316(b) Proposal for Information Collection for AES's Alamitos Generating Station

Submitted In Compliance with
316(b) Phase II Regulatory Requirements

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List of Acronyms

Board	California Regional Water Quality Control Board, Los Angeles Region
BTA	Best Technology Available
CDS	Comprehensive Demonstration Study
CDFG	California Department of Fish and Game
CEC	California Energy Commission
CWIS	Cooling Water Intake Structure
EPA	Environmental Protection Agency
HBGS	Huntington Beach Generating Station
IM	Impingement Mortality
NPDES	National Pollutant Discharge Elimination System
PIC	Proposal for Information Collection
QA/QC	Quality Assurance/Quality Control
RS	Representative Species
TIOP	Technology Installation and Operation Plan
USFWS	United States Fish and Wildlife Service

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EXECUTIVE SUMMARY

This Proposal for Information Collection (PIC) is submitted in compliance with the final 316(b) Phase II Rule (the Rule) for existing electric generating stations published in the Federal Register on July 9, 2004. This PIC is specific to AES's Alamitos Generating Station (Alamitos) and provides the California Regional Water Control Board, Los Angeles Regional (Board) with AES's plans for:

- providing necessary biological information,
- evaluating alternative fish protection technologies,
- evaluating the Rule's compliance alternatives and options, and
- providing information on consultations with fish and wildlife agencies.

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The Rule requires facilities that withdraw cooling water from oceans and that have a capacity utilization that exceeds 15% to meet both the Rule's impingement mortality (IM) and entrainment (E) reduction standards of 80% to 95% and 60% to 90% respectively. Alamitos Generating Station (Alamitos) currently consists of six generating Units, numbered 1 to 6. Units 1&2, Units 3&4 and Units 5&6 each have separate cooling water intake structures (CWISs). Units 1&2 have capacity factors below 15% while 3&4 and Units 5&6 have capacity factors in excess of 15%. Therefore, the Units 1&2 CWIS is only subject to the IM performance standard while the intakes for Units 3&4 and Units 5&6 will be subject to both the IM&E performance standards.

AES's preferred means to comply with the Rule's entrainment performance standard is use of restoration measures. Due to some uncertainty regarding use of this alternative as a result of litigation, technologies and/or operational measures as well as site-specific standards will also be evaluated as discussed in Section 3 of this PIC. AES plans to initiate new IM&E studies to establish the IM&E characterization baseline in January of 2006. This PIC also provides an updated schedule consistent with the previously proposed schedule submitted in November of 2004.

1 INTRODUCTION

EPA signed into regulation new requirements for existing electric power generating facilities for compliance with Section 316(b) of the Clean Water Act on July 9, 2004. These regulations became effective on September 7, 2004 and are based on numeric performance standards[1]. The Rule at 125.94(a)(1-5) provides facilities with five compliance alternatives as follows:

1. *A facility can demonstrate it has or will reduce cooling water flow commensurate with wet closed-cycle cooling to be in compliance with all applicable performance standards. A facility can also demonstrate it has or will reduce the maximum design through-screen velocity to less than 0.5 ft/s in which case it is deemed in compliance with the impingement mortality (IM) performance standard (the entrainment standard, applicable still applies).*
2. *A facility can demonstrate that it already has a combination of technologies, operational measures, and restoration measures in place to meet the applicable performance standards.*
3. *A facility can propose to install a combination of new technologies, operational measures, and restoration measures to meet applicable performance standards.*
4. *A facility can propose to install, operate and maintain an approved design and construction technology.*
5. *A facility can request a site-specific determination of best technology available (BTA) by demonstrating that the either the cost of installing technologies, operational measures, and restoration measures are either significantly greater than the cost for the facility listed in Appendix A of the rule or significantly greater than the benefits of complying with the applicable performance standards.*

All facilities that use Compliance Alternatives 2, 3 and 4 are required to demonstrate a minimum reduction in impingement mortality of 80% (125.94(b)(1)). Facilities with a capacity factor that is greater than 15% that are located on oceans, estuaries, the Great Lakes, or on rivers and have a design intake flow that exceeds more than 5% of the mean annual flow must also reduce entrainment by a minimum of 60% (125.94(b)(2)).

The Rule further requires that facilities using Compliance Alternatives 2, 3, and 5 prepare a Comprehensive Demonstration Study (CDS) as described at 125.95(b) of the Rule based on each of the seven components of the CDS (as appropriate) for the compliance alternative or alternatives selected. Facilities using Compliance Alternative 1 are not

[1] Performance standards are found at Federal Register, Vol. 69, 7/9/04, 125.94(b)

required to submit a CDS and those using Compliance Alternative 4 are only required to submit the Technology Installation and Operation Plan (TIOP) and Verification Monitoring Plan. All facilities that use Compliance Alternatives 2, 3 and 5 are required to prepare and submit a "Proposal for Information Collection" (PIC), the first component of the CDS. The Rule at 125.95(b)(1) requires that the PIC include:

1. *A description of the proposed and/or implemented technologies, operational measures, and restoration measures to be evaluated.*
2. *A list and description of any historical studies characterizing impingement mortality and entrainment (IM&E), and /or the physical and biological conditions in the vicinity of the cooling water intake structures and their relevance to this proposed Study. If you propose to use existing data, you must demonstrate that the data are representative of current conditions and were collected using appropriate quality assurance/quality control procedures.*
3. *A summary of any past or ongoing consultations with relevant Federal, State, and Tribal fish and wildlife agencies and a copy of written comments received as a result of each consultation.*
4. *A sampling plan for any new studies you plan to conduct in order to ensure that you have sufficient data to develop a scientifically valid estimate of IM&E at your site. The sampling plan must document all methods and quality assurance/quality control procedures for sampling and data analysis. The sampling and data analysis methods you propose must be appropriate for a quantitative survey and include consideration of the methods used in other studies performed in the source waterbody. The sampling plan must include a description of the study area (including the area of influence of the CWIS), and provide a taxonomic identification of the sampled or evaluated biological assemblages (including all life stages of fish and shellfish).*

The preamble to the Rule on Federal Register Page 41635 states that the PIC should provide other information, where available, to the NPDES permitting authority regarding plans for preparing the CDS such as how the facility plans to conduct a Benefits Valuation Study or gather additional data to support development of a Restoration Plan.

