmental review in accordance with State law. The California Coastal Commission (CCC) acts as the lead agency. PG&E will initiate the necessary state environmental review process in early 2004 and encourages NRC coordination with the CCC. This ER is being written to address the requirements of the National Environmental Policy Act and the California Environmental Quality Act. Separate and apart from the 10 CFR 72 application, PG&E is submitting a 10 CFR 50 license amendment request for HBPP Unit 3 related to cask handling activities in the HBPP Unit 3 RFB.

ENVIRONMENTAL SUMMARY

PG&E has evaluated the above proposed actions and has determined that the proposed actions and mitigating measures do not involve: (a) a significant hazards consideration, (b) a significant change in the types or significant increase in the amounts of any effluents that may be released offsite, or (c) a significant increase in individual or cumulative occupational radiation exposure. This document should allow federal and state agencies to conclude that PG&E's proposed actions to implement a spent fuel storage program consisting of a 10 CFR 72 license application and modification to the HBPP Unit 3 10 CFR 50 SAFSTOR license do not involve any significant adverse environmental impacts.

In its Waste Confidence Decision, the NRC examined the environmental impacts of the operation of ISFSIs built at operating nuclear power plant sites. The Commission has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored without significant environmental impacts for at least 30 years beyond the licensed life for operation of that reactor at onsite or offsite ISFSIs (10 CFR 51.23: 49 Fed. Reg. 34688, August 31, 1984). The NRC has reviewed the Waste Confidence Decision twice since it was first issued (in 1990 [55 Fed. Reg. 38474, September 18, 1990] and in 1999 [64 Fed. Reg. 68005, December 6, 1999]), and in both cases, the Commission reaffirmed the findings of the original decision. On July 18, 1990, the NRC published a final rule on "Storage of Spent Nuclear Fuel in NRC-Approved Storage Casks at Nuclear Power Plant Sites" (55 Fed. Reg. 29181-29190, July 18, 1990), and issued a general license for storage of spent nuclear fuel at reactor sites (10 CFR 72.210). The environmental impacts of spent nuclear fuel storage at reactor sites were also addressed in an environmental assessment and its accompanying "finding of no significant impact". The finding of no significant impact states that the Commission concludes that the proposed rulemaking, entitled "Storage of Spent Nuclear fuel in NRC-Approved Storage Casks at Nuclear Power Reactor Sites," will not have a significant incremental impact on the quality of the human environment. In addition, the NRC has issued site-specific licenses for ISFSIs located in various parts of the country. For these ISFSIs, environmental assessments were completed and findings of no significant impact were reached.

In April 1987, the NRC issued NUREG-1166, "Final Environmental Statement for Decommissioning Humboldt Bay Power Plant, Unit 3" (Reference 4) and concluded that storing spent fuel assemblies at HBPP Unit 3 in the spent fuel pool had minimal environmental impact. The proposed storage of spent fuel in an in-ground storage vault at HBPP Unit 3 in HI-STAR HB storage casks would also have a similar minimal environmental impact.

1.4 PROPOSED PROJECT SCHEDULE

Initial site characterization and storage system design activities have been conducted for the Humboldt Bay Independent Spent Fuel Storage Installation (ISFSI). Pacific Gas and Electric does not plan to initiate extensive facility construction activities until the NRC environmental review is completed, permits are obtained, and the Humboldt Bay ISFSI license has been issued or the necessary environmental findings made. Pending NRC approval of the Humboldt Bay ISFSI license application, PG&E intends to proceed with relatively minor site preparation activities, such as infrastructure development and access road work, and is in the process of obtaining the appropriate permits from other agencies for such work.

PG&E's schedule for constructing and operating the Humboldt Bay ISFSI is dependent upon the timely completion of the NRC environmental review process and timely technical reviews of the site-specific license application. Based on a review of other applicants licensing schedules, PG&E believes that the review process of the NRC can be completed in approximately 2 years. Assuming no delays in the review process and NRC issuance of the ISFSI license in 2005, PG&E would apply to the California Public Utilities Commission (CPUC) to use Humboldt Decommissioning Trust funds for procurement and construction of the ISFSI and after CPUC approval, will proceed with ISFSI procurement and construction long lead time items.

1.5 REFERENCES

1. Defueled Safety Analysis Report for Humboldt Bay Power Plant Unit 3, Revision 4, August 2002.

2. Final Safety Analysis Report for the HI-STAR 100 System, Holtec International Report No. HI-2012610, Revision 1, December 2002.

3. Final Safety Analysis Report for the HI-STORM 100 System, Holtec International Report No. HI-2002444, Revision 1, September 2002.

4. Final Environmental Statement for Decommissioning Humboldt Bay Power Plant, Unit 3, NUREG-1166, April 1987.

HUMBOLDT BAY ISFSI
ENVIRONMENTAL REPORT

CHAPTER 2

THE SITE AND ENVIRONMENTAL INTERFACES

CONTENTS

HUMBOLDT BAY ISFSI
ENVIRONMENTAL REPORT

CHAPTER 2

THE SITE AND ENVIRONMENTAL INTERFACES

CONTENTS

CHAPTER 2

THE SITE AND ENVIRONMENTAL INTERFACES

TABLES

CHAPTER 2

THE SITE AND ENVIRONMENTAL INTERFACES

TABLES

CHAPTER 2

THE SITE AND ENVIRONMENTAL INTERFACES

TABLES

HUMBOLDT BAY ISFSI
ENVIRONMENTAL REPORT

CHAPTER 2

THE SITE AND ENVIRONMENTAL INTERFACES

FIGURES

CHAPTER 2

THE SITE AND ENVIRONMENTAL INTERFACES

FIGURES

CHAPTER 2

THE SITE AND ENVIRONMENTAL INTERFACES

FIGURES

CHAPTER 2

THE SITE AND ENVIRONMENTAL INTERFACES

2.1 SITE LOCATION

The Humboldt Bay Independent Spent Fuel Storage Installation (ISFSI) site is located on the northern California coast in Humboldt County, which has a resident population of approximately 126,000 based on the 2000 census. The site is 3 miles southwest of the city of Eureka. Eureka has a population of 26,000 and is located 250 miles north of San Francisco. The township of King Salmon is located to the west, adjacent to the site location. Pacific Gas and Electric (PG&E) Company owns 143 acres of land area along the mainland shore of Humboldt Bay. PG&E also owns the intertidal areas extending approximately 500 ft into Humboldt Bay from this land area.

As discussed in Section 1.1, the ISFSI is located within the Humboldt Bay Power Plant site boundary near the power plant buildings on a small peninsula known as Buhne Point, nominally at 44 ft above mean lower low water. The site is above the surrounding flood plain and wetland areas of Humboldt Bay. The site lies between the Northwestern Pacific Railroad tracks and the north shoreline of Buhne Point.

A topographical map of the Humboldt Bay area is shown in Figure 2.1-1 and a site plan of the ISFSI is shown in Figure 2.1-2.

In accordance with 10 CFR 72.106, a 100-meter controlled area will be established around the ISFSI, as shown in Figure 2.2-3. A public trail to access a breakwater for fishing traverses the ISFSI controlled area (see Figure 2.1-2), a condition allowed by 10 CFR 72.106, so long as appropriate and effective arrangements are made to control traffic and to protect public health and safety. Public access to and recreation activities on the breakwater and in the bay will not be restricted by PG&E, except during ISFSI activities that require limited access within the 100-meter controlled area. Such activities will be for short time periods during cask movements or handling evolutions. The evolutions will occur primarily during the initial transport of storage casks to the ISFSI and potentially not again until the casks are transported offsite to the U.S. Department of Energy permanent storage repository.

The coordinates of the ISFSI site are latitude 40°44'30.6" North and longitude 124°12'39" West. The universal transverse mercator coordinates are 4,510,592.5 meters North and 397,761.3 meters East.

2.2 GEOGRAPHY, LAND USE, AND DEMOGRAPHY

2.2.1 GEOGRAPHY

The Humboldt Bay Independent Spent Fuel Storage Installation (ISFSI) is located within the Pacific Gas and Electric (PG&E) Company owner-controlled area at the Humboldt Bay Power Plant (HBPP). HBPP is located near the coastal community of King Salmon on the mainland shore of Humboldt Bay in Humboldt County, in northwestern California. Eureka, the largest city in Humboldt County, is located approximately 3 miles north of the ISFSI site (see Figure 2.2-1). An aerial view of the ISFSI site vicinity is shown in Figure 2.2-2.

The terrain in the vicinity of the HBPP rises rapidly from the bay on the north side to an elevation of approximately 69 ft mean lower low water (MLLW) at Buhne Point peninsula (peninsula). Terrain to the north and east of the site is generally flat. To the south and east, the terrain rises rapidly forming Humboldt Hill, which reaches an elevation of over 500 ft MLLW within 2 miles of the ISFSI and is the site of several small neighborhoods. Humboldt County is mostly mountainous except for the level plain that surrounds Humboldt Bay. The coastal mountains extend to the Central Valley. The ISFSI will be located near the top of a small hill surrounded by wetlands to the east and Humboldt Bay to the west.

The controlled access areas are shown in Figure 2.2-3. The peninsula ranges in elevation from sea level to approximately 69 ft MLLW. The owner-controlled area varies between sea level and 64 ft MLLW and is approximately 900 ft in width. The owner-controlled area is not traversed by public highway or railroad. The only access to the ISFSI site is from the south via King Salmon Avenue, which also serves the community of King Salmon situated on the western part of the peninsula. A public trail runs along the shoreline and along the fence to the northwest of the owner-controlled area.

The major travel access in the vicinity of the ISFSI and other communities of Humboldt County is via US Highway 101, which generally traverses north-south through Humboldt County. This highway passes about 0.3 mile southeast of the ISFSI site and is accessible at approximately 0.35 mile to the southeast of the site.

There are several landings in the community of King Salmon, located just west of the entrance gate to the owner-controlled area. The community of King Salmon serves frequent commercial and recreational boat traffic. Commercial air traffic into and out of Humboldt County is primarily through the Eureka/Arcata Airport, located in McKinleyville, approximately 16 miles north of the ISFSI site.

A set of Northwestern Pacific railroad tracks runs generally north-south along the southeastern PG&E property line. This rail system has been out of service since 1997. Presently, there are no existing plans to repair and reuse the tracks; however, the railroad owner and Humboldt County are considering this possibility.

Two small streams discharge into Humboldt Bay near the site. Salmon Creek and Elk River are located within a mile south and north of the site, respectively. These streams are used for watering livestock, but are not used for potable drinking water supply.

2.2.2 LAND USE

PG&E has full authority to control all activities within its property lines. The mineral rights within the site are owned by PG&E; there is no information suggesting that the land contains commercially valuable minerals. HBPP consists of four electric generation units currently in use and Unit 3, which is not in use. Unit 3, a boiling water reactor, operated for approximately 13 years before being shut down for refueling in July 1976. The reactor has remained inactive since that time. Units 1 and 2 are collocated conventional 53 megawatt-electric (MWe) units capable of operating on fuel oil or natural gas. Unit 3 is located in a separate building, but is adjacent to Unit 2. There are also 2 gas turbines, rated at 15 MWe each, located in the vicinity of the Units 1, 2, and 3 structures. The four generating units and Unit 3, as well as the plant site, are owned by PG&E.

Humboldt Bay and the surrounding lowlands dominate the region south, east, and west of the site. The lowland areas around the site are primarily vacant land and are used to a limited extent for grazing beef cattle. The small community of Fields Landing is located adjacent to a lumber shipyard approximately 0.4 mile south of the ISFSI site. Humboldt Hill is the dominant feature southeast of the site. Most of the mountainous area east and southeast of the site is inaccessible; however, there are several small communities located on Humboldt Hill and within 50 miles of the site (see Table 2.2-1). The City of Eureka is the largest population center in Humboldt County and is located approximately 3 miles northeast of the ISFSI site.

Humboldt County has relatively little level land, except along the coast of the Pacific Ocean. Overall, land use in Humboldt County is 74 percent forests, 10 percent agriculture, 6 percent public use, 4 percent residential, 3 percent water resources, 2 percent industrial, and 1 percent commercial. Logging and recreation are the most significant land uses in the county. The county ranks 35 out of 58 in total agricultural production in the State of California. The county's primary agricultural products in 2000 were dairy ($33.5 million), nursery and greenhouse crops ($32.9 million), and cattle and calves ($17.2 million). The total farm acreage in the county was approximately 584,000 in 1997 (Reference 1).

Figure 2.2-4 shows the location of sensitive land uses (nearest residences, farms, gardens, and groundwater wells) within 5 miles of the ISFSI site. The Humboldt County Department of Agriculture identified a total of nine farms and ranches and one community vegetable garden within 5 miles of the ISFSI site. The primary local farming products are dairy products, cattle, goats, and llamas. Most of the dairies are located along the Elk River while the coastal lowlands are used primarily for cattle grazing and ranching. The nearest dairy is 1.8 miles east of the site. This dairy produces approximately 800 gallons of milk per day. The nearest vegetable garden is the Wiyot

Tribe community vegetable garden located approximately 4.2 miles southwest of the site.

There are several small residential communities within 5 miles of the ISFSI site, including King Salmon, Humboldt Hill, Fields Landing, and the suburban communities surrounding the City of Eureka. Figure 2.2-4 identifies the location of the nearest residence within each of 16 segments centered on the major compass points. Most of these residences are within 1 mile of the site.

The Humboldt Bay Municipal Water District (HBMWD) provides water to residential and industrial users in the Humboldt Bay area. The district operates two separate water systems. Drinking water is supplied through the domestic water system. Raw water, used only for industrial purposes, is taken directly from the surface of the Mad River and delivered, untreated, to industrial customers. HBMWD produces a capacity of 20 million gallons per day of water from five Ranney wells in the Mad River near Essex. Within a 2- mile radius of the plant, there are 60 known wells. Table 2.5-8 lists these wells and Figure 2.5-3 shows the location of wells.

The ISFSI site is located in the vicinity of several ports that support commercial and sport fishing activities. Humboldt Bay, inland waterways, and the coastal waters of the Pacific Ocean are used for recreational fishing. The California Department of Fish and Game (CDFG) calculates sport fishing activity by the number of fish landed and commercial fishing activity by poundage of landings. According to data provided by CDFG, the combined sport catch for Eureka, King Salmon, Shelter Cove, and Trinidad in 2001 totaled approximately 10,260 rockfish, 4,465 crabs, 1,640 salmon, and 728 fish of other species.

Commercial landings are calculated by poundage of landings by port. In 2001, at Eureka, King Salmon, Shelter Cove, and Trinidad, the landings were estimated by CDFG to be as follows: 2,619,534 pounds of sole, 1,397,057 pounds of shrimp and prawns, 1,056,681 pounds of rockfish, 879,357 pounds of tuna, 615,259 pounds of crab, and 766,399 pounds of other fish species.

The primary industry in the area, and in Humboldt County, is lumber and lumber/paper manufacturing. Lumber production in Humboldt County in 2000 was valued at $285.5 million. A lumber-loading shipyard is located less than 1 mile south of the ISFSI site. Lumber mills are located in the nearby communities of Eureka and Arcata and farther inland in the communities of Scotia, Korbel, and Redcrest. A pulp mill is located on the Samoa Peninsula.

Although the fishing and lumber industries are in decline, service industries and recreation are becoming increasingly important parts of the county's economic base. The primary service employers in the Humboldt Bay area include medical services, education, and government. Visitors are attracted to the area by the numerous state and county parks both along the coast and in the inland forests.

In addition to the small beach on the western side of the peninsula, there are public beaches located along Humboldt Bay and the Pacific Ocean coast that are popular with local residents as well as tourists. Much of the coastal area on the inside of the bay falls within the Humboldt Bay National Wildlife Refuge, which is within 5 miles of the ISFSI site.

HBPP is located in unincorporated Humboldt County, and lies within the City of Eureka sphere of influence. This area is subject to the provisions of the City of Eureka Zoning Ordinance. Additionally, HBPP is located in the coastal zone for purposes of the California Coastal Act. In 1984, the City of Eureka adopted a Local Coastal Program (LCP) in accordance with the California Coastal Act. The LCP superceded the City of Eureka's 1977 General Plan and governed land use and development within the coastal zone until it was superceded by the city's 1997 General Plan (Reference 2).

The PG&E-owned land around the ISFSI site is zoned Coastal-Dependent Industrial. The areas immediately south and east of the site are zoned Waterfront Commercial. The community of King Salmon, located immediately southwest of the site, is zoned Low-Density Residential. The Humboldt Hill area to the south and east of the site has a variety of residential zoning designations and is surrounded by land zoned for agriculture. No major new developments are currently planned for the area within 5 miles of the ISFSI site. Areas near the ISFSI site experiencing significant growth are generally situated to the south of the City of Eureka and include the communities of Bayview, Cutten, and Humboldt Hill (see Table 2.2-1).

2.2.3 DEMOGRAPHICS

2.2.3.1 Population Distribution and Trends

The population distribution and projections for areas around the ISFSI site are based on the 2000 census and on estimates prepared by the California Department of Finance. The population data presented in this section for the ISFSI are based on distances from the ISFSI site.

The population data are provided for areas within a 50-mile radius of the ISFSI. Population distributions are provided for areas within specific radii and sectors, and include the 2000 Census data as well as projections for the years 2010 and 2025. Census data was analyzed at the census block level within the 1-mile radius and at the block group level outside of 1 mile. Population projections were based on California Department of Finance projected growth rates for Humboldt County between 1990 and 2040.

The area within 50 miles of the ISFSI includes most of Humboldt County, and a small sparsely populated portion of Trinity County (see Figure 2.2-5). Approximately 50 percent of the area within the radius is on land, with the balance being Humboldt Bay and the Pacific Ocean. In general, the portion of California that lies within 50 miles of the ISFSI is relatively sparsely populated, with the exception of a few urbanized areas along the coast.

2.2.3.2 Regional Population

According to the 2000 Census, the population of Humboldt County was 126,518 and the population of Trinity County was 13,022 in 2000. Table 2.2-2 shows the population trends of the State of California and Humboldt and Trinity Counties from 1940 to 2000. Humboldt County has seven incorporated cities ranging in size from approximately 300 to 26,000 persons. Approximately one half of Humboldt County's residents live in incorporated communities, and 59 percent of the County population lives in the area surrounding Humboldt Bay. This area includes the cities of Arcata, Ferndale, Fortuna, and Eureka, and the unincorporated community of McKinleyville (Reference 3).

According to the State Department of Finance, the cities of Eureka and Arcata together contain about 35 percent of Humboldt County's population, while 13 percent of the population is scattered among five other incorporated cities.

Approximately 67,000 of county residents reside in unincorporated communities. Table 2.2-1 shows the growth since 1970 of the incorporated cities and other major communities within 50 miles of the ISFSI site and provides distance and direction from the site (Reference 4).

Table 2.2-3 provides the age and sex of the total population for Humboldt County in 2000. Table 2.2-4 provides the distribution of population by race as reported in the 2000 census.

2.2.3.3 Population Between 10 and 50 Miles

Figure 2.2-5 shows the 2000 census population distribution between 10 and 50 miles, within the sectors of 22.5 degrees, with part circles of radii of 10, 20, 30, 40, and 50 miles. The 2000 U.S. Census reported 123,938 people living within 50 miles of the ISFSI site. In 2000, some 76 percent of Humboldt County's total population resided in the population centers listed in Table 2.2-1.

Figures 2.2-6 and 2.2-7 show projected population distributions for 2010 and 2025, respectively, and are based primarily on population projections published by the California Department of Finance (Reference 5).

2.2.3.4 Population within 10 Miles

The 2000 census counted approximately 49,741 residents within 10 miles of the ISFSI site. The nearest residence is about 0.15 mile southwest of the ISFSI site. There are approximately 35,790 residents within 5 miles of the ISFSI site.

Figure 2.2-8 shows the 2000 population distribution within a 10-mile radius wherein the area is divided into 22.5-degree sectors and part circles with radii of 1, 2, 3, 4, 5, and 10 miles. Figures 2.2-9 and 2.2-10 show projected population distribution for 2010 and 2025, respectively, and are based primarily on population projections published by the California Department of Finance (Reference 5). The distributions are based on the assumption that the land usage will not change in character during the next 25 years, and that the population growth within 10 miles will be proportional to growth in Humboldt County as a whole (0.61 percent annual growth rate) (Reference 5).

The nearest population center is the City of Eureka located approximately 3 miles north-northeast of the ISFSI site. The 2000 census shows the city to have a population of 26,128.

There are numerous schools located within 10 miles of the ISFSI site, particularly in the population centers listed in Table 2.2-1. Several K-12 schools are located within 5 miles of the site, serving the City of Eureka and neighboring communities. Humboldt State University, with an enrollment of approximately 7,500 students, is located in the City of Arcata approximately 15 miles northeast of the ISFSI site. The College of the Redwoods is located within 5 miles of the site just south of the City of Eureka and has an enrollment of approximately 5,000 full and part-time students.

Several parks and recreation areas are located within 10 miles of the ISFSI site. The beaches around Humboldt Bay and the Pacific Ocean are popular with local residents as well as visitors from outside the local area. The City of Eureka has several municipal parks and there is a municipal golf course located approximately 3 miles northeast of the ISFSI site.

2.2.3.5 Transient Population

In addition to the resident population presented in the tables and population distribution figures, there is a seasonal influx of vacation and weekend visitors within a 50-mile radius, especially during the summer months. The influx is heaviest in the area around Humboldt Redwoods State Park and along the Pacific Ocean coast to the north of the site in the area around the City of Trinidad.

The Humboldt County Convention and Visitors Bureau estimated that the County receives between 2.1 and 2.2 million visitors per year (Reference 6). Table 2.2-5 lists state and county recreation areas and public lands within 50 miles of the site.

2.2.4 REFERENCES

1. 1997 Census of Agriculture, County Profile, Humboldt California, USDA National Agricultural Statistics Service.

2. City of Eureka General Plan Background Report, J. Lawrence Mintier and Associates,1997.

3. Humboldt County Profile, Humboldt County, 2002.

4. Historical Census Populations of California State, Counties, Cities, Places, and Towns,1850-2000, California State Department of Finance, 2002.

5. Population Projections,1990-2040, California State Department of Finance, 1998.

6. D. Leonard, Executive Director, Humboldt County Visitor Bureau, Telephone Conversation, November 14, 2002.

2.3 ECOLOGY

This section addresses the vegetation, terrestrial, and aquatic ecology in the area of the Humboldt Bay Independent Spent Fuel Storage Installation (ISFSI). The discussion focuses primarily on the ISFSI site and the immediate vicinity (a 5-mile radius around the site). For this section, "region" indicates the general area of Humboldt County, "vicinity" describes the study area approximately 5 miles in radius from the Humboldt Bay Power Plant (HBPP) property, and "site" refers to the specific location of the ISFSI project site including all areas potentially disturbed by project activities. Within this section, the possible occurrence of special status species is discussed. For purposes of this discussion, special status species are defined as those species listed under the federal and/or state Endangered Species Acts as endangered, threatened, proposed (or candidates) for listing as endangered or threatened, or special concern species. The information in this section was obtained from review of historical and current literature (including published and unpublished Pacific Gas and Electric (PG&E) report documents), PG&E biological field surveys of HBPP lands, and the ISFSI site. PG&E Staff Biologists, Jones and Stokes Associates, Inc., and LSA Associates, Inc. conducted these surveys between 1999 and 2002. All of the potential impact areas for the vault, transportation route, construction buffers, and fill disposal area (see Figure 2.2-3) were surveyed on foot.

2.3.1 TERRESTRIAL ECOLOGY

2.3.1.1 Species/Habitat Inventories

The vicinity within 5 miles of the Humboldt Bay ISFSI provides a wide array of habitats for plants and animals (Reference 1). Humboldt Bay (see Figure 2.3-1) is one of California's largest coastal estuaries. Humboldt Bay's 223 square mile drainage basin lies in the foothills of the Coast Range. The bay region is immediately surrounded by lowlands, formerly marshy extensions of the bay, which were diked and drained for agricultural use, primarily grazing, beginning in the 1880s. The lowlands are intersected by low foothills of the Coast Range, which extend nearly to the bay shore at several locations (Reference 2). No large rivers enter the bay; primary sources of fresh water are Jacoby Creek and Freshwater Creek in Arcata Bay, Elk River in Entrance Bay, and Salmon Creek in South Bay. Gradations of physical features yield an almost unlimited variety of aquatic and terrestrial microhabitats, but there are large areas that are sufficiently uniform in composition and population to allow categorization.

2.3.1.1.1 Botanical Resources

Vegetation Community Types: A map of the plant communities in the vicinity of the ISFSI is shown in Figure 2.3-2. The list of plant species observed or expected to occur within these communities, as shown in Table 2.3-1, was compiled with information from the California Wildlife Habitat Relationships Program (CWHR), a computerized database of California's wildlife and associated habitats (Reference 3) and other literature (Reference 4).

Dune Communities: Dune communities occur in areas of sand accumulation along the coast region. In the ISFSI vicinity, dune communities occur along the Samoa Peninsula and along the North and South Spit of Humboldt Bay. The species composition in the dune communities is determined by the degree of exposure to wind and salt spray, stability of the substrate, and moisture availability (Reference 5). Dune communities in the ISFSI vicinity include Northern Foredunes, Northern Foredune Grassland, and Northern Dune Scrub.

Northern Foredunes: Northern Foredunes are dominated by perennial grasses and low, succulent, perennial herbs and subshrubs (Reference 6). This community is exposed to the high levels of wind and salt spray. The dominant species include European beachgrass (*Ammophila arenaria*), beach bursage (*Ambrosia chamissonis*), sea rocket (*Cakile maritima*), and iceplant (*Carpobrotus edule*). Other common species include yellow sand-verbena (*Abronia latifolia*), dune buckwheat (*Eriogonum latifolium*), dune sagebrush (*Artemisia pycnocephala*), and dune tansy (*Tanacetum camphoratum*). Foredune species often have extensive root systems that help stabilize the substrate. Two federal- and state-listed endangered species occur in the ISFSI vicinity in the Northern Foredune community: beach layia (*Layia carnosa*) and Humboldt Bay wallflower (*Erysimum menziesii ssp. eurekense*) (Reference 7).

Northern Foredune Grassland: Northern Foredune Grassland is a sparse grassland community dominated by native perennial grasses (Reference 6). This community is also subject to high levels of wind and salt spray, but is in a higher, relatively more stable zone. The dominant grasses are typically native dunegrass (*Leymus mollis*) and seashore bluegrass (*Poa douglasii*). Species characteristic of the Northern Foredune community are common in this plant community as well.

Northern Dune Scrub: Northern Dune Scrub is a shrub-dominated community occurring on the inland side of the dune system and subject to lower levels of wind and salt spray (Reference 6). The dominant shrubs typically include coyote brush (*Baccharis pilularis*) and yellow bush lupine (*Lupinus arboreus*). Openings between shrubs are vegetated by grasses and herbs characteristic of the Northern Foredune community.

Herbaceous Wetland Communities: Wetlands are lands transitional between terrestrial and aquatic systems (Reference 8). Under the federal definition, wetlands are "areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR 328.3[b], 40 CFR 230.3). Wetlands in the ISFSI vicinity include Northern Coastal Salt Marsh, Coastal Freshwater Marsh, and Wet Meadow.

Northern Coastal Salt Marsh: Northern Coastal Salt Marsh is an herbaceous wetland plant community subject to regular tidal inundation. It is horizontally stratified with cordgrass (*Spartina species*) dominant in the zone of deepest inundation, pickleweed (*Salicornia species*) dominant in the middle zone, and a diverse mix of species in the zone of shallowest inundation (Reference 6). In the ISFSI vicinity, Northern Coastal Salt Marsh occurs around the edges of Humboldt Bay, including the tidal sloughs. Other common species in the vicinity include rough sedge (*Carex obnupta*), saltgrass (*Distichlis spicata*), and seaside arrowgrass (*Triglochin maritima*).

Coastal Freshwater Marsh: Coastal Freshwater Marsh is an herbaceous wetland plant community dominated by perennial, emergent monocots, most commonly bulrush (*Scirpus species*) and cat-tails (*Typha species*) (Reference 6). Coastal Freshwater Marsh occurs in low-lying, non-tidal areas along the east side of Humboldt Bay. This community is located on PG&E lands adjacent to the south and east sides of the ISFSI. Common species in the vicinity include broad-leaved cat-tail (*Typha latifolia*) and salt-marsh bulrush (*Scirpus robustus*). In the vicinity, western lily (*Lilium occidentale)*, which is federal- and state-listed as endangered, is reported from the sedge-dominated (*Carex species*) freshwater marsh south of Fields Landing.

Wet Meadow: Wet Meadow is an herbaceous wetland plant community dominated by perennial grasses, sedges, and rushes. Low elevation Wet Meadow communities were not classified in Reference 6. In the ISFSI vicinity, areas of Wet Meadow are interspersed with upland grassland in a vegetation mosaic along river flood plains, such as along the Elk River. Western lily is reported from wet meadows in the ISFSI vicinity of Humboldt Bay.

Herbaceous Upland Communities: The primary upland herbaceous plant community in the ISFSI vicinity is Coastal Terrace Prairie. Coastal terrace prairie is a dense, tall grassland dominated by both sod and tussock-forming perennial grasses (Reference 6). This plant community occurs on Table Bluff, along the south side of Humboldt Bay (Reference 7). Coastal prairie also occurs along low lands adjacent to the east side of Humboldt Bay and along the flood plain of the Elk River. On Table Bluff, the dominant grass is California oatgrass (*Danthonia californica*). Other dominant or common species include vernal grass (*Anthoxanthum odoratum*), tufted hairgrass (*Deschampsia caespitosa*), velvet grass (*Holcus lanatus*), rough cat's ear (*Hypochaeris radicata*), and English plantain (*Plantago lanceolata*).

Riparian Communities: Riparian communities occur along flowing rivers and streams. Riparian communities are frequently seasonally flooded. North Coast Riparian Scrub is the primary riparian community in the project vicinity. It occurs along rivers and sloughs, including the Elk River and Hookton Slough. Stands of North Coast Riparian Scrub not associated with a stream course are also found in low-lying areas that are seasonally flooded, such as the grassland/meadow areas south of Fields Landing and in dune areas on the Samoa Peninsula.

North Coast Riparian Scrub: North Coast Riparian Scrub is a common riparian community along coastal streams and is characterized by dense stands of willows (*Salix species*) (Reference 6). In the ISFSI vicinity, the dominant species is Hooker willow (*Salix hookeriana*). Blackberries (*Rubus species*) and wax-myrtle (*Myrica californica*) are commonly found associated with this plant community.

Forest Communities: Historically, the hills east of Highway 101 were forested with Redwood Forest. Extensive timber harvest in the ISFSI vicinity removed all old growth Redwood Forest, and the present forest is a mixture of second growth redwood forest, tree plantations, and other forest communities. Some formerly forested areas are no longer forested. Three forest communities are present in the ISFSI vicinity: Red Alder Forest, Upland Redwood Forest, and Sitka Spruce Forest.

Red Alder Forest: Red Alder Forest is a broadleafed, deciduous forest dominated by red alder (*Alnus rubra*) (Reference 6). In the ISFSI vicinity, this community occurs along drainages in a mosaic with other forest types. This community occurs along the north-facing slope of Table Bluff and with Upland Redwood Forest in the hills east of Highway 101. A small stand of Red Alder Forest is also present on Buhne Point. Other species associated with Red Alder Forest in the ISFSI vicinity include salal (*Gaultheria shallon*), Hooker willow, twinberry (*Lonicera involucrata*), cascara (*Rhamnus purshianus*), blackberries, and wild rose (*Rosa* sp.).

Upland Redwood Forest: Upland Redwood Forest is present in the hills east of Highway 101. Upland Redwood Forest is a moderately dense forest dominated by coast redwood (*Sequoia sempervirens*), with a high diversity of other tree species and a shrubby understory (Reference 6). Other tree species present in this community in the ISFSI vicinity include Sitka spruce (*Picea sitchensis*), Douglas-fir (*Pseudotsuga menziesii*), red alder, and madrone (*Arbutus menziesii*). Where dense understory is present, the associated species are often those found in Red Alder Forest.

Sitka Spruce Forest: Sitka Spruce Forest is a dense forest dominated by Sitka Spruce occurring on exposed headlands (Reference 6). This community has an understory of broadleaved trees, shrubs, and perennial herbs, similar to that found in the Red Alder Forest occurring in the project vicinity. A single stand of Sitka Spruce Forest occurs on the west end of Table Bluff. (Reference 7) Other forest stands adjacent to Table Bluff have Sitka Spruce as a dominant species but also include planted species such as Monterey cypress (*Cupressus macrocarpa*). Western lily is also reported occurring on the margins of the Table Bluff stand (Reference 7).

Special Status Species: PG&E-owned land near of the ISFSI site was inventoried for the presence of special status species in July of 1999 (Reference 9) and in 2002 (Reference 10). Site vegetation habitats, present in the project area (storage site, fill disposal area, and transportation route), consist primarily of disturbed coastal terrace prairie. The grassland on the site and the related project area, is occasionally mown, and many areas have been disturbed by vehicles or other equipment. Considerable disturbance was caused by disposal of spoils from the initial power plant discharge canal excavation. Excess material was placed near the ISFSI proposed fill disposal area (see Figure 2.2-3) when the power plant was first constructed. This fill raised the elevation of the soil favoring the development of disturbed coastal terrace prairie vegetation. Most of the species occurring on the site and related project areas are non-native species, many of which are ruderals. 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. Table 2.2-3 is the list of special-status plant species that are known to occur in the ISFSI vicinity (Reference 7). Identification of suitable habitat of these special status species indicates that they are not present in the ISFSI site area and related project areas.

A special-status plant species, as defined here, meets one or more of the following criteria:

(1) Officially listed by the California Department of Fish and game (CDFG) as rare, threatened, or endangered, and/or by the U.S. Fish and Wildlife Service as threatened or endangered, or proposed for listing.

(2) A federal or state candidate species for listing as threatened or endangered or state candidate for listing as rare. Such a species may become formally listed during the course of a project.

(3) Listed under one of the following categories in the California Native Plant Society inventory of rare and endangered plants of California. (Reference 11).

List 1A - Plants presumed extinct in California.

List 1B - Plants rare, threatened, or endangered in California and elsewhere.

List 2 - Plants rare, threatened, or endangered in California, but more common elsewhere.

HBPP lies within the distributional range of several special-status plant species. Of the 24 species considered in the evaluation of sensitive botanical resources in and/or near the proposed project site, only three have a potential to occur on the project site. These are: Point Reyes bird's-beak (*Cordylanthus maritimus* ssp. *Palustris),* Humboldt Bay owl's –clover (*Castilleja affinis* spp. *Littoralis*), and Western sand-spurrey (*Spergularia Canadensis* var *occidentalis*). It should be noted that marginal habitat is present for three other species, Lyngbye's sedge (*Carex lyngbyei*), coast checkerbloom (*Sidalcea oregana* spp. *Eximia*), and marsh violet (*Viola palustris*). However, a comprehensive field survey on July 31, and August 1, of 2002) was conducted during the blooming period of these species and none were observed. Therefore, it was determined that these species are not present at the project site. No proposed or listed threatened or endangered plant species have been identified within the immediate ISFSI site area. In the vicinity, three species (Beach Layia (*Layia camosa*), Humboldt Bay wallflower (*Erysimum menziesii* ssp. *Eurekense)*, and Western lily (*Lilium occidentale*) are currently listed or proposed for listing as either threatened or endangered occur or have the potential to occur based on the presence of suitable habitat. LSA Associates (Reference 10) found no suitable habitat for these species at the ISFSI site.

Keystone Species: Environmental impacts can disrupt the equilibrium of well-established plant or animal populations. Severe fluctuations in sensitive populations may create substantial community stability problems. The Dictionary of Ecology, Evolution and Systematics (Reference 12) defines keystone species as "[any] capable of having a major influence on community structure, often in excess of that expected from its relative abundance." In complex natural communities, changes in population levels of one species do not typically imply similar changes in other species. Stability is very complicated because of the diversity of organisms. Therefore, the productivity of a species may increase as it numbers decline, or vice versa, depending on the cause of the population change. It is also possible that one species holds another below some critical level above which it would undergo massive population growth. Those species that hold the trigger to population outbreaks in other species potentially have importance far out of proportion to their numbers. Paine (Reference 13), called these trigger organisms "keystone species." Community stability relies on both the relative abundance of the plant or animal populations and the composition and structure of the various habitats those populations use.

There are no known keystone plant species at the ISFSI site.

2.3.1.1.2 Wildlife Resources

Wildlife Habitats: A generalized view of Humboldt Bay region habitats is shown in Figure 2.3-3. The figure was adapted from Reference 14, and generally follows Reference 8. Common and scientific names for wildlife are generally consistent compared with inconsistencies found in plant or marine invertebrate names. Therefore, common names will appear without scientific names. The scientific names for wildlife resources are contained in Tables 2.3-3, 2.3-4, and 2.3-5. Humboldt Bay is separated from the ocean by long sand spits. South Spit is narrow with low sand dunes and sparse vegetation. During extreme high tides and high seas, the ocean surf may pass over South Spit into the Bay. The northern spit (Samoa Spit) is much higher and wider than South Spit and, although there is a dune community remaining, much of the spit has been developed for industrial and residential use.

Marshes, Fringing Wetlands, and Grass Beds: In the Humboldt Bay region, nearly 90 percent of the original salt marsh areas have been either diked or filled. Only 971 acres of the original estimated 7,000 acres of salt marsh remain. Other remaining wetland habitats in the Humboldt Bay region include 249 acres of brackish marsh, 274 acres of freshwater marsh, 6,664 acres of grazed seasonal wetlands, and 170 acres of woody freshwater swamp (Reference 14). Three main factors influence the vegetation of all wetlands: duration of inundation, water chemistry, and site history. Currently, the salt marshes exist largely as remnants in a narrow perimeter around the bay. Notable exceptions include the large areas of salt marsh on low islands in the middle of Entrance Bay and islands included in Mad River Slough. Brackish and freshwater wetlands most often occur contiguously with the salt marshes and, with the exception of the extensive areas of grazed seasonal wetlands, are usually narrow remnants and sloughs near riparian woodlands.

Eelgrass Community: The eelgrass (*Zostera marina*) community in the Humboldt Bay region occurs between approximately -3 and +1 ft mean lower low water (MLLW) and covers approximately 2,900 acres (Reference 15). The presence adds greatly to mid- and low-tide use of the bay by a variety of birds including American coot, black brant, and American widgeon. The eelgrass area near the ISFSI site has been almost decimated by channel dredging in the area around Buhne Point. Wave action near the ISFSI site decreases eelgrass communities and increases siltation, making the area less suitable for eelgrass (Reference 16).

Mud and Sand Flats: The mud and sand flats extend from approximately -1 to +7 ft MLLW and vary from approximately 10,000 to 1,100 acres depending on the height of the low tide (Reference 17). While eelgrass grows on the lower flats, green algae, primarily *Enteromorpha*, occurs at higher elevations. These areas are primary shorebird habitat, and the most common species include plover, willet, sandpiper, dunlin, dowitchers, and godwit (see Table 2.3-3). Other prominent birds in the vicinity of the ISFSI include herons and egrets, brown pelican, cormorant, brant, ducks, coot, gulls, and approximately 10 species of terns. The common raven occurs as a migrant and wintering species. Evans and Harris (Reference 18) reported a wintering avocet population intertidal mud flats in the Northeast corner of Humboldt Bay.

Mud and sand flat areas are in the vicinity frequented by harbor seals, which use the flats as haul-out areas for resting and birthing. In Reference 16, Springer reported that the seal population of the bay area is not more than 700.

Salt Marshes: Salt marshes are dominated by pickleweed (*Salicornia virginica*) and California cordgrass (*Spartina foliosa*), which exhibit a clumped growth pattern atypical of the grass south of the Humboldt Bay region (Reference 19). These species are in areas subjected to daily tidal flooding. In more upland marsh areas, the vegetation is dominated by saltgrass (*Distichlis spicata*). The salt marsh area has been greatly reduced because of diking, drainage, and filling. The largest remaining marsh is on Indian Island. Mitigation to restore several marshes is now underway.

Typical birds in the Humboldt Bay region include herons, egrets, ducks, several species of hawk, Virginia rail, American coot, gulls, and several species of shorebirds (see Table 2.3-3). Many species are present throughout the year using the marsh as a roosting place at high tide or foraging in or over the marsh. The marsh wren and song sparrow nest in the marsh the vicinity of the ISFSI. Various mammals (see Table 2.3-4) inhabit the marsh, including shrew, bat, mice, vole, raccoon, mink, and river otter. Mammals typically inhabit the upland saltgrass areas and forage lower areas at low tide (Reference 16).

Brackish Marshes: In the vicinity of the ISFSI, brackish marshes exist in the higher parts of the tidal marsh and upstream in tidal creeks where salinity is lowered by reduced tidal flooding and increased freshwater inflow. These marshes also are found in channels, ditches, borrow pits, and other features cut off from direct tidal action.

Birds and mammals in the brackish marshes are the same as those found in the salt marsh and freshwater marsh areas. More birds nest in these areas than in other marshes nearby.

Freshwater Marshes and Ponds: Freshwater ponds and marshes are found in the region above the area of tidal influences, primarily along rivers and creeks draining into the bay (Reference 20). These ponds and marshes can also occur in upland areas as a result of natural depressions or man-made features such as dikes impounding surface flow. Freshwater marshes and ponds near the bay include approximately 365 acres, including the Arcata oxidation ponds. Arcata marsh projects and Eureka sewage treatment plant areas are located in the vicinity of the ISFSI. A large variety of bird species use these areas, including grebe, cormorant, herons, egrets, American bittern, ducks, rail, coot, and several species of shorebirds. There are also kingfishers, phoebe, sparrow, swallows and the red-winged blackbird. The birds include year-round and migrant species (see Table 2.3-3). Mammals are plentiful. They include shrews, bats, mice, vole, raccoon, weasel, mink, river otter, and domestic or feral cat (see Table 2.3-4).

Agriculture Lands: Much of the Humboldt Bay regional area used for agriculture is former tidal marsh that was diked and drained in order to provide pasture. Despite the lack of tidal action, these pasture areas are heavily used by a variety of birds, particularly during the rainy winters and when high tides force wading birds inland. Principal species include herons, egrets, tundra swan, dabbling ducks, hawks, coot, plover, sandpipers, gulls, owl, swift, swallows, raven, crow, and several songbirds. Birds include year-round residents, migrants, and seasonal visitors. Agricultural lands in the region are major winter feeding areas for American robin and European starling (see Table 2.3-3). In Reference 21, Hoff noted that heavily grazed areas have the greatest birdday use. On a density basis, however, plowed fields and croplands are more heavily used. Similar results were observed by Verhey (Reference 22). Mammals include shrews, moles, bats, gophers, mice, voles, raccoon, weasel, skunk, domestic or feral dogs and cats, gray fox, and mule deer (see Table 2.3-4).

Sand Beaches and Islands: Sand beaches within the ISFSI vicinity are rare, but limited areas occur on the spits near the bay entrance. Sediment deposition from dredging has elevated some areas above water line. Filling and dredging have decreased some beach extent. Human recreation in these areas has limited bird use of these habitats. Typical birds include gulls and terns, which use the land as resting roosts; snowy plover and sanderlings, which forage; and black brant (for preening, sand ingestion as grit), pelican, and cormorant (see Table 2.3-3). Nesting of snowy plovers in the upland areas has been greatly disturbed by human activity. The snowy plover is listed as federally threatened, and it is also listed as a species of special concern by the State of California. Over 100 pairs of Caspien (terns) use Sand Island as a nesting area (Reference 23).

Man-made structures: There are numerous jetties, wharves, pilings, and breakwaters currently in the Humboldt Bay region. Brown and red algae grow plentifully on these substrates, along with the associated invertebrate populations. These areas provide specialized habitat for shorebirds, such as the American black oystercatcher, black turnstone, surfbird, and wandering tattler. These species would be absent or rare without these rocky areas. Other common species are gulls and cormorants using the rocks as roosts. Foraging does occur among rocks near the waterline. Variousshorebirds, particularly gulls, plovers, godwits, willets, dunlin, and sandpipers roost at high tide on old pilings (Reference 24). The black rat is the primary mammal (Reference 17).

Woody Riparian Community: The tree and shrub community occurs on islands in the Humboldt Bay region and including portions of the bay shore. Two examples are the planted Monterey cypress and eucalyptus on Indian Island, and the Sitka spruce and brush on both Indian Island and Table Bluff. These islands have historically been used as nesting areas for egrets, herons, night herons, and other shorebirds (Reference 2). The woody riparian community provides habitat for a large number of birds, including the black-crowned night heron, and numerous species of songbirds, including warblers (see Table 2.3-3). Mammals frequenting this habitat include bat, brush rabbit, mice, vole, fox, raccoon, weasel, mink, skunk, and mule deer (see Table 2.3-4).

Species and Relative Abundance: The tables of birds and mammals provided in Tables 2.3-3 and 2.3-4 were derived from information in Reference 14 with updated federal and state status information. For reptiles and amphibians, Table 2.3-5 was compiled with information from the CWHR, a computerized database of California's wildlife and associated habitats (Reference 3). Input variables used for the CWHR computer analysis were matched as closely as possible to the wildlife habitat types used by Reference 14 and vegetation community types listed in Section 2.3.1.1.1. Reference 25 provides more information on how CWHR predicts wildlife occurrence. CWHR computer-generated tables identify those wildlife species with some potential to occur in the ISFSI vicinity. Few of the CWHR species/habitat models have been field-validated, and were developed from information published in scientific literature.

Special Status Species: Numerous special status wildlife species occur within the ecologically diverse and productive habitats in the vicinity of the ISFSI project. PG&E-owned land associated with the HBPP including the ISFSI site was inventoried for the presence of special status species in 1999 and 2002 (Reference 10). No special-status terrestrial wildlife species have been identified within the PG&E-owned land including the ISFSI site. Table 2.3-6 lists the terrestrial special-status species that are known to occur in the ISFSI vicinity (References 7 and 10). Lack of suitable habitat of these species indicates that they are not present at the ISFSI site.

Commercially and Recreationally Important Species: Wildlife viewing is a significant form of recreation in the Humboldt Bay region. In September 1971, portions of South Bay and Arcata Bay were set aside to form the Humboldt Bay National Wildlife Refuge, primarily to preserve and enhance migratory birds and their habitats. The refuge contains the largest eelgrass beds in California, and provides a spring staging area for the Pacific black brant (where more than 10,000 can be viewed at one time) and other migratory waterfowl. Tidal flats in the area also provide a wintering area for shorebirds including western sandpipers, dunlins, curlews, and willets. Harbor seals haul out and bear their young on intertidal mudflats. American bitterns and other wading birds feed along Salmon Creek and Hookton Slough. Songbirds are present in adjacent grasslands in the spring. California's northernmost heron rookery is located on Indian Island. Resident harbor seals are present in the open water areas, sharing the habitat with northern pintails, tundra swans, and other waterfowl. When the planned property acquisition is complete, the refuge will contain approximately 9,000 acres of diked marshes and seasonal wetlands, salt marshes, mudflats, and open water. The present refuge covers 2,200 acres (Reference 26).

Several recreationally important wildlife species occur in the region, including mule deer, mourning doves, brush rabbits, and several species of migratory waterfowl. Although these species are recreationally harvested elsewhere in Humboldt County under regulations issued annually by CDFG, no hunting is allowed on PG&E property including the ISFSI site.

Keystone Species: There are no known keystone wildlife species present on the ISFSI site.

2.3.2 AQUATIC ECOLOGY

2.3.2.1 Estuarine and Marine Ecology

Humboldt Bay: In Reference 27, Humboldt Bay is classified as a "normal" or "positive" type of estuary, although the large opening to the sea near the middle creates a complex environment that is not easily classified. In Reference 28, Costa characterized Humboldt Bay as a multi-basin, tide driven, coastal lagoon with limited fresh water input. True estuarine conditions occur only where bay waters are measurably diluted by fresh water from major winter storms events. Humboldt Bay consists of three arms: South Bay, a wide, shallow southern arm; Entrance Bay, a relatively narrow, deeper central area; and Arcata Bay, the largest arm to the north, also wide and shallow. Humboldt Bay is 14 miles long and 4.5 miles wide at its widest point; its area is 24 square miles at mean high tide and 10.8 square miles at MLLW (Reference 29). Entrance Bay is located directly opposite the ISFSI site and has one deep connecting channel (Samoa Channel) that sets between the two major arms. Entrance Bay is unique as it opens to the ocean, providing daily exchanges of seawater. The entrance to the bay is maintained by concrete and rock jetties, 1.2 miles or longer.

The major regional aquatic habitats of Humboldt Bay estuary can be classified as subtidal channels, intertidal flats, wharves and pilings, jetties and reefs, beaches, and open water (pelagic) areas. The plants and animals of the bay region represent an enormous range of taxons. There is no complete catalog of the species of the bay, though studies have been made of many of the major forms. The information provided in Tables 2.3-7 and 2.3-8 was derived from Reference 14 and includes a representative listing of aquatic species of Humboldt Bay.

Subtidal Channels: Almost all of Entrance Bay and about one-third of South Bay consist of subtidal flats. Water depths over the Entrance Bay flats range up to about 20 ft at MLLW, whereas those over South Bay flats are only about 2 ft at MLLW. These flats provide a habitat for a diverse assemblage of polychaetes, crustaceans, and molluscs (Reference 30).

