# CARLSBAD SEAWATER DESALINATION PROJECT

## SAN DIEGO REGIONAL WATER QUALITY CONTROL BOARD

## REGION 9, SAN DIEGO REGION

## ORDER NO. R-9-2006-0065

## NPDES NO. CA0109223

# FLOW, ENTRAINMENT AND IMPINGEMENT MINIMIZATION PLAN

## ATTACHMENT 4 - PROPOSAL FOR INFORMATION COLLECTION CLEAN WATER ACT SECTION 316(B), ENCINA POWER STATION, CABRILLO POWER I LLC, NPDES PERMIT NO. CA0001350, APRIL 1, 2006.

**March 27, 2009**

# PROPOSAL FOR INFORMATION COLLECTION
# CLEAN WATER ACT SECTION 316(B)

## ENCINA POWER STATION
## CABRILLO POWER I LLC

## NPDES PERMIT NO. CA0001350

**Project No. 1009704003**

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## Acronyms and Abbreviations

| | |
|---|---|
| AEL | Adult Equivalent Loss |
| AFC | Application for Certification |
| AHL | Agua Hedionda Lagoon |
| amsl | above mean sea level |
| BTA | Best Technology Available |
| CCC | California Coastal Commission |
| CDFG | California Department of Fish & Game |
| CDS | Comprehensive Demonstration Study |
| CEC | California Energy Commission |
| CEQA | California Environmental Quality Act |
| CFR | Code of Federal Regulations |
| cfs | cubic feet per second |
| CWA | Clean Water Act |
| CWIS | Cooling Water Intake Structure |
| DCTP | Design & Construction Technology Plan |
| E | entrainment |
| EAM | Equivalent Adult Model |
| EPA | Environmental Protection Agency |
| EPRI | Electric Power Research Institute |
| EPS | Encina Power Station |
| ETM | Empirical Transport Model |
| FH | Fecundity Hindcasting |
| F&WS | Fish and Wildlife Service |

## *Acronyms and Abbreviations (continued)*

| | |
|---|---|
| fps | feet per second |
| gpm | gallons per minute |
| HEA | Habitat Equivalency Analysis |
| hrs | hours |
| IM&E | Impingement Mortality and/or Entrainment |
| JWPCP | Joint Water Pollution Control Plant |
| MBC | MBC Applied Environmental Sciences |
| MGD | million gallons per day |
| mi | miles |
| min | minute |
| MLES | Marine Life Exclusion System |
| MLLW | mean lower low water |
| mm | millimeter |
| MW | megawatt |
| N | North |
| NMFS | National Marine Fisheries Service |
| NOAA | National Oceanic & Atmospheric Administration |
| NPDES | National Pollutant Discharge Elimination System |
| NRDA | National Resources Defense Council |
| O&M | Operation and Maintenance |
| OBGS | Ormond Beach Generating Station |
| PIC | Proposal for Information Collection |
| psig | pounds per square inch gauge |
| QA/QC | Quality Assurance/Quality Control |
| RP | Restoration Plan |
| SAP | sampling and analysis plan |
| SCE | Southern California Edison |
| SDG&E | San Diego Gas and Electric Company |
| SDRWQCB | San Diego Regional Water Quality Control Board |
| SGS | Scattergood Generating Station |
| TAG | Technical Advisory Group |
| TDD | Technical Development Document |
| TIOP | Technology Installation & Operation Plan |
| USFWS | U.S. Fish & Wildlife Service |
| W | West |
| $y^3$ | cubic yard |
| °F | degrees Fahrenheit |

# 1.0 Introduction

Section 316(b) of the Clean Water Act (CWA) requires that the location, design, construction, and capacity of cooling water intake structures (CWIS) reflect the best technology available (BTA) to minimize adverse environmental impacts due to the impingement (IM) of aquatic organisms (i.e., fish, shellfish, and other forms of aquatic life) on intake structures and the entrainment (E) of eggs and larvae through cooling water systems. On July 9, 2004, the U.S. Environmental Protection Agency (EPA) promulgated regulations in the Federal Register applicable to large existing power plants (Phase II facilities) that use large amounts of cooling water. These regulations, published in the Code of Federal Regulations (CFR) Chapter 40 Part 125 Subpart J, became effective on September 7, 2004.

The Phase II regulations establish performance standards for CWIS of existing power plants that withdraw more than 50 million gallons per day (MGD) of surface waters and use more than 25 percent of the withdrawn water for cooling purposes. The new rule requires all large existing power plants to reduce impingement mortality by 80 – 95 percent and to reduce the number of smaller aquatic organisms drawn through the cooling system by 60 – 90 percent. The water body type on which the facility is located, the capacity utilization rate, and the magnitude of the design intake flow relative to the waterbody flow determine whether a facility will be required to meet the performance standards for IM or both IM&E. The final rule allows these performance standards to be met through using a combination of the existing intake design, additional intake technologies, operational modifications, and using restoration measures. This approach also provides flexibility by allowing site-specific performance standards, if economic conditions do not justify the full cost of meeting the standards.

The EPA 316(b) Phase II rule requires that each affected facility develop and submit a *Proposal for Information Collection (PIC)* to the applicable permitting agency prior to implementation of data collection activities. The PIC must include the following key elements:

- A description of the proposed and/or implemented technologies, operational measures, and/or restoration measures to help develop a compliance strategy to meet the performance standards;
- A description of any historical studies characterizing IM&E and/or the physical and biological conditions in the vicinity of the CWIS and their relevance to the proposed study;
- A summary of any past or ongoing consultations with regulatory agencies and other stakeholders that are relevant to the study; and

- A sampling and analysis plan (SAP) for any new field studies needed to estimate IM&E.

This PIC serves as a study plan for a Comprehensive Demonstration Study (CDS), which provides the information to:

- Determine the baseline calculations of IM&E to be compared with performance standards;
- Evaluate combinations of technologies, operational measures and/or restoration measures, which may be implemented to meet the performance standards; and
- Evaluate whether a site-specific BTA determination is warranted and can be justified using a cost/cost or cost/benefit test.

## 1.1 Regulatory Applicability

The Encina Power Station (EPS) is located adjacent to the *Agua Hedionda Lagoon* (or AHL) on the Pacific Ocean. Because of its location near the ocean, the facility is subject to the following national performance standards (Table 1-1) for the reduction of IM&E resulting from the operation of the CWIS:

**Table 1-1**
**IM&E Performance Standards for Phase II Facilities**

| Standard | Reduction Requirement |
|---|---|
| Impingement mortality | 80 – 95% |
| Entrainment | 60 – 90% |

The EPA 316(b) Phase II rule generally requires that facilities subject to the rule submit the CDS with the application for renewal of the National Pollutant Discharge Elimination System (NPDES) permit. Facilities with NPDES permits expiring prior to July 9, 2008 may request an extension for submittal of the CDS no later than January 7, 2008. The current EPS NPDES permit has expired on February 5, 2005. A timely application for renewal was submitted to the San Diego Regional Water Quality Control Board (SDRWQCB) on June 23, 2004. The EPS has submitted a letter to the SDRWQCB on January 6, 2005 requesting the following schedule for submittal of the two reports required under the EPA 316(b) Phase II Rule:

- Proposal for Information Collection – submittal due April 1, 2006
- Comprehensive Demonstration Study – submittal due January 7, 2008

## 1.2 Purpose

The purpose of this document is to meet or exceed the requirement for the preparation and submittal of the PIC in accordance with 40 CFR 125.95(b)(1). This Plan is being submitted for agency review and comment in advance of implementation. However, information collection activities may be initiated prior to receipt of agency comments.

## 2.0 Facility Description

The EPS has been owned and operated by Cabrillo Power I LLC (Cabrillo) since May 22, 1999. The power plant was previously owned by San Diego Gas and Electric Company (SDG&E).

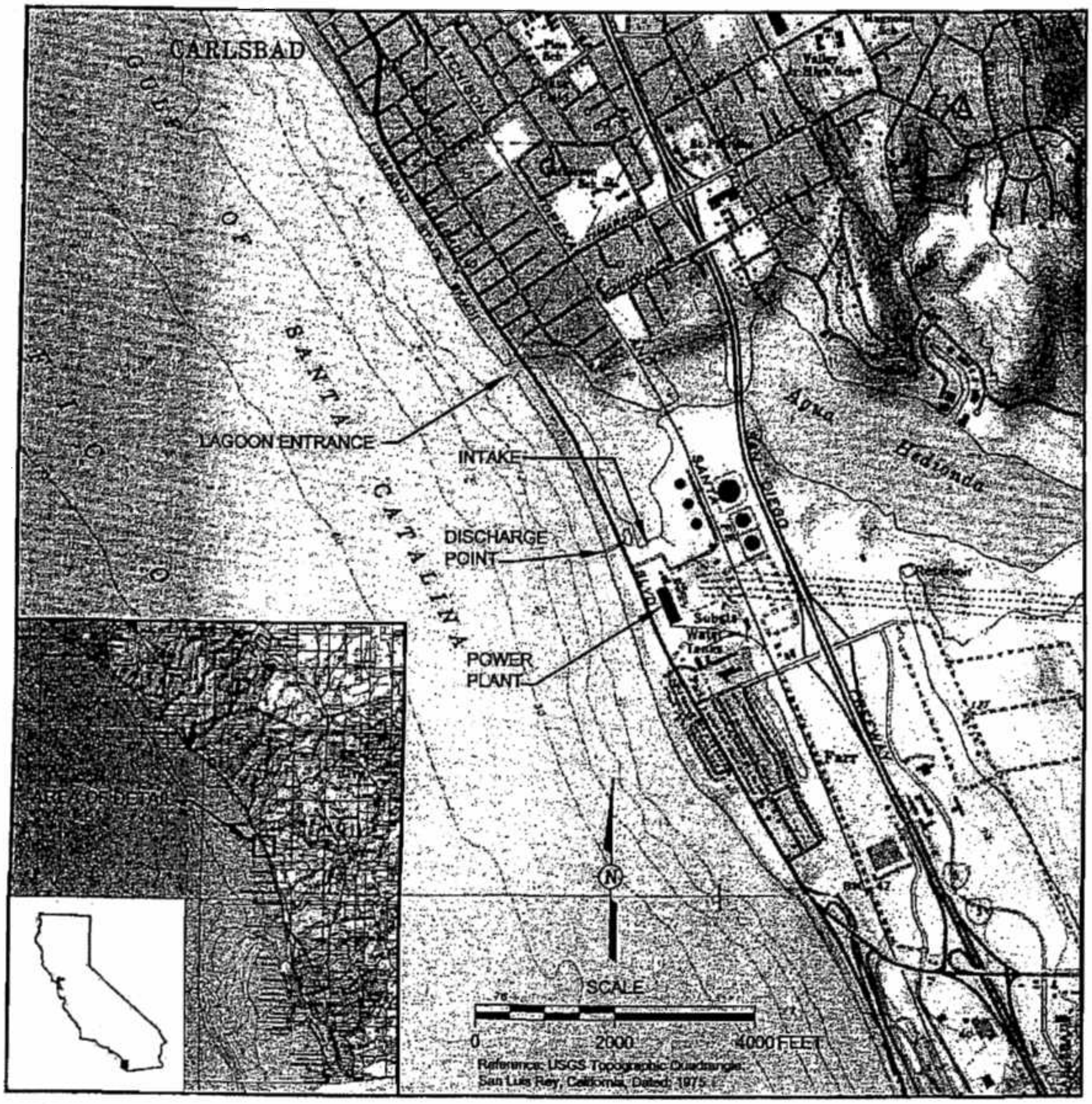
The EPS is a fossil-fueled steam electric power generating station that began operation in 1954. Thermal energy provided by the combustion of the fossil-fuels is used to generate steam to drive five steam turbine generators. The plant also has one air-cooled gas turbine generator achieving a combined nominal thermal energy output capacity for the plant of 939 megawatts. Waste heat generated at EPS is discharged to the Pacific Ocean. The combined cooling and service water design flow is 857.29 MGD.

Cooling water is withdrawn from the Pacific Ocean via the AHL. The cooling water intake structure complex is located approximately 2200 feet from the ocean inlet to the lagoon. Variations in the water surface due to tide range from a low of –3.52 feet to a high of +4.79 feet [elevation "0" being mean sea level, (msl)], based on measurements made by Coastal Environments (2005). The intake structure is located in the lagoon, in front of the generating units.

### 2.1 Facility Location

The EPS is located at 4600 Carlsbad Boulevard, in the southwest area of the City of Carlsbad, California, adjacent to the AHL on the Pacific Ocean in Section 18, Township 12 South, Range 4 West of the San Bernardino Baseline Meridian. Figure 2-1 depicts the location of the facility and the location of the cooling water intake and discharge points relative to the shoreline.

**Figure 2-1**
**Encina Power Station Location Map**




## 2.2 Source Water Body Description

The environmental setting of AHL, the primary source water body for the EPS, is discussed in detail in Bradshaw et al (1976), SDG&E (1980), and summarized in EA Engineering, Science and Technology (1997). The following is a description of the physical and ecological characteristics of the AHL, on which the EPS is located.

### 2.2.1 *Physical Characteristics*

Agua Hedionda is the third largest watershed within the Carlsbad Hydrologic Unit. The watershed, dominated by Agua Hedionda Creek, extends approximately 10.62 miles (mi) inland from the coast and is about 18,837 acres in area, comprising 14 percent of the Carlsbad Hydrologic Unit. Agua Hedionda Creek originates on the southwestern slopes of the San Marcos Mountains in west central San Diego County and discharges into the Pacific Ocean via AHL. The highest elevation within the watershed is 1,500 feet above mean sea level (amsl), located in the San Marcos Mountains.

The EPS is located on the AHL, which is a man-enhanced coastal lagoon that extends 1.7 mi inland and is up to 0.5 mi wide. The lagoon is located along the Pacific Coast in San Diego County approximately 26 mi north of the City of San Diego. The lagoon was constructed in 1954 to provide cooling water for the power plant. The construction enhancement involved a permanent opening of the connection of the lagoon with the ocean. Prior to this, the lagoon was ephemerally connected to the ocean when creek flows were high. A railroad trestle and the Interstate Highway 5 bridge separate AHL into three interconnected segments: an Outer, Middle, and Inner lagoon. The surface areas of the Outer, Middle, and Inner lagoons are 53, 24, and 190 acres, respectively based on measurements made by Coastal Environments (2005). The lagoon is separated from the ocean by Carlsbad Boulevard and a narrow inlet 151 feet wide and 9 feet deep at the northwest end of the Outer Lagoon that passes under the highway and allows tidal exchange of water with the ocean.

Circulation and input into AHL is dominated by semi-diurnal tides that bring approximately 1,454 acre feet of seawater through the entrance to the Outer Lagoon on flood tides based on measurements made by Coastal Environments (2005). Approximately half of this tidal volume flows into the Middle and Inner lagoons. On ebb tides this same tidal volume flows out through the entrance to the ocean. As a result of this tidal flushing, the lagoon is largely a marine environment. Although freshwater can enter the lagoon through Agua Hedionda Creek, which drains an 18,500 acre watershed, for most of the year freshwater flow is minimal. Heavy rainfall in the winter can increase freshwater flows, reducing salinity, especially in the Inner Lagoon. The lagoon system is kept open to the ocean by routine dredging of the Outer Lagoon and the channel to the ocean.

Bottom sediments in the lagoon reflect the speed and location of the periodic tidal currents. The Outer Lagoon sediments consist of coarser gravel and sands in areas of highest current velocities. The Middle Lagoon consists of an inter-tidal zone largely comprised of mud. The largest water body segment, the Inner Lagoon, consists of mostly finer sands, silt, and clay with organic detritus, especially at the far eastern end of the lagoon. Some narrow sand beaches and rock rip-rap substrate are also present in the Inner Lagoon.

AHL is tidally flushed through the small inlet in the Outer Lagoon by waters from the Pacific Ocean. The physical oceanographic processes of the southern California Bight that influence the lagoon includes, the tides, currents, winds, swell, temperature, dissolved oxygen, salinity, nutrients. These are most affected by the daily tidal exchange of coastal seawater. Near the mouth of the lagoon the mean tide range is 3.7 feet with a diurnal range of 5.3 feet. Waves breaking on the shore generally range in height from 2 to 4 feet, although larger waves (6 to 10 feet) are not uncommon. Larger waves exceeding 15 feet occur infrequently and are usually associated with winter storms. Surface water in the local area ranges from a minimum of 57 degrees Fahrenheit (°F) to a maximum of 72°F with an average annual temperature between 63°F and 66°F.

### 2.2.2 Agua Hedionda Lagoon Ecological Characteristics

The AHL is listed by the State of California as a Section 303(d) impaired waterbody largely due to sedimentation/siltation and coliform contamination resulting from multiple non-point source discharges in Agua Hedionda watershed. Sedimentation of the lagoon can occur both from sediment flows within the watershed and from tidal flows from the Pacific Ocean. The bacterial contamination is likely from multiple sources within the watershed.

In November of 2000, the U. S. Fish and Wildlife Service (F&WS), under the Endangered Species Act of 1973, as amended, designated AHL as critical habitat for the tidewater goby (*Eucyclogobius newberryi*), a federally listed endangered species. However, no tidewater gobies have been observed in the AHL since the 1950's when the lagoon was originally dredged as the power plant cooling water source and the lagoon is no longer viable habitat for the species. Based on that fact, Cabrillo Power I LLC filed for declaratory and injunctive relief in federal district court on August 31, 2001, against the F&WS for failing to base the AHL and Creek critical habitat designation on best scientific data and failing to analyze the economic and other impacts of the designation. On February 28, 2003, based upon a stipulated settlement, the United States District Court ordered that the tidewater goby critical habitat designation for AHL and Creek be vacated without prejudice.

Land use within the watershed is dominated by urban development. Natural habitats are scattered and occur in a matrix of agricultural and urban development, however, several relatively large patches of native vegetation occur in the eastern portion of the watershed and in the central area just inland from AHL.

A study on the ecological resources of Agua Hedionda showed that it has good water quality and supports diverse benthic infauna, bird, and fish communities (MEC Analytical 1995). Eelgrass was found in all three lagoon segments, but was limited in the Inner Lagoon to depths above approximately –6.5 feet mean lower low water (MLLW) because water turbidity reduced penetration of light for photosynthesis in deeper areas. The eelgrass beds provide a valuable habitat for benthic organisms that are fed upon by birds and fishes. Although eelgrass beds were less well developed in areas of the Inner Lagoon, it was found to provide a wider range of habitats, including mud flats, salt marsh, and seasonal ponds than elsewhere in Aqua Hedionda. As a result, bird and fish diversity was highest in the Inner Lagoon.

A total of 35 species of fishes was found during the 1994 and 1995 sampling conducted by MEC (MEC Analytical 1995). The Middle and Inner lagoons had more species and higher abundances than the Outer Lagoon. During the 1995 survey, only four species were collected in the Outer Lagoon, compared to 14 to 18 species in the Middle and Inner lagoons. Silversides (Atherinopsidae) and gobies (Gobiidae) were the most abundant fishes collected. Silversides, including jacksmelt and topsmelt, that occur in large schools in shallow waters where water temperatures are warmest were most abundant in the shallower Middle and Inner lagoons. Gobies were most abundant in the Inner Lagoon, which has large shallow mudflat areas that are their preferred habitat.

An impingement and entrainment study was conducted at EPS in 1979-1980 (SDG&E 1980). In the impingement study, fishes and invertebrates were collected and quantified from the traveling screens and bar rack system of the power plant. Seventy-six species of fishes, 45 species of macroinvertebrates, and 7 species of algae and marine plants were impinged. There were also seven thermal treatments (intake tunnel heat shock treatments) sampled during the year and 90 percent of the fishes collected consisted of nine species: deepbody anchovy, topsmelt, northern anchovy, shiner surfperch, California grunion, walleye surfperch, queenfish, round stingray, and giant kelpfish.

The recent assessment of the ecological resources of Agua Hedionda (MEC Analytical 1995) did not find any tidewater gobies (*Eucyclogobius newberryi*). This federally endangered species was once recorded as occurring in the lagoon prior to construction of the Outer Lagoon in the early 1950s. The present marine-influenced environment in the lagoon would not tend to support tidewater gobies because they prefer brackish water habitats. No listed fish species were collected in the recent study.

### 2.2.3 Pacific Ocean Ecological Resources

The outer coast has a diversity of marine habitats and includes zones of intertidal sandy beach, subtidal sandy bottom, rocky shore, subtidal cobblestone, subtidal mudstone and water column. Organisms typical of sandy beaches include polychaetes, sand crabs, isopods, amphipods, and clams. California grunion utilize the beaches around EPS during spawning season from March through August. Numerous infaunal species occur in subtidal sandy bottoms with mollusks, polychaetes, arthropods, and echinoderms comprising the dominant invertebrate fauna. Typical fishes in the sandy subtidal include queenfish, white croaker, several surfperch species, speckled sanddab, and California halibut. Also, California spiny lobster and *Cancer* spp. crabs forage over the sand. Many of the typically outer coast species can occasionally occur within AHL, carried by incoming tidal currents.

The rocky habitat at the discharge canal and on offshore reefs supports various kelps and invertebrates including barnacles, snails, sea stars, limpets, sea urchins, sea anemones, and mussels. Giant kelp (*Macrocystis*) forests are an important community in the area offshore from Agua Hedionda. Kelp beds provide habitat for a wide variety of invertebrates and fishes. The water column and kelp beds are known to support many fish species, including northern anchovy, jack smelt, queenfish, white croaker, garibaldi, rockfishes, kelp bass, white seabass, surfperches, and halibut.

Marine-associated wildlife that occur in the Pacific waters off AHL are numerous and include birds such as brown pelican, surf scoter, cormorants, western grebe, gulls, terns and loons. Marine mammals, including porpoise, sea lions, and migratory gray whales, also frequent the adjacent coastal area.

## 2.3 Cooling Water Intake Structure Design

Cooling water is withdrawn from the Pacific Ocean via the AHL. The CWIS complex is located approximately 2,200 feet from the ocean inlet to the lagoon. The intake structure is located on the lagoon, to the north of the generating units as shown on Figure A-1 included in Appendix A.

As the water flows into the intake structure, it passes through trash racks made up of metal bars spaced about 3½ inches apart, which prevent passage of large debris into the intake. The trash rack inlet structure is shown on Figure A-2 included in Appendix A. The intake downstream of the trash rack tapers into two, 12-foot wide intake tunnels. From these tunnels, the cooling water enters four six-foot wide conveyance tunnels. Cooling water for conveyance tunnels 1 and 2 passes through one of two vertical traveling screens to prevent fish, grass, kelp, and debris from entering pump intakes for generating units 1, 2, and 3.

Conveyance tunnels 3 and 4 carry cooling water to the intakes for generating units 4 and 5, respectively. Traveling water screens are located at the intake of pump 4 and the intake of pump 5. A detailed plan layout of the entire tunnel system is shown on Figure A-1 included in Appendix A.

Each cooling water intake consists of two circulating water pumps and one or two service pumps. During normal operation, one circulating water pump serves each half of the condenser, so when a unit is generating power, both pumps are in operation.

There are a total of seven traveling screens that remove any debris which has passed through the trash racks. Two screens service the combined flows of generating Units 1, 2, and 3. Unit 4 has two traveling water screens, while Unit 5 has three traveling water screens. The screens are conventional through-flow, vertically rotating, single entry, band-type screens, mounted in the screen wells of the intake channels. Each screen consists of a series of baskets or screen panels attached to a chain drive. Since the screens are designed to prevent the passage of particles large enough to clog the condenser tubes, the screening surface is made of 3/8-inch meshed stainless steel wire, with the exception of Unit 5 screens, which have 5/8-inch square openings. Cooling water passes through the wire mesh screening surface and floating or suspended matter is retained on the screens. The screens rotate automatically when the debris buildup causes a predetermined pressure differential across the screen (or the difference in sea water level before and after the screen increases to a set level). As the screens revolve, the material is lifted from the front of the intake screenwell by the upward travel of the baskets. The screens travel 3 feet per minute, making one complete revolution in about 20 minutes. A screen wash system in the traveling screen structure provides water (sea water from the intake tunnel) to wash the debris from the traveling screen. At the head of the screen, matter is removed from the baskets by a spray of water, which is evenly distributed over the entire basket width. The jet spray washes the accumulated material into a trough and the trough conveys the debris into debris collection baskets. Accumulated organic debris is discharged to the outfall structure.

Characteristics and specifications of the CWIS are presented in Table 2-1.

**Table 2-1**
**Design Characteristics of EPS Cooling Water Intake Structure**

| | Unit 1 | Unit 2 | Unit 3 | Unit 4 | Unit 5 |
|---|---|---|---|---|---|
| Latitude | 33° 08' 16" N | 33° 08' 16" N | 33° 08' 16" N | 33° 08' 16" N | 33° 08' 16" N |
| Longitude | 117° 20' 16" W | 117° 20' 16" W | 117° 20' 16" W | 117° 20' 16" W | 117° 20' 16" W |
| Number of circulating water pumps | 2 | 2 | 2 | 2 | 2 |
| Pump capacity (per pump) | 24,000 gpm | 24,000 gpm | 24,000 gpm | 100,000 gpm | 104,000 gpm |
| Service water | 3000 gpm | 3000 gpm | 6000 gpm | 13,000 gpm | 18,200 gpm |
| Trash bar opening | 3 ½ inch | 3 ½ inch | 3 ½ inch | 3 ½ inch | 3 ½ inch |
| Number of traveling water screens | 2 (shared) | 2 (shared) | 2 (shared) | 2 | 3 |
| Screen type | Standard through flow | Standard through flow | Standard through flow | Standard through flow | Standard through flow |
| Screen mesh opening | 3/8 inch | 3/8 inch | 3/8 inch | 3/8 inch | 5/8 inch |
| Screen height (in water, high tide) | 24.8 feet | 24.8 feet | 24.8 feet | 24.8 feet | 24.8 feet |
| Approach velocity (low tide) | 1.2 fps | 1.2 fps | 1.2 fps | 1.6 fps | 1.1 fps |
| Through-screen velocity (low tide) | 2.1 fps | 2.1 fps | 2.1 fps | 2.9 fps | 2.0 fps |
| Screen rotation | Automatic on ΔP | Automatic on ΔP | Automatic on ΔP | Automatic on ΔP | Automatic on ΔP |
| Screen wash pressure | 70 psig | 70 psig | 70 psig | 70 psig | 70 psig |

## *2.4 Cooling Water Intake Structure Operation*

During normal operation, one circulating water pump serves each half of the condenser, so when a unit is generating power, both pumps are in operation.

Traveling water screens normally are set on automatic, starting up when the differential pressure across the screen exceeds the set point. At the beginning of each work shift (0600, 1800), the screens are turned on and the automatic start is checked to ascertain that the screens are functioning properly.