An important feature of the Rule is use of the calculation baseline. The calculation baseline is defined in the rule as follows:

Calculation baseline means an estimate of impingement mortality and entrainment that would occur at your site assuming that: the cooling water system has been designed as a once-through system; the opening of the cooling water intake structure is located at, and the face of the standard 3/8-inch mesh traveling screen is oriented parallel to, the shoreline near the surface of the source waterbody; and the baseline practices, procedures, and structural configuration are those that your facility would maintain in the absence of any structural or operational controls, including flow or velocity *reductions, implemented in whole or in part for the purposes of reducing impingement mortality and entrainment. You may also choose to use the current level of impingement mortality and entrainment as the calculation baseline. The calculation baseline may be estimated using: historical impingement mortality and entrainment data from our facility or another facility with comparable design, operational, and environmental conditions; current biological data collected in the waterbody in the vicinity of your cooling water intake structure; or current impingement mortality and entrainment data collected at your facility. You may request that the calculation baseline be modified to be based on a location of the opening of the cooling water intake structure at a depth other than at or near the surface if you can demonstrate to the Director that the other depth would correspond to a higher baseline level of impingement mortality and/or entrainment.*

This definition provides existing facilities with a variety of study options to take credit for facility features that deviate from the calculation baseline and provide the benefit of fish protection. Facilities can also simply develop the baseline by documenting current IM&E.

This PIC provides a description of Alamitos including deviations from the calculation baseline and applicable performance standards in Section 2. Section 3 describes the compliance alternatives and options to be evaluated including a description of alternative fish protection technologies and operational measures. Section 4 provides a brief description of existing biological information and plans for new studies. Section 5 summarizes voluntary and ongoing discussions with fish and wildlife agencies related to 316(b) and Section 6 discusses the schedule for completion of studies.

2 DESCRIPTION OF ALAMITOS GENERATING STATION

2.1 Location and Physical Description of Cooling Water Intake Structure and Cooling System

Alamitos Generating Station utilizes a once-through cooling water system. The plant is located on the Los Cerritos Channel in the City of Long Beach, California, as shown in Figure 1. Alamitos has six gas/oil units (Units 1-6) with a total generating capacity of 1,950 MW. The capacity utilization rate, calculated from operational data, ranges from 3% for Unit 2 to 56% for Unit 6. Table 1 presents a summary of pertinent plant data.

There are three cooling water intake structures (CWISs) at Alamitos. Units 1&2 use one CWIS, Units 3&4 use a second and Units 5&6 are mirror images of eachother located at the end of a separate intake cannal (Figure 2). The CWISs for Units 1, 2, 3 and 4 are located in one intake canal. Units 5&6 withdraws water through a second canal. A site layout is shown in Figure 2. Both intake canals withdraw water off the Los Cerritos Channel which withdraws water from Alamitos Bay and the Pacific Ocean.

All six of the units discharge the heated cooling water into the San Gabriel River, which is also the receiving water for cooling water discharge from the Los Angeles Department of Water and Power (LADWP) Haynes facility. The Haynes Generating Station is located directly across the river from Alamitos.