Subtidal channels are extensions of the subtidal flats that are never exposed. Because of the steeper slopes of the sides and the varying rates of water flow, the substrate composition is highly variable. Subtidal channels run north and south from the Entrance Channel on the west side of Entrance Bay. In South Bay, the main channel divides into Southport and Hookton channels, draining the west and east sides of South Bay, respectively. Hookton Channel runs just southwest of Buhne Point. Channel substrates are highly variable, consisting usually of mud and clay and occasionally sand (Reference 31). Channel depths range from approximately 5 to 30 ft below MLLW (Reference 32). The channels offer passageways for fish in Humboldt Bay as well as habitat for many species of benthic fishes and invertebrates.

Some of the bay region's most economically important clams burrow in to the substrate: Washington (*Saxidomus species*), gaper (*Tesus species*), softshell (*Mya arenaria*), littleneck (*Protothaca staminea*), and bentnose clams (*Mascoma nasuta*) (Reference 32). Dungeness crabs (*Cancer magister*) occur in nearshore waters outside of Humboldt Bay, but some adults are found in the deeper channels within the bay. Some of these crabs reside permanently in the channels, whereas others are in transition from spawning grounds in the mud flats to the waters beyond Entrance Bay (Reference 33). Other important crustaceans in the channels include bay shrimp (*Cragon spp*), pink shrimp (*Pandalus jordani*), rock crab (*Cancer antennarius*), and red crab (*Cancer productus*). The benthic fauna on subtidal flats in the vicinity of the HBPP discharge has been sampled (Reference 34). Substrata were predominantly medium-to-fine sand. One hundred and three different species or taxa were identified. Numerically, polychaetes and crustaceans were the predominant organisms present. Two abundant and widely distributed taxa were glycerid polychaetes and the olive snail (*Olivella biplicata*). Harpacticoid copepods were also found abundant at times. Several species of clams, crabs, and shrimps were collected incidentally.

Mud Flats: Nearly 60 percent of South Bay (4.1 square miles) is exposed at MLLW (References 30 and 35). The only intertidal flats in Entrance Bay, which is in the ISFSI vicinity, is found along the southeast shore, near the HBPP discharge. Substrates in this area are predominantly sand, rather than mud (References 34 and 35). Extensive mud flats surround the entrance to Fisherman's Channel, through which the plant intake draws cooling water from South Bay. Most of the Humboldt Bay region's important clam species can be found burrowing in the mud-flat substrate (Reference 33), including geoducts (*Panope generosa*), gapers (*Tresus species*), Washington (*Saxidomus species*), basket cockels (*Clinocardium nuttallii*), and softshell clams (*Mya arenaria*). Other burrowing organisms are the ghost shrimp (*Callianassa californiensis*) and blue mud shrimp (*Upogebia pugettensis*), which are valued as sport fishing baits. Native oysters (*Ostrea lurda*) occur on the mud flats, usually on the surface or attached to vacant shells, and giant Pacific oysters (*Cassosrea gigas*) are cultured on the bottom muds and suspended rocks by commercial fisherman (Reference 33).

At least three species of crabs including the dungeness crab (*Cancer magister*), red crab (*Cancer productus*), and rock crab (*Cancer antennarius*) are known to use the mud flats in the vicinity of the ISFSI as nursery grounds. Most dungeness crabs eventually migrate to deeper water, but many red and rock crabs remain on the tidal flats, even as adults (Reference 32). Besides serving as habitat for numerous macroinvertebrates, the mud substrate supports a rich assemblage of epibenthic meiofauna. These minute organisms, predominantly harpacticoid copepods, play an important role in the marine food chain.

Eelgrass Beds: In 1959, over 3 square miles of South Bay supported extensive beds of eelgrass (*Zostera marina*), comprising almost all of the South Bay below MLLW. Channels do not support the growth of eelgrass, though some eelgrass does grow on the sides of channels. Channels deeper than approximately 1 ft MLLW probably do not support eelgrass at all (Reference 36).

Many Humboldt Bay region invertebrates are associated with the eelgrass beds, some finding shelter among roots and blades, some attaching directly to the plant's surface, and others using the beds as feeding grounds. Eelgrass itself is an important source of detritus (Reference 37) and a major contributor to the overall productivity of Humboldt Bay (Reference 33).

In Reference 15, epiphytic invertebrates on eelgrass in South Bay were studied and it was found that the dominant sessile forms were bryozoans, hydrozoans, and ascidians. One motile gastropod, the opisthobranch *Phyllaplysia taylori*, is associated with eelgrass, passing through its entire life cycle on *Zostera marina* blades.

Polychaetes and bivalve mollusks, including numerous gaper clams (*Tresus species*), are often found burrowing along eelgrass roots (Reference 38). The eelgrass blades provide excellent cover for juvenile crabs and larval fish, and the associated epiphytes also serve as a source of food. Several shorebirds, most notably the black brant, feed directly on eelgrass. Some fishes, including the Pacific herring, use the eelgrass beds for spawning.

Wharves and Pilings: Wharves and pilings provide a unique habitat for marine organisms. Within the ISFSI vicinity, the many channels branching of Fisherman's Channel at Buhne Point are the sites of numerous piers and pilings. Although most newer pilings are coated with creosote and constitute a poor substrate for bio-foulers, numerous older or unprotected pilings provide substrate for a variety of marine flora and fauna. They are thought to be favorable to the sea anemone *Metridium senile* (Reference 39).

Algae such as the relatively large brown *Desmerestia* species and several smaller forms attach to unprotected pilings, especially near the water line. These pilings are also a favorite habitat for the boring piddocks and shipworms (Reference 33).

Fish and benthic invertebrates seek shelter among the pilings and rubbish associated with piers. The refuse provides attachment sites for many small invertebrates that in turn attract fishes to the area for feeding (Reference 31).

Rocky Intertidal: Jetties and reefs in the Humboldt Bay region include rocky man-made shoreline structures and sunken boats and barges. The shoreline adjacent to the HBPP discharge and near the ISFSI site consists of a rock revetment that extends nearly to MLLW. Similar rock seawalls line portions of Fisherman's Channel in the HBPP intake area. The irregular rocky surfaces of jetties and reefs attract a diverse assemblage of inhabitants, drawing fish from open waters and predators from land and air (Reference 33). They also provide shelter for crabs and small fishes, and attract larger fishes such as lingcod, rockfish, greenling, and cabezon (References 31 and 33). The flora and fauna are similar to those inhabiting rocky shores north of the Humboldt Bay area (Reference 33). The most obvious inhabitants include macroscopic algae, crabs, barnacles, limpets, mussels, and anemones (Reference 33).

In Reference 34, 50 species of macro-algae and 82 species of invertebrates were identified in surveys conducted in 1971 and 1972. The predominant invertebrates were limpets and barnacles. Red algae, anemones, and limpets dominated the 0- to 2-ft tide level, where the bottom is covered and uncovered twice a day. From 2 to 5 ft above MLLW, a variety of green, brown, and red algae were found, as well as limpets, barnacles, crabs, and starfish. This zone is characterized by organisms capable of tolerating more air than water. The high intertidal zone (5 to 7 ft) was inhabited primarily by barnacles and limpets, organisms capable of tolerating long exposures to air. The uppermost zone (7 to 10 ft), receiving only spray from crashing waves, was limited to certain limpets and periwinkles (*Littorina species*).

Beaches: The sand beaches of the Humboldt Bay region are characterized by a high sand-to-silt ratio. They often extend through the intertidal range and are found along the perimeter of the Bay. In the ISFSI vicinity, sand beaches are found near Buhne Point (Reference 33).

Among the intertidal habitats, sand beaches are probably the least productive (Reference 33). Few macroinvertebrates and no attached plants are found in the ocean beach environment because of the unstable, shifting substrate. This may be less the case at bay beaches where substrates are more stable. In the low intertidal and subtidal portions of beaches, frequent inhabitants include Washington, softshell, and littleneck clams (Reference 31).

Open-water (pelagic) areas: The open-water areas of the Bay region provide habitat for a variety of planktonic, and nektonic organisms. Plankton, consisting of phytoplankton and zooplankton, floats or drifts passively with prevailing currents. Nekton is composed of large, motile fishes, crustaceans, and marine mammals.

Fishes within Humboldt Bay: Humboldt Bay has a regionally diverse fish community made up of transient coastal and offshore species and also of year-round residents (see Reference 14 and Table 2.3-8). Common and scientific names for fishes are generally consistent compared with inconsistencies found in plant or marine invertebrate names. Therefore, common names will appear without scientific names. The scientific names for fish resources are contained in Table 2.3-8. The bay supports some commercial fishing and a significant sport fishery (Reference 32). The fishes of Humboldt Bay, including 113 species from 47 families, are listed in Reference 40. Humboldt Bay has been the subject of studies that provide a considerable amount of information on the fish community (Reference 30). In Entrance Bay near the ISFSI site, PG&E (see Reference 41) conducted quarterly fishery surveys in October 1971 and February, May, and July 1972. Of 751 fishes collected, the most numerous were flatfishes at 248, including 131 English sole and 78 speckled sanddab. Eight species of surfperches totaling 239 fish were collected, including 92 redtail, 39 spotfin, and 37 silver surfperch. Eleven topsmelt and 168 jacksmelt (155 of the latter on a single sample date) were taken. Only a few true smelt were collected, and only two northern anchovy and no Pacific herring were reported. In all, 30 species and two undifferentiated families were represented in the collection. An analysis of variance indicated that there were no significant differences between the stations in the number of fish or the numbers of species collected.

The regional distribution of fishes within Humboldt Bay is primarily a function of habitat (Table 2.3-8). Pacific herring spawn in the extensive areas of eelgrass, but most spawning is confined to the North Bay, which has a greater influx of fresh water (Reference 42). English sole juveniles (see Reference 42) and black rockfish juveniles (see Reference 43) are concentrated in intertidal waters when they migrate into Humboldt Bay from the ocean. In the fall, English sole juveniles migrate to the deeper channels before returning to the ocean. Habitat of the surfperches varies considerably (see Reference 44). Shiner perch habitat preference is diverse; white seaperch prefer deep open water and move inshore only to feed; walleye surfperch prefer shallow waters; and striped seaperch prefer rocks, jetties, and piers.

Reference 45 reported more recent (fall 1992 through fall 1997) fish sampling near Fields Landing, just south of the ISFSI site. Although qualitative, the results of the sampling show that bay pipefish, threespine stickleback, and tubesnouts are very abundant over the eelgrass beds adjacent to the Fields Landing Channel. Saddle gunnels and penpoint gunnels were common, but less abundant in these areas. Other species commonly caught over the eelgrass beds, mudflats, and channel areas included California halibut, speckled sanddabs, English sole, starry flounder, northern anchovy, and Pacific sardines. Walleye and shiner surfperches have been caught sporadically in the recent trawling surveys. Limited long-line and gillnet sampling in the deeper water areas of the Fields Landing Channel has captured spiny dogfish and bat rays.

The species composition and seasonal occurrence of juvenile and adult fish of Humboldt Bay were studied in References 46 and 47. The most abundant species were shiner perch, English sole, speckled sanddab, Pacific tomcod, longfin and surf smelt, staghorn and buffalo sculpin, white surfperch, walleye surfperch, Pacific herring, kelp greenling, and pile surfperch. The surfperches were abundant from spring through fall. The flatfishes (English sole and speckled sanddab) were abundant year-round. The other species were either sporadic or year-round residents.

Surfperch adults in these studies were generally abundant only in the spring and early summer, when they bear their young (surfperch are live-bearers). Young were abundant from late spring to the fall, but sharp declines in abundance generally occurred by late fall.

Flatfishes (English sole, speckled sanddab, and starry flounder) were predominantly juveniles of the first 2-year classes. Early juveniles (0.8 to 1.6 inches long) moved into Humboldt Bay during the winter from the ocean, where spawning and early development occur. They remained in the bay for 1 year and returned to the ocean the following spring and summer. Recent distributions of bat rays in Humboldt Bay were reported by Gray (Reference 48).

Pacific herring adults migrated into Humboldt Bay to spawn from early December to early March and returned to the ocean after spawning. Juveniles were common during the rest of the year.

The regional species composition and seasonal occurrence of larval fish in Humboldt Bay were reported in References 49 and 50. The only abundant species collected were bay and arrow gobies, Pacific herring, and staghorn sculpin. These species are predominantly bay spawners (Reference 51). Very few rockfishes, flatfishes, or anchovy larvae were collected. Surfperches are not present as larvae because the young are born as juveniles (1.2 to 2 inches long). Pacific herring larvae are abundant from January through May. Smelt larvae are present year-round. Goby larvae are abundant from April through December.

Phytoplankton: Phytoplankton productivity in the Humboldt Bay region is generally high for coastal marine waters, but is seasonally variable (Reference 33). The vast tidal exchange of bay and ocean waters results in a phytoplankton community similar to that found in nearshore oceanic waters (Reference 33).

In Reference 52, the nearshore phytoplankton of northern California during 1958 to 1961 was examined. The phytoplankton consisted almost entirely of diatoms. Major genera included *Chaetoceros, Coscinodiscus, Nitzschia, Rhizosolenia, Skeletonema, Thalassionema,* and *Thalassiosira*. Of secondary importance were *Bacteriastrum, Biddulphia, Corethron,* and *Eucampia*. Only a few heavy-walled (thecate) dinoflagellates were found.

Reference 52 also noted that the greatest phytoplankton densities and diversity were observed in summer months, and the lowest in winter months. Phytoplankton communities were strongly influenced by the Davidson current and nutrients associated with upwelling. Winter populations were dominated by centric and pennate diatoms that were thick-shelled, heavy-bodied, and devoid of projecting spines or setae. During the spring, genera of larger diatoms such as *Coscinodiscus* and *Nitzschia* became abundant, followed later by *Chaetoceros*. Summer populations reached seasonal peak densities, often caused by blooms of species such as *Rhizosolenia fragilissima*. During the fall, densities declined dramatically. The number of species also fell, from 34 in September to only 6 in November. During all seasons, the phytoplankton was primarily neritic and northern in character.

Diatoms were the preferred food of the northern anchovy (Reference 53). *Coscinodiscus* was the most abundant genus. Other abundant genera were *Thalassiosira, Skeletonema, Biddulphia,* and *Chaetoceros*. The pennate diatom *Pleurosyma species* and benthic diatoms were also taken in abundance.

The phytoplankton of the Humboldt Bay region undergo an annual cycle of increases and decreases in standing crop. Diatoms and dinoflagellates are the predominant groups over the course of a year.

Zooplankton: Zooplankton can be subdivided into holoplankton and meroplankton. Holoplankton consists of copepods, ctenophores, and other groups that remain floating throughout their life cycle. The meroplankton consists of forms such as eggs and larvae of fish (ichthyoplankton) or benthic organisms that are temporary members of the plankton community, but eventually develop into benthic or nektonic forms. PG&E (see Reference 41) sampled the zooplankton entrained at HBPP monthly during 1971 to 1972. The most abundant zooplankton in the vicinity of the ISFSI were copepod taxa *Acartia clausi, Oithona similis, Acartia species,* copepodites, Harpacticoida, and *Calanus species* Nauplii. In the more regional North and South Bays, in addition to marine copepods such as *Acartia causi*, estuarine forms such as *Acartia tonsa* and *Eurytemora affinis* are also abundant at certain times (References 54 and 55). The copepod fauna of Entrance Bay, across the bay from the ISFSI site, is similar to that found in the nearshore Pacific (Reference 33). The zooplankton biomass of Humboldt Bay is relatively low compared to that of other estuaries (References 55 and 56). This may be a result of the rapid flushing of the bay through tidal exchanges (Reference 56).

Meroplankton is rarely a significant part of the zooplankton biomass of the Humboldt Bay region, except in Entrance Bay (References 55, 56, and 33). The primary meroplanktons in North Bay are *Balanus species* Nauplii, pelecypod (clam) veligers, and polychaete larvae (Reference 56). PG&E (see Reference 41) found *Balanus species* Nauplii and polychaete larvae to be the most abundant meroplankton entrained at HBPP, representing about 26 percent and 3 percent of the entrained zooplankton, respectively. Other crustacean and pelecypod larvae were minor components of the entrained zooplankton, constituting only 1 to 2 percent of the total.

Northern Coastal Waters: The major aquatic habitats of the Pacific Ocean outside the Humboldt Bay estuary are similar to the jetties and reefs, beaches, and open water (pelagic) areas within the bay. The plants and animals of the open ocean within a five mile radius of the ISFSI represent an enormous range of taxons. Because many of the species occur inside Entrance Bay, Tables 2.3-7 and 2.3-8 include a representative listing of aquatic species of the northern California coastal waters. Although regional in scope, it is convenient to discuss the organisms of the coastal area in a geographic context according to their taxonomic level beyond the Humboldt Bay region.

Fishes of Northern California Coastal Waters: The fishes of northern California waters are characteristic of the general fish fauna found along the Pacific Coast from Baja California to Alaska. The major groups of fishes in these waters are flatfishes, rockfishes, anchovies, silversides, smelts, herrings, salmons, sea basses, gobies, surfperches, sculpins, cods, sharks, and rays (Reference 57). The following species are important components of the northern California commercial fish catch: salmon, albacore, rockfishes, flatfishes (including Dover sole, petrale sole, English sole, rex sole, and sanddab), sablefish, and lingcod (References 58 and 59).

The most abundant fishes in California coastal waters are the northern anchovy and Pacific herring (Reference 60). Pacific herring are concentrated in northern California waters near larger coastal bays such as Humboldt Bay (Reference 61), including stocks located near central and southern Baja California, northern Baja and southern California, and from northern California to British Columbia. The northern stock is concentrated between Point Reyes and Monterey Bay, and the northern anchovy is far less numerous in Humboldt Bay than in San Francisco Bay.

The surfperches, rockfishes, and flatfishes are probably the next most abundant coastal fishes along the Pacific Coast. Surfperches and flatfishes are generally distributed from California to British Columbia (Reference 57). The rockfishes have a variable distribution (depending on the species) between Baja California and Alaska (Reference 62).

Reference 63 described the species composition and abundance of fish eggs and larvae in coastal (1 to 12 miles from the coast) and offshore (23 to 68 miles) waters of Yaquina Bay, Oregon. The area is similar in species composition, seasonality, and inshore-offshore assemblages of larval fishes to other areas of the broader shelf-slope area in the northeast Pacific. The fish larvae most abundant in coastal waters were smelt (*Osmeridae*), Pacific tomcod, and flatfishes (primarily English sole and butter sole). Northern anchovy and rockfish larvae were far more abundant offshore. Peaks in larval abundance occurred from May to July during the upwelling season.

The open-water areas also provide habitat for a variety of marine and anadromous fishes. Marine species are distributed throughout the bay. Important fish groups include sharks, skates, rays, silversides, herrings, surfperches, sculpins, flounders, and salmon.

Marine Mammals: Marine mammals found in northern coastal waters include sea lions, fur seals, harbor seals, dolphins, and porpoises (Reference 32). Most of these mammals represent migratory populations, and the local populations vary accordingly. The most common mammals are the Pacific harbor porpoise, a regular visitor to the bay, and the harbor seal. The Humboldt Bay region serves as a pupping area for the latter. The common dolphin (saddle-backed dolphin) and the Pacific bottlenose dolphin are seen offshore but seldom in the bay. The northern sea lion and the Steller sea lion also venture into the bay, but are more common in the ocean.

Commercially and Recreationally Important Species: Reference 45 reported the most recent fin fishery catch statistics for the Humboldt Bay region. During the period 1980 through 1986, the five most abundant fish species caught in Humboldt Bay sport fishery were kelp greenling (19 percent of total catch for period), striped surfperch (18 percent), red-tailed surfperch (16 percent), black rockfish (13 percent), and walleye surfperch (13 percent). Five species of surfperches accounted for about 61 percent of the total sport fishery harvest in Humboldt Bay during this survey. Most of the fish were landed by anglers fishing from the South Jetty, though anglers fishing from South Bay access points (King Salmon, Fields Landing) harvested about 32 percent of the bay recreational catch. Reference 45 concluded that while dated, these figures probably still accurately reflect the current recreational fishery in Humboldt Bay, with the exception of the red-tailed surfperch, which is no longer as abundant in the creel of bay anglers.

Reference 64 surveyed sport fishing near the ISFSI site between July and October 1974. Fishing was done both from boats and along the shoreline, but 95 percent of the angling was by shore fishermen. One-half of all the shore fishing was done adjacent to HBPP near the ISFSI site and resulted in more than 90 percent of the catch reported. The catch rate was 1.5 fish per angler-hour. Reference 65 reported a catch rate of 1.2 fish per angler-hour from the PG&E jetty near the ISFSI site, and Reference 61 found a catch rate of 0.7 fish per angler-hour at the Buhne Point Jetty, also near the ISFSI site. In a survey (Reference 64), 14 species of fish were reported by the anglers interviewed or observed, and surfperches, constituting 75 percent of the catch, were most abundant. Red-tailed surfperch (50 percent of the catch) was the most abundant single species, followed by silver surfperch (16 percent), jacksmelt (2 percent) and rockfish (3 percent). Similar species compositions were reported in References 64 and 66. Sportfishing is best between October and May, when jacksmelt are available to shore anglers (Reference 66).

Reference 31 described the Humboldt Bay region as a nursery area for English sole, lingcod, and kelp greenling. Salmon and steelhead use the bay for feeding. The major sport fishes are surfperches (primarily shiner, redtail, striped, and walleys surfperch), jacksmelt, black and blue rockfishes, kelp greenling, northern anchovy, and Chinook salmon.

Special Status Estuarine and Marine Aquatic Species: PG&E-owned land, including the ISFSI site was inventoried for the presence of threatened and endangered aquatic species in 1999 and 2002 (Reference 10). No special status aquatic species have been observed on PG&E property or at the ISFSI site. In the vicinity of the project, five special status species of fish (tidewater goby, Chinook salmon, coho salmon, steelhead, and coastal cutthroat trout) occur or have the potential to occur based on the presence of suitable habitat. Table 2.3-9 lists special status marine and estuarine aquatic species that are known to occur in the vicinity of the ISFSI project (Reference 7and 10). Lack of suitable habitat for these species indicates that they are not present at the ISFSI site. Harbor seals, *Phoca vitulina*, do not have official status as a listed endangered or threatened species; however, they are protected under the Marine Mammal Protection Act. Harbor seals are year-round residents of the Humboldt Bay region. 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 South Bay is a key breeding and hauling-out area used by harbor seals.

Keystone Species: There are several possible keystone species in the vicinity of the ISFSI. The nearby estuarine mud flats are probably the most ecologically important aquatic habitat. They provide habitat for a wide variety of invertebrates and small fishes, as well as nursery grounds for several species of fish and crabs and feeding areas for larger fish and shorebirds. In a study of the availability of mudflat invertebrates as food for shorebirds, Reference 67 observed 56 species of invertebrates. It found the bentnose clam (*Mascoma nasuta*), the California lyonsia clam (*Lyonsia californica*), and a polychaete *Notomastus tenuis* to be the most important species in terms of biomass. Numerically abundant were the polychaete *Notomastus tenuis*, the tenaid *Letochelia dubia*, and the clam *Tansenella tantilla*. As these estuarine organisms are a vital link in the shore bird food chain, they are potential keystone species. Potentially, a substantial loss of habitat for these invertebrates could depress populations of important prey species and therefore could have a major influence on the community stability of predator species. Trophic level carnivores, particularly shore birds, occur in relatively small numbers compared to their abundant prey (invertebrates). As prey populations decline, relative populations of certain shore bird predator species would similarly decrease potentially changing the stability of the community structure and composition of the habitat.

2.3.2.2 Freshwater Ecology

Buhne Slough drains the ISFSI site and much of the coastal marsh immediately adjacent to the site. The slough is narrow and winding, eventually draining into a portion of the intake canal, located south of King Salmon Avenue. The productivity of the slough is high, largely autotropic with only minor fish populations. The slough is a favorite shorebird feeding area, with an abundance of small invertebrates.

The two streams immediately north and south of the ISFSI site, Elk River and Salmon Creek (see Figure 2.3-1), have their origins in forested basins; however, in their lower reaches near the bay, these streams flow through agricultural areas and are subject to high suspended solids. They are utilized for farm irrigation briefly in the summer and for livestock water year-round. Productivity of these streams is largely governed by sediment loading. Algae blooms are frequent and the tropic chain primarily consists of algae-periphyton-benthic invertebrates (including imago stages of mayflies) and other ephemeral dipterans, benthic feeding fish, and their small fish predators. Amphibians are plentiful, even in late winter.

Commercially and Recreationally Important Species: There are no commercially and recreationally important freshwater species at the ISFSI site.

Special Status Freshwater Aquatic Species: PG&E-owned land in the vicinity of the ISFSI site was inventoried for the presence of special status freshwater aquatic species in 1999 and 2002 (Reference 10). No special status freshwater aquatic species have been identified on the ISFSI site. Table 2.3-10 lists five special-status aquatic species that occur in the vicinity of the ISFSI project (northern red-legged frog, foothill yellow-legged frog, tailed frog, southern torrent salamander, and northwestern pond turtle). The northern red-legged frog occurs in the extreme northern portion of California (see Reference 68) and could occur in the ISFSI vicinity if habitat were available. Northern red-legged frogs live in quiet pools in streams and ponds with emergent vegetation for cover. Small coastal drainages appear to be the only regions still supporting significant numbers of this species. Although several populations are known from Humboldt County, none appear to occur at the ISFSI site. Habitat assessment using U.S. Fish and Wildlife Service approved procedures, conducted in August 1999, found that the ISFSI site and surrounding PG&E property, have limited habitat that is suitable for northern red-legged or tailed frogs because of the lack of freshwater streams. Although no frogs or tadpoles were observed at the ISFSI site, a small stream directly east of the intake canal has limited potential to be a low-quality breeding habitat for the northern red-legged frog. Additionally, there are freshwater ponds with cattails near Highway 101 that could provide foraging and dispersal habitat for northern red-legged frogs. No suitable habitat for tailed frogs was found at the ISFSI site or adjacent PG&E property. A paucity of suitable habitat of these species indicates that they are unlikely to be present at the ISFSI site. No suitable habitat was found for the southern torrent salamander, the foothill yellow-legged frog, or the northwestern pond turtle at the ISFSI site or on the adjacent PG&E property.

Keystone Species: There are no keystone freshwater species present on the ISFSI site.

2.3.3 PRE-EXISTING ENVIRONMENTAL STRESSES AND STATUS OF ECOLOGICAL SUCCESSION

Pre-existing environmental stresses at the ISFSI site stem largely from prior activities associated with construction and operation of HBPP and associated switch yards. These activities included removal of native vegetation, cut-and-fill impacts to the natural soil profile, diversion of the natural stream channels, soil compaction, surface paving, and control, treatment, and discharge of surface water runoff. Additional stresses include vegetation management along access roads, buildings, and other structures, and pavement maintenance. Operation of HBPP extracts water from the bay, heats it, and returns it. Ecological succession of vegetation at the immediate ISFSI site including the proposed fill disposal area has been arrested and held either at a bare ground stage, or an early successional stage of coastal headland characterized by several species of non-native annual grasses and low growing herbaceous plants. Ecological succession of aquatic organisms at the ISFSI site has been altered and succession has likely been retarded for more sensitive marine, estuarine, and fresh-water species.

2.3.4 HISTORIC EFFECTS ON LOCAL POPULATIONS (INFESTATIONS, EPIDEMICS, AND CATASTROPHES)

In the ISFSI vicinity and surrounding region, the greatest single historic effect on naturally occurring aquatic species may have occurred as a result of diking and draining of the bay for agricultural use, primarily grazing, beginning in the 1880s. Much of the shoreline of Entrance Bay is now occupied by port facilities for shipping, commercial fishing, and associated services that have expanded over the years. A number of other industrial sites are situated at various locations around Humboldt Bay. The remaining shoreline is used for agricultural purposes or remains undeveloped. Rapid wetland changes occurred after the completion of the Northwestern Pacific Railroad along the eastern margins of Humboldt Bay in 1901. The railroad functioned as a dike in most locations, and tide gates were placed at almost all slough crossings. Many wetlands were converted to agricultural land, and seasonal wetlands were used for grazing. By 1927, with the construction of Highway 101 and the associated filling, most of the marshes east of Humboldt Bay had been diked and drained (Reference 69). An area of dunes at the Buhne Point sandspit was restored by revegetation with native plants in a 1985-1986 experiment (Reference 70). Oil spills have occurred infrequently in Humboldt Bay with notable effects on estuarine habitats. The most recent spill (September 8, 1999) littered the beaches outside of Humboldt Bay with asphalt-like tar balls when 2,000 gallons of fuel oil leaked from a damaged dredge vessel fuel tank. Hundreds of shore birds were contaminated by the spill.

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2.4 CLIMATOLOGY AND METEOROLOGY

2.4.1 REGIONAL 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 are frequently observed. Winters are wet, with frequent passage of Pacific storms and temperatures are mild.

Because of close proximity to the ocean and bay, the region experiences high relative humidity throughout the year. The humidity is generally highest in the late night and early morning hours when the coastal stratus clouds and fog are most prevalent. At these times the humidity averages 87 percent. During the late morning and early evening hours, the humidity decreases to an average of 78 percent.

The coastal range mountains extend south from the state of Washington to near San Francisco, passing around the Humboldt Bay region. The coastal hills surrounding Humboldt Bay begin with Patrick's Point, 30 miles to the north, and then extend 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 ft, with the highest point (Kings Peak) reaching 4,087 ft, 40 miles directly south of Eureka. These hills greatly modify the rainfall and temperatures of the region by creating a rain shadow and sheltering the region from the brunt of the heavier rainfall and temperature extremes.

As winter storms move in from the Pacific and Gulf of Alaska, the prefrontal winds are generally from the southeast to southwest. Over the Humboldt Bay region, the hills generally deflect these winds south to southeast. After frontal passage, the winds are generally from the north to northwest.

The cold and unstable air that follows many of the winter systems causes Eureka to experience most of its thunderstorm activity. This is also when the region receives most of its hail and/or ice pellets (note that thunderstorms in the summer are extremely rare).

In the adjacent ocean water, the California current flows south along the coast constantly modifying the colder air behind any frontal activity. The sea surface temperature averages 50 to 52°F in the winter and protects Eureka from the frigid temperatures that accompany winter storms.

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 stratus usually retreat offshore late in the morning and early afternoon and returns during the night.

The marine layer is typically 800 to 1,500 ft thick. There are also periods when the day to night cycle is broken, and the entire area remains under continuous low clouds and fog for days on end.

2.4.1.1 Temperature, Dew Point Temperature, and Relative Humidity

Temperatures in Eureka and much of the surrounding bay experience relatively small change in the daily and seasonal ranges. In the summer, the daily average range of temperatures is within 10°F, but with fog and stratus over the area, the daily range can be as low as 2°F. In the winter, the average daily range is larger with an average 14°F spread.

Most summertime record high temperatures occur when offshore flow develops when the inland valleys are under the influence of a thermal low-pressure trough. As the thermal low moves west towards the coast, the stratus and fog disappear and clear weather prevails over much of the region. The ambient temperature range has varied from a low of 20°F recorded on January 14, 1888, to a high of 87°F recorded on October 26, 1993 (Reference 1).

Other temperature statistics include:

• Coldest Maximum Temperature	33°F on Feb. 08, 1900
• Highest Daily Average Temperature	73°F on Sept. 21, 1939
• Warmest Minimum Temperature	63°F on Aug. 27, 1894, Feb. 26, 1980, Jan. 14, 1981
• Lowest Daily Average Temperature	28°F on Jan. 14, 1888
• Number of days per year when high or low Temperature is:	
⇒ Greater than 90°F	0 (Period of record 1941 - 1992)
⇒ Less than 32°F	5 (Period of record 1941 - 1992)

Based on hourly observations at Arcata/Eureka National Weather Service Station during 1949 to through 2001, daily and monthly averages of temperatures, dew point temperature, and relative humidity representative of the Independent Spent Fuel Storage Installation (ISFSI) project area are presented in Table 2.4-1. Within that data period the maximum and minimum observed dew point temperature was 68°F and 3°F, respectively, and the maximum and minimum observed relative humidity was 100 and 9 percent, respectively (Reference 2).

2.4.1.2 Precipitation

Precipitation records at Eureka are representative of the ISFSI site. During the rainy season, generally November through March, Eureka receives about 75 percent of its average annual rainfall, with greatest monthly totals in December and January. The average annual rainfall over the 110 year measured record at Eureka is 38.87 inches.

This is one of the lowest averages in northwest California and is caused by a rain shadow due to the surrounding hills and minimal uplifting along the immediate west facing beaches. The rain shadow effect can be seen by comparing Eureka's average rainfall with nearby sites surrounding the area. For example, at Patrick's Point State Park, 24 miles north of Eureka, the average is 60.79 inches and at Scotia, 23 miles south, the rainfall averages 47.20 inches and at Willow Creek, 29 miles east of Eureka, the average is 48.34 inches (Reference 1). There is clearly substantial variation within relatively small distances. Table 2.4-2 shows a list of maximum rainfall statistics and several calculated return periods (Reference 3). Annually, there is an average of 117 days with precipitation greater than or equal to 0.01 inch and 8 days with precipitation greater than equal to 1.00 inch, based on the 1971 to 2000 period (Reference 4).

In general, frozen precipitation falls as small hail or ice pellets. This occurs after the passage of a moderate to strong cold front, with its cold unstable air mass. Eureka has received snow on rare occasions, and because it is so rare, annual normal snowfall is just a trace (0.3 inches). The record storm of 1907 produced most of Eureka's snowfall records. There are 12 other snowfalls of note during the 110-year database. All other snowfall events have been less than 1 inch, and the majority of those have been reported just as a "Trace" (Reference 1). Table 2.4-3 shows the design basis snowfall parameters applicable for Humboldt Bay Power Plant (HBPP). No published statistics were available for the frequency of ice storms in the Eureka area.

2.4.1.3 Winds

The wind direction and speeds in Eureka are governed by the seasonal location of the eastern Pacific high pressure system and the low pressure systems that bring the winter storms to the northwest coast. For about 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 southeast as the weather is largely influenced by low-pressure systems that originate in the Gulf of Alaska. Figure 2.4-1 shows the directional distribution based on the period 1905 through 1996.

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 down slope flows from the surrounding hills. Eureka's highest daily wind speed is 38.2 mph for the 24-hour period on April 29, 1915. The highest peak gust is 69 mph and was recorded twice, both in 1981 with first occurred on January 21 and the second on November 13. Table 2.4-4 shows peak gusts recorded at Eureka between 1887 and 1996 (Reference 1). The 50-year return period for a 1-minute average wind speed is 58 mph with an expected 50-year peak gust of 71 mph (Reference 5).

2.4.1.4 Tornadoes and Thunderstorms

The Eureka area experiences relatively few tornadoes. Over the period 1950-1995 there was one tornado recorded in the Eureka area. It occurred on March 29, 1958, and was reported as an F2 in force (winds 113-157 mph) on the 7 point Fujita scale F0 to F6 (Reference 6).

During the wet season, the thunderstorm frequency is one day per month (Table 2.4-5). Only infrequent (less than one per day per month) thunderstorm activity occurs during the dry season. There is no published information on the frequency of lightning strikes.

2.4.1.5 Solar Radiation

Solar radiation data considered representative of the HBPP ISFSI site are available from the Renewable Resources Data Center's website http://rredc.nrel.gov/. Statistics of measurements made at Arcata Airport during 1961-1990 are available. Arcata Airport is located about 17 miles north-northeast of the ISFSI site. Maximum flat-plate solar radiation measured at the Arcata site was 7.0 kwh/m^2/day in May. This is equivalent to 602 g-cal/cm^2/day.

2.4.1.6 Existing Air Quality

The Humboldt Bay ISFSI site is located within the North Coast Unified Air Quality Management District (NCUAQMD). This agency monitors the air quality in the area and publishes air quality information pertinent to the ISFSI. U.S. Environmental Protection Agency and California Air Resources Board have set ambient air quality standards for criteria pollutants to protect human health; the listed criteria pollutants are ozone, sulfur dioxide, nitrogen dioxide, particulate PM10, carbon monoxide, sulfates, lead, hydrogen sulfide, and vinyl chloride. Based on information from the NCUAQMD, the ambient air quality at the ISFSI site meets national and state standards for all criteria pollutants except particulate PM10. Particulate PM10 is matter less than 10 microns in size and is regulated by air quality standards (Reference 7). Ambient air concentrations of particulate PM10 would not impact the operation of the ISFSI facility.

Based on the attainment status with all other ambient air quality standards, there would be no existing air quality impact on the operation of the ISFSI facility.

2.4.2 LOCAL METEOROLOGY

Meteorology for the HBPP was reviewed as part of the Environmental Report for Decommissioning in July 1984 (Reference 8). Data acquired by the National Weather Service (NWS) and other sources are summarized below. The first Eureka weather station was established by the U. S. Army Signal Service on December 1, 1886. Since that date there has been continuous weather observations within the region. The current NWS Office is currently located on Woodley Island about 6 miles northeast of HBPP. All of the data described in Section 2.4.1, except the tornado data, were compiled from local meteorology. Figure 2.4-2 shows the average rainfall recorded at Eureka and Figure 2.4-3 shows the maximum rainfall for each month over the 110-year period of record. Figure 2.4-4 shows the average temperature by month over the period of record and Figure 2.4-5 shows the maximum and minimum temperatures at Eureka (Reference 1). A map showing the detailed topographic features within 8 km is shown in Figure 2.4-6 and a smaller scale map of topographic features out to 16 km is shown in Figure 2.4-7. Profiles of maximum elevation versus distance from the ISFISI site, out to 16 km, for each 22.5 degree compass point sectors are shown in Figures 2.4-8, a-i. Note that sectors 247.5 through 067.5 degrees are over the ocean and are not shown.

2.4.3 ONSITE METEOROLOGICAL MEASUREMENT PROGRAM

Table 2.4-6 shows the joint frequency distributions of wind speed, direction and atmospheric stability class for data collected onsite. The distributions are for stability Classes A through G, as defined in Regulatory Guide 1.23. Figure 2.4-9 shows the windrose for the data collected at the project site during the 1966-1967 period. Specifications of those measurements are given in the Final Hazards Summary Report (Reference 9). Table 2.4-7 shows the average mixing height for the Eureka area by season for morning and afternoon (Reference 10).

There is no ongoing meteorological measurement program at HBPP. Meteorological measurements are made by the NWS at their Woodley Island offices. In support of on-going ISFSI operations, PG&E will use the data measured at NWS Woodley Island in lieu of an onsite measurement program at HBPP. The Woodley Island location is about 6 miles northeast of HBPP. The general topography at Woodley Island is flat, which is similar to the ISFSI site, and the regional topography involving the coastline and hills/mountains are similar for the two areas as well. The intervening area between the Woodley Island site and HBPP is a relatively flat plain that lies adjacent to the water edge in the Humboldt Bay. Based on proximity and these regional topography factors, winds measured at Woodley Island are considered representative of winds at the ISFSI site.

2.4.4 DIFFUSION ESTIMATES

2.4.4.1 Basis

No routine or accidental releases are planned or postulated as a result of ISFSI operation in accordance with NRC Interim Staff Guideline 18 (Reference 11). Nevertheless, atmospheric dispersion factors (χ/Qs) were developed for the site, for long-term average and for short-term worst case meteorological conditions. The χ/Q values for these conditions have been determined in accordance with Regulatory Guide 1.145 (Reference 12).

2.4.4.2 Diffusion Modeling for Normal Operations and Anticipated Occurrences

Atmospheric dispersion factors (χ/Q) were modeled as follows (Reference 13):

- The dispersion factors were developed from meteorological data collected at the top of a 250 foot tower located at the ISFSI site during 1966 and 1967. Wind speed (10 minutes average) was classified into hours of occurrence for 8 wind speed intervals, 7 atmospheric stability classes, and 17 direction intervals (the data for "calm" was listed in the same manner as data for 16 compass direction sectors).

- To develop dispersion factors for each combination of wind speed, direction, and stability class, the hourly occurrence data for each wind speed interval was assigned a mean wind speed equal to the average speed for the interval. These mean wind speeds were adjusted to account for decreased wind speed closer to the ground. The adjustment is for the change from the measurement elevation to 10 meters above grade.

- Data for calm conditions (i.e., without an associated compass direction measurement) was assigned a nominal wind speed equal to 0.1 m/sec, and distributed equally over 16 sector directions.

- A release at the surface (H=0) is assumed. Short-term dispersion factors were then calculated for each hourly combination of stability class and wind speed, following the steps of the procedure presented in Figure A-1 of Regulatory Guide 1.145 (Reference 12) to account for the combined effects of increased plume meander and building wake on diffusion during light winds and stable or neutral atmospheric conditions. The calculation used a distance of 100 meters for all sectors, and the approximate cross-sectional area of one cask (13 square meters) for the building wake correction.

- The largest hourly dispersion factor is selected as the most conservative short term dispersion factor for the ISFSI location.

- For each of 16 sector directions, the hourly dispersion factors for each combinations of stability class and wind speed are multiplied by the observed fractional frequency of occurrence of each combination of stability class and wind speed, and the products are summed to produce the annual average dispersion factors for the sector.

- Finally, the largest annual average dispersion factor of any of the sectors is selected as the annual average dispersion factor for the ISFSI location. This dispersion factor is appropriate estimating airborne pathway exposure for an individual who may remain at the 100-meter distance throughout the year in the direction expected to have the highest annual average air concentration.

The onsite meteorological data given in Table 2.4-6 were used in the model analysis. The modeled short-term and annual (χ/Q) factor results are shown in Tables 2.4-8 and 2.4-9, respectively.

2.4.4.3 Calculations – Worse Case Short -Term Event

The short term dispersion factor (χ/Q) was determined to be 1.51 x 10^{-1}sec/m^3. This represents conditions of atmospheric stability class G, which is more conservative than required by NUREG-1567, and a "calm" 10 meter wind speed equal to 0.1 m/sec. During the 2 years of data collection, this condition was observed for 89 hours out of 16,900 hours (0.53 percent of the time). A map showing the ISFSI source location, other features of the HBPP, and the fence line is shown in Figure 2.1-2.

2.4.4.4 Calculations – Long -Term Dispersion

The sector identified as 360 degrees (i.e., wind from true North) has the least atmospheric dispersion (i.e., It has the highest annual average dispersion factor). The factor for the sector is 7.66 x 10^{-4} sec/m^3.

2.4.5 REFERENCES

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4. 2001 Local Climatological Data, Annual Summary with Comparative Data, Eureka, Publication of National Oceanic and Atmospheric Administration, California; National Climatic Data Center, Ashville, N.C.

5. Holets, Extreme Wind Speed Estimates Along PG&E Transmission Line Corridors, PG&E R&D Report 006.4-90.6, May 1990.

6. California Tornadoes 1950-1995, (http://www.tornadoproject.com/alltorns/astorn.htm).

7. North Coast Unified Air Quality Management District, "North Coast Air Quality Facts", 2000 (Http://www.ncuaqmd.org/documents/AIRFACTS.PDF)

8. Environmental Report for HBPP Decommissioning, July 1984.

9. HBPP Unit 3 Final Hazards Summary Report, September 1, 1961.

10. Holzworth, Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States, EPA, 1972.

11. USNRC Interim Staff Guidance document 18, "The Design/Qualification of Final Closure Welds on Austenitic Stainless Steel Canisters as Confinement Boundary for Spent Fuel Storage and Containment Boundary for Spent Fuel Transportation".

12. Regulatory Guide 1.145, Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants, US NRC, 1983.

13. Calculation N-273, Revision 0; HBPP ISFSI – Annual Average Meteorological Dispersion Factor.

2.5 HYDROLOGY

The data and analysis in the surface hydrology section were obtained from material presented in the "Memorandum Report: Flood Hydrology for the Decommissioning of HBPP Unit No. 3," dated June 1985 (Reference 1), supplemented where appropriate with information contained in the "HBPP Final Hazards Summary Report" (Reference 2) and the "SAFSTOR Environmental Report" (Reference 3). The data and analysis in the subsurface hydrology section are referenced throughout the text.

2.5.1 SURFACE HYDROLOGY

The Humboldt Bay Independent Spent Fuel Storage Installation (ISFSI) lies in the Eureka Plain Sub-basin of the North Coast Basin. The Eureka plain drainage basin is within the hydrologic unit defined as the Redwood Creek-Mad River-Humboldt Bay Unit. This unit can supply water to an area with a projected population of 80,000. Redwood Creek discharges directly into the Pacific Ocean 38 miles north of the ISFSI site, independent of Humboldt Bay. The Mad River flows west approximately 13-15 miles northeast of the site. The only major surface water storage in the area is provided by the 2.7-billion gallon capacity Ruth Reservoir on the Mad River, which regulates municipal and industrial water supply for the Arcata-Eureka area. The Mad River Sub-basin presently exports water to the Eureka Plain Sub-basin, which enters the Pacific Ocean independent of Humboldt Bay. The mouth of the Eel River lies approximately 8 miles south of the site. The Eel River also discharges directly into the Pacific Ocean. This river is not used for potable water supply within 25 miles of the site.

With respect to the ISFSI site, the watersheds of Humboldt Bay and the bay itself are the most relevant surface water bodies (see Figure 2.5-1). The four major creeks that drain into Humboldt Bay are Freshwater Creek, Elk River, Salmon Creek, and Jacoby Creek. Several smaller tributaries also drain into the bay. Salmon Creek and Elk River are the nearest streams to the site; both within a mile south and north of the ISFSI site, respectively. Salmon Creek and Elk River are used for watering livestock, but are not used as a potable water supply.

Freshwater Creek is the largest drainage basin in the drainage system, it drains an area of 61.73 square miles. It rises in the north-central part of T.4N, R.2E; flows west 5 miles, then northwest into the north end of Humboldt Bay. The creek has a length of 13 miles.

Elk River drains an area of 51.3 square miles. It rises in the central part of T.3N, R.1E; then flows northwest and discharges into Humboldt Bay near the town of Elk River. The river has a length of 12 miles with North and South Forks as principle tributaries.

Salmon Creek drains a total area of 28.30 square miles. It rises in the central part of T.3N, R.1E, Humboldt base and meridian. It flows west 9 miles, then northwest about 4 miles to the western part of T.4N, R.1W; where it enters the south end of Humboldt Bay. The lower course of the creek is marshy.

Jacoby Creek drains an area of 16.40 square miles. It rises in the northern part of T.4N, R.2E; flows northwestward to the northern part of T.5N, R.1E; then it enters the north end of Humboldt Bay. The creek has a length of about 8 miles.

Other small tributaries in the watershed that drain into the bay are called sloughs.

2.5.1.1 Humboldt Bay

Humboldt Bay is a tidal bay receiving and discharging ocean water through its inlet. Figure 2.5-1 shows Humboldt Bay divided into an entrance bay extending from Buhne Point to the mouth of the Elk River; a south bay, south of Buhne Point; and a north bay, north of the mouth of the Elk River and including Arcata Bay. Very little fresh water discharges into Humboldt Bay.

Humboldt Bay is a large, shallow body of water with deep channels. It is separated from the ocean by two long, narrow spits. The middle portion of the bay is joined to the ocean by a narrow channel passing between the north and south spits. The bay is approximately 14 miles long, its width ranges from 0.5 miles near its middle to over 2 miles at the south end and 4 miles at the north end, with an average depth of 12 ft mean lower low water (MLLW).

Humboldt Bay can be separated into three distinct units: South Bay, extending from Table Bluff to Buhne Point; Entrance Bay, extending from Buhne Point to the mouth of the Elk River; and North Bay, extending from the river mouth to the Arcata Bottoms. South Bay is a broad, shallow area approximately 4 miles long and 2 miles wide. Southport and Hookton channels, draining the west and east sides of South Bay, respectively, are long, narrow, fairly deep channels. Entrance Bay is an oval-shaped area directly inshore from the entrance channel. Except for the west side, where the main channels flow north and south, there is a broad shoal area. Its area is 2.9 square miles. The area exposed at low tide is nearly all sand beach. North of Humboldt Bay is a broad, shallow area drained by three channel systems which combine northwest of the Eureka waterfront into a narrow deep-water channel communicating with Entrance Bay. Eureka Channel drains the southern edge of North Bay, a large area of flat farmland, and receives runoff from the Freshwater Creek watershed. Arcata Channel drains the large central portion of North Bay and receives the runoff from Jacoby Creek and minor tributaries flowing through Arcata.

North and South Bays have mud bottoms for the most part, although there is one exception in each bay. Sand Island in North Bay is a sandy hummock surrounded by mud flats. A flat near the junction of Hookton and Southport channels in South Bay is made up of firm black sand. Entrance Bay, however, has a sand bottom, with abundant broken clam shells in some areas.

The tides of Humboldt Bay are of moderate height. The mean and diurnal tide ranges are 4.3 ft and 6.2 ft at the entrance, 4.8 ft and 6.6 ft at Hookton Slough, and 5.0 ft and 7.0 ft at Arcata Wharf. Because the bay is so shallow, its tidal prism is large in comparison to its low-tide volume. The average volume of the tidal exchange from a higher high to a lower low tide amounts to approximately 61,000 acre-ft, or 44 percent of the mean higher high tide volume. Since this water is replaced by the subsequent tide, water quality conditions in the ocean have a considerable influence on water quality and ecological characteristics of the bay.

2.5.1.2 ISFSI Site

The ISFSI site is located on a relatively flat area on Buhne Point at elevation 44 ft MLLW. Surface drainage around the ISFSI area flows naturally into the existing plant drainage system. By way of the plant drain system, the surface water then discharges into the cooling water intake canal, flows through the plant, and discharges into Humboldt Bay via the cooling water discharge canal. Outside the area served by the plant drainage system, most of the surface runoff drains to the east and into the discharge canal. The remainder drains into Buhne Slough, a natural drainage for the area, which drains directly into both the intake canal and Humboldt Bay.