The plant produces its own sodium hypochlorite electrolytically from seawater for use in chlorination of the cooling water system. A bromide additive (sodium bromide), which reacts with chlorine to form hypobromous acid, and a bio-dispersant are also used with the sodium hypochlorite as enhancers.

The treatment solution is injected to the channel immediately upstream of the once-through cooling water and saltwater service pump suctions for each unit. Each injection point is individually controlled. Chlorination is conducted for about five minutes per hour per unit on a timed cycle each day. This method of chlorination results in a minimal chlorine residual in the cooling water being discharged to the ocean.

The intake tunnels are thermally treated (tunnel re-circulation) approximately every five weeks. Encrusting organisms in the early stages of development are small enough to pass through the trash racks and screens and enter the intake tunnels, attach themselves to the tunnel walls, traveling water screens, and other parts of the cooling-water system. If not removed, the encrusting organisms grow and accumulate at a rate of approximately 1000 $yd^3$ over a six-month period. These accumulations restrict the flow of cooling water to and through the condensers, causing a rise in the condenser operating temperature and the temperature of the discharged circulating water. A thermal tunnel re-circulation treatment process prevents encrusting organisms from developing to any significant size or quantity. The treatment causes the encrusting organisms to release from the surfaces and wash through the condensers to the ocean with the circulating water discharge, reducing the need for maintenance outages for normal cleaning of the circulating water inlet tunnels and condensers. This practice also helps to maintain the lowest possible temperature rise across the condensers, thereby improving plant efficiency and reducing thermal load to the ocean.

Thermal treatment is performed by restricting the flow of cooling water from the lagoon and re-circulating the condenser discharge water through the conveyance tunnels and condensers until an inlet water temperature of approximately 105°F is attained. Maintaining a temperature of 105°F in the intake tunnels for approximately two hours has proven to be effective in removing encrusting organisms. The total time required for the thermal treatment operation, including temperature buildup and cool down, is approximately six hours.

## 2.5 Calculation Baseline

EPA, in its 316(b) Phase II rule for existing facilities, requires reductions in IM&E when compared against a "calculation baseline." This calculation baseline is the level of IM&E that would occur if the CWIS were designed with the following characteristics:

- Once-through cooling system;
- Opening of CWIS located at, and the face of the traveling screens is oriented parallel to, the shoreline near the surface of the source waterbody;

- Conventional traveling screens with 3/8 inch mesh; and
- No structural or operational controls to reduce IM&E.

The EPS intake system is equivalent in terms of entrainment of aquatic organisms and impingement of organisms on screens to the baseline shoreline intake with no fish protection features defined by the Environmental Protection Agency in the new Section 316(b) Phase II Existing Facilities Rule (National Pollutant Discharge Elimination System-Final Regulations). The EPS CWIS design has a few deviations from these baseline conditions. The traveling water screens on Unit 5 have 5/8" screens and each of the 7 sets of traveling water screens are set well back from the shoreline of the lagoon. The recent IM&E study performed at the EPS will provide the necessary information for determining a representative calculation baseline for the station.

# 3.0 Historical Studies

EPA Phase II 316(b) regulations [40 CFR 125.95(b)(1)(ii)] require that the PIC includes a list and description of any historical studies characterizing IM&E, as well as physical and biological conditions in the vicinity of the facility CWIS. The following sections provide a summary of previous entrainment and impingement studies conducted at the EPS and within AHL.

The following sections also present a discussion of the relevance of the data to the current conditions and the IM&E studies at the EPS.

## 3.1 EPS Impingement Mortality and Entrainment Characterization Studies

The following sections summarize previous IM&E characterization studies performed at the EPS.

### 3.1.1 1980 EPS 316(b) Demonstration

In 1980, SDG&E owned and operated the EPS (SDG&E, 1980). A 316(b) demonstration was conducted for the facility (SDG&E 1980) as required at the time by the SDRWQCB. The study included descriptions of the facility, descriptions of the physical and biological environment of AHL and surroundings, studies of entrainment, impingement, and entrainment survival at the plant, and an environmental impact assessment that also evaluated the feasibility of alternative intake technologies to reduce IM&E.

A list of taxa ("critical species") that included 16 fishes, 11 ichthyoplankton, and one zooplankter, were selected based on six criteria and approved by the SDRWQCB for detailed study during the program (Table 3-1). Some additional species that were found to be common in the subsequent sampling were also added to the list. The report reviewed the life histories of the critical species.

#### 3.1.1.1 Entrainment

A one-year entrainment and source water characterization study was conducted beginning in 1979 as part of the 316(b) demonstration studies at the EPS. Plankton samples were collected monthly at five offshore stations using 505 and 335 micron mesh nets attached to a 2 feet diameter bongo net system. Collections were also made monthly in the Middle and Upper lagoon segments and every two weeks in the Outer Lagoon using 1.6 feet diameter nets (505 and 335 micron mesh size). The procedures specified the use of a depressor weight connected to the towing apparatus but there was no indication at what depths the plankton samples were typically taken. Tows were targeted at 10 minutes at a speed of 1.5 to 2 knots. Entrainment samples were also collected every two weeks using a plankton pumping system in front of the intakes.

Although most samples were collected during daylight hours some samples were occasionally taken in the evening or early morning hours.

**Table 3-1**
**Critical Species Studied During 1979-1980**

| "Critical Species" | Common Name |
|---|---|
| ***Adult fishes*** | |
| *Engraulis mordax* | northern anchovy |
| *Atherinops affinis* | topsmelt |
| *Paralabrax clathratus* | kelp bass |
| *Paralabrax maculatofasciatus* | potted sand bass |
| *Paralabrax nebulifer* | barred sand bass |
| *Cynoscion nobilis* | white seabass |
| *Menticirrhus undulatus* | California corbina |
| *Seriphus politus* | queenfish |
| *Amphistichus argenteus* | barred surfperch |
| *Hyperprosopon argenteum* | walleye surfperch |
| *Semicossyphus pulcher* | California sheephead |
| *Mugil cephalus* | striped mullet |
| *Citharichthys sordidus* | Pacific sanddab |
| *Paralichthys californicus* | California halibut |
| *Pleuronichthys verticalis* | hornyhead turbot |
| *Heterostichus rostratus* | giant kelpfish |
| ***Ichthyoplankton*** | |
| *Anchoa compressa* | deepbody anchovy |
| *Engraulis mordax* | northern anchovy |
| Cottidae | sculpins |
| Serranidae | sea basses |
| Sciaenidae | croakers |
| *Coryphopterus nicholsi* | blackeye goby |
| Gobiidae | gobies |
| *Citharichthys stigmaeus* | spotted sanddab |
| *Paralichthys californicus* | California halibut |
| Pleuronectidae | righteye flounders |
| *Hypsopsetta guttulata* | diamond turbot |
| Atherinopsidae | silversides |
| ***Zooplankton*** | |
| *Acartia tonsa* | copepods |

Anchovies (primarily deep body and northern) were the most abundant larval forms in both the source water and entrainment samples, followed by croakers and sanddabs (Table 3-2). There were fewer fish eggs and more goby larvae in the entrainment samples whereas kelp and sand bass larvae were substantially more abundant in the combined source water samples from the Lagoon and offshore. Overall the average composition between the entrainment and source water data sets were very similar for the ten most abundant taxa. Only English sole, *Parophrys vetulus*, larvae were among the top ten entrainment taxa not represented in the top ten source water taxa.

**Table 3-2**
**Average Annual Densities of the Ten Most Abundant Ichthyoplankton Taxa per 100 m³ (26,417 gal) In Source Water (lagoon and offshore stations combined) & Entrainment (pump sampling) Collections for 335µ Mesh Nets During 1979**

| | Taxon | Source Water | Entrainment |
|---|---|---|---|
| anchovies | Engraulidae | 952.7 | 855.2 |
| croakers | Sciaenidae | 341.7 | 400.6 |
| speckled sanddab | *Citharichthys* sp. | 73.2 | 82.7 |
| fish eggs | unidentified fish egg | 33.8 | 20.2 |
| gobies | Gobiidae | 29.2 | 42.9 |
| silversides | Atherinidae | 8.3 | 10.8 |
| wrasses | Labridae | 6.4 | 4.0 |
| combtooth blennies | *Hypsoblennius* sp. | 6.1 | 5.7 |
| sea basses | Serranidae | 5.1 | 0.9 |
| rockfishes | *Sebastes* sp. | 2.8 | 2.5 |
| English sole | *Parophrys vetulus* | 0 | 1.9 |

*Note: English Sole not collected in source waterbody.*

Entrainment losses were calculated for each two-week sampling interval by multiplying the average plankton densities at the intake by the volume of cooling water drawn through the plant during that period. Annual, monthly, and daily rates were estimated by averaging the entrainment estimates for all sampling periods and calculating values for the indicated duration. Annual estimates for total zooplankton entrainment were $7.4 \times 10^9$ (505µ net data) and $30.9 \times 10^9$ (335µ net data) individuals. The copepod *Acartia tonsa* was the most abundant species in the entrainment collections (Table 3-3).

Annual estimates of the abundance of ichthyoplankton entrained through the power plant were $4.15x10^9$ (505µ net data) and $6.66x10^9$ (335µ net data) individuals per year. Fish eggs comprised 98 percent and 86 percent of the total annual ichthyoplankton entrainment using the 505µ and 335µ net estimates, respectively. Through-plant entrainment mortality was assumed to be 100% for larvae and 60% for eggs based on survival experiments that were conducted. The report presented average annual densities of the critical species by net type and daily entrainment estimates for selected plankton groups (Table 3-3).

**Table 3-3**
**Average Daily Entrainment Estimates at EPS Based On Daily Plant Circulating Water Flow of 795 MGD**

| | Daily Entrainment | | Mean Percent |
|---|---|---|---|
| Plankton Group | 335 µ | 505 µ | of Total |
| *Acartia tonsa* (copepod) | $4.77x10^7$ | $7.63x10^6$ | 41.2% |
| fish eggs | $1.57x10^7$ | $1.11x10^7$ | 19.9% |
| Decapoda | $1.32x10^7$ | $4.44x10^6$ | 13.1% |
| other Copepoda | $8.47x10^6$ | $2.16x10^6$ | 7.9% |
| other Crustacea | $6.95x10^6$ | $2.70x10^6$ | 7.2% |
| other Zooplankton | $5.68x10^6$ | $4.55x10^5$ | 4.6% |
| Chaetognatha | $1.83x10^6$ | $1.56x10^6$ | 2.5% |
| fish larvae | $2.52x10^6$ | $2.46x10^5$ | 2.1% |
| Mysidacea | $6.70x10^5$ | $1.34x10^6$ | 1.5% |
| | | | 100.0% |

Entrainment impacts were assessed by qualitative comparisons of entrainment losses to the estimated numbers of larvae in nearby source waters, comparisons of additional power plant mortality to natural mortality rates, entrainment probabilities based on current studies, and primary productivity studies. It was concluded that the entrainment of $1.82x10^7$ fish larvae and eggs daily was small compared to the egg and larval concentrations measured in monthly plankton tows in the source water body. It was estimated that average daily losses of planktonic organisms amounted to about 0.2% of the plankton available within one day's travel time from the power plant by current transport. At the seaward entrance to AHL, a water parcel was estimated to have a 34% probability of entering the lagoon. The 10% probability of entrainment isopleth was calculated to lie near the northern and eastern extremities of AHL, and the 70% and 90% entrainment probability isopleths were calculated to be near the intakes and well within the southern third of the Outer Lagoon. The modeled isopleths shifted toward the seaward entrance on a flood tide and toward the Middle Lagoon on an ebb tide. Using the 70% entrainment probability isopleth to define intake effects, it was shown that the maximum extent of intake effects was about 1000 feet into the southern end of the Outer Lagoon segment. With natural mortality rates assumed to be 99% for egg and larval stages of most marine fish species it was concluded that additional mortality from the EPS was not significant. There was no modeling of entrainment impacts on larvae using demographic or proportional loss models. It was also concluded, based on results of light-dark bottle experiments, that entrainment effects on source water primary productivity were negligible.

#### *3.1.1.2 Impingement*

Impingement of fishes and invertebrates on the traveling screens and bar rack system of the EPS were monitored daily during normal operations for 336 consecutive days in 1979. The main method was to obtain abundance and weights from samples accumulated over two 12-hour periods (daylight and night) each day for all three screening systems at the plant. During this period there were a total of 79,662 fishes from 76 taxonomic categories weighing a total of 3,076 lbs collected (Table 3-4). The six highest-ranking fishes by numbers impinged were queenfish, deepbody anchovy, topsmelt, California grunion, northern anchovy, and shiner surfperch. These are all open water forms that occur in schools. These six species represented 82% of all fishes impinged during normal operations sampling.

There were also seven heat treatments conducted during the study period. Heat treatments are operational procedures designed to eliminate mussels, barnacles, and other fouling organisms growing in the cooling water conduit system. During a heat treatment, heated effluent water from the discharge is redirected to the intake conduit via cross-connecting tunnels until the water temperature rises to approximately 105°F in the screenwell area. This water temperature is maintained for at least one hour, during which time all biofouling organisms, as well as fishes and invertebrates living within the cooling water system, succumb to the heated water. During heat treatment surveys, all material impinged onto the traveling screens are removed from the forebay. Fishes and macroinvertebrates were separated from incidental debris, identified, and counted. During the 1979 studies, the total weight of fishes impinged during these operations was 5,340 lb (Table 3-4). Over 90% of the fishes collected consisted of nine species: deepbody anchovy, topsmelt, northern anchovy, shiner surfperch, California grunion, walleye surfperch, queenfish, round stingray, and giant kelpfish. The numbers of fishes resident in the tunnels during heat treatments was greatest in winter and least in summer.

Macroinvertebrates that ranked high in the total numbers impinged included yellow crab (*Cancer anthonyi*) with 2,540 individuals, swimming crab (*Portunus xantusii*) with 884, lined shore crab (*Pachygrapsus crassipes*) with 866, and market squid (*Loligo opalescens*) with 522. The yellow crab and market squid both have commercial fishery value whereas the other two species are small and are not fished commercially. California spiny lobster, the most valuable invertebrate in the local commercial fishery, was rare in the samples with only two individuals impinged during the entire year-long study period.

**Table 3-4**
**Impingement Summary Of Fishes Collected During Normal And Heat Treatment Surveys Conducted From January 1979 To January 1980 at the EPS**

| | | Normal | | Heat Treatment | |
|---|---|---|---|---|---|
| Common Name | Scientific Name | Count | Weight (lb [kg]) | Count | Weight (lb [kg]) |
| queenfish | *Seriphus politus* | 18,681 | 201 (91.3) | 3,483 | 212 (96.3) |
| deepbody anchovy | *Anchoa compressa* | 13,299 | 142 (64.3) | 23,142 | 402 (182.2) |
| topsmelt | *Atherinops affinis* | 10,915 | 248 (112.3) | 21,788 | 366 (166.1) |
| California grunion | *Leuresthes tenuis* | 8,583 | 75 (33.8) | 9,671 | 180 (81.7) |
| northern anchovy | *Engraulis mordax* | 7,434 | 32 (14.6) | 19,567 | 207 (94.0) |
| shiner surfperch | *Cymatogaster aggregata* | 6,545 | 118 (53.3) | 12,326 | 607 (275.5) |
| walleye surfperch | *Hyperprosopon argenteum* | 1,877 | 111 (50.4) | 8,305 | 1153 (522.8) |
| white surfperch | *Phanderodon furcatus* | 1,751 | 37 (17.0) | 604 | 19 (8.6) |
| round stingray | *Urolophus halleri* | 1,686 | 410 (185.9) | 1,685 | 891 (404.2) |
| California halibut | *Paralichthys californicus* | 1,215 | 126 (57.1) | 329 | 117 (53.0) |
| all others | | 7,676 | 1,577 (715.2) | 7,200 | 1,366 (619.7) |
| Total | | 79,662 | 3,076 (1,395.2) | 108,102 | 5,340 (2,422.4) |

*Note: The top 10 species by number are listed.*

Impacts caused by impingement were assessed by comparing the numbers and biomass of fishes lost to plant operations to the abundance and biomass of fishes resident in the nearby source waters of AHL, nearshore habitats, and the San Diego coastal area. Samples of adult and juvenile fishes in the nearby source water were collected monthly with beach seines, otter trawls and gill nets. Seventeen of the 27 fish species were taken by all three types of gear. The role of gear selectivity in determining actual population sizes of the critical species was recognized. The ten most abundant species collected by all types of gear were California grunion (49%), topsmelt (17%), deepbody anchovy (7%), slough anchovy (6%), northern anchovy (3%), queenfish (3%), walleye surfperch (2%), speckled sanddab (2%), shiner surfperch (1%), and California halibut (1%). Most of the species removed by the power plant are widespread along the southern California and Baja California coasts and losses were small relative to these populations. On a local scale, it was calculated that the average daily power plant removal, including normal operations and heat treatment operations averaged throughout the year, was about 0.02% of the estimated standing crop in the local study area that extended along a shoreline distance of 3.6 miles out to a depth of 60 feet (1,211 acres). The removals also represented about 0.07% of local commercial fish landings by weight (excluding tuna) from the area between San Clemente and the Mexican border, and less than 7% of the recreational fishing landings by numbers annually in the area between Dana Point and the Mexican border.

### 3.1.2 1997 EPS Supplemental 316(b) Assessment Report

The SDRWQCB issued Order 94-58 in 1994 requiring SDG&E to conduct additional analyses of data from the 316(b) study conducted in 1979-1980 (EA Science and Technology, 1997). The supplemental analyses were completed in 1997. The purpose of the study was to further evaluate the effects of the EPS cooling water intake on the designated beneficial uses of AHL and the Southern California Bight using additional analysis methods. The three Special Conditions of the Order were:

1. Analysis of Family-Specific Entrainment Losses of Fish Eggs and Larvae—*Analysis shall include the estimated monthly and annual entrainment losses for each ichthyoplankton RIF (Representative Important Families) (i.e. identify the specific fish larvae and egg removals for each ichthyoplankton family considered in this study).*
2. Estimation of Combined Impingement Losses for Each of the Target Species—*The specific ichthyoplankton losses shall be evaluated using such factors as the importance of that species in food web structure, natural mortality, and plant selectivity for that species, and potential mitigating factors to reduce the kill of that species.*
3. Estimation of Annual Equivalent Adult Losses From Both Entrainment And Impingement—*Ichthyoplankton losses shall be evaluated using such factors as the importance of that species in the marine food web and its importance as a commercial or recreational species. This assessment shall include the use of a time reference for impact assessment longer than the 1-day entrainment zone. SDG&E may use the existing zone. SDG&E may use the existing data collected during the original demonstration project, but shall propose an alternative approach to assess the long-term effect of plankton removal.*

Estimates of loss were calculated for 17 selected species that included the original 16 "critical species" identified in the original 316(b) report and also tidewater goby, the only endangered aquatic species likely to occur in the area. Estimates of adult equivalent loss were calculated for the three representative species with the highest estimates of entrainment or impingement loss: northern anchovy, topsmelt, and queenfish. The modeling uses life stage-specific estimates of total mortality and yields estimates of the number of individual adult fishes which would have resulted from the young lost to entrainment and impingement under the conservative assumption of equal survival.

In order to put the entrainment losses in perspective and evaluate the magnitude of potential impacts, the report considered the life history characteristics of each target species (reproductive ability, geographic distribution, migratory capabilities) as well as estimates of current population size or harvest by commercial or sport fishermen. Although the original report touched on these topics, the 1997 report went into greater detail to evaluate potential impacts. Impacts were considered at three levels: individual population, overall community, and designated beneficial uses of the source waterbody.

The report concluded that the potential for adverse impacts from the EPS CWIS on individual target species was small compared to the sizes of the existing populations and the effects of fisheries. It similarly concluded that operation of the EPS cooling water intake has not, and will not, adversely affect the continued maintenance of balanced aquatic communities or designated beneficial uses of AHL or the Pacific Ocean in the vicinity of the EPS. Finally, the report stated that since the existing intake is not causing any adverse environmental impacts as defined under the CWA 316(b) guidelines that were in effect in 1997, it should be designated as best technology available.

### *3.1.3 2004-2005 EPS 316(b) Demonstration*

In 2004 the EPS initiated new IM&E studies prior to the publication of the new Phase II rules to take advantage of sampling synergies associated with the permitting of a desalination facility planned for construction on the EPS property. A study plan for the desalination facility studies was submitted to the San Diego Regional Water Quality Control Board (SDRWQCB) staff. The desalination facility study plan was designed to provide information on the larval fish and target invertebrates contained in the source of feedwater for the desalination facility, which is the power plant's cooling water discharge, that would be at risk to entrainment by the desalination plant, and information on the larval fish and target invertebrates contained in the power plant's source waterbody and intake flows. Data being collected for the desalination facility on the power plant's source population of entrainable larval fish and target invertebrates was similar to the information required under the new Phase II rules.

A plan for IM&E studies that directly addressed the requirement of 316(b) was submitted to the San Diego Regional Water Quality Control Board in September 2004 following the final publication of the new Rules in July 2004. The IM&E study plan was submitted as a first step in the facility's compliance with the new Phase II rule. The study plan was reviewed by the Board staff and their consultants, Tetra Tech Inc., and was approved contingent on certain comments and questions. Comments on the study plan were resolved and the studies continued through

June 2005 under the direction of a Technical Advisory Group comprised of staff from the Board, state and federal resource agencies, EPS, and their consultants. A summary of the 2004-2005 IM&E studies is presented in Section 9.0. The final report on the studies is being prepared and will be submitted as part of the CDS.

## 3.2 Survey of Ecological Resources of Agua Hedionda Lagoon (MEC Analytical Systems, Inc., 1995)

A series of field studies was completed in 1995 in AHL to characterize ecological resources of the lagoon prior to a proposed maintenance dredging project. The study delineated the extent of eelgrass and saltmarsh habitats in the lagoon, and provided quantitative information on the distribution and abundance of birds, fishes and benthic invertebrates. The studies occurred over a 14-month period from April 1994 to June 1995.

The fish surveys were conducted during two different seasons, spring and summer. A total of 29 species of fishes were collected during the two surveys (Table 3-5). Fewer taxa occurred in the Outer Lagoon compared to the Middle and Inner lagoons. The species composition recorded was indicative of the proximity of each lagoon segment to the outer coast with a higher proportion of nearshore species found in the Outer Lagoon samples and more estuarine/bay species in the Inner Lagoon. Mean total densities ranged from 0.016 fish per $m^2$ (10.76 $feet^2$) in the Outer Lagoon in April 1995 to 7.90 per $m^2$ (10.76 $feet^2$) in the east Inner Lagoon, also in April 1995. Overall densities were higher in the April than July for all lagoon segments. Silversides and gobies comprised over 90% of the individuals collected. The high densities recorded in the spring survey were due to recruitment of juveniles.

Although 29 species of fishes were found in the 1994-1995 surveys by MEC Analytical Systems, earlier studies (Bradshaw et al. 1976) reported a total of 42 species from occasional surveys and from intake screen collections from the power plant. A similar distribution pattern of increased diversity in the Inner Lagoon compared to the Outer Lagoon was also found in the SDG&E study. MEC Analytical Systems (1995) noted a lower abundance of California halibut in the lagoon than in previous surveys. California halibut were one of the most abundant species reported by Bradshaw and Estberg (1973), and were only collected in the Inner Lagoon in their survey. Studies by Kramer (1990) demonstrated the importance of the Middle and Inner lagoons as nursery habitat for California halibut.

**Table 3-5**
**Mean Density per m² and Percent Composition Of Fish Species Collected In Aqua Hedionda Lagoon During Two Surveys By Benthic Trawl, Beach Seine, And Otter Trawl**

| Species | Common Name | AHL Mean | Percent |
|---|---|---|---|
| Gobiidae (< 25 mm) | gobies (< 25 mm) | 0.550 | 31.54 |
| Atherinopsidae (< 25 mm) | silversides (< 25 mm) | 0.520 | 29.80 |
| *Atherinops affinis* | topsmelt | 0.325 | 18.64 |
| Gobiidae | goby, unid. | 0.076 | 4.33 |
| *Acanthogobius flavimanus* | yellowfin goby | 0.050 | 2.87 |
| *Hypsopsetta guttulata* | diamond turbot | 0.040 | 2.30 |
| *Clevlandia ios* | arrow goby | 0.037 | 2.15 |
| *Quietula y-cauda* | shadow goby | 0.021 | 1.21 |
| *Fundulus parvipinnis* | California killifish | 0.019 | 1.06 |
| *Cymatogaster aggregata* | shiner surfperch | 0.013 | 0.75 |
| *Syngnathus* sp. | pipefish, unid. | 0.013 | 0.75 |
| *Heterostichus rostratus* | giant kelpfish | 0.013 | 0.74 |
| *Paralichthys californicus* | California halibut | 0.012 | 0.70 |
| *Gillichthys mirabilis* | longjaw mudsucker | 0.012 | 0.67 |
| *Leptocottus armatus* | staghorn sculpin | 0.010 | 0.54 |
| *Paralabrax maculatofasciatus* | spotted sandbass | 0.009 | 0.52 |
| *Syngnathus auliscus* | barred pipefish | 0.005 | 0.28 |
| *Engraulis mordax* | northern anchovy | 0.005 | 0.27 |
| *Hypsoblennius gentilis* | bay blenny | 0.004 | 0.22 |
| *Ilypnus gilberti* | cheekspot goby | 0.004 | 0.20 |
| *Syngnathus leptorhynchus* | bay pipefish | 0.003 | 0.19 |
| *Seriphus politus* | queenfish | 0.003 | 0.17 |
| *Anchoa compressa* | deepbody anchovy | 0.002 | 0.10 |
| *Mustelus californicus* | grey smoothhound shark | * | |
| *Gymnura marmorata* | California butterfly ray | * | |
| *Paralabrax clathratus* | kelp bass | * | |
| *Micropterus dolomieui* | small mouth bass | * | |
| *Umbrina roncador* | yellowfin croaker | * | |
| *Sphyraena argentea* | California barracuda | * | |
| *Citharichthys stigmaeus* | speckled sanddab | * | |

**Table 3-5 (Continued)**
**Mean Density per $m^2$ and Percent Composition Of Fish Species Collected In Aqua Hedionda Lagoon During Two Surveys By Benthic Trawl, Beach Seine, And Otter Trawl.**

| Species | Common Name | AHL Mean | Percent |
|---|---|---|---|
| *Pleuronichthys ritteri* | spotted turbot | * | |
| *Symphurus atricauda* | California tonguefish | * | |

**Indicates species with no quantitative summary data included in report (from MEC 1995, Table 3.5).*
*$M^2$ = 10.76 $feet^2$*

Tidewater gobies (*Eucyclogobius newberryi*) were collected from AHL historically, but were not found in the 1994–1995 sampling. It is thought that the dredging and opening of the lagoon to higher saline marine waters in the 1950s significantly affected the tidewater goby population, which is adapted to primarily brackish water conditions.