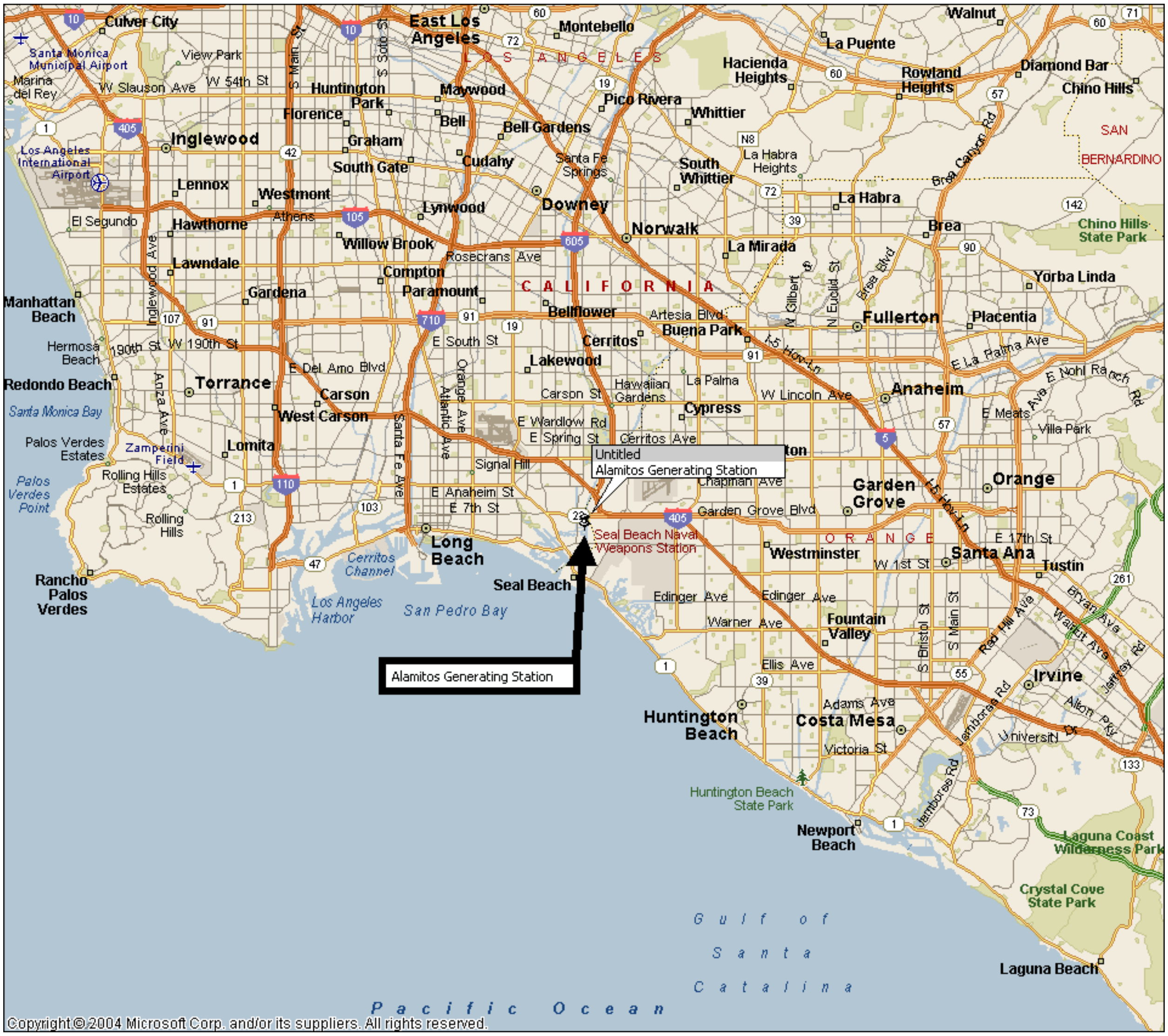

Figure 1 Location of the Alamitos Generating Station

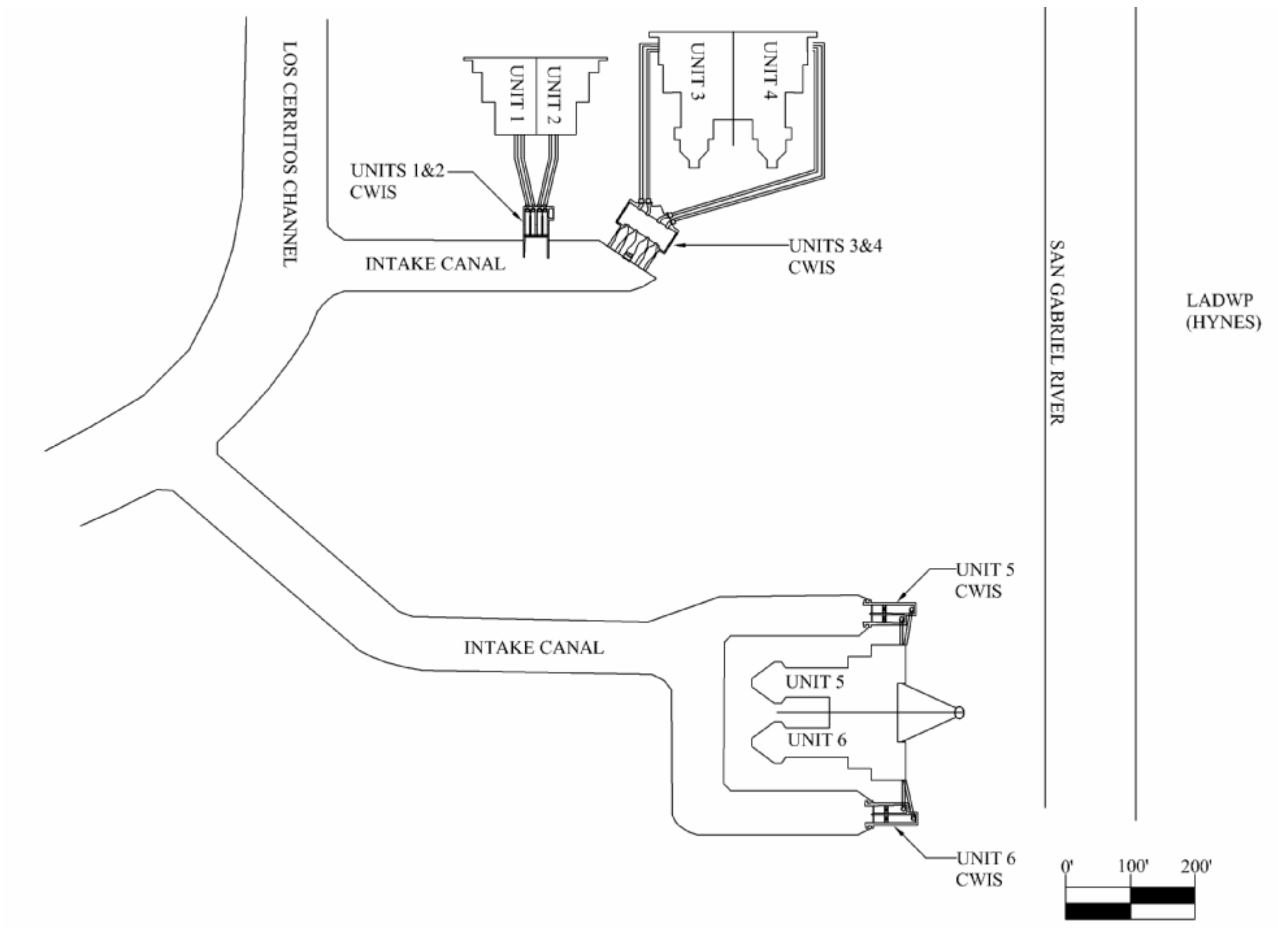

Figure 2 Plan View of the Alamitos Cooling Water Intake Structures

Table 1 Capacity Factors for Alamitos's Once Through Cooling Units

	2000	2001	2002	2003	2004	5 Years
AL1	6.03%	9.95%	9.48%	7.90%	6.19%	7.89%
AL2	14.93%	20.66%	11.17%	8.25%	6.55%	12.23%
AL3	30.13%	45.52%	35.69%	49.77%	22.90%	34.00%
AL4	40.60%	47.60%	23.89%	28.11%	18.40%	30.02%
AL5	50.75%	66.90%	34.05%	32.00%	24.17%	38.88%
AL6	40.93%	63.77%	18.98%	29.17%	10.38%	30.15%

2.2 Units 1&2 CWIS

The CWIS for Units 1&2 is located in the north intake canal, as shown on Figure 2. This canal also supplies water to Units 3&4 CWIS. The Units 1&2 CWIS has four intake bays, two for each unit (Figure 3). These bays are 8.2 ft wide. The invert of these bays range from El. -6.0 ft at the entrance to El. -9.0 ft at the traveling water screens (Figure 4). All the elevations in this report are based on Mean Sea Level (MSL). To prevent debris from passing through the intake bays and damaging the circulating water pumps, each bay has a curtain wall and a traveling water screen. The Units 1&2 curtain wall extends down to El. 2.0 ft (2 feet above the mean low water level). The traveling water screens are located downstream of the curtain wall.

The traveling water screens for Units 1&2 were replaced in 2001. The old screens were replaced because large amounts of debris carryover resulted in high O&M costs associated with cleaning plugged condenser tubes. The current screens have no individual screen baskets. The wire screen belt material is a continuous mesh loop. The F.P.I. screens are 8.1 ft wide and fit into an 8.2 ft wide screen bay. The screen mesh is a multi-layer balanced wire mesh belt made out of 12 gage wire with 24 wire loops per foot wide and 20 cross rods per foot length (24-20-12). This results in a 68% open area through the mesh with a 0.5 in. long and 0.75 in. wide (maximum) openings. The screens can be operated either manually or in automatic mode. In automatic mode, the screens are rotated at 7.6 fpm when there is an 8 in. differential across the screens. When the pressure differential reaches 6 in. the screens stop. Screens are cleaned with a backwash system that uses 85 -90 psig of water. Fish and debris removed from the screens are deposited in a dumpster, hauled from site, and disposed.

Downstream of each traveling water screen is a circulating water pump. Each pump has a capacity of 80.2 cfs (36,000 gpm), providing a total unit flow of 160.4 cfs (72,000 gpm). The pumps are Allis-Champers, vertical stage propeller type pumps. The total CWIS flow for the Units 1&2 CWIS is 320.8 cfs.