2.5.2 FLOODS

2.5.2.1 Site Flooding

The elevation of the ISFSI area is approximately 44 ft above MLLW. This elevation is approximately 32 ft higher than the main power plant level. Thus any drainage will be away from the ISFSI area, and flooding is not a concern.

2.5.2.2 Probable Maximum Flood (PMF) on Streams, Rivers, and Bay

The climate of the ISFSI site and vicinity, characteristic of most of California, is divided into a wet and a dry season. Most of the rainfall occurs from storms during the wet season, which extends from November through March. About 75 percent of the annual precipitation occurs during this season. The dry season extends from May through September, and only 10 percent of the average annual precipitation is contributed during this period. The rest of the annual precipitation is contributed during the transitional months of October and April.

The mean annual precipitation at the site is approximately 40 inches. The mean annual precipitation at Eureka from 1948 through 2002 as published by the National Climactic Center (Reference 4) is shown in Figure 2.5-2. The normal monthly precipitation data for Eureka are shown in Table 2.5-1.

Major floods in the study area have all occurred during the winter months, as a combination of rainfloods and high tides.

The rainfloods have sharp high peaks and are usually of short duration and comparatively small volume. Because of the relatively low elevation of the area, snowfall and snowmelt are not considerations for flooding in the area.

Table 2.5-2 shows historic annual maximum peak flows measured at two stream gages in the basin for rainfloods. The Elk River Station, 11-4797, is located near Falk and the Jacoby Creek Station, 11-4800, is located near Freshwater.

Water surface profiles were run through sub-basin 15 to determine the elevations under various conditions of the PMF. The U.S. Army Corps of Engineers computer program, HEC-2 (Reference 5) was used to develop the profiles. Initially, the flood profiles were run through the bay under the antecedent bay level at a level of 6.7 ft above MLLW. A water level of 6.7 ft represents a mean value from all historic high tides. For the study, a more conservative approach was used to assign the antecedent bay level, representing reasonably probable highest tide level. Based on the 38 years of data (from 1920 to 1958), and applying a 95 percent exceedance criterion, the 2nd highest tide data point should be used. Therefore, the antecedent value of 9.96 ft MLLW, or 6.57 ft MLLW, for the 95 percent exceedance criterion (Table 2.5-3), is applied to the determination of probable maximum flood impact to the site (Table 2.5-4).

Table 2.5-4 shows the water surface elevation at the bay near the ISFSI site during the various probable maximum floods. It can be seen that the incremental increase in water levels by the PMF are insignificant, at less than 0.1 ft. The freeboard estimated for the ISFSI site is about 34 ft, as shown in Table 2.5-4.

Freeboard estimations under wave runup scenarios are shown in Table 2.5-5. As shown, the ISFSI has sufficient freeboard.

2.5.3 FLOODING PROTECTION REQUIREMENTS

Surface drainage around the ISFSI area flows naturally into the existing plant drainage system. By way of the plant drain system, the surface water then discharges into the cooling water intake canal, flows through the plant, and discharges into Humboldt Bay via the cooling water discharge canal. Outside the area served by the plant drainage system, most of the surface runoff drains to the east and into the discharge canal. The remainder drains into Buhne Slough, a natural drainage for the area, which drains directly into both the intake canal and Humboldt Bay. Thus, the drainage system at the site is efficient, and flooding of the ISFSI is not a concern.

2.5.4 ENVIRONMENTAL ACCEPTANCE OF EFFLUENTS

Best management practices for effluent management are discussed in Sections 4.1 and 4.2 of this Environmental Report. Surface runoff from the ISFSI has no radioactive contamination and will not adversely affect the surrounding ecosystem.

2.5.5 SUBSURFACE HYDROLOGY

Groundwater level and flow direction at the Humboldt Bay ISFSI is influenced by several factors, including topography, proximity to Humboldt Bay, and stratigraphy. The ISFSI is sited west of the power plant on a low hill east of Buhne Point as illustrated in the oblique aerial photos of the Humboldt Bay ISFSI site (Figure 4.2-1). The hill is bounded on the north by Humboldt Bay, on the east by the discharge canal and marshes, on the south by the intake canal and remnant marshes that existed around Buhne Slough prior to their filling for construction of the power plant, roads and so forth, and on the west by filled marshes at King Salmon (Figure 2.5-3). About a half mile to the southeast is Humboldt Hill.

In this section of the ER, the ISFSI Site Area is defined as the area within 1500 ft of the ISFSI and includes Buhne Point Hill, the adjacent marshes and the bordering tidal zone in Humboldt Bay. The larger ISFSI Site Vicinity is the area within 2 miles of the ISFSI (Figure 2.5-3). The ISFSI Region for the groundwater analysis is within about 10 miles of the ISFSI and extends from the Eel River north to Eureka.

2.5.5.1 Stratigraphy

The geology in the ISFSI Region and Site Vicinity is summarized in Section 2.6. A detailed discussion of geology is presented in Safety Analysis Report Section 2.6. The geology and aquifer characteristics that are important to understanding the groundwater at and near the ISFSI site is summarized in this section. The main geologic formation in this area is the Pleistocene Hookton Formation that is about 1,100 ft thick beneath the ISFSI Site Area. Its sediments hold several of the important groundwater aquifers in the ISFSI Site Area as well as in the ISFSI Region. The Hookton Formation unconformably overlies the Pleistocene Scotia Bluffs Formation. The Pleistocene marine terrace deposits that cap the Hookton are generally included as part of the formation. The Hookton Formation locally is overlain by Holocene Bay deposits of Humboldt Bay and by Holocene alluvial deposits along the streams in the region (Figure 2.5-3).

The generalized stratigraphic section of the Hookton Formation at the ISFSI Site Area is illustrated in Figure 2.5-4 and briefly described below.

2.5.5.1.1 Hookton Formation

The Hookton Formation in the ISFSI Region consists of interbedded shallow-water marine, estuarine, and fluvial deposits of sand, silty sand, chert-rich gravel, and clay that is about 1100 ft thick below the ISFSI. The formation is divided into upper and lower Hookton (Figure 2.5-4). The upper unit is 60 to 80 ft thick and consists of laterally discontinuous beds of clay and silt, and sand and gravel that change laterally with interfingering, cut-and-fill, and gradational facies changes. The clay beds that are ancient bay sediments have more lateral persistence than interbedded sandy and silty layers.

The Hookton strata beneath Buhne Point Hill have been tectonically tilted to the east a few degrees toward the intake and discharge canals. The Discharge Canal fault has displaced the Hookton Formation, the south side up-thrown compared to the north side.

Lower Hookton Formation - The lower Hookton Formation consists of laterally persistent beds of alternating sand, silty sand, gravel, gravely sand, silty clay, and clay. The upper 26 ft to 150 ft consists of sand and gravel that overlies the Unit F clay. The Unit F clay, which is about 50 ft thick, is a distinctive marker bed with relatively low permeability that functions as a regional aquitard. Beneath the Unit F clay are alternating layers of clean, well-sorted sand and clay that extend from 200 to about 1,100 ft deep.

Upper Hookton Formation - The upper Hookton Formation in the ISFSI Site Area can be divided into two informal lithologic units 'upper Hookton silt and clay beds' and the 'upper Hookton sand beds.' The upper Hookton sand beds overlie a discontinuous clay bed (the '2nd bay clay') that underlies the Unit 3 power plant area and the waste disposal ponds where it is 8 to 13 ft thick and is present in much of the Site Area. The upper Hookton sand beds are 25 to 40 ft thick and consist of sand and gravel layers with lesser silt and clay beds.

Under Buhne Point Hill the upper Hookton sand beds are overlain by the upper Hookton silt, clay and silty sand beds, which extend from the surface to a depth of about 30 ft. Included in the upper part of this unit are late Pleistocene estuarine/marine terrace deposits that consist of silty sand and silt beds with lenses of sand. The lower part consists of clay and silt beds referred to as the 'first bay clay' that is present in the subsurface across beneath Buhne Point Hill.

2.5.5.1.2 Bay and Estuarine Deposits

In the ISFSI Site vicinity surrounding Buhne Point Hill, the Hookton Formation is overlain by bay and marsh deposits. These consist of the several different deposits: the tidal flat sands to the northwest, thicker bay deposits to the southwest at King Salmon, and estuarine and marsh deposits to the east and southeast. Figure 2.5-5 illustrates these conditions in 1858. Since 1858 the creation of the broad tidal flats northwest of Buhne Point Hill by wave erosion since about 1900 have truncated the Hookton Formation and expose it directly to the bay waters; the bay deposits there are thin sand sheets. Many of the marshes and tidal channels south and have been filled or modified for construction of the Humboldt Bay Power Plant (HBPP), the development of the village of King Salmon, building of highways and railroads, and other uses (Figure 2.5-3).

The Holocene bay deposits have been investigated at the former waste-disposal surface impoundments (waste disposal ponds) that are about 1000 ft east of the ISFSI Site (Figure 2.5-6). In this area the bay deposits consist of interfingering silt and clay layers and local sand lenses that extend from the surface to 25 to 40 ft deep.

2.5.5.2 Aquifers

2.5.5.2.1 Regional Aquifers

The U.S. Geological Survey (Reference 6) describes the groundwater conditions in the Eel River-Humboldt Bay area. This information is summarized in this section of the report.

Groundwater in the region is contained primarily in two zones. The first zone is in the loosely consolidated surficial deposits. These deposits form several separate aquifers including alluvial sand and gravel, terrace deposits, and dune sand. Shallow, unconfined water table conditions characterize these aquifers. The second zone is in the poorly to moderately consolidated sediments of the Hookton and Carlotta formations. These formations have thick sand beds that contain several widespread, confined groundwater aquifers in the region.

<u>Aquifers in Alluvium</u> - Alluvium underlies the various floodplains of the major rivers, and also occurs as stringers within estuarine and marsh deposits. This freshwater bearing zone consists of shallow, poorly sorted layers of sand and gravel that makes it the most productive aquifer in the region. Beneath the Mad River and Eel River floodplains this aquifer is as much as 100 ft and 200 ft thick, respectively. However, because of the high well yields, most wells tapping the alluvium are less than 70 ft in depth with many less than 30 ft deep. The alluvial aquifer of the Elk River Valley (Figure 2.5-3), southeast of the ISFSI, is the main water bearing body in the ISFSI Site Vicinity.

<u>Aquifers in Terrace Deposits</u> - Terrace deposits are also an important source of water in the region. They occur on the hillsides bordering the large river valleys and the coast. The maximum thickness of the terrace deposits is about 100 ft. Most wells tapping the terrace deposits are less than 60 ft deep. Marine and estuarine terrace deposits capping the Hookton Formation occur on the top and flanks of Humboldt Hill south of the ISFSI and on Buhne Point Hill, but these deposits are discontinuous from terrace to terrace and generally have not been developed as aquifers.

<u>Aquifers in Dune Sand</u> - Dune sand on the North spit of Humboldt Bay, where they are locally more than 100 ft thick, are important local sources of fresh water (Figure 2.5-3). However, this aquifer is separated from the ISFSI Site Area by Humboldt Bay and is not connected to any of the aquifers in the ISFSI Site Area. Potential fresh water aquifers in the dune sands on the South Spit have not been tested, but the sand dunes above sea level are much thinner and more limited than on the North Spit.

<u>Aquifers in the Hookton Formation</u> - The Hookton Formation is second to alluvium as a groundwater reservoir and water supply source in the region. Wells north of Eureka produce artesian water from confined layers of sand or gravel in the formation. In the Eureka area, the Hookton Formation supplies unconfined water to many domestic wells. In parts of the Eel River Valley and Eureka Plain, the strata supporting this aquifer are as much as 400 ft thick. Although regionally the Hookton is an important source of

water, the yield from individual wells is generally small. Silting has been a problem in many wells.

Other Aquifers - Although the aquifers in the Carlotta Formation are developed south of the Eel River, these are not an important source of water north of the Eel River. The formation is not present beneath the ISFSI Site Area. The underlying consolidated rocks of the Wildcat Group, Yager Formation, and Franciscan Assemblage do not yield appreciable amounts of water to wells and are not a source of water near the ISFSI.

2.5.5.2.2 Aquifers in the ISFSI Site Area

The groundwater in the ISFSI Site Area has been investigated over a several year period by Pacific Gas and Electric (PG&E). The results of these studies are reported in Bechtel, 1984 (Reference 7), PG&E Department of Engineering Research, 1985 (Reference 8), Woodward-Clyde Consultants (WCC), 1985 (Reference 9), and PG&E Department of Technical and Ecological Services (TES), 1987, 1988 and 1999 (References 10, 11, 12). Two areas have been investigated in detail, one near the Unit 3 Power Plant and one near the former wastewater pond site that is east of Unit 3. The various borings used to establish the stratigraphy, including those that held piezometers and monitoring wells, are shown in Figure 2.5-6. Table 2.5-6 summarizes the basic information about the 67 borings and monitoring wells used to measure the piezometric levels taken on May 6, 1999. Of these only the 10 Bechtel wells have been left open. The others were destroyed in September 1999.

Based on the information from these borings and analysis of the stratigraphy and aquifer characteristics, several aquifers and zones of perched groundwater in the ISFSI Site Area are evident. The current interpretation of the groundwater aquifers and zones varies significantly from earlier interpretations because the strata within the Hookton Formation are better understood. Also in the earlier interpretations the Holocene bay deposits were lumped with the Hookton, but are now separated and shown to unconformably overlie the upper Hookton Formation. In addition, the tectonic tilting and faulting of the Hookton Formation in part controls water movement and piezometric levels.

The identified aquifers and groundwater zones are listed below. For reference, the earlier interpretations are noted in parentheses as well as illustrated on the generalized model of aquifers shown in Figure 2.5-7. The zones are described in the following section from deeper to shallower and illustrated in Figures 2.5-8 through 2.5-12.

(1) 'Lower Hookton aquifer' - The lower Hookton aquifer is the fresh water aquifer in the sands and gravels below the Unit F clay in the lower Hookton Formation (second aquifer of Bower, 1988; in TES, 1988, Reference 11).

(2) 'Aquifer between Unit F and second bay clays' - The sand and gravel beds of lower Hookton Formation above the Unit F Clay and below the

second bay clay are probably also an aquifer that connects hydraulically to the upper Hookton aquifer. However, little is known of this aquifer and is not discussed further in this report.

(3) 'Upper Hookton aquifer' - The upper Hookton aquifer is the brackish water aquifer in the upper Hookton sand beds above the second bay clay and below the overlying silt and clay beds of the upper Hookton Formation. (This aquifer is the zone C and D of the semi-unconfined second water bearing zone of Bower, 1988; in TES, 1988, Reference 11; upper sand zone of Dames and Moore as reported in WCC, Reference 9).

(4) 'Zone of perched groundwater in the upper Hookton silt and claybeds' - The zone of perched groundwater in the upper Hookton silt and clay beds includes several perched water tables in the upper Hookton fine-grained deposits. The upper part of this zone consists of sandy silt, silt and clay beds and the lower part consists of silt and clay beds (zones A and B of first water bearing zone of Bower, 1988; in TES, 1988, Reference 11).

(5) 'Zone of perched groundwater in the Holocene bay silts and clays' - The zone of perched groundwater in the Holocene bay silt and clay deposit is the unconfined groundwater zone (zones A and B of first water bearing zone of Bower, 1988; in TES, 1988, Reference 11).

Lower Hookton Aquifer – The lower Hookton aquifer lies below the 50-ft thick, regional aquitard known as the Unit F clay. Beneath this impermeable layer, the aquifer is defined as the freshwater bearing zone of clean, sorted sands that are deeper than about 200 ft below the ISFSI. Although the sand layers extend deeper, they are utilized in wells above 450 ft depth, which defines the boundary of interest for the groundwater flow directions and gradients at the ISFSI. This confined aquifer is artesian in places.

The conductivity of the aquifer ranges from 140 to 200 micromhos/cm (Table 2.5-7).

Upper Hookton Aquifer – Above the Unit F clay aquitard and below the upper Hookton silt and clay beds (comprising permeable beds in both the lower and upper Hookton Formation) is the shallow, brackish-water aquifer that is called for convenience in this report as the upper Hookton aquifer. The aquifer, which is over 100 ft thick, is semi-confined by the upper silt and clay bed aquitard. The unit is comprised of sand and gravel lenses, including some clean sand strata. A clay bed of varying thickness and extent is about 20 ft below the top of the aquifer. This clay bed is shown as the second bay clay in the geologic sections and has been referred to as a site-wide aquitard (clay layer of Bower, 1988; in TES, 1998, Reference 11). The analysis, however, shows that it is discontinuous; in Figure 2.5-9, the clay bed bifurcates: the upper part pinches out and the lower part appears to pinched out to the west of the western most boring; in Figure 2.5-10 the upper bifurcation of the clay bed pinches out. The lower part of the bifurcation is below the borings; however, it is not present in the deeper borings (D&M

59-1A and D&M73-3) on the up-dip projection of the clay bed. The second bay clay is present beneath the ISFSI Site as illustrated in Figures 2.5-8 and 2.5-9.

The character of the upper Hookton aquifer is known from several piezometers and monitoring wells in the wastewater pond area and in the Unit 3 area (Table 2.5-6). The monitoring wells were screened at two intervals: the C-level monitoring wells were screened in the upper portion of the aquifer and the D-level monitoring wells were screened at a deeper level in the aquifer but above the second bay clay "aquitard." Several other wells also record the piezometric surface of the upper Hookton aquifer on Buhne Point Hill.

The piezometric surface in May 1999 from the upper Hookton aquifer is shown in the cross sections (Figures 2.5-8 through 2.5-11) and as contours in Figure 2.5-12. Analysis of the figures shows that the piezometric levels for both the C and D wells are essentially identical, indicating good vertical communication in the aquifer above the 2nd bay clay bed. The piezometric surface beneath Buhne Point Hill is nearly horizontal, and slopes gradually to the north toward Humboldt Bay. North of the Discharge Canal fault piezometric surface slopes northwest. The difference in the amount and direction of slope of the piezometric surface on either side of the fault indicates that the fault is an aquitard, with higher water levels on the north side than the south.

As evident on the cross sections, the upper Hookton aquifer is confined by the upper Hookton silt and clay beds in the Unit 3 and wastewater ponds area, but is unconfined beneath the higher part of Buhne Point Hill, making it a semi-confined aquifer.

The depth to the piezometric surface on the upper Hookton aquifer below the ISFSI Site is estimated from information interpreted in Borehole GMX99-2 that was drilled in February during the wet season (Figure 2.5-12). The shear and compression wave velocity profile from this boring (February 18, 1999' Reference 13) indicates that saturated deposits occur at 34 ft below ground, placing it at about elevation 6 ft (MLLW) within the lowermost deposits of the upper Hookton aquifer. Considering the three-month time difference between the measurements of the other wells in May, the estimate of 6 ft during the wet season is consistent with the other data, and it is estimated that the groundwater level in early part of the dry season would be lower, at about 5 ft (MLLW).

The tides have a strong influence on the upper Hookton piezometric surfaces. This is illustrated in wells at the wastewater pond site and near Unit 3 (Figures 2.5-13 and 2.5-14). The piezometric surface lags the tidal changes by a few hours and has up to about 3 ft elevation change during a tidal cycle. This indicates that water in Humboldt Bay and in this aquifer at the ISFSI Site Area is connected in the outcrops below the bay, as illustrated in Figures 2.5-9 and 2.5-15. The salinity in the upper Hookton aquifer is discussed in Section 2.5.5.6.

Zone of Perched Groundwater in the Upper Hookton Silt and Clay Beds – The zone of perched groundwater in the upper Hookton deposits is in the silt and clay beds between the surface and the upper Hookton aquifer. These silt and clay beds are approximately 30 ft thick in the ISFSI Site Area. The groundwater in this zone occurs as discontinuous zones of perched water tables. The piezometers were placed in the upper and lower parts of this zone, indicated as A and B, respectively (Table 2.5-6), and these show somewhat different piezometric levels. The piezometric surface in 1999 from the A and B levels is shown in cross sections A-A and C-C (Figures 2.5-10 and 2.5-11) and as contours in Figures 2.5-16 and 2.5-17.

Analysis of Figures 2.5-13 and 2.5-14 shows that the piezometric surface in the lower part (B) of the groundwater zone slopes to the north south of Unit 3 (where the wells are).

The upper part (A) of the zone of perched groundwater in the upper Hookton silt and clay beds shows a perched table at Boring MW-8 (BEC84-8) on Buhne Point Hill north of Unit 3 that is at elevation 17.92 ft, only 6 ft below the surface. South of Unit 3 a different perched surface is near horizontal at about 8.5 ft, as evident in 5 wells, 1 to 3 ft above the piezometric surface of the B zone.

At the ISFSI site, perched water is interpreted from the Borehole GMX99-2 (Figure 2.5-12). The shear and compression wave velocity profile from this boring (February 18, 1999) indicates that saturated deposits occurred between depths of 10 to 15 ft (elevation 25 to 30 ft) (Reference 13). In addition, when the trenches were excavated at the site, groundwater flowed into the trench for a few hours from local groundwater zones, but had stopped by the next day.

Zone of Perched Groundwater in the Holocene Bay Silt and Clay Beds - The zone of perched groundwater in the Holocene bay silt and clay beds is in the tidal marsh deposits and bay mud that underlie the former wastewater pond site and is believed to be similar to other locations in bay deposits near the ISFSI. This groundwater zone is in unconsolidated silt and clay beds that unconformably overlie the upper Hookton sand beds that are 23 to 26 ft below the surface.

Monitoring wells in the Holocene bay silt and clay beds at the pond site help characterize the water table and piezometric surfaces in this unit. The A-level monitoring wells were screened to bracket the surface of the water table and the B-level monitoring wells were screened in the middle and lower portions of the deposit. The cross section through the area (Figure 2.5-11) illustrates the conditions. The general piezometric surface for the B part of the zone ranges between 6 and 10 ft elevation, a foot or two below the water table in the A part of the zone. Contours on the B part of the zone (Figure 2.5-17) show a northwest trending trough to the northwest of the ponds site with highs on either side, indicating that flow directions are toward Humboldt Bay and away from the bay toward the marsh to the southeast. The figure also illustrates that the B piezometric surface in the Holocene bay deposits is separate from the B piezometric surface in the upper Hookton groundwater zone by the unconformity between them.

The A part of the zone appears to record a perched water table or various localized water tables. Two such groundwater levels are at boring WWC-9A on the south side of the ponds (Figure 2.5-11) and a high to the north of the closed ponds (Figure 2.5-16). The surface indicates that the A part of the groundwater flows to the northwest toward the discharge canal and southeast toward the marsh.

The piezometric surfaces for the A part of the zone at the pond site fluctuates about 3 ft seasonally. The tides have almost no influence on any of the A or B perched water tables in the Holocene bay deposits as illustrated in well cluster 6 (WCC85-6A and B, and DER85-6) (Figure 2.5-13).

2.5.5.3 Groundwater Recharge, Gradients, And Discharge

2.5.5.3.1 Regional Area

As discussed by the U.S. Geological Survey (Reference 6) and in PG&E's environmental report (Reference 3), groundwater in the Humboldt Bay region generally flows west and northwest toward the coast. Water level contours for the alluvial aquifer in the Eel River Valley and the Elk River Valley show that the groundwater flows west to northwest, down the valleys, and toward the coast in these alluvial aquifers.

Recharge of fresh groundwater resources is generally from direct precipitation and by direct seepage from rivers and streams. Some water also moves laterally into the various water bearing zones from adjacent formations and some moves upward from leakage due to differences in head between the shallow and deeper water bearing formations. The confined aquifers in the Carlotta and Hookton Formations primarily receive recharge from precipitation and stream seepage in their outcrop areas that are considerable distances away from the ISFSI Site.

Groundwater discharge in the Humboldt Bay region is both natural and artificial. Natural discharge occurs by subsurface flow to streams, tidal estuaries on the coastal plains and to the ocean; by evaporation and transpiration; and by discharge through springs. Artificial discharge of groundwater occurs by pumping or artesian flow from wells. The discharge of groundwater along the coastal plains is partly controlled by tidal conditions.

2.5.5.3.2 ISFSI Site Vicinity

The two shallow groundwater tables in the ISFSI Site Vicinity are the alluvial aquifer in the Elk River Valley and the alluvial aquifer in the 'Buhne Slough valley.' These were investigated by Marliave (References 14 and 15) in 1959 and 1960. Analysis of data from seven shallow 'test holes' drilled in the area east of and south of Buhne Point as presented by Marliave and the geomorphic and stratigraphic information provides the following understanding concerning constraints on the groundwater conditions in this area.

The three test holes (wells) in the alluvial aquifer along the Elk River Valley (Figure 2.5-3) showed that the water table slopes down valley and has a gradient of about 12 ft/mile (about 0.002 ft/ft). Regardless of the effect of tides near the mouth of the Elk River Valley, the alluvial aquifer is flushed each year by high flows during winter and spring runoff.

The groundwater divide that follows the low ridge at Spruce Point and extends north from there separates the Elk River alluvial aquifer and the ISFSI Site Area from the alluvial aquifer in the much smaller 'Buhne Slough valley' that is west and southwest of Spruce Point. Thus, groundwater flow east of this area is to the northeast toward Elk River and then to Humboldt Bay and groundwater flow west and south of this area is to the west toward the now mostly buried Buhne Slough. Buhne Slough, but not Spruce Point, is shown in Figure 2.5-6, it is also shown as an unnamed slough in the 1858 map (Figure 2.5-5) as winding east of Buhne Point into the short valley southwest of Spruce Point. Buhne Slough and nearby marshes have been filled by development in the area and only exist in part; the intake canal for the HBPP has diverted most of the water that used to enter Buhne Slough; only the intake canal is shown in Figure 2.5-3.

Information from the four test holes (wells) around Buhne Slough valley as analyzed by Marliave (Reference 15) shows that shallow groundwater flows toward the remnants of Buhne Slough. The water table slopes west at 3 to 5 ft/mi (0.001 to 0.0006 ft/ft) from the slopes of the northern end of Humboldt hill (0.005 ft/ft to the upper part of Buhne Slough area, but a lesser gradient of 0.001 ft/ft from the divide area westward toward the lower reach of Buhne Slough). The topographic high of Buhne Point Hill has a water table that slopes east toward the remnants of Buhne Slough at 2.5 to 5 ft/mi (0.001 to 0.0005 ft/ft) from the southern flank of Buhne Point Hill.

2.5.5.3.3 ISFSI Site Area

Recharge and discharge of the aquifers and groundwater zones in the ISFSI Site Area varies as illustrated in Figure 2.5-15 and are described below.

<u>Lower Hookton Aquifer</u> - Recharge of the lower Hookton confined aquifer beneath the regionally contiguous Unit F clay bed is believed to be through deep percolation of rainfall into formation outcrops in the Humboldt Hill area, beneath the terraces on the hill, and from alluvium along the Elk River Valley (Figure 2.5-3). Subsequent lateral flow beneath confining beds transports the water beneath the ISFSI site and to areas of discharge in Humboldt Bay and probably into the Pacific Ocean beyond Humboldt Bay.

<u>Upper Hookton Aquifer</u> - Recharge of the upper Hookton aquifer in the ISFSI Site Vicinity comes from three sources. The first consists of fresh water from the nearby, topographically higher Humboldt Hill area where percolation of rainfall enters the formation outcrops and from beneath the terraces on the hill (Figure 2.5-3). Lateral flow

brings it into the Site Area. A second potential area of recharge is brackish water from the Buhne Slough area east of Buhne Point Hill, including cooling water intake and discharge canals. The third area of recharge is from seepage of seawater into the aquifer from Humboldt Bay.

Little vertical flow occurs within the upper Hookton aquifer. Vertical gradients range from 10 to 20 ft/mile (0.002 to 0.004 ft/ft) (Reference 6).

Tidal fluctuations in Humboldt Bay have significant short-term (hours) effects on the groundwater flow directions and rates within the upper Hookton aquifer at Buhne Point Hill. During rising tides, bay water flows into the formation near Buhne Point Hill in a generally southerly direction; during falling tides, the flow is out of the formation into the bay, generally in a northerly direction. However, the upper Hookton aquifer is believed to have a net discharge of groundwater into Humboldt Bay and possibly offshore into the Pacific Ocean. Net horizontal flow velocities within the upper Hookton aquifer range from 2×10^{-7} to 1×10^{-5} cm/s (Reference 6).

<u>Zone of Perched Groundwater in the Upper Hookton Silt and Clay Beds</u> - Recharge into the zone of perched groundwater in the upper Hookton silt and clay beds beneath Buhne Point Hill at the ISFSI site is primarily from direct precipitation and percolation into the interfingering layers of silt, clay and lesser sand lenses that characterize the deposits. Local perched water tables occur in these beds, but the southeast tilting of these layers tends to direct groundwater flow toward the intake and discharge canals. Near Unit 3, the perched water table is at about 8.5 ft elevation (Figures 2.5-10 and 2.5-16). This water is somewhat brackish (salinity about 2600 to 2800 micromhos/cm) reflecting a mixing with some bay water from the nearby marshes and the intake and discharge canals, or from upward migration of water into these beds from the underlying upper Hookton aquifer. The recharge potential on Buhne Point Hill is low because the silty sand, silt and clay deposits directly below ground are relatively impermeable.

Based on the definite piezometric head separation between the zone of perched groundwater and the upper Hookton aquifer (Figures 2.5-10 and 2.5-11) and the first bay clay that separates them, hydraulic communication between the two aquifers is poor; hence, minimal flow are believed to occur between these two zones. The perched groundwater in the upper Hookton Formation appears to discharge into the nearby marshes and into the intake and discharge canals. Little discharge is expected to reach the underlying upper Hookton aquifer because the first bay clay that is at the base of the deposit restricts vertical flows. Moreover, in the Unit 3 area the piezometric surface of the underlying upper Hookton aquifer is higher than the base of the first bay clay providing upward piezometric pressure into the perched groundwater zone.

<u>Zone of perched groundwater in the Holocene bay silt and clay beds</u> - Recharge of the zone of perched groundwater in the Holocene bay silt and clay beds in the wastewater pond area and nearby marshes is primarily from direct precipitation and percolation into the interfingering layers of silt, clay and lesser sand lenses that characterize the deposits. Local perched water occurs in these beds. The lower parts of the beds are

recharged in part by inflows of bay water at high tides from the tidal marshes, Humboldt Bay, and the intake and discharge canals, particularly at high tides.

Groundwater flow within the zone of perched groundwater in the Holocene bay silt and clay beds is primarily horizontal. Estimated horizontal flow velocities (5×10^{-8} to 7×10^{-5} cm/s) are one to two orders of magnitude greater than estimated vertical velocities (3×10^{-9} to 6×10^{-7} cm/s) (Reference 6).

Based on the lack of response within the zone of perched groundwater in the Holocene bay silt and clay beds to tidal fluctuations (Figure 2.5-14) and the definite piezometric head separation between the two zones (Figure 2.5-11), hydraulic communication between the zone of perched groundwater and upper Hookton aquifer is poor; hence, minimal flow occurs between these two zones.

Discharge is into the adjacent tidal marshes, Humboldt Bay, and the intake and discharge canals. This is probably highest when the tides are low.

2.5.5.4 Hydraulic Properties Of Aquifers

2.5.5.4.1 Regional Well Yields

Information on wells in the region comes from References 3 and 7. Specific capacities of wells tapping the regional alluvial aquifers range from 20 to 350 gpm/ft of drawdown. The terrace deposits commonly yield more than 150 gpm with specific capacities of up to 90 gpm/ft of drawdown.

Although regionally the Hookton Formation is an important source of water, the yield from individual wells is generally small, commonly less than 10 gpm from flowing wells (artesian) to 30 gpm from pumped wells. Specific capacity is on the order of 0.5 gpm/ft of drawdown. PG&E Well No. 2, which draws water from the lower Hookton aquifer, produces 75 gpm, the capacity of the pump.

Yields from wells tapping aquifers in the Carlotta Formation vary, but are generally less than those in the alluvium and terrace deposits, and more than those tapping aquifers in the Hookton Formation. Most Carlotta wells have specific capacities ranging from 15 to 100 gpm/ft of drawdown.

2.5.5.4.2 Hydraulic Properties of Aquifers in the ISFSI Site Area

In the wastewater ponds area (Reference 11), the transmissivity, hydraulic conductivity (permeability), and storage coefficients for the perched water zone in the Holocene Bay deposits and the Upper Hookton aquifer were estimated by several methods. Laboratory permeability tests were performed on soil samples collected from both the zone and the aquifer to estimate the vertical hydraulic conductivity of the respective water-bearing zones. Slug test data were analyzed according to the method reported in Reference 11 to provide an estimate of the horizontal hydraulic conductivity in the vicinity of each well tested. A tidal fluctuation analysis method was applied to water level data collected from wells completed in the upper Hookton aquifer to provide estimates of the transmissivity, hydraulic conductivity, and storativity of that zone. The tidal method was not appropriate for the perched groundwater zone because tidally induced fluctuations in this zone were negligible. Copies of test data and methodology are provided in the appendices for Reference 11.

Zone of perched groundwater in the Holocene bay deposits - During the 1988 study period (Reference 11), the horizontal groundwater gradients within the zone of perched groundwater in the Holocene bay deposits ranged from 0.007 to 0.025 ft/ft, while the vertical gradients ranged from zero (no vertical flow) to 0.146 ft/ft. Estimated horizontal permeability for this zone ranged from 2×10^{-6} to 8×10^{-4} cm/s. Estimated vertical permeability values for soil samples collected from the zone ranged from 2×10^{-7} to 5×10^{-6} cm/s. Estimated horizontal flow velocities (5×10^{-8} to 7×10^{-5} cm/s) are one to two orders of magnitude greater than estimated vertical velocities (3×10^{-9} to 6×10^{-7} cm/s).

Based on a saturated thickness of approximately 20 ft, the range of transmissivity values for the zone of perched groundwater in the Holocene bay deposits is 1×10^{-3} to 5×10^{-1} cm^2/s (Reference 11).

Upper Hookton Aquifer - During the 1988 study period, horizontal groundwater gradients (Reference 11) within the upper Hookton aquifer in the vicinity of the former wastewater ponds ranged from 0.001 to 0.002 ft/ft, while the vertical gradients ranged from 0.002 to 0.004 ft/ft. The range of horizontal permeability values for this aquifer, estimated by the tidal method, was 7×10^{-5} to 2×10^{-3} cm/s with most values being close to 1×10^{-3} cm/s. The range of vertical permeability was estimated as 1×10^{-5} to 4×10^{-4} cm/s. Net horizontal flow velocities within the upper Hookton aquifer range from 2×10^{-7} to 1×10^{-5} cm/s, while estimated vertical flow velocities ranged from 2×10^{-6} to 4×10^{-6} cm/s.

Based on a saturated thickness of approximately 25 ft for the upper Hookton aquifer, the range of transmissivity values is 0.04 cm^2/s to1.21 cm^2/s. Estimated storativity values were all in the 10^{-5} range.

Based on down-hole flow meter measurements in the upper Hookton aquifer in the Unit 3 area (Reference 7) for wells MW-1 through MW-11 and calculated permeability using the tidal method, a flow velocity range of 3,100 to 10,400 ft/yr (3×10^{-3} to 3×10^{-2} cm/sec) was calculated. This range is higher than that calculated for the aquifer beneath the wastewater ponds area (described above) and on the high side of those values calculated for References 3 and 11 (2,000 ft/yr or 1.9×10^{-3} cm/s). The differences most likely reflect different local stratigraphic characteristics in the aquifer.

2.5.5.5 Groundwater Use

Regional Area - Groundwater in the region is used for irrigation, industrial water supply, public and domestic water supplies. Some wells are used for environmental monitoring. Except for the water supply for the City of Eureka, which is supplied by surface water from the Mad River, all of the domestic, industrial and agricultural water needs in Humboldt County are met by groundwater. In the area extending from the Eel River Valley north to the Mad River Valley, the quantity of groundwater that was pumped for all purposes was nearly 9 billion gallons in 1975. This water is extracted mainly from shallow wells in alluvium and terrace deposits of the Eel, Mad and Van Duzen River Valleys. Sands of the Hookton and Carlotta Formations are also important sources of groundwater, but well yields are generally less than from the alluvium.

ISFSI Site Vicinity

Table 2.5-8 lists the wells within a radius of slightly more than 2 miles from the ISFSI Site. Of the 39 active wells, two are industrial, 7 are municipal water companies or commercial, 7 are used for irrigation, 19 are individual domestic wells, 3 are monitoring (generally with more than one well), and 1 is a test well. These wells are located as shown in Figure 2.5-3.

2.5.5.6 Groundwater Quality

Regional Area - The quality of the groundwater in regional aquifers is generally good, most of it being moderately hard, calcium-magnesium-bicarbonate water. Typically, chloride concentrations from wells completed in the alluvial aquifers that are generally less than 50 ft deep are below 100 mg/l. The only well (16 ft deep) completed in the dune sand for which there are data showed a chloride concentration of 24 mg/l. Chloride concentrations from wells less than 100 ft to several hundred ft deep completed in the Hookton Formation generally are less than 100 mg/l and often less than 50 mg/l. Wells completed in the Carlotta Formation are typically several hundred ft deep, and generally have chloride concentrations less than 50 mg/l. One 268-ft deep well had a chloride concentration of 230 mg/l. Concentrations in some wells have been reported at 28 parts per million (ppm) and chloride concentrations in shallow aquifers near the tidal reaches of the rivers range from 500 to 1,000 ppm (Reference 6). In these areas along the coast, a concentration of 100 mg/l chloride indicates the landward edge of the freshwater-seawater transition zone, although it does not necessarily represent the landward limit of brackish or unusable groundwater.

ISFSI Site Area - The quality of the groundwater in the aquifers in the ISFSI Site Area is summarized in Table 2.5-7.

The quality of the water in the lower Hookton aquifer at the ISFSI is known from the former PG&E Well No. 1 (Table 2.5-7; Figure 2.5-3) that was destroyed in September 2000. It was freshwater that had 12 to 26 ppm chloride and total conductivity of 140 to 200 micromhos/cm.

The salinity in the upper Hookton aquifer as measured by the conductivity ranges between 1,100 and 26,000 micromhos/cm and cloride ranges from 200 to 9,000 ppm (Table 2.5-7). The lowest conductivity readings, 1,000 to 2,500, are south of Unit 3; the conductivity is higher around the wastewater pond site where the conductivity is 5,500 to 26,000 (Figure 2.5-12), probably reflecting saltwater intrusion from the marshes in this area.

The water in the upper part (A) of the zone of perched groundwater in the Holocene silt and clay beds is brackish. The conductivity of the A part of the zone ranges from 5,000 to 7,000 micromhos/cm and chloride from 1500 to 5,000 ppm (Table 2.5-7; Figure2.5-16). The lower conductivity, when compared to the B zone, reflects the higher elevation of the perched water table where saltwater intrusion is less.

The quality of water in the lower part (B) of the zone of perched groundwater in the Holocene bay silt and clay beds is brackish. The conductivity of the B part of the zone ranges from 9,000 to 17,500 micromhos/cm and chloride ranges from 1,800 to 4,500 ppm (Table 2.5-7). The highest reading is south of the wastewater ponds area near the marsh (Figure 2.5-17). The high conductivity reflects saltwater intrusion into the lower aquifer from the marshes and discharge canal.

The confined nature of the deeper, lower Hookton aquifer (the two PG&E industrial wells were artesian at the time of installation) also serves to protect this zone by preventing downward vertical migration of brackish water. Aside from the brackish nature of the water, there are no currently known areas of groundwater contamination beneath the ISFSI site. Clean closure of both the oil water separator and former evaporation pond areas related to Unit 3 was obtained from the California North Coast Regional Water Quality Control Board in October 1997. The monitoring wells used to assess the aquifer were destroyed in September 1999.

2.5.6 CONTAMINANT TRANSPORT ANALYSIS

The spent fuel at the ISFSI will be maintained in dry storage casks. There will not be any routine radiological effluent releases or any credible off-normal events or accidents that result in liquid effluents. Therefore, the ISFSI will have no radiological effect on surface water or groundwater.

2.5.7 REFERENCES

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13. Humboldt Bay Power Plant Data Report C, Downhole Geophysics in the ISFSI Site Area, Humboldt Bay Power Plant ISFSI, Narayanan, Kathek, 2002, 220p.

14. Geologic reconnaissance of groundwater conditions, Buhne Point, Eureka, Marliave, E.C., 1959, 9 p. plus figures: in Appendix II of the HBPP Final Hazards Summary Report (in Reference 2).

15. Letter to J.F Bonner, re: Unit No. 3, Eureka Plant, from Marliave, E.C., 1960, 6p. plus figures: in Appendix II of the Final Hazards Summary Report (in Reference 2).

2.6 GEOLOGY AND SEISMOLOGY

Section 2.6 of the Humboldt Bay Independent Spent Fuel Storage Installation (ISFSI) Safety Analysis Report (SAR) describes and evaluates the geologic and seismic conditions for the region around the Humboldt Bay ISFSI site. It also provides detailed information regarding foundation conditions and stability, slope stability, and potential vibratory ground motions at the ISFSI site, and the transport route between the fuel handling building and the ISFSI. Section 2.6.9 of the Humboldt Bay ISFSI SAR describes tsunami hazard at the ISFSI site.

2.6.1 PRINCIPAL FINDINGS – ISFSI SITE

Detailed geotechnical studies have been performed in accordance with the applicable Nuclear Regulatory Commission guidance to determine the safety of the proposed development from geologic hazards.

The following geologic issues: seismic safety (including ground motions, surface fault rupture, liquefaction, and tsunami runup), bearing capacity of the foundation elements, safety from coastal bluff retreat and shoreline erosion, and stability of slopes adjacent to the proposed development are discussed below and are summaries developed from the above Humboldt Bay ISFSI SAR. No geologic hazards or adverse geologic or geotechnical conditions were identified that would preclude construction and operation of the ISFSI. Therefore the Humboldt Bay ISFSI site is in conformance with 10 CFR Part 72.

2.6.2 GEOLOGIC SETTING

Humboldt Bay Power Plant (HBPP) and the ISFSI site are on the east flank of Buhne Point, a small headland on the eastern shore of Humboldt Bay. The site is underlain by a thick sequence of late Tertiary and Quaternary sedimentary rocks, and is capped by a late Pleistocene terrace. Buhne Point is situated within the Little Salmon fault zone, and has been uplifted and tilted gently to the northeast by displacement on the fault. Mapping, borehole, trenching, and dating studies at and near the HBPP site were used to document the stratigraphy of the site.

Four traces of the Little Salmon fault zone are mapped in the vicinity of the ISFSI site. These include two primary fault traces, the Little Salmon and Bay Entrance faults; and two subsidiary faults in the hanging wall of the Bay Entrance fault, the Buhne Point and Discharge Canal faults. The Little Salmon fault corresponds to the middle trace of the Little Salmon fault zone to the southeast, and the Bay Entrance fault corresponds to the eastern trace of the Little Salmon fault zone to the southeast. The Little Salmon, Bay Entrance, and Buhne Point faults all dip to the northeast and displace the late Pleistocene Hookton Formation down to the southwest. The Discharge Canal fault dips steeply to the southwest and has down-to-the-northeast displacement.
The site conditions at HBPP consist of more than 400 ft of firm alluvial soils.

Faults in the Little Salmon Fault Zone are very close to the site and have the potential to generate large-magnitude earthquakes.

The structure and style of deformation at and near the ISFSI site indicate future activity on the Little Salmon fault zone will not produce surface faulting at the site. Fault displacement along the Buhne Point fault southwest of the ISFSI site will probably result in small amounts of slip on many of the conjugate faults, and perhaps additional small displacements within the existing zone of conjugate faulting. Minor displacements may also accrue on the backthrust northeast of the site (the Discharge Canal fault). The terrace underlying the site can be expected to be elevated during future faulting events on the Little Salmon fault zone, but the angle of tilt will likely change very little, if at all (less than 1 degree), and no significant secondary faults are expected to form in the hanging wall through the ISFSI site. Small fractures and faults having up to about 2 centimeters of vertical displacement in the strata that underlie the site cannot be completely precluded during future great earthquakes along the Little Salmon fault zone, but are not considered to pose a significant hazard. Based on the analysis of the geologic data, surface-fault rupture does not pose a hazard to the ISFSI site, and thereby the stability of the site with respect to surface rupture can be assured. Slope stability analyses were performed to evaluate the factor of safety against sliding at the site. Analyses of slope stability indicate that static factors of safety for circular failure surfaces daylighting beneath the ISFSI vault are 2.7 or greater. It is concluded that the site is not susceptible to deep landslides, but that small amounts of ground deformation are possible during maximum earthquake loading. Results of these analyses indicate critical bluff-side slide mass displacements of up to 0.5 ft. Similar analyses indicate critical plant-side slide mass displacements of up to 4.7 ft. The average displacement for the full range of input motions is 1.4 ft.

2.6.3 TSUNAMI HAZARD

Tsunami hazards along the coast of northern California have been recognized for many decades. The tsunami associated with the 1964 Alaska earthquake was very destructive in Crescent City, and caused minor runups within Humboldt Bay.
Using conservative estimates of tsunami runup, the inundation height would be 21 to 36 ft above mean lower low water (MLLW) if the tsunami occurred at low tide, or 28 to 43 ft above MLLW if the tsunami occurred at high tide at the ISFSI site area. The offshore bathymetry at Humboldt Bay is smooth and wide, and topographic enhancement of tsunamis is not expected at the ISFSI site. Even if a tsunami runup flowed above the ISFSI elevation, the tsunami hazard at the ISFSI site is negligible. The casks can be temporarily wetted without harm; they are contained in underground vaults which protects them from the effects of water velocity and debris damage.

2.7 SOCIOECONOMICS

This section provides a description of the local social, economic, and community characteristics of the area surrounding the Independent Spent Fuel Storage Installation (ISFSI). Most of the information was taken from References 1 through 4 for Humboldt County, the county in which the ISFSI is located (see Section 2.2.1 and Figure 2.2-1). The nearest adjoining county is Trinity County, the closest boundary of which lies about 35 miles east of the ISFSI.

2.7.1 LOCAL AREA

2.7.1.1 Historic and Natural Landmarks

The ISFSI is located on Buhne Point between the towns of Eureka and Fields Landing, adjacent to Humboldt Bay. The earliest known occupants of the Humboldt County coastal area arrived before 3000 B.C. and spoke a language of the Hokan stock known as ancestral Karok. The ancestral Karok were replaced by Yurok and Wiyot (Algic stock), who were thought to have arrived in approximately 900 A.D. At the time of Euroamerican contact (approximately 1850), the area was inhabited by speakers of Wiki, a dialect of Wiyot.

Historic maps indicate that a small town named Humboldt was located in the ISFSI area in the 1880s. The town consisted of about 12 houses on a 40-acre tract of land, all of which were abandoned by the late 1800s. No evidence of the town remained during construction of Humboldt Bay Power Plant (HBPP) in the 1950s.

Over 200 registered historical buildings, structures, and objects (BSOs) are located within a 10-mile radius of the ISFSI site. Most of these BSOs are a part of the Eureka Historic District, which is listed in the National Register of Historic Places and the California Register of Historical Resources. Thirteen of the BSOs are listed as individual properties in these registers.

A more detailed discussion of the historic and natural features of the area in the vicinity of the ISFSI is presented in Section 2.9.

2.7.1.2 Economy

Approximately 74 percent of Humboldt County is covered with forests of commercial Douglas Fir and Redwood. These forests provide timber to support the primary industry in the area and county of lumber production and lumber/paper manufacturing, which was valued at about $286 million in 2000. A lumber-loading shipyard is located less than 1 mile southwest of the ISFSI site. Lumber mills are located in Eureka, Arcata, Scotia, Korbel, and Redcrest.

Several ports in the area support commercial fishing activities. Commercial fish landings in 2001 at Eureka, King Salmon, Shelter Cove, and Trinidad were estimated to be 2.6 million pounds of sole, 1.4 million pounds of shrimp and prawns, 1 million pounds of rockfish, 880,000 pounds of tuna, 615,000 pounds of crab, and 766,000 pounds of other fish species.

Although the lumber and fishing industries are in decline, service industries and recreation are becoming increasingly important parts of the county's economic base. The primary service employers include medical services, education, and government. Visitors to the numerous state and county parks along the coast and in the inland forests support tourist-related businesses. The Humboldt County Convention and Visitors Bureau estimates that county visitors number 2.1 to 2.2 million per year.

An economic profile of Humboldt County is shown in Table 2.7-1. The estimated population for Humboldt County in 2001 was 126,468 (Reference 3). The population employed within the county was approximately 50,100 in 2001 with an unemployment rate of 6.1 percent (Reference 2). The unemployment rate of 6.1 percent was higher than the state's rate of 5.3 percent for 2001; however, Humboldt's unemployment rate steady declined in the 1997-2001 period.

2.7.1.3 Income

The median family income in Humboldt County for 1999 was $31,226, compared with $47,493 for the state of California. In 1999, 19.5 percent of the population in Humboldt County was considered to have incomes below the poverty level, compared with 14.2 percent in California and 12.4 percent in the U.S. (Poverty level income, as defined by the U.S. Census Bureau in Reference 5, varies by family size and composition.)

2.7.1.4 Infrastructure

As described in Reference 1, there is an established infrastructure throughout most of the county that provides water supply and delivery, wastewater services, transportation systems (roadways, trucks, public transit, aviation, and marine), utilities (electricity, natural gas, telephone, cable television, and internet access), and solid waste disposal.