A total of 143 macroinvertebrate taxa were collected with beam trawls in AHL during the MEC study. Very few of these taxa would be susceptible to impingement from EPS because of their primarily benthic habitat requirements. The most abundant taxa included the cockle (*Laevicardium substriatum*), a non-native mussel (*Musculista senhousi*); bubble snails (*Acteocina inculta, Bulla gouldiana, Haminaea vesicular*), mud dwelling snails, and several species of small crustaceans including amphipods, isopods, mysids, and shrimps. Differences in abundance of several taxa among the three lagoon segments was noted in the sampling and was attributed mainly to predominantly coarser sediments in the Outer Lagoon and finer sediments in the eastern inner portion of the Inner Lagoon.

A total 76 infaunal taxa was collected using a small coring apparatus with the sediments sieved through a 0.04 inches mesh screen. It was concluded that benthic infaunal populations were generally more diverse and abundant in the eelgrass beds than in non-vegetated sediments or in areas where currents deposited littoral sands.

Speckled scallop, *Argopecten circularis*, is a protected species that was known to occur in AHL. Only one individual was collected by MEC during the 1994-95 studies. The species had been studied previously by the California Department of Fish and Game (CDF&G) at AHL from March 1984 to October 1986 to obtain basic life history data (Haaker et al. 1988). Monthly samples of scallops were collected, measured, and released to obtain length frequency data for estimates of growth, life span, and spawning period. In 1984 large concentrations of speckled scallops were found on the sand-silt bottom of the lagoon, closely associated with eelgrass. During the course of the study the numbers of scallops declined, until their virtual disappearance at the end of 1986. Monthly length frequency plots from 24,375 scallop measurements indicate that this is a rapidly growing species with a short life span.

Special studies were done in conjunction with the new IM&E studies done in 2004 and 2005 to supplement the information on fishes provided in the MEC report. The MEC studies did not include sampling of mudflats in the Inner Lagoon and rocky habitat in the Outer Lagoon. The fishes in these two habitats produce large numbers of larvae at risk to entrainment. The data from these studies will be combined with data from the MEC study to provide more accurate estimates of the populations of fishes in the lagoon that will help provide some context for the estimates of EPS entrainment.

# 4.0 Agency Consultations

As required by the EPA 316(b) Phase II regulation [40 CFR 125.95 (b)(1)(iii)], a summary of any past and ongoing consultations with federal and state Fish and Wildlife Agencies relevant to the development of the PIC for this facility is presented in this section. All communications related to the IM&E issues at the EPS have been conducted through the SDRWQCB with federal and state resource agencies providing input on the IM&E studies as described below.

IM&E studies at EPS were started in June 2004 prior to the publication of the new Phase II rules to take advantage of entrainment sampling that was being done as part of the permitting for a desalination facility planned for construction on the EPS property. A plan for IM&E studies that directly addressed the requirements of 316(b) under the new Phase II rule was submitted to the San Diego Regional Water Quality Control Board on September 2, 2004. The IM&E study plan was submitted as a first step in the facility's compliance with the new Phase II rule. The study plan was reviewed by the Board staff and their consultants, Tetra Tech Inc., and was approved contingent on certain comments and questions that did not affect the sampling procedures being used in the studies. A copy of the September 30, 2004 Tetra Tech review of the study is included as in Attachment B. A copy of the EPS response to the Tetra Tech comments, dated January 10, 2005 is included in Attachment B.

One of the recommendations of the Tetra Tech review was that the SDRWQCB staff and other resource agencies be involved in approving certain aspects of the study including the selection of the target organism that would be used in the final assessment of cooling water system effects. In response to these comments a Technical Advisory Group (TAG) was formed to provide guidance on the IM&E studies. The TAG consists of staff from the SDRWQCB, the National Marine Fisheries Service, the CDF&G, the EPS and their consultants, Tenera Environmental and Dr. Scott Jenkins, an oceanographer from the University of California, San Diego Scripps Institute of Oceanography. The functions of the TAG included the following:

- providing input and review on selection of target organisms for assessment;
- providing input and review on the definition of the source water for entrainment assessment modeling;
- providing input on special studies and other data sources that may be available for assessing source water populations; and
- providing review on reports.

The SDRWQCB and resource agencies' staff participated in three TAG meetings in March, June and in September of 2005. Details on discussion topics of PICs and conclusions from each meeting are presented in Table 4-1. Based on preliminary analyses of the IM&E data, a suite of target fishes and shellfishes for detailed analysis in the IM&E Characterization Study Final Report were selected by the TAG at the September 2005 meeting.

On January 6, 2005, EPS submitted a letter to the SDRWQCB requesting a schedule for submittal of information required to comply with the EPA 316(b) Phase II rule. The letter requested a schedule for submittal of the PIC on April 1, 2006 and for submittal of the CDS on January 7, 2008. A copy of the subject correspondence is included in Attachment B.

**Table 4-1**
**Technical Advisory Group Meetings Held on Impingement Mortality and Entrainment Studies at EPS**

| Date | Attendees | Discussion Topics | Conclusions |
|---|---|---|---|
| March 14, 2005 | Tim Hemig, Sheila Henika - EPS<br>John Steinbeck, David Mayer - Tenera<br>John Phillips, Peter Michael - SDRWQCB<br>Bob Hoffman - NMFS<br>Bill Paznokas - CDF&G | Discussion of study design, assessment models, and methods for defining the source water for the study. Description of special studies on fishes of Agua Hedionda Lagoon that will help fill in data gaps from previous studies. | Agency representatives agreed with the sampling design since it follows the same model used for the South Bay Power Plant and Huntington Beach Generating Station studies. |
| June 13, 2005 | Tim Hemig, Sheila Henika - EPS<br>John Steinbeck, David Mayer - Tenera<br>John Phillips, Paul Richter - SDRWQCB<br>Bob Hoffman - NMFS<br>Bill Paznokas - CDF&G<br>Scott Jenkins - Scripps | Updates on impingement and entrainment sampling, and special studies. Presentation of population model for source water target organisms that accounts for the reduced residency time in Agua Hedionda Lagoon which limits the period of time that larvae are exposed to entrainment. | Agency representatives agreed with the need for more complicated population model and approach used for special studies |
| Sept. 29, 2005 | Tim Hemig, Sheila Henika - EPS<br>John Steinbeck, David Mayer, John Hedgepeth - Tenera<br>Charles Cheng - SDRWQCB<br>Bob Hoffman - NMFS<br>Bill Paznokas - CDF&G<br>Scott Jenkins - Scripps | Presentation of preliminary impingement and entrainment sampling results and recommendations for target organisms that will be analyzed in final report. Presentation of results from studies on the hydrodynamics of AH Lagoon and the use of the results in assessment models. | Agreement on target organisms that will be analyzed in detail for cooling water system effects in the final report. |

# 5.0 Evaluation of Intake Technology Alternatives

The EPA Phase II 316(b) regulation requires in 40 CFR 125.95(b)(1(i) that the PIC include a description of technologies which will be evaluated further to determine feasibility of implementation and effectiveness in meeting IM&E performance standards at the facility. The EPS CWIS, being located on a tidal/estuarine waterbody, must meet the performance standards for reduction in both IM&E.

A preliminary screening of technologies has been conducted to determine which alternatives offer the greatest potential for application at the EPS facility and therefore warrant further evaluation. Technologies have been screened based upon feasibility for implementation at the facility, biological effectiveness (i.e. ability to achieve reductions in both IM&E), and cost of implementation (including capital, installation, and annual operations and maintenance costs). Table 5-1 includes a list of technologies for which a preliminary screening was conducted.

**Table 5-1**
**Fish Protection Technologies**

| Technology | Fish Protection Potential | |
|---|---|---|
| | Impingement Mortality | Entrainment |
| Modified traveling screens with fish return | Yes | No |
| Replacement of existing traveling screens with fine mesh screens | Yes | Yes |
| New fine mesh screening structure | Yes | Yes |
| Cylindrical wedge-wire screens – fine slot width | Yes | Yes |
| Fish barrier net | Yes | No |
| Aquatic filter barrier (e.g. Gunderboom) | Yes | Yes |
| Fine mesh dual flow screens | Yes | Yes |
| Modular inclined screens | Yes | No |
| Angled screen system – fine mesh | Yes | Yes |
| Behavior barriers (e.g. light, sound, bubble curtain) | Maybe | No |

In a cursory analysis of the industry costs of implementing the new 316(b) Performance Rule, the EPA has selected retrofit of Fish Screens and a Fish Handling and Return Systems as an applicable technology for the EPS intake system.

The technologies selected for further consideration, which address both impingement and entrainment, as well as those determined not to warrant further consideration are discussed below.

## 5.1 Technologies Selected For Further Evaluation

A technology, which may be feasible for achieving performance standards, in whole or in part, for reduction in IM&E will be evaluated on the basis of the following:

- Ability to achieve required reductions in both IM&E for all species, taking into account variations in abundance of all life stages;
- Feasibility of implementation at the facility;
- Cost of implementation (including installed costs and annual O&M costs); and
- Impact upon facility operations.

The evaluation will involve the following:

- Comprehensive review of facility CWIS design and operation;
- Engineering design of proposed CWIS upgrades and/or equipment replacements;
- Development of design drawings;
- Analysis of capital and installation costs; and
- Assessment of level of IM&E reductions expected.

After reviewing the site conditions, the following design and construction technologies were selected for further evaluation for the feasibility of implementation to meet, in whole or in part, IM&E reduction standards:

- Modified traveling screens with fish return
- New fine mesh screening structure

### 5.1.1 Fish Screens, Fish Handling, and Return Systems

Traveling screens that are modified to enhance fish survival are designed with the latest fish removal features, including the Fletcher type buckets on the screen baskets, dual pressure spray systems (low pressure to remove fish, and high pressure to remove remaining debris), and separate sluicing systems for discarding trash and returning the impinged fish back to the water body. Impingement survival may be improved with the use of continuously operating modified traveling water screens. A fish return system is required as part of this system to transport fish washed from the screens alive back to the water body to a location where they would not be subject to re-entrainment into the intake.

Installation of modified Ristroph traveling screens at the EPS CWIS would consist of replacing the existing traveling water screens within the tunnel system with the screens as described above. A fish return system would be installed to return fish collected on the traveling water screens to the lagoon. The replacement screens would be equipped with the same 3/8 inch mesh size as the existing traveling screens.

The feasibility of replacing the existing traveling screens at the EPS CWIS with modified Ristroph traveling screens with conventional 3/8 inch mesh, fish handling and fish return systems will be evaluated. The evaluation will include an assessment of the additional reduction in IM that may be expected through implementation of this technology. Additionally, the feasibility of transporting the collected fish back to a location that would be an appropriate habitat and not result in likely re-entrainment into the intake will be assessed.

### 5.1.2 New Fine Mesh Screening Structure

Fine mesh traveling water screens have been tested and found to retain and collect fish larvae alive with some success. Fine mesh traveling water screens have been installed at a few large-scale steam electric cooling intakes including marine applications at Big Bend Station in Tampa, Florida (EPRI, 1986), and at an operating nuclear generating station at Prairie Island on the Mississippi River (Kuhl, 1988). Results from field studies of fine-mesh traveling water screens generally show higher survival at lower approach velocities and with shorter impingement duration (EPRI, 1986). In addition, many regulatory agencies have in the past adopted an expectation that traveling water screen approach velocities should be 0.5 feet per second (fps) or less. The National Pollutant Discharge Elimination System - Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Facilities in Section VII A states a maximum through screen design intake velocity of 0.5 fps as the acceptable design standard. This would require a screen approach velocity of 0.25 fps or less depending on the percent open area of the screen mesh used.

Application of fine mesh traveling water screen technology for EPS would likely require a complete new screen structure constructed at the south shore of the lagoon, including both trash racks and fine mesh traveling screen systems and fish collection and return systems; and would replace the existing trash rack structure with a much larger screening structure. It appears that there may be adequate space at the shore for a new fine mesh screen structure, but additional evaluation is still necessary. The approach velocities to the existing traveling screens, as discussed in subsection 2.3 above, are currently well above 0.5 fps and adding sufficient additional screens to the intake tunnel system to reduce approach velocities to 0.5 fps or less would require major modifications to the tunnel system, which may not be feasible. Additionally, an appropriate and suitable location to return collected fish, shellfish, and their eggs and larvae would have to be identified, as well as an assessment of the feasibility of constructing such a return system.

Design layouts and cost estimates for implementation and operation and maintenance will be developed for the above described fine mesh screen structure, as part of the CDS evaluation.

## 5.2 Technologies Considered Infeasible and Eliminated From Further Evaluation

### 5.2.1 Replacement of Existing Traveling Screens with Fine Mesh Screens

As discussed above in section 5.1.2, simple replacement of the existing traveling screens in the tunnel system with fine mesh Ristroph screens is not feasible due to high screen approach velocities. Therefore, further evaluation of this technology for implementation at the EPS CWIS will not be conducted.

### 5.2.2 Cylindrical Wedge-Wire Screens – Fine Slot Width

Wedge-wire screens are passive intake systems, which operate on the principle of achieving very low approach velocities at the screening media. Wedge-wire screens installed with small slot openings may enable a facility to meet performance standards for both IM&E. The wedge-wire screen is an EPA-approved technology for compliance with the EPA 316(b) Phase II rule provided the following conditions exist:

- The cooling water intake structure is located in a freshwater river or stream;
- The cooling water intake structure is situated such that sufficient ambient counter currents exist to promote cleaning of the screen face;
- The through screen design intake velocity is 0.5 fps or less;
- The slot size is appropriate for the size of eggs, larvae, and juveniles of any fish and shellfish to be protected at the site; and
- The entire main condenser cooling water flow is directed through the technology.

Wedge-wire screens are designed to be placed in a water body where significant prevailing ambient cross flow current velocities (≥ 1 fps) exist. This cross flow allows organisms that would otherwise be impinged on the wedge-wire intake to be carried away with the flow. An integral part of a typical wedge-wire screen system is an air burst back-flush system, which directs a charge of compressed air to each screen unit to blow off debris and impinged organisms back into the water body where they would be carried away from the screen unit by the ambient cross flow currents.

The EPS CWIS, located on the tidal AHL would not meet the first two EPA criteria discussed above. The intake is not located on a freshwater river and there are not sufficient ambient crosscurrents in the lagoon to sweep organisms and debris away from the screen units. Debris and organisms back-flushed from the screens would immediately re-impinge on the screens following the back-flush cycle because the principal water current in the outer lagoon would be the station intake flow toward the screen units. For these reasons, wedge-wire screen technology is not considered feasible for application at the EPS.

### 5.2.3 Fish Barrier Net

A fish net barrier, as it would be applied to a power station intake system, is a mesh curtain installed in the source water body in front of intake structures such that all flow to the intakes passes through the net, blocking entrance to the intake of all aquatic life forms large enough to be blocked by the net mesh. The net barrier is sized large enough to have very low approach and through net velocities to preclude impingement of juvenile fish with limited swimming ability. The mesh size must be large enough to preclude excessive fouling during normal station operation while at the same time small enough to effectively block entrainment of organisms into the intake system. These conditions typically limit the mesh size such that adult and a percentage of juvenile fish can be blocked. The mesh is not fine enough to block most larvae and eggs. The fish net barrier could potentially meet the performance requirements of the EPA Phase II Existing Facilities Rule for impingement; however, it would not meet the performance requirements for reduction of entrainment of eggs and larvae.

The fish net barrier technology is still experimental, with very few successful installations at power station intakes. Using a 20 gpm/ft$^2$ design loading rate, a net area of approximately 30,000 feet$^2$ would be required for EPS. Maintaining such a large net moored in the lagoon is not practical. In addition, the fish barrier is a passive screening device, which is subject to fouling and has no means for self-cleaning. This technology would be rapidly clogged due to fouling. The services of a diving contractor would be required to remove the net for cleaning onshore and to replace the fouled net with a clean net on each cleaning cycle. For these reasons, this technology is not practically feasible for implementation at EPS and further evaluation is not warranted.

### 5.2.4 Aquatic Filter Barrier

An aquatic filter barrier system, such as the Gunderboom Marine Life Exclusion System (MLES)™ (Gunderboom), is a moored water permeable barrier with fine mesh openings that is designed to prevent both impingement and entrainment of ichthyoplankton and juvenile aquatic life. An integral part of the MLES is an air-burst back flush system similar in concept to the air burst system used with wedge-wire screen systems to back flush impinged organisms and debris into the water body to be carried away by ambient cross currents.

A MLES has been installed and tested at the Lovett Station on the Hudson River. This test installation was applied to a cooling system of significantly smaller capacity than the EPS intake system and in a very different environment on the Hudson River, as opposed to the lagoon intake of the EPS.

Although the MLES has much smaller mesh openings and will block fish eggs and larvae from being entrained into the intake, these smaller organisms will be impinged permanently on the barrier due to the lack of cross currents to carry them away. This system therefore offers no significant advantage over other technologies such as the fish net barrier concept and would offer no biological improvement over the barrier net design. For these reasons, this technology is not practically feasible for implementation at EPS and further evaluation is not warranted.

### 5.2.5 Fine Mesh Dual Flow Screens

A modified dual flow traveling water screen is similar to the through flow design, but the screen would be turned 90 degrees so that its two faces would be parallel to the incoming water flow. When equipped with fine mesh screening media, the average 0.5 fps approach velocity to the screen face would have to be met by the dual flow screen design. Water flow enters the dual flow screen through both the ascending and the descending screen faces, and then flows out between the two faces. All of the fish handling features of the Ristroph screen design would be incorporated in the dual flow screen design. However, the dual flow screen configuration has been shown to produce low survival rates for fish larvae. This is because of the longer impingement time endured by organisms impinged on the descending face of the screen. This longer impingement time is suspected to result in higher mortality rates than similar fine mesh screens with a flow through screen design.

The primary advantage of this screen configuration is the elimination of debris carryover into the circulating water system. Also, because both ascending and descending screen faces are utilized, there is greater screening area available for a given screen width than with the conventional through-flow configuration. However, the flow pattern and therefore the velocity distribution along the screen face is not uniform and is concentrated toward the back or downstream end of the screen. The dual flow screen can also create adverse flow conditions in the approach flow to the circulating water pumps. The flow exiting the dual flow screens is turbulent with an exit velocity of greater than 3 fps. Modifications to the pump bays downstream of the screens, usually in the form of baffles to break up and laterally distribute the concentrated flow prior to reaching the circulating water pumps, are usually required. This would not be the case for EPS if a new fine mesh dual flow screen structure were constructed at the lagoon, similar to the through flow fine mesh screen structure discussed in Section 5.1 above.

For similar reasons, as discussed above for through flow fine mesh screens, implementation of this technology to the EPS CWIS would require an entirely new screen structure similar to the fine mesh through flow screen structure discussed in Section 5.1 above. The dual flow fine mesh screen configuration offers no advantages in terms reduction of impingement and entrainment mortality as compared to through flow fine mesh traveling screens discussed above and in fact would probably not perform as well as the through flow design. The design concept for the dual flow screen structure would be similar to the through flow fine mesh screen structure with trash racks, coarse mesh traveling screens and fine mesh traveling screens in each screen train. The implementation cost and operation and maintenance costs for this facility would be of the same order of magnitude as for the through flow screen structure. Dual flow screen technology does not offer a significant performance or cost advantage as compared with through flow screen technology. Therefore, further evaluation of this technology for the EPS is not warranted.

### 5.2.6 Modular Inclined Screens

Modular Inclined Screen (MIS) is a fish protection technology for water intakes developed and tested by the Electric Power Research Institute (EPRI) (Amaral, 1994). This technology was developed specifically to bypass fish around turbines at hydro-electric stations. The MIS is a modular design including an inclined section of wedge-wire screen mounted on a pivot shaft and enclosed within a modular structure. The pivot shaft enables the screen to be tilted to back-flush debris from the screen. The screen is enclosed within a self-contained module, designed to provide a uniform velocity distribution along the length of the screen surface. Transition guide walls taper in along the downstream third of the screen, which guide fish to a bypass flume. A full size prototype module would be capable of screening up to 800 cfs (360,000 gpm) at an approach velocity of 10 fps.

The MIS design underwent hydraulic model studies and biological effectiveness testing at Alden Research Laboratory to refine the hydraulic design and test its capability to divert fish alive. Eleven species of freshwater fish were tested including Atlantic salmon smolt, coho salmon, Chinook salmon, brown trout, rainbow trout, blueback herring, American shad and others. After some refinements in the design were made during this testing, the results showed that most of these species and sizes of fish can be safely diverted (Amaral, 1994).

Following laboratory testing the MIS design was field tested at the Green Island Hydroelectric Project on the Hudson River in New York in the fall of 1995 (Shires, 1996). In addition to the MIS, the effectiveness of a strobe light system was also studied to determine its ability to divert blueback herring from the river to the MIS. Results for rainbow trout, golden shiner and blueback herring, which were released directly into the MIS module were similar to the laboratory test results in terms of fish survivability. The limited amount of naturally entrained blueback herring did not allow reliable evaluation of test results (Amaral, 1994).

The MIS technology, as tested, does not address entrainment of eggs and larvae. Also, this technology has never been tested for, or installed in, a power station with a seawater intake system. Further research would be required to evaluate the efficacy of this technology for application to a seawater intake system. MIS is not a suitable and proven technology, at this time, for retrofit to the EPS intake system. Therefore, further evaluation of this technology for the EPS is not warranted.

### 5.2.7 Angled Screen System – Fine Mesh

Angled screens are a special application of through-flow screens where the screen faces are arranged at an angle of approximately 25 degrees to the incoming flow. The conventional through-flow screen arrangement would place the screen faces normal or 90 degrees to the incoming flow. The objective of the angled-screen arrangement is to divert fish to a fish bypass system without impinging them on the screens. Most fish would not be lifted out of the water but would be diverted back to the receiving water by screw-type centrifugal or jet pumps. Using fine screen mesh on the traveling screens minimizes entrainment, but increases potential for impingement of organisms that would have otherwise passed through the condenser.

Application of this technology would require construction of new angled screen structure at the south shore of the lagoon similar to the fine mesh screen structure discussed above in Section 5.1. The angled screen facility would not provide a significant performance advantage in terms of reducing IM&E as compared to the proposed fine mesh screen structure as presented above and would be at least as large and a significantly more complex structure. This facility would be potentially more costly to implement and maintain than the fine mesh screen facility. Therefore, further evaluation of this technology for the EPS is not warranted.

### 5.2.8 Behavior Barriers

A behavioral barrier relies on avoidance or attraction responses of the target aquatic organisms to a specific stimulus to reduce the potential of entrainment or impingement. Most of the stimuli tested to date are intended to repulse the organism from the vicinity of the intake structure. Nearly all the behavioral barrier technologies are considered to be experimental or limited in effectiveness to a single target species. There are a large number of behavioral barriers that have been evaluated at other sites, and representative examples these are discussed separately below.

**Offshore Intake Velocity Cap** – This is a behavioral technology associated with a submerged offshore intake structure(s). The velocity cap redirects the area of water withdrawal for an offshore intake located at the bottom of the water body. The cap limits the vertical extent of the offshore intake area of withdrawal and avoids water withdrawals from the typically more productive aquatic habitat closer to the surface of the water body.

This technology operates by redirecting the water withdrawal laterally from the intake(rather than vertically from an intake on the bottom), and as a result, water entering the intake is accelerated laterally and more likely to provide horizontal velocity cues that allow fish to respond and move away from the intake. Potentially entrainable fish are able to identify these changes in water velocity as a result of their lateral line sensory system and are able to respond and actively avoid the highest velocity areas near the mouth of the intake structure.

This technology reduces impingement of fish by stimulating a behavioral response. The technology does not necessarily reduce entrainment, except when the redirected withdrawal takes water from closer to the bottom of the water body and where that location has lower plankton abundance.

Application of this technology to the EPS CWIS, to be fully effective, would require development of an entirely new intake system with a submerged intake structure and connecting intake conduit system installed out into the Pacific Ocean similar to the offshore intake system at the El Segundo Generating Station (Weight, 1958). This is not a practically feasible consideration for the EPS. Also, this technology would probably not be capable of meeting the performance requirements of the EPA Phase II Existing Facilities Rule for reduction of entrainment of larvae, eggs and plankton. Therefore, this technology is not potentially applicable for the EPS CWIS and further evaluation of this technology is not warranted.

**Air Bubble Curtain** – Air bubble curtains have been tested alone and in combination with strobe lights to elicit and avoidance response in fish that might otherwise be drawn into the cooling water intake. Generally, results of testing the bubble curtain have been poor (EPRI, 1986). Tests have been conducted with smelt, alewife, striped bass, white perch, menhaden, spot, gizzard shad, crappie, freshwater drum, carp, yellow perch, and walleye. Many species exhibited some avoidance response to the air bubble or the combination air bubble and light combination. However, there has been little if no testing of species common to the AHL.

This technology has some potential to enhance fish avoidance response in some species of fish. However, there is no reliable data for the species that are subject to impingement at the EPS and no way to estimate what type of reaction fish would have to the existing intake with the addition of a bubble curtain. Unless some type of testing were conducted, this technology does not appear suitable for the EPS. As a result, there is no basis to recommend an air curtain as an enhancement to reduce impingement or entrainment at the EPS CWIS. Therefore, further evaluation of this technology for the EPS is not warranted.

**Strobe Lights** – There has been a great deal of research with this stimulus over the last 15 years to guide fish away from intake structures. The Electric Power Research Institute has co-funded a series of research projects (EPRI 1988, EPRI 1990, EPRI 1992) and reviewed the results of research in this field by others (EPRI 1986, EPRI 1999). In both laboratory studies and field applications strobe lights were shown to effectively move selected species of fish away from the flashing lights. Most of the studies conducted to date have been with riverine fish species and for projects associated with hydroelectric generating facilities. One early study was conducted at the Roseton Generating Facility on the Hudson River in New York, another study was conducted on Lake Cayuga in New York, and others for migratory stages of Atlantic and Pacific salmon. Few species similar to those occurring in the AHL have been tested for avoidance response either in the lab or in actual field studies.

Laboratory testing was done for an application of strobe lights for the San Onofre Nuclear Generating Facility. Testing was conducted for white croaker, Pacific sardine and northern anchovy. Limited availability of test specimens and limited testing demonstrated no conclusive results and the California Coastal Commission (2000) found this device not useful at this station.