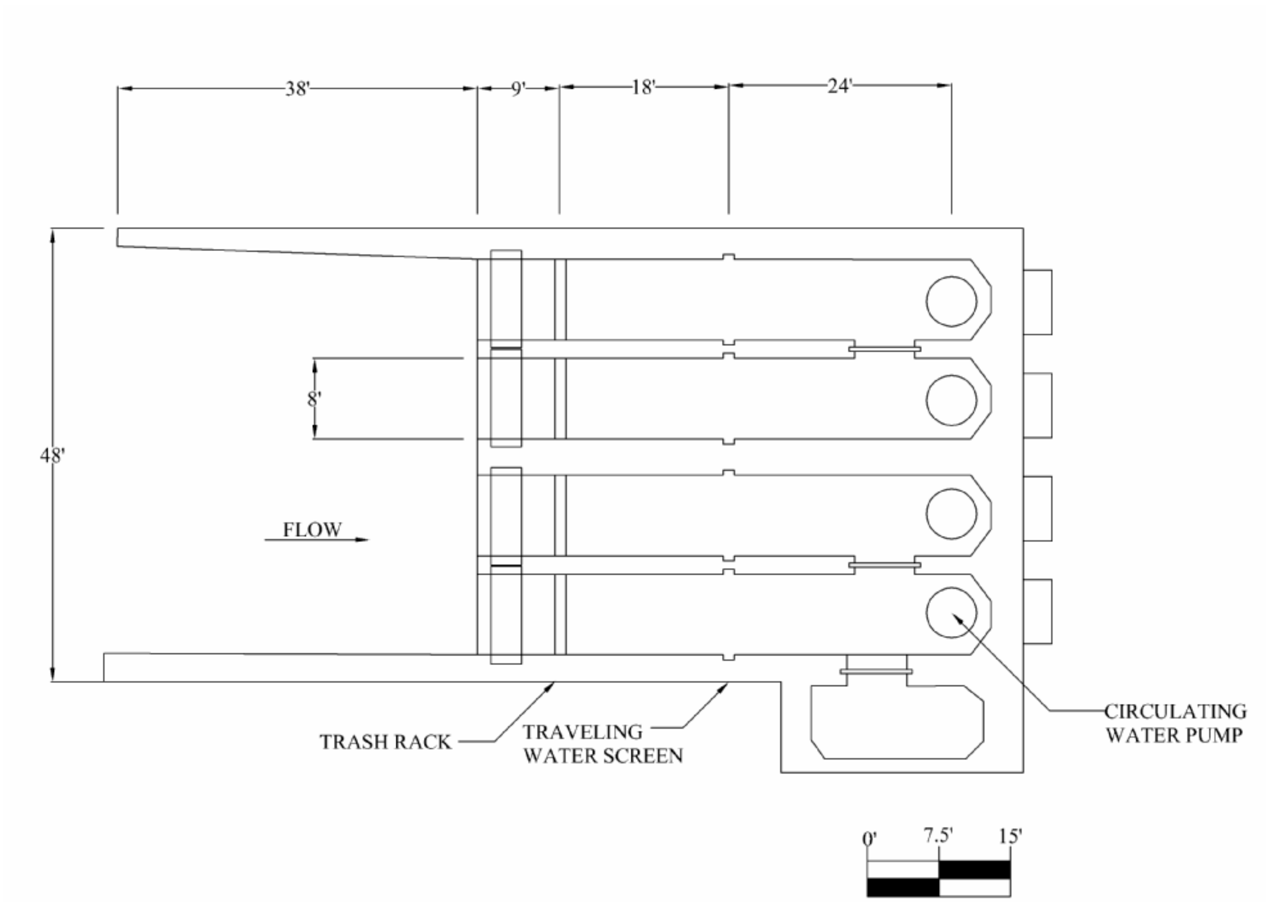

Figure 3 Plan View of Alamitos Units 1 and 2

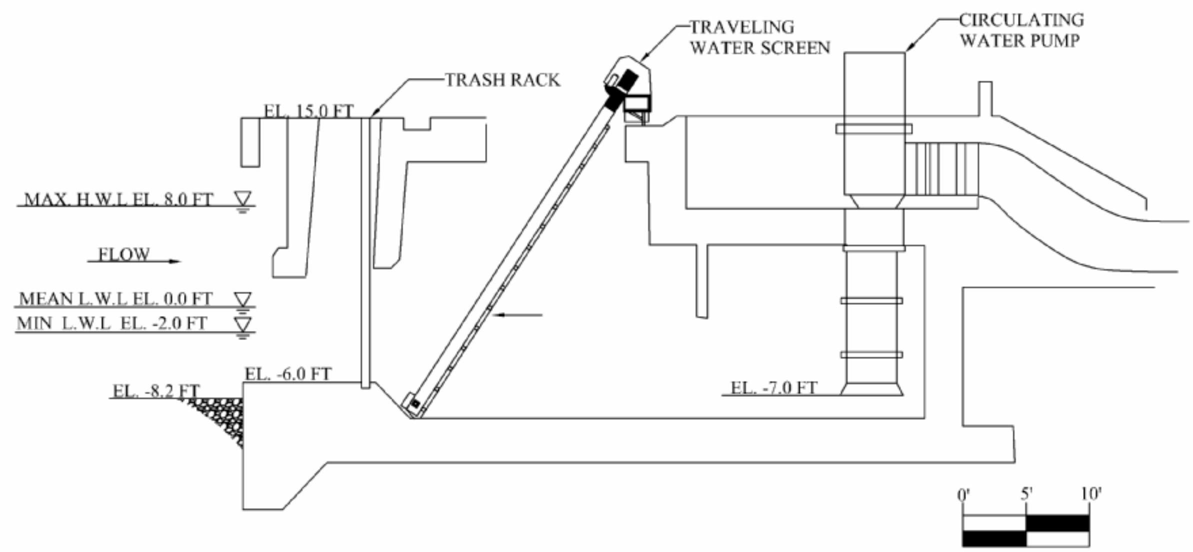

Figure 4 Side View of Alamitos Units 1 and 2 CWIS

2.3 Units 3&4 CWIS

The Units 3&4 CWIS is located at the end of the intake canal downstream from the Units 1&2 CWIS (Figure 2). This CWIS has four screenbays (two for each Unit) which are 9.0 ft wide (Figure 5). The invert of the CWIS is at El. -14.0 ft with a top deck elevation at El.12.0 ft (Figure 6). The CWIS has a curtain wall and traveling water screens to prevent fish and debris from entering the circulating water system. The bottom of the curtain wall is at El. -4.0 ft. A plan and section of the Units 3&4 CWIS is shown on Figure 5 and Figure 6, respectively. The Unit 3&4 CWIS does not have trash racks.