Water to residential and industrial users in the Humboldt Bay area is provided by the Humboldt Bay Municipal Water District. Two separate water systems are operated by the district. Water is supplied through a domestic water system and raw water for industrial purposes is taken directly from the Mad River and delivered, untreated, to industrial customers. Each of the county's urban areas provides its own stand alone wastewater services.

Humboldt County has a wide variety of transportation infrastructure and services. The Humboldt County Association of Governments has a Regional Transportation Plan prepared every 2 years that establishes policies for all forms of travel, details the current state of transportation systems, and details action steps needed to keep pace with anticipated use over the next 20 years.

The safe and efficient collection and disposal of solid waste is an important issue affecting all Humboldt County residents. The rate of waste generated in the county is steadily increasing. Solid waste is collected and disposed of by the Humboldt County Waste Management Authority at a location outside the county.

Electric power is provided by Pacific Gas and Electric to virtually the entire county. Transmission and distribution power lines cross through the county to provide electrical service. Telephone, natural gas, cable television, and internet access services are also available to most of the county.

2.7.1.5 Public Services

Fire protection to HBPP is provided by the Humboldt Fire District (which serves the greater Eureka area with two fire stations), and responds to all medical emergency calls. In addition, the Counties of Humboldt and Del Norte are members of a Joint Powers Authority, providing hazardous material specialists to the two counties.

Police protection to HBPP is provided by the Humboldt County Sheriff's Department, which is also headquartered in downtown Eureka.

Within 5 miles of the ISFSI site, there are two general hospitals serving the greater Eureka area (St. Joseph Hospital and General Hospital). There are 4 senior nursing facilities in Eureka and more than 20 residential care homes for the elderly. A private ambulance company provides emergency response services in concert with the Humboldt Fire District.

There are 23 schools within 5 miles of the ISFSI site, including 11 elementary schools, 2 junior high schools, 3 high schools, and several special program schools. These schools had a combined enrollment of 7,465 in 1999, based on information from the Humboldt County Office of Education. One college, the College of the Redwoods, is located just south of Eureka and within 5 miles of the ISFSI site. The college has an enrollment of approximately 5,000 full and part-time students.

The City of Eureka contains a number of neighborhood and community parks located within 5 miles of the ISFSI site. The City Parks and Recreation Department prepares estimates of the annual number of visitors/users of its major facilities, including large city parks, sports fields, and the zoo. For 1998, the department estimates that city parks had approximately 400,000 users, recreation programs (e.g., league softball) had approximately 300,000 users, and the Sequoia Park Zoo had approximately 95,000 visitors. These numbers represent repeat visits over the course of a year, and include Eureka residents and visitors from other parts of Humboldt County.

Eureka's location on the north coast of California makes it accessible to several recreational areas of state and national significance. These include Redwood National Park, Six Rivers National Forest, Patrick's Point State Park, and Humboldt Redwoods State Park, all of which are located greater than 5 miles from the ISFSI site. The

Humboldt Bay National Wildlife Refuge is located within the Eureka city limits and within 5 miles of the ISFSI site. The state and county recreation areas and public lands within 50 miles of the ISFSI site are listed in Table 2.2-5.

2.7.1.6 Transportation

The City of Eureka and Humboldt County are accessible via state highway, ship, and air.

Highway 101 traverses California from Los Angeles, through San Francisco, and north to Eureka. It continues north into Oregon, through Tillamook, and intersects with Highway 6 en route to Portland. Highway 299 travels east inland from just north of Arcata and joins with Interstate 5 in Redding. Interstate 5 is a north-south route through central California to Oregon and Washington.

The North Coast Railroad (previously Northwestern Pacific Railroad) runs from the south through Eureka. As described in Section 2.8.2.3, the railroad is presently inactive.

The air transportation system in Humboldt County serves a range of aircraft types and aeronautical uses. Nine public use airports are located in Humboldt County. Scheduled passenger service, typically turbo-prop planes, is only available from the Arcata-Eureka Airport, located north of Arcata in McKinleyville.

The Port of Humboldt Bay is the largest marine shipping facility between San Francisco Bay, located 225 nautical miles to the south, and Coos Bay, Oregon, located 156 nautical miles to the north. Humboldt Bay can accommodate vessels up to 700 ft length over all, 110 ft width, and weighing a total of 50,000 dead weight tons. On-board cranes and manpower are used to load and off-load cargo, as there are currently no dockside cranes in use.

Mass transit services in Eureka are provided by Eureka Transit Service, owned by the City of Eureka, and the Redwood Transit Service. The Redwood Transit Service is jointly funded by the county and several cities through a Joint Powers Agreement. Both systems are operated by the Humboldt Transit Authority.

2.7.2 ENVIRONMENTAL JUSTICE

Pursuant to Executive Order 12898 (Reference 6), this section describes the relationship between the socioeconomic characteristics of area residents and neighborhoods, and the potential impacts and benefits of the ISFSI project. Executive Order 12898 requires federal agencies to "make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately higher adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations."

Impacts and benefits of ISFSI projects result from the siting, design, and management of such facilities, as compared with the effects of taking no action. This evaluation examines whether ethnic minorities and low-income populations in the project area would experience these types of impacts, and if they are inconsistent with the benefits created.

As shown in Reference 3, the ethnic composition of Humboldt County is approximately 85 percent white, 1 percent black, 6 percent American Indian and Alaska Native Persons, 2 percent Asian and Pacific Islander, and 6 percent other. Approximately 7 percent of the county population is Hispanic or Latino origin. The City of Eureka and the census tracts located within 5 miles of the ISFSI project have ethnic compositions similar to that of the county. (The concept of race as used by the Bureau of the Census reflects self-identification. It does not denote any clear-cut definition of biological stock. The data for race represents self-classification by people according to the race with which they most closely identify. The question of Hispanic origin was asked independently of the question concerning race. A person of Hispanic origin may be of any race.)

No minority populations have been identified that are disproportionately high and would be adversely affected by the proposed ISFSI project.

Eureka and Humboldt County have a relatively high number of lower-income households. As a result, median household income in the county is substantially lower than for California as a whole. According to data in Reference 3, the median household income in Humboldt County was about $31,200 in 1999. By comparison, California's median household income was about $47,500 in 1999. There are a total of 10 census tracts within 5 miles of the ISFSI site. In 1999, 4 of these 10 census tracts had median household incomes below the median household income for Humboldt County. The median household income levels for Census Tracts 1, 5, 2, and 11 were $19,180, $20,880, $23,230, and $26,570, respectively, compared with $31,200 for Humboldt County.

According to Reference 3, 19.5 percent of the population in Humboldt County was considered to have incomes below the poverty level in 1999, compared with 14.2 percent in California and 12.4 percent in the U.S.

2.7.3 REFERENCES

1. Prosperity: The North County Strategy for the New Economy - 1999/2000 Comprehensive Economic Development Strategy (CEDS), Volume III, The County of Humboldt, Office of Economic Development and the CEDS Com., www.co.humboldt.ca.us/planning/ECONDEV/PROSPERY/VOLIII.html.

2. County Snapshot - Humboldt 2002, Labor Market Information Division, California Employment Development Department, http://www.calmis.cahwnet.gov/file/COsnaps/humbosnap.pdf.

3. State and County QuickFacts - Humboldt County, California, U.S. Census Bureau, http://quickfacts.census.gov/qfd/states/06/06023.html.

4. Census 2000 - Humboldt County, California State Department of Finance, http://www.dof.ca.gov/html/demograp/SF 1/Humboldt.pdf.

5. How the Census Bureau Measures Poverty, U.S. Census Bureau, http://www.census.gov/hhes/poverty/povdef.html.

6. Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, Federal Register, p. 7629, February 16, 1994.

2.8 NOISE AND TRAFFIC

2.8.1 NOISE

This section addresses the existing noise and traffic environment for the Independent Spent Fuel Storage Installation (ISFSI) vicinity. Noise impacts related to construction and operation of the ISFSI are addressed in Sections 4.1.7 and 4.2.7, respectively.

2.8.1.1 Local Noise Policies

The Noise Element of the Humboldt County General Plan, Section 3240, has established noise standards for residential and public institutional land uses. The maximum A-weighted decibel level (dBA) for stationary noise sources as measured at the nearest residential area is 45 dBA indoors and 60 dBA outdoors. The General Plan also lists the Environmental Protection Agency's maximum permissible noise levels at 45 L_{dn} indoors and 55 L_{dn} outdoors.

The Humboldt County Zoning Ordinance, Section A314-18, Part C. 1, "Industrial Performance Standards," sets operational noise generation limits as measured at residential zones at no higher than 5 dBA above ambient noise levels. Further, Part D.1, "Standards for industrial Development that Impact Non-residential Zones," states, "Mitigation measures shall be required where necessary to insure that noise generated by industrial operations does not exceed 70 dBA anywhere off the site premises."

2.8.1.2 Existing Noise Environment

Noise-sensitive receptors are those facilities or activities (i.e., residential areas, hospitals, schools, performance spaces, offices) for which excessive noise may cause annoyance or loss of business (e.g., commercial activities with heavy telephone use for which a quiet environment is required).

Measurements were taken at 3 locations: at the ISFSI project site, approximately 200 yards east of Humboldt Bay Power Plant (HBPP) Unit 3, and on King Salmon Avenue approximately 130 yards southwest of the HBPP Main Entrance Gate, numbered respectively in Figure 2.8-1. The measurements were taken on weekend and weekday periods between September 16 and 21, 1999. Acoustic measurements for determination of existing noise levels were taken for multiple 24-hour periods using Larson-Davis Models 700 and 820 noise dosimeters. Noise profiles at mid-octave ranges were obtained using a calibrated microphone and a B&K Model 2230 sound-level meter in conjunction with a Sony TCD-7 digital audio tape recorder. These measurements describe the ambient sound at 10 selective frequency ranges (octaves). Average noise measurements are shown in Table 2.8-1. Octave band analyses of existing noise are presented in Figures 2.8-2 and 2.8-3.

These measurements were necessary to aid in the estimation of noise propagation to the nearest receptors outside of the HBPP property line. Estimates of noise contributions from construction and operation of the ISFSI (discussed in Sections 4.1.7 and 4.2.7, respectively) were developed using standard rules of sound propagation as an inverse function of distance from the source of noise and the knowledge of the types and intensities of noise generators at the site.

The nearest receptors and residences are located approximately 350 yards west of the HBPP Main Entrance Gate on King Salmon Avenue. Several small businesses are located on the canal across from the entrance gate and a recreation area is located at the jetty to the west of the ISFSI.

2.8.1.3 Noise Survey Results

Table 2.8-1 summarizes the noise survey results in terms of average energy equivalent levels: L_{eq}; L_{10}; L_{50}; and L_{90}. Figure 2.8-4 is a graphic representation of the hourly L_{eq} values for the sound measurements taken on the perimeter of the project site on Friday September 17, 1999, through Monday September 20, 1999. The L_{eq} is the equivalent average noise level over the given time frame, and L_{10}, L_{90} and L_{50} are statistical descriptors in which noise level is exceeded a given percentage of the time.

The gate location noise monitoring shown in Figure 2.8-4 demonstrates a diurnal pattern of high and lows at between 1300-1600 hr and between 0100 and 0400 hr, respectively. The high values are most probably associated with traffic along King Salmon Avenue. As shown in Figure 2.8-3, there is an approximately 20 dBA increase in sound levels during the periods of vehicle traffic on the road.

2.8.2 TRAFFIC

2.8.2.1 Roadway Network

A network of roads, including an interstate freeway, state highways and local streets, serves the HBPP area. As of November 2002, approximately 100 full-time personnel commute to HBPP each workday. These employees travel predominantly the highways serving the HBPP area. The following is a description of road facilities in Humboldt County and the HBPP area.

2.8.2.1.1 U.S. Highway 101

U.S. Highway 101 connects Humboldt County north to Interstate 5 via U.S. Highway 299. U.S. Highway 101 also connects the county to areas south along the coast including Ukiah and San Francisco. Most of the highway south of King Salmon Avenue is a fast, four-lane freeway. To the north of King Salmon Avenue, there is a short section of freeway followed by city streets through Eureka. To the north of Eureka, U.S. Highway 101 continues as a fast two-lane road. Based on 2000 data collected by Caltrans, Highway 101 has a daily two-way traffic volume of approximately 49,500 vehicles per day in the vicinity of HBPP.

2.8.2.1.2 State Highway 299

State Highway 299, which intersects U.S. Highway 101 approximately 13 miles north of the ISFSI site, connects Humboldt County east to Redding where it connects to Interstate 5. Highway 299 in Humboldt County begins as a four-lane freeway for the first 5 miles. The rest of the highway is scenic and winding, with rate congestion. Daily two-way traffic volume on Highway 299, as collected by Caltrans in 2000, is approximately 7,300 vehicles per day. Because of distance, Highway 299 contributes little or no noise exposure at the ISFSI site.

2.8.2.1.3 King Salmon Avenue

King Salmon Avenue is a county-maintained road between Highway 101 and the community of King Salmon. It is also the main access road to the entrance of the HBPP and the ISFSI site. King Salmon Avenue is lightly traveled by passenger cars and trucks. Heavy trucks are limited to those associated with plant operation.

According to the Humboldt County Public Works Department (Reference 1), traffic surveys for King Salmon Avenue showed 1,273 vehicles per day in June 1968, 2,290 vehicles per day in June 1970, and 2,355 vehicles per day in June 1973. Employment at HBPP and the population of King Salmon Avenue have been relatively stable since 1973. Therefore, PG&E believes the traffic volume of 2,355 vehicles per day measured in 1973 is representative of current traffic volumes on King Salmon Avenue.

2.8.2.2 Vehicular Traffic Patterns

The traffic volume numbers described in the above sections are typically duplicated when inbound traffic counts are compared with outbound numbers on the highways and roads serving the ISFSI site and vicinities.

2.8.2.3 Railroad Service

The North Coast Railroad runs from the south through Eureka. There are numerous spurs to lumber and ships yards within Humboldt County. A vacated spur track area exists into HBPP. A considerable program of upgrading will be necessary if operations and competitiveness of the railroad are to be improved.

2.8.2.4 Shipping

The port of Humboldt Bay, located at Eureka, is the largest marine shipping facility between San Francisco and Coos Bay, Oregon. Vessel size that can be accommodated by the 35 ft channel is limited to 50,000 tons and 700 ft in length. Predominately, the Port of Humboldt services the lumber industry (Reference 2).

2.8.2.5 Airport

The air transportation system in Humboldt County serves a range of aircraft types and aeronautical uses. Nine public use airports are located in Humboldt County. Scheduled passenger services, typically turbo-prop planes, are only available from the Arcata-Eureka Airport, located north of Arcata at McKinleyville (Reference 2). Because of flight patterns and the fact that the Arcata-Eureka airport is approximately 20 miles to the north of the ISFSI, little or no noise exposure to the ISFSI site is created by air traffic.

2.8.3 REFERENCES

1. Personal Communication, Philippe Soenen, PG&E, with Michael Garotte, Humboldt County Public works, February 25, 2003.

2. Prosperity: The North County Strategy for the New Economy – 1999-2000 Comprehensive Economic Development Strategy (CEDS), Volume III, The County of Humboldt, Office Economic Development and the CEDS Com., www.co.humboldt.ca.us/planning/ECONDEV/PROSPERY/VOLIII.htm.

2.9 REGIONAL HISTORIC, SCENIC, CULTURAL, AND NATURAL FEATURES

The significant historic, scenic, archaeological, architectural, cultural, and natural features of the Independent Spent Fuel Storage Installation (ISFSI) site, associated power plant site, and surrounding area are described in this section. Information was gathered primarily from searches of archival databases, field surveys, and consultation with local Native Americans (Reference 1).

In accordance with Section 106 of the National Historic Preservation Act (NHPA), reviews should be conducted to identify previously recorded or otherwise known cultural resources within or adjacent to three defined zones: Zone A is the Humboldt Bay ISFSI and the power plant site; Zone B is the area within a 5-mile radius of the ISFSI site; and Zone C is the area within a 10-mile radius of the ISFSI site.

2.9.1 ETHNOGRAPHIC OVERVIEW

At the time of Euroamerican contact, the project area was inhabited by speakers of Wiki, a dialect of Wiyot, an Algonquian language (Reference 2). Wiyot speaking people inhabited an area that extended from the Little River northwards to the Bear River Mountains and that extended east from the ocean to the top of the crest of the first mountain range beyond the coastal plain (References 2, 3, and 4).

Wiyot settlements were mostly along the Pacific coast and along several of the rivers in the area. No ethnographic sites are located within the area (Reference 4). According to a map of ethnographic site locations made by L. L. Loud near the turn of the century, one village site was located adjacent to the project on Buhne Point. However, Loud indicated that the site had been washed away by 1918 (Reference 4).

Twenty-two ethnographic sites recorded by Loud are located within Zone B and 35 ethnographic sites have been recorded within Zone C. Most of the sites are located near the coast, bay shore, or along the rivers. Many of these sites are camps or villages, while others are resource procurement or resource processing areas. In general, the Wiyot exploited the forest, riverine, and coastal environments for resources. Both salt water and fresh water fish and shellfish played a primary role in their diet (References 2, 3, and 4). Several varieties of plants were also utilized. L. L. Loud gives an extensive overview of the Wiyot culture and settlements in his 1918 ethnography. Additional sources of ethnographic information about the Wiyot are found in (References 2 through 6).

2.9.2 HISTORIC OVERVIEW

Humboldt Bay and an associated town were both named in 1850 by a group of explorers known as the Laura Virginia Association (named after the ship that transported them to America). The name Humboldt was given to both the bay and the town in honor of a German naturalist. Historic maps indicate that the project site is situated on the same place that the town site was planned (Reference 7). This town was surveyed and laid out almost immediately after the passengers of the Laura Virginia had landed, however it never grew as large as its founders' dreamed. Maps from 1850 (Reference 8) depict a town that spans 3 to 4 miles of the shoreline and that was about 1 mile wide. However, these maps were planning maps and, in reality, the town consisted of approximately 12 houses in a 40-acre tract of land, all of which were abandoned by the late 1800s (Reference 9). The buildings associated with the town fell into disrepair and collapsed or were gradually removed. No buildings from this era can be seen standing in a 1950s aerial photograph of the PG&E property. Cultural remains associated with the town of Humboldt were probably removed during construction of the power plant facilities.

The introduction of electricity to Humboldt County occurred as a direct result of the region's widespread lumber industry. The town of Eureka was lit via gaslights by 1878, after Herbert Kraft built a small plant and established a gas utility. Kraft used a poor quality gas in his system and was unsuccessful, forcing the sale of his Eureka Gas Company in 1883. By the time Kraft sold his company, lumber mills on Gunther Island had begun generating electricity for arc lamps through steam-powered generators. The success of the steam generators led to the formation of the Eureka Electric Light Company on May 17, 1886, and on March 21, 1894, the gas and electric utilities of the city were consolidated under the umbrella of the Eureka Lighting Company (Reference 10).

The new light company was able to use the steam engine facilities at the many lumber mills in the region and installed electric generators to service Eureka and the surrounding communities. In the 1890s streetlights illuminated with arc lamps were put up in Arcata, Fortuna, Ferndale, Loleta, Rohnerville, Alton, Hydesville, and Carlotta. These electric streetlights were soon followed by service to individual homes and businesses within the communities (Reference 10). In the late 1890s and the first decade of the twentieth century, ownership of Humboldt County's growing utility system changed hands several times, from the Eureka Lighting Company to Pacific Light Company to Western States Gas and Electric Company (WSGEC). WSGEC's system, including the Eureka facility, was acquired by Pacific Gas and Electric Company (PG&E) in 1910 (Reference 10).

When PG&E acquired WSGEC's system they made few changes to the operation. PG&E continued to operate the one steam generator plant and transmission system through World War II. As postwar construction began across the nation in 1945, Humboldt County's lumber industry expanded rapidly to meet the new demand and the area boomed with industrial, commercial, and residential growth. This boom resulted in a demand for more electrical power than PG&E could quickly produce (Reference 10).

In response to this need PG&E planned both short-term and long-term solutions. The short-term solution was to create a temporary steam plant, called the Donbass, on the waterfront of Eureka. The Donbass plant was unique in electrical history because it used part of a shipwrecked tanker as the base for the steam plant. The *Donbass III* was an electrically propelled ship built by Americans and turned over to Russia on a lendlease agreement during the war. The tanker broke apart during a storm, with a loss of all personnel, but was found still afloat 5 days after the disaster by an American tanker, the S.S. *Puente Hills*. The captain of the S.S. *Puente Hills* towed the *Donbass III* to Port Angeles, Washington and sold it as salvage to the War Shipping Administration for $110,000 as salvage (Reference 10).

The stern half of the *Donbass III* still contained a 4,800-kilowatt generator and a steam plant for its operation. Both were in good working order, despite the wrecked condition of the ship. PG&E purchased the stern half of the tanker from the War Shipping Administration and had it towed from Puget Sound to Humboldt Bay, where it was beached on the waterfront in 1946. In order to meet the emergency needs of the growing region, PG&E engineers converted the power plant from marine to land purposes and brought it on line December 16, 1946. The Donbass plant continued to serve stand-by and peak-load requirements until PG&E's new fossil fuel plants came on line in the late 1950s (Reference 10).

The Donbass plant, combined with the original steam plant, met the short-term needs of the region, but the lumber industry continued to grow, as did the demand for increased amounts of power. To meet the long-term growth needs of the region, PG&E began plans to build two oil-burning plants just south of Eureka in Field's Landing, in the vicinity of the old town of Humboldt. This new facility would replace the two steam generating plants that PG&E operated in Eureka and support a new 115-kV transmission line connecting the Humboldt Bay area to California electric grid via the Sacramento Valley.

As designed, PG&E's new Humboldt Bay Power Plant site consisted of two fossil fuel plants, oil storage tanks, a 60-kV switchyard, and associated facilities like a warehouse, fire pump house, office, shop, yard relay building, and an intake structure. Unit 1 was completed in 1956 and Unit 2 came on line in 1958. These new plants operated on oil and natural gas and were capable of producing 25 megawatt (MW) of power; a capacity that eventually would be increased to 52 and 53 MW, respectively. However, PG&E knew that this power output still was not enough to meet the needs of the vast and growing northwest region and its booming lumber industry. Even as the two fossil fuel units came on line, PG&E was already examining options to meet long-term regional electrical demands.

In 1959, PG&E decided to construct Unit 3 at the HBPP site, a small General Electric Boiling Water Nuclear Reactor. Unit 3 was completed in 1963 and began producing electricity in August of that year.

In the early 1970s, oil company geologists exploring for natural gas near the Humboldt Bay plant determined that a local earthquake fault called the Little Salmon Fault was active. Previous studies conducted before the plant was built suggested that this fault was dormant. In response to this new information, PG&E began its own seismic studies and began designing plans to retrofit the plant.

On July 9, 1976, Unit 3 was shut down for routine refueling and for seismic retrofit work. The work was projected to cost $30 million, $10 million more than it took to build the initial unit in 1963. A year later, as work was nearing completion, the NRC told PG&E it would not support restarting the plant until further studies were performed to resolve what they viewed as outstanding seismic questions. PG&E immediately suspended work at Unit 3 and began additional seismic studies. It was in the midst of these new studies that the Three Mile Island (TMI) accident occurred.

Following the TMI accident, the Nuclear Regulatory Commission (NRC) immediately put a hold on all major licensing efforts while they reevaluated the industry as a whole. In 1980 the NRC issued new standards for all plants, requiring their compliance. In light of these studies, PG&E evaluated the cost of completing the seismic work and upgrading the plant, the feasibility of refueling Unit 3 with fossil fuel, and the cost of decommissioning the plant. The analysis indicated that given the new standards the dollar amounts for restarting or repowering the plant might be between $300 to $400 million. In light of this fact, PG&E chose to decommission the plant, announcing the decision in July 1983.

Decommissioning Unit 3 followed a process defined by the NRC as SAFSTOR. The NRC provides three different alternatives for decommissioning: DECON, SAFSTOR, or ENTOMB. Under DECON (immediate dismantlement), parts of a facility containing radioactive contaminants are removed or decontaminated to a level that permits release of the site for unrestricted use soon after the facility closes. Radioactive material is transported to a facility for permanent storage. Under SAFSTOR, a nuclear facility is maintained and monitored in a condition that allows radioactivity to decay, then it is dismantled. ENTOMB status encases radioactive contaminants in a structurally sound material like concrete and maintains and monitors the structure until radioactivity decays to a level permitting unrestricted release of the property. The NRC requires that decommissioning must be completed within 60 years.

Unit 3 formally entered SAFSTOR status in 1988. Under this federal NRC storage mode, most of the plants radioactive parts, including the spent fuel, can remain in place until 2015. At that time, the United States Department of Energy would take possession of the fuel and transport it to a central repository. All of the spent nuclear fuel has been taken out of the reactor and housed in the spent fuel storage pool inside the plant. Plant staff monitor and maintain this pool in accordance with NRC regulations. The age of the spent fuel and the way it is stored prevent it from ever restarting a critical nuclear reaction.

In 1998, PG&E announced that it would seek to proceed with dry cask storage and, if successful, would consider moving forward with early decommissioning. PG&E considered many factors in reaching this decision, including safety, the latest developments in decommissioning technology and geology, economics, and community opinion. Accordingly, PG&E is pursuing the development of an ISFSI to allow the fuel's removal and thus open the way for complete dismantling of Unit 3.

2.9.3 ARCHEOLOGICAL OVERVIEW

Present knowledge of the cultural development of Humboldt Bay and surrounding areas is derived from a combination of archaeological and linguistic information. The earliest studies focused on coastal and riverine archaeological sites (References 2, 4, 5, and 11). The analysis of data from the sites studied contributed to the development of a tentative prehistoric cultural sequence for northwestern California. More recent work has been conducted in mountainous areas as well as the coast. The more recent studies have not only furthered understanding of the cultural sequence of the area, but subject matter has also focused on settlement patterns and resource procurement strategies.

In general, the earliest occupants of the Humboldt county coastal area arrived before 3000 B.C. and spoke a language of the Hokan stock known as ancestral Karok (References 12, 13, and 14). Diagnostic data recovered from this occupational period can be attributed to the Borax Lake Aspect of the Borax Lake Pattern. The assemblages are characterized by pointed and round-stemmed projectile points. Sites of this age are rarely found in coastal areas and the lithic technology is indicative of interior hunting and gathering adaptations implying seasonal occupation of coastal areas (References 13 and 14).

Archaeological and linguistic evidence suggests speakers of ancestral Karok were replaced by speakers of ancestral Yurok and Wiyot (Algic stock), whom are thought to have arrived in the North Coastal areas at approximately 900 A.D. (References 13 and 14). The Wiyot settled along the Pacific coast, Humboldt Bay, and along the major streams of the area, such as the Mad River. Archaeological data recovered from this occupation can be attributed to the Gunther Pattern. Assemblages include Gunther-barbed points, haliotis ornaments, bone harpoons, and other fishing technologies that are indicative of coastal rather than interior adaptations (References 12, 13, and 14).

This cultural sequence presented here and elsewhere will evolve further over time as work continues in the region. Overviews of Humboldt Bay prehistory, as well as the prehistory of the region can be found in (References 4, 5, 11, and 13 through 21).

A search of archival records gave no indications of previous cultural resource studies, recorded prehistoric and historic archaeological resources or historical buildings, structures, or objects (BSOs) within Zone A. However, historic maps indicated that the bluff where the power plant is located was about 100 ft higher during the historic period (References 22 and 23). Over 115,700 cubic yards of soil were removed during the construction of the power plant facilities (storage tank locations and buildings) and over 51,467 cubic yards of soil were used as fill (References 24 and 25). Unless the elevations given on the historic maps are inaccurate, HBPP construction documents indicate that human alterations may have brought the bluff to its current height.

The selected location of the ISFSI was once the site of the meteorological tower . The tower was removed after Unit 3 was permanently shut down. The area was heavily disturbed during geological investigations that required the excavation of several trenches.

As noted earlier, review of the historic literature indicated that the ISFSI site area was the location of the first town adjacent to Humboldt Bay and was settled by 1850 (References 8 and 9). Due to the amount of human earth-moving activities, it is unlikely remnants of the town or any prehistoric remains would be identified during future construction activities.

No archaeological resources that have been listed on national or state registries are located within a 5-mile radius of the ISFSI. However, there are approximately 30 archaeological sites that have been recorded within a 5-mile radius of HBPP. These sites have not been evaluated with regard to their eligibility for listing in national or state registers.

The archeological site that lies closest to HBPP is CA-HUM-79. This is the same site as the one noted by L. L. Loud at Bunhe Point (Reference 4). An examination of this site in 1976 by J. Goodrich indicated that a remnant of the site still remained on the beach. His records noted two net sinkers, six chert flakes, shell casts from baked bivalves, and midden. Two subsequent letters written by U.S. Army Corps Archaeologist Susan Berry indicate that it was inundated in 1983 and that the site had little or no integrity (References 26 and 27).

Several historic period BSOs are located within Zone B. However, none of them have been evaluated with regard to their eligibility for listing in national or state registers.

Record search data indicated that one Native American archaeological site, CA-HUM-67/H, listed in the National Register of Historic Places (NRHP), the California Register of Historical Resources, and the California Inventory of Historic Resources, is located within Zone C. No other archaeological resources that have been listed in national or state registers are located within a 10-mile radius of the project area. However, there are approximately 184 archaeological sites that have been recorded within this zone.

Over 200 registered historical BSOs are located within a 10-mile-radius of HBPP. Most of the BSOs are part of the Eureka Historic District, which is listed in the National Register of Historic Places (NRHP) and the California Register of Historical Resources (CRHP). However, 13 of the BSOs are listed in the NatRHP and CRHR as individual properties. Fifteen of the aforementioned buildings are also listed in the California Inventory of Historic Resources. One State Point of Historic Interest is located within the town of Eureka—the E. Janssen Building at 422 1st Street. Finally, two State Historic Landmarks (SHL) lie within a 10-mile radius of the project area; Fort Humboldt (SHL No. 154) and the Town of Eureka (SHL No. 477). No other historical BSOs that are listed on national and/or state inventories are located within a 10-mile radius of the project area.

HBPP Unit 3 was assessed for its historic and engineering importance in light of the NRHP and CRHP criteria. While PG&E does not plan to list the facility with the NRHP or CRHP, the facility was assessed for potential eligibility. HBPP Units 1 and 2 are fossil fuel units built in the late 1950s, and were not included in the assessment since they are less than 45 years old.

The eligibility of Unit 3 for the NRHP was previously reviewed by the NRC and the State Historic Preservation Officer (SHPO) during decommissioning licensing. In the Final Environmental Statement (FES) for Unit 3 SAFSTOR, published by the NRC in April 1987, the NRC stated that "No impacts to any properties in or eligible for the National Register of Historic Places are expected" (Reference 28). The FES included and referenced an SHPO letter on the same subject, which stated that the Unit 3 decommissioning "does not involve National Register or eligible properties" (Reference 29).

Based on the recent assessment, Unit 3 appears exceptionally significant (Criterion Consideration G) in the history of the commercial nuclear power industry and appears to meet Criteria A and C of the NRHP at a national level. Unit 3 has had few modifications since it went on line in 1963 and retains integrity of location, setting, design, workmanship, feeling and association. Its period of significance stretches from 1961 when the unusual construction methods and design elements used in the pressure suppression chamber began, until 1984 when Unit 3 was placed in a SAFSTOR status. Under Criterion A, Unit 3 is important for its association with the development of nuclear power on a national level. Under Criterion C, certain elements of the unit, such as the pressure suppression chamber and the spent fuel pool, are key factors of its importance, while other equipment (e.g., the control room, turbine, reactor) are contributing features of overall plant design. The key factors of the unit will not be impacted by the project. Removal of the spent fuel to an outside facility will not change the design elements of the spent fuel pool and therefore will not affect the overall integrity of the resource. Therefore, the ISFSI project will have no effect on Unit 3.

As part of the future decommissioning plan, the significance of Unit 3 will be reevaluated in accordance with Section 106 of the NHPA. If it is determined that those elements of the Unit 3 facility that contribute to its historical and engineering significance will be impacted, then mitigation measures designed in consultation with the NRC and the State Office of Historic Preservation may need to be outlined and completed prior to project implementation.

To confirm the findings of the ISFSI NHPA review, PG&E initiated consultation with SHPO in September 1999 (Reference 30). In a letter to PG&E dated October 25, 1999, SHPO stated that input from the NRC is needed before SHPO review can proceed (Reference 31). Consequently, no further action will be taken by PG&E on this matter unless required by the NRC following review of this section (Reference 32).

No cultural resources were identified within Zone A during the current study. As noted previously, the location of CA-HUM-79 was found to be well out of the area and will not be impacted by project activities. Considering the amount of ground disturbance that has taken place in the project area in the past it is highly unlikely that additional unidentified resources may be present. However, certain conditions, such as dense vegetation or pavement, may have prevented a resource from being detected during the inventory.

Prehistoric resources that may be identified during the ISFSI construction include, but are not limited to, concentrations of stone tools and manufacturing debris made of obsidian, basalt and other stone materials; milling equipment (e.g., bedrock mortars, portable mortars, and pestles); locally darkened soils (midden) that may contain dietary remains such as shell and bone; and human remains. No human remains are known to exist in Zone A. Historic resources that may be identified include, but are not limited to structural foundations, wire nails, fragments of ceramic or porcelain, cans with soldered seams or tops, and bottles or fragments of clear and colored glass. If any new cultural resources are located during project activities, all work must stop and the PG&E archaeologist should be notified immediately.

2.9.4 ARCHIVAL DATABASE SEARCH

A cultural resource record search for Zones A-C was conducted at the Northwest Information Center, Sonoma State University, Rohnert Park, California. The research was conducted to identify recorded or otherwise known cultural resources within or adjacent to Zone A, and archaeologically sensitive portions of the study area, as determined by the locations of previously recorded archaeological sites nearby and their relationship to environmental factors and topography.

In addition, records on file at HBPP were examined. These records included power plant construction reports, engineering designs, and photographs. Historical photographs housed at the PG&E Photo Library in San Francisco were also examined. Information regarding the development of commercial nuclear energy was also obtained from the United States Department of Energy's Internet web site (www.em.doe.gov/timeline), Sacramento City Library, main collection and special collections, and the California State Library. The Humboldt County Historical Society in Eureka was contacted by telephone on August 4, 1999.

2.9.5 FIELD VERIFICATION

A field survey of Zone A was conducted on May 18, 1999. The proposed ISFSI site and the proposed access road were visually examined for Native American and other cultural remains.

Complete survey coverage techniques were used to examine the areas of interest. Several zig-zag transects that varied between 20 and 30 meters apart were walked in these areas. The ground was covered with dense grass in most areas; therefore, trowels were used intermittently to clear the vegetation and improve ground visibility.

2.9.6 NATIVE AMERICAN CONSULTATION

The Native American Heritage Commission and several local Native American groups and individuals were contacted by letters dated May 24, 1999. The letters stated PG&E's plan to construct and operate an ISFSI at HBPP and requested the recipients to provide PG&E with any comments or concerns regarding the proposed project. No responses to the letters were received.

During a meeting with the Table Bluff Tribal Council on July 12, 1999, in which PG&E described its plans to decommission Unit 3 and construct an ISFSI, the Council expressed an interest in monitoring the progress of the work.

PG&E will keep the Native American Heritage Commission and other interested Native-American groups and individuals informed of the ISFSI progress through periodic, publicly announced, meetings of the CAB. PG&E will address any Native American comments and concerns through appropriate communication channels.

2.9.7 SCENIC AND NATURAL RESOURCES

A record search for significant natural features that are listed in the National Registry of Natural Land Marks was conducted by the PG&E Land Management Division. The research indicated that no natural landmarks located within any of the three areas of concern (Zones A through C) have been listed in the registry.

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32. Letter From PG&E to California Office of Historic Preservation, March 24, 2000.

2.10 BACKGROUND RADIOLOGICAL CHARACTERISTICS

2.10.1 GENERAL INFORMATION

Background radiological characteristics for the Humboldt Bay Independent Spent Fuel Storage Installation (ISFSI) were determined from results obtained for the 1998 Humboldt Bay Power Plant (HBPP) Annual Facility Status and Survey Report (Reference 1), the HBPP Environmental Radiological Survey Report (Reference 2), and from supplemental air and vegetation samples collected. Air sampling data collected for the State of California's Intercomparison Program Report were also used to compare the air particulate gross beta activity of the proposed location with that of an offsite control station. The sampling locations of interest are shown in Figures 2.10-1 and 2.10-2.

2.10.2 DIRECT RADIATION

The ambient direct radiation levels in the vicinity of the ISFSI were measured using thermoluminescent dosimeters (TLDs) located at 16 onsite TLD stations and one offsite station, T17, which is located at the Humboldt Substation, off Mitchell Heights, Eureka. The average quarterly exposure rate for the onsite stations was 12.8 mrem/qtr or 51.1 mrem/yr (see Table 2.10-1). This average dose rate was comparable to that found at station T17 (Reference 3).

2.10.3 CORE AND SOIL SAMPLES

Results of the gamma spectrometry analysis of surface soil samples taken in the vicinity of the ISFSI are shown in Table 2.10-2. Only naturally occurring radionuclides and Cesium-137 attributable to fallout from previous nuclear weapons testing were found in these samples (Reference 2). The Cesium-137 concentrations measured in these samples ranged from a high of 1.42 pCi/gm to less than detectible activity (approximately 0.010 pCi/gm). These samples were taken from the surface (0 to 6 inches in depth).

2.10.4 GRASS SAMPLES

Since broad leaf vegetation was unavailable for collection onsite, grass samples were collected from three locations onsite (see Figure 2.10-2 for locations). Gamma spectrometry analysis performed on these samples showed only naturally occurring radionuclides (Reference 4). The results are as shown in Table 2.10-3.

2.10.5 SURFACE AND DRINKING WATER SAMPLES

There is no drinking water source on site. Surface water is available from the saline water canals, which are used to provide cooling water to the fossil units. Composite water samples are collected from the plant effluent canal weekly. Gamma spectrometry and tritium analyses were performed on these water samples. Data from 1998 showed only naturally occurring radionuclides with the exception of one sample collected in May (Reference 5). This sample contained 10 pCi/liter of Cesium-137 and 6 pCi/liter of Cobalt-60. A summary of the average concentration of the naturally occurring radionuclides found in the samples is shown in Table 2.10-4.

2.10.6 AIR SAMPLES

Weekly air samples were collected at Humboldt Hill for the State of California's Intercomparison Program. This station is located in the South-southeast sector with a radial direction of 158 degrees, and radial distance of 0.9 miles from the plant. In 1998, the average gross beta activity of the samples collected at Humboldt Hill was 0.006pCi/m^3. The measurements ranged from 0.001 to 0.014 pCi/m^3 (Reference 6). Gamma spectrometry and gross beta analyses were performed on the samples collected from the ISFSI site (Reference 7). The average gross beta concentration at the proposed site was found to be 0.006 pCi/m^3 and was within the range of measurements obtained from the control station at Humboldt Hill. A summary of the average concentration of the gross beta activity found in the air particulate samples at these two stations is shown in Table 2.10-5.

2.10.7 MARINE SAMPLES

Samples collected from Humboldt Bay (sediment and algae) were also analyzed during 1998. These samples were collected as elective samples from three stations within 1000 ft of the outfall from HBPP as part of the plant Radiological Environmental Monitoring Program (defined in Reference 8). No plant-related radionuclides were detected in any of the algae samples collected during 1998 (Reference 6). Cesium-137 was measured in 5 of 6 sediment samples with an average concentration of 16 pCi/kg dry basis. The presence of cesium-137 in these sediment samples is within the range attributable to global fallout from atmospheric nuclear weapons testing.

2.10.8 REFERENCES

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8. HBPP SAFSTOR Off-site Dose Calculation Manual (ODCM), Revision 9, April 2003

TABLE 2.2-1

POPULATION CENTERS WITHIN 50 MILES OF ISFSI SITE

Community	Distance and Direction from Site	2000 Population	1990 Population	1980 Population	1970 Population
Arcata	15 miles NE	16,651	15,197	12,340	8,985
Bayview	3 miles NNE	2,359	1,318	na	na
Blue Lake	16 miles NE	1,135	1,235	1,201	1,112
Cutten	5 miles ENE	2,933	1,516	2,375	2,228
Eureka	4 miles NNE	26,128	27,025	24,153	24,337
Ferndale	12 miles SSW	1,382	1,331	1,367	1,352
Fortuna	11 miles SSE	10,497	8,788	7,591	4,203
Humboldt Hill	2 miles SE	3,246	2,865	na	na
Hydesville	15 miles SSE	1,209	1,131	na	na
McKinleyville	18 miles NNE	13,599	10,749	7,772	na
Myrtletown	9 miles ENE	4,459	4,413	3,959	na
Pine Hills	3 miles NE	3,108	2,947	2,686	na
Redway	45 miles SSE	1,188	1,212	1,094	na
Rio Dell	18 miles SSE	3,174	3,012	2,687	2,817
Trinidad	30 miles N	311	362	379	300
Westhaven-Moonstone	21 miles NNE	1,044	1,109	na	na
Willow Creek	35 miles ENE	1,743	1,576	na	na
Total		94,166	85,786	67,604	45,334

Source: State of California Department of Finance
na = not available

TABLE 2.2-2

POPULATION TRENDS OF THE STATE OF CALIFORNIA AND OF HUMBOLDT AND TRINITY COUNTIES

Year	California	Humboldt County	Trinity County
1940	6,907,387	45,812	3,970
1950	10,586,233	69,241	5,087
1960	15,717,204	104,892	9,706
1970	19,953,134	99,692	7,615
1980	23,668,562	108,514	11,858
1990	29,760,021	119,118	13,063
2000	33,871,648	126,518	13,022

Source: State of California Department of Finance 2002

TABLE 2.2-3

AGE AND SEX OF TOTAL POPULATION: 2000
HUMBOLDT COUNTY, CALIFORNIA

Age Group	Number			Percent of Total		
	Both Sexes	Male	Female	Both Sexes	Male	Female
Total Population	126,518	62,532	63,986	100.0	100.0	100.0
Under 5 years	7,125	3,671	3,454	5.6	5.9	5.4
5 to 9 years	7,899	4,086	3,813	6.2	6.5	6.0
10 to 14 years	8,817	4,470	4,347	7.0	7.1	6.8
15 to 17 years	5,572	2,847	2,725	4.4	4.6	4.3
18 and 19 years	4,453	2,193	2,260	3.5	3.5	3.5
20 to 24 years	11,209	5,630	5,579	8.9	9.0	8.7
25 to 34 years	16,016	8,353	7,663	12.7	13.4	12.0
35 to 44 years	18,679	9,148	9,531	14.8	14.6	14.9
45 to 54 years	19,861	9,894	9,967	15.7	15.8	15.6
55 to 59 years	6,313	3,140	3,173	5.0	5.0	5.0
60 to 64 years	4,798	2,375	2,423	3.8	3.8	3.8
65 to 74 years	8,020	3,702	4,318	6.3	5.9	6.7
75 to 84 years	5,754	2,408	3,346	4.5	3.9	5.2
85 years and over	2,002	615	1,387	1.6	1.0	2.2
Under 18 years	29,413	15,074	14,339	23.2	24.1	22.4
18 to 64 years	81,329	40,733	40,596	64.3	65.1	63.4
65 years and older	15,776	6,725	9,051	12.5	10.8	14.1

Source: US Census Bureau, 2000 Census of Population and Housing

HUMBOLDT BAY ISFSI
ENVIRONMENTAL REPORT

TABLE 2.2-4

PERCENT OF POPULATION BY RACE FOR THE STATE OF CALIFORNIA AND FOR HUMBOLDT AND TRINITY COUNTIES

Race	Percent of Total Population		
	California	Humboldt County	Trinity County
Hispanic or Latino	32.4	6.5	4.0
White	46.7	81.6	86.6
Black or African American	6.4	0.8	0.4
Native American	0.5	5.3	4.5
Asian	10.8	1.6	0.4
Pacific Islander	0.3	0.2	0.1
Some other race	0.2	0.4	0.1
Two or more races:	2.7	3.7	3.9

Source: US Census Bureau, 2000 Census of Population and Housing

TABLE 2.2-5

STATE AND COUNTY PARKS AND PUBLIC LANDS
WITHIN 50 MILES OF ISFSI SITE

State Parks (SP)	County Parks (CP)	Public Lands
Humboldt Lagoons SP	Mad River CP	Six Rivers National Forest
Patrick's Point SP	Moonstone Beach CP	Humboldt Bay National Wildlife Refuge
Trinidad State Beach	Table Bluff CP	Arcata Marsh and Wildlife Sanctuary
Little River SP	Centerville Beach CP	Avenue of the Giants
Grizzly Creek Redwoods SP	Freshwater CP	Samoa Dunes
Humboldt Redwoods SP	Clam Beach CP	Trinity Alps Wilderness
Fort Humboldt State Historic Park		Redwood National Park

TABLE 2.3-1

PLANT SPECIES OBSERVED OR EXPECTED TO OCCUR IN THE VICINITY OF THE HUMBOLDT BAY POWER PLANT

Occurrences are based on a survey of the Humboldt Bay Power Plant by Jones & Stokes Associates on July 26, 1999; on records from the NDDB (1999), and on plant community descriptions in Holland (1986) and Sawyer and Keeler-Wolf (1995).