Before strobe lights could be seriously considered for use at the EPS CWIS, a series of lab and or field studies on their effectiveness for the species most likely to be entrained into the EPS CWIS would need to be completed. Based on studies of strobe lights conducted to date, it is likely that these studies would show differential effectiveness based on background light conditions (day vs. night), ambient seawater turbidity, and most likely there would also be great differences in species specific response. As a result there is no basis to recommend these strobe lights as an enhancement to reduce impingement or entrainment at the EPS CWIS. Therefore, further evaluation of this technology for the EPS is not warranted.

**Other Lighting** – Incandescent and mercury vapor lights have also been tested as a behavioral stimulus to direct fish away from an intake structure. Mercury lights have generally been tested as a means of drawing fish to a safe bypass of the intake structure as generally the light has an attractive effect on fish. Tests have not demonstrated a uniform and clearly repeatable pattern of attraction for all fish species. The mercury lights have been somewhat effective in attracting European eel, Atlantic salmon, and Pacific salmon. But results with other species including American shad, blue back herring and alewife had more variable results. One test with different life stages of Coho salmon shows both attraction and repulsion from the mercury light for the different life stages of the coho.

Testing with incandescent, sodium vapor and fluorescent lamps was more limited but also had variable and species specific results.

Other lighting systems, as with most all the behavioral barrier alternatives, have not been tested with the species of fish common in AHL. As a result, there is no basis to recommend these lights systems as an enhancement to reduce impingement or entrainment at the EPS CWIS. Therefore, further evaluation of this technology for the EPS is not warranted.

**Sound** – Sound has also been extensively tested in the last 15 years as a method to alter fish impingement rates at water intake structures. Three basic groups of sound systems including percussion devices (hammer, or poppers), transducers with a wide range of frequency output, and low frequency or infrasound generators, have all been tested on a variety of fish species.

Of all the recently studied behavioral devices the sound technology has demonstrated some clear success with at least one group of fish species. Clupeids, such as alewife, demonstrate a clear repulsion to a specific range of high frequency sound. A device has been installed in the Fitzpatrick Nuclear Generating station on Lake Ontario in New York State, which has been effective in reducing impingement of landlocked alewives. The results were repeated with alewife at a coastal site in New Jersey. Similar results with a high frequency generator also reported a strong avoidance response for another clupeid species, the blue back herring, in a reservoir in South Carolina. Testing of this high frequency device on many other species including weakfish, spot, Atlantic croaker, bay anchovy, American shad, blue back herring, alewife, white perch, and striped bass only demonstrated a similar and strong avoidance response by American shad and blue back herring.

Alewife and sockeye salmon have also been reported to be repelled by a hammer percussion device at another facility. But testing of this same device at other facilities with alewife did not yield similar results.

Although high frequency sound has potential for eliciting an avoidance response by the Alosid family of fish species, there is no data to demonstrate a clear avoidance response for the species of fish common to the AHL. Therefore there is no basis to recommend sound as a method to reduce impingement of fish at the EPS CWIS. Therefore, further evaluation of this technology for the EPS is not warranted.

## 6.0 Evaluation of Operational Measures

The EPA 316(b) Phase II regulation [40 CFR 125.95(b)(1)(i)] requires that the PIC should include a description of operational measures which will be evaluated further to determine feasibility of implementation and effectiveness in meeting IM&E performance standards at the facility. A preliminary screening of such measures has been conducted to determine those which offer the greatest potential for application at the facility and therefore warrant further evaluation. Operational measures have been screened based upon feasibility for implementation at the facility, biological effectiveness (i.e. ability to achieve reductions in IM&E), and cost of implementation (including additional power requirements and loss in generating capacity and unit availability).

Several operational measures have been proven effective in reducing IM&E at CWIS. Such measures include:

- CWIS flow reductions (e.g. capping capacity utilization rate)
- Variable speed drives for CWIS pumps
- Other cooling water efficiency improvements

The following is a discussion of operational measures for which further evaluation will be conducted in the CDS to determine their potential for reducing IM&E at EPS. The results of the evaluation of such measures will be utilized to develop the plan for implementation of technologies, operational and/or restoration measures that will be proposed to achieve IM&E performance standards at the facility. Upon selection of the most appropriate operational measures, engineering design calculations and drawings, as well as estimates of expected reductions in IM&E and a schedule for implementation will be developed. This information will become part of the Design and Construction Technology Plan (DCTP) (or Site-Specific Technology Plan in the event that the facility chooses to seek a site-specific determination of BTA) and Technology Installation and Operation Plan (TIOP) that will be included in the CDS to be submitted for the facility. The DCTP explains the intake technologies or operational measures selected for use at EPS to meet the E&I performance standards for the Phase II Rule. The compliance with the performance standards will be measured and monitored through documentation of the TIOP.

### 6.1 Circulating Water Flow Reduction / Caps

Circulating water flow caps are an operational control measure which would include administratively limiting the total withdrawal of cooling water from the AHL to an agreed upon value. The flow reductions may be scheduled for periods of the year when entrainment or impingement are highest to achieve a greater reduction to impingement and entrainment. Any reduction in flow reduces both entrainment and impingement effects associated with the operation of the plant. If flow reductions are concentrated during the seasons of the year that plankton life stages of species of concern are present, the overall seasonal reductions in fisheries impacts can greatly exceed the quantity of the flow reduction. Utilizing variable speed drive technology on the circulating water pumps could be an effective means of controlling total annual flow withdrawal.

## 6.2 Variable Speed Drives For Circulating Water Pumps

Variable-speed drives for circulating water pumps allow reduction in cooling water flow during periods when the unit is not operating at full-rated capacity, or during known periods of high entrainment. With this technology it would be possible to vary the speed of the motor from 10% to 100% and reduce the cooling water intake flow by up to 90%. Any reduction in flow reduces both entrainment and impingement effects associated with the operation of the plant. The lower pumping capacity allows for a lower approach velocity at the traveling screens and reduces the number of entrainable organisms drawn into the cooling water system. In addition, if flow reductions are concentrated during the seasons of the year that plankton life stages of species of concern are present, the overall seasonal reductions in fisheries impacts can greatly exceed the quantity of the flow reduction. The installation of variable speed drives will be evaluated further to determine the effectiveness in reducing IM&E at the EPS CWIS.

## 6.3 Heat Treatment Operational Changes

Potential operational and procedural enhancements to reduce impingement during heat treatment events will also be evaluated. In the CDS, EPS will evaluate a couple of alternative biofouling control measures that might reduce the number, or eliminate the need for, heat treatments in the intake tunnels. In addition, EPS will also evaluate a couple of modifications of the existing heat treatment procedures that might reduce the numbers of fish impinged during these events, but still provide effective heat treatment removal of fouling organisms in the intake and intake tunnels.

# 7.0 Evaluation of Restoration Alternatives

The EPA Phase II 316(b) regulation [40 CFR 125.95(b)(1)(i)] allows the consideration of restoration measures as one of the options that may be implemented, either alone or in combination with technology and/or operational measures, to achieve performance standards for reduction in IM&E losses. Facilities may propose restoration measures that will result in increases in the numbers of fishes and shellfishes in the waterbody that would be similar to those achieved with meeting performance standards through the implementation of technologies and/or operational measures. EPS will conduct an evaluation of potential restoration measures that may be implemented in the event that it is determined that meeting performance standards through the implementation of technologies and/or operational measures alone is less feasible, less cost-effective, or less environmentally desirable than use of restoration measures.

## 7.1 Potential Restoration Measures

This section introduces the type of habitat restoration projects that could potentially be used to offset IM&E losses at EPS. The offsets that will later be calculated for each project will be based on a numerical comparison of IM&E losses resulting from the operation of EPS, and the expected production of equivalent adults of the affected species resulting from the restoration efforts using various habitat models.

Any specific conservation, enhancement, or restoration project that is to be used for this purpose should have a nexus (i.e. relationship between the environmental impacts and the proposed project) to the impingement and entrainment effects of the power plant. The projects that will be evaluated to offset potential EPS IM&E losses fall into three general categories:

- Projects that would directly restore or enhance habitat in AHL;
- Projects that would preserve, restore, or enhance the AHL watershed; and
- Projects that enhance the nearshore coastal environment in the vicinity of EPS Power Station.

The following is a list of some of the potential restoration measures, in each of the above categories, which will be evaluated to determine their feasibility of implementation, and potential efficacy in meeting IM&E performance standards at the EPS:

I. **Restoration or Enhancement of AHL**

- Invasive species removal and prevention
- Restoration of historic sediment elevations to promote reestablishment of eelgrass beds
- Enhancement of AHL State Reserve
- Marine fish hatchery enhancement
- Community outreach soliciting public agency and landowner participation

**II. Restoration or Enhancement of Agua Hedionda Watershed**

- Erosion control projects along upland watercourses
- Construction of catchment basins, swales, and other sediment containment features
- Land acquisition for purposes of creating conservation easements
- Minimizing runoff from development activities
- Restoration of floodplain habitat
- Invasive species removal and prevention

**III. Restoration or Enhancement of Nearshore Coastal Areas**

- Marine fish hatchery stocking program
- Artificial reef development
- Marine Protected Area establishment
- Kelp bed enhancement

The "value" of the ecological services or benefits that will result from implementation of any of these restoration projects will be assessed using various habitat models to demonstrate that the ecological "credits" gained through restoration will outweigh the ecological "debits" caused by the IM&E losses. A preliminary screening of these potential restoration measures will be conducted to determine which projects warrant further evaluation. Selected projects will be evaluated further based upon the criteria described below.

## 7.2 Project Selection Criteria

A set of restoration project selection criteria has been developed to aid in the evaluation of potential projects. The project selection criteria include:

- Location
- Nexus to EPS IM&E effects
- Basic need or justification for project
- Nature and extent of ecological benefits
- Stakeholder acceptance
- Consistency with ongoing resource agency work and environmental planning

- Administrative considerations
- Implementation costs
- Cost effectiveness
- Ability to measure performance
- Success of comparable projects
- Length of time before benefits accrue
- Technical feasibility
- Opportunities for leveraging of funds/availability of matching funds
- Legal requirements (e.g., permits, access)
- Likely duration of benefits

Depending on the nature of a particular project, the relative importance and weighting of these criteria may vary. As a general proposition, however, projects will be selected so as to maximize the ecological benefits to AHL and adjacent nearshore areas. This process will ensure that the most effective projects are assigned the highest priority.

## 8.0 Other Compliance Options for EPS

Two additional compliance alternatives that EPS may pursue in the course of developing the most appropriate CDS for the EPS CWIS include a site-specific determination of BTA and a trading approach for cooperative restoration solutions. The site-specific determination option would be undertaken if the implementation of some combination of an intake technology, operation change or restoration is significantly greater in cost than that estimated by US EPA or the costs are significantly greater than the benefits of such measures. The trading program compliance alternative would involve EPS teaming with other water users in the area to develop a more comprehensive solution to reduce or mitigate for IM&E with a cooperatively funded technology or restoration alternative. EPS has no specific plans and has not developed potential teaming partners to pursue this compliance alternative at this time. However, EPS will remain open to exploring this compliance alternative if the right opportunity is identified prior to submittal of the CDS.

### 8.1 Site-Specific Determination of BTA

The intent of the EPS approach to compliance is to meet the entrainment and impingement performance standards established by the EPA when the new rule was promulgated. That is, EPS hopes to demonstrate that the EPS intake has reduced the effects of entrainment by 60 to 90% and reduced the effects of station operation on impingement mortality by 80 to 95% from the calculation baseline. However, EPS also recognizes that if the costs of reaching these goals cannot reasonably be achieved that the EPA 316(b) Phase II regulation allows a somewhat lower IM&E reduction standard. Specifically the new rule would allow EPS to demonstrate that the EPS facility is eligible for a site-specific determination of BTA to minimize IM&E and that EPS has selected, installed, and is properly operating and maintaining, or will install and properly operate and maintain, design and construction technologies, operational measures, and/or restoration measures that the Director has determined to be the BTA to minimize adverse environmental impact of the EPS cooling water operations.

This compliance alternative allows the EPS facility to request a site-specific determination of BTA for minimizing IM&E if EPS can demonstrate that the costs for compliance with the new rule are significantly greater than those considered by EPA in the development of the rule (cost/cost test) or that the costs associated with compliance are significantly greater than the benefits (cost/benefit test) that would accrue to the environment.

### 8.1.1 Cost/Cost Test

If EPS chooses to seek a site-specific determination of BTA, a cost/cost test will be performed to compare the cost of implementing options to achieve full compliance with the 316(b) Phase II standards to costs estimated by the EPA for the EPS facility for achieving full compliance. In the 316 (b) Phase II rule, the EPA has assumed that the EPS facility would add a fish handling and return system to the existing traveling water screen system. There was no expectation in that recommendation that the EPS facility would need to meet the entrainment performance standards. Therefore EPA has projected compliance capital costs for the EPS facility of $2,841,330 (Federal Register, Vol. 69 – 7/9/2004, page 41677 – see Facility ID# AUT0625). This same source cites an expected existing baseline O&M annual cost of $104,168 and a post construction O&M annual cost of $380,113 for EPS.

If pursuit of this compliance option is justified, EPS will conduct its evaluation following a three-step method, as follows:

1. Identification of feasible options for achieving full compliance (e.g. combinations of engineering, operational, and restoration actions);
2. Estimation of the dollar costs of implementing these actions (including capital, O&M, and lost generation revenue due to extended outages); and
3. Comparison of the total estimated cost of compliance based upon the compliance options identified with EPA's estimated cost of compliance for the facility in question.

One thing that has not been fully resolved by EPA is what constitutes "significant" compared to the costs that EPA projected for the EPS. EPS will develop its perspective on what constitutes significant during the development of the CDS. It is likely that significance will be judged from the perspective of the capital and operating costs and revenues from the operation of EPS.

### 8.1.2 Cost/Benefit Test

A cost/benefit test may also be performed for EPS to compare the total costs of achieving compliance with the environmental benefits through implementation of the required technologies, operational, and/or restoration measures. Costs are the sum of direct costs and the indirect costs of any intake, operational or restoration mitigation actions. Direct costs include the costs of implementing compliance alternatives, including capital, O&M, and lost generation revenue due to extended outages. Indirect costs include any costs associated with impairment of navigation, higher energy prices, and negative ecological effects of the mitigation actions on the waterbody. An initial phase of the cost/benefit test will identify whether any of these indirect cost elements are relevant at the EPS. The cost/benefit test would specify the nature of the relevant direct and indirect cost components at the facility.

The benefits arise from reducing IM&E by the full amount of the 316(b) Phase II rule's performance standard relative to baseline conditions. The economic benefits of reductions in IM&E have been specified by the EPA in its evaluation of the national benefits of the rule. The classes of benefits identified by EPA in its assessment include direct use benefits (e.g. those from commercial and recreational fishing), indirect use benefits (e.g. increased forage organisms), and existence, or passive use benefits (e.g. improved biodiversity). These benefits are based on standard definitions of value used by economists in cost/benefit analysis. Methods for quantifying benefits to commercial and recreational fishing and other changes in natural resources have been widely employed by environmental and natural resource economists over the past several decades.

The exact nature of the data and methods required for a cost/benefit analysis will vary depending upon the magnitude of the potential IM&E effects on a local and regional scale, the availability of existing economic benefit studies that may be applied, as well as the comments of the regulators and natural resource agencies involved with reviewing this PIC. These can vary widely and will not really be well understood until the results of the IM&E study are complete. When the IM&E study is complete, the numbers of each species affected by operation of the intake can be quantified, and then a value for each species affected by IM&E at the EPS CWIS can be developed.

The benefit studies would be undertaken using a phased approach. Following an initial scoping phase to determine the approach to conducting a cost/benefit analysis, an outline of a benefits assessment approach will be determined. EPS will develop an approach to conducting a benefits valuation for use in supporting a site-specific determination of BTA if that becomes the selected approach for meeting compliance with the new rule. The approach will address the following requirements for such a study as outlined in the Phase II rule:

1. Description of the methodologies to be used to value commercial, recreational, and other ecological benefits;
2. Documentation of the basis for any assumptions and quantitative estimates; and
3. Analysis of the effects of significant sources of uncertainty.

If restoration is a component of the compliance approach, the ability of the restoration project(s) to generate benefits to offset impingement and/or entrainment effects must be demonstrated. This requires specification of a metric that can be used to quantify restoration benefits in a manner comparable to entrainment and impingement effects in the ecosystem.

Habitat assessment methods will be used for assessing the relative value of restoration actions. The approach taken will be to:

1. Identify the key species of concern affected by the facility;
2. Identify critical factors or habitat needs for those species;
3. Identify technically feasible and cost-effective restoration actions that address such critical factors and needs factors; and
4. Choose an appropriate ecological metric for scaling effects of mitigation and/or enhancing habitat needs within the adjacent ecosystem or area.

For example, if it is determined that the restoration project needs to compensate for entrainment of a species for which spawning habitat is a limiting factor, then creation of sufficient new spawning habitat to increase the population by the amount of entrainment would be required for full compliance with the Rule. This would then translate to acreage of created habitat with certain required structural characteristics.

If entrainment losses are of key concern, and the population of associated fish is of less concern, then biomass could also serve as the metric. The present value of the entrained biomass would be computed as the ecological debit. Then, a wetland or other habitat creation project could be scaled in size to produce the equivalent present value of biomass from the primary productivity of the wetland or new habitat.

### 8.1.3 Evaluation of a Site-Specific BTA

The 316(b) Phase II Rule allows facilities to seek site-specific determinations of BTA if it can be demonstrated that the costs of achieving full compliance with the IM&E performance criteria at a facility are either:

1. Significantly greater than those considered by the EPA in development of the rule (cost/cost test), or
2. Significantly greater than the net environmental benefits to be achieved (cost/benefit test).

If either of these methods is implemented, EPS may propose this as the compliance approach if the costs are significantly higher than either the expected costs at the time the rule was promulgated or, for the amount of benefits that would be derived.

## 8.2 Trading For Cooperative Mitigation Solutions

In the preamble to the EPA 316(b) Phase II rule, as published in the Federal Register (Vol. 69, No. 131, pgs 41576 - 41693), there is a discussion of the role of trading under the rule (VII. F.2). The preamble describes how trading "...raises complex issues on how to establish appropriate units of trade and how to measure these units effectively given the dynamic nature of the populations of aquatic organisms subject to impingement mortality and entrainment." However, EPA suggests that delegated authorities responsible for implementing the 316(b) Phase II rule wishing to develop trading options "...would be best off focusing on programs based on metric of compatibility between fish and shellfish gains and losses among trading facilities.". This section of the rule also states that if the delegated NPDES authority can demonstrate to the EPA Administrator that they have adopted a NPDES program within a watershed that provides for comparable reductions in IM&E, then the EPA Administrator must approve such alternative compliance alternative requirements.

EPS may consider a watershed-approach trading program as a possible compliance alternative if the right combination of coastal water users identify mutual goals for achieving compliance, either in whole or in part, with the new rule. EPS has not developed any specific alliance of water dependent organizations to implement such a watershed-approach trading compliance alternative. However, EPS expects that after field studies have characterized CWIS effects, that restoration may be the most feasible and cost-effective measure to meet the performance standards. This might be done alone, or in combination with other intake technologies or operational modifications. However, it might well be that different technologies implemented to achieve CWIS compliance at different electric generating facilities may result in mutual benefits for the regional ecosystem. If mutual benefits of mitigation are identified among different generating facilities, then EPS would then consider establishing a trading program with other generating facilities to achieve the lowest cost, most comprehensive and effective method to comply with the new 316 b rule.

EPS will remain open to seeking comprehensive solutions to the IM&E issues in the region and develop a plan for compliance with the possible cooperation of other water users such that the issue is addressed in the most comprehensive manner for the regional ecosystem.

## 9.0 Impingment Mortality & Entrainment Sampling

An IM&E sampling program was conducted to characterize the fishes and shellfishes affected by impingement and entrainment by the CWIS at the EPS. The data from the study will be used in calculating baseline levels of IM&E against which compliance with performance standards will be measured. A detailed IM&E sampling plan was developed for the IM&E studies (Attachment C) and was previously submitted to the SDRWQCB in August 2004. The sampling plan was approved by the SDRWQCB and the sampling was done for one year starting in June 2004 and continued into June 2005. The report is in the final stages of preparation.

As required in 40 CFR 125.95(b)(3), the results of the IM&E sampling program will be summarized in a report submitted as part of the CDS that includes the following:

- Taxonomic identifications of all life stages of fishes, shellfishes, and any threatened or endangered species collected in the vicinity of the CWIS and are susceptible to IM&E;
- Characterization of all life stages of the target taxa in the vicinity of the CWIS and a description of the annual, seasonal, and diel variations in IM&E; and
- Documentation of the current level of IM&E of all life stages of the target taxa.

The goal of the study was to characterize the fishes and shellfishes affected by impingement and entrainment by the EPS CWIS. The studies examined losses at the EPS resulting from impingement of juvenile and adult fishes and macroinvertebrates on traveling screens during normal operations and during heat treatment operations and entrainment of ichthyoplankton and invertebrates into the cooling water intake system. The sampling methodologies and analysis techniques were derived from recent impingement and entrainment studies conducted for the AES Huntington Beach Generating Station (MBC and Tenera 2005), and the Duke Energy South Bay Power Plant (Tenera 2004). The studies at Huntington Beach were performed as part of the CEC California Environmental Quality Act (CEQA) process for permitting power plant modernization projects, while the South Bay project was for 316(b) compliance.

### 9.1 Assessment of Cooling Water Intake System Effects

Considerable effort among regulatory agencies and the scientific community has been expended on the evaluation of power plant intake effects over the past three decades. Power plant intake effects occur due to impingement of larger organisms onto the intake screens and entrainment of smaller organisms through the CWIS that are smaller than the screen mesh on the intake screens. For the purposes of the EPS study we assumed that both processes lead to mortality of all impinged and entrained organisms. The variety of approaches developed to assess the CWIS impacts reflects the many differences in power plant locations and resource settings (MacCall et al. 1983). The various approaches have been divided into those that offer a judgment on the presence or absence of impact and those that describe the sensitivity of populations to varying operational conditions. These efforts have helped to establish the context for the modeling approaches being used to estimate impingement and entrainment effects at the EPS.

Impact assessment approaches that will be used in the analysis of the entrainment data include:

- Adult-Equivalent Loss (*AEL*) (Horst, 1975; Goodyear, 1978);
- Fecundity Hindcasting (*FH*) proposed by Alec MacCall, NOAA/NMFS, and is related to the adult-equivalent loss approach; and
- Empirical Transport Model (ETM), which is similar to the approach described by MacCall et al. (1983), and used by Parker and DeMartini (1989).

The application of several models to estimate power plant effects is not unique (Murdoch et al. 1989; PSE&G 1993; Tenera 2000a; Tenera 2000b). Equivalent Adult Modeling (*AEL* and *FH*) is an accepted method that has been used in many 316(b) demonstrations (PSE&G 1993; Tenera 2000a; Tenera 2000b). The advantage of demographic models like *AEL* and *FH* is that they translate losses into adult fishes that are familiar units to resource managers. Estimates of entrainment losses from these demographic models can be combined with estimated losses to adult and juvenile organisms due to impingement to provide combined estimates of cooling water system effects. The U.S. Fish and Wildlife Service proposed the empirical transport model (*ETM*) to estimate mortality rates resulting from cooling water withdrawals at power plants (Boreman et al. 1978, 1981). The *ETM* estimates the conditional mortality due to entrainment while accounting for spatial and temporal variability in distribution and vulnerability of each life stage to power plant withdrawals. The *ETM* provides an estimate of power plant effects that may be less subject to inter-annual variation than demographic model estimates. It also provides an estimate of population-level effects not provided by demographic approaches. But the *ETM* calculations require information about the composition and abundance of larval organism from the source water, necessitating the collection of samples from additional stations. A description of each of these models and how they will be used to evaluate data collected in the IM&E study is included in the study plan (Attachment C).

The assessment approach used in the final report in the CDS for the EPS will also depend upon the facility's baseline calculations and its method(s) of compliance with the 316(b) Phase II performance standards for reductions in impingement mortality and entrainment. Compliance at EPS may be achieved by implementing either singly, or in combination the following: technological or operational changes to the CWIS (TIOP), restoration methods, or site-specific BTA standards. To demonstrate compliance through the TIOP it is only necessary to analyze impingement and entrainment data to determine baseline levels and assess those levels against the improvements achieved through the implementation of the TIOP. In the case where restoration is limited to only commercially or recreationally important species (use species), impingement and entrainment data may also be adequate to assess the levels of restoration necessary to offset impingement and entrainment losses, assuming that scientifically valid population models exist for the species providing the lost benefits. In assessing compliance with the performance standard in whole or in part through restoration of habitat to include non-recreational and non-commercial species (non-use species) in addition to the losses of use species it is necessary to assess the impingement and entrainment losses also from the source water using a combination of assessment methods to determine the commensurate level of restoration. The same source water and entrainment data, and assessment methods would also be used to determine a site-specific BTA standard based on cost-benefit analysis of entrainment losses to all use and non-use species. Source water data would not be necessary for cost-benefit analysis based simply on the value of use species losses.

## 9.2 Target Species

Analysis of CWIS effects will be done on the most abundant organisms in the samples, and commercially or recreationally important species from entrainment and impingement samples. All fishes and shellfishes during the impingement sampling were identified and up to fifty individuals of each species of fishes, crabs, shrimp, lobsters, octopus, and squid were measured and weighed. In instances where more than fifty individual of any one species were collected, the first fifty were measured and the rest were counted and then weighted as a group. All other invertebrates were recorded as present. The following marine organisms were sorted, identified and enumerated from entrainment intake and source water plankton samples:

**Vertebrates:**

- Fishes (all life stages beyond egg)

**Invertebrates:**

- Rock crab megalopal larvae (*Cancer* spp.)
- California spiny lobster phyllosoma larvae (*Panulirus interruptus*)

These groups were also analyzed in most of the recent entrainment studies in southern California, including the AES Huntington Beach Generating Station. Fishes and rock crab larvae were selected because of their respective ecological roles or commercial and/or recreational fisheries importance. The California spiny lobster was selected because of its commercial and/or recreational importance in the area.

The organisms analyzed will be limited to taxa that are sufficiently abundant to provide reasonable assessment of impacts. For the purposes of this study plan, we will limit the analysis to the most abundant taxa that comprise 90 percent of all larvae entrained and/or juveniles and adults impinged by the EPS. The most abundant organisms are used in the assessment because they provide the most robust and reliable estimates of CWIS effects. Since the most abundant organisms may not necessarily be the organisms that experience the greatest effects on the population level, the data will be examined carefully before the final selection of target species to determine if additional species should be included in the assessment. This may include commercially or recreationally important species, and species with limited habitats.