The traveling water screens for Units 3&4 are very similar to those in the CWIS for Units 1&2. The screens are 8 ft wide and extend from the invert at El. -14.0 ft to above the top deck and are angled at 34^{o} from vertical. The screen backwash system provides 85-90 psig of wash water. The screenwash pumps for Units 1&2 and Units 3&4 are cross connected to allow the two CWISs to use the same screenwash pumps in an emergency. The screenwash pumps also provide backup fire protection water.

The total flow through the Units 3&4 CWIS is 606.6 cfs (272,000gpm), with each unit requiring 303.3 cfs (136,000 gpm) of water. This water is provided by four circulating water pumps, two for each unit. The pumps are horizontal dry pit pumps.

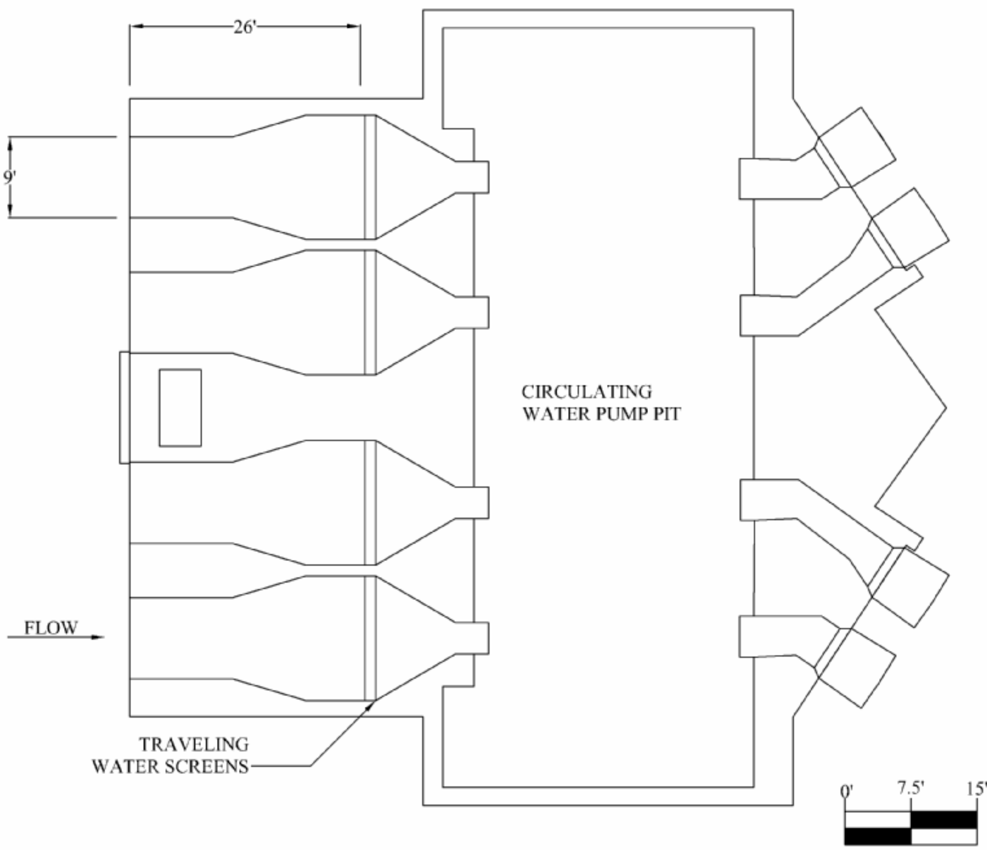

Figure 5 Plan View of Alamitos Units 3 and 4

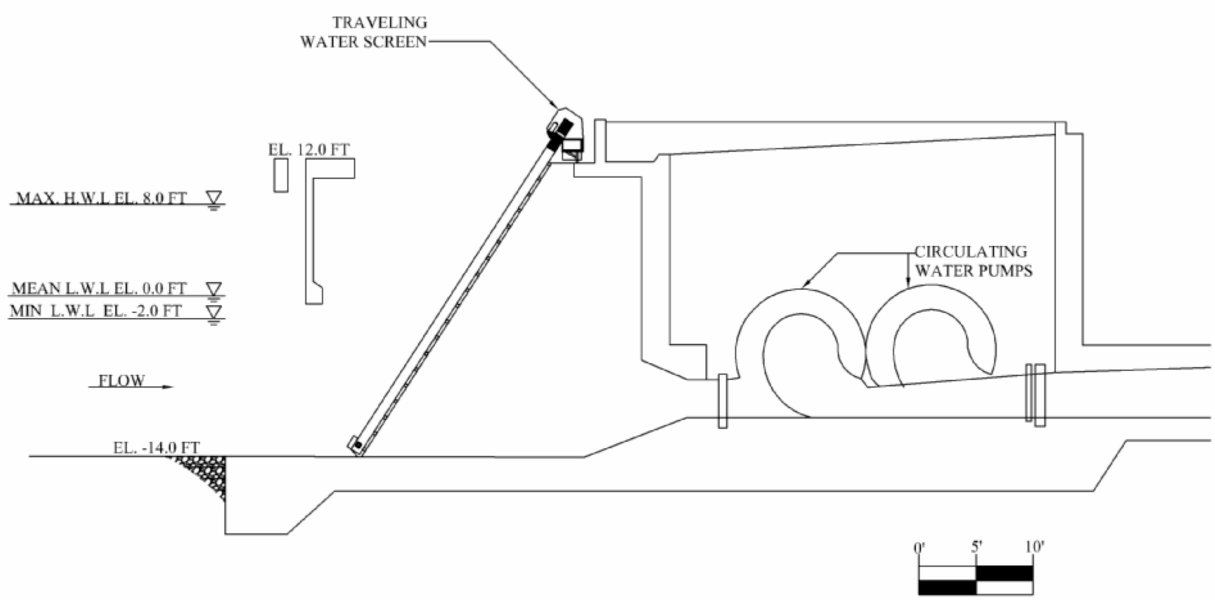

Figure 6 Side View Alamitos Units 3 and 4 CWIS

2.4 Units 5&6 CWIS

Units 5&6 each have a separate CWIS. However, the CWISs are mirror images of each other. The two CWISs are located in the southern intake canal, as shown on Figure 2. Each of these CWISs has two screenbays equipped with a trash rack, traveling water screen, and circulating water pump. A plan and section of the Unit 5 intake is shown on Figure 7 and

Figure 8 (note that the Unit 6 CWIS is a mirror image of Unit 5). The trash racks are located at the face of the CWISs and have 3 in. bar spacing. The trash racks are cleaned by an automatic trash rake when there is a 6 in. differential across the bars. The trash rake can also be manually operated. The traveling water screens are 20.5 ft downstream of the bottom of the trash racks.