Habitat Type	**Species Name**	**Common Name**	**Remarks**
Northern Foredunes	*Abronia latifolia*	yellow sand-verbena	
	Abronia umbellata ssp. *breviflora*	pink sand-verbena	
	Aira praecox	European hairgrass	exotic
	Ambrosia chamissonis	beach bursage	
	Ammophila arenaria	European beachgrass	exotic
	Artemisia pycnocephala	dune sagebrush	
	Briza maxima	quaking grass	exotic
	Cakile maritime	Sea rocket	
	Calystegia soldanella	beach morning-glory	
	Camissonia cheiranthifolia	beach evening-primrose	
	Carpobrotus edule	iceplant	exotic
	Cortaderia jubata	pampas grass	exotic
	Eriogonum latifolium	dune buckwheat	
	Erysimum menziesii ssp. *Eurekense*	Humboldt Bay wallflower	
	Fragaria chiloensis	beach strawberry	
	Hypochaeris glabra	smooth cat's-ear	exotic
	Hypochaeris radicata	rough cat's-ear	exotic
	Juncus lesueurii	salt rush	

TABLE 2.3-1

Habitat Type	Species Name	Common Name	Remarks
	Lathyrus littoralis	beach pea	
	Layia carnosa	beach layia	
	Tanacetum camphoratum	dune tansy	
Northern Foredune Grassland	*Abronia latifolia*	yellow sand-verbena	
	Abronia umbellata ssp. *Breviflora*	pink sand-verbena	
	Ambrosia chamissonis	beach bursage	
	Ammophila arenaria	European beachgrass	
	Artemisia pycnocephala	dune sagebrush	
	Cakile maritima	sea rocket	
	Calystegia soldanella	beach morning-glory	
	Carpobrotus edulis	iceplant	exotic
	Leymus mollis	native dunegrass	
	Poa douglasii	seashore bluegrass	
Northern Dune Scrub	*Abronia latifolia*	yellow sand-verbena	
	Ambrosia chamissonis	beach bursage	
	Artemisia pycnocephala	dune sagebrush	
	Baccharis pilularis	coyote brush	
	Eriogonum latifolium	dune buckwheat	
	Eschscholzia californica	California poppy	

TABLE 2.3-1

Habitat Type	Species Name	Common Name	Remarks
	Lathyrus littoralis	beach pea	
	Lupinus arboreus	yellow bush lupine	
	Lupinus bicolor	miniature lupine	
	Lupinus chamissonis	Chamisso bush lupine	
	Poa douglasii	seashore bluegrass	
	Scrophularia californica	California figwort	
Northern Coastal Salt Marsh	*Carex obnupta*	rough sedge	
	Castilleja ambigua ssp. humboldtiensis	Humboldt Bay owl's-clover	
	Cordylanthus maritimus ssp. *Palustris*	Point Reyes bird's-beak	
	Cotula coronopifolia	brass-buttons	exotic
	Distichlis spicata	saltgrass	
	Grindelia stricta	Pacific gumplant	
	Jaumea carnosa	jaumea	
	Limonium californicum	sea-lavender	
	Puccinellia pumila	dwarf alkali grass	historic occurrence
	Salicornia virginica	common pickleweed	
	Spartina densiflora	dense-flowered cordgrass	exotic
	Spergularia sp.	sand spurry	

TABLE 2.3-1

Habitat Type	**Species Name**	**Common Name**	**Remarks**
	Triglochin concinna	arrow-grass	
	Triglochin maritima	seaside arrow-grass	
Coastal Freshwater Marsh	*Carex leptalea*	flaccid sedge	historic occurrence
	Carex obnupta	rough sedge	
	Lathyrus palustris	marsh pea	historic occurrences
	Lilium occidentale	western lily	endangered
	Scirpus robustus	saltmarsh bulrush	
	Typha latifolia	broad-leaf cat-tail	
	Viola palustris	marsh violet	historic occurrence
Wet Meadow	*Carex leptalea*	flaccid sedge	historic occurrence
	Carex praticola	meadow sedge	historic occurrence
	Juncus sp.	rush	
	Puccinellia pumila	dwarf alkali grass	historic occurrence
	Sidalcea oregona ssp. *eximia*	Coast checkerbloom	historic occurrences
Coastal Terrace Prairie	*Achillea millefolium*	yarrow	observed on project site
	Agrostis capillaris	colonial bentgrass	exotic; observed on project site
	Agrostis densiflora	bent grass	ruderal; observed on project site

TABLE 2.3-1

Habitat Type	Species Name	Common Name	Remarks
	Aira caryophyllea	silver hairgrass	exotic; observed on project site
	Anagallis arvensis	scarlet pimpernel	exotic; ruderal; observed on project site
	Anthoxanthum odoratum	sweet vernal grass	exotic; observed on project site
	Avena barbata	slender wild oat	exotic; ruderal; observed on project site
	Bellis perennis	English daisy	exotic; ruderal; observed on project site
	Bromus diandrus	ripgut brome	exotic; ruderal; observed on project site
	Carex sp.	sedge	observed on project site
	Centaurium muehlenbergii	June centaury	observed on project site
	Cirsium vulgare	bull thistle	exotic; ruderal; observed on project site
	Conyza bonariensis	South American conyza	exotic; ruderal; observed on project site
	Cortaderia jubata	Pampas grass	exotic; observed on project site
	Cyperus eragrostis	umbrella sedge	observed on project site
	Dactylis glomerata	orchard grass	exotic; observed on project site
	Danthonia californica	California oatgrass	observed on project site
	Danthonia pilosa	hairy oatgrass	exotic; observed on project site

TABLE 2.3-1

Habitat Type	Species Name	Common Name	Remarks
	Daucus carota	Queen Anne's lace	exotic; observed on project site
	Deschampsia caespitosa	tufted hairgrass	observed on project site
	Epilobium ciliatum	northern willow-herb	observed on project site
	Equisetum arvense	common horsetail	observed on project site
	Erica lusitanica	heath	exotic; observed on project site
	Gnaphalium palustre	low cudweed	ruderal; observed on project site
	Hirschfeldia incana	Mediterranean mustard	exotic; ruderal; observed on project site
	Holcus lanatus	velvet grass	exotic; observed on project site
	Hordeum marinum ssp. *gussoneanum*	Mediterranean barley	exotic; ruderal; observed on project site
	Hypochaeris radicata	rough cat's-ear	exotic; observed on project site
	Juncus bufonius	toad rush	observed on project site
	Juncus sp. 1	rush	observed on project site
	Juncus sp. 2	rush	observed on project site
	Leontodon taraxacoides	hairy hawkbit	exotic; observed on project site
	Leucanthemum vulgare	ox-eye daisy	exotic; observed on project site
	Lilium occidentale	western lily	endangered

TABLE 2.3-1

Habitat Type	Species Name	Common Name	Remarks
	Linum bienne	flax	exotic; observed on project site
	Lolium multiflorum	annual ryegrass	exotic; observed on project site
	Lolium perenne	perennial ryegrass	exotic; observed on project site
	Lotus corniculatus	bird's-foot trefoil	exotic; observed on project site
	Lotus micranthus	tiny lotus	observed on project site
	Lythrum hyssopifolium	hyssop loosestrife	exotic; observed on project site
	Matricaria discoidea	pineapple weed	exotic; ruderal; observed on project site
	Medicago lupulina	black medick	exotic; observed on project site
	Medicago polymorpha	bur-clover	exotic; observed on project site
	Melilotus albus	white sweet-clover	exotic; ruderal; observed on project site
	Melilotus indica	Indian sweet-clover	exotic; ruderal; observed on project site
	Mentha pulegium	pennyroyal	exotic; ruderal; observed on project site
	Navarretia mellita	sticky navarretia	ruderal; observed on project site
	Parentucellia viscosa	yellow parentucellia	exotic; observed on project site

TABLE 2.3-1

Habitat Type	Species Name	Common Name	Remarks
	Picris echioides	bristly ox-tongue	exotic; ruderal; observed on project site
	Plantago lanceolata	English plantain	exotic; observed on project site
	Plantago subnudata	Mexican plantain	observed on project site
	Poa annua	annual bluegrass	exotic; observed on project site
	Polygonum persicaria	lady's thumb	exotic; ruderal; observed on project site
	Polypogon monspeliensis	annual rabbit's-foot grass	exotic; observed on project site
	Prunella vulgaris	self-heal	exotic; observed on project site
	Pteridium aquilinum	bracken fern	observed on project site
	Raphanus sativus	wild radish	exotic; observed on project site
	Rosa nutkana	Nootka rose	observed on project site
	Rubus discolor	Himalaya blackberry	exotic; observed on project site
	Rubus ursinus	Pacific blackberry	observed on project site
	Rumex acetosella	sheep sorrel	exotic; observed on project site
	Rumex conglomeratus	whorled dock	exotic; observed on project site
	Rumex crispus	curly dock	exotic; observed on project site
	Rumex salicifolius	willow dock	observed on project site

TABLE 2.3-1

Habitat Type	Species Name	Common Name	Remarks
	Senecio vulgaris	common groundsel	exotic; observed on project site
	Silene gallica	common catchfly	exotic; ruderal; observed on project site
	Sonchus asper	prickly sow-thistle	exotic; observed on project site
	Spiranthes romanzoffiana	hooded ladies'-tresses	observed on project site
	Tragopogon sp.	salsify	exotic; ruderal; observed on project site
	Trifolium dubium	shamrock	exotic; ruderal; observed on project site
	Trifolium pratense	red clover	exotic; observed on project site
	Trifolium repens	white clover	exotic; observed on project site
	Trifolium subterraneum	sub clover	exotic; ruderal; observed on project site
	Vicia sativa	common vetch	exotic; ruderal; observed on project site
	Vulpia bromoides	foxtail fescue	exotic; observed on project site
North Coast Riparian Scrub	*Acer macrophyllum*	big-leaf maple	
	Alnus rubra	red alder	
	Lonicera involucrata	twinberry	

TABLE 2.3-1

Habitat Type	Species Name	Common Name	Remarks
	Myrica californica	wax-myrtle	
	Rhamnus purshiana	cascara	
	Rubus discolor	Himalaya blackberry	exotic
	Salix hookeriana	Hooker willow	
	Umbellularia californica	California bay	
Red Alder Forest	*Alnus rubra*	red alder	
	Aralia californica	elk-clover	
	Baccharis pilularis	coyote bush	present on project site
	Epilobium angustifolium	fireweed	
	Erica lusitanica	heath	exotic; present on project site
	Gaultheria shallon	salal	
	Heracleum lanatum	cow-parsnip	
	Lonicera involucrata	twinberry	present on project site
	Myrica californica	wax-myrtle	present on project site
	Picea sitchensis	Sitka spruce	present on project site
	Rhamnus purshianus	cascara	
	Rosa nutkana	Nootka rose	
	Rubus discolor	Himalaya blackberry	exotic
	Rubus spectabilis	salmonberry	
	Rubus ursinus	Pacific blackberry	present on project site

TABLE 2.3-1

Habitat Type	Species Name	Common Name	Remarks
	Salix hookeriana	Hooker willow	
	Scrophularia californica	California figwort	
	Stachys sp.	hedge-nettle	
	Vinca major	periwinkle	exotic; present on project site
Upland Redwood Forest	*Abies grandis*	grand fir	
	Acer macrophyllum	big-leaf maple	
	Alnus rubra	red alder	
	Arbutus menziesii	madrone	
	Chrysolepis chrysophylla	giant chinquapin	
	Digitalis purpurea	foxglove	
	Gaultheria shallon	salal	
	Lithocarpus densiflora	tanoak	
	Monotropa uniflora	Indian-pipe	
	Montia howellii	Howell's montia	historic occurrence
	Picea sitchensis	Sitka spruce	
	Polystichum munitum	sword fern	
	Pseudotsuga menziesii	Douglas-fir	
	Rhododendron macrophyllum	California rhododendron	
	Sequoia sempervirens	coast redwood	
	Torreya californica	California nutmeg	
	Umbellularia californica	California bay	

TABLE 2.3-1

Habitat Type	Species Name	Common Name	Remarks
	Vaccinium ovatum	black huckleberry	
Sitka Spruce Forest	*Baccharis pilularis*	coyote brush	
	Cupressus macrocarpa	Monterey cypress	
	Lilium occidentale	western lily	endangered
	Lonicera involucrata	twinberry	
	Maianthemum dilatatum	two-leaved Solomon's seal	
	Malus fusca	Oregon crab apple	
	Marah sp.	manroot	
	Myrica californica	wax-myrtle	
	Picea sitchensis	Sitka spruce	
	Polystichum munitum	sword fern	
	Rhamnus californica	California coffeeberry	
	Rubus spectabilis	salmonberry	
	Salix hookeriana	Hooker willow	
	Sambucus racemosa	coast red elderberry	

TABLE 2.3-2

SPECIAL STATUS PLANT SPECIES KNOWN TO OCCUR IN THE VICINITY OF THE ISFSI

Species	Status* Fed/State/ CNPS	Habitat Requirements	Blooming Period	Potential for Occurrence in Study Area
Abronia umbellata ssp. *Breviflora* Pink sand-verbena	B/B/List 1B	Coastal dunes and strand.	Jun-Oct	Not present. No suitable habitat.
Carex arcta Northern clustered sedge	B/B/List 2	Bogs and fens, north coast coniferous forest; on mesic sites.	Jun-Aug	Not present. No suitable habitat.
Carex leptalea Flaccid sedge	B/B/List 2	Bogs and fens, meadows, marshes and swamps; mostly known from bogs and wet meadows.	May-Jul	Not present. No suitable habitat.
Carex lyngbyei Lyngbye's sedge	B/B/List 2	Freshwater or brackish marshes.	May-Aug	Highly unlikely. Marginal habitat present. Species not observed at time of LSA's fieldwork during blooming period.
Carex praticola Meadow sedge	B/B/List 2	Meadows; on moist to wet sites.	May-Jul	Not present. No suitable habitat. Only one CNDDB record in 'Eureka" from 1915.
Castilleja affinis ssp. *Litoralis* Oregon Coast Indian paintbrush	B/B/List 2	Coastal bluff scrub, coastal dunes, coastal scrub; on sandy sites.	Jun	Not present. No suitable habitat.
Castilleja ambigua ssp. *Humboldtiensis* Humboldt Bay owl's clover	B/B/List 1B	Coastal salt marsh.	Apr-Aug	Potentially present. Habitat present. Species not observed at time of LSA's fieldwork during blooming period.

TABLE 2.3-2

Species	Status* Fed/State/ CNPS	Habitat Requirements	Blooming Period	Potential for Occurrence in Study Area
Cordylanthus maritimus ssp. *Palustris* Point Reyes bird's-beak	B/B/List 1B	Coastal salt marsh.	Jun-Oct	Potentially present. Habitat present. Species not observed in study area at time of LSA's fieldwork during blooming period. Undocumented population located by LSA approx. 60 ft from study area, across King Salmon Avenue.
Erysimum menziesii ssp. *Eurekense* Humboldt Bay wallflower	FE/SE/List 1B	Coastal dunes and foredunes.	Mar-Apr	Not present. No suitable habitat.
Erythronium revolutum Coast fawn lily	B/B/List 2	Bogs and fens, broadleaved upland forest, north coast coniferous forest.	Mar-Jun	Not present. No suitable habitat.
Lathyrus japonicus Sand pea	B/B/List 2	Coastal dunes.	May-Aug	Not present. No suitable habitat.
Layia carnosa Beach layia	FE/SE/List 1B	Coastal dunes; on sparsely vegetated, semi-stabilized dunes, usually behind foredunes.	Mar-Jul	Not present. No suitable habitat.
Lilium occidentale Western lily	FE/SE/List 1B	Coastal scrub, coastal bluff scrub, coastal prairie, freshwater marsh, bogs and fens, north coast coniferous forest; on well-drained, old beach washes overlain with wind-blown alluvium and organic topsoil.	Jun-Jul	Not present. No suitable habitat. Substrate consisting of fill and vegetation continually disturbed through mowing. - Closest CNDDB records from east part of Humboldt Bay National Wildlife Refuge and near Fields Landing; other location information suppressed.

TABLE 2.3-2

Species	Status* Fed/State/ CNPS	Habitat Requirements	Blooming Period	Potential for Occurrence in Study Area
Lycopodium clavatum Running-pine	B/B/List 2	North coast coniferous forest, marshes and swamps; on forest floors, in shady and semi-exposed mesic areas.	Jul-Aug (fertile period)	Not present. No suitable habitat.
Mitella caulescens Leafy-stemmed mitrewort	B/B/List 2	Broadleaved upland forest, lower montane and north coast coniferous forests, meadows and seeps; in mesic sites.	May-Jul	Not present. No suitable habitat.
Monotropa uniflora Indian-pipe	B/B/List 2	Broadleaved upland forest, north coast coniferous forest; often under redwoods and western hemlock.	Jun-Jul	Not present. No suitable habitat.
Montia howellii Howell's montia	B/B/List 2	Meadows, north coast coniferous forest, vernal pools.	Mar-May	Not present. No suitable habitat.
Puccinellia pumila Dwarf alkali-grass	B/B/List 1B	Meadows and seeps, coastal salt marsh.	Jul	Highly unlikely. Habitat present. Only one CNDDB record at mouth of Eel River from 1938.
Sidalcea malachroides Maple-leaved checkerbloom	B/B/List 1B	Coastal prairie, coastal scrub, broad-leaved upland forest, north coast coniferous forest; in clearings, often in disturbed areas.	Apr-Aug	Not present. Marginal habitat present. Not observed by LSA at time of fieldwork during blooming period.

TABLE 2.3-2

Species	Status* Fed/State/ CNPS	Habitat Requirements	Blooming Period	Potential for Occurrence in Study Area
Sidalcea malviflora ssp. *Patula* Siskiyou checkerbloom	B/B/List 1B	Coastal prairie, broadleaved upland forest; in open coastal forest.	May-Jun	Not present. No suitable habitat.
Sidalcea oregana ssp. *Eximia* Coast checkerbloom	B/B/List 1B	Meadows and seeps, north coast and lower montane coniferous forests.	Jun-Aug	Not present. No suitable habitat. Not observed at time of LSA's fieldwork during blooming period.
Spergularia canadensis var. *occidentalis* Western sand-spurrey	B/B/List 2	Coastal salt marsh.	Jun-Aug	Potentially present. Suitable habitat present. Species not observed by LSA at time of fieldwork during blooming period. - Closest CNDDB records from 'south spit', Samoa, and Indian Island.
Usnea longissima Long-beard lichen	B/B/B	North coast coniferous forest, broadleaved upland forest; in the 'redwood zone' on a variety of trees.	C	Not present. No suitable habitat. Study area (with trees) not in 'redwood zone'.
Viola palustris Marsh violet	B/B/List 2	Coastal scrub, fens and bogs; in swampy, shrubby places.	Mar-Aug	Not present. Marginal habitat present. Not observed at time of LSA's fieldwork during blooming period. Only one CNDDB record from 1923 in 'Eureka'.

*Status

FE = Federally-listed as an endangered species.

SE = State-listed as an endangered species.

List 1B= (California Native Plant Society) Plant considered rare, threatened or endangered in California and elsewhere.

List 2 = Plant considered rare, threatened or endangered in California but more common elsewhere.

TABLE 2.3-3

BIRDS OF HUMBOLDT BAY ENVIRONS

Data are based on Barnhart et al. (1992) with status information compiled from the Wildlife Habitat Relationships Program (Mayer and Laudenslayer (1988).

			Status[a]				Habitat use[b]												
Taxa	**Common Name**	**WHR[c]**	**Sp**	**S**	**F**	**W**	**Ent**	**Dep**	**Sma**	**Eel**	**Snd**	**Mud**	**Opn**	**Salt**	**Wrac**	**Dike**	**Shrub**	**Pond**	**Jett**
Family Gaviidae																			
Gavia stellata	Red-throated loon		C	Ca	C	C	P	P	S				S					S	
Gavia pacifica	Pacific loon		C	R	C	R	P	P	S				S					S	
Gavia immer	Common loon	7	C	U	C	C	P	P	S				S					S	
Gavia adamsii	Yellow-billed loon		-	-	Ca	Ca	P	P	S				S						
Family Podicipedidae																			
Podilymbus podiceps	Pied-billed grebe		U	U	U	U			S				S					P	
Podiceps auritus	Horned grebe		C	Ca	C	C	S	P	P				P					S	
Podiceps grisegena	Red-necked grebe		U	Ca	U	U	P	S											
Podiceps igricollis	Eared grebe		C	-	C	C		S	S				S					P	
Aechmophorus occidentalis	Western grebe		C	U	C	C	P	P	S				S					S	
Aechmophorus clarkii	Clark's grebe		Ca	-	Ca	Ca	P	P	S				S					S	
Family Procellariidae																			
Fulmarus glacialis	Northern fulmar		-	-	Ac	Ac	S						S						
Family Hydrobatidae																			
Oceanodroma furcata	Fork-tailed storm-petrel	7	-	Ac	Ac	-	S	S											
Oceanodroma leucorhoa	Leach's storm-petrel		Ac	-	-	-		S											
Family Pelecanidae																			
Pelecanus erythrorhynchos	American white pelican	7	Ca	-	Ca	Ca						S	S						
Pelecanus occidentalis	Brown pelican	1,3,5	R	C	C	R	P	P	S				S			P		S	S

TABLE 2.3-3

			Status[a]				Habitat use[b]												
Taxa	**Common Name**	**WHR[c]**	**Sp**	**S**	**F**	**W**	**Ent**	**Dep**	**Sma**	**Eel**	**Snd**	**Mud**	**Opn**	**Salt**	**Wrac**	**Dike**	**Shrub**	**Pond**	**Jett**
Family Phalacrocoracidae																			
Phalacrocoraax auritus	Double-crested cormorant	7	C	C	C	C	S	P	P			S	S			S		S	P
Phalacrocorax penicillatus	Brandt's cormorant		C	C	C	R	P	P	S									S	S
Phalacrocorax pelagius	Pelagic cormorant		C	C	C	C	P	P											P
Family Fregatidae																			
Fregata magificens	Magnificent frigatebird		-	Ca	Ca	-	S	S											
Family Ardeidae																			
Botaurus lentiginosus	American bittern		R	R	R	R												P	
Ardea herodias	Great blue heron	13	C	C	C	C		S	P	P	S	S	P	S		S	P	P	S
Casmerodius albus	Great egert	13	C	C	C	C			P	P	S	P	P	S		S	P	P	S
Egretta thula	Snowy egert		C	C	C	C			P	P	S	P	S	S		S	P	P	S
Bubulcus ibis	Cattle egert		C	Ca	C	C										S	S	S	S
Butorides striatus	Green-backed heron		U	U	U	R											S	S	S
Nycticorax nycticorax	Black-crowned night-heron	?	C	C	C	C			S	S	S	S	S	S		S	P	P	S
Family Threskiornithidae																			
Plegadis chihi	White-faced ibis	7	-	-	Ac	Ac						S						S	
Family Anatidae																			
Cygnus columbianus	Tundra swan	14	R	-	R	R							S					S	
Anser albifrons frontalis	Greater white-fronted goose	14	-	-	R	R						S							
Chen c. caerulescens	Lesser snow goose	14	-	-	R	R							S						
Chen rossii	Ross' goose	14	-	-	R	R							S					S	
Chen canagica	Emperor goose		Ac	-	Ac	Ac				S			S						
Branta bernicla nigricans	Black brant	14	C	Ca	U	R	S	S	S	P	P	S	P		S	S			
Branta canadenis	Canada goose	2,14	Ca	-	Ca	Ca							S					S	

TABLE 2.3-3

			Status[a]				Habitat use[b]												
Taxa	**Common Name**	**WHR[c]**	**Sp**	**S**	**F**	**W**	**Ent**	**Dep**	**Sma**	**Eel**	**Snd**	**Mud**	**Opn**	**Salt**	**Wrac**	**Dike**	**Shrub**	**Pond**	**Jett**
Aix sponsa	Wood duck	14	R	-	R	R							S					S	
Anas crecca carolinenis	Green-winged teal	14	C	Ca	C	C				S	S	P	S	S	S	S		P	
Anas platyrhynchos	Mallard	14	C	U	C	C	S	S	S	S	S	S	S	S		S		P	
Anas acuta	Northern pintail	14	C	R	C	C	S	S	S	S	S	P	P	S		S		S	
Anas discors	Blue-winged teal	14	R	R	Ca	Ca												P	
Anas cyanoptera	Cinnamon teal	14	C	C	C	R							S			S		P	
Anas clypeata	Northern shoveler	14	C	Ca	C	C				S		S	S	S		S		P	
Anas strepera	Gadwall	14	R	Ca	R	R							S					S	
Anas penelope	Eurasian wigeon	14	R	-	R	R			S	P		S	P	S		S		S	
Anas americana	American wigeon	14	C	Ca	C	C			S	P		S	P	S		S		S	
Aythya valisineria	Canvasback	14	U	Ca	U	U			S	S		S	P					P	
Aythya americana	Redhead	14	U	Ca	U	U	P	S	S	P			P					S	
Aythya collaris	Ring-necked duck	14	U	Ca	U	U			S	S			S					P	
Aythya fuligula	Tufted duck		Ca	Ca	Ca	Ca			S	S			S					P	
Aythya marila	Greater scaup	14	C	R	C	C	P	S	P	S	S	S	P	S		S		P	
Aythya affinis	Lesser scaup	14	U	R	U	U	S	S	S	S	S	S	P	S		S		P	
Somateria spectabilis	King eider		-	-	Ac	Ac		S											
Polysticta stelleri	Steller's eider	2	-	-	Ac	-		S											
Histrionicus histrionicus	Harlequin duck	14	Ca	Ca	Ca	Ca	S	S	S										S
Clangula hyemalis	Oldsquaw	14	R	Ca	R	R	P	P	S				S					S	
Melanitta nigra	Black scoter	14	R	Ca	R	R	P	S											
Melaitta perspicillata	Surf scoter	14	C	U	C	C	P	P	S				S					S	
Melanitta fusca	White-winged scoter	14	C	U	C	C	P	P	S				S					S	
Bucephala clangula	Common goldeneye	14	R	-	R	R	S	P	S				S					S	
Bucephala islandica	Barrow's goldeneye	7,14	-	-	Ca	Ca												S	
Bucephala albeola	Bufflehead	14	C	Ca	C	C	S	S	P				P					P	
Lophodytes cucullatus	Hooded merganser	14	Ca	Ca	Ca	Ca												S	
Mergus merganser	Common merganser	14	Ca	-	Ca	Ca		S										S	

TABLE 2.3-3

			Status[a]				Habitat use[b]												
Taxa	**Common Name**	**WHR[c]**	**Sp**	**S**	**F**	**W**	**Ent**	**Dep**	**Sma**	**Eel**	**Snd**	**Mud**	**Opn**	**Salt**	**Wrac**	**Dike**	**Shrub**	**Pond**	**Jett**
Mergus serrator	Red-breasted merganser	14	C	Ca	C	C	P	P	S				P					S	
Oxyura jamaicensis	Ruddy duck	14	C	R	C	C	S	S	P				P					P	
Family Catharidae																			
Cathartes aura	Turkey vulture		C	C	C	R								S	S	S	S	S	
Family Accipitridae																			
Pandion haliaetus	Osprey	7,13	C	C	C	Ca	S	P	P				P					P	S
Elanus caeruleus	Black-shouldered kite		U	U	U	U								S		S	S	S	
Circus cyaneus	Northern harrier	7	U	U	U	U								S		S	S	S	
Accipiter stratus	Sharp-skinned hawk	7	U	R	U	U											S	S	
Accipiter cooperii	Cooper's hawk	7	R	R	R	R											S	S	
Beteo lineatus	Red-shouldered hawk		U	R	U	U											S	S	
Buteo jamaicensis	Red-tailed hawk		C	U	C	C								S		S	S	S	
Buteo lagopus	Rough-legged hawk		U	-	U	U								S		S	S	S	
Family Falconidae																			
Falco sparverius	American kestrel		C	U	C	C										S	S	S	
Falco columbarius	Merlin	7	U	-	U	U				S	S	P				P	S	P	
Falco peregrinus	Peregrine falcon	1,3,5,13	U	R	U	U				S	S	P				P		P	
Falco mexicanus	Prairie falcon	7	Ca	-	Ca	Ca					S	S				S		S	
Family Phasianidae																			
Callipepla california	California quail	14	R	R	R	R											S		
Family Rallidae																			
Rallus limicola	Virginia rail		C	U	C	C							P					P	
Porzana carolina	Sora		U	R	U	U							P					P	
Fulica americana	American coot	14	C	U	C	C			S	P	S	S	P	S	S	S		P	
Family Charadriidae																			
Pluvialis squatarola	Black-bellied plover		C	R	C	C				S	S	P		S	S	P		S	P
Pluvialis dominica	Lesser golden-plover	?	Ca	-	Ca	Ca					S	S				S			

			Status[a]				Habitat use[b]												
Taxa	**Common Name**	**WHR[c]**	**Sp**	**S**	**F**	**W**	**Ent**	**Dep**	**Sma**	**Eel**	**Snd**	**Mud**	**Opn**	**Salt**	**Wrac**	**Dike**	**Shrub**	**Pond**	**Jett**
Charadrius alexandrinus	Snowy plover	2,7	R	R	R	Ca					S				S				
Charadrius semipalmatus	Semipalmated plover		U	Ca	U	U					P	S			S	S		S	
Charadrius vociferus	Killdeer		C	C	C	C								S	S	S		S	
Family Haematopodidae																			
Haematopus bachmani	Black oystercatcher		Ca	Ca	Ca	Ca													P
Family Recurvirostridae																			
Himantopus mexicanus	Black-necked stilt		R	R	R	R												P	
Recurvirostra americana	American avocet		Ca	Ca	C	C					S	P	P	S		P		S	
Family Scolopacidae																			
Tringa melanoleuca	Greater yellowlegs		C	R	C	C				S		S	S	S		S		P	
Triga flavipes	Lesser yellowlegs		R	Ca	C	R						S						P	
Tringa solitaria	Marsh sandpiper		Ca	Ca	Ca	-												S	
Catoptrophorus semipalmatus	Willet		C	Ca	C	C				S	S	P	S	S	S	P		S	S
Heteroscelus incanus	Wandering tattler		U	R	U	U												P	
Actitis macularia	Spotted sandpiper		U	U	U	R					S				S	S		S	S
Numenius phaepus	Whimbrel		C	U	U	R				S	S	S		S	S	S		S	S
Numenius americanus	Long-billed curlew	7	U	R	U	U				S	S	P		S	S	S		S	S
Limosa haemastica	Hudsonian godwit		Ac	Ac	Ac	-						S						S	
Limosa lapponica	Bar-tailed godwit		-	Ac	Ac	-						S				S			
Limosa fedoa	Marbled godwit		A	U	A	A				P	S	P	P	S	S	P		S	S
Arenaria interpres	Ruddy turnstone		U	R	U	R					P	S		S	S	S		S	S
Arenaria melanocephala	Black turnstone		C	R	C	C				S	S	S		S	S	S		S	P
Aphriza virgata	Surfbird		U	R	U	U													P
Calidris canutus	Red knot		U	Ca	U	Ca				S	S	P		S	S	P			
Calidris alba	Sanderling		U	Ca	C	C					P					S			S

TABLE 2.3-3

			Status[a]				Habitat use[b]												
Taxa	**Common Name**	**WHR[c]**	**Sp**	**S**	**F**	**W**	**Ent**	**Dep**	**Sma**	**Eel**	**Snd**	**Mud**	**Opn**	**Salt**	**Wrac**	**Dike**	**Shrub**	**Pond**	**Jett**
Caldris pusilla	Semipalmated sandpiper		Ca	Ca	Ca	-									S			S	
Calidris mauri	Western sandpiper		A	U	A	C				S	S	P		S	S	P		S	S
Calidris ruficollis	Red-necked stint		Ac	Ac	-	-						S						S	
Calidris minutilla	Least sandpiper		C	U	C	C				S	S	P		S	P	P		P	S
Calidris bairdii	Baird's sandpiper	7	Ca	Ca	U	-						S				S		P	
Caildris melanotos	Pectoral sandpiper		Ca	Ca	C	-												P	
Calidris acuminata	Sharp-tailed sandpiper		-	-	Ca	-												P	
Calidris ptilocnemis	Rock sandpiper		R	-	R	R													P
Calidris alpina	Dunlin		A	Ca	A	C				S	S	P		S	S	P		P	S
Calidris himantopus	Stilt sandpiper		-	R	R	-						S						S	
Philomachus pugnax	Ruff		-	Ac	R	-												P	
Limnodromus griseus	Short-billed dowitcher		A	C	A	R			S	S	S	P		S	S	P		S	
Limnodromus scolopaceus	Long-billed dowitcher		C	-	C	U				S		S		S		S		P	
Gallinago gallinago	Common snipe	7	C	Ca	C	C								S				P	
Phalaropus tricolor	Wilson's phalarope		R	R	R	-												P	
Phalaropus lobatus	Red-necked phalarope		C	Ca	C	-		S	S				S					P	
Phalaropus fulicarius	Red phalarope		U	Ca	U	R		S	S				S					P	
Family Laridae																			
Stercorarius pomarinus	Promarine jaeger		-	-	U	-	P	P	S				S						
Stercorarius parasiticus	Parasitic jaeger		-	-	U	-	P	P	S				S						
Larus articilla	Laughing gull	7	-	Ac	Ac	-												S	
Larus pipixcan	Franklin's gull		R	Ca	R	Ca							S					S	
Larus minutus	Little gull		Ac	-	Ac	Ac							S					S	
Larus ridibundus	Common black-headed gull		Ac	Ac	-	Ac							S					S	
Larus philadelphia	Bonaparte's gull		C	R	C	R		S	S	P			P			S		S	S
Larus heermanni	Heermann's gull		Ca	C	C	Ca	P	P	S	S	S	S	P			S		S	S

TABLE 2.3-3

			Status[a]				Habitat use[b]												
Taxa	**Common Name**	**WHR[c]**	**Sp**	**S**	**F**	**W**	**Ent**	**Dep**	**Sma**	**Eel**	**Snd**	**Mud**	**Opn**	**Salt**	**Wrac**	**Dike**	**Shrub**	**Pond**	**Jett**
Larus canus	Mew gull		C	-	C	C	S	S	S	S	S	S	S			S		S	
Larus delawarensis	Ring-billed gull		C	R	C	C	S	S	S	S	S	S	S	S	S	S		S	
Larus californicus	California gull	7	C	R	C	U	S	S	S				S			S			S
Larus argentatus	Herring gull		R	Ca	R	R	S	S	S				S			S			S
Larus thayeri	Thayer's gull		Ca	-	Ca	Ca	S	S	S				S			S			S
Larus occidentalis	Western gull		A	C	A	A	S	S	P	P	S	S	P	S	S	P		S	P
Larus glaucescens	Glaucous-winged gull		C	U	C	C	S	S	P	P	S	S	P	S	S	P		S	P
Laus hyperboreus	Glaucous gull		R	-	R	R	S	S	S	S		S	S	S		S		S	S
Rissa tridactyla	Black-legged kittiwake		R	Ca	R	R	S	S					S						P
Xema sabini	Sabine's gull		-	-	Ac	-												S	
Sterna caspia	Caspian tern		C	C	C	-	P	P	P				P	S		P		S	S
Sterna elegans	Elegant tern	7	-	Ca	R	-	S	P	S		P		P			S		S	
Sterna hirundo	Common tern		U	R	U	-	S	P	S		P		P			S		S	S
Sterna forsteri	Foster's tern		R	R	U	Ca	S	S	S				P			S		P	S
Sterna antillarum	Least tern	1,3,5	Ac	Ac	Ac	-							S			S			
Childonias niger	Black tern	7	Ca	Ca	Ca	-							S					S	
Family Alcidae																			
Uria aalge	Common murre		U	C	U	Ca	P	P	S				S						
Cepphus columba	Pigeon guillemot		R	U	R	-	P	S											
Brachyramphus marmoratus	Marbled murrelet	2,3,13	R	R	R	Ca	P	S											
Family Columbidae																			
Columba livia	Rock dove		C	C	C	C													P
Zenaida macroura	Mourning dove	14	R	R	R	-											S	S	
Family Tytonidae																			
Tyto alba	Common barnowl		U	U	U	U							S				S		
Family Strigidae																			
Bubo virginianus	Great horned owl		R	R	R	R													
Nyctea scandiaca	Snowy owl		Ca	-	Ca	Ca								P		S	S		
Athene cunicularia	Burrowing owl	7	Ca	-	Ca	Ca										S			
Asio flammeus	Short-eared owl	7	U	-	U	U								S		S			

			Status[a]				Habitat use[b]												
Taxa	**Common Name**	**WHR[c]**	**Sp**	**S**	**F**	**W**	**Ent**	**Dep**	**Sma**	**Eel**	**Snd**	**Mud**	**Opn**	**Salt**	**Wrac**	**Dike**	**Shrub**	**Pond**	**Jett**
Family Apodidae																			
Chaetura vauxi	Vaux's swift	7	C	C	U	-											S	S	
Family Trochilidae																			
Calypte anna	Anna's hummingbird		U	U	U	R											S		
Selasphorus sasin	Allen's hummingbird		C	C	U	-											S		
Family Alcedinidae																			
Ceryle alcyon	Belted kingfisher		C	C	C	C		S	S				S			S		S	P
Family Picidae																			
Sphyrapicus ruber	Red-breasted sapsucker		R	R	R	R											S		
Picoides pubescens	Downy woodpecker		R	R	R	R											S		
Picoides villosus	Harry woodpecker		R	R	R	R											S		
Colaptes auratus	Northern flicker	3	C	C	C	C											S		
Family Tyrannidae																			
Emidonax traillii	Willow flycatcher	1,3,12	R	Ca	R	-											S		
Empidonax difficilis	Western flycatcher		C	C	U	-											S		
Sayornis nigricans	Black phoebe		C	C	C	C									S	S	S	P	S
Myiarchus cinerascens	Ash-throated flycatcher		R	R	R	-											S		
Family Alaudidae																			
Eremophila alpestris	Horned lark	7	Ac	-	Ac	Ac										S			
Family Hirundinidae																			
Progne subis	Purple martin	7	U	U	U	-												S	
Tachycineta bicolor	Tree swallow		C	C	C	R								S	S	S	S	S	
Tachycineta thalassina	Violet-green swallow		C	C	C	R								S	S	S	S	S	
Stelgidopteryx serripennis	Northern rough-winged swallow		U	U	U	-								S	S	S	S	S	
Riparia riparia	Bank swallow	4	Ac	Ac	Ac	-												S	
Hirundo pyrrhonota	Cliff swallow		C	C	C	-								S	S	S	S	S	
Hirundo rustica	Barn swallow		C	C	C	R								S	S	S	S	S	

TABLE 2.3-3

			Status[a]				Habitat use[b]												
Taxa	**Common Name**	**WHR[c]**	**Sp**	**S**	**F**	**W**	**Ent**	**Dep**	**Sma**	**Eel**	**Snd**	**Mud**	**Opn**	**Salt**	**Wrac**	**Dike**	**Shrub**	**Pond**	**Jett**
Family Corvidae																			
Corvus brachyrhynchos	American crow	14	C	C	C	C										S	S	S	
Corvus corax	Common raven		C	C	C	C								S	S	S	S	S	S
Family Paridae																			
Parus rufescens	Chestnut-backed chicadee		C	C	C	C											S		
Family Aegithalidae																			
Psaltriparus minimus	Bushtit		R	R	R	R											S		
Family Sittidae																			
Sitta canadenis	Red-breasted nuthatch		Ca	-	Ca	Ca											S		
Family Certhiidae																			
Certhia americana	Brown creeper		R	R	R	R											S		
Family Troglodytidae																			
Thryomanes bewickii	Bewick's wren		U	U	U	U											S		
Troglodytes trogoldytes	Winter wren		U	U	U	U											S		
Troglodytes aedon	House wren		Ca	Ca	Ca	-											S		
Cistothorus palustris	Marsh wren		C	C	C	C								P		S	S	P	
Family Muscicapidae																			
Regulus calendula	Ruby-crowned kinglet		C	-	C	C											S		
Regulus satrapa	Golden-crowned kinglet		U	R	U	U											S		
Catharus guttatus	Hermit thrush		R	-	U	C											S		
Catharus ustulatus	Swainson's thrush		R	U	R	-											S		
Turdus migratorius	American robin		C	C	C	C										S	S	S	
Chamaea fasciata	Wrentit		R	R	R	R											S		
Family Motacillidae																			
Anthus spinoletta	Water pipit	?	C	-	U	C									S	P		P	

TABLE 2.3-3

			Status[a]				Habitat use[b]												
Taxa	**Common Name**	**WHR[c]**	**Sp**	**S**	**F**	**W**	**Ent**	**Dep**	**Sma**	**Eel**	**Snd**	**Mud**	**Opn**	**Salt**	**Wrac**	**Dike**	**Shrub**	**Pond**	**Jett**
Family Bombycillidae																			
Bombycilla cedrorum	Cedar waxwing		U	U	U	Ca											S		
Family Laniidae																			
Lanius excubitor	Northern shrike		R	-	R	R											S		
Lanius ludovicianus	Loggerhead shrike	1,7	Ca	-	Ca	Ca											S		
Family Sturnidae																			
Sturnus vularis	European starling		A	C	A	A								S	S	S	S	S	S
Family Vireonidae																			
Vireo solitarius	Blue -headed vireo		R	R	R	-											S		
Vireo huttoni	Hutton's vireo		R	R	R	R											S		
Vireo gilvus	Warbling vireo		R	R	R	-											S		
Family Parulidae																			
Vermivora peregrina	Tennessee warbler		Ac	-	Ac	-											S		
Vermivora celata	Orange-crowned warbler		C	C	C	R										P			
Vermivora ruficapilla	Nashville warble		R	R	R	Ca											S		
Dendroica petechia	Yellow warbler		R	R	C	-											S		
Dendroica tigrina	Cape May warbler		-	Ac	-	-											S		
Dendroica coronata	Yellow-rumped warbler		C	-	C	C											P		
Dendroica nigrescens	Black-throated gray warbler		R	R	R	-											S		
Dendroica townsendi	Townsend's warbler		R	-	R	R											S		
Dendroica palmarum	Palm warbler		R	-	R	R										S	S	S	
Dendroica castanea	Bay-breasted warbler		-	Ca	-	-											S		
Dendroica striata	Blackpoll warbler		-	-	Ca	-											S		
Mniotilta varia	Black-and-white warbler		Ca	-	Ca	Ca										S			
Seiurus aurocapillus	Ovenbird		-	-	Ca	-											S		
Seiurus noveboracensis	Northern waterthrush		-	-	Ca	-											S		

TABLE 2.3-3

			Status[a]				Habitat use[b]												
Taxa	**Common Name**	**WHR[c]**	**Sp**	**S**	**F**	**W**	**Ent**	**Dep**	**Sma**	**Eel**	**Snd**	**Mud**	**Opn**	**Salt**	**Wrac**	**Dike**	**Shrub**	**Pond**	**Jett**
Oporornis tolmiei	MacGillivray's warbler		R	Ca	R	-											S		
Geothlypis trichas	Common yellowthroat	7	C	C	C	R								P		S	S	P	
Wilsonia pusilla	Wilson's warbler		C	C	C	Ca											S		
Family Thraupidae																			
Piranga ludoviciana	Western tanager		U	U	U	-											S		
Family Emberizidae																			
Pheucticus melanocephalus	Black-headed grosbeak		R	R	R	-											S		
Pipilo erythrophthalmus	Rufous-sided towhee		U	-	U	U											S		
Spizzela passerina	Chipping sparrow		U	U	U	-											S		
Spizella pallida	Clay-colored sparrow		-	-	Ca	-											S		
Pooecetes gramineus	Vesper sparow		Ca	U	Ca	-										S		S	
Chondestes grammacus	Lark sparrow		Ca	Ca	Ca	-										S		S	
Passerculus sandwichensis	Savannah sparrow	3,7	C	C	C	C								P	S	S	S	S	
Passerculus iliaca	Fox sparrow		U	-	U	U										S			
Melospiz melodia	Song sparrow	7		C	C	C	C							P	S	S	P	S	
Melospiza lincolnii	Lincoln's sparrow		U	-	U	U								S	S	S	S	S	
Melospiza georgiana	Swamp sparow		Ca	-	Ca	Ca								S	S	S	S	S	
Zonotrichia albicollis	White-throated sparrow		R	-	R	R											S		
Zonotrichia atricapilla	Golden-crowned sparrow		C	-	C	C									S	S			
Zonotrichia leucophrys	White-crowned sparrow		C	C	C	C										S	S		
Junco hyemalis	Dark-eyed junco	7	C	-	C	C											S		
Calcarius lapponicus	Lapland longspur		-	-	Ac	Ac										S			
Family Icteridae																			
Plectrophenax nivalis	Snow bunting		-	-	Ac	Ac										S			

TABLE 2.3-3

			Status[a]				Habitat use[b]												
Taxa	**Common Name**	**WHR[c]**	**Sp**	**S**	**F**	**W**	**Ent**	**Dep**	**Sma**	**Eel**	**Snd**	**Mud**	**Opn**	**Salt**	**Wrac**	**Dike**	**Shrub**	**Pond**	**Jett**
Dolichonyx oryzivorus	Bobolink		Ca	Ca	R	-								S		S	S		
Agelaius phoeniceus	Red-winged blackbird		C	C	C	U								P	S	S	S	P	
Sturnella neglecta	Western meadowlark		U	U	U	U								S	S	S	S	S	
Eurphagus cyanocephalus	Brewer's blackbird		C	C	C	C								S	S	S	P	S	
Eughagus carolinus	Rusty blackbird		-	-	Ca	-												S	
Molothrus ater	Brown-headed cowbird		C	C	C	R								S		S	S	S	
Xanthocephalus xanthocephalus	Yellow-headed blackbird		Ca	-	Ca	-												S	
ICTERUS GALBULA	Baltimore oriole		U	U	U	Ca											S		
Family Fringillidae																			
Fringilla mortifringilla	Brambling		-	-	Ac	-											S		
Carpodacus purpureus	Purple finch		U	R	U	U											S		
Carpodacus mexicanus	House finch		C	C	C	C								S	S	S	P	S	
Carduelis pinus	Pine siskin		R	-	R	R										S	S	S	
Carduelis psaltria	Lesser goldfinch		U	U	U	Ca										S	S	S	
Carduelis tristis	American goldfinch		U	C	U	Ca										S	S	S	
Loxia curvirostra	Red crossbill		R	-	-	-											S		
Family Passeridae																			
Passer domesticus	House sparrow		C	C	C	C										P	P	S	

(a) Status: Sp = spring; S = summer; W = winter; F = fall; A = abundant; C = common; U = uncommon; R = rare; Ca = casual; Ac = accidental.

(b) Habitat use: Ent = entrance bay; Dep = deep channels; Sma = small, shallow channels; Elg = eelgrass beds; Snd = sand flats; Mud = mud flats; Opn = open waters; Salt = salt marsh; Wrac = shoreline eelgrass wracks; Dike = dikes and elevated islands; Shrub = shrub and tree patches; Pond = fresh and brackish ponds; Jett = jetties, piers and ruins; P = primary use; S = secondary use.

(c) Wildlife Habitat Relationship Program Species Sensitivity: 1=Fed End, 2=Fed Threat, 3=CA End, 4=CA Threat, 5=CA Full Prot, 6=CA Prot, 7=CA SSC, 8=Fed Pop End, 9=Fed Pop Threat, 10=Fed Cand, 11=BLM Sens, 12=USFWS Sens, 13=CDF Sens, 14=Harvest, ?=Habitat is variable

TABLE 2.3-4

MAMMALS OF HUMBOLDT BAY

Data are based on Barnhart et al. (1992) with species sensitivity status information compiled from the Wildlife Habitat Relationships Program (Mayer and Laudenslayer (1988)

			Habitat designation[a]							
Taxa	**Common name**	**Status[b]**	**Agri**	**Ripn**	**Salt**	**Frsw**	**Mudf**	**Smal**	**Open**	**Jett**
Family Didelphidae										
Didelphis virginiana	Virginia opossum	14	?	?						
Family Soricidae										
Sorex pacificus	Pacific marsh shrew									
Sorex vagrans	Vagrant shrew	7		+						
Sorex bendirii	Marsh shrew			+						
Sorex trowbridgii	Trowbridge's shrew			+						
Family Talpidae										
Neurotrichus gibbeii	Shrew-mole			+						
Scapanus townsendii	Townsend's mole		+	?						
Scapanus orarius	Coast mole			+						
Family Vespertilionidae										
Myotis lucifugus	Little brown bat	7	+	+	?	+	+	?	?	
Myotis thysanodes	Fringed myotis		+	+	?	+	+	?	?	
Myotis californicus	California myotis		+	+	?	+	+	?	?	
Myotis volans	Long-legged myotis		+	+	?	+	+	?	?	
Myotis evotis	Long-eared myotis	7	?	+	?	+		?		
Myotis yumanensis	Yuma myotis	7	?	+	?	+		?		
Lasiurus cinereus	Hoary bat		?	+	?	+	?	?	?	
Lasionycteris noctivagans	Silver-haired bat		?	+	?	+		?		
Plecotus townsendii	Townsend's big-eared bat	7,12	+		?	+	?	?	?	

TABLE 2.3-4

		Habitat designation[a]								
Taxa	**Common name**	**Status[b]**	**Agri**	**Ripn**	**Salt**	**Frsw**	**Mudf**	**Smal**	**Open**	**Jett**
Eptesicus fuscus	Big brown bat		+	?	?	+	?	?	?	
Family Leporidae										
Lepus californicus	Black-tailed jack rabbit	7,14	+	+						
Sylvilagus bachmani	Brush rabbit	3,8,14	+	+						
Family Aplodontiidae										
Aplodonita rufa	Mountain beaver	1,7		X						
Family Sciuridae										
Spermophilus beecheyi	California ground squirrel		+	+						
Tamias townsendii	Townsend's chipmunk									
Sciurus griseus	Western gray squirrel	14		+						
Tamiasciurus douglasii	Douglas' squirrel	14								
Glaucomys sabrinus	Northern flying squirrel	7,12		?						
Family Geomyidae										
Thomomys bottae	Botta's pocket gopher		+							
Family Costoridae										
Castor canadensis	Beaver	14		+						
Family Muridae										
Reithrodontomys megalotis	Western harvest mouse		?	?	?					
Peromyscus truei	Pinon mouse									
Peromyscus maniculatus	Deer mouse	7	+	+						
Neotoma fuscipes	Dusky-footed woodrat	7,10								

TABLE 2.3-4

		Habitat designation[a]								
Taxa	**Common name**	**Status[b]**	**Agri**	**Ripn**	**Salt**	**Frsw**	**Mudf**	**Smal**	**Open**	**Jett**
Arborimus albipes	White-footed vole	7								
Arborimus longicaudus	Red tree vole	7								
Clethrionomys californicus	Western red-backed vole									
Microtus longicaudus	Long-tailed vole			+						
Microtus oregoni	Creeping vole			+						
Microtus californicus	California vole	1,3,7	+							
Microtus townsendii	Townsend's vole		?							
Rattus norvegicus	Norway rat		+							
Rattus rattus	Black rat		+	+						
Mus musculus	House mouse		+							
Family Dipodidae										
Zapus trinotatus	Pacific jumping mouse	7								
Family Erethizontidae										
Erethizon dorsatum	Porcupine		+	+						
Family Delphinidae										
Delphinus delphis	Saddle-backed dolphin	?								
Tursiops gillii	Pacific bottlenose dolphin	?								
Lagenorhynchus obliquidens	Pacific white-sided dolphin	?								
Family Phocoenidae										
Phocoena phocoena	Harbor porpoise	?							X	
Phocoenoides dalli	Dall's porpoise	?								
Family Eschrichtius										

TABLE 2.3-4

		Habitat designation[a]								
Taxa	**Common name**	**Status[b]**	**Agri**	**Ripn**	**Salt**	**Frsw**	**Mudf**	**Smal**	**Open**	**Jett**
Eschrichtius robustus	Grey whale	?								
Family Otariidae										
Eumetopias jubatus	Northern sea lion	2,6								
Zalophus californicus	California sea lion	6								
Family Phocidae										
Phoca vitulina	Harbor seal	6					X		X	
Family Canidae										
Urocyon cinereoargenteus	Gray fox	14	?	?						
Canis latrans	Coyote	14	+	+	?					
Family Ursidae										
Ursus americanus	Black bear	14		+						
Family Procyonidae										
Procyon lotor	Raccoon	14	+	+	+		+			
Bassariscus astutus	Ringtail	5		+						
Family Mustelidae										
Martes americana	Marten	7,12								
Martes pennanti	Fisher	7,12								
Mustela vison	Mink	14		+						
Mustela frenata	Long-tailed weasel	14		+						
Mustela erminea	Ermin	14								
Mephitis mephitis	Striped skunk	5,7		+						
Spilogale putorius	Spotted skunk	7,14								
Lutra canadensis	River otter	7		X		X		X	X	
Family Felidae										
Felis concolor	Mountain lion	5,7		+						
Lynx rufus	Bobcat	14		+						
Family Cervidae										

TABLE 2.3-4

		Habitat designation[a]								
Taxa	**Common name**	**Status[b]**	**Agri**	**Ripn**	**Salt**	**Frsw**	**Mudf**	**Smal**	**Open**	**Jett**
Ococoileus hemionus	Mule deer	14	+	+						
Cervus elaphus	Elk (wapiti)	14	+							

(a) Habitat Designation: Agri = agricultural land; Ripn = riparian brush and forest; Salt = salt marsh; Frsw = freshwater marsh; Mudf = mud flats; Smal = small tidal channels, creeks, sloughs; Open = open baywaters; Jett = jetties, reefs, ruins; X = for species use based on voucher material or published records.