### 9.3 Impingement

The following is a summary of the methods used to collect impingement samples at the EPS. More complete details are included in the attached 316(b) Cooling Water Intake Effects Entrainment and Impingement Sampling Plan (Attachment C). Sampling was completed during both normal operations periods and tunnel recirculation (heat treatment) events.

Each normal operations impingement survey was conducted over a 24-hour period one day each week from mid June 2004 through mid June 2005. Prior to each survey any accumulated debris and organisms on the bar racks and traveling screens was removed and discarded. Each 24-hour survey was divided into six 4-hour cycles. The traveling screens at EPS take approximately 30-35 minutes to complete a complete rotation and washing. The traveling screens generally remained stationary for a period of about 3.5 hours and then are rotated and washed for 30-35 minutes depending on traveling screen rotation speed. All impinged material rinsed from the traveling screens was rinsed into its respective collection basket. The impinged material was removed from these baskets and all organisms removed from the debris. Due to the design of the intake traveling screens, there are three collection basket assemblies, one for Units 1-3, one for Unit 4, and one for Unit 5. All impinged material from each set of screens was processed and recorded separately. Length and weight of up to 50 individual of each taxa of impinged fishes, crabs, lobsters, shrimp, gastropods, some pelecypods, octopus, and squid were recorded. If more than 50 individuals of any taxa were impinged on any set of screens during a single cycle, this extra group was counted and its total bulk weight was determined and recorded. All other invertebrates were recorded as present when observed. The amount and general identity of the debris collected during each screen cycle was also recorded. The number of circulating water pumps in operation during each survey, obtained from operator logs was used to calculate the volume of water passing through the traveling screens during each survey. The number of screens rotated during each cycle was also recorded during the screen washing periods.

EPS conducts tunnel recirculations to control biofouling organisms growing on the intake conduits. During these events, all impinged organism washed off the traveling screens and rinsed into the collection baskets were removed from debris and identified, counted, and measured using the same procedures used during the normal operations surveys. A total of six tunnel recirculations took place during this 2004-2005 study period.

The abundance and biomass of the organisms impinged during the once per week normal operations sampling will be used to estimate the impingement for the entire year by first estimating the weekly impingement. This is done by combining the information on the impinged organisms with the total circulating water flow for the period between surveys. These weekly estimates are then combined to estimate the annual impingement rate during normal operations. All organism impinged during tunnel recirculation events are combined with those impinged during normal operations to generate an estimate of the overall annual impingement of the CWS.

## 9.4 Entrainment

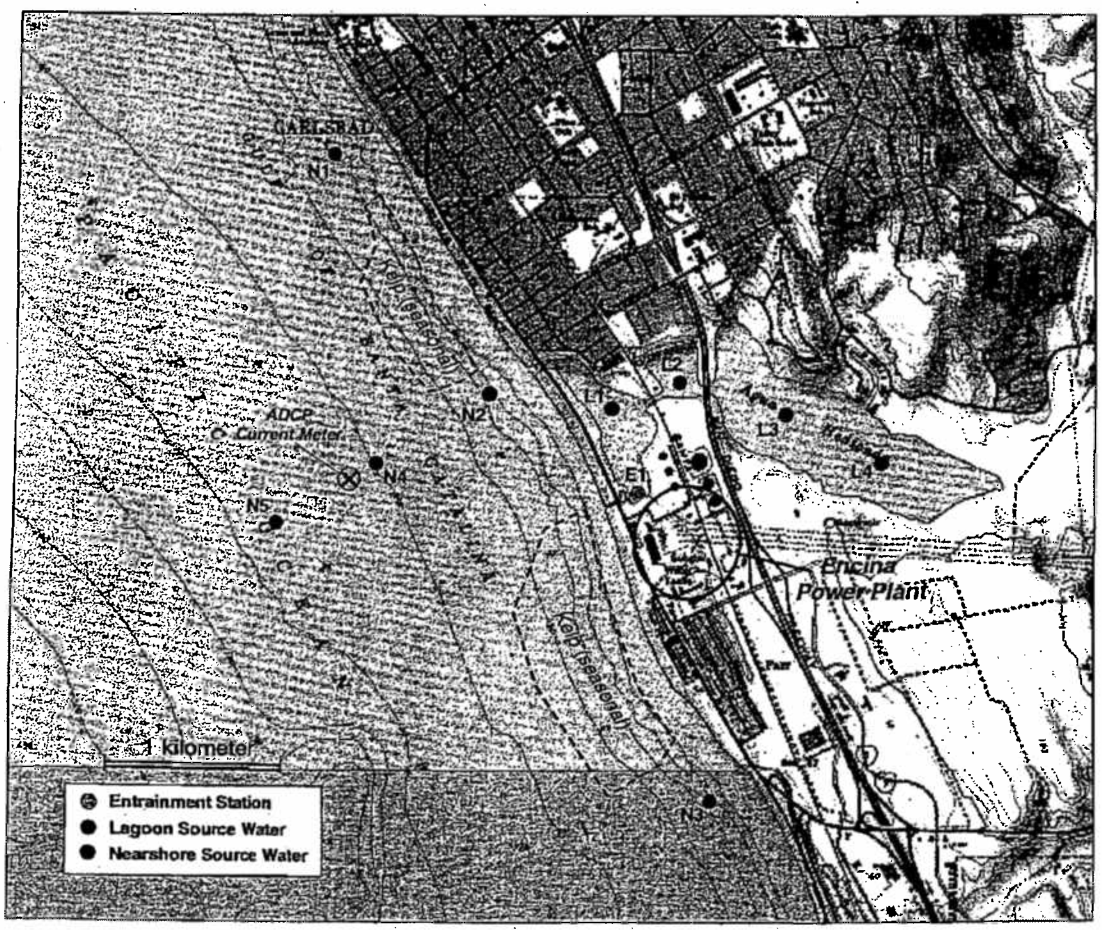
The following is a summary of the methods used to collect entrainment and source water plankton samples at the EPS. More complete details are included in the attached 316(b) Cooling Water Intake Effects Entrainment and Impingement Sampling Plan (Attachment C).

Sampling to determine the composition and abundance of larval fishes, *Cancer* spp. megalopae, and spiny lobster larvae at the EPS intake structure and in the local vicinity began in June 2004. The sampling was completed monthly thereafter, with the final sampling being completed in May 2005. Samples during each of these monthly surveys were collected over a 24-hour period, with sampling being divided into four 6-hour periods. Sampling was conducted near the intake structure to estimate larval entrainment, and at eight nearby stations in two sub-areas (~~three~~ Four stations in the AHL and five stations in the nearshore) to estimate larvae in the source water (Figure 7-1).

The samples at the entrainment location (E1), at all the nearshore stations (N#), and at the Outer Lagoon station (L1) were collected using a bongo net frame equipped with two 0.71 m (2.33 feet) diameter opening with attached 335 μm (0.013 in) mesh plankton nets and codends. Each net had a calibrated flowmeter that was used to determine the volume of water filtered during sample collection. Samples were collected by first lowering the frame and nets from the surface to as close to the bottom as practical without contacting it, and then moving the boat forward and retrieving the nets at an oblique angle. The target volume of the combined volume filter through both nets was at least 2,120 feet$^3$ (60 m$^3$). After retrieving the nets from the water, all collected material was rinsed into the codend. The collected material from both nets was placed into a labeled jar and preserved.

Due to the shallow depths in the vicinity of the Middle (L2) and Inner Lagoon (L3 and L4) stations, especially during low tides, samples at these stations were collected using a different sampling protocol. These stations are sampled using a single plankton net and frame attached to the bow of a small boat that pushes the net through the water and collects a sample from approximately the upper 1 meter of water. By placing the net on the bow of the boat, the net collects a sample from undisturbed water. The collected material was rinsed into the codend and then placed into a labeled jar and preserved.

**Figure 9-1**
**Location of EPS Entrainment (E1) and Source Water Stations (L1 through L4, and N1 through N5).**



# 10.0 Summary

This PIC has been prepared in accordance with 40 CFR 125.95(b)(1) and is being submitted to the SDRWQCB prior to implementation of information collection activities. The following is a brief summary of the information collection activities described in this document that will be undertaken to support the development of the CDS, the plan for compliance with IM&E performance standards outlined in the EPA 316(b) Phase II Rule.

## 10.1 Evaluation of IM&E Reduction Measures

The EPS has selected several intake technologies, operational measures, and restoration measures that will be evaluated to determine effectiveness and feasibility of implementation, either alone or in combination, to achieve the required reductions in IM&E. In summary, these include the following:

Intake Technologies:

- Modified traveling screens with fish return
- New fine mesh screening structure

Operational Measures:

- Circulating water flow reductions / caps
- Variable speed drives for circulating water pumps
- Heat Treatment Operational Changes

Restoration Measures:

- Restoration or Enhancement of AHL various)
- Restoration or Enhancement of Agua Hedionda Watershed (various)
- Restoration or Enhancement of Nearshore coastal projects (various)

Preliminary assessments of these IM&E reduction measures will be conducted to determine those which warrant further evaluation. A more detailed evaluation of those measures will be conducted and a combination of the most feasible measures proposed to meet IM&E performance standards will be presented in the CDS.

## 10.2 Impingement Mortality & Entrainment Sampling Plan

The IM&E Characterization Study Plan that was the basis for the 2004-2005 EPS IM&E Study is included in Attachment C. The study plan described the collection, analysis, and evaluation methodologies for the twelve months of impingement and entrainment sampling data at the EPS.

The following are the main components of the sampling effort:

Impingement:

1. Weekly impingement sampling at each CWIS during normal plant operations
2. Impingement sampling at the CWIS during each heat treatment cycle

Entrainment:

1. Monthly entrainment sampling at the CWIS
2. Source waterbody sampling at five near shore source water locations and four lagoon source water locations

The characterization study plan also describes the sampling, quality assurance / quality control (QA/QC), and data management procedures that will be used in the study. Results of the study will be used to:

1. Determine the current level of IM&E occurring at the CWIS.
2. Compare the level of IM&E occurring due to the location, design, and operation of each existing CWIS with that which would occur if the CWIS were designed as a "calculation baseline" intake.
3. Determine the additional level of reduction in IM&E that would be required to meet performance standards.
4. Assist in the determination of the most feasible combination of intake technologies, operational measures, and/or restoration measures that may be implemented to reduce IM&E to vulnerable species.

## 10.3 Agency Review of PIC

As required by the EPA 316(b) Phase II regulation, this PIC is being submitted in accordance with the schedule requested by EPS in a letter dated January 6, 2005 to the SDRWQCB. The regulation requires that the SDRWQCB *"provide their comments expeditiously (i.e. within 60 days) to allow facilities time to make response modifications in their information collection plans"* (Federal Register, Vol. 69, No. 131, Pg. 41635). EPS has completed the IM&E sampling following its approved plan (Attachment C) and is working toward completing the final study report. The EPS PIC represents the rest of the requirement information to comply with the PIC requirements of Phase II 316(b) and EPS respectfully requests that SCRWQCB approve the PIC within 60 days such that work may begin on the CDS in order to meet the January 8, 2008 due date.

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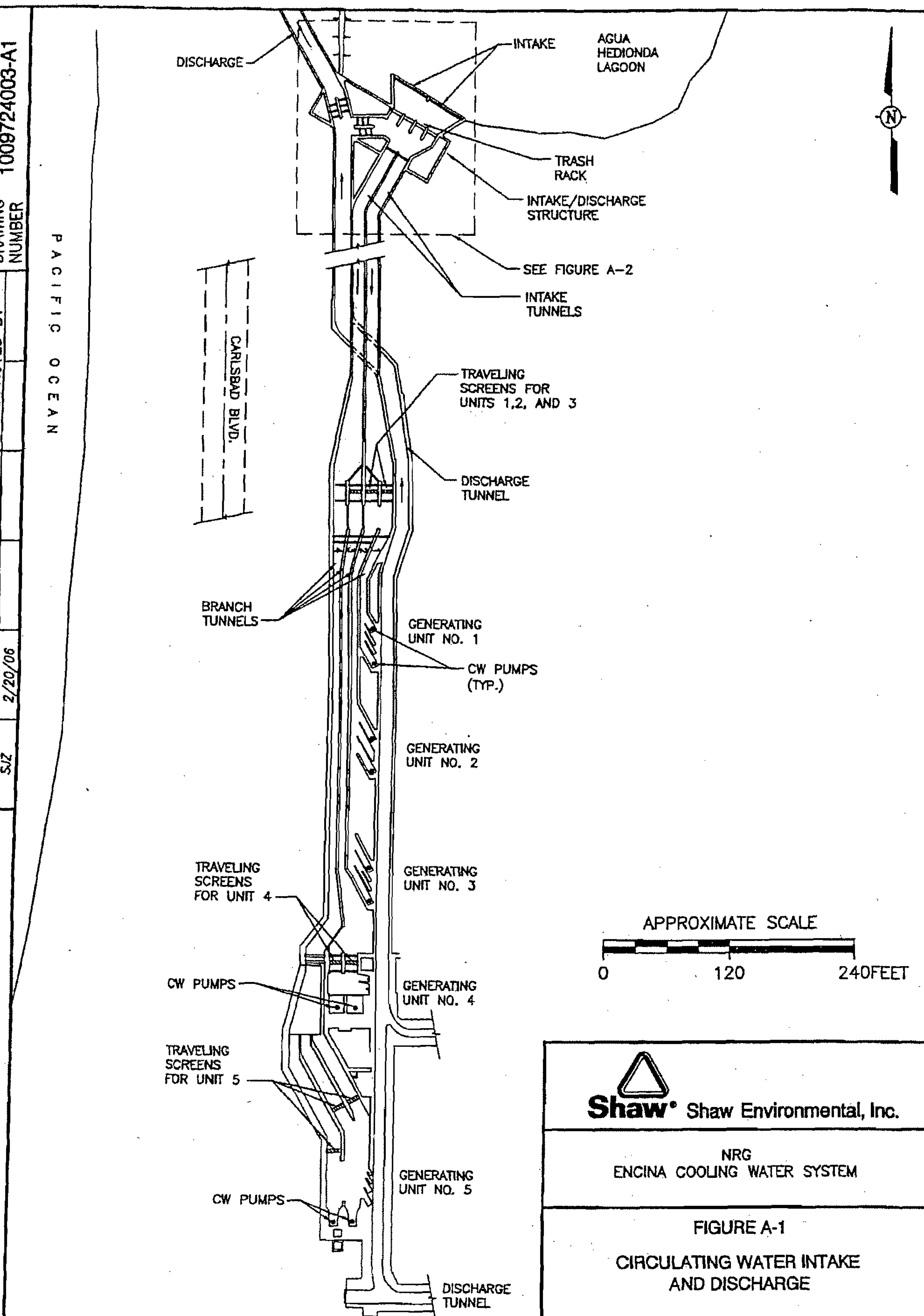
***Attachment A***
***Structural Design Drawings***




Shaw® Shaw Environmental, Inc.

NRG
ENCINA COOLING WATER SYSTEM

FIGURE A-1

CIRCULATING WATER INTAKE AND DISCHARGE

| DRAWN BY | CHECKED BY | APPROVED BY | DRAWING NUMBER |
|---|---|---|---|
| SJZ 2/20/06 | | | 1009724003-A1 |

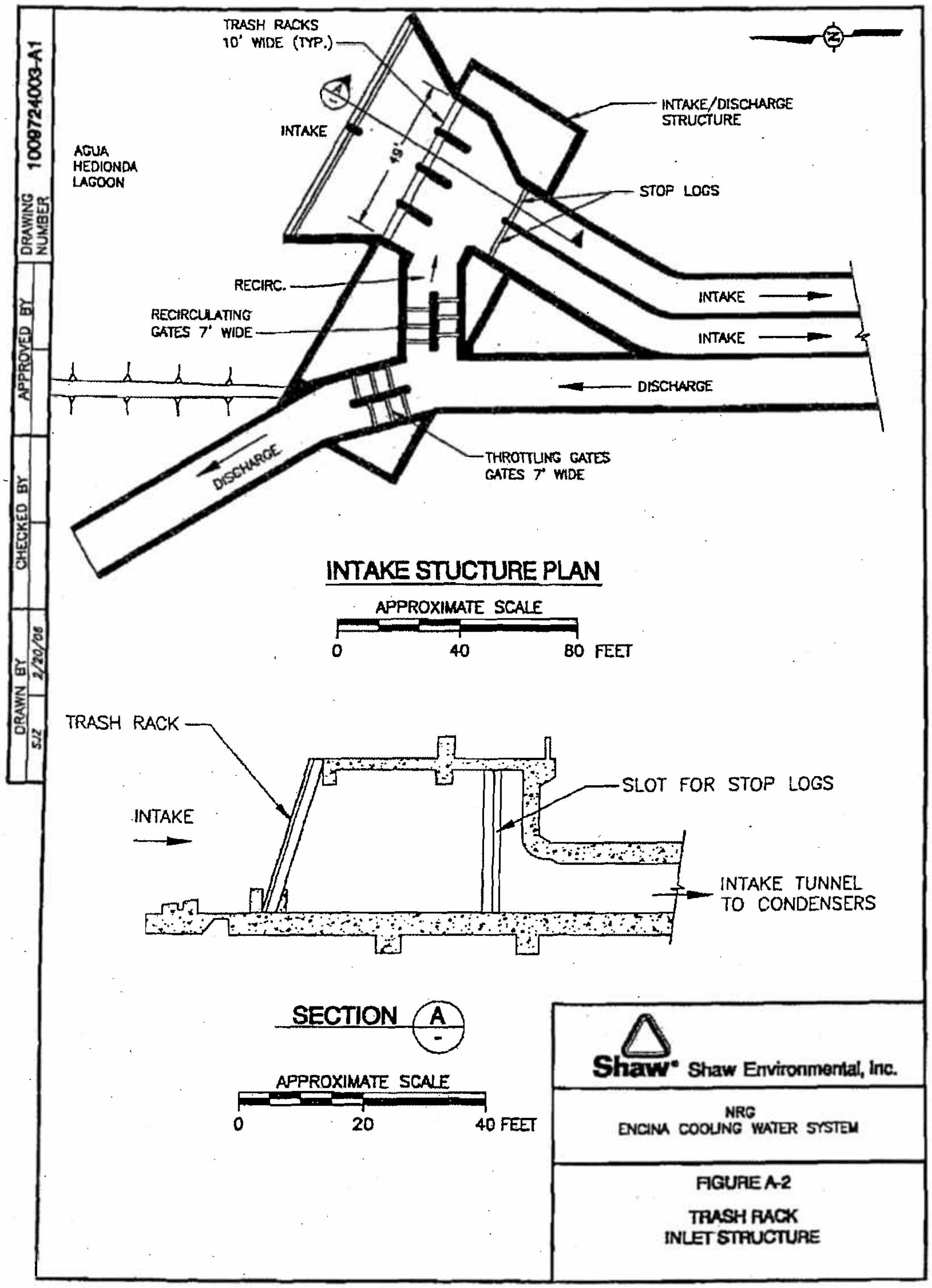



FIGURE A-2
TRASH RACK INLET STRUCTURE

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Carlsbad, CA 92008-4301

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**NRG CABRILLO POWER OPERATIONS INC.**

January 10, 2005

Mr. John Phillips
San Diego Regional Water Quality Control Board
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4340

**RE: Cabrillo Power I LLC – Encina Power Station; Request for Schedule to Submit Information to Comply with the Phase II 316(b) Rule (40 CFR Part 125 Subpart J)**

**Ref: NPDES Permit Number CA0001350, Order No. 2000-03**

Dear Mr. Phillips,

By this letter Cabrillo Power I LLC (Cabrillo) requests a schedule for submitting the information required by EPA's new Phase II 316(b) Rule for cooling water intake structures for the Encina Power Station (EPS). For the reasons to be presented in the following letter, Cabrillo requests your approval to allow the information required by 40 CFR 125.95 to be submitted to you no later than January 7, 2008. In our circumstances, this date is as "expeditious as practicable." The basis for our request is explained below.

As you know, on July 9, 2004, EPA published its final rule prescribing how "existing facilities" may comply with Section 316(b) of the Clean Water Act.[1] For most existing facilities, this rule will require a large amount of data to establish "best technology available" for the facility's intake structure and to demonstrate compliance with the rule.

EPS is a "Phase II existing facility" within the meaning of 40 CFR 125.91. As such, it is required to comply with the Phase II rule, and in particular to submit the studies and information required by 40 CFR 125.95.

Section 125.95 of the new rule requires detailed studies and other information to establish what intake structure technology or other measures will be used to comply with the rule. Ordinarily this material is to be submitted with the facility's next application for renewal of its NPDES permit.[2] For permits that expire less than four years after the rule was published on July 9, 2004 (that is, before July 9, 2008), the facility may have up to three and half years to submit the information, so long as it is submitted "as expeditiously as practicable."[3] The facility may

[1] 69 Fed. Reg. 41575, 41683 (July 9, 2004).
[2] 40 CFR 125.95, 122.21(r)(1)(ii), 122.21(d)(2).
[3] 40 CFR 125.95(a)(2)(ii).

have even longer, until the end of the permit term, under 40 CFR 122.21(d)(2)(i), if the permitting agency agrees.

The current NPDES permit for EPS expires on February 9, 2005, well before July 9, 2008. Therefore, Cabrillo hereby requests that you authorize the information called for in 125.95 to be submitted as expeditiously as practicable, which, as explained below, will require until January 7, 2008.

In order to satisfy the "expeditiously as practicable" requirement, it should be noted that Cabrillo began the process of collecting the necessary information even before the final rule was published. Cabrillo actually began as early as 2003 to begin collecting information and conducting internal evaluations on how the, at that time draft, requirements could be complied with at EPS. Such information collection included preliminary technology assessments and research into existing data and information. Cabrillo also initiated an impingement and entrainment sampling program in June 2004 that is scheduled to conclude toward the end of 2005.

Despite our early efforts, we will still need until January 7, 2008, to complete the studies and collect the information required by 40 CFR 125.95. Our detailed explanation is presented below by first summarizing the significant number of informational requirements that must be submitted and then concludes by presenting the schedule by which the information would be submitted.

**Cooling Water System Data**

First, all facilities covered by the Phase II Rule must submit "cooling water system data" as required by 40 CFR 122.21(r)(5). This includes a narrative description of the operation of the cooling water system, its relationship to cooling water intake structures, the proportion of the design intake flow that is used in the system, the number of days of the year the cooling water system is in operation, and the seasonal changes in the operation of the system, if applicable. It also includes design and engineering calculations prepared by a qualified professional and supporting data to support the description of the operation of the cooling water system.[4] This information must be submitted at the same time as the Comprehensive Demonstration Study as discussed below.[5]

**Proposal for Information Collection**

Under 40 CFR 125.95(a)(1), Cabrillo must also submit a Proposal for Information Collection (PIC). Preparing the PIC is a large undertaking. The PIC must contain the items listed in 40 CFR 125.95(b)(1), including a description of proposed and/or implemented technologies, operational measures, and/or restoration measures to be evaluated, a list and description of historical studies characterizing impingement mortality and entrainment and/or the

[4] 40 CFR 122.21(R)(5)(i) and (ii).
[5] 40 CFR 125.95(a)(2).

physical and biological conditions in the vicinity of the cooling water intake structures and their relevance to the proposed study. For existing data, it must demonstrate the extent to which the data are representative of current conditions and that the data were collected using appropriate quality assurance/quality control procedures. The PIC must also include a summary of past or ongoing consultations with federal, state and tribal fish and wildlife agencies and a copy of their written comments, as well as a sampling plan for any new field studies describing all methods and quality assurance/quality control procedures for sampling and data analysis. As you know, Cabrillo already submitted the sampling plan portion of the PIC on September 2, 2004, which was later approved by the San Diego Regional Water Quality Control Board (Regional Board). The impingement and entrainment sampling actually commenced in June 2004 and is expected to conclude toward the end of 2005.

Because of the magnitude and specialized nature of the information to be submitted in the PIC, Cabrillo will have to contract with an outside consulting firm to obtain qualified personnel to perform the work and to handle the increased workload. Cabrillo's contractor procurement process has precise steps that must be undertaken to conform to internal policies and procedures and applicable law.

Including the time it takes to contract with a qualified consulting firm and to develop the PIC using the impingement and entrainment data collected during 2004 and 2005, Cabrillo believes a comprehensive PIC could not be submitted for the Regional Board's review and approval any earlier than April 1, 2006. Cabrillo asks that the Regional Board either approve it or advise us of any needed changes within 60 days as described in 40 CFR 125.95(a)(1), 125.95(b)(1).

**Comprehensive Demonstration Study**

The Comprehensive Demonstration Study (CDS), as described in 40 CFR 125.95(b), includes many mandatory sections that require substantial effort and time to develop and submit. Many sections of the CDS require that the information collection process described in the PIC be completed prior to being able to initiate those sections of the CDS. Because the PIC data collection will not be completed until early 2006, as described below in the Impingement Mortality and/or Entrainment Characterization Study section, much of the CDS will have to be completed during calendar years 2006 and 2007. This will most likely be a significant time constraint due to the level of work required by the Phase II 316(b) regulation. Below, ESP will describe each section of the CDS in detail, providing ample justification that Cabrillo's proposed complete CDS submission schedule is "as expeditiously as practicable."

Source Water Flow Information

Because EPS does not operate on a river or a lake, no specific source waterbody flow information is required to be submitted.[6]

Impingement Mortality and/or Entrainment Characterization Study

Cabrillo must provide, pursuant to 40 CFR 125.95(b)(3), an Impingement Mortality and/or Entrainment Characterization Study. This study must include (i) taxonomic identifications of all life stages of fish, shellfish, and any species protected under federal, state, or tribal law that are in the vicinity of the cooling water intake structures and are susceptible to impingement and entrainment; (ii) a characterization of all life stages of fish, shellfish, and any protected species, including a description of the abundance and temporal and spatial characteristics in the vicinity of the cooling water intake structures, based on sufficient data to characterize annual, seasonal, and diel variations in impingement mortality and entrainment (e.g., related to climate and weather differences, spawning, feedings, and water column migration). These may include historical data that are representative of current operation of the facility and of biological conditions at the site.

Cabrillo must also document the current impingement mortality and entrainment of all life stages of fish, shellfish, and protected species and provide an estimate of impingement mortality and entrainment to be used as the "calculation baseline."[7] This may include historical data representative of the current operation of the facility and of biological conditions at the site. Impingement mortality and entrainment samples to support the calculations must be collected during periods of representative operational flows for the cooling water intake structure, and the flows associated with the samples must be documented.

Cabrillo expects to submit, within the PIC document, justification for using the historical and representative impingement and entrainment data as well as the new data being collected during calendar years 2004 and 2005. As described above, impingement and entrainment sampling at EPS was initiated in June 2004 and is expected to continue through the end of 2005, which includes the necessary time to complete taxonomic identification, modeling, and development of draft and final reports.