The traveling screens are standard traveling water screens with 2 ft high and 10 ft wide screen panels The screen mesh is constructed out of 5/8 in. woven wire mesh. The screens rotate automatically when there is a 9 in. differential pressure on the screens. The screens can also be rotated manually. The screens are designed to handle a 9 ft differential. The screens are cleaned by a frontwash system, which provides 3.3 cfs (1,500 gpm) of washwater at 100 psi. There are two screenwash pumps per CWIS, but only one is needed to provide the washwater. The screenwash water is withdrawn from the circulating water pump discharges and therefore does not add to the flow of the CWIS. Fish and debris removed from the screens are disposed.

Units 5&6 each require 450.3 cfs (202,000 gpm) of circulating water. This flow is provided by two centrifugal mixed-flow pumps per unit. Each of these pumps is rated for 260.7 (117,000 gpm) at 20.4 ft of total dynamic head. These pumps can be operated as low as 167.1 cfs (75,000 gpm) without adversely affecting the pump.

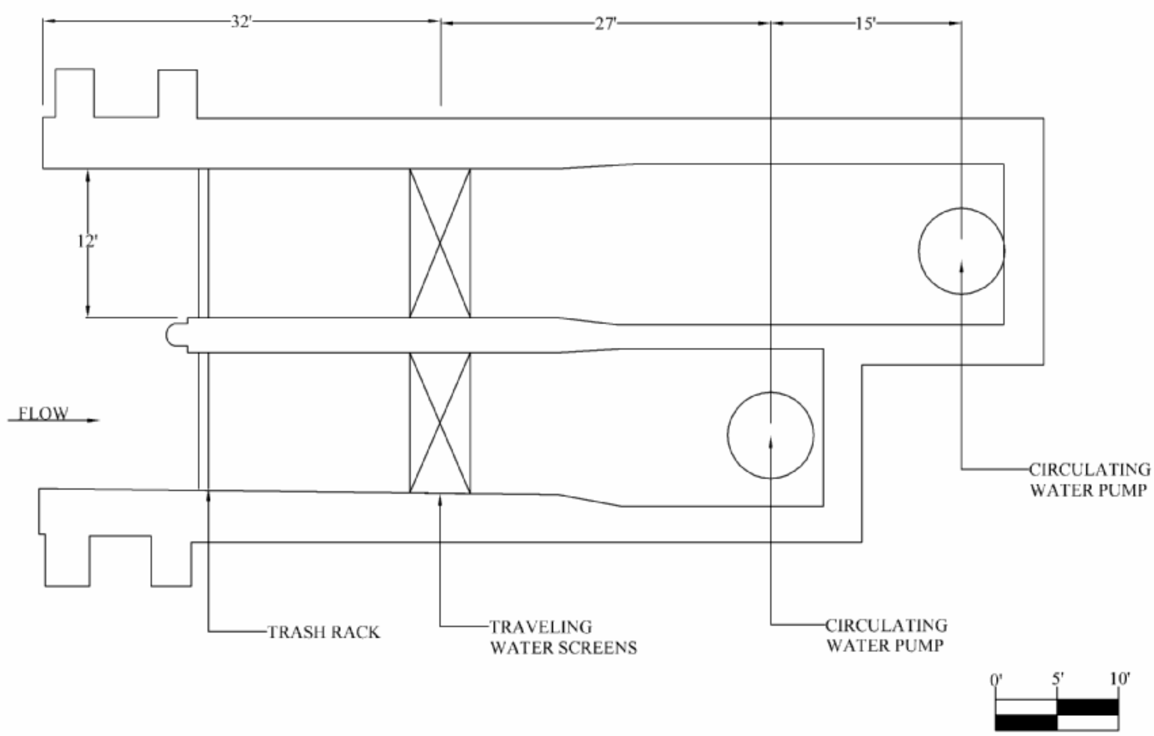

Figure 7 Top View of Unit 5 Cooling Water Intake Structure (Unit 6 is a mirror image of Unit 5)

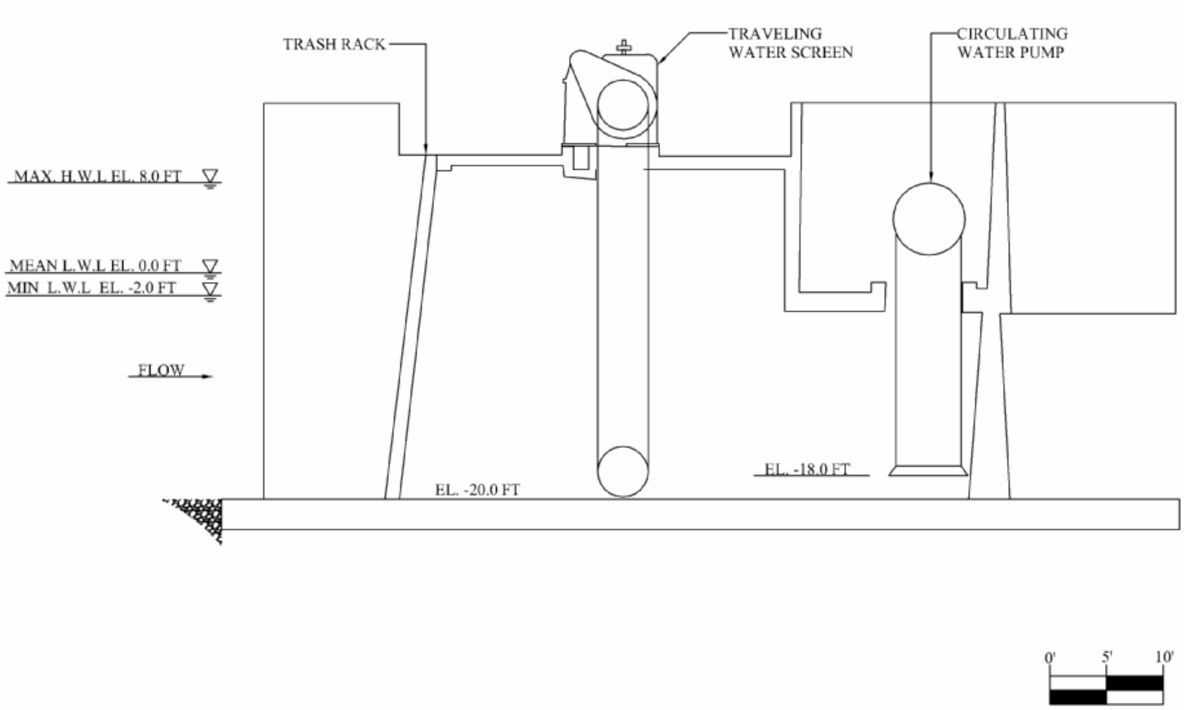

Figure 8 Side View Alamitos Unit 5 Cooling (Unit 6 is a mirror image of Unit 5)