(b) Status: 1=Fed End, 2=Fed Threat, 3=CA End, 4=CA Threat, 5=CA Full Prot, 6=CA Prot, 7=CA SSC, 8=Fed Pop End, 9=Fed Pop Threat, 10=Fed Cand, 11=BLM Sens, 12=USFWS Sens, 13=CDF Sens, 14=Harvest, ?=Habitat is variable

TABLE 2.3-5

AMPHIBIANS AND REPTILES OF HUMBOLDT BAY

Data are compiled from the Wildlife Habitat Relationships Program (1988)

			Habitat Importance[a]							
Taxa	**Common name**	**Status[b]**	**Agr**	**Ripn**	**Salt**	**Frsw**	**Mudf**	**Smal**	**Meado**	**Forest**
Ambystoma gracile	Northwestern Salamander			H		M			L	M
Rhyacotriton variegatus	Southern Seep Salamander	6,7,12		M					M	H
Tarcha rivularis	Red-Bellied Newt			H						H
Plethodon elongatus	Del Norte Salamander	6,7								H
Ensatina eschscholtzii	Ensatina	7,12								H
Batrachoseps attenuatus	California Slender Salamander								L	H
Aneides flavipunctatus	Black Salamander								L	H
Aneides ferreus	Clouded Salamander									M
Aneides lugubris	Arboreal Salamander								L	L
Bufo Boreas	Western Toad		L	H		M			M	L
Pseudacris cadaverina	Pacific Chorus Frog		H	H		H			H	
Rana aurora	Red Legged Frog	2,6,7,12		H		H			L	M
Rana boylii	Foothill Yellow-Legged Frog	6,7,12		H					M	L
Rana catesbeiana	Bullfrog	14	H	H		H			M	H
Dicamptodon tenebrosus	Pacific Giant Salamander			H		M			M	H
Clemmys marmorata	Western Pond Turtle	6,7,12	L	H		H			H	
Sceloporus occidentalis	Western Fence Lizard		L						L	M
Eumeces skiltonianus	Western Skink	7	L						M	L
Elgaria panamintina	Southern Alligator Lizard		L						L	M
Elgaria coerulea	Northern Alligator Lizard								L	M
Charina bottae	Rubber Boa	4,6,12							L	M

TABLE 2.3-5

			Habitat Importance[a]							
Taxa	**Common name**	**Status[b]**	**Agr**	**Ripn**	**Salt**	**Frsw**	**Mudf**	**Smal**	**Meado**	**Forest**
Diadophis punctatus	Ringneck Snake	12	L			L			L	
Contia tenuis	Sharp-Tailed Snake								H	L
Coluber constrictor	Racer		M			M			M	L
Masticophis lateralis	Striped Racer	2,4,6							M	
Pituophis melanoleucus	Gopher Snake	7	H			L			M	
Lampropeltis getula	Common Kingsnake		M			M			M	L
Lampropeltis zonata	California Mountain Kingsnake	6,7,12							H	M
Thamnophis sirtalis	Common Garter Snake	1,3,5,6,7	M			H			H	M
Thamnophis elegans	Western Terrestrial Garter Snake			M		H			H	M
Crotalus viridis	Western Rattlesnake		L			L			L	L
Thamnophis atratus	Pacific Coast Aquatic Garter Snake			H		H			H	M

(a) Habitat Designation: Agri = agricultural and pasture land; Ripn = riparian brush and forest; Salt = salt marsh; Frsw = emergent freshwater marsh; Mudf = mud flats; Smal = small tidal channels, creeks, sloughs; Meado = wet meadow; Forest = redwood and other forest.

(b) Status: 1=Fed End, 2=Fed Threat, 3=CA End, 4=CA Threat, 5=CA Full Prot, 6=CA Prot, 7=CA SSC, 8=Fed Pop End, 9=Fed Pop Threat, 10=Fed Cand, 11=BLM Sens, 12=USFWS Sens, 13=CDF Sens, 14=Harvest.

TABLE 2.3-6

SPECIAL STATUS TERRESTRIAL SPECIES POTENTIALLY OCCURRING IN THE ISFSI AREA

Name	Status[a]	Habitat	Occurrence Onsite
California Brown Pelican	FE/SE,C FP	Nearshore marine and estuarine habitats. Roost on offshore rocks and man-made structures.	Not present. No suitable habitat.
Double-crested Cormorant	CSC	Historically nested on coastal cliffs and offshore rocks, but now mostly at inland lake sites.	Not present. No suitable habitat.
Black-Crowned Night Heron	*	Usually nests in trees adjacent to aquatic or wetland habitats (i.e., foraging areas).	May forage in the salt marsh and drainage near the main access road; may occasionally roost in the site's trees, but no known nesting occurs. Nearest known rookery is at Indian and Woodley Islands.
Snowy Egret	*	Usually nests in trees adjacent to aquatic or wetland habitats (i.e., foraging areas).	May forage in the salt marsh and grassland and occasionally roost in the site's trees, but no known nesting occurs. Nearest known rookery is at Indian and Woodley Islands.,
Great Egret	*	Usually nests in trees adjacent to aquatic or wetland habitats (i.e., foraging areas).	May forage in the salt marsh and drainage near the main access road; may occasionally roost in the site's trees, but no known nesting occurs. Nearest known rookery is at Indian and Woodley Islands.

TABLE 2.3-6

Name	Status[a]	Habitat	Occurrence Onsite
Great Blue Heron	*	Usually nests in trees adjacent to aquatic or wetland habitats (i.e., foraging areas).	May forage in the salt marsh and drainage near the main access road; may occasionally roost in the site's trees, but no known nesting occurs. Nearest known rookery is at Indian and Woodley Islands.
California Clapper Rail	FE/SE,CFP	Tidal salt marshes traversed by tidal sloughs. It is found in pickleweed and cordgrass stands in the bay.	Not present. No suitable habitat.
Western Snowy Plover	FT/CSC	Sandy beaches on marine and estuarine shores, also salt pond levees and the shores of large alkali lakes.	Not present. No suitable habitat.
White-tailed Kite	CFP	Nests in shrubs and trees adjacent to grasslands; forages in grasslands and agricultural lands.	Possible. PG&E property provides potential nesting habitat in the riparian scrub and limited foraging habitat salt marsh-riparian scrub habitats. Not present at ISFSI site. No suitable habitat.
Northern Harrier	CSC	Nests on the ground in wet meadows and seasonal wetlands; forages over grassland.	Possible. PG&E property provides potential nesting habitat in the seasonal wetlands. Not present at ISFSI site. No suitable habitat.
Osprey	CSC	Coniferous forests, snags, and nesting platforms near open water for foraging.	Not present. No suitable nesting or foraging habitat.

TABLE 2.3-6

Name	Status(a)	Habitat	Occurrence Onsite
American Pregrine Falcon	SE	Nesting habitat includes high, protected cliffs and ledges near water; forages along shorelines, marshes, and grasslands.	Not present. No suitable nesting or foraging habitat.
Northern Spotted Owl	FT/CSC	Old-Growth forests or mixed stands of old-growth and mature trees.	Not present. No suitable habitat.
Tricolored Blackbird	CSC	Nests in dense cattails or shrubby vegetation in close proximity to open water.	Not present. No suitable habitat.
Red Tree Vole	CSC	Douglas fir, redwood and hardwood-conifer forests.	Not present. No suitable habitat.
White-Footed Vole	CSC	Coastal forests in northern California and Oregon with dense riparian vegetation along small streams.	Not present. No suitable habitat on ISFSI site. Remnant red alder forest just west of the site may provide potential habitat but considered marginal due to isolated patch of forest, absence of streams, and disturbance in surrounding area.

(a) Special Status Species Code Designations:
FE = Federally listed endangered
FT = Federally listed threatened
SE = State listed endangered
ST = State listed threatened
CSC = California Species of Special Concern
CFP = California Full Protected Species
* = Special Animal

TABLE 2.3-7

SELECTED AQUATIC INVERTEBRATES OF HUMBOLDT BAY

Data are from reports and records compiled by Barnhart et al. (1992).

TAXA	Common name	Abundance[(a)]	Habitat[(b)]	Remarks
Porifera				
Haliclona permollis	Sponge	C	Ro,Epi	
Haliclona sp.				
Cliona sp.	Sponge	C	Sym	On shells
Cnidarians				
Aequorea sp.	Hydromedusa	C	Pk	With other hydroids
Campanularia integra	Hydroid	C	Sym	
Obelia borealis	Hydoid	A	Ro,Epi,Pi	
Obelia longissima	Hydroid	A	Pi	
Plumularia spp.	Hydroid			
Sertularia spp.	Hydroid	C	Epi	On algae
Thuiaria similis	Hydroid			
Tubularia crocea	Hydroid	A	Ro,Pi,Epi	
Tubularia marina	Hydroid	A	Ro	
Velella lata	By-the-wind sailor	A	Pk	
Aurelia spp	Jellyfish	C	Pk	
Chysaora sp.	Jellyfish	O	Pk	
Pelagia sp.	Jellyfish	O	Pk	
Antholpleura artemisia	Sand anemone	C	Sa	
Anthopleura elegantissima	Aggregating anemone	C	Ro	
Anthopleura xanthogrammica	Great green anemone	C	Ro	
Cerianthus sp.	Burrowing anemone	O	Sa,Mi	
Diadumene spp.	Orange striped anemone	C	Ro,Pi	
Epiactis prolifra	Brooding anemone	C	Ro,Pi	

TABLE 2.3-7

TAXA	Common name	Abundance[a]	Habitat[b]	Remarks
Gersemia rufriformis	Sea strawberry	O	Ro	Near bay mouth
Haliplanella luciae	Anemone	C	Pi	
Metridium senile	White anemone	C	Pi	
Nematostella vectensis	Salt marsh anemone	C	Mu	In salt marshes
Tealia crassicornis	Splotched anemone	C	Ro,Pi	
Cenophora				
Pleurobrachia bachei	Comjelly	A	Pk	
Nemertea				
Amphporus imparispinosus	Ribbon worm	C	Ro,Pi	
Carinoma mutabilis	Ribbon worm	C	Sa,Mu	
Carinomella lactea	Ribbon worm	O	Sa,Mu	
Cerebratulus californiensis	Ribbon worm	C	Sa,Mu	
Emplectonema sp.	Ribbon worm	O	Sa	On shell fragments
Paranemertes californica	Ribbon worm	C	Sa,Mu	
Tubulanus pellucidus	Ribbon worm	C	Sa,Mu	
Tubulanus polymorphus	Ribbon worm	C	Sa,Mu	
Annelida				
Polychaeta				
Abarenicola antebranchia	Lugworm	O	Mu	
Abarenicola humboldtensis	Lugworm	O	Mu	
Abarenicola pacifica	Lugworm	O	Sa	
Amaena occidentalis	Hairy-gill worm	O	Mu	
Ampharete arctica	Bristle worm	O	Sa	
Anaitides groenlandica	Paddle worm	R	Sa	
Anaitides williamsi	Paddle worm	C	Sa,Mu	
Aricidea suecica	Paranoid worm	O	Sa,Mu	
Armandia brevis	Bristle worm	C	Sa,Mu	
Autolytus sp.	Bristle worm	C	Sa,Mu	

TABLE 2.3-7

TAXA	Common name	Abundance[a]	Habitat[b]	Remarks
Boccardia berkeleyorum	Spionid worm	O	Sym	Bores podesmus shells
Brania sp.	Bristle worm	R	Sa	
Capitella capitata	Tube worm	A	Mu	
Caulleriella alata	Thread worm	O	Sa	
Caulleriella hamata	Thread worm			
Caulleriella sp.	Thread worm	O	Sa	
Chaetozone setosa	Hairy-gill worm	C	Sa,Mu	
Chaetozone sp.	Hairy-gill worm	C		
Cheilonereis cyclurus	Hermit crab worm	C	Sym	With hermit crabs
Chone gracilis	Paddle worm	O	Sa	
Chone sp.	Paddle worm			
Cirratulus cirratus	Bristle worm	R	Sa	
Cistenides brevicoma	Turbe worm	O	Mu	
Cossura pygodactylata	Bristle worm	R	Mu	
Dodecaceria concharum	Bristle worm	R	Sa	
Drilonereis falcata	Bristle worm	C	Sa,Mu	
Eteone california	Paddle worm	C	Sa,Mu	
Eteone dilatae	Paddle worm	C	Sa	
Eteone Pacifica	Paddle worm	C	Sa,Mu	
Euclymene delineata	Polychaete worm	C	Sa,Mu	
Eulalia aviculiseta	Paddle worm	O	Sa	With shell debris
Eumidia bifoliata	Paddle worm	C	Sa,Mu	
Eumidia sanguinea	Paddle worm	C	Sym	
Eunereis sp.	Mussel worm			
Eupolymnia crescentis	Terebellid worm	R	Sa,Mu	
Eusyllis assimilis	Paddle worm	O	Sa	
Euzonus mucronata	Bristle worm	C	Sa	
Exogone lourei	Bristle worm	A	Sa,Mu	

TABLE 2.3-7

TAXA	Common name	Abundance[a]	Habitat[b]	Remarks
Exogone sp.	Bristle worm		Sa,Mu	
Glycera americana	Bristle worm	O	Sa	
Glycera capitata	Bristle worm	O	Sa	
Clycera oxycephala	Bristle worm	C	Sa,Mu	
Glycera tenuis	Bristle worm	A	Sa	
Glycinde polygnatha	Bristle worm	A	Sa,Mu	
Glycinde sp.	Bristle worm			
Gyptis brevipalpa	Bristle worm	O	Sa,Mu	
Halosydna brevisetosa	Scale worm	O	Sa,Mu	
Halosydna latior	Scale worm	O	Sa	
Haploscoloplos elongatus	Orbinid worm	A	Sa,Mu	
Harmothoe imbicata	Scale worm	A	Ro	
Harmothoe lunulata	Scale worm	A	Sa,Mu	
Harmothoe priops	Scale worm	O	Sa	
Hemipodus borealis	Slaty blue worm	O	Sa,Mu	
Hemipodus imbriacata	Slaty blue worm			
Hesperone adventor	Scale worm	O	Sym	In *Urechis* burrows
Heteromastus filobranchus	Capitellid worm	A	Mu	
Lumbrineris calforniensis	Bristle worm	O	Mu	
Lumbrineris japonica	Bristle worm	O	Sa,Mu	
Lumbrineris tetraura	Bristle worm	A	Sa,Mu	
Lumbrineriszonata	Bristle worm	C	Mu	
Lysilla labiata	Polychaete worm	A	Sa,Mu	
Magelona pacifica	Bristle worm	O	Mu	
Magelona pitelkai	Bristle worm	O	Sa,Mu	
Magelona sacculata	Bristle worm	O	Sa	
Mediomastus californiensis	Lugworm	A	Sa,Mu	
Mellina oculata	Polychaete worm			

TABLE 2.3-7

TAXA	Common name	Abundance[a]	Habitat[b]	Remarks
Mesochaetopterus taylori	Bristle worm	O	Sa	In eelgrass beds
Nairereis sp.	Bristle worm	R	Sa	
Neanthes sp.	Bristle worm	C	Sa,Ro	
Nepthtys caecoides	Bristle worm	C	Sa,Mu	
Nephtys californiensis	Bristle worm	C	Sa	
Nephtys ferruginea	Bristle worm	R	Mu	
Nephtys parva	Bristle worm	C	Sa,Mu	
Nereis procera	Bristle worm	C	Sa,Mu	
Nereis sp.	Bristle worm	O	Sa	
Nothria sp.	Bristle worm	O	Sa	
Notomastus tenuis	Thin red worm	O	Mu	
Ophelia assimilis	Bristle worm	A	Sa,Mu	
Ophelia magna	Bristle worm		Sa,Mu	
Owenia collaris	Tube worm	A	Sa,Mu	
Paleonotus bellis	Bristle worm	C	Sa,Mu	
Paraonis gracilis	Bristle worm	R	Sa,Mu	
Phloe glabra	Polychaete worm	O	Sa,Mu	
Phloe tuberculata	Polychaete worm	A	Sa,Mu	
Pholoides aspera	Polychaete worm	O	Sa,Mu	
Phragmatopoma clifornica	Tube worm		Ro	
Pilargis maculata	Polychaete worm	R	Sa,Mu	
Pisione remota	Polychaete worm	R	Sa	
Pista cristata	Bristle worm	O	Sa	
Pista pacifica	Bristle worm	C	Sa,Mu	
Platynereis ogassizi	Bristle worm			
Platynereis bicanaliculata	Tube worm	A	Sa,Mu,Ro	
Polydora brachycephala	Spionid worm	A	Sa,Mu	
Polydora ligni	Spionid worm			

TABLE 2.3-7

TAXA	Common name	Abundance[a]	Habitat[b]	Remarks
Polydora pygidialis	Spionid worm	R	Sa	
Polydora socialis	Spionid worm	A	Sa,Mu	
Polydora websteri	Spionid worm		Sym	Bores in shell
Prionospio cirrifera	Tube worm	R	Sa	
Protodorvillea gracilis	Bristle worm	O	Sa	
Pseudopolydora kempi	Spionid worm	O	Sa,Mu	
Sabellaria cementarium	Plume worm	C	Ro	Attached shell debris
Sabellaria gracilis	Plume worm	C	Ro	Attached shell debris
Scalibregma inflatum	Bristel worm	O	Sa,Mu	
Schistomeringos longicornis	Polychaete worm	A	Sa,Mu	
Scolelepis sp.	Spionid worm	R	Mu	
Scoloplos sp.	Bristle worm		Sa,Mu	
Serpula vermicularis	Plume worm	C	Ro	On shell debris
Sphaerosyllis californiense	Syllid worm	A	Sa,Mu	
Spio filicornis	Spionid worm	O	Sa	
Spiophanes anoculata	Plume worm			
Spiophanes berkeleorum	Plume worm	O	Sa,Mu	
Spiophanes bombyx	Plume worm	A	Sa,Mu	
Sternapsis fossor	Bristle worm	R	Mu	
Sthenelais berkeleyi	Bristle worm	C	Sa,Mu	
Sthenelais terniaglabrata	Bristle worm	R	Mu	
Streblosoma crassibranchia	Bristle worm	R	Mu	
Streblospio benedicti	Spionid worm	O	Mu	
Tenonia kitsapensis	Polychaete worm	O	Sa,Mu	
Tharyx monilaris	Bristle worm	A	Sa,Mu	
Tharix multifilis	Bristle worm	A	Sa,Mu	
Trochochaeta franciscanum	Bristle worm	R	Mu	
Typosyllis fasciata	Syllid worm	C	Sa,Mu	

TABLE 2.3-7

TAXA	Common name	Abundance[a]	Habitat[b]	Remarks
Typosillis halina	Syllid worm	C	Sa,Mu	
Archiannelida				
Polygordius sp.		O	Sa	
Saccocirrus sp.		O	Sa	
Sipundcula				
Goldfingia hespera	Peanut worm	C	Mu	Among eelgrass rhizomes
Echiura				
Listriolobus pelodes	Spoon worm	R	Mu	In eelgrass beds
Urechis caupo	Fat innkeeper	C	Sa	
Phornida				
Phronopsis viridis	Green plume worm	A	Sa,Mu	
Phoronis pallida	Plume worm	R	Sym	In *Upogebia* burrows
Crustacea				
Allorchestes angusta	Beach hopper	C	Sa	Intertidal on algae
Anisogammarus confervicolus	Gammarid	C	Mu	In intertidal marshes
Anisogammarus pugettensis	Gammarid	C	Mu	In marshes
Aoroides columbiae	Gammarid	C	Sa,Mu	In tubes
Atylus tridens	Gammarid	O	Sa,Mu	Nestles in algae & debris
Caprella angusta	Skeleton shrimp	C	Epi	
Caprella california	Skeleton shrimp	C	Epi	
Caprella equilibra	Skeleton shrimp	C	Epi	
Caprella gracilior	Skeleton shrimp	C	Epi	
Caprella laeviuscula	Skeleton shrimp	C	Epi	On pilings, alge
Corophium acherusicum	Gammarid	A	Epi	Estuarine
Corophium spinicorne	Gammarid	A	Mu	Estuarine
Corophium stimpsoni	Gammarid	A	Mu	Builds tubes on algae
Cymadusa sp.	Gammarid			
Eohausorius sp.	Gammarid	O	Sa	Intertidal marshes

TABLE 2.3-7

TAXA	Common name	Abundance[a]	Habitat[b]	Remarks
Ischyrocerus anguipes	Gammarid	O	Sa	Intertidal
Jassa falcata	Gammarid	C	Sa	Intertidal
Megamphopus martesia	Gammarid		Epi	
Melita dentata	Gammarid	C	Sa	
Metacaprella kennerlyi	Skeleton shrimp	C	Epi	
Orchestia traskiana	Beach hopper	C	Mu	
Orchestoidea benedicti	Beach hopper	C	Sa	
Orchestoidea californiana	Beach hopper	C	Sa	
Paraphoxus spp.	Gammarid	O	Sa	
Photis brevipes	Gammarid	C	Sa,Mu	
Podocerus cristatus	Gammarid	O	Sa	
Protomedia articulata	Gammarid	C	Sa,Mu	
Sychelidium rectipalmum	Gammarid	O	Sa,Mu	
Synchelidium shoemakeri	Gammarid	O	Sa,Mu	
Tritella pilimana	Skeleton shrimp	O	Sa,Mu	
Cirripedia				
Balanus crenatus	White barnacle	A	Ro,Pi	
Balanus glandula	Chalky white barnacle	A	Ro,Pi	
Banaus nubilus	Piling barnacle	O	Pi	
Chthamalus dalli	Gray barnacle	A	Ro,Pi	
Pollicipes polymerus	Goose barnacle	C	Ro,Pi	
Semibalanus cariosus	Thatched barnacle	C	Ro,Pi	
Copepoda				
Acartia clausi	Copepod	A	Pk	
Acartia logiremis	Copepod	A	Pk	
Acartia tonsa	Copepod	A	Pk	Estuarine
Calanus finmarchicus	Copepod	C	Pk	
Clausidium vancouverense	Copepod		Sym	On *Callianassa*

TABLE 2.3-7

TAXA	Common name	Abundance[a]	Habitat[b]	Remarks
Coryceaus affinis	Copepod		Pk	
Eucalanus bungii	Copepod		Pk	
Eurytemora affnis	Copepod		Pk	Estuarine
Mytilicola orientalis	Copepod	O	Sym	In gut of *Mytilus edulis*
Oithona similus	Copepod		Pk	
Oithona spinirostris	Copepod		Pk	
Paracalanus parva	Copepod		Pk	
Pseudocalanus minutus	Copepod		Pk	
Tortanus discaudatis	Copepod		Pk	
Cumacsea				
Cumacea sp.	Cumacean			
Cumella vulgaris	Cumacean	O	Mu	
Diastylis sp.	Cumacean	C	Sa,Mu	
Diastylopsis dawsoni	Cumacean	C	Sa	
Eudorella pacifica	Cumacean	C	Mu	
Lamprops sp.	Cumacean	C	Sa,Mu	
Decapoda				
Callianassa californiensis	Ghost shrimp	O	Mu	
Callianassa gigas	Ghost shrimp	O	Sa,Mu	
Cancer antennarius	Rock crab	C	Sa,Mu	
Cancer anthonyi	Yellow crab	O	Ro	
Cancer gracilisi	Slender crab	O	Sa	
Cancer magister	Dungeness crab	C	Sa	
Cancer productus	Red crab	C	Sa,Mu	
Cancer franciscorum	Bay shrimp	C	Sa,Mu	
Crangon nigricauda	Black-tailed shrimp	C	Sa	
Crangon nigromaculata	Black-tailed shrimp	C	Sa,Mu	
Crangon stylirostris	Bay shrimp	O	Sa	

TABLE 2.3-7

TAXA	**Common name**	**Abundance[a]**	**Habitat[b]**	**Remarks**
Emerita analoga	Sand crab	O	Sa	Intertidal, beaches
Hemigrapsus nudus	Purple shore crab	C	Sa	Intertidal
Hemigrapsus oregonensis	Green shore crab	C	Sa,Mu	Intertidal
Heptacarpus brevirostris	Grass shrimp	O	Sa	
Hippolyte californiensis	Grass shrimp	C		On eelgrass blades
Lophopanopeus bellus	Pebble crab	R	Ro	Near bay mouth
Pachycheles rudis	Porcelain crab	C	Ro	
Pachygrapsus crassipes	Lined shore crab	C	Ro	
Pagurus spp.	Hermit crabs	C	Ro	Intertidal
Pandalus danae	Coon stripe shrimp	O	Sa	
Petrolisthes cinctipes	Procelain crab	C	Ro	Intertidal
Pinnixia franciscana	Pea crab	O	Sym	In burrows of *Urechis*
Pugettia producta	Kelp crab	C	Ro,Pi	Among large algae
Upogebia pugettensis	Blue mud shrimp	O	Mu	
Isopoda				
Alloniscus perconvexus	Isopod	C	Sa	Intertidal beaches
Armadilloniscus coronacapitalis	Isopod	O	Mu	Intertidal beaches
Cirolana harfordi	Isopod	C	Ro,Pi	Intertidal
Gnorimosphaeroma oregonensis	Isopod	C	Mu	Intertidal beaches
Idotea stenops	Isopod			
Idotea wosnesenskii	Isopod	C	Epi	On eelgrass, algae
Limnoria quadripunctata	Isopod	C	Pi	Bores into wood
Limnoria tripunctata	Isopod	C	Pi	Bores into wood
Littorophiloscia richardsonae	Isopod	O	Mu	Intertidal marshes
Munna sp.	Isopod	O	Sa	
Porcellio sp.	Isopod	C	Mu	Intertidal marshes
Synidotea sp.	Isopod	O	Sa	
Mysidacea				

TABLE 2.3-7

TAXA	**Common name**	**Abundance[a]**	**Habitat[b]**	**Remarks**
Archaeomysis grebnitzkii	Mysid	O	Sa	
Tenaidacea				
Leptochelia dubia	Cheliferan	C	Sa,Mu	
Tenais sp.	Cheliferan	O	Sa	
Pysnogonida				
Achelia chelata	Sea Spider	O	Sa,Ro	
Achelia nudiuscula	Sea Spider	O	Sa	
Halosoma viridintestinale	Green sea spider		Epi	On eelgrass and hydroids
Mollusca				
Bivalvia				
Adula diegensis	Mytilid	A	Sa,Mu	Bores in shale, mudstone
Axinopsida serricata		O	Mu	
Bankia setacea	Pacific shipworm	C	Pi	Bores into pilings, wood
Clinocardium nuttallii	Basket cockle	C	SaMu	
Crassostrea gigas	Giant Pacific oyster	A	Sa,Mu	Introduced, harvested
Gemma gemma	Gem clam	A	Mu	
Hinnites giganteus	Rock scallop	C	Ro,Pi	
Lyonsia californica	California lyonsia	A	Mu	
Macoma balthica	Baltic macoma	O	Mu	Estuarnine, possibly introduced
Macoma identata	Identate macoma	O	Mu	
Macoma inquinata	Inquinate macoma	C	Sa,Mu	
Macoma nasuta	Bent-nose clam	A	Sa,Mu	
Mercenaria mercenaria	Quahog clam	R	Mu	Introduced
Mya arenaria	Soft-shell clam	A	Mu	Introduced
Mysella tumida	Clam	A	Sa,Mu	
Mytilus edulis	Bay mussel	A	Ro,Pi	
Mytilus californianus	California mussel	C	Ro,Pi	
Ostrea lurida	Native oyster	C	Ro,Pi	

TABLE 2.3-7

TAXA	Common name	Abundance[a]	Habitat[b]	Remarks
Ostrea edulis	European oyster	O	Ro,Pi	Introduced, cultured
Panopea generosa	Geoduck	O	Mu	Very deep burrowing
Penitella penita	Common piddock	O	Ro	Bores in mudstone
Petricola carditoides	Petricolid clam	R	Mu	
Pododesmus cepio	Rock oyster	O	Ro	
Protothaca staminea	Pacific littleneck	A	Sa,Mu	
Protothaca tenerrima	Thin-shelled littleneck	O	Sa,Mu	
Saxidomus giganteus	Smooth Washington clam	C	Sa,Mu	
Saxidomus nuttalli	Common Washington clam	C	Sa,Mu	
Siliqua patula	Razor clam	O	Sa	Near by mouth
Solen sicarius	Sickle razor clam	I	Sa,Mu	
Tagelus californianus	Jackknife clam	R	Sa,Mu	
Tapes japonica	Manila clam	R,C	Mu	Introduced, cultured
Tellina bodegensis	Bodega tellin	C	Sa	
Tellina modesta	Modesta tellin	C	Sa,Mu	
Tellina nuculoides	Tellin clam	C	Sa,Mu	
Transennella tantilla	Little transennella	A	Sa,Mu	
Tresus capax	Gaper clam	A	Sa,Mu	
Tresus nuttallii	Gaper clam	O	Sa,Mu	
Zirfaea pilsbryi	Rough piccock	O	Ro,Mu	Bores in rock, mudstone
Gastropoda				
Acmaea mitra	Dunce cap limpet	O	Ro	Near bay mouth
Aglaja diomedea	Sea slug	A	Sa,Mu	
Alvinia compacta	Snail	C	Sa,Mu	
Anisodoris nobilis	Sea lemon nudibranch	O	Ro	Near bay mouth
Assiminea californica	Translucent assiminea	A	Mu	In *Salicornia* marshes
Calliostoma canaliculatum	Top shell	O	Ro	Near bay mouth

TABLE 2.3-7

TAXA	Common name	Abundance[a]	Habitat[b]	Remarks
Collisella asmi	Limpet	O	Sym	On *Tegula funebralis*
Collisella digtalis	Common limpet	O	Ro	Near bay mouth
Collisella pelta	Sheild limpet	C	Ro	Near bay mouth
Collisella scabra	Rough limpet	C	Ro	Intertidal near bay mouth
Cyclostremella sp.	Snail	R	Sa	
Cylichna alba	Snail	O	Sa	
Dendronotus giganteus	Giant nudibranch	O	Ro	
Dialula sandiegensis	Nudibranch	O	Ro	
Diodora aspera	Rough keyhole limpet	O	Ro	
Epitonium sawinae	Snail	O	Sa	
Fartulum occidentale	Snail	R	Sa	
Haminoea vesicula	Snail	R	Sa	
Hermissenda crassicornis	Nudibranch	O	Ro	
Lacuna sp.	Snail	C	Sa,Mu,Ro	
Littornia newcombiana	Newcomb's littorine	R	Mu	In salt marshes
Littorina planaxis	Periwinkle	C	Ro	Near bay mouth, intertidal
Littorina scutulata	Periwinkle	C	Ro	Near bay mouth, intertidal
Mitrella gouldii	Snail	C	Sa,Mu	
Nassarius fossatus	Channeled dog whelk	A	Sa,Mu	
Nassarius mendicus	Lean dog whelk	A	Sa,Mu	
Nucella emarginata	Dog winkle	O	Ro	Near bay mouth
Nucella lamellosa	Dog winkle	O	Ro	Near bay mouth
Odostomia sp.	Snail	A	Sa,Mu	
Olivella biplicata	Purple olive shell	C	Sa	Near bay mouth
Olivella pycna	Olive shell	C	Sa	Near bay mouth
Ovatella myosotis	Mud snail	A	Mu	In salt marshes
Phyllaplysia taylori	Tectibranch	A	Epi	On eelgrass
Polinices lewisii	Moon snail	C	Sa,Mu	

TABLE 2.3-7

TAXA	Common name	Abundance[a]	Habitat[b]	Remarks
Rictaxis punctocaelatus	Barrel shell	R	Sa,Mu	Sporadic recruitment
Searlesia dira	Snail	O	Ro	Near bay mouth
Tegula brunnea	Brown tegula	O	Ro	Near bay mouth
Tegula funebralis	Black tegula	O	Ro	Near bay mouth
Turbonilla sp.	Snail	R	Sa	
Octopoda				
Octopus dolfeini	Octopus	O	Ro	Near bay mouth
Polyplacophora				
Ischnochiton regularis	Blue chiton	R	Ro	Near bay mouth
Katharina tunicata	Black chiton	O	Ro	Near bay mouth
Mopalia ciliata	Notched chiton	C	Ro,Pi	
Mopilia lignosa	Hairy chiton	C	ro,Pi	
Echinodermata				
Amphiodia occidentalis	Brittle star	C	Sa,Mu	
Amphipholis sp.	Brittle star	O	Sa	
Dendraster excentricus	Sand dollar	C	Sa	Near bay mouth
Eupentacta quinquessemita	White sea cucumber	C	Ro,Pi	
Leptasterias pusilla	Six-rayed sea star	C	Ro	
Leptosynapta albicans	Sea cucumber	O	Sa	
Pisaster brevispinus	Short spined sea star	C	Sa	
Pisaster ochraceous	Common sea star	C	Ro	Near bay mouth
Pycnopodia helianthoides	Sun star	O	Ro	Near bay mouth
Strongylocentrotus purpuratus	Purple urchin	O	Ro	Near bay mouth
Bryozoa				
Bowerbankia gracilis	Bryozoan	C	Ro,Epi,Pi	
Bugula pacifica	Bryozoan	C	Ro	
Crisia occidentalis	Bryozoan	C	Ro,Epi	
Membranipora membranacea	Bryozoan	C	Epi	On eelgrass

TABLE 2.3-7

TAXA	Common name	Abundance[a]	Habitat[b]	Remarks
Schizoporella unicornis	Bryozoan	C	Pi,Epi	
Tricellaria occidentalis	Bryozoan	C	Ro,Epi,Pi	
Ctenophora				
Pleurobrachia bachei	Comb jelly	A	Pk	
Nemertea				
Amphiporus imparispinosus	Ribbon worm	C	Ro,Pi	
Carinoma mutabilis	Ribbon worm	C	Sa,Mu	
Carinomella lactea	Ribbon worm	O	Sa,Mu	
Cerebratulus californiensis	Ribbon worm	C	Sa,Mu	
Emplectonema sp.	Ribbon worm	O	Sa	On shell fragments
Paranemertes californica	Ribbon worm	C	Sa,Mu	
Tubulanus pellucidus	Ribbon worm	C	Sa,Mu	
Tubulanus polymorphus	Ribbon worm	C	Sa,Mu	
Annelida				
Polychaeta				
Abarenicola antebranchia	Lugworm	O	Mu	
Abarenicola humboldtensis	Lugworm	O	Mu	
Abarenicola pacifica	Lugworm	O	Sa	
Amaena occidentalis	Hairy-gill worm	O	Mu	
Ampharete arctica	Bristle worm	O	Sa	
Anaitides groenlandica	Paddle worm	R	Sa	
Anaitides williamsi	Paddle worm	C	Sa,Mu	
Aricidea suecica	Paranoid worm	O	Sa,Mu	
Armandia brevis	Bristle worm	C	Sa,Mu	
Autolytus sp.	Bristle worm	C	Sa,Mu	
Boccardia berkeleyorum	Spionid worm	O	Sym	Bores *podesmus* shells
Brania sp.	Bristle worm	R	Sa	
Capitella capitata	Tube worm	A	Mu	

TABLE 2.3-7

TAXA	Common name	Abundance[a]	Habitat[b]	Remarks
Caulleriella alata	Thread worm	O	Sa	
Caulleriella hamata	Thread worm			
Caulleriella sp.	Thread worm	O	Sa	
Chaetozone setosa	Hairy-gill worm	C	Sa,Mu	
Chaetozone sp.	Hairy-gill worm	C		
Cheilonereis cyclurus	Hermit crab worm	C	Sym	With hermit crabs
Chone gracilis	Paddle worm	O	Sa	
Chone sp.	Paddle worm			
Cirratulus cirratus	Bristle worm	R	Sa	
Cistenides brevicoma	Tube worm	O	Mu	
Cossura pygodactylata	Bristle worm	R	Mu	
Dodecaceria concharum	Bristle worm	R	Sa	
Drilonereis falcata	Bristle worm	C	Sa,Mu	
Eteone californica	Paddle worm	C	Sa,Mu	
Eteone dilatae	Paddle worm	C	Sa	
Eteone pacifica	Paddle worm	C	Sa,Mu	
Euclymene delineata	Polychaete worm	C	Sa,Mu	
Eulalia aviculiseta	Paddle worm	O	Sa	With shell debris
Eumidia bifoliata	Paddle worm	C	Sa,Mu	
Eumidia sanguinea	Paddle worm	C	Sym	With algae
Eunereis sp.	Mussel worm			
Eupolymnia crescentis	Terebellid worm	R	Sa,Mu	
Eusyllis assimilis	Paddle worm	O	Sa	
Euzonus mucronata	Bristle worm	C	Sa	
Exogone lourei	Bristle worm	A	Sa,Mu	
Exogone sp.	Bristle worm		Sa,Mu	
Glycera americana	Bristle worm	O	Sa	
Glycera capitata	Bristle worm	O	Sa	

TABLE 2.3-7

TAXA	Common name	Abundance[a]	Habitat[b]	Remarks
Glycera oxycephala	Bristle worm	C	Sa,Mu	
Glycera tenuis	Bristle worm	A	Sa	
Glycinde polygnatha	Bristle worm	A	Sa,Mu	
Glycinde sp.	Bristle worm			
Gyptis brevipalpa	Bristle worm	O	Sa,Mu	
Halosydna brevisetosa	Scale worm	O	Sa,Mu	
Halosydna latior	Scale worm	O	Sa	
Haploscoloplos elongatus	Orbinid worm	A	Sa,Mu	
Harmothoe imbricata	Scale worm	A	Ro	
Harmothoe lunulata	Scale worm	A	Sa,Mu	
Harmothoe priops	Scale worm	O	Sa	
Hemipodus borealis	Slaty blue worm	O	Sa,Mu	
Hemipodus imbricata	Slaty blue worm			
Hesperone adventor	Scale worm	O	Sym	In *Urechis* burrows
Heteromastus filobranchus	Capitellid worm	A	Mu	
Lumbrineris californiensis	Bristle worm	O	Mu	
Lumbrineris japonica	Bristle worm	O	Sa,Mu	
Lumbrineris tetraura	Bristle worm	A	Sa,Mu	
Lumbrineris zonata	Bristle worm	C	Mu	
Lysilla labiata	Polychaete worm	A	Sa,Mu	

(a) A = abundant, C = common, O = occasional, R = rare.
(b) Epi = epifaunal or epiphytic, Mu = mud, Pi = pilings or other artificial structures, Pk = planktonic, Ro = rocks, Sa = sand, Sym = symbiotic.

TABLE 2.3-8

FISHES OF HUMBODLT BAY

Data on relative abundance, life history, use, and season of occurrence are adapted from reports and records compiled (Reference 14). Nomenclature follows usage of the American Fisheries Society.

Taxa	Common name	Abundance[a]	Life history type[b] E	L	J	A	Habitat[c]	Season of occurrence[d]	Remarks
Family Petromyzontidae									
Lampetra tridentata	Pacific lamprey	C			X	X	TCSFW,CR	SP, S	Spawns in bay tributaries
Family Hexanchidae									
Notorynchus maculatus	Sevengill shark	C				X	DTS,STS	SP, S, F	Current small commercial and recreational fishery
Family Carcharhinidae									
Galeorhinus zyopterus	Soupfin shark	R							One record, caught by angling
Mustelus henlei	Brown smoothhound	C			X	X	STS,MF	All	
Triakis semifasciata	Leopard shark	C			X	X	DTS,STS, MF	All	Current small commercial and recreational fishery

TABLE 2.3-8

Taxa	Common name	Abundance[a]	Life history type[b] E	L	J	A	Habitat[c]	Season of occurrence[d]	Remarks
Family Squalidae									
Squalus acanthias	Spiny dogfish	O			X	X	STS,MF	S	
Family Rajidae									
Raja binoculata	Big skate	O			X	X	STS,MF	SP, S	Sometimes taken from TCSSW piers by anglers
Family Dasyatidae									
Urolophus halleri	Round stingray	R				X	DTS,MF	SP, S	One record
Family Myliobatidae									
Myliobatis californica	Bat ray	C			X	X	DTS,STS, MF	SP, S, F	Sometimes taken from piers by anglers; preys on commercial oysters in bay
Family Chimaeridae									
Hydrolagus colliei	Spotted ratfish	R					DTS		One record, dipnetted
Family Acipenseridae									
Acipenser medirostris	Green sturgeon	O			X	X	DTS,STS, MF	S, F, W	

TABLE 2.3-8

Taxa	Common name	Abundance[a]	Life history type[b] E	L	J	A	Habitat[c]	Season of occurrence[d]	Remarks
Family Ophichthidae									
Ophichthus zophochir	Yellow snake eel	O			X	X	DTS,STS	W	One record
Family Clupeidae									
Alosa sapidissima	American shad	O			X	X	STS,MF,CR	SP, S	Not known to spawn in bay tributaries
Clupea harengus pallasi	Pacific herring	A	X	X	X	X	DTS,STS,MF,P	All	Spawn on eel grass in winter; larvae and juveniles in bay to fall; small commercial fishery on adults
Dorosoma petenense	Threadfish shad	O				X	STS	S	Only three recorded from the bay
Family Engraulidae									
Engraulis mordax	Northern anchovy	A	X	X	X	X	DTS,STS,P,J	All	Throughout the bay in scattered schools in summer and fall; fewest in winter; eggs and larvae in spring; important forage

TABLE 2.3-8

Taxa	Common name	Abundance[a]	Life history type[b] E L J A	Habitat[c]	Season of occurrence[d]	Remarks
						fish
Family Salmonidae						
Oncorhynchus clarki	Cutthroat trout	O	X X	TCSSW,CR, TCSFW	All	Remnant populations in bay tributary streams; numbers severely depressed
Oncorhynchus kisutch	Coho salmon	C	X X	DTS,STS, TCSFW,CR	All	Adults migrate through bay to spawning tributaries; juveniles use bay as nursery habitat; summer adults move in with tides to feed; anglers take from jetties
Oncorhynchus mykiss	Rainbow trout	C	X X	TCSSW,CR, TCSFW	All	Adult migrate through bay to spawning tributaries; juveniles may use bay as nursery habitat for short time; abundant in

TABLE 2.3-8

Taxa	Common name	Abundance[a]	Life history type[b] E	L	J	A	Habitat[c]	Season of occurrence[d]	Remarks
									tributaries
Taxa	**Common name**	**Abundance[a]**	**Life history type[b] E**	**L**	**J**	**A**	**Habitat[c]**	**Season of occurrence[d]**	**Remarks**
Oncorhynchus tshawytscha	Chinook salmon	C			X	X	DTS,STS, TCSFW,CR ,J	All	Same as coho salmon
Family Osmeridae									
Allosmerus elongatus	Whitebait smelt	O			X	X	STS,DTS	F, W, S	Spawning habits unknown
Hypomesus pretiosus	Surf smelt	C		X	X	X	STS,DTS	All	Spawns in marine waters on exposed sandy beaches
Spirinchus starksi	Night smelt	C		X	X	X	STS,DTS	All	Same as surf smelt
Spirinchus thaleichthys	Longfin smelt	A	X	X	X	X	All	All	Probably spawns in freshwater tributaries on Humboldt Bay
Thaleichthys pacificus	Eulachon	O				X	STS,DTS	W	Ascends freshwater streams to spawn but not reported in

TABLE 2.3-8

Taxa	Common name	Abundance[a]	Life history type[b] E	L	J	A	Habitat[c]	Season of occurrence[d]	Remarks
									Humboldt Bay tributaries
Family Gonostomatidae									
Cyclothone acclinidens	Benttooth bristlemouth	R		X			DTS	W	Mesopelagic species
Family Myctophidae									
Stenobrachius leucopsarus	Northern lampfish	O		X			DTS	W, SP	Oceanic species, probably carried into Humboldt Bay during very high tides
Tarletonbeania crenularis	Blue lanternfish	O		X			DTS		Same as northern lampfish
Family Gadidae									
Microgadus proximus	Pacific tomcod	A			X	X	DTS,STS, MF	All	Use the bay as a nursery area
Family Ophidiidae									
Chilara taylori	Spotted cusk-eel	O			X	X	DTS	W, S	
Family Athernidae									
Atherinops affinis	Topsmelt	C			X	X	DTS,STS,	All	Spawn over

TABLE 2.3-8

Taxa	Common name	Abundance[a]	Life history type[b] E	L	J	A	Habitat[c]	Season of occurrence[d]	Remarks
							MF		mudflats, though eggs and larvae have not been collected in Humboldt Bay
Atherinopsis californiensis	Jacksmelt	C	X	X	X	X	STS,TCSW, MF,P,J	All	Spawns over vegetation in shallow tidal channels and mudflats; adults commonly taken by pier and jetty anglers
Family Trachipteridae									
Trachipterus altivelis	King-of-the-salmon	R					DTS		One record
Family Gasterosteidae									
Aulorhynchus flavidus	Tube-snout	C			X	X	DTS,STS	All	
Gasterosteus aculeatus	Threespine stickleback			X	X	X	STS,TCSW, TCFW,CR	All	
Family Syngnathidae									
Syngnathus	Bay pipefish	C	X	X	X	X	STS,MF,TC	All	

TABLE 2.3-8

Taxa	Common name	Abundance[a]	Life history type[b] E	L	J	A	Habitat[c]	Season of occurrence[d]	Remarks
leptorhynchus							SW		
Family Percichthyidae									
Morone saxatilis	Striped bass	R							One record, angler caught
Stereolepis gigas	Giant sea bass	R							One record, angler caught
Family Scianidae									
Atractoscion nobilis	White seabass	O		X			DTS,STS	W	
Genyonemus lineatus	White croaker	O				X	DTS,J	S, F	
Family Embiotocidae									
Amphistichus koelzi	Calico surfperch	O			X	X	DTS,J	W, SP S	
Amphistichus rhodoterus	Redtail surfperch	C			X	X	DTS,STS,P	All	Popular recreational fish in Humboldt Bay
Cymatogaster aggregata	Shiner perch	A			X	X	DTS,STS TCSW,P,J	All	One of most abundant species in Humboldt Bay
Embiotoca lateralis	Striped seaperch	C			X	X	DTS,STS,P, J	All	Recreational species
Hyperprosopon anale	Spotfin surfperch	R				X	J		One record

TABLE 2.3-8

Taxa	Common name	Abundance[a]	Life history type[b] E	L	J	A	Habitat[c]	Season of occurrence[d]	Remarks
Hyperprosopon argenteum	Walleye surfperch	A			X	X	DTS,STS,P, J	All	Recreational species
Hyperprosopon ellipticum	Silver surfperch	C			X	X	STS,DTS, TCSW,P,J	All	Recreational species
Phanerodon furcatus	White seaperch	A			X	X	DTS,STS,P, J	All	Recreational species
Rhacochilus vacca	Pile perch	C			X	X	DTS,STS,P, J	All	Recreational species
Family Trichodontidae									
Trichodon trichodon	Pacific sandfish	O			X	X	DTS,STS		One record
Family Stichaeidae									
Anoplarchus purpurescens	High cockscomb	O			X	X	DTS,STS	Sp	
Cebidichthys violaceus	Monkeyface prickleback	R				X	J,DTS		
Chirolophis decoratus	Decorated warbonnet	R					J		One record
Lumpenus sagitta	Snake prickleback	O			X	X	DTS,STS	Sp, S	
Family Pholidae									
Apodichthys flavidus	Penpoint gunnel	C			X	X	DTS,STS, MF	All	

TABLE 2.3-8

Taxa	Common name	Abundance[a]	Life history type[b] E	L	J	A	Habitat[c]	Season of occurrence[d]	Remarks
Pholis ornata	Saddleback gunnel	C			X	X	DTS,STS,MF,J	All	
Family Anarhichadidae									
Anarrhichthys ocellatus	Wolf-eel	R			X	X	J,DTS	All	
Family Cryptacanthodidae									
Delolepis gigantea	Giant wrymouth	O			X	X	DTS,STS	W	One record
Family Ammodytidae									
Ammodytes hexapterus	Pacific sand lance	C		X	X	X	DTS,STS	All	Important food item for salmon at times
Family Gobiidae									
Clevelandia ios	Arrow goby	C		X	X	X	MF,TCSW, STS	All	Strongly euryhaline
Coryphopterus nicholsii	Blackeye goby	O			X	X	STS,DTS	All	
Eucyclogobius newberryi	Tidewater goby	O			X	X			
Lepidogobius lepidus	Bay goby	A	X	X	X	X	MF,TCFW, TCSW,STS	All	One of most abundant species in Humboldt Bay; strongly

TABLE 2.3-8

Taxa	Common name	Abundance[a]	Life history type[b]				Habitat[c]	Season of occurrence[d]	Remarks
			E	L	J	A			
									euryhaline
Family Luvaridae									
Luvarus imperialis	Louvar	O				X	DTS		One record
Family Stromateidae									
Icichthys lockingtoni	Medusafish	O			X	X	DTS,STS	F	One record
Peprilus simillimus	Pacific pompano	O			X	X	DTS,STS		
Family Scorpaenidae									
Sebastes auriculatus	Brown rockfish	C		X	X	X	DTS,STS	All	
Sebastes caurinus	Copper rockfish	C		X	X	X	DTS,STS,J, P	All	
Sebastes flavidus	Yellowtail rockfish	O		X			DTS,STS		One record
Sebastes melanops	Black rockfish	C		X	X	X	DTS,STS,P, J	All	Common recreational species of jetties
Sebastes miniatus	Vermillion rockfish	O		X			DTS,STS		One record
Sebastes mystinus	Blue rockfish	O			X	X	DTS,STS,J	S, F, W	
Sebastes paucispinis	Bocaccio	O			X	X	DTS,STS	S, F, W	
Sebastes rastrelliger	Grass rockfish	C		X	X	X	DTS,STS,P, J	All	

TABLE 2.3-8

Taxa	Common name	Abundance[a]	Life history type[b] E	L	J	A	Habitat[c]	Season of occurrence[d]	Remarks
Family Hexagrammidae									
Hexagrammos decagrammus	Kelp greenling	C	X	X	X	X	DTS,STS, MF,J,P	All	Common recreational species off jetties
Hexagrammos lagocephalus	Rock greenling	O	X	X	X	X	DTS,STS	All	
Ophiodon elongatus	Lingcod	C	X	X	X	X	DTS,STS,J, MF	All	Popular recreational species because of large size
Oxlebius pictus	Painted greenling	C	X	X	X	X	DTS,J	All	
Family Cottidae									
Artedius fenestralis	Padded sculpin	C		X	X	X	DTS,STS,P, J	All	
Artedius harringtoni	Scalyhead sculpin	O				X	DTS,STS	Sp	
Artedius notospilotus	Bonehead sculpin	R				X	DTS		One record
Ascelichthys rhodorus	Rosylip sculpin	O		X	X	X	DTS,STS,J	All	
Blepsias cirrhosus	Silverspotted sculpin	R				X	DTS		One record
Clinocottus acuticeps	Sharpnose	R							One record

TABLE 2.3-8

Taxa	Common name	Abundance[a]	Life history type[b] E	L	J	A	Habitat[c]	Season of occurrence[d]	Remarks
	sculpin								
Cottus aleuticus	Coastrange sculpin	R				X	CR		One record, freshwater sculpin
Cottus asper	Prickly sculpin	O				X	CR		Freshwater sculpin occasionally carried into bay by tributary floods
Enophrys bison	Buffalo sculpin	C	X	X	X	X	DTS,STS,P, J	All	
Hemilepidotus hemilepidotus	Brown Irish lord	C	X	X	X	X	DTS,STS,J	All	
Leptocottus armatus	Pacific staghorn sculpin	A	X	X	X	X	DTS,STS,TCSW,TCFW,P, J	All	Strongly euryhaline
Nautichthys oculofasciatus	Sailfin sculpin	O			X	X	TS,STS,J	All	
Oligocottus snyderi	Fluffy sculpin	R			X				Two specimens, taken in baytide pool
Scorpaenichthys marmoratus	Cabezon	C	X	X	X	X	DTS,STS,P, J	All	Important bay sportfish, particularly off jetties

TABLE 2.3-8

Taxa	Common name	Abundance[a]	Life history type[b] E	L	J	A	Habitat[c]	Season of occurrence[d]	Remarks
Family Agonidae									
Odontopyxis trispinosa	Pygmy poacher	O		X	X		DTS,STS	W	
Pallasina barbata	Tubenose poacher	R				X	DTS	W	
Stellerina zyosterna	Pricklebreast poacher	O		X	X	X	DTS,STS	S, F, W	
Family Cyclopteridae									
Liparis fucensis	Slipskin snailfish	O	X	X	X	X	DTS,STS,MF	All	
Liparis pulchellus	Showy snailfish	R				X	DTS,STS,MF	All	
Liparis rutteri	Ringtail snailfish	R				X	J		One record
Family Bothidae									
Citharichtys sordidus	Pacific sanddab	O			X	X	DTS,STS, MF	All	
Citharichtys stigmaeus	Speckle sanddab	A	X	X	X	X	MF,STS,DTS,J	All	
Paralichthys californicus	California halibut	R			X	X	DTS,STS	S, F	
Family Pleuronectidae									
Isopsetta isolepis	Butter sole	O			X	X	DTS,STS	W, S	
Microstomus pacificus	Dover sole	O			X	X	DTS,STS		Important

TABLE 2.3-8

Taxa	Common name	Abundance[a]	Life history type[b] E	L	J	A	Habitat[c]	Season of occurrence[d]	Remarks
									commercial species outside the bay
Parophrys vetulus	English sole	A	X	X	X	X	DTS,STS, MF	All	Juveniles very abundant in bay; important commercially outside bay
Platichthys stellatus	Starry flounder	C	X	X	X	X	DTS,STS,MF,TCSW,TCFW	All	
Pleuronichhtys coenosus	C-O sole	O			X		DTS,STS	W	
Pleuronichthys decurrens	Curlfin sole	O			X	X	DTS,STS	All	
Psettichthys melanostictus	Sand sole	O			X	X	DTS,STS,J	All	
Family Cynoglossidae									
Symphurus atricauda	California tonguefish	O			X	X	DTS,STS	F, W	
Family Molidae									
Mola mola	Ocean sunfish	O			X				One record

(a) Abundance: A = abundant, C = common, O = occasional, R = rare.
(b) Life history type: E = egg, L = larva, J = juvenile, A = audit.