Cabrillo plans on submitting its final PIC after submittal and review of the Impingement and Entrainment Characterization Study Final Report so that all of the collected information and its results can be incorporated into the development of the PIC. This appears to be the most efficient and complete way to produce the PIC, as the information from that study is necessary to complete the other components of the PIC, as described above. Since the Impingement and Entrainment Characterization Study Final Report is not expected to be complete until the end of 2005, the most expeditious submittal date for the final PIC is April 1, 2006.

[6] 40 CFR 125.95(b)(2) only requires source water information for facilities that withdraw water from rivers or lakes other than the Great Lakes. Although not specifically required, a characterization of the source water will be provided in the report on the results of the Impingement and Entrainment Characterization Study.
[7] 40 CFR 125.95(b)(3)(iii).

Design and Construction Technology Plan

Another analysis that must be provided is the Design and Construction Technology Plan.[8] If Cabrillo decides to use design and construction technologies and/or operational measures to comply with the Phase II rule, a plan must be submitted that provides the capacity utilization rate for the intake structure at EPS and provide supporting data (including the average annual net generation of the facility in MWh) measured over a five-year period (if available) of representative operating conditions and the total net capacity of the facility in MW, along with the underlying calculations. The plan must explain the technologies and/or operational measures that Cabrillo has in place and/or have selected to meet the requirements of the rule.

This Design and Construction Technology Plan must contain a large amount of information, as described in 40 CFR 125.95(b)(4)(A)-(D). This information includes (A) a narrative description of the design and operation of all design and construction technologies and/or operational measures, including fish handling and return systems, and information that demonstrates the efficacy of the technologies and/or operational measures; (B) a narrative description of the design and operation of all design and construction technologies and/or operational measures and information that demonstrates the efficacy of the technologies and/or operational measures for entrainment; (C) calculations of the reduction in impingement mortality and entrainment of all life stages of fish and shellfish that would be achieved by the technologies and/or operational measures we have selected; and (D) design and engineering calculations, drawings, and estimates prepared by a qualified professional to support the descriptions described above.

Technology Installation and Operation Plan (TIOP)

Assuming Cabrillo decides that the best way to comply with the Phase II rule is to use design and construction technologies and/or operational measures, in whole or in part, we must submit to you the following information, in accordance with 40 CFR 125.95(b)(4)(ii): (A) A schedule for the installation and maintenance of any new design and construction technologies; (B) a list of operational and other parameters to be monitored and the location and frequency that we will monitor them; (C) a list of activities we will undertake to ensure to the degree practicable the efficacy of installed design and construction technologies and operational measures and our schedule for implementing them; (D) a schedule and methodology for assessing the efficacy of any installed design and construction technologies and operational measures in meeting applicable performance standards or site-specific requirements, including an "adaptive management plan" for revising design and construction technologies, operational measures, operation and maintenance requirements, and/or monitoring requirements in the event the assessment indicates that applicable performance or site-specific requirements are not being met; and (E) if Cabrillo chooses the compliance alternative in 125.94(a)(4) (wedge-wire screens or a technology approved by the state), documentation that the appropriate site conditions described in 125.99(a) or (b) exist at our facility.

[8] 40 CFR 125.95(b)(4).

Restoration Plan

If Cabrillo determines that restoration measures are the best method to comply with the new rule, in whole or in part, then a Restoration Plan must be submitted in the CDS. This plan must include the information described in 40 CFR 125.95(b)(5). It must include a plan using an adaptive management method for implementing, maintaining, and demonstrating the efficacy of the restoration measures that are selected and for determining the extent to which the restoration measures, or the restoration measures in combination with design and construction technologies and operational measures, have met the applicable performance standards.

Site-Specific Requirements

If Cabrillo determines that site-specific requirements are appropriate because the cost of complying with the Phase II rule will be "significantly greater" than either the cost that EPA considered in its rulemaking or the benefits of complying with the rule, then Cabrillo will have to submit the information described in 40 CFR 125.95(b)(6). This includes a Comprehensive Cost Evaluation Study and, for the cost-benefit analysis, a Benefits Evaluation Study. Cabrillo must also include a Site-Specific Technology Plan describing and justifying the site-specific requirements.

Verification Monitoring Plan

Finally, Cabrillo must prepare a Verification Monitoring Plan as part of a complete CDS.[9] This is a plan to conduct, at a minimum, two years of monitoring to verify the full-scale performance of the proposed or already implemented technologies and/or operational measures.

**PIC and CDS Schedule**

The first official submittal (besides this request for a schedule) that Cabrillo will make to the Regional Board in compliance with the Phase II 316(b) regulation will be the PIC. For the reasons explained above, Cabrillo proposes to submit a comprehensive PIC for the Regional Board's review and approval by April 1, 2006. Cabrillo asks that the Regional Board either approve the PIC or advise us of any needed changes within 60 days as described in 40 CFR 125.95(a)(1), 125.95(b)(1).

Because Cabrillo plans to collect substantial new information as part of the expected PIC, and since the report presenting the results of the new impingement and entrainment data collected in 2004 and 2005 will not be finalized until the end of 2005, and allowing for the period of time the Regional Board has to review and approve the PIC, it is unlikely that the information needed to commence the majority of the sections of the CDS (including the Design and Construction Technology Plan, the Technology Installation and Operation Plan, the

[9] 40 CFR 125.95(b)(7).

Restoration Plan (if applicable), the Site Specific Requirements (if applicable), and the Verification Monitoring Plan) will be available until mid to late 2006.

Due to the step by step process by which the data must be collected, processed, evaluated, and then turned into a detailed plan of action to achieve the new Phase II 316(b) standards, Cabrillo does not believe a comprehensive CDS can be submitted earlier than January 7, 2008. It is for these important reasons that Cabrillo believes the most expeditious schedule possible for submittal of a comprehensive CDS is by January 7, 2008.

**Conclusion**

Collecting, generating, compiling, and analyzing the large amount of information required by the Phase II 316(b) rule will require a substantial effort. Cabrillo will have to collect and review the large volumes of already-existing data on the plant and the source waterbody, as well as integrate the substantial new biological information currently being collected.

Because the Phase II rule is new and untried, we foresee the need to coordinate closely with your department as we collect the necessary information, analyze it, and determine what combination of technology, operational measures, or restoration measures will best meet the Phase II rule for EPS. Cabrillo hopes your staff will be available to consult with us throughout this schedule as we complete these efforts.

For the above reasons, we request that we be allowed until January 7, 2008, to submit the information required for a permit application by the Phase II Rule, 40 CFR Part 125 Subpart J.

Sincerely,
Cabrillo Power I LLC
By: Its Authorized Agent,

By: NRG Cabrillo Power Operations Inc.
Gregory J. Hughes
Regional Plant Manager

cc: [redacted]
Sheila Henika (Cabrillo)
John Steinbeck (Tenera)
Pedro Lopez (Cabrillo)
Hashim Navrozali (Regional Board)

***Attachment C***
***Impingement Mortality & Entrainment Characterization Study Sampling Plan***

**Encina Power Station**
4600 Carlsbad Boulevard
Carlsbad, CA 92008-4301

Direct: (760) 268-4000
Fax: (760) 268-4026

## NRG CABRILLO POWER OPERATIONS INC.

September 2, 2004

Mr. John R. Phillips, P.E.
Senior Water Resource Control Engineer
San Diego Regional Water Quality Control Board
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4340

Subject: **Cabrillo Power I LLC - Encina Power Station; Phase II 316(b) Entrainment and Impingement Sampling Plan**

Dear Mr. Phillips;

Cabrillo Power I LLC (Cabrillo) is pleased to submit a plan to conduct entrainment and impingement sampling for the Encina Power Station (EPS) to comply with the US EPA's recently published Phase II rule for compliance with Section 316(b) of the Clean Water Act. The approval of the EPS Entrainment & Impingement Sampling Plan (E&I Plan) is one of the early steps in the facility's compliance with the Phase II rule. Cabrillo requests expedited review and approval of this E&I Plan in order to optimize the sampling synergies available by virtue of the data collection efforts already underway on behalf of Poseidon Resources (Poseidon) for their proposed desalination project at EPS.

This sampling plan was prepared by Tenera Environmental (Tenera), which is the same firm that prepared the desalination sampling plan submitted to the San Diego Regional Water Quality Control Board (San Diego RWQCB) on behalf of Poseidon in July 2004. Consistent with that sampling plan, Poseidon has already collected several complete sets of entrainment and source water samples at EPS. The Poseidon study plan and collected data will produce information on the larval fish and target invertebrates contained in Poseidon's source of desalination feedwater (the power plant's cooling water discharge), as well as information on the larval fish and target invertebrates contained in the power plant's source waterbody and intake flows.

Data being collected for Poseidon on the power plant's source population of entrainable larval fish and target invertebrates is identical to the information Cabrillo will be required to collect and analyze for EPS Phase II 316(b) studies. Tenera has prepared this sampling plan to seamlessly and consistently continue the collection of the Poseidon entrainment data. In that way, Cabrillo can continue the sampling effort for compliance with the new Phase II performance standards in an efficient and cost-effective manner.

In the past five years, Tenera has completed 316(b) resource assessments for the Diablo Canyon Nuclear Power Plant, Moss Landing Power Plant, Morro Bay Power Plant and Potrero Plant. Tenera study design and assessment methods are also being employed in the ongoing 316(b) studies for the Huntington Beach Generating Station. Throughout these projects, Tenera has worked closely with State and Federal agencies in the development of their field study, impact assessment, and benefits evaluation methods. Tenera has also just recently completed a 316(b) resource assessment for the South Bay Power Plant that has been presented in final form to the San Diego RWQCB. Cabrillo's proposed E&I Plan has been developed in consideration of, and in keeping with, the 316(b) study rationales, content, sampling methodology, analysis and reporting that were used in the South Bay Power Plant 316(b) Assessment (Duke Energy South Bay, May 2004), as well as all of the power plants listed above.

This submission of the EPS E&I Plan is intended to meet part of the requirements for the Proposal for Information Collection (PIC) section of the Phase II 316(b) regulation, but not to address all of the PIC requirements at this time. All of the sampling plan requirements specified in Section 125.95(b)(1)(iv) are incorporated into the EPS E&I Plan. At a later date, Cabrillo will submit the remainder of the PIC requirements pursuant to Section 125.95(b)(1). Cabrillo requests approval of this E&I Plan specifying how new E&I data will be collected, but acknowledges that the San Diego RWQCB will be able to review the other portions of the PIC once submitted by Cabrillo.

Therefore, in order to provide continuous, efficient and cost-effective sampling at EPS, Cabrillo requests that the San Diego RWQCB expedite review and approval of this E&I Plan. Cabrillo understands that San Diego RWQCB is considering retaining an outside consultant in order to provide timely response to this request. Cabrillo is available and prepared to work with your staff and the consultant to provide any additional clarification necessary to obtain timely approval.

Please contact Tim Hemig directly at 760.268.4037 if there are any questions.

Sincerely,
Cabrillo Power I LLC
By: Its Authorized Agent,

Gregory J. Hughes

By: NRG Cabrillo Power Operations Inc.
Gregory J. Hughes
Regional Plant Manager

cc: Tim Hemig, Sheila Henika, John Steinbeck (Tenera)

## Cabrillo Power I LLC, Encina Power Station

# 316(b) Cooling Water Intake Effects Entrainment and Impingement Sampling Plan

*Submitted to the California Regional Water Quality Control Board – San Diego Region for Compliance with Section 316(b) of the Clean Water Act*

**September 2, 2004**


*Prepared by:*
**Tenera Environmental**
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# 1.0 INTRODUCTION

## 1.1 Development of the 316(b) Sampling Plan

This document presents a sampling plan for conducting the entrainment and impingement sampling necessary for a cooling water intake assessment required under Section 316(b) of the Federal Clean Water Act (CWA). Our sampling plan is based on a survey and compilation of available background literature, results of completed Encina Power Station (EPS) intake studies, and cooling water system studies at other power plants. The data from this study will form the basis of demonstrating compliance with the new Phase II regulations recently developed by the U.S. Environmental Protection Agency (USEPA).

## 1.2 Overview of the 316(b) Program

Section 316(b) of the Clean Water Act requires that "the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact" (USEPA 1977). Because no single intake design can be considered to be the best technology available at all sites, compliance with the Act requires a site-specific analysis of intake-related organism losses and a site-specific determination of the best technology available for minimizing those losses. Intake-related losses include losses resulting from entrainment (the drawing of organisms into the cooling water system) and impingement (the retention of organisms on the intake screens).

### *1.2.1 Target Organisms Selected for Study*

The USEPA in its original 316(b) lists several criteria for selecting appropriate target organisms for assessment including the following:

1. representative, in terms of their biological requirements, of a balanced, indigenous community of fish, shellfish, and wildlife;
2. commercially or recreationally valuable (e.g., among the top ten species landed—by dollar value);
3. threatened or endangered;
4. critical to the structure and function of the ecological system (i.e., habitat formers);
5. potentially capable of becoming localized nuisance species;
6. necessary, in the food chain, for the well-being of species determined in 1–4; and
7. meeting criteria 1–6 with potential susceptibility to entrapment/impingement and/or entrainment.

In addition to these USEPA criteria there are certain practical considerations that limit the selection of target organisms such as the following:

- identifiable to the species level;
- collected in sufficient abundance to allow for impact assessment, i.e., allowing the model(s) constraints to be met and confidence intervals to be calculated; and
- having local adult and larval populations (i.e., source not sink species). For example, certain species that may be relatively abundant as entrained larvae may actually occur offshore or in deep water as adults.

These criteria, results from the previous 316(b) studies at EPS completed in 1980, results from a supplemental 316(b) study completed in 1997 (EA Engineering 1997), results from more recent studies on the ecological resources of Aqua Hedionda Lagoon (MEC Analytical Systems 1995), and data collected from studies described in this document will be used to determine the appropriate target organisms that will be evaluated in detail. The final target taxa will include the fishes that are found to be most abundant in the entrainment and impingement samples. In addition to large invertebrates that may be abundant in impingement, megalopal (final) larval stage of all species of cancer crabs (*Cancer* spp., which includes the edible species of rock crabs) and the larval stages of California spiny lobster will be identified and enumerated from all processed entrainment and source water plankton samples.

## 1.3 Sampling Plan Organization

This sampling plan first describes the EPS environment, design, and operating characteristics. The methods for obtaining updated information on the types and concentrations of planktonic marine organisms entrained by the power plant's CWIS are then discussed. A discussion of the theoretical considerations behind the assessment methods for the entrainment and impingement data is then presented. The final 316(b) report will also include an overview of alternative intake technologies and an analysis of feasible alternatives and their cost-effectiveness to minimize adverse entrainment and impingement effects of the EPS CWIS.

# 2.0 DESCRIPTION OF THE ENCINA POWER STATION AND CHARACTERISTICS OF THE SOURCE WATER BODY

## 2.1 Background

The Encina Power Station (EPS) is situated on the southern shore of the outer segment of the Agua Hedionda Lagoon in the city of Carlsbad, California, approximately 193 km (85 miles) south of Los Angeles and 16 km (35 miles) north of San Diego. EPS is a gas- and oil-fueled generating plant with five steam turbine generators (Units 1 through 5), which all use the marine waters of Agua Hedionda Lagoon for once-through cooling, and a small gas turbine generator. EPS began withdrawing cooling water from Agua Hedionda Lagoon in 1954 with the startup of commercial operation of Unit 1. Unit 2 began operation in 1956, Unit 3 in 1958, Unit 4 in 1973, and Unit 5 in 1978. The gas turbine was installed in 1968, which does not use cooling water in its operation. The combined net generation capacity of EPS is 966 megawatts electric (Mwe) (**Table 1**).

### *2.1.1 Plant Cooling Water System Description and Operation*

Cooling water for the five steam electric generating units are supplied by two circulating and one or two service water pumps for each unit. The quantity of cooling water circulated through the plant is dependent upon the number of units in operation. With all units in full operation, the cooling water flow through the plant is 2,253 $m^3$/min (595,200 gallons per minutes [gpm]) or 3,244,430 $m^3$/day (857 million gallons per day [mgd]) based on the manufacturer ratings for the cooling water pumps (**Table 1**).

**Table 1.** Encina Power Station generation capacity and cooling water flow volume.

| Unit | Gross Generation (MWe) | Cooling Water Flow $m^3$/min (gpm) | Daily Flow $m^3$/day (mgd) |
|---|---|---|---|
| 1 | 107 | 193 (51,000) | 278,000 (73) |
| 2 | 104 | 193 (51,000) | 278,000 (73) |
| 3 | 110 | 204 (54,000) | 294,350 (78) |
| 4 | 300 | 806 (213,000) | 1,161,060 (307) |
| 5 | 325 | 856 (226,200) | 1,233,010 (326) |
| Gas Turbine | 20 | | |
| **Total** | *966* | **2,252 (595,200)** | **3,244,430 (857)** |

Cooling water for all five steam-generating units is supplied through a common intake structure located at the southern end of the outer segment of Aqua Hedionda Lagoon, approximately 854 m (2,800 ft) from the opening of the lagoon to the ocean (**Figure 1**). Cooling water from the system is discharged into a small discharge pond that is located to the west of the intake structure. Water from the discharge pond flows through a culvert under Carlsbad Blvd and through a discharge canal across the beach and out to the ocean.

Seawater entering the cooling water system passes through metal trash racks on the intake structure that are spaced 8.9 cm (3½ in) apart and keep any large debris from entering the system. The trash racks are cleaned periodically. Behind the trash racks the intake tapers into two 3.7 m (12 ft) wide tunnels that further splits into four 1.8 m (6 ft) wide conveyance tunnels (**Figure 2**). Conveyance tunnels 1 and 2 provide cooling water for Units 1, 2 and 3, while conveyance tunnels 3 and 4 supply cooling water to Units 4 and 5, respectively. Vertical traveling screens prevent fish and debris from entering the cooling water system and potentially clogging the condensers. There are two traveling screens for Units 1, 2 and 3, two screens for Unit 4, and three screens for Unit 5. The mesh size on the screens for Units 1 through 4 is 0.95 cm (3/8 in), while the mesh size for Unit 5 is 1.6 cm (5/8 in).

The traveling screens can be operated either manually or automatically when a specified pressure differential is detected across the screens due to the accumulation of debris. When the specified pressure is detected the screens rotate and the material on the screen is lifted out of the cooling water intake. A screen wash system (70-100 psi), located at the head of the screen, washes the debris from each panel into a trough, which empties into collection baskets where it is accumulated until disposal.

The velocity of the water as it approaches the traveling screens has a large effect on impingement and entrainment and varies depending on the number of pumps operating, tidal level, and cleanliness of the screen faces. Approach velocities at high and low tide with all pumps operating were presented in the previous 316(b) study conducted in 1979 and 1980 (**Table 2**).

**Table 2.** Approach velocities at traveling screens for Encina Power Station with all circulating water and service water pumps in operation.

| | Estimated Mean Approach Velocity (fps) | |
|---|---|---|
| **Unit** | **High Tide** | **Low Tide** |
| 1 | 0.7 | 1.2 |
| 2 | 0.7 | 1.2 |
| 3 | 0.7 | 1.2 |
| 4 | 1.0 | 1.6 |
| 5 | 0.7 | 1.1 |

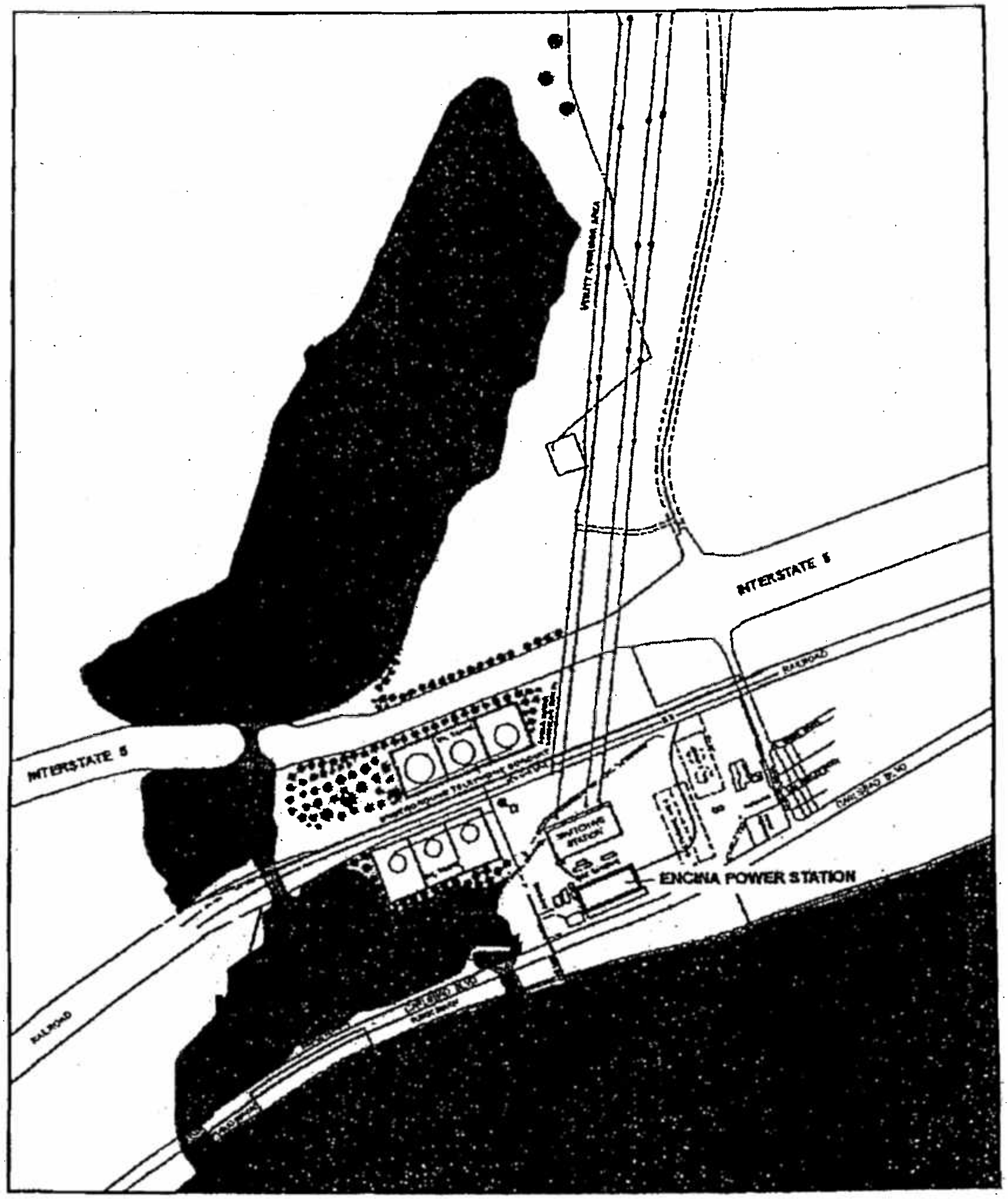


**Figure 1.** Location of Encina Power Station in Carlsbad, California

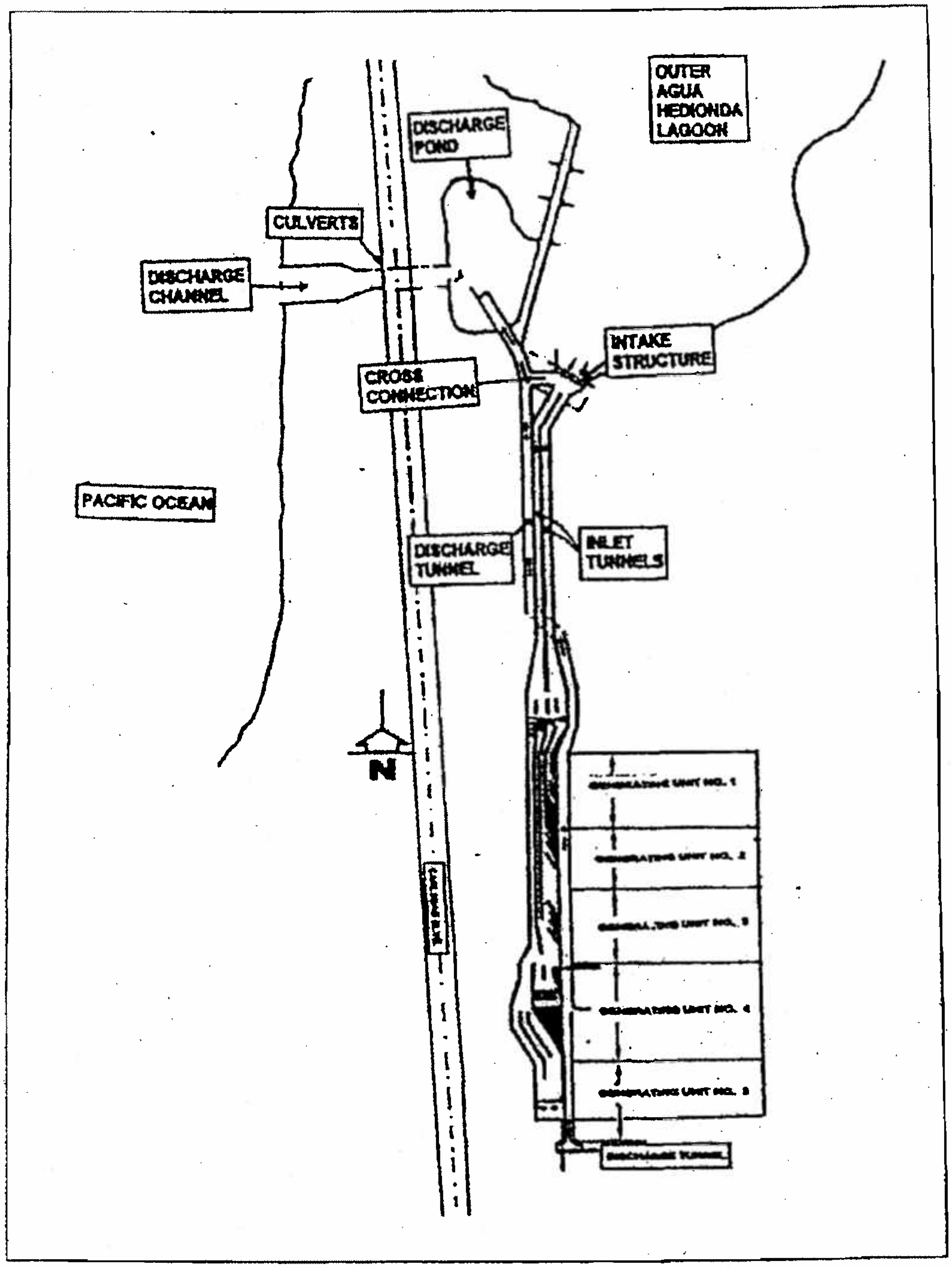


**Figure 2.** Schematic of Encina Power Station cooling water intake system.

## 2.2 Aquatic Biological Resources in the Vicinity of EPS

### 2.2.1 Agua Hedionda Lagoon

The Encina Power Station (EPS) is located on Agua Hedionda Lagoon, which is a man-made coastal lagoon that extends 2.7 km (1.7 miles) inland and is up to 0.8 km (0.5 mi) wide. The lagoon was constructed in 1954 to provide cooling water for the power plant. A railroad trestle and the Interstate Highway 5 bridge separate Agua Hedionda Lagoon into three interconnected segments: an Outer, Middle, and Inner lagoon. The surface areas of the Outer, Middle, and Inner lagoons are 26.7 (66 acres), 9.3 (23 acres), and 79.7 (197 acres) hectares, respectively. The lagoon is separated from the ocean by Carlsbad Boulevard and a narrow inlet 46 m [151 ft] wide and 2.7 m [9 ft] deep at the northwest end of the Outer Lagoon that passes under the highway and allows tidal exchange of water with the ocean.