2.5 Existing Hydraulic Conditions

The Alamitos CWISs withdraws water from the Los Cerritos Channel, about 1.5 miles upstream of where the channel discharges into Alamitos Bay. The Los Cerritos Channel is about 87 ft wide at the base and 107 ft wide at the top, with an average depth of 10 ft. The channel watershed is about 25 square miles and highly urbanized. Peak flow through the channel occurs between November and April. During this period the maximum daily flow through the channel is about 300 cfs. The extreme maximum flow through the canal was 1,560 cfs, which occurred in 1983. Most of the flow entering the Alamitos CWISs is seawater (i.e., flow is drawn up the canal from the downstream end of the canal). During drier periods most of the flow in the channel is a direct result of the Alamitos circulating water system.

Alamitos Bay is small and home to several marinas and the Marine Stadium, which was built to showcase rowing in the 1933 Olympics. The remainder of the harbor is mostly used by the marinas. Facility personnel indicated that there is no naturally occurring flow through the harbor except for the tidal flow. The flow through the harbor created by Alamitos prevents the harbor from becoming stagnant and removes garbage from the water. Thus, operation of the power plant may provide a benefit to the overall water quality of the harbor.

Velocities in the intake canals as a result of the intake flow were calculated for maximum facility flow and mean low water levels. Assuming both intake canals are identical, velocities through the intake canals would be about 0.8 ft/sec at an assumed design flow of 926.8 cfs (416,000 gpm) for Units 1-4 and 900.6 cfs (404,000 gpm) for Units 5&6. Approach velocities at various CWIS locations are shown in Table 2.

Table 2 – Approach velocities at various CWIS locations.

Approach Velocities at Various CWIS Locations	Units 1&2 (fps)	Units 3&4 (fps)	Units 5&6 (fps)
Under Curtain Wall	3.3	3.4	N/A
Approaching Trash Racks	N/A	N/A	1.0
Approaching Travelling Screens	2.2	2.7	1.1

N/A – Not applicable to the CWIS

Approach velocities are approximately half the through-screen velocity, therefore the current maximum through-screen flows preclude use of Compliance Alternative 1 for all three intake structures with the current design.

2.6 Applicable Performance Standards

Because Alamitos withdraws water from an ocean, it is potentially subject to both the impingement mortality and entrainment reduction performance standards. However, if a facility's capacity utilization rate based on five years of operating data is 15% or less, it is only subject to the impingement mortality reduction performance standard. Importantly, in the Rule's definition of capacity utilization rate it states, "In cases where a facility has more than one intake structure, and each intake structure provides cooling water exclusively to one or more generating units, the capacity utilization rate may be calculated separately for each intake structure, based on the capacity utilization of the units it services". As noted above, Alamitos has one intake structure each for Units1&2 and Units3&4 and Units 5&6 are located at the end of a seperate intake cannal. Therefore, one can consider the capacity utilization to be applied independently for each CWIS. As shown in Table 1, capacity utilization for Units 1&2 over the last five years has been well below 15%. Therefore, the Units 1&2 CWIS will only be subject to the IM performance standard while the intakes for Units 3&4 and Units 5&6 will be subject to both standards.

The capacity factor information also has significant implications for establishing the IM&E baseline characterization. For facilities with lower capacity utilization such as Alamitos, estimating entrainment based on actual flow is consistent with the Rule's baseline calculation reference to "the baseline practices and procedures". EPA in the Rules preamble on page 41617[2] points out that some comments on the Rule "suggested that the calculation baseline should reflect unrestricted operation at full design capacity year-round to avoid continually changing the baseline". However, EPA chose not to base the calculation baseline on this approach stating "EPA chose not to incorporate operating capacity into the calculation baseline, as the definition is not dependent upon intake flow volumes." EPA chose instead to adopt baseline practices and procedures under the calculation baseline or the "current level of impingement mortality and entrainment". For facilities with lower capacity utilization such as Alamitos, estimating entrainment based on actual flow is consistent with the Rule. It is therefore appropriate for AES to calculate the level of IM&E by determining the current impingement mortality and entrainment based on cooling water pump operation rather than design flow. The IM&E baseline characterization using this approach will remain the baseline unless operations change. In the event cooling water pump operation increases in the future, that would constitute a change in facility operations and require further study and/or additional compliance measures. The 316(b) Rule contemplates review of compliance during each permit cycle[3]. This ensures that if operations such as increased cooling water pump

[2] Federal Register, Vol 69, No.131, 7/9/04, pg. 41617, Column 2

[3] The Rule at §125.98(a)(3) states "At each permit renewal, you (referring to NPDES permitting authority) must review the application materials and monitoring data to determine whether new or revised

operation occur, the permit can be modified to ensure that the performance standards will continue to be achieved.

2.7 Conformance with the Calculation Baseline

None of Alamitos's CWISs conform to the Rule's calculation baseline. Significant deviations include:

- Use of an intake canal for Units 1 through 4 and a separate intake canal for Units 5&6,
- Units' 1-4 screens have a multidimensional mesh with 1/5 in. long by 3/4 in. wide at it is widest and Units' 5&6 traveling water screens have 5/8 in. square mesh.

The Rule allows facilities to take credit for deviations from the calculation baseline if it can be demonstrated that these deviations provide the benefit of fish protection to impingeable sized organisms. Neither of the differences from the calculation baseline is believed to provide a benefit in terms of fish protection. Therefore, AES plans to use the "as built" method for the IM&E baseline.

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requirements for design and construction technologies, operational measures, or restoration measures should be included in the permit to meet applicable performance standards in §125.94(b) or alternative site-specific requirements established pursuant to §125.94(a)(5).

3 COMPLIANCE ALTERNATIVES TO BE EVALUATED

AES intends to evaluate the full range of compliance alternatives and options available in the final Rule for potential use in the Comprehensive Demonstration Study (CDS). However, AES also has certain preferences for compliance because some options are considered to be more feasible, cost-effective and environmentally beneficial than others. This section of the PIC provides a description of specific alternatives and options that will be evaluated for compliance. It also indicates AES's preferred compliance alternatives and options based on currently available information, as well as, some of the issues currently identified with these alternatives and options.