TABLE 2.3-8

(c) Habitat: DTA = deep tidal channel; STS = shallow tidal channels; MF = mudflats; TCSSW = tidal creeks and sloughs, salt water; TCSFW = tidal creeks and sloughs, fresh water; CR = creeks and rivers; P = piers; J = jetties.

(d) Season of occurrence: SP = spring, S = summer, F = fall, W = winter.

TABLE 2.3-9 Sheet 1 of 2

SPECIAL STATUS AQUATIC SPECIES
POTENTIALLY OCCURRING IN THE ISFSI AREA

Name	Status[(a)]	Habitat	Occurrence Onsite
Coastal cutthroat trout	CSC	Small coastal streams from the Eel River to the Oregon Border. Small, low gradient coastal streams & estuaries. Need shaded steams with water temperatures below 18 degrees C, and small gravel for spawning.	Not present. No suitable habitat. Reported in tributaries to Humboldt Bay in 1995, and may occasionally be present seasonally inn the bay itself.
Tidewater goby	FE/CSC	Brackish water habitats along the California coast from Agua Hedionda lagoon, San Diego County, to the mouth of the Smith River. Found in shallow lagoons and lower stream reaches, they need fairly still but not stagnant water and high oxygen levels.	Not present. No suitable habitat. Reported in northeastern portion of Humboldt Bay in 1994.
Coho Salmon	FT	Spawn in small coastal streams and tributaries with silt to coarse gravel. Rearing sites are in mainstream side channels and slack water areas.	Highly unlikely. No suitable habitat near ISFSI site, but may occasionally occur in the adjacent intake canal of the Power Plant. Adults and juveniles are known to occur in Humboldt Bay.
Chinook Salmon	FT	Spawn in coastal streams, rivers, and tributaries with moderate flow and cobble-gravel substrate.	Highly unlikely. No suitable habitat near ISFSI site, but may occasionally occur in the adjacent Power Plant intake canal. Adults and juveniles are known to occur in Humboldt Bay.
Steelhead	FT	Spawn in small coastal streams, rivers, and tributaries with moderate flow and small to medium-sized gravel. Rearing sites are in tributaries.	Highly unlikely. No suitable habitat near ISFSI site, but may occasionally occur in the adjacent Power Plant intake canal. Adults and juveniles are known to occur in Humboldt Bay.

TABLE 2.3-9

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[a] Special Status Species Code Designations:

FE	=	Federally listed endangered
FT	=	Federally listed threatened
SE	=	State listed endangered
ST	=	State listed threatened
CSC	=	California Species of Special Concern
CFP	=	California Full Protected Species
*	=	Special Animal

TABLE 2.3-10

SPECIAL STATUS FRESH-WATER AQUATIC SPECIES POTENTIALLY OCCURRING IN THE ISFSI AREA

Name	Status[(a)]	Habitat	Occurrence Onsite
Southern torrent salamander	CSC	Coastal redwood, douglas fir, mixed conifer, montane riparian, and montane hardwood-conifer habitats. Old growth forest. Cold, well-shaded, permanent streams and seepages, or within splash zone or on moss-covered rock within trickling water.	No suitable habitat
Tailed Frog	CSC	Flowing streams in coniferous or hardwood-conifer forests.	No suitable habitat
Northern Red-Legged Frog	CSC	Primarily in perennial ponds, pools or streams with emergent or shoreline riparian vegetation. Also in ephemeral streams where water remains long enough for breeding and development. Occur in moist upland habitats during seasonal movements and dispersal times.	Highly unlikely. No suitable breeding habitat at ISFSI site. Frogs may occur in the freshwater drainages and riparian scrub-red alder forest nearby during the non-breeding season, but the likelihood of this is low due to the surrounding conditions.
Foothill Yellow-Legged Frog	CSC	Flowing, perennial streams with large grain size substrate.	Not present. No suitable habitat.
Northwestern Pond Turtle	CSC	Perennial freshwater ponds or drainages with adequate basking sites and some canopy cover.	Not present. No suitable ponded habitat occurs on-site and it is unlikely that the drainages in the vicinity serve as movement corridors for this species.

(a) Special Status Species Code Designations:

FE = Federally listed endangered
FT = Federally listed threatened
SE = State listed endangered
ST = State listed threatened
CSC = California Species of Special Concern
CFP = California Full Protected Species
* = Special Animal

HUMBOLDT BAY ISFSI
ENVIRONMENTAL REPORT

TABLE 2.4-1

TEMPERATURE, DEW POINT TEMPERATURE, AND RELATIVE HUMIDITY (REFERENCE 2)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
AVERAGE DAILY TEMPERATURE (°F)	47	48	48	49	52	55	56	57	56	53	50	47	51
AVERAGE OF MAX DAILY TEMPERATURE (°F)	53	55	52	55	58	59	61	62	62	57	54	52	54
AVERAGE OF MIN DAILY TEMPERATURE (°F)	42	42	44	46	49	51	53	52	53	48	44	39	49
AVERAGE DAILY DEW POINT (°F)	41	42	42	44	47	50	52	53	52	49	45	41	46
AVERAGE OF DAILY MAX DEW POINT (°F)	48	50	49	48	54	55	56	58	56	52	50	48	50
AVERAGE OF DAILY MIN DEW POINT (°F)	34	36	37	37	44	46	46	49	47	44	39	35	45
AVERAGE DAILY RELATIVE HUMIDITY (%)	82	82	82	82	84	86	87	88	87	86	85	83	85
AVERAGE OF DAILY MAX RELATIVE HUMIDITY (%)	91	90	91	90	94	94	96	96	93	97	91	90	88
AVERAGE OF DAILY MIN RELATIVE HUMIDITY (%)	65	66	71	65	72	73	74	77	78	78	76	70	77

TABLE 2.4-2

EUREKA MAXIMUM RAINFALL STATISTICS AND SEVERAL CALCULATED RETURN PERIODS

	Measured	200-yr Return Period	1000-yr Return Period	Probable Max. Precip.
Average Annual Rainfall (inches)	38.87	n/a	n/a	n/a
Annual Maximum (inches)	67.23	67.70	74.97	189.93
Hourly Maximum (inches)	1.20	1.25	1.47	3.48
Daily Maximum (inches)	5.04	6.19	7.25	17.20

TABLE 2.4-3

DESIGN BASIS SNOWFALL PARAMETERS (REFERENCE 1)

Average Annual Snow (inches)	< 1	
Daily Maximum (inches)	3.4	Jan. 13, 1907
Maximum Storm Total (inches)	5.9	Jan. 12 - 15, 1907
Maximum Depth on Ground (inches)	3.4	Jan. 13, 1907
Monthly Maximum (inches)	6.9	Jan. 1907

TABLE 2.4-4

PEAK WIND GUSTS RECORDED AT EUREKA BETWEEN 1887 AND 1996

Record Peak Gusts by Month at Eureka

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

HUMBOLDT BAY ISFSI
ENVIRONMENTAL REPORT

TABLE 2.4-5

MEAN FREQUENCY OF METEROLOGICAL PHENOMENA

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Thunderstorms	1	1	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	1	1
Heavy Fog(b)	4	3	2	2	1	2	3	5	8	9	7	4

(a) Less than ½ day (b) Visibility less than ¼ mile

TABLE 2.4-6

JOINT FREQUENCY DISTRIBUTIONS OF WIND SPEED,
AND ATMOSHPERIC STABILITY CLASS[(a)]

Stability Class A

	Wind Speed (mph)								Row
Direction	**0-2**	**3**	**4-7**	**8-12**	**13-18**	**19-24**	**25-50**	**51-100**	**Sum**
Calm	1	0	0	0	0	0	0	0	1
22.5	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0
67.5	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0
112.5	0	0	0	0	0	0	0	0	0
135	0	0	1	0	0	0	0	0	1
157.5	0	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0	0
202.5	0	0	0	0	0	0	0	0	0
225	0	0	1	0	0	0	0	0	1
247.5	0	0	0	3	7	1	0	0	11
270	0	0	1	0	1	0	0	0	2
292.5	0	0	0	0	0	0	0	0	0
315	0	0	0	0	0	0	0	0	0
337.5	0	0	0	0	0	0	0	0	0
360	0	0	0	0	0	1	0	0	1
Col. Sum	**1**	**0**	**3**	**3**	**8**	**2**	**0**	**0**	**17**

TABLE 2.4-6

Stability Class B

Direction	0-2	3	4-7	8-12	13-18	19-24	25-50	51-100	Row Sum
				Wind Speed (mph)					
Calm	0	0	0	0	0	0	0	0	0
22.5	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0
67.5	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0
112.5	0	0	0	0	0	0	0	0	0
135	0	0	0	0	0	0	0	0	0
157.5	0	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0	0
202.5	0	0	0	0	0	0	0	0	0
225	0	0	0	1	2	0	0	0	3
247.5	0	0	1	3	5	0	1	0	10
270	0	0	1	3	1	0	0	0	5
292.5	0	0	1	2	0	0	0	0	3
315	0	0	0	1	0	0	0	0	1
337.5	0	0	0	0	0	0	0	0	0
360	0	0	0	0	0	0	0	0	0
Col. Sum	**0**	**0**	**3**	**10**	**8**	**0**	**1**	**0**	**22**

TABLE 2.4-6

Stability Class C

Direction	**Wind Speed (mph)** 0-2	**3**	**4-7**	**8-12**	**13-18**	**19-24**	**25-50**	**51-100**	**Row Sum**
Calm	1	0	0	0	0	0	0	0	1
22.5	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0
67.5	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0
112.5	0	0	0	0	0	0	0	0	0
135	0	0	0	0	0	0	0	0	0
157.5	0	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0	0
202.5	0	0	0	0	0	0	0	0	0
225	0	1	1	3	5	0	2	0	12
247.5	0	0	2	14	7	2	1	0	26
270	0	0	6	7	1	0	0	0	14
292.5	0	0	2	0	0	0	0	0	2
315	0	0	0	0	0	0	0	0	0
337.5	0	0	0	0	0	0	0	0	0
360	0	0	0	0	0	0	0	0	0
Col. Sum	**1**	**1**	**11**	**24**	**13**	**2**	**3**	**0**	**55**

TABLE 2.4-6

Stability Class D

Direction	**0-2**	**3**	**4-7**	**8-12**	**13-18**	**19-24**	**25-50**	**51-100**	**Row Sum**
				Wind Speed (mph)					
Calm	30	0	0	0	0	0	0	0	30
22.5	0	3	9	7	7	2	0	0	28
45	0	1	6	2	1	0	0	0	10
67.5	0	1	2	0	1	0	0	0	4
90	0	0	1	1	0	0	0	0	2
112.5	0	0	2	1	0	0	0	0	3
135	0	2	3	1	3	2	0	0	11
157.5	0	2	3	6	22	8	0	0	41
180	0	0	9	37	31	11	0	0	88
202.5	0	2	12	35	20	9	1	0	79
225	1	6	33	68	57	18	15	0	198
247.5	7	4	88	114	38	11	5	0	267
270	6	9	108	82	11	3	0	0	219
292.5	3	15	57	40	5	2	0	0	122
315	1	5	44	36	5	5	3	0	99
337.5	1	2	20	18	11	12	4	0	68
360	1	2	22	16	33	25	26	0	125
Col. Sum	**50**	**54**	**419**	**464**	**245**	**108**	**54**	**0**	**1394**

TABLE 2.4-6

Stability Class E

Direction	0-2	3	4-7	8-12	13-18	19-24	25-50	51-100	Row Sum
				Wind Speed (mph)					
Calm	602	0	0	0	0	0	0	0	602
22.5	15	40	288	393	173	44	20	0	973
45	7	39	182	144	23	0	0	0	395
67.5	12	29	134	56	8	1	0	0	240
90	16	31	108	44	6	0	0	0	205
112.5	3	21	99	54	4	3	1	0	185
135	2	12	53	66	104	63	71	0	371
157.5	8	18	78	98	287	220	134	0	843
180	16	24	127	230	269	89	32	0	787
202.5	19	28	175	254	141	60	38	0	715
225	15	38	242	233	90	64	47	0	729
247.5	33	57	169	82	22	21	9	0	393
270	37	54	178	51	14	11	5	0	350
292.5	31	47	156	70	8	8	5	0	325
315	32	75	287	211	43	7	7	0	662
337.5	33	40	411	540	287	73	20	0	1404
360	20	61	550	988	749	340	161	0	2869
Col. Sum	**901**	**614**	**3237**	**3514**	**2228**	**1004**	**550**	**0**	**12048**

TABLE 2.4-6

Stability Class F

	Wind Speed (mph)								**Row**
Direction	**0-2**	**3**	**4-7**	**8-12**	**13-18**	**19-24**	**25-50**	**51-100**	**Sum**
Calm	264	0	0	0	0	0	0	0	264
22.5	6	15	32	45	23	1	0	0	122
45	4	18	67	47	14	0	0	0	150
67.5	8	8	72	23	3	0	0	0	114
90	7	17	90	30	2	0	0	0	146
112.5	4	15	80	52	10	1	0	0	162
135	4	10	86	47	35	9	2	0	193
157.5	9	11	61	42	37	8	18	0	186
180	9	26	92	68	10	1	0	0	206
202.5	20	27	101	87	7	0	0	0	242
225	20	27	120	50	7	4	2	0	230
247.5	30	31	69	9	1	0	2	0	142
270	25	20	40	4	1	0	0	0	90
292.5	20	22	25	3	0	0	0	0	70
315	18	12	29	11	2	0	1	0	73
337.5	14	19	62	20	0	0	0	0	115
360	10	12	45	28	5	0	1	0	101
Col. Sum	**472**	**290**	**1071**	**566**	**157**	**24**	**26**	**0**	**2606**

TABLE 2.4-6

Stability Class G

	Wind Speed (mph)								Row
Direction	**0-2**	**3**	**4-7**	**8-12**	**13-18**	**19-24**	**25-50**	**51-100**	**Sum**
Calm	89	0	0	0	0	0	0	0	89
22.5	5	8	7	1	0	0	0	0	21
45	0	1	19	3	5	1	0	0	29
67.5	1	4	15	7	0	0	0	0	27
90	9	12	32	6	0	0	0	0	59
112.5	2	11	39	15	1	0	0	0	68
135	2	8	32	18	3	1	0	0	64
157.5	2	3	25	9	4	0	0	0	43
180	6	9	24	7	3	0	0	0	49
202.5	8	4	26	16	1	0	0	0	55
225	7	8	29	7	0	0	0	0	51
247.5	3	12	11	0	0	0	0	0	26
270	12	5	9	1	0	0	0	0	27
292.5	5	2	9	0	0	0	0	0	16
315	2	3	3	1	0	0	0	0	9
337.5	1	5	5	3	0	0	0	0	14
360	2	1	5	2	1	0	0	0	11
Col. Sum	**156**	**96**	**290**	**96**	**18**	**2**	**0**	**0**	**658**

(a) Jan 1966 through Dec 1967 (Wind Speed 250 ft, Delta Temp. 250-25 ft)

TABLE 2.4-7

EUREKA MIXING HEIGHTS – METERS (REFERENCE 10)

Season	Morning	Afternoon
Winter	500	700
Spring	800	1100
Summer	500	600
Autumn	500	800
Annual	500	800

HUMBOLDT BAY ISFSI
ENVIRONMENTAL REPORT

TABLE 2.4-8

SHORT TERM DISPERSION FACTOR $(\chi/\dot{Q})$
VS. WIND SPEED AND PASQUILL CLASS

Wind Speed (meters/sec)	Pasquill Class						
	A	B	C	D	E	F	G
0.1	9.59E-03	1.68E-02	3.46E-02	3.96E-02	5.12E-02	9.04E-02	1.51E-01
0.337	2.84E-03	5.00E-03	1.03E-02	1.18E-02	1.52E-02	2.68E-02	4.48E-02
1.01	9.49E-04	1.67E-03	3.42E-03	3.92E-03	5.07E-03	8.95E-03	1.50E-02
1.85	5.18E-04	9.10E-04	1.87E-03	2.14E-03	2.77E-03	4.89E-03	8.17E-03
3.37	2.84E-04	5.00E-04	1.03E-03	1.63E-03	2.56E-03	5.19E-03	1.05E-02
5.22	1.84E-04	3.23E-04	6.62E-04	1.39E-03	2.56E-03	5.61E-03	1.09E-02
7.25	1.32E-04	2.32E-04	4.77E-04	1.04E-03	1.92E-03	4.04E-03	7.87E-03
12.6	7.61E-05	1.34E-04	2.74E-04	5.98E-04	1.11E-03	2.32E-03	4.53E-03
25.4	3.77E-05	6.63E-05	1.36E-04	2.97E-04	5.49E-04	1.15E-03	2.25E-03

TABLE 2.4-9

ANNUAL AVERAGE DISPERSION FACTORS ($\chi/\dot{Q}$) BY SECTOR DIRECTION

Direction	$\chi/\dot{Q}$
22.5	5.00E-04
45.0	4.03E-04
67.5	3.74E-04
90.0	4.17E-04
112.5	3.94E-04
135.0	4.18E-04
157.5	4.76E-04
180.0	5.18E-04
202.5	5.42E-04
225.0	5.47E-04
247.5	4.97E-04
270.0	4.84E-04
292.5	4.28E-04
315.0	4.66E-04
337.5	5.78E-04
360.0	7.66E-04

TABLE 2.5-1

NORMAL MONTHY PRECIPITATION AND TEMPERATURES
AT EUREKA WSO (No. 04-2910)
LATITUDE 40°48'N, LONGITUDE 124°10'W
ELEVATION 43 FT (NGVD)

MONTH	PRECIPITATION (in.)	TEMPERATURE (°F)
JAN	7.42	47.3
FEB	5.15	48.4
MAR	4.83	48.3
APR	2.95	49.7
MAY	2.11	52.5
JUN	0.66	55.2
JUL	0.14	56.3
AUG	0.27	57.0
SEP	0.65	56.6
OCT	3.23	54.4
NOV	5.77	51.7
DEC	5.58	48.6

TABLE 2.5-2

ANNUAL MAXIMUM PEAK DISCHARGES

	11-4797 ELK RIVER NEAR FALK		11-4800 JACOBY CREEK NEAR FRESHWATER	
WATER YEAR	DATE	DISCHARGES (cfs)	DATE	DISCHARGES (cfs)
1955			12/30/54	1,670
1956			12/21/55	1,490
1957			12/11/56	516
1958	2/12/58	2,790	11/13/57	729
1959	2/14/59	3,220	2/14/59	749
1960	2/8/60	2,090	2/8/60	644
1961	2/11/61	2,160	2/11/61	276
1962	1/19/62	2,120	1/19/61	389
1963	4/12/63	2,220	12/2/62	446
1964	1/20/64	2,950	1/6/64	563
1965	12/22/65	3,430	12/22/64[a]	1,530
1966	1/4/66	3,270		
1967	12/5/66	3,110		
1968	Record Discontinued		1/15/68	380
1969			1/13/69	626
1970			11/23/70	897
1971			11/24/700	936
1972			3/2/72	2,510
1973				
1974			1/16/74	1,170

[a] Station converted to a crest-stage partial-record station.

TABLE 2.5-3

ANNUAL HIGHEST TIDE LEVEL

Year	Date	Highest Tide (MLLW)	Tide Station	Adjusted Tide Elevation At Powerplant Vicinity
1920	12/25	8.1	SOUTH JETTY	8.2
1932	12/26, 11/28	8.2	SOUTH JETTY	8.3
1933	12/17	8.1	SOUTH JETTY	8.2
1934	12/8	7.8	SOUTH JETTY	7.9
1935	12/9	7.8	SOUTH JETTY	7.9
1936	12/27	7.9	SOUTH JETTY	8.0
1937	12/17	8.2	SOUTH JETTY	8.3
1939	12/10	7.6	SOUTH JETTY	7.7
1940	12/27	7.6	SOUTH JETTY	7.7
1941	12/17	8.0	SOUTH JETTY	8.1
1942	12/8	7.9	SOUTH JETTY	8.0
1943	12/27	7.7	SOUTH JETTY	7.8
1944	11/29	7.8	SOUTH JETTY	7.9
1945	12/18	8.1	SOUTH JETTY	8.2
1946	12/9	8.1	SOUTH JETTY	8.2
1947	12/27	8.1	SOUTH JETTY	8.2
1948	12/28, 12/17, 11/29	7.5	SOUTH JETTY	7.6
1949	12/18	7.9	SOUTH JETTY	8.0
1950	12/9	8.1	SOUTH JETTY	8.2
1977	12/11	8.87 (a)	NORTH SPIT	
1978	12/28	8.33 (a)	NORTH SPIT	
1979	12/30	8.86	NORTH SPIT	
1980	12/21	8.81	NORTH SPIT	
1981	11/27	12.46	NORTH SPIT	
1982	11/30	9.69	NORTH SPIT	
1983	1/26	9.96	NORTH SPIT	
1984	1 (b)	8.41 (c)	NORTH SPIT	
1985	12 (b)	8.43 (c)	NORTH SPIT	
1986	12 (b)	9.14 (c)	NORTH SPIT	
1987	1 (b)	9.11 (c)	NORTH SPIT	
1988	11 (b)	8.72 (c)	NORTH SPIT	
1989	12 (b)	8.50 (c)	NORTH SPIT	
1990	1 (b)	8.71 (c)	NORTH SPIT	
1994	12 (b)	9.08 (c)	NORTH SPIT	
1995	1 (b)	9.07 (c)	NORTH SPIT	
1996	12 (b)	9.29 (c)	NORTH SPIT	
1997	12 (b)	9.24 (c)	NORTH SPIT	
1998	1 (b)	9.14 (c)	NORTH SPIT	

(a) Record not complete for the year, but values used here are for December when highest tides usually occur.
(b) Month of highest tide.
(c) Verified historic tide values obtained from the CO-OPS database, from the National Water Level Observations Network of the National Oceanic and Atmospheric Administration (NOAA).

NOTE: According to the correction table of the "Official Tide Table for Humboldt Bay and Vicinity," tides at Fields Landing are 0.3 ft higher than South Jetty Landing. Since the powerplant site is located about 1/3 of the distance between South Jetty Landing and Fields Landing, 0.1 ft is used for correcting tides recorded at South Jetty Landing for the plantsite. No correction is assumed needed for tides recorded at North Spit.

TABLE 2.5-4

PROBABLE MAXIMUM FLOOD PEAKS AND LEVELS
HUMBOLDT BAY

PMP EVENT	PMP INFLOW (cfs)	5-DAY VOLUME (ac-ft)	BAY W.S. ELEV.[(a)] (ft)	FREEBOARD[(b)] (ft)
OCT	108,070	256,150	10.05	33.95
NOV	103,920	262,350	10.05	33.95
DEC	99,460	267,060	10.04	33.96
JAN-FEB	97,670	270,940	10.03	33.97
MAR	97,490	263,180	10.03	33.97
APR	96,030	248,280	10.03	33.97

(a) Elevation is based on National Ocean Survey Datum of MLLW level of zero at North Spit tidal gage and transposed to the ISFSI site. Antecedent Bay level was assumed equal to 9.96 ft above MLLW.

(b) Freeboard is determined from the ISFSI site elevation of 44 ft MLLW.

TABLE 2.5-5

ESTIMATES OF WAVE RUNUP[a,b]

PMF	DESIGN WIND (mph)		PERIOD	RUNUP	SETUP	TOTAL RUNUP	FREE-BOARD
MONTH	Over-land	Over-water	(sec)	(ft)	(ft)	(ft)	
OCT	27	33	2.5	1.6	0.3	11.86	32.14
NOV	31	38	2.3	1.6	0.4	11.96	32.04
DEC	36	45	2.5	1.9	0.5	12.36	31.64
JAN-FEB	40	49	2.6	2.0	0.6	12.56	31.44
MAR	36	45	2.5	1.9	0.5	12.36	31.64
APR	31	38	2.3	1.6	0.4	11.96	32.04
WINDSTORM 66-YR PERIOD OF RECORD	56	69	2.9	2.7	1.2	13.86	30.14
100-YEAR	62	77	3.0	3.0	1.5	18.86	25.14

Notes:

(a) Based on the antecedent Bay level of 9.96 ft MLLW.

(b) Determined from elevation of the ISFSI site, which is at elevation 44 ft MLLW, using PG&E survey data dated January 12, 1983.

TABLE 2.5-6

PIEZOMETERS USED IN 1999 GROUNDWATER MEASUREMENTS IN THE HUMBOLDT BAY ISFSI SITE AREA

BORING NUMBER	Year	Boring Depth/ Elevation (feet)	Top Screen Elevation (feet)	Bottom Screen Elevation (feet)	Geologic/ Hydrologic Unit in Screened Zone	Piezometric Elevation 5/6/99 (9am-12pm) (feet)
MW-1 (BEC 84-1)	1984	49.5/ -37.6	-28.19	-32.59	Upper Hookton aquifer	4.74
MW-2A (BEC 84-2A)	1984	50.0/ -39.2	-28.14	-37.54	Upper Hookton aquifer	4.29
MW-4 (BEC 84-4)	1984	50.6/ -38.5	-41.00	-50.20	Upper Hookton aquifer	4.43
MW-5 (BEC 84-5)	1984	45.0/ -33.3	-40.50	-44.80	Upper Hookton aquifer	4.24
MW-6 (BEC 84-6)	1984	50.0/ -38.6	-32.57	-36.87	Upper Hookton aquifer	4.21
MW-7 (BEC 84-7)	1984	45.0/ -20.9	-16.23	-20.53	Upper Hookton aquifer	4.10
MW-8 (BEC 84-8)	1984	12.5/ 11.1	17.3	11.8	Perched ground-water zone (A) in upper Hookton silts and clays	17.92
MW-9 (BEC 84-9)	1984	45.0/ -33.4	-23.58	-32.78	Upper Hookton aquifer	4.76
MW-10 (BEC 84-10)	1984	60.0/ -31.9	-50.20	-59.40	Upper Hookton aquifer	3.81
MW-11 (BEC 84-11)	1984	50.0/ -37.6	-35.80	-45.00	Upper Hookton aquifer	4.76
1 (DER) ** (DER 85-1)	1985	38.0/ -25.8	-16.01	-26.01	Upper Hookton aquifer	4.73
2 (DER) ** (DER 85-2)	1985	38.0/ -25.9	-15.91	-25.41	Upper Hookton aquifer	4.78
3 (DER) ** (DER 85-3)	1985	46.5/ -34.6	-22.75	-32.25	Upper Hookton aquifer	4.75
4 (DER) ** (DER 85-4)	1985	46.5/ -34.5	-22.99	-32.49	Upper Hookton aquifer	4.80
5 (DER) ** (DER 85-5)	1985	41.5/-27.3	-17.35	-27.35	Upper Hookton aquifer	4.20
6 (DER) ** (DER 85-6)	1985	51.5/ 37.3	-24.80	-34.30	Upper Hookton aquifer	4.40
7 (DER) ** (DER 85-7)	1985	41.5/ -28.2	-10.74	-20.24	Upper Hookton aquifer	4.6
8 (DER) ** (DER 85-8)	1985	38.0/ -26.0	-15.49	-24.99	Upper Hookton aquifer	4.66
9 (DER) ** (DER 85-9	1985	41.5/ -29.7	-13.17	-28.17	Upper Hookton aquifer	4.76

TABLE 2.5-6

BORING NUMBER	Year	Boring Depth/ Elevation (feet)	Top Screen Elevation (feet)	Bottom Screen Elevation (feet)	Geologic/ Hydrologic Unit in Screened Zone	Piezometric Elevation 5/6/99 (9am-12pm) (feet)
1A (WCC) ** (WCC 85-1A)	1985	14.0/ -1.9	8.6	-1.9	Perched groundwater zone (A) in upper Hookton silts and clays	8.56
1B (WCC) ** (WCC 85-1B)	1985	26.5/ -14.4	-7.4	-12.4	Perched groundwater zone (B) in upper Hookton silts and clays	5.90
2A (WCC) ** (WCC 85-2A)	1985	14.0/ -2.3	7.6	-2.3	Perched groundwater zone (A) in upper Hookton silts and clays	8.44
2B (WCC) ** (WCC 85-2B)	1985	26.5/ -14.8	-8.1	-13.1	Perched groundwater zone (B) in upper Hookton silts and clays	7.30
3A (WCC) ** (WCC 85-3A)	1985	14.0/ -1.4	8.6	-1.2	Perched groundwater zone (A) in upper Hookton silts and clays	8.61
3B (WCC) ** (WCC 85-3B)	1985	36.5/ -23.9	-5.7	-10.7	Perched groundwater zone (B) in upper Hookton silts and clays	5.17
4A (WCC) ** (WCC 85-4A)	1985	14.0/ -2.5	7.5	-2.5	Perched groundwater zone (A) in Holocene bay deposits	9.03
4B (WCC) ** (WCC 85-4B)	1985	26.5/ -15.0	-8.4	-13.4	Perched groundwater zone (B) in upper Hookton silts and clays	8.32
5A (WCC) ** (WCC 85-5A)	1985	10.0/ 3.1	8.1	3.1	Perched groundwater zone (A) in Holocene bay deposits	10.01
5B (WCC) ** (WCC 85-5B)	1985	21.5/ -8.4	3.1	-6.3	Perched groundwater zone (B) in Holocene bay deposits	9.77
6A (WCC) ** (WCC 85-6A)	1985	10.0/ 3.3	8.3	3.3	Perched groundwater zone (A) in Holocene bay deposits	10.03
6B (WCC) ** (WCC 85-6B)	1985	26.5/ -13.0	0.5	-8.9	Perched groundwater zone (B) in Holocene bay deposits	10.24
7B (WCC) ** (WCC 85-7B)	1985	22.0/ -8.3	5.5	-8.5	Perched groundwater zone (B) in Holocene bay deposits	9.1
8A (WCC) ** (WCC85-8A)	1985	10.0/ 3.5	8.5	3.5	Perched groundwater zone (A) in Holocene bay deposits	8.75

TABLE 2.5-6

BORING NUMBER	Year	Boring Depth/ Elevation (feet)	Top Screen Elevation (feet)	Bottom Screen Elevation (feet)	Geologic/ Hydrologic Unit in Screened Zone	Piezometric Elevation 5/6/99 (9am-12pm) (feet)
8B (WCC) ** (WCC 85-8B)	1985	21.5/ -7.9	7.2	-6.8	Perched groundwater zone (A) in Holocene bay deposits (intermediate, placed in zone A)	8.86
9A (WCC) ** (WCC 85-9A)	1985	10.0/ 2.1	7.1	2.1	Perched groundwater zone (A) in Holocene bay deposits	11.04
9B (WCC) ** (WCC 85-9B)	1985	21.5/ -9.1	2.4	-7.6	Perched groundwater zone (A) in Holocene bay deposits (intermediate, placed in zone A)	8.09
10B (WCC) ** (WCC 85-10)	1985	21.5/ -7.5	4.0	-6.0	Perched groundwater zone (A) in Holocene bay deposits	9.07
7A (TES) ** (DER 87-7A)	1987	12/ 8	10.97	3.97	Perched groundwater zone (A) in Holocene bay deposits	10.40
8C (TES) ** (DER 87-8C)	1987	39/ -25.5	-18.21	-23.21	Hookton sands	5.44
11B (TES) ** (DER 87-11B)		20.5/ -5.4	5.14	-4.86	Perched groundwater zone (A) in Holocene bay deposits (intermediate, placed in zone A)	9.01
12B (TES) ** (DER 87-12B)		20.5/ -5.03	5.25	-4.75	Perched groundwater zone (A) in Holocene bay deposits	9.48
13A (TES) ** (DER 87-13B)		-- /-2.0?	8.17	-1.83	Perched groundwater zone (A) in upper Hookton silts and clays	8.25
14A (TES) ** (DER 87-14A)		-- /-2.0?	8.39	-1.61	Perched groundwater zone (A) in upper Hookton silts and clays	8.62
15A (TES) ** (DER 87-15A)	1987	11.5/ 4	11.27	4.27	Perched groundwater zone (A) in Holocene bay deposits	8.74
15B (TES) ** (DER 87-15B)	1987	22/ -8.5	0.84	-6.16	Perched groundwater zone (A) in Holocene bay deposits (intermediate, placed in zone A)	7.09

TABLE 2.5-6

BORING NUMBER	Year	Boring Depth/ Elevation (feet)	Top Screen Elevation (feet)	Bottom Screen Elevation (feet)	Geologic/ Hydrologic Unit in Screened Zone	Piezometric Elevation 5/6/99 (9am-12pm) (feet)
15C (TES) ** (DER 87-15C)	1987	41.5/ -27.0	-17.86	-22.86	Upper Hookton aquifer	5.15
16A (TES) ** (DER 87-16A)	1987	12/ 1	11.01	4.01	Perched groundwater zone (A) in Holocene bay deposits	9.41
16B (TES) ** (DER 87-16B)	1987	23/ -10	1.05	-5.95	Perched groundwater zone (B) in Holocene bay deposits	9.21
16C (TES) ** (DER 87-16C)	1987	39/ -25.5	-11.19	-16.19	Upper Hookton aquifer	4.37
16D (TES) ** (DER 87-16D)	1987	51/ -38	-29.45	-34.45	Upper Hookton aquifer	4.32
17A (TES) ** (DER 87-17A)	1987	13/ 1.5	10.57	3.57	Perched groundwater zone (A) in Holocene bay deposits	11.85
17B (TES) ** (DER 87-17B)	1987	24/ -9.5	0.58	-6.42	Perched groundwater zone (B) in Holocene bay deposits	7.47
17C (TES) ** (DER 87-17C)	1987	40/ -26	-12.57	-17.57	Upper Hookton aquifer	4.29
17D (TES) ** (DER 87-17D)	1987	51/ -36	-25.27	-30.27	Upper Hookton aquifer	4.48
18A (TES) ** (DER 87-18A)	1987	12/ 1.3	11.05	4.05	Perched groundwater zone (A) in Holocene bay deposits	9.03
18B (TES) ** (DER 87-18B)	1987	23/ -10	-0.65	-7.65	Perched groundwater zone (B) in Holocene bay deposits	5.60
101 (TES) **	1989	16.7/ -2.5	8.1	-1.9	Perched groundwater zone (A) in Holocene bay deposits	12.07
102 (TES) **	1989	16.7/ -2.8	7.8	-2.2	Perched groundwater zone (A) in Holocene bay deposits	12.14

TABLE 2.5-6

BORING NUMBER	Year	Boring Depth/ Elevation (feet)	Top Screen Elevation (feet)	Bottom Screen Elevation (feet)	Geologic/ Hydrologic Unit in Screened Zone	Piezometric Elevation 5/6/99 (9am-12pm) (feet)
103 (TES) **	1989	16.9/ -2.2	8.4	-1.6	Perched groundwater zone (A) in Holocene bay deposits	9.10
104 (TES) **	1989	18.0/ -2.9	7.1	-2.9	Perched groundwater zone (A) in Holocene bay deposits	9.39
105 (TES) **	1989	17.5/ -2.2	7.3	-2.2	Perched groundwater zone (A) in Holocene bay deposits	9.59
106 (TES) **	1989	17.5/ -3.9	6.7	-3.3	Perched groundwater zone (A) in Holocene bay deposits	10.03
P-1 (TES) ** (TES 87P-1)	1987	-- /-6.0?	9.45	-5.55	Upper Hookton aquifer	4.17
P-2 (TES) ** (TES 87-P2)	1987	-- /-2.0?	8.51	-1.49	Upper Hookton aquifer	4.95
OWSP-1 **		-- /-12.0?	11.82?	11.82	Perched groundwater zone (A) in upper Hookton silts and clays	8.39
WEST ** (20A)		21.5/ -9.6	1.9	-8.1	Perched groundwater zone (B) in intermediate Hookton silts and clays	6.36

Notes:

1. Elevations are referenced to 'Plant 0' that equals mean lo low water (MLLW), which is 3.6 feet below mean sea level (MSL)
2. MW-2 (BEC) = Bechtel Borings (1984) (Boring MW-3 closed prior to May 1999)
3. DER = PG&E Department of Engineering Research (1985/86)
4.
5. WCC = Woodward Clyde Consultants (1985)
6. TES = PG&E Department of Technical and Ecological Services (7A to 18B, P-1 & P-2: 1987; 101 to 106: 1989)
7. ** Well sealed and abandoned in September 1999
8. * = boring not plotted on map (Figure 2.5-3)

TABLE 2.5-7

SELECTED WATER QUALITY DATA FOR WELLS IN THE HUMBOLDT BAY ISFSI SITE VICINITY

PERCHED GROUNDWATER ZONE (A) IN UPPER HOOKTON SILTS AND CLAYS

South of Unit 3 Parameter	WCC85-2A 8/15/85	WCC85-3A 08/15/85
pH	5.9	6.4
Conductivity	2590	2830
TDS	1510	1620
Sulfate	248	87
Chloride	450	790
Sodium	430	300

PERCHED GROUNDWATER ZONE (A) IN HOLOCENE SILTS AND CLAYS

South of Unit 3 Parameter	WCC85-4A 08/15/85	WCC85-1OB 08/15/85
pH	5.8	7.0
Conductivity	5220	6680
TDS	3410	3090
Sulfate	420	405
Chloride	1560	1280
Sodium	780	1000

PERCHED GROUNDWATER ZONE (B) IN HOLOCENE BAY DEPOSITS

Wastewater Pond Site Parameter	WCC85-5B 08/15/85	WCC85-7B 08/15/85	WCC85-9B 08/15/85
pH	5.4	5.7	6.7
Conductivity	8900	11100	17300
TDS	288	358	9870
Sulfate	1450	1190	987
Chloride	1850	3500	4650
Sodium	1200	2000	1900

UPPER HOOKTON AQUIFER

Southeast of Unit 3 Parameter	DER85-1 04/11/85	DER85-4 04/11/85	DER85-5 04/11/85	DER85-7 04/11/85	DER85-8 04/11/85	DER85-10 4/11/1985
pH	7.0	6:9	7.2	7.0	7.1	7.2
Conductivity	1058	2363	5638	13022	9048	25776
TDS						
Sulfate	49	23	67	77	174	103
Chloride	200	640	1990	4550	3010	9050
Sodium	150	370	1000	2600	2000	5600

LOWER HOOKTON AQUIFER

PG&E Water Supply Wells Parameter	Well No. 1 11/18/93	Well No. 1 02/24/94	Well No. 2 02/24/94
pH	7.4	7.8	7.7
Conductivity	140	200	150
TDS	130	130	100
Sulfate	1.9	5.8	4.3
Chloride	12	26	13
Sodium	12	18	11

Note: 1. pH is in pH units; conductivity is in micromhos/cm, and others are ppm.
2. See Figures 2.5-3, -6, -12, -16, and -17 for location of wells.

TABLE 2.5-8

GROUNDWATER WELLS WITHIN TWO MILES OF THE HUMBOLDT BAY ISFSI

Well No.	Owner	Site Location	Township/ Range/ Section	Use	Depth (feet)	Diameter (inches)	Casing Year Completed	Casing Material
1 *	PG&E	HBPP	4N/1W/08P1	industrial	450	8	1955	steel
2	PG&E	Humboldt Hill Rd	4N/R1W/17B 1	industrial	491	8	1955	steel
3 *	PG&E	HBPP	4N/R1W/08M 1	domestic	55	12		
5	Dr. Stone	Spruce Pt near Bucksport School	4N/R1W/08J1	domestic	360	12	1950	
6	Fields Landing water Co	end of Princeton Dr	4N/R1W/17	municipal	176	8	1961	steel
7	Walter Eich	2035 Eich Rd. Spruce Point		commercial	180	6	1993	steel
8	Humboldt Community Services District	County Ag Site Spruce Point		public, domestic	450	12	1988	steel
9	McMahan	Pine Hill Trailer Ct.	4N/R1W/04A	domestic	105	8	1949	
10	Glen Reed	6477 Elk River Rd		domestic			1980	plastic
11	John Giocomini		4N/R1W/16A	irrigation	160	14		
12	Gene Senistrano		4N/R1W/16H 1	irrigation	210		1956	
13	John Jerome			domestic	50	6		
14	Walter Eich		4N/R1W/16N		779		1944	
15	Humboldt Community Services District		4N/R1W/17	municipal	366	6•5/8	1980	
16	Coast Guard							
17	George Reeves	5823 Humboldt Hill Rd. next to Grange Hall	4N/R1W/08	domestic-irrigation	160	14	1969	pvc
18	Evenson	Elk River Rd		domestic	95	8		kiawell
19	Laurie Cummings	5850 Elk River Rd		domestic	82	8•5/8	1989	steel
20	Pierce Mortuary	Sunset Memorial Park		irrigation	120	12	1978	steel
21	Dale Lindholm	Berta Rd		domestic	180	8	1988	steel
22	Kenneth Evans	Berta Rd		domestic	200	8	1998	steel
23	Clinton Parks	Berta Rd		domestic	130	8	1993	steel
24	Jay Egan	2216 Burns Dr		domestic			1991	
25	Reynold Water Co	Humboldt Hill area		public domestic	400	8	1977	steel
26	Lloyd Barker	2100 Stanford Dr.		domestic	100	6	1977	pvc
27	Frank Bisio	4900 Broadway	4N/R1W/04H	monitoring (3)	7	4	1995	pvc
28	Humboldt Fire District	755 Herrick Ave		monitoring (3)	17	2	1997	pvc
29	Joan Scuri	Zazone & Elk River Rd	4N/R1W/15	domestic	60	8	1966	
30	Pacific Bell	5749 Humboldt Hill Rd	4N/R1W/08H	monitoring (4)	16.5		1995	
31	Pete Lorenzen	Elk River Rd at Elk River School	4N/R1W/16H 1	irrigation	210		1956	

TABLE 2.5-8

Well No.	Owner	Site Location	Township/ Range/ Section	Use	Depth (feet)	Diameter (inches)	Casing Year Completed	Casing Material
32	Reynold Water Co	Vista Dr – Humboldt Hill	4N/R1W/7H	municipal	272	8	1969	Steel
33	Jose Lopez	Elk River Road 125' E of house (address un-certain - map location approx)	4N/R1W/04	domestic		6	1977	Steel
34	H. E. Reardon	Elk River Rd 3rd house on Left	4N/R1W/04H	irrigation	103	12	1960	
35	Shanahan Bros.	Spruce Pt 1 mi E of 101	4N/R1W/08H	test well (2)	205		1956	
36	Tony Dutra	Spruce Pt	4N/R1W/08H	domestic	84	8	1962	steel
37	Walter Eich	Spruce Pt btw 101 & Humboldt Hill Rd	4N/R1W/08H	domestic	190	6	1962	
38	H. E. Reardon	2 mi S Elk River Rd	4N/R1W/09H	irrigation	106	12	1967	steel
39	Frank Shanahan	Elk River Rd 2 mi E of 101	4N/R1W/15	domestic	147		1962	
40	Ann Miller	6710 Fields Landing Dr	4N/R1W/17H	monitoring	15	2	1993	pvc
41	Sun Bridge Sea View Csre Center	6400 Purdue Road	4N/R1W/17H	industrial	275	8	1968	steel
42	Humboldt County	Humboldt Hill Rd @ S. Broadway	4N/R1W/8	municipal	380	6	1988	pvc

Notes:

1. Table complete as of November 1999.
2. *Indicates that well was sealed and abandoned in 2000.
3. Well number 4 referred to several monitoring wells near HBPP Unit 3; these are listed in Table 2.5-6.