Circulation and input into Aqua Hedionda Lagoon is dominated by semi-diurnal tides that bring approximately 2.0 million $m^3$ of seawater through the entrance to the Outer Lagoon on flood tides. Approximately half of this tidal volume flows into the Middle and Inner lagoons. On ebb tides this same tidal volume flows out through the entrance to the ocean. As a result of this tidal flushing the lagoon is largely a marine environment. Although freshwater can enter the lagoon through Buena Creek, which drains a 7,500 hectare (18,500 acres) watershed, for most of the year freshwater flow is minimal. Heavy rainfall in the winter can increase freshwater flows, reducing salinity, especially in the Inner Lagoon.

A study on the ecological resources of Agua Hedionda showed that it has good water quality and supports diverse infaunal, bird, and fish communities (MEC Analytical 1995). Eelgrass was found in all three lagoon segments, but was limited to shallower depths in the Inner Lagoon because water turbidity reduces photosynthetic light penetration in deeper areas. The eelgrass beds provide a valuable habitat for benthic organisms that are fed upon by birds and fishes. Although eelgrass beds were less well developed in areas of the Inner Lagoon, it also provides a wider range of habitats, including mud flats, salt marsh, and seasonal ponds that are not found elsewhere in Aqua Hedionda. As a result bird and fish diversity was highest in the Inner Lagoon.

A total of 35 species of fishes was found during the 1994 and 1995 sampling conducted by MEC (MEC Analytical 1995). The Middle and Inner lagoons had more species and higher abundances than the Outer Lagoon. During the 1995 survey only four species were collected in the Outer Lagoon, compared to 14 to 18 species in the Middle and Inner lagoons. The sampling did not include any surveys of the rocky revetment lining the Outer Lagoon that would increase the abundance and number of species collected. Silversides (Atherinopsidae) and gobies (Gobiidae) were the most abundant fishes collected. Silversides, including jacksmelt and topsmelt, that occur in large schools in shallow waters where water temperatures are warmest were most abundant in the shallower Middle and Inner lagoons. Gobies were most abundant in the Inner Lagoon which has large shallow mudflat areas that are their preferred habitat.

*Special Status Species*

The recent assessment of the ecological resources of Agua Hedionda did not collect any federally endangered tidewater goby (*Eucyclogobius newberryi*) that was once recorded from the lagoon (MEC Analytical 1995). The record of the occurrence may not be accurate or may predate the construction of the Outer Lagoon that provided a direct connection with the ocean. The current marine environment in the lagoon would not generally support tidewater gobies because they prefer brackish water habitats. No other listed fish species were collected in the study.

### 2.2.2 Pacific Ocean

Agua Hedionda Lagoon is tidally flushed through the small inlet in the Outer Lagoon by waters from the Pacific Ocean. The physical oceanographic processes of the southern California Bight that influence the lagoon include tides, currents, winds, swell, temperature, dissolved oxygen, salinity and nutrients through the daily tidal exchange of coastal seawater. Near the mouth of the lagoon the mean tide range is 3.7 ft (1.1 m) with a diurnal range of 5.3 ft (1.6 m). Waves breaking on the shore generally range in height from 2 to 4 ft (0.6 to 1.2 m), although larger waves (6 to 10 ft [1.8 to 3.0 m]) are not uncommon. Larger waves exceeding 15 ft (4.6 m) occur infrequently, usually associated with winter storms. Surface water in the local area ranges from a minimum of 57°F (13.9°C) to a maximum 72°F (22.2°C) with an average annual temperature between 63°F (17.2°C) and 66°F (18.9°C).

The outer coast has a diversity of marine habitats and includes zones of intertidal sandy beach, subtidal sandy bottom, rocky shore, subtidal cobblestone, subtidal mudstone and water column. Organisms typical of sandy beaches include polychaetes, sand crabs, isopods, amphipods, and clams. Grunion utilize the beaches around EPS during spawning season from March through August. Numerous infaunal species have been observed in subtidal sandy bottoms. Mollusks, polychaetes, arthropods, and echinoderms comprise the dominant invertebrate fauna. Sand dollars can reach densities of 1,200 per square meter. Typical fishes in the sandy subtidal include queenfish, white croaker, several surfperch species, speckled sanddab, and California halibut. Also, California spiny lobster and *Cancer* spp. crabs forage over the sand. Many of the typically outer coast species can occasionally occur within Agua Hedionda Lagoon, carried by incoming tidal currents.

The rocky habitat at the discharge canal and on offshore reefs supports various kelps and invertebrates including barnacles, snails, sea stars, limpets, sea urchins, sea anemones, and mussels. Giant kelp (*Macrocystis*) forests are an important habitat-forming community in the area offshore from Agua Hedionda. Kelp beds provide habitat for a wide variety of invertebrates and fishes. The water column and kelp beds are known to support many fish species, including northern anchovy, jack smelt, queenfish, white croaker, garibaldi, rockfishes, surfperches, and halibut.

Marine-associated wildlife that occur in the Pacific waters off Agua Hedionda Lagoon are numerous and include brown pelican, surf scoter, cormorants, western grebe, gulls, terns and loons. Marine mammals, including porpoise, sea lions, and migratory gray whales, also frequent the adjacent coastal area.

# 3.0 Entrainment Study and Assessment Methods

Entrainment studies were previously conducted in 1979 and 1980 at the EPS as part of the plant's initial Section 316(b) Demonstration requirement. The original study was conducted using pump sampling for plankton at the intake structure and net sampling of plankton at three source water stations in the Outer Lagoon (SDG&E 1980). For this study, plankton net sampling at the intake station and at an array of source water stations will be used to collect data for impact models that will be used to update the previous 316(b) Demonstration study. The following questions will be addressed by the entrainment and source water studies:

- What is the baseline entrainment mortality?
- What are the species composition and abundance of larval fishes, cancer crabs, and lobsters entrained by the EPS?
- What are the estimates of local species composition, abundance and distribution of source water stocks of entrainable larval fishes, cancer crabs, and spiny lobsters in Agua Hedionda Lagoon and the nearshore oceanic source waters?

The basis for estimation of entrainment effects is accurate knowledge of the composition and densities of planktonic organisms that are at risk of entrainment through the power plant cooling water system. Recent studies addressing 316(b) issues have focused on larval fishes and commercially important crustacean species (Tenera 2001, 2004). The basic study design involves the collection of plankton samples directly from the intake cooling water flow (entrainment sampling) and comparing the densities of various target species from plankton samples taken concurrently from the source water body (source water sampling). In the case of Encina Power Station (EPS), two areas contribute to the source water body; the lagoon sub-area and the nearshore sub-area, each having a unique contribution to the cooling water flows in terms of species composition and probability of entrainment.

## 3.1 Entrainment Study

Field data on the composition and abundance of potentially entrained larval fishes, *Cancer* spp. megalopae, and larval spiny lobster *Panulirus interruptus* will provide a basis to estimate the total number and types of these organisms passing through the power plant's cooling water intake system. For the purposes of modeling and calculations, through-plant mortality will be assumed to be 100 percent; unless otherwise determined through a San Diego RWQCB approved entrainment mortality study. Monthly entrainment and source water surveys started in June 2004 will be continued on a monthly basis through May 2005.

### 3.1.1 Entrainment Sampling Methods

This study was designed to quantify the composition and abundance of entrained larval fishes, *Cancer* spp. megalopae, and spiny lobster larvae. A map of the station locations that were sampled starting in June 2004 is shown in **Figure 3**. These stations will continued to be sampled through May 2005 on a monthly basis.

Sample collection methods are similar to those developed and used by the California Cooperative Oceanic and Fisheries Investigation (CalCOFI) in their larval fish studies (Smith and Richardson 1977) but modified for sampling in the shallow areas of Agua Hedionda Lagoon. Two replicate entrainment samples are collected from a single station (E1) located in front of the EPP intakes by towing plankton nets from a small boat. A net frame is equipped with two 0.71 m (2.33 ft) diameter openings each with a 335 μm (0.013 in) mesh plankton net and codend. The start of each tow begins close to the intake structure, proceeds in a northerly direction against the prevailing intake current, and ends approximately 100 m from the structure. It is assumed that all of the water sampled at the entrainment station would have been drawn through the EPS cooling water system.

The tows are done by first lowering the nets as close to the bottom as practical without contacting the substrate. Once the nets are near the bottom, the boat is moved forward and the nets retrieved at an oblique angle (winch cable at approximately 45° angle) to sample the widest strata of water depths possible. Total time of each tow is approximately two minutes at a speed of 1 kt during which a combined volume of at least 60$m^3$ (2,119 $ft^3$) of water is filtered through both nets. In similar studies conducted by Tenera, this volume has been shown to typically provide a reasonable number and diversity of larvae for data modeling. The water volume filtered is measured by calibrated flowmeters (General Oceanics Model 2030R) mounted in the openings of the nets. Accuracy of individual instruments differed by less than 5% between calibrations. The sample volume is checked when the nets reach the surface. If the target volume is not collected, the tow was repeated until the targeted volume is reached. The nets are then retrieved from the water, and all of the collected material rinsed into the codend. The contents of both nets are combined into one sample immediately after collection. The sample is placed into a labeled jar and preserved in 10 percent formalin. Each sample is given a serial number based on the location, date, time, and depth of collection. In addition, the information is logged onto a sequentially numbered data sheet. The sample's serial number is used to track it through laboratory processing, data analyses, and reporting.

Entrainment samples are collected over a 24-hour period, with each period divided into four 6-hour sampling cycles. Larval fishes show day-night differences in abundances related to their vertical migratory behavior and spawning periodicity, and the 24-hr sampling regime allows these differences to be averaged for assessing entrainment abundances. Concurrent surface water temperatures and salinities are measured with a digital probe (YSI Model 30).

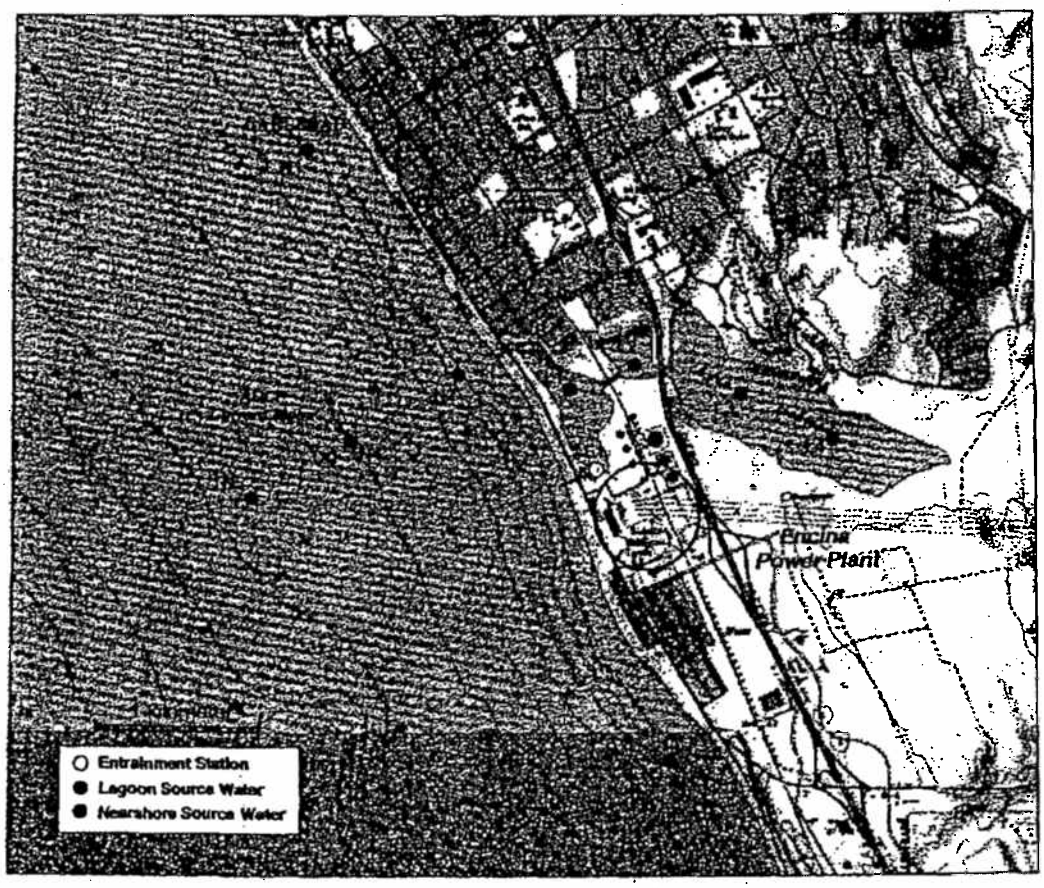


**Figure 3.** Location of Encina Power Station entrainment (E1) and source water stations (L1 through L4, and N1 through N5).

## 3.2 Source Water Study

This study was designed to quantify the local source water composition and abundance of larval fishes, *Cancer* spp. megalopae, and larval *Panulirus interruptus* in Agua Hedionda Lagoon and the nearshore source waters. The source water is partitioned into lagoon and nearshore sub-areas for modeling cooling water withdrawal effects (**Figure 3**). Collection methods are identical to the entrainment sample collection, with the exception that a single paired-net sample is collected at each station and the nearshore samples are be collected from a larger vessel capable of navigating open coastal waters in all weather conditions, day or night. The shallow waters in the Middle and Inner lagoons required a different sampling protocol than the oblique tows used at the Outer Lagoon and nearshore stations. The Inner Lagoon is sampled using a single frame plankton net mounted on the bow of a small boat which pushes the net through the water thereby eliminating any obstructions in front of the net during sampling. The net is raised and lowered during sampling to sample the range of depths available in the shallow Inner Lagoon.

The stations are stratified to include four lagoon stations within the inner (2), middle (1), and outer lagoons (1), and five nearshore stations that cover a depth range of 5–30 m (16–98 ft). The array of locations and depths was chosen to assure that all potential source water community types are represented. For example, stations in the inner lagoon will have a greater proportion of larvae from species with demersal eggs, such as gobies, that spawn in quiet water environments, while nearshore stations will have more larvae of species that spawn in open water such as California halibut and white seabass. The study will allow comparison to earlier larval fish studies done for the original EPS 316(b) in 1979-80 (SDG&E 1980).

A current meter is placed in the nearshore between Stations N4 and N5. The data from the meter will be used to characterize currents in the nearshore area that would directly affect the dispersal of planktonic organisms that could be entrained by the power plant. The data will be used to define the size of the nearshore component of the source water by using the current speed and the estimated larval durations of the entrained organisms.

The number of source water stations will be evaluated as data become available to determine if fewer stations can be sampled. For example, a reduction in the number of stations may be recommended if analysis indicates that only one station is necessary to characterize the Inner Lagoon, or the Middle Lagoon is sufficiently similar to the Inner Lagoon that it does not need to be sampled separately. Analysis of current meter data may also indicate that Station N5 does not need to be sampled because the current is predominantly alongshore and can be adequately characterized using the other stations closer to shore.

### 3.2.1 Source Water Sampling Methods

Sampling is conducted using the same methods and during the same time period described earlier for the entrainment collections (Section 3.1.1) with target volumes for the oblique tows of approximately 60 $m^3$ (2–3 minute tow at approximately 1 knot).

## 3.3 Laboratory Processing and Data Management

Laboratory processing will remove all larval fishes, megalopal stages of *Cancer* spp., and larvae of spiny lobster from the samples. Fish eggs will not be sorted from the samples. Although many marine fish eggs are described in the scientific literature, most identifications are difficult and very time consuming, and impact models can be adequately parameterized without egg density data. Larval fishes and all species of cancer crab megalopae will be identified to the lowest taxonomic level possible by Tenera's taxonomists. In addition, the developmental stage of fish larvae (yolk-sac, preflexion, flexion, postflexion, transformation) will be recorded on the data sheet. A laboratory quality control (QC) program for all levels of laboratory sorting and taxonomic identification will be applied to all samples. The QC program will also incorporate the use of outside taxonomic experts to provide taxonomic QC and resolve identification uncertainties.

Many larval fish cannot be identified to the species level; these fish will be identified to the lowest taxonomic classification possible (e.g., genus and species are lower orders of classification than order or family). Myomere and pigmentation patterns are used to identify many species; however, this can be problematic for some species. For example, sympatric members of the family Gobiidae share similar characteristics during early life stages (Moser 1996), making identifications to the species level uncertain. Those gobiids that we are unable to identify to species will be grouped into an "unidentified goby" category.

Laboratory data sheets will be coded with species or taxon codes. These codes will be verified with species/taxon lists and signed off by the data manager. The data will be entered into a computer database for analysis.

Length measurements will be taken on a representative sample of the target larval fish taxa. Approximately 100 fish from each taxon will be measured using a video capture system and Optimus™ image analysis software. The 100 fish from each taxon will be selected from the entrainment station based on the percentage frequency of occurrence of a taxon in each survey. For example, if 20 percent of the California halibut larvae for the entire year-long study were collected from during the June survey then 20 fish will be measured from that survey.

## 3.4 Assessment Methods

Potential cooling water intake system (CWIS) entrainment effects will be evaluated using a suite of methods, with no single method being superior to any others. The potential entrainment effects of the EPS CWIS, assuming 100 percent through-plant mortality, will be estimated using the site-specific field data collected in this proposed study. The potential for any such CWIS effects to cause long-term population level impacts will be evaluated through the use of three analytical techniques: proportional entrainment (*PE*), adult equivalent loss (*AEL*), and fecundity hindcasting (*FH*). The results of these analytical steps will support assessments with respect to species population demographics (e.g., standing stock, age structure stability, fishery trends, and sustainable harvest management plans).

### *3.4.1 Demographic Approaches (*FH *and* AEL*)*

The fecundity hindcasting or *FH* analysis approach (Horst 1975) compares larval entrainment losses with adult fecundity to estimate the amount of adult female reproductive output eliminated by entrainment. It thereby hindcasts the numbers of adult females effectively removed from the reproductively active population. The accuracy of these estimates of effects is dependent upon such factors as accurate estimates of age-specific mortality from the egg and early larval stages to entrainment, and also on age-specific estimates of adult fecundity, spawning periodicity, and reproductive lifespan. If it is assumed that the adult population has been stable at some current level of exploitation and that the male:female ratio is known and constant, then fecundity and mortality are integrated into an estimate of loss by converting entrained larvae back into females (i.e., hindcasting). In making this conversion, the number of eggs, derived from the number of larvae adjusted for egg to larvae mortality, are divided by the average number of eggs produced by each age class (size) of reproductive females in the stable population's ideal age structure. However this degree of information is rarely available for a population. In most cases, a simple range of eggs per females is reported without age-specificity.

An advantage of *FH* is that survivorship need only be estimated for a relatively short period of the larval stage (i.e., egg to larva). This method does not require source water sampling in addition to estimates of larval entrainment concentrations. This method assumes that the loss of a single female's reproductive potential is equivalent to the loss of adults. For the purpose of the resource assessment, if EPS-induced entrainment losses are to be equated to population level units in terms of fractional losses, it is still necessary to estimate the size of the population of interest. To this end, our assessment will employ any available, scientifically acceptable sources of information on fisheries stock or population estimates of unexploited species entrained by the EPS.

The adult equivalent loss or *AEL* approach (Goodyear 1978) uses age-specific estimates of the abundance of entrained or impinged organisms to project the loss of equivalent numbers of adults based on mortality schedules and age at recruitment. The primary advantage of this approach is that it translates power plant-induced, early life-stage mortality into equivalent numbers of adult fishes, the units used by resource managers. Adult equivalent loss does not necessarily require source water estimates of larval abundance in addition to entrainment estimates, as required in *PE*. This latter advantage may be offset by the need to gather age-specific mortality rates to predict adult losses and the need for information on the adult population of interest for estimating population-level effects (i.e., fractional losses). However, the need for age-specific mortality estimates can be reduced by various approximations as shown by Saila et al. (1987), who used six years of entrainment and two years of impingement data for winter flounder *Pleuronectes americanus*, red hake *Urophycis chuss*, and pollock *Pollachius virens* at the Seabrook Station in New Hampshire. Their model assumed an adult population at equilibrium, a stable age distribution, a constant male:female ratio, and an absence of density-dependent (i.e., compensatory) mortality between entrainment and recruitment to the adult or fished stocks. Input data to their model parameters were gathered in field surveys of spawning populations, egg and larval production, and local hydrology.

Declining populations can be accounted for in both the *AEL* and *FH* approaches by using age-specific adult mortality estimates from fishery catch data and by assuming no compensatory mortality. However, we know that this is not an assumption that fits the reality of population dynamics. The removal (mortality) of any life stage will have an effect if it exceeds the number of reproductive adults required to produce that number of larvae. That is, the adult population will decline one for one with every larva lost. This is clearly not the case, nor does every larva survive to become an adult. Although we have essentially no way of estimating the degree to which a population can sustain losses and remain stable, it is an important issue when estimating long-range effects. The effect, known as density-dependence (sometimes called compensation), can affect the vital rates of impacted organisms. Density-dependence is not confined to acting through mortality; growth and fecundity may also be density-dependent. In fisheries management models, which we will take as our working models in forecasting long-term population trends, the level of compensation possible in species can be examined empirically by the response of its population to harvest rates.

Some entrainment studies have assumed that compensation is not acting between entrainment and the time when adult recruitment would have taken place, and further, that this specific assumption resulted in conservative estimates of projected adult losses (Saila et al. 1987). Others, such as Parker and DeMartini (1989), did not include compensatory mortality in estimates of equivalent adult losses because of a lack of consensus on how to include it in the models and, more importantly, uncertainty about how compensation would operate on the populations under study. The uncertainty arises because the effect of compensation on the ultimate number of adults is directly related to which of the vital processes (fecundity, somatic growth, mortality) and which life stages are being affected. In particular, Nisbet et al. (1996) showed that neglecting compensation does not always lead to conservative long-term estimates of equivalent adult losses.

### 3.4.2 Empirical Transport Model (ETM)

The *PE* approach (Boreman et al. 1978, Boreman et al. 1981) will provide an estimate of incremental (conditional, Ricker 1975) mortality imposed by EPS on local source water larval populations by using empirical data (plankton samples) rather than relying solely on hydrodynamic and demographic calculations. Consequently, *PE* requires an additional level of field sampling to characterize abundance and composition of larvae using results from the larval fish surveys defined in this document (Section 3.2.1). These estimates of species-specific fractional losses (entrainment losses relative to source water abundance) can then be expanded to predict regional effects on appropriate adult populations using an empirical transport model (*ETM*), as described below. Required parameters for the *PE* approach include the rate of cooling water withdrawal, estimates of entrained larval fish concentrations, and estimates of the larval fish concentrations in the source waters.

The use of *PE* as an input to the empirical transport model (*ETM*) has been proposed by the U.S. Fish and Wildlife Service to estimate mortality rates resulting from cooling water withdrawals by power plants (Boreman et al. 1978, and subsequently in Boreman et al. 1981). Variations of this model have been discussed in MacCall et al. (1983) and have been used to assess impacts at a southern California power plant (Parker and DeMartini 1989). The *ETM* has also been used to assess impacts at the Salem Nuclear Generating Station in Delaware Bay, New Jersey (PSE&G 1993) as well as other power stations along the East Coast. Empirical transport modeling permits the estimation of annual conditional mortality due to entrainment while accounting for the spatial and temporal variability in distribution and vulnerability of each life stage to power plant withdrawals. The generalized form of the *ETM* incorporates many time-, space-, and age-specific estimates of mortality as well as information regarding spawning periodicity and duration, many of which are limited or unknown for the marine taxa being investigated at EPS. The applicability of the *ETM* to the present study at EPS will be limited by a lack of either empirically derived or reported demographic parameters needed as input to the model. However, the concept of summarizing *PE* over time that originated with the *ETM* can be used to estimate entrainment effects over appropriate temporal scales either through modeling or by making assumptions about species-specific life histories. We will employ a *PE* approach that is similar to the method described by MacCall et al. (1983) and used by Parker and DeMartini (1989) in their final report to the California Coastal Commission (Murdoch et al. 1989), as an example for the San Onofre Nuclear Generating Station (SONGS). This estimate can then be summarized over appropriate blocks of time in a manner similar to that of the *ETM*.

# 4.0 IMPINGEMENT EFFECTS

The two primary ways cooling water withdrawal can affect aquatic organisms are through impingement and entrainment. Larger organisms are subjected to impingement on the screening system on the power plant's cooling water intake system (CWIS) that excludes debris from the circulating water pumps. EPS presently has seven sets of vertical traveling screens in three separate areas. Approach velocities vary from approximately 0.7 fps at high tide to 1.6 fps at low tide. Impingement occurs when an organism larger than the traveling screen mesh size is trapped against the screens. These impinged organisms are assumed to undergo 100 percent mortality for the purposes of this study. The following questions will be addressed by the impingement study:

- What is the baseline impingement mortality?
- What are the species composition and abundance of fishes and macroinvertebrates impinged by EPS?

## 4.1 Review of 1980 Impingement Study

In earlier impingement studies at EPS, fish samples were collected from screen washes during high and low impingement periods for one year (SDG&E 1980). Samples were collected over two-12 hour periods during each day to represent daytime and nighttime impingement. Since samples were collected every day the study provides a direct measure of EPS impingement. During the one-year period during normal plant operations 76 species of fishes and 45 species of macro-invertebrates totaling 85,943 individuals and weighing 1,548 kg (3,414 lb) were impinged. During the seven heat treatments conducted during the sampling period 108,102 fishes weighing 2422 kg (5,341 lb) were collected. The most abundant fishes collected in impingement samples were actively swimming, open-water schooling species such as deepbody and northern anchovy, topsmelt, and California grunion. Other abundant species included queenfish and shiner surfperch. During heat treatments larger fishes were collected that were less common during normal impingement. These larger fishes probably live in the CWIS and are able to avoid impingement during normal plant operation, but succumb to the warmer temperatures during heat treatment. Marine plants, largely eelgrass and giant kelp, made up the largest component of material in impingement samples.

Impingement losses at EPS were much less when compared with impingement at other coastal plant in southern California. Impingement was much greater at the Redondo Beach Generating Station and San Onofre Nuclear Generating Station Unit 1, even though the cooling water flows at those two facilities are less than the flow at EPS (673 and 500 MGD, respectively compared with 828 mgd at EPS). The intake approach velocities at the screenwells at EPS are lower than the velocities at these other facilities allowing most fishes to avoid impingement by continuous or burst swimming. The SDG&E report (SDG&E 1980) and a later evaluation (EA 1997) both concluded that the biological impact of EPS was insignificant in terms of impingement losses.

## 4.2 Impingement Study Methods

The purpose of the proposed 316(b) impingement study will be to characterize the juvenile and adult fishes and selected macroinvertebrates (e.g., shrimps, crabs, lobsters, squid, and octopus) impinged by the power plant's CWIS. The sampling program is designed to provide current estimates of the abundance, taxonomic composition, diel periodicity, and seasonality of organisms impinged at EPS. In particular, the study will focus on the rates (i.e., number or biomass of organisms per $m^3$ water flowing per time into the plant) at which various species of fishes and macroinvertebrates are impinged. The impingement rate is subject to tidal and seasonal influences that vary on several temporal scales (e.g., hourly, daily, and monthly) while the rate of cooling water flow varies with power plant operations and can change at any time. A review of the previous impingement study at EPS will provide context for interpreting changes in the magnitude and characteristics of the present day impingement effects. Studies of the Agua Hedionda fish assemblages independent of EPS (e.g., MEC Analytical 1995) will also provide information regarding the marine environment in southern and central Agua Hedionda Lagoon.

In accordance with procedures employed in similar studies, impingement sampling will occur over a 24-hour period one day per week. Before each sampling effort, the trash racks will be cleaned and the traveling screens will be rotated and washed clean of all impinged debris and organisms. The sluiceways and collection baskets will also be cleaned before the start of each sampling effort. The operating status of the circulating water pumps on an hourly basis will be recorded during the collection period. Each 24-hour sampling period at the traveling screens will be divided into six 4-hour cycles. The traveling screens will remain stationary for a period of 3.5 hours then they will be rotated and washed for 30 minutes. The trash racks will be cleaned once every 24 hours. The impinged material from the traveling screens will be rinsed into the collection baskets associated with each set of screens and the impinged material from the trash racks will be collected in the bin on the rake apparatus. The debris and organisms rinsed from each set of traveling screens and the trash racks will be kept separate and processed according to the procedures presented in the following section.

If the traveling screens are operating in the continuous mode, then sampling will be coordinated with the intake crew so samples can be collected safely. A log containing hourly observations of the operating status (on or off) of the circulating water pumps for the entire study period will be obtained from the power plant operation staff. This will provide a record of the amount of cooling water pumped by the plant, which will then be used to calculate impingement rates. The same procedure will be used to coordinate additional sampling efforts at the trash racks in case they need to be cleaned more frequently than once every 24 hours. The sampling at each of the three sets of traveling screens will be offset by one hour to allow screen wash and collection to occur at each set of screens separately.

Impingement sampling will also be conducted during heat treatment "tunnel shock" operations. Procedures for heat treatment will involve clearing and rinsing the traveling screens prior to the start of the heat treatment procedure. At the end of the heat treatment procedure normal pump operation is resumed and the traveling screens rinsed until no more fish are collected on the screens. Processing of the samples will occur using the same procedures used for normal impingement sampling. We anticipate that up to eight heat treatments will occur during the one-year study period.

A quality control (QC) program will be implemented to ensure the correct identification, enumeration, length and weight measurements of the organisms recorded on the data sheet. Random cycles will be chosen for QC re-sorting to verify that all the collected organisms were removed from the impinged material.

Depending on the number of individuals of a given target species present in the sample, one of two specific procedures is used, as described below. Each of these procedures involves the following measurements and observations:

1. The appropriate linear measurement for individual fishes and motile invertebrates is determined and recorded. These measurements are made in millimeters to the nearest 1 mm. The following standard linear measurements are used for the animal groups indicated:

| | |
|---|---|
| Fishes | Total body length for sharks and rays and standard lengths (fork length) for bony fishes. |
| Crabs | Maximum carapace width. |
| Shrimps & Lobsters | Carapace length, measured from the anterior margin of carapace between the eyes to the posterior margin of the carapace. |
| Gastropod & Pelecypod Molluscs | Maximum shell length or maximum body length. |
| Octopus | Maximum "arm" spread, measured from the tip of one tentacle to the tip of the opposite tentacle. |
| Squid | Maximum body length, measured from the tip of one tentacle to the posterior end of the body. |

2. The wet body weight of individual animals is determined after shaking loose water from the body. Total weight of all individuals combined is determined in the same manner. All weights are recorded to the nearest 1 g.

3. The qualitative body condition of individual fishes and macroinvertebrates is determined and recorded, using codes for decomposition and physical damage. These codes are shown on the attached form.

4. Other non-target, sessile macroinvertebrates are identified to species and their presence recorded, but they are not measured or weighed. Rare occurrences of other impinged animals, such as dead marine birds, are recorded and their individual weights determined and recorded.

5. The amount and type of debris (e.g., *Mytilus* shell fragments, wood fragments, etc.) and any unusual operating conditions in the screen well system are noted by writing specific comments in the "Notes" section of the data sheet.

The following specific procedures are used for processing fishes and motile invertebrates when the number of individuals per species in the sample or subsample is $\leq 29$ :

1. For each individual of a given species the linear measurement, weight, and body condition codes are determined and recorded on separate lines.

The following specific subsampling procedures are used for fishes and motile invertebrates when the number of individuals per species is > 29:

1. The linear measurement, individual weight, and body condition codes for a subsample of 30 individuals are recorded on individual lines of the data sheet. The individuals selected for measurement should selected after spreading out all of the individuals in a sorting container, making sure that they are well mixed and not segregated into size groups. Individuals with missing heads or other major body parts are eliminated from consideration, since linear measurements of them are not representative.

2. The total number and total weight of all the remaining individuals combined are determined and recorded on a separate line.

### 4.2.1 Sampling Frequency

Results from the previous impingement study indicated that the impingement is much greater during the heat treatment "tunnel shock" events. Almost 60 percent of the total impinged fishes (over 60 percent by weight) were collected during the seven tunnel shock events. Impingement rates during normal operations were much less. Although we have proposed to sample normal impingement weekly, we will evaluate the potential to reduce the sampling frequency to once every two weeks. The analysis will be done using the weekly data collected at EPS during this study and data from other southern California power plants with shoreline intake structures. The reduced sampling frequency may provide an adequate estimate of impingement especially since we will continue to sample impingement during each of the tunnel shock events when impingement is highest.

# 5.0 Cooling Water System Impact Assessment

The entrainment and impingement effects of the cooling water intake system for the EPS project will be assessed on the basis of historical studies and 12 months of recent plankton and 12 months of impingement survey information. The assessment will consider the effects of entraining larval fishes, crabs and lobsters, and impinging larger fishes and invertebrates in the CWIS. The three methods for assessing CWIS effects are fecundity hindcasting (*FH*), adult equivalent loss (*AEL*) and empirical transport modeling (*ETM*). These methods were explained in Section 3.5—Assessment Methods. The report will contain estimates of *AEL* and *FH* where data are available to parameterize these demographic approaches.

The impacts of impingement and entrainment on source water populations can be evaluated by estimating the fractional losses to the population attributable to the CWIS. Impingement rates and biomass estimates from the study will provide estimates of impingement losses that can then be translated directly to estimate potential impingement effects on local fisheries. Estimated entrainment losses are extrapolated to fishery losses using *FH* and *AEL* estimates. One constraint in the modeling approach is that life history data are available for only a portion of the entrained taxa and commercial fishery statistics will also only be available for a few of the entrained species (e.g., California halibut, northern anchovy, white croaker). Many of the fishes that have historically been entrained in highest numbers are small fishes that are not the focus of any recreational or commercial fishery.

Present-day findings on the EPS CWIS entrainment effects will be reviewed and assessed for the most abundant larval fish taxa, megalopal cancer crabs, and larval spiny lobster. By comparing the number of larvae and megalopae withdrawn by the power plant to the number available (i.e., at risk to entrainment), an estimate of the conditional mortality due to entrainment (*PE*) can be generated for each taxon or species. These estimates of conditional mortality will be combined in the *ETM* model to provide an estimate of the annual probability of mortality due to entrainment ($P_m$) that can be used for determining CWIS effects and the potential for long-term population declines. Fishery management practices and other forms of stock assessments will provide the context required to interpret $P_m$. In the case of a harvested species, $P_m$ must be considered in addition to these harvest losses when assessing impacts and any potential for population decline.

## 5.1 Entrainment Effects Assessment

The assessment will focus on entrainment effects to the most abundant and to commercially or recreationally important fish taxa, cancer crab megalops and lobster larvae. Larval fishes analyzed will tentatively be the Goby complex, three Engraulid species, three Atherinopsid species, California halibut, white croaker, black croaker, spotted sand bass, and barred sand bass. These taxa likely comprise over 90 percent of all the entrained larval fishes based on earlier studies. Other species, which may occur in lower abundances, may also be included in the assessment because they represent species of commercial or recreational importance

## 5.2 Summary of Entrainment Effects

The length of time that a larval fish is in the plankton and subject to entrainment is a key parameter in *ETM* calculations. Length measurements taken from representative samples of the larval fish taxa presented in Section 4.0 will be used to estimate the number of days that larvae (for a specific taxon) are at risk to entrainment. Reports on larval duration from the scientific literature are likely to overestimate the period of time that larvae are exposed to entrainment. This is because ontogenetic changes during larval development result in increased swimming ability or behavioral changes, such as association with the bottom or other pre-settlement microhabitats. Possible outliers are eliminated by basing the minimum and maximum lengths on the central 98 percent of the length distribution for a taxon and excluding the lengths of the top and bottom percentiles. Estimates of larval growth rates (mm/day) are then used on this range to estimate the number of days the larvae are exposed to entrainment. The estimates of growth rates and their source from the literature will be presented in the impact assessment section for the different taxa. The average duration of entrainment risk for a taxon is calculated from the bottom percentile value to the mean value, while the maximum duration is calculated from the bottom percentile value to the 99 percentile value. Our estimates of the period of entrainment risk for cancer crabs and spiny lobster will be derived from literature values on the average age of the stages for each crustacean species.

## 5.3 Summary of Impingement Effects

Impingement effects in relation to source water fishery resources and potential ecological effects will be summarized based on data summarized from the earlier impingement study (SDG&E 1980), data on fish populations in Agua Hedionda Lagoon (MEC 1995), and CDF&G catch records for sport and commercial fishery resources.

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**NRG CABRILLO POWER OPERATIONS INC.**

January 10, 2005

Mr. John Phillips
San Diego Regional Water Quality Control Board
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4340

**Subject: Cabrillo Power I LLC Response to Comments from Tetra Tech to San Diego Regional Water Quality Control Board on the Encina *316(b) Cooling Water Intake Effects Entrainment & Impingement Sampling Plan***

Dear Mr. Phillips:

Cabrillo Power I LLC (Cabrillo) appreciates the opportunity to respond to the comments from Tetra Tech on the *316(b) Cooling Water Intake Effects Entrainment and Impingement Sampling Plan* for the Encina Power Station (EPS) submitted to the San Diego Regional Water Quality Control Board (Regional Board) on September 2, 2004. Tenera Environmental prepared the plan for the EPS 316(b) studies, and Cabrillo had them respond to comments from Tetra Tech. The responses from Tenera are incorporated into this letter and identified accordingly.

The Tetra Tech comments generally call for further clarification of the study plan or additions to the plan that will not affect the sampling procedures currently being used. The Tetra Tech comments (numbered the same as on the Tetra Tech memo) with specific questions of Cabrillo have responses that are highlighted in boldface type. Tetra Tech also made several suggestions that we have responded to in the final section of this letter.

**TETRA TECH COMMENTS AND CABRILLO RESPONSES:**

1) *Page 2:* The authors state that they will use EPA's criteria for selecting appropriate target organisms for assessment, results from previous 316(b) studies, Aqua Hedionda Lagoon ecological surveys, and results from the upcoming study to "determine the appropriate target organisms that will be evaluated in detail." Final selection of target organisms should involve consultation with the appropriate resource agencies. Will the California Regional Water Quality Control Board (and others) be contacted to approve target organism selection before commencement of assessment analyses?

***Response*: The final selection of the specific target organisms will be made in collaboration with the Regional Board and other appropriate agencies. The**

**sampling and processing is currently focused on fishes and selected macroinvertebrates; the same groups of organisms that were studied in San Diego Bay in 2001–2003 at the Duke Energy South Bay Power Plant in San Diego. The final list of target organisms will be based largely on their abundances in the entrainment and impingement samples. The impact assessment will be restricted to the most abundant taxa to ensure that there is have reasonable confidence in the results.**

3) *Page 7*: The MEC Analytical (1995) ecological surveys will be used to provide "data on fish populations in Aqua Hedionda Lagoon" (see page 24) for the evaluation of EPS impingement effects in relation to source water fishery resources. The authors mention that the MEC Analytical sampling "did not include any areas of the rocky revetment lining the Outer Lagoon that would increase the abundance and number of species collected." It appears that the surveys focused on the Middle and Inner Lagoons. Since the MEC Analytical data will be used for impingement effects analyses, the search for and/or collection of supplemental information for Outer Lagoon fishes may be warranted (however, it should be noted that we have not reviewed the contents of the MEC Analytical report).

*Response*: **The MEC study utilized multiple gear types that effectively sampled most of the habitats in Aqua Hedionda Lagoon. Cabrillo is currently evaluating if supplemental studies of the habitats not sampled in the MEC study are necessary and will propose those to the Regional Board if warranted. These habitats include the shallow mudflats areas that are common in the middle and inner lagoon, the rocky habitat that lines the boundary of the outer lagoon, and the artificial substrates on the piers, docks and floats of the outer lagoon. Gobies that occur in burrows on the mudflats and combtooth blennies, garibaldi and rockfishes that occur on the rocky habitat and artificial substrates in the outer lagoon were not effectively sampled by any of the gear types used in the MEC study. The larvae from these fishes will likely be abundant in the entrainment samples and this study will provide an estimate of their adult source water populations that will be used in the assessment of cooling water intake system (CWIS) effects.**

6) *Page 11*: The authors state that entrainment sampling began in June 2004 and will continue through May 2005. Has this proposed index period changed, or was approval received for sampling commencement prior to the preparation and review of this sampling plan (Plan is dated September 2004)? Did source water sampling also begin before this plan was written?

*Response*: **Both entrainment and source water sampling began in June 2004. The sampling started before a sampling plan was submitted to the Regional Board to take advantage of studies of the cooling water system that were being conducted in association with the permitting for the desalination facility being proposed for construction at the plant site by Poseidon Resources. The original proposal for the Poseidon study did not include the more extensive source water sampling in the final study plan. The scope of the study was expanded to conform to other 316(b) demonstration studies Tenera has completed in California including the study recently completed at the Duke Energy South Bay Power Plant in San Diego Bay. This provided Cabrillo the opportunity to continue the sampling in response to EPA's recently published Phase II rule for compliance with Section 316(b) of the Clean Water Act.**

7) *Page 11*: Entrainment samples will be collected from the lagoon, near the intake structure. Is entrainment sampling not possible from a location within the EPS CWIS?

*Response*: **Entrainment sampling conducted at ocean and estuarine power plants over the last ten years in California has been done in the source waters as near as possible to the intakes. This sampling location has been used because studies at the Diablo Canyon Power Plant in central California showed that large losses of planktonic organisms such as larval fishes can occur as a result of filtering by biofouling organisms that grow on the surfaces inside the power plant cooling water intake system. Studies have shown reductions in densities of greater than 90 percent between intake and discharge samples that have been attributed to biofouling losses. Although the entrainment sampling proposed for the EPS with plankton nets in the source waters at the power plant intake structure requires the assumption that the densities of organisms in the source waters are representative of the densities of organisms that are entrained, sampling inside the power plant introduces additional assumptions, sampling problems, and the known problem of cropping by biofouling organisms. One of these problems involves obtaining representative, well-mixed samples and sampling in rapidly flowing water. In addition, sampling inside the plant cooling water system usually requires pump sampling methods that are different than the towed net sampling used in the source waters, therefore introducing additional assumptions affecting comparisons between density estimates. All of these issues have resulted in the recommendation that entrainment sampling be done in the lagoon using nets towed as close as practical to the intake structure.**

8) *Page 11*: As part of the description of entrainment sampling methods, the authors mention that the "accuracy of individual instruments differed by less than 5% between calibrations." This is mentioned as a statement. Is it intended to be a quality standard?

*Response*: **No, it is not intended as a quality standard, it is just a statement that the difference in rotor constants between calibrations was generally less than 5%. In addition to maintaining the flowmeters before and after each survey, they are calibrated every three months to recalculate a new rotor constant, which is used to calculate the flow of water through the net. If the value of a constant changes greater than 10% between calibrations, which is almost never the case, the readings from the field data sheets are reviewed to determine when the change occurred. If the change in the flowmeter can be detected from the data, the values will be adjusted using the average difference between the two flowmeters used on the bongo frame prior to that sample; otherwise the flowmeter reading for the instrument that is within the 10% calibration range will be used to estimate the volume of seawater filtered through both nets on the bongo frame.**

9) *Page 11*: The authors state that if the target volume of water is not filtered during the entrainment tow, the tow will be repeated until the targeted volume is reached. Will the tow distance be extended to accomplish this, or will the tow truly be "repeated?"

*Response*: **The tow will be continued at the lagoon and entrainment stations by extending the tow, covering the vertical depth of the water column until the target volume is collected. Some of the deeper nearshore samples cannot simply be extended because it would not be possible to collect an unbiased sample that extended across all depths without greatly increasing the sample volume. In these cases, or if flowmeters are fouled with kelp, the samples are discarded and the sampling is repeated at the station.**

10) *Page 12*: The source water sampling methods are said to be "identical to the entrainment sample collection" (with a few noted exceptions). Does that mean that all source water stations will be sampled concurrently with entrainment sampling, and during the same (four) six-hour cycles? Is the source water sampling index period the same as the June 2004-May 2005 entrainment period?

*Response*: **Yes, all of the stations, source water and entrainment, are sampled during the same four six-hour blocks on the day the survey is conducted. All of the stations are usually sampled within a 2-3 hour period. All of the**

**stations have been sampled since June 2004 with a total of eight surveys collected as of December 2004.**

11) *Page 13*: The Inner Lagoon will be sampled with a single pushnet. Will the targeted volume of water be the same as the paired net (oblique) samples taken in the Outer Lagoon and nearshore ocean areas?

*Response*: **Yes. The targeted volume for the lagoon source water and entrainment samples is approximately 50 $m^3$. The volumes for samples from the nearshore stations may be greater, especially at the deepest stations, N4 and N5, where the minimum sample volume may exceed 50 $m^3$ because the nets are lowered through the entire water column and then retrieved.**

13) *Page 13*: The authors mention that "the number of source water stations will be evaluated as data become available to determine if fewer stations can be sampled." More information may be warranted to explain this process, and in particular, to explain whether reviewing agencies will be included in the decision process.

*Response*: **A proposal for this or any other change in the sampling program would first be submitted to the Regional Board for review. Any changes would only be implemented after review and approval by Regional Board and other reviewing agencies.**

14) *Page 14*: The authors state that, "A laboratory quality control (QC) program...will be applied to all samples." Is this a printed and approved QA/QC plan? If so, it should be cited. If not, what are the specific data quality objectives for laboratory processing (e.g., sorting efficiencies, taxonomic agreement, etc.)?

*Response*: **The laboratory QC program is an internal Tenera document that was not cited in the study plan. The QC program includes a procedure for preserving, transferring, splitting, and sorting plankton samples. There is a separate procedure for identification of the organisms from the samples. The following data quality objectives are used for sorting:**

1. **The first ten samples that are sorted by an individual are completely resorted by a designated QC sorter. A sorter is allowed to miss one target organism when the original sorted count is 1-19. For original counts above 20 a sorter must maintain a sorting accuracy of 90%.**
2. **After the sorter has passed 10 consecutive sorts, the program is switched to a '1 sample in 10' QC program for that sorter. After the sorter has**

**completed another 10 samples, one sample is randomly selected by the designated QC sorter for a QC resort.**

3. **If the sorter maintains the 90% accuracy sorting rate for this sample, then the sorter continues in the '1 sample in 10' QC mode.**
4. **If a sample does not meet the 90% accuracy rate their subsequent samples will be resorted until 10 consecutive samples meet the criteria.**

**A similar QC procedure is used for taxonomic identification except that the taxonomist must maintain an accuracy level of 95% for the identifications.**

16) *Page 15*: The FH model requires specific input parameter data (e.g., age-specific mortality) that may not be readily available. The authors state that, "...this degree of information is rarely available for a population." They also mention that "...our assessment will employ any available, scientifically acceptable sources of information on fisheries stock or population estimates of unexploited species entrained by the EPS." Will adequate input parameter data be available, or is it too early in the process to tell?

*Response*: **The initial review of the data showed that many of the same fish taxa that were analyzed from other studies were also abundant in the EPS samples. Also, similar to other studies, the majority of the fishes were small, forage species that do not have direct commercial/recreational fishery values. Therefore, while it has been possible to parameterize the adult equivalent models (FH and AEL) for many of these species in past studies, estimates of their adult populations that were necessary to interpret the results of the modeling efforts were usually not available. The MEC study on the fishes of Aqua Hedionda Lagoon and results from supplemental studies on adult fishes will help provide some of this information.**

19) *Page 19*: The impingement study methods do not mention an index period. Has impingement sampling begun, and will the sampling period coincide with entrainment sampling (June 2004-May 2005)?

*Response*: **Yes, impingement sampling began in early July 2004 and will continue through June 2005. Although it does not exactly coincide with entrainment sampling, it is close enough to capture the same seasonal changes in fish and target invertebrate abundance that will be present in the entrainment sampling. The sampling was started in July to take advantage of studies at the plant being conducted in association with the permitting for the desalination facility being proposed for construction at the plant site by Poseidon Resources (See *Tenera Response* to Comment 6).**

20) *Page 20*: The authors mention a quality control (QC) program for impingement sampling. Is this a printed and approved QA/QC plan? If so, it should be cited. If not, what are the "random cycles for re-sorting" and the specific quality objectives (e.g., for sorting efficiency)?

**_Response_: Tenera has written procedures for conducting the impingement sampling at EPS that all participating samplers are required to follow. A quality control plan is part of this procedure. Each impingement sampling team is comprised of two qualified biologists familiar with the fish and invertebrate fauna likely to be impinged. The goal of the sampling is to correctly identify, and accurately count and weigh all impinged organisms according to the criteria in the sampling protocol. In addition to ongoing quality control checks by samplers (e.g., consultations among team members, supervisor involvement, preservation of specimens of uncertain identity), Tenera personnel will check the counts and identifications from two cycles of impinged material on a quarterly basis. Unlike the laboratory identification process where a 90% sorting accuracy objective is specified, a specific quantitative objective for the impingement QC program is not feasible because of the variability in the quantity and types of impinged material. The objective is 100% accuracy. Tenera will document the results of the QC checks and implement any corrective actions necessary to ensure compliance with the written procedures.**

21) *Page 22*: The authors state that, "Although we have proposed to sample normal impingement weekly, we will evaluate the potential to reduce the sampling frequency to once every two weeks." More information may be warranted to explain this process, and in particular, to explain whether reviewing agencies will be included in the decision process.

**_Response_: See response to Comment 13.**

22) *Page 23*: The authors state that, "Fishery management practices and other forms of stock assessments will provide the context required to interpret [the estimate of the annual probability of mortality due to entrainment]." The data types mentioned may not be available for some of the most frequently entrained fishes (e.g., non-commercial /non-recreational species). Will adequate evaluation data be available, or is it too early in the process to tell?

**_Response_: See response to Comment #16. The MEC study on the fishes of Agua Hedionda Lagoon will help provide this information for the small,**

**estuarine, forage species that are not targeted by commercial or recreational fisheries.**

23) *Page 23 and 24*: Potential target organisms are mentioned. Comment 1 (above) applies here. Will the California Regional Water Quality Control Board (and others) be contacted to approve target organism selection before commencement of assessment analyses?

*Response*: **See response to Comment 1.**

SUGGESTIONS

- The governing regulatory/resource agencies should be given the opportunity to consider and approve/reject: the selection process for representative species (mentioned in comments 1 and 23, above); the possible reduction in the number of source water sampling stations (comment 13); and the possible reduced impingement sampling frequency.

  *Response*: **See responses to comments 1, 13, and 23. Proposals for these, or any other, change to the sampling program would first be submitted to the Regional Board for review. Any changes would only be implemented after review and approval by the Regional Board.**

- The temporal aspects of the study questioned in comments 6, 10 and 19 (above) need to explained in more detail.

  *Response*: **See responses to Comments 6 and 19.**

- The quality control program needs to be described in more detail (see comments 14 and 20), or the QA/QC plan should be cited and/or attached as an appendix.

  *Response*: **Procedures for the sampling and laboratory processing will be submitted as attachments to the study plan.**

- As mentioned previously, the study plan was obviously developed by qualified and experienced contractors, and we think that their study design is conceptually valid. Most comments listed above represent the need for relatively minor clarifications or additions.

Thank you again for the opportunity to respond to the comments from Tetra Tech. The study being conducted by Tenera Environmental is based on the design used for the entrainment and impingement studies at the Duke Energy South Bay Power Plant in San

Diego Bay. These studies were required for the plant's NPDES permit that was recently approved by the Regional Board. Therefore, we are confident that the study will provide the information necessary for Cabrillo Power I LLC to comply with EPA's recently published Phase II rule for Section 316(b) of the Clean Water Act. We look forward to working with you and the other Regional Board staff on this project and would be available to discuss our responses to these comments at your convenience.

If you have any questions or comments, please contact Mr. Tim Hemig at (760) 268-4037.

Sincerely,
Cabrillo Power I LLC
By: Its Authorized Agent,

Gregory J. Hughes

By: NRG Cabrillo Power Operations Inc.
Gregory J. Hughes
Regional Plant Manager

cc: Tim Hemig (Cabrillo)
Sheila Henika (Cabrillo)
John Steinbeck (Tenera)
Pedro Lopez (Cabrillo)
Hashim Navrozali (Regional Board)