TABLE 2.7-1

HUMBOLDT COUNTY ECONOMIC PROFILE

A. Estimated Population (2001)	126,468
B. Median Family Income (1999)	$31,226
C. Estimated Employment	
Private Non-farm (1999)	36,953
Government (1997)	5,273
D. County Unemployment Rate (2001)	6.1%
E. Income Below Poverty Level (1999)	19.5%

TABLE 2.8-1

NOISE MEASUREMENT RESULTS [A-WEIGHTED DECIBELS (dBA)]

Location (a)	Avg. (L_{eq})	Max. (L_{eq})	Min. (L_{eq})	Avg. (L_{10})	Avg. (L_{50})	Avg. (L_{90})	Max. (L_{dn})	Min. L_{dn})
1. At Base of Met. Tower	58	71	54	58	57	56	63	61
2. East of HBPP Unit 3	61	71	57	62	60	59	68	62
3. Gate at King Salmon Road	61	67	46	64	48	44	66	65

(a) See Figure 2.8-1

HUMBOLDT BAY ISFSI
ENVIRONMENTAL REPORT

TABLE 2.10-1

TLD MEASUREMENTS

Station	Quarterly Exposure (mrem/qtr)	Total Annual Exposure (mrem/yr)
T1	13.9	55.8
T2	12.9	51.4
T3	12.3	49.0
T4	12.3	49.2
T5	12.5	49.9
T6	12.4	49.8
T7	12.1	48.4
T8	11.9	47.7
T9	12.4	49.5
T10	11.8	47.0
T11	12.7	50.6
T12	13.8	55.2
T13	13.5	53.8
T14	13.5	54.1
T15	13.7	54.8
T16	12.7	50.7
T17(offsite)	12.6	50.4
Average (onsite)	12.8	51.1

HUMBOLDT BAY ISFSI
ENVIRONMENTAL REPORT

TABLE 2.10-2

SOIL SAMPLES

Sample ID	Cesium-137 (pCi/g)	Sample Depth (ft)
2SS001	0.11	Surface to 0.5
2SS002	<MDA	Surface to 0.5
2SS009	<MDA	Surface to 0.5
2SS012	<MDA	Surface to 0.5
2SS014	1.42	Surface to 0.5
2SS017	0.13	Surface to 0.5
2SS019	0.23	Surface to 0.5
2SS030	0.73	Surface to 0.5
2SS036	0.17	Surface to 0.5
2SS037	<MDA	Surface to 0.5
2SS038	0.21	Surface to 0.5
2SS039	0.12	Surface to 0.5

HUMBOLDT BAY ISFSI
ENVIRONMENTAL REPORT

TABLE 2.10-3

VEGETATION SAMPLES

Sample Location	Radium-226 (pCi/kg)	Beryllium-7 (pCi/kg)	Potassium-40 (pCi/kg)
V1	1.12E+03	1.28E+03	4.24E+03
V2	5.99E+03	2.42E+03	8.59E+03
V3	1.52E+03	8.18E+02	4.86E+02
Average	2.88E+03	1.51E+03	4.44E+03

HUMBOLDT BAY ISFSI
ENVIRONMENTAL REPORT

TABLE 2.10-4

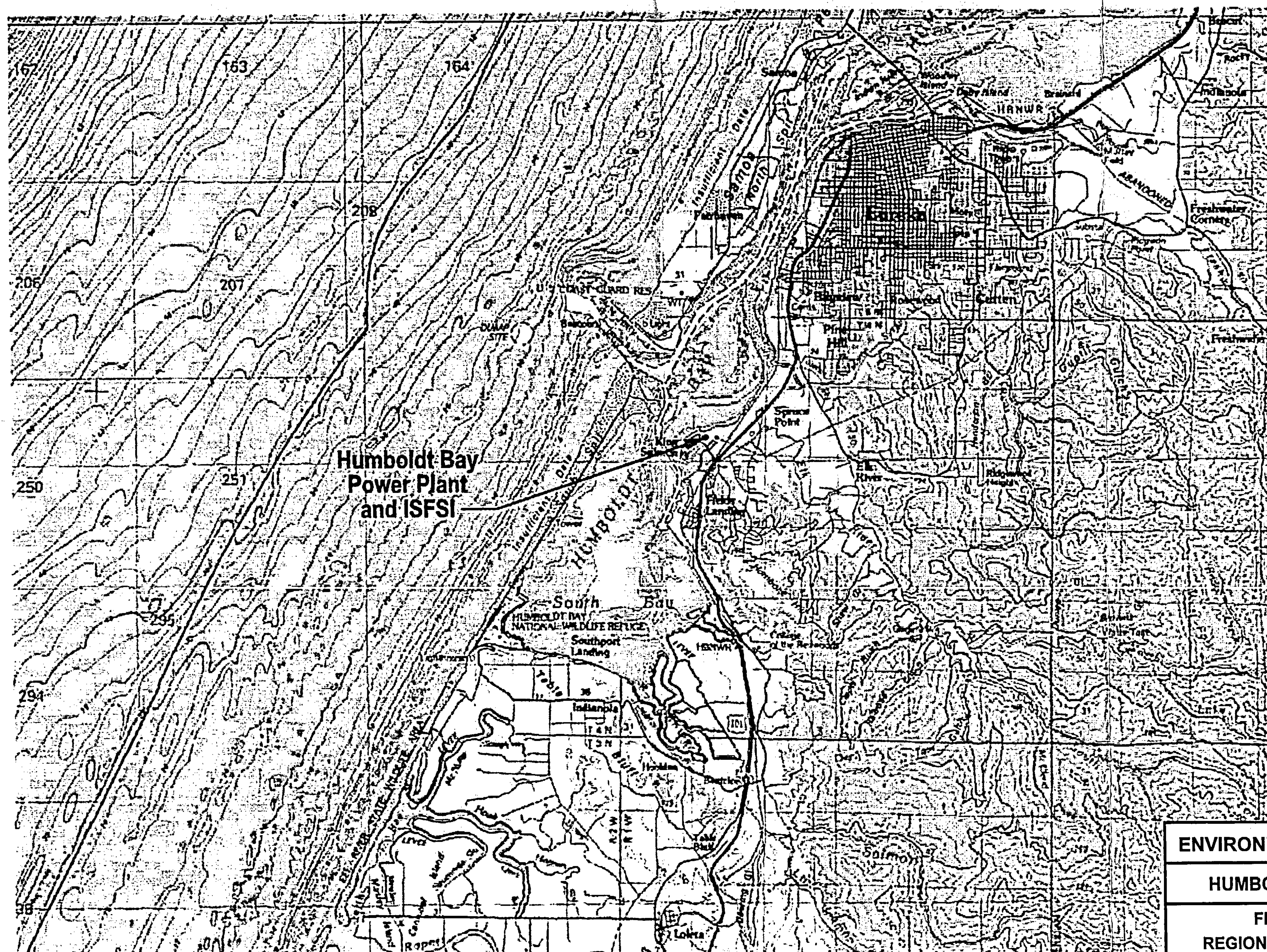
CANAL EFFLUENT COMPOSITE

	Radium-226 (pCi/liter)	**Potassium-40 (pCi/liter)**	**Tritium (pCi/liter)**
Average Concentration in Canal Effluent Composite	1.02E+02	3.05E+02	<MDA

TABLE 2.10-5

AVERAGE GROSS BETA ACTIVITY ON AIR PARTICULATE FILTERS
NOVEMBER 1999 THROUGH JULY 2000

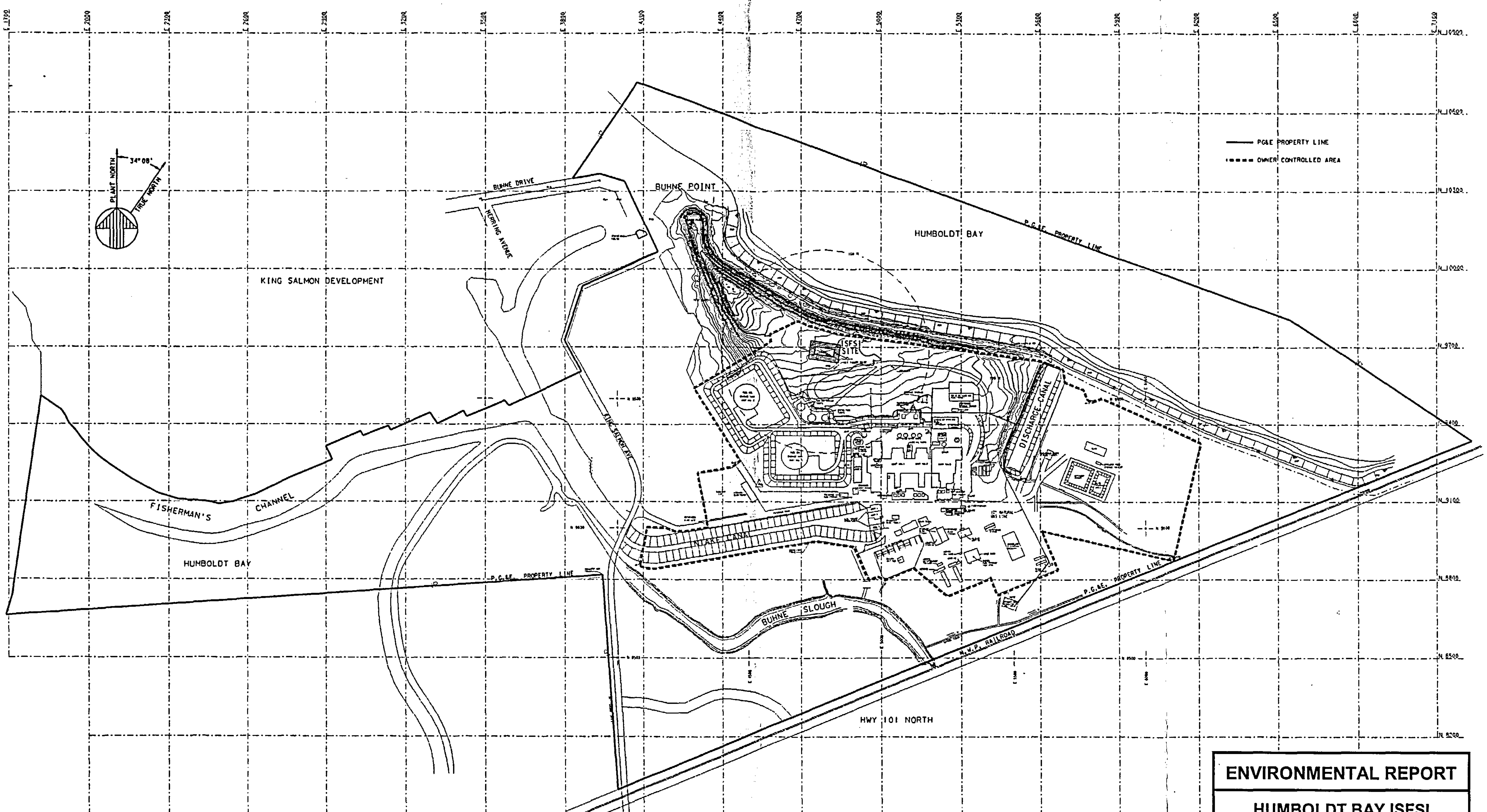
Air Sampling Station	**Average Gross Beta Concentration (pCi/m^3)**
ISFSI Station	0.006
Humboldt Hill	0.006



ENVIRONMENTAL REPORT

HUMBOLDT BAY ISFSI

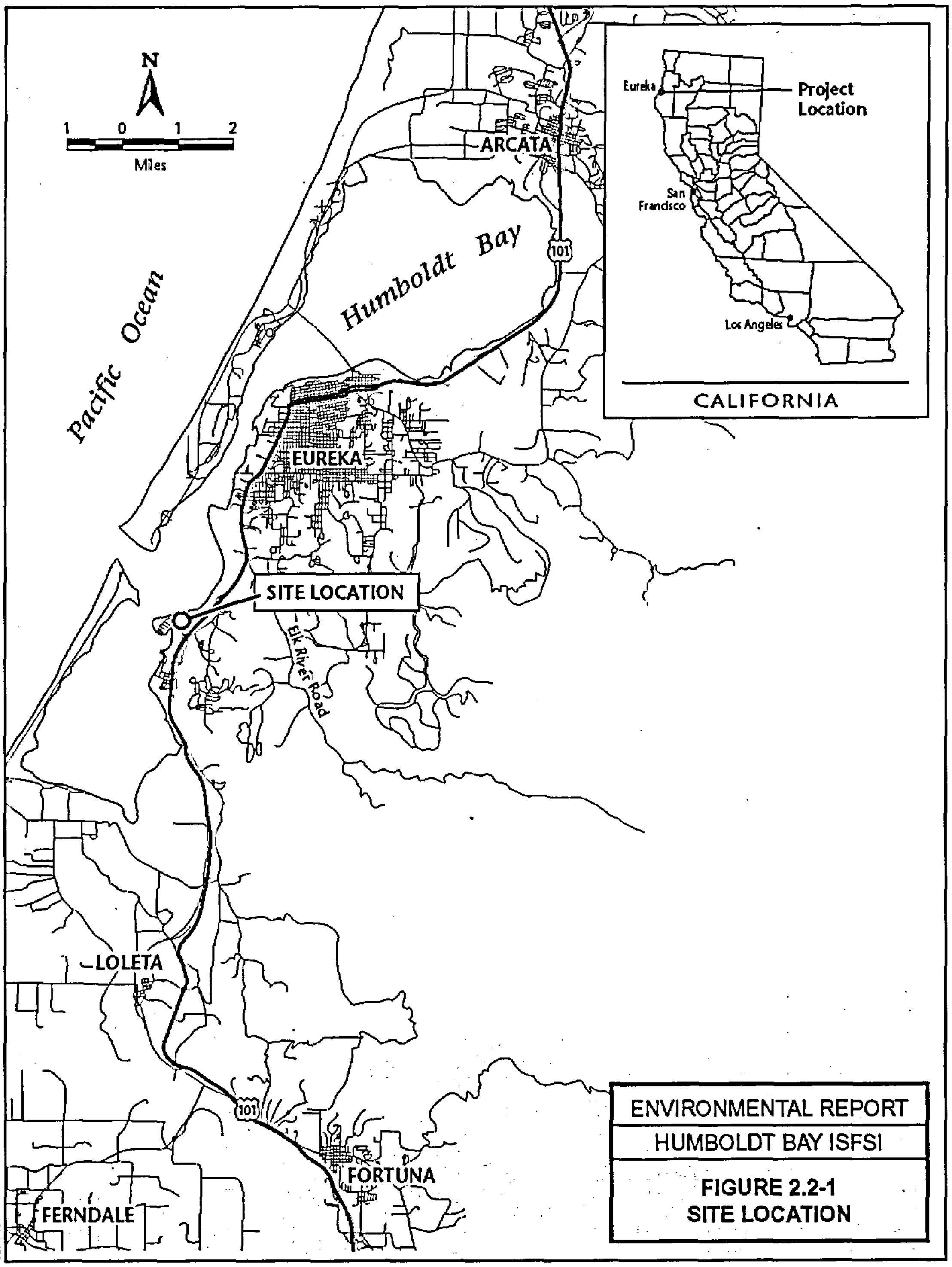
FIGURE 2.1-1
REGIONAL TOPOGRAPHY



ENVIRONMENTAL REPORT

HUMBOLDT BAY ISFSI

FIGURE 2.1-2
PROPERTY PLAN



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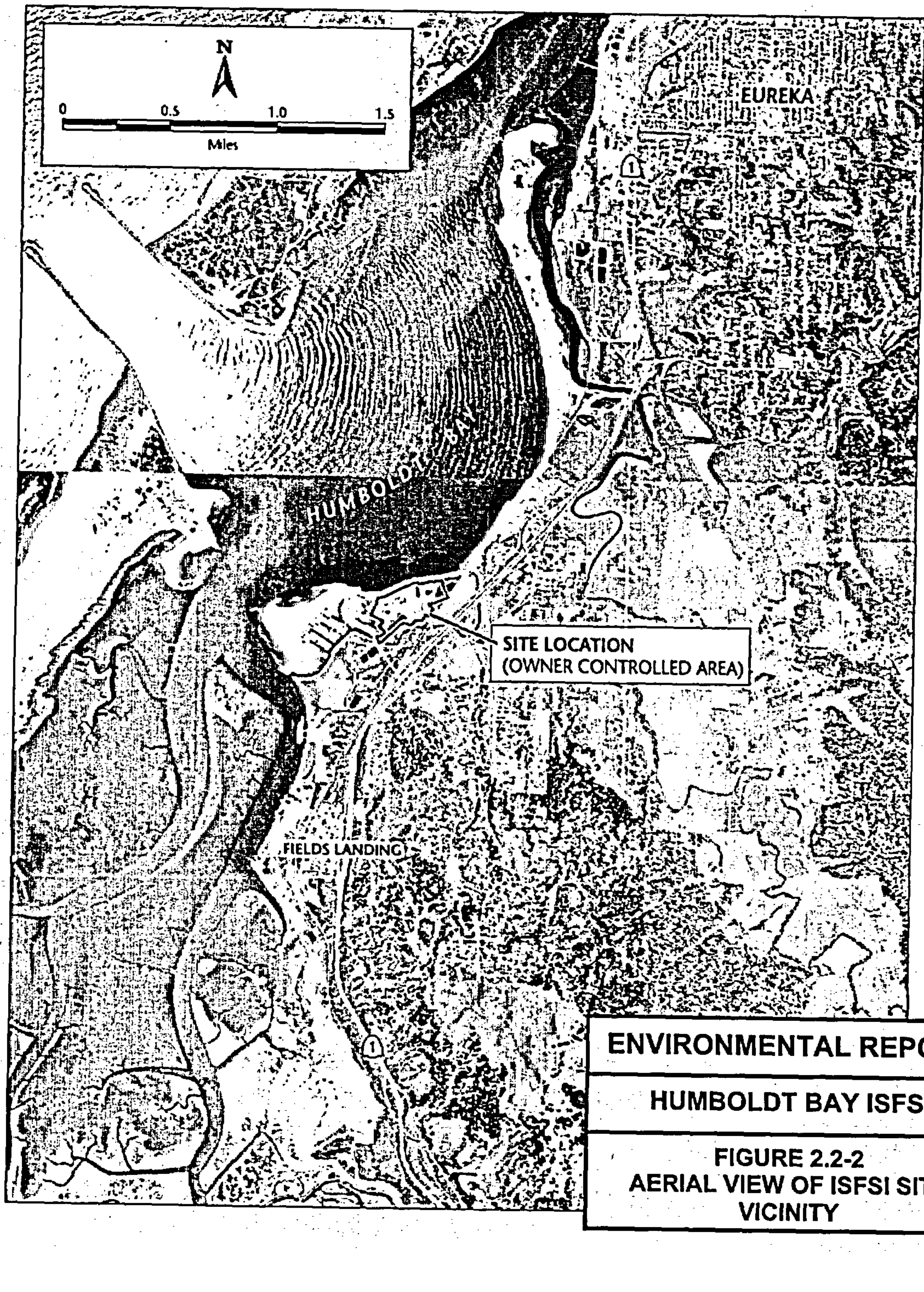
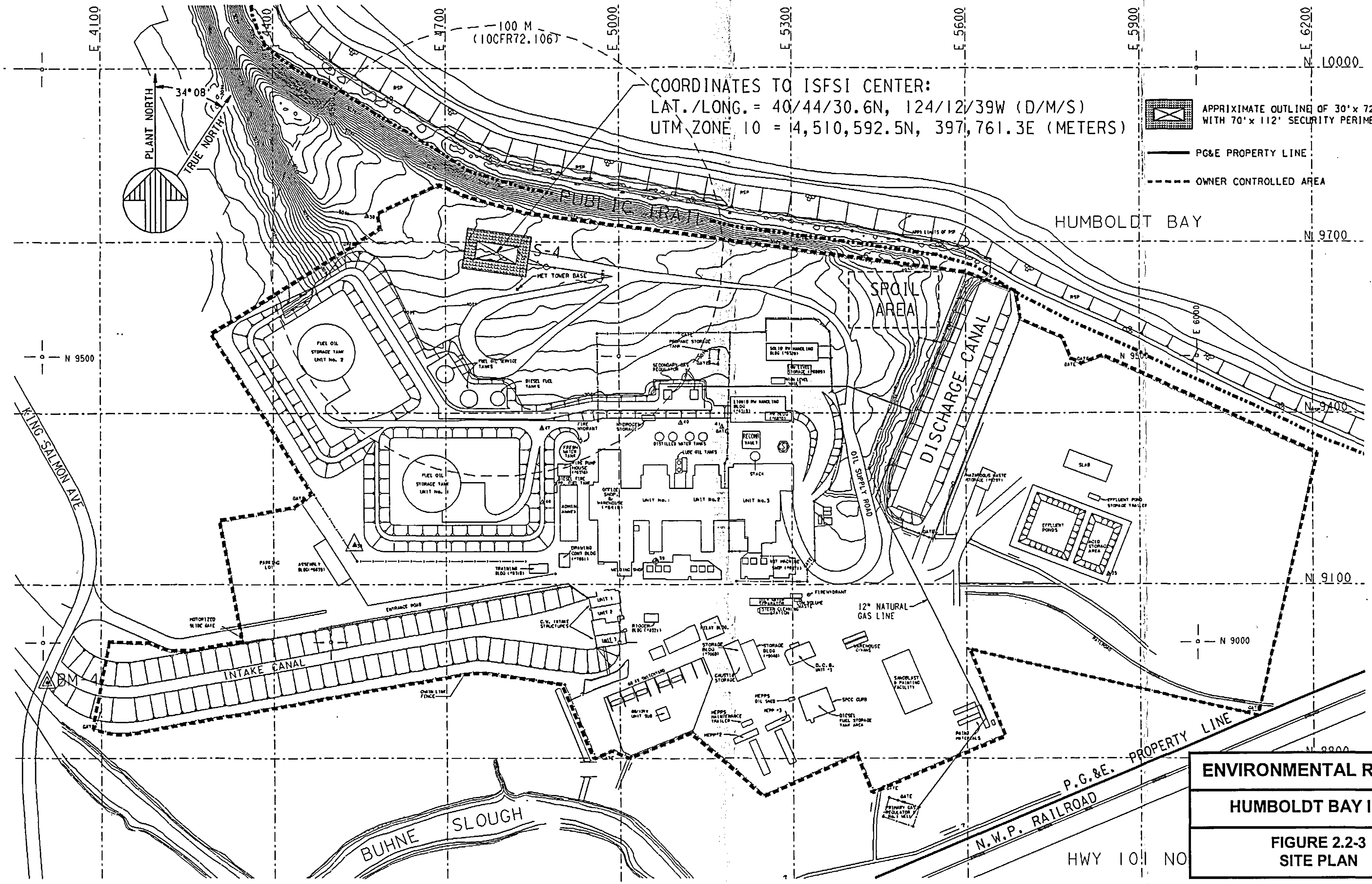
HUMBOLDT BAY ISFSI

FIGURE 2.2-1
SITE LOCATION



ENVIRONMENTAL REPORT
HUMBOLDT BAY ISFSI
FIGURE 2.2-2 AERIAL VIEW OF ISFSI SITE VICINITY



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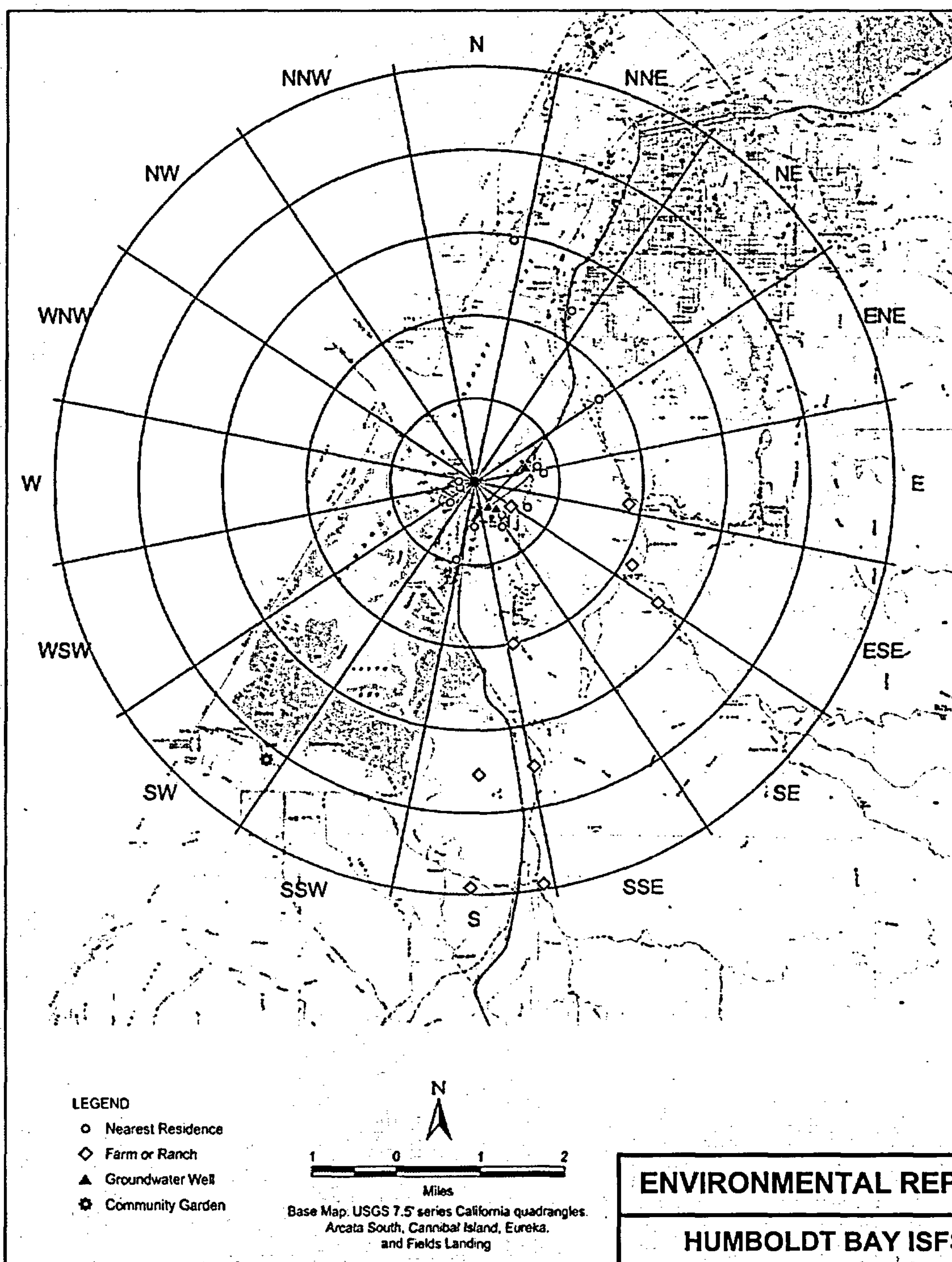
HUMBOLDT BAY ISFSI

FIGURE 2.2-3
SITE PLAN



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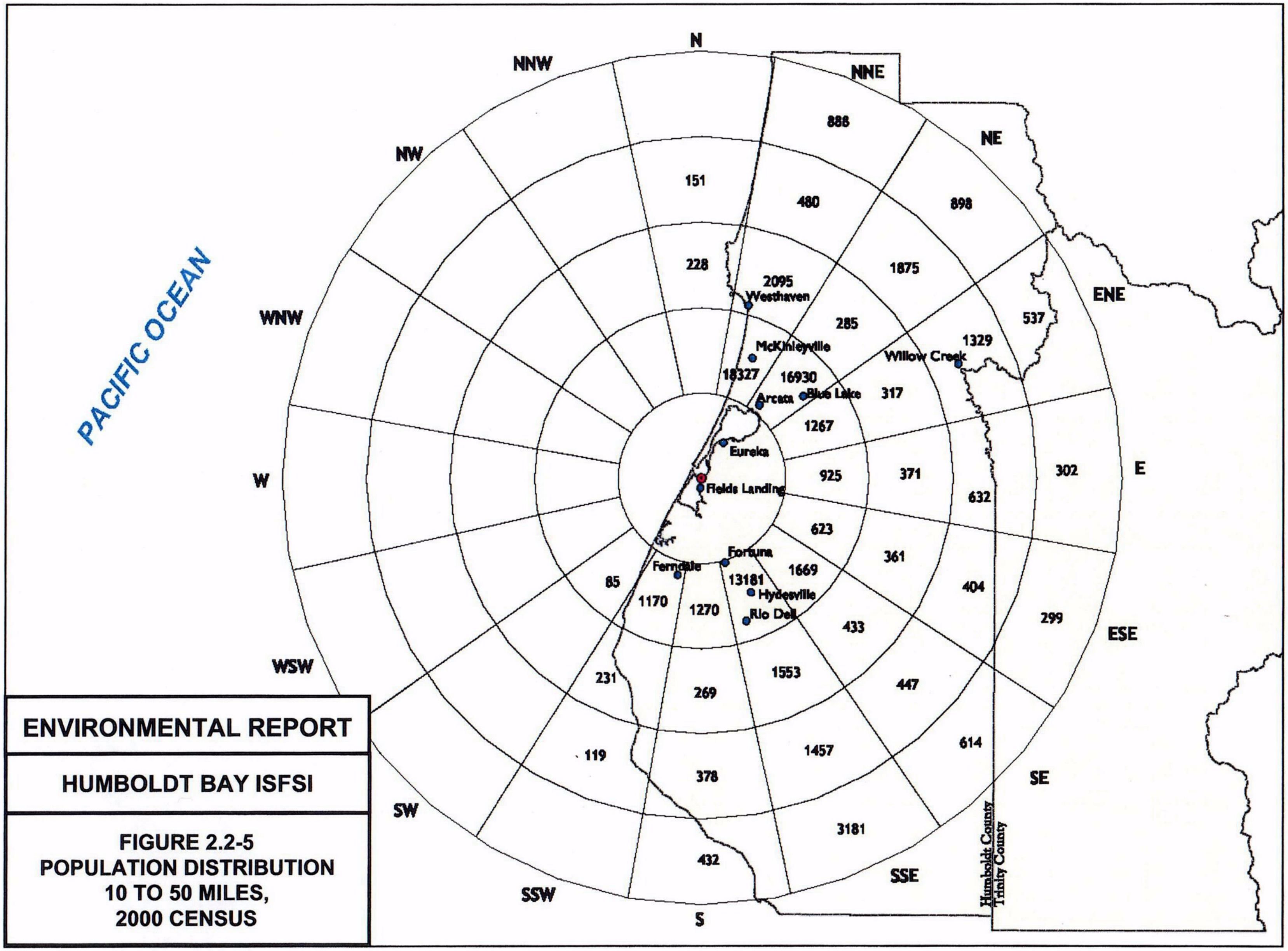
HUMBOLDT BAY ISFSI

FIGURE 2.2-4
SENSITIVE LAND USE

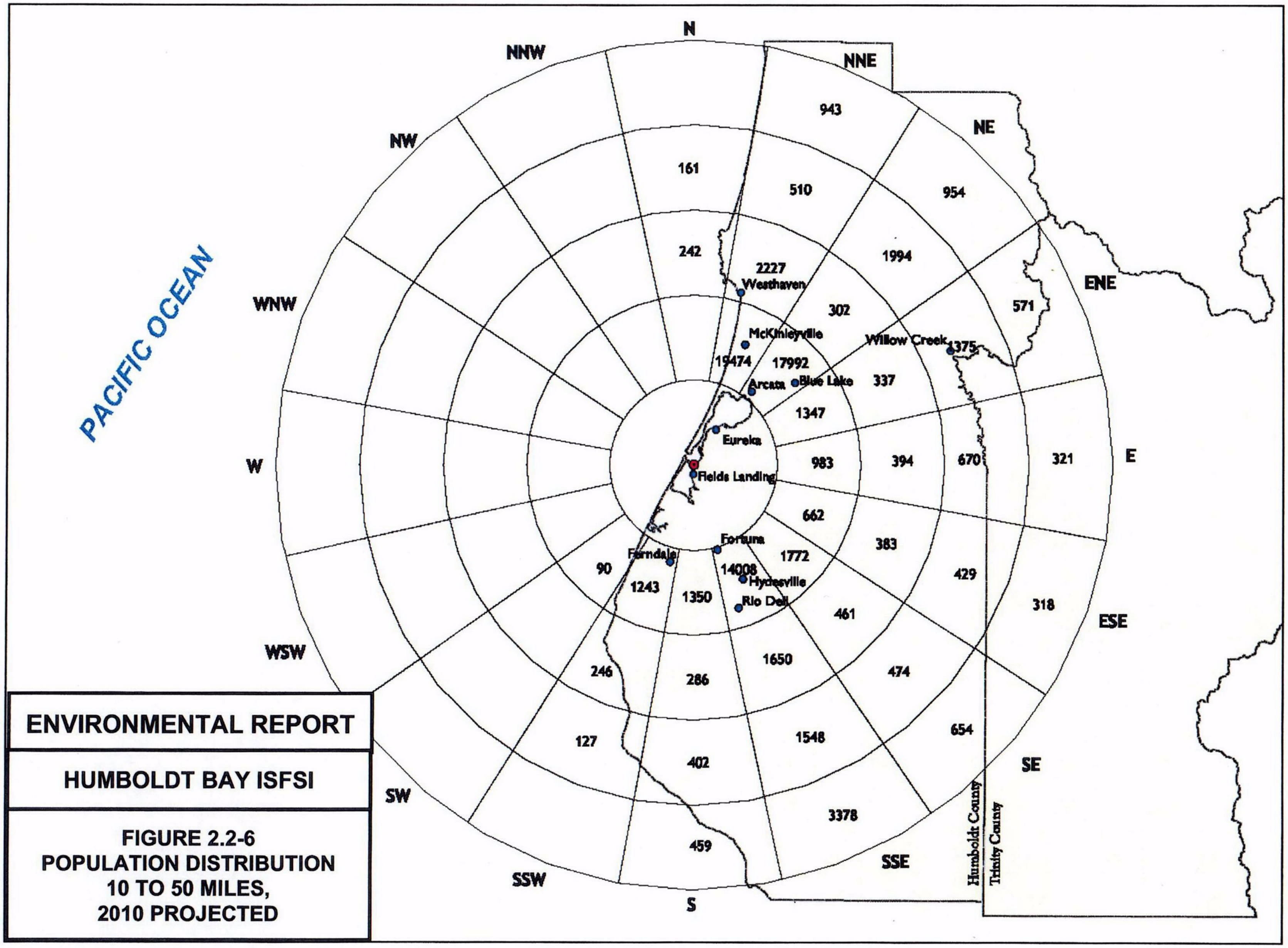


ENVIRONMENTAL REPORT

HUMBOLDT BAY ISFSI

FIGURE 2.2-5
POPULATION DISTRIBUTION
10 TO 50 MILES,
2000 CENSUS

C-01

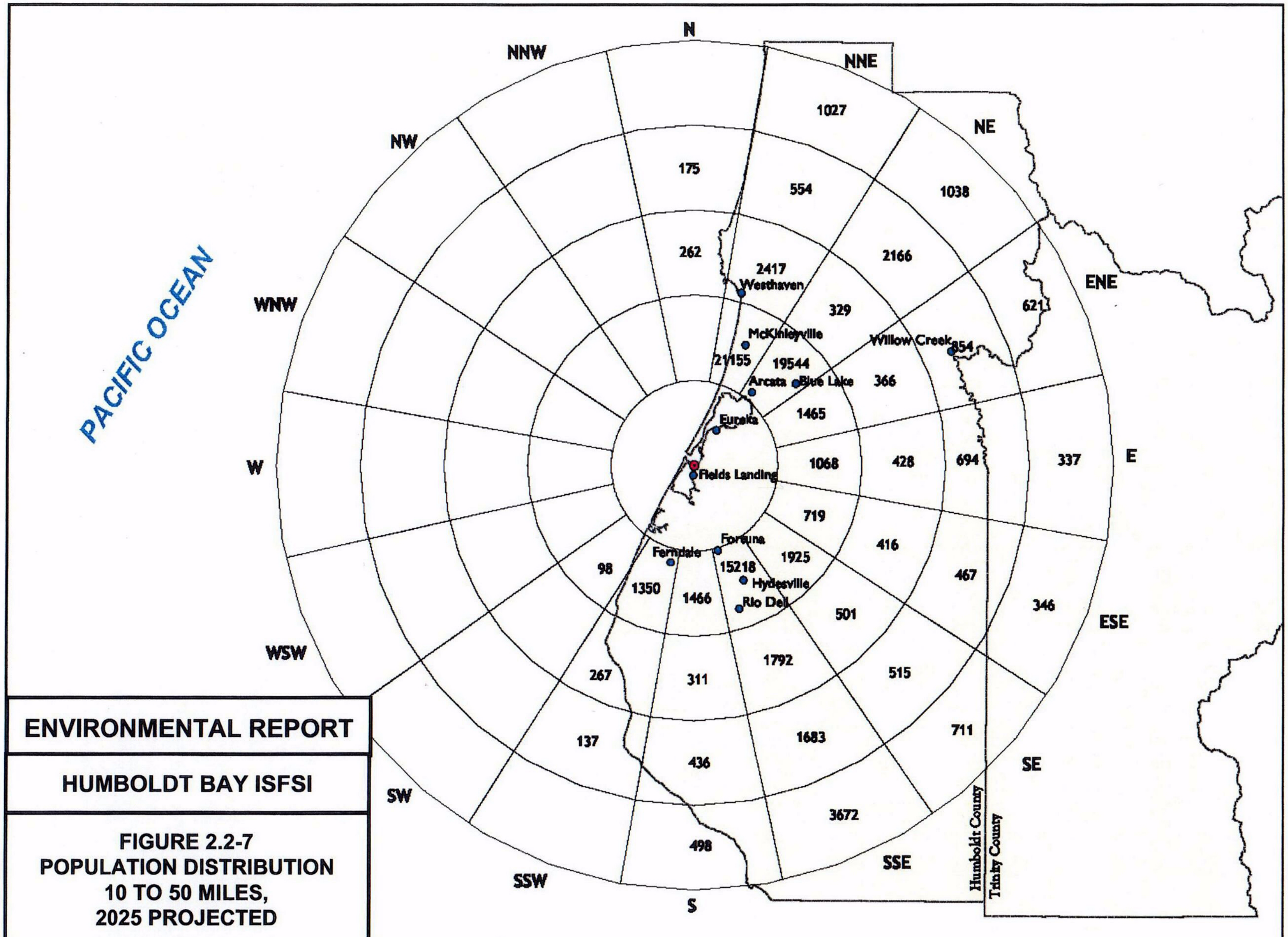


ENVIRONMENTAL REPORT

HUMBOLDT BAY ISFSI

FIGURE 2.2-6
POPULATION DISTRIBUTION
10 TO 50 MILES,
2010 PROJECTED

C-02

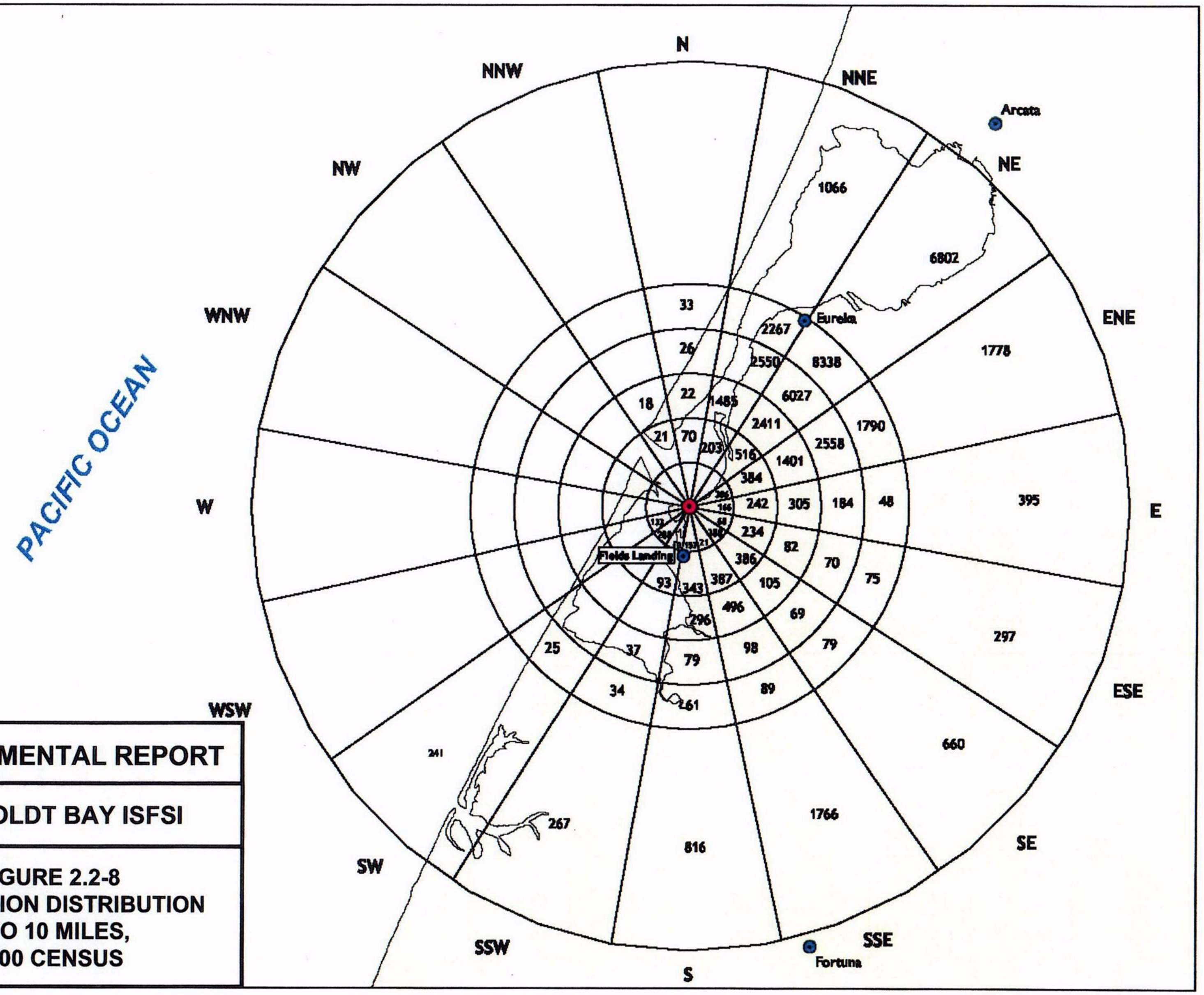


ENVIRONMENTAL REPORT

HUMBOLDT BAY ISFSI

**FIGURE 2.2-7
POPULATION DISTRIBUTION
10 TO 50 MILES,
2025 PROJECTED**

C-03

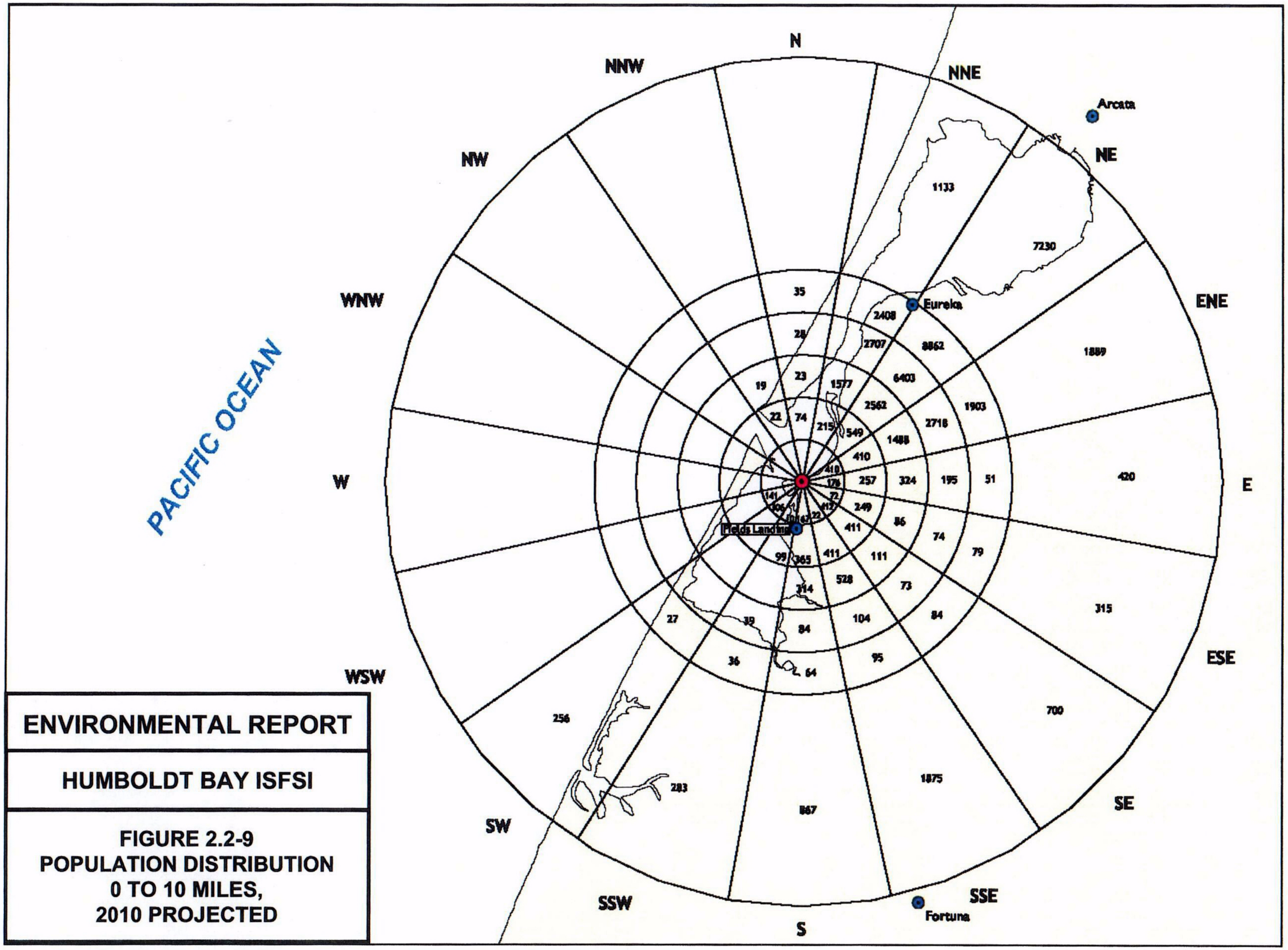


ENVIRONMENTAL REPORT

HUMBOLDT BAY ISFSI

FIGURE 2.2-8
POPULATION DISTRIBUTION
0 TO 10 MILES,
2000 CENSUS

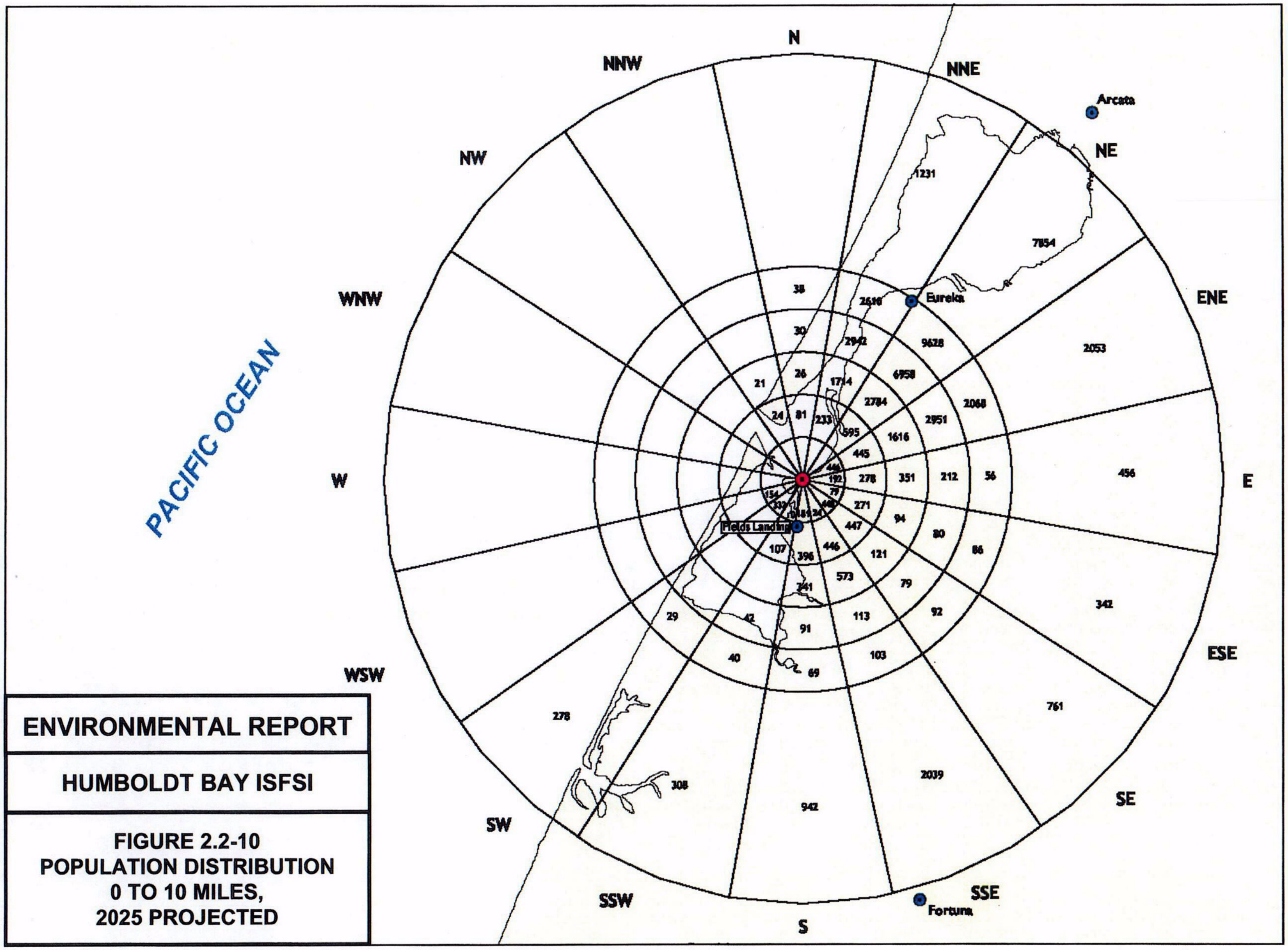
C-204



ENVIRONMENTAL REPORT

HUMBOLDT BAY ISFSI

FIGURE 2.2-9
POPULATION DISTRIBUTION
0 TO 10 MILES,
2010 PROJECTED



ENVIRONMENTAL REPORT

HUMBOLDT BAY ISFSI

FIGURE 2.2-10
POPULATION DISTRIBUTION
0 TO 10 MILES,
2025 PROJECTED