3.1 Use of Restoration under Compliance Alternative 3

The EPA final Phase II Rule provides that applicants may use restoration measures in addition to, or in lieu of, technology measures to meet performance standards or in establishing best technology available (BTA) on a site-specific basis. The basic philosophy of restoration is mitigation of fish losses at a CWIS by either direct supplementation (stocking) of a "species of concern" potentially impacted by the CWIS, or provision, protection and restoration of habitat that "produces" fish and thereby replaces those lost due to IM&E. AES views restoration as a preferred method for meeting the entrainment reduction performance standard. However, it is also recognized that there is some risk this option may not be available[4].

Attachment A provides a summary of the kinds of restoration measures that will be considered. Project examples are listed for the following reasons: (1) their 316(b) application history by other power companies, (2) known interest in the local area based on an internet review of state programs, and (3) because design and implementation

[4] AES is aware that use of restoration is currently the subject of Phase II Rule litigation. The Second Circuit ruled that restoration could not be used for compliance with the 316(b) Phase I Rule. Based on the Phase I litigation decision, EPA added significant text to the Phase II Rule to support its use in Phase II. AES plans to initially limit evaluation of this compliance option in 2005 to discussions with the Board and approapiate State and Federal fish and wildlife agencies to identify potential projects of interest and methods for scaling and verification monitoring related to projects of interest. It is AES's current understanding that the Phase II Rule litigation decision should be rendered sometime around the end of the second quarter of 2006.

information is readily available. The basic categories of considered projects are as follows:

- Habitat Protection or Creation Program
- Fish Stocking
- Waterbody Restoration

Other types of projects may be identified in discussions with appropriate state and federal agencies.

AES plans to discuss these ideas and consider other restoration alternatives that may be suggested with the Board and other appropriate organizations such as the California Department of Fish and Game and will also consider working with other companies with Phase II facilities located in southern California to develop joint projects. As part of the requirement for use of restoration, AES plans to fully evaluate available technologies and/or operational measures to demonstrate that restoration is more feasible, cost-effective or environmentally desirable than use of meeting performance standards through use of technologies and/or operational measures (see below in Section 3.3). The analysis of IM&E data described in Attachment B will be used in determining the amount of restoration necessary to provide a minimum benefit equivalent to an 80% impingement mortality reduction and 60% entrainment reduction as required by the Rule.

3.2 Use of Fish Protection Technologies and/or Operational Measures under Compliance Alternatives 3 and 4

AES plans to evaluate a variety of technologies and operational measures for compliance. Generally the cost of technologies required for compliance with the entrainment performance standard is significantly more costly than those required for compliance with the impingement reduction performance standard. While AES plans to evaluate IM reduction technologies and operational measures for all three intakes, it will limit evaluation of entrainment reduction technologies only to the Units 3&4 and Units 5&6 intakes. It should also be noted that the entrainment reduction technologies and operational measures proposed for evaluation also provide the benefit of impingement mortality reduction as well. AES is using Alden Research Laboratory to assist in evaluating alternative technologies and operational measures and, based on a site visit and review of existing information, Alden has already made a preliminary evaluation of these options.

The Rule references three technologies that have the potential to meet the entrainment performance standard. These include use of an aquatic filter barrier (AFB), passive fine mesh (narrow slot) cylindrical wedgewire screens and fine mesh Ristroph traveling screens. The AFB works by deploying a large amount of fine mesh fabric to reduce through fabric velocities to a very low level and exclude entrainable life stages. The result is this technology requires an extremely large surface area. An AFB at Alamitos would significantly impede recreational use of Alamitos Bay. Since Alamitos Bay contains several marinas and the Marine Stadium an AFB is not considered a viable alternative. Narrow slot wedgewire screens are also designed to reduce the through-screen velocity to not exceed 0.5 ft/sec, therefore automatically meeting the impingement mortality standard by excluding fish. Wedgewire screens also have cleaning features that give them an advantage over other fixed screens and barrier nets that are more difficult to maintain. For this technology to be effective, the screens need to be located in an area with a sweeping current. Since the intake canals do not have outlets and most of the flow in the Los Cerritos Channel is a result of the Alamitos flow, there would be no sweeping flow to remove the debris from the screens and carry the entrainable life stages past the screen. The only location where adequate sweeping velocity is available would be offshore in the Pacific. However, since the distance that cooling water would have to be transported is on the order of two miles, such a location would not be feasible. Therefore, wedgewire screens are not considered a viable alternative for evaluation at Alamitos. In the event that use of restoration measures is not available to offset IM&E losses, the following technologies and operational measures will be evaluated:

Fine-mesh Ristroph Traveling Water Screens - AES also plans to evaluate replacing the existing 3/8 in. traveling water screens for Units 3, 4, 5 and 6 with new 0.5 mm fine-mesh Ristroph screens. This technology works by collecting impinged and entrainable life stages and returning them to the source waterbody to a location where they would not be subject to re-impingement. The technology employs a combination of Ristroph fish buckets attached to the bottom of traveling screen panels (Figure 9) and replacing the 3/8 in. stainless steel mesh with a fine mesh fabric (Figure 10). A low pressure screenwash spray system (~10 psi) is installed to wash entrained fish eggs and larvae gently off the screens into the Ristroph buckets. The Ristroph buckets then discharge the fishes into a fish return system to transport them back to the source waterbody in a location away from the intake to prevent re-entrainment. Fine-mesh screens are typically designed with an approach velocity of 0.5 ft/sec to help maximize survival of fish eggs and larvae. There are several issues that will need to be evaluated relative to this technology. First, the current approach velocities of 2.7 ft/sec at Units 3&4 and 1.1 ft/sec at Units 5&6 significantly exceed this design criterion. Due to these higher velocities, it will be essential to perform laboratory and/or field studies to verify that that survival will meet the performance standards. If survival of impinged and entrainable organisms is low at the current velocities, the screenhouse may need to be expanded to accommodate additional screens necessary to reduce the approach velocity. Such an expansion may require each unit to be shutdown for a substantial amount of time and would require considerable site work. A second issue is the return of collected organisms to a location that maximizes their survival. Returning entrainable life stages to the Los Cerritos Channel would subject entrainable life stages to re-entrainment. The organisms could be transported to the San Gabriel River, but this would be a somewhat different waterbody compared to the one from which they were withdrawn. The third option is return them to the Pacific Ocean, but this presents issues due to the long distance over which they would need to be transported. Species and associated life stages tend to vary considerably in terms of their ability to tolerate the collection and handling associated with this option. Currently there is no data available for survival rates of Pacific coastal species necessary to verify survival rates. For these reasons, and especially if expansion of the intake and installing more Ristroph screens is required, this option may not be a feasible and/or effective solution capable of meeting the performance standards.

Figure 9 Ristroph screen buckets attached to bottom of traveling screen panels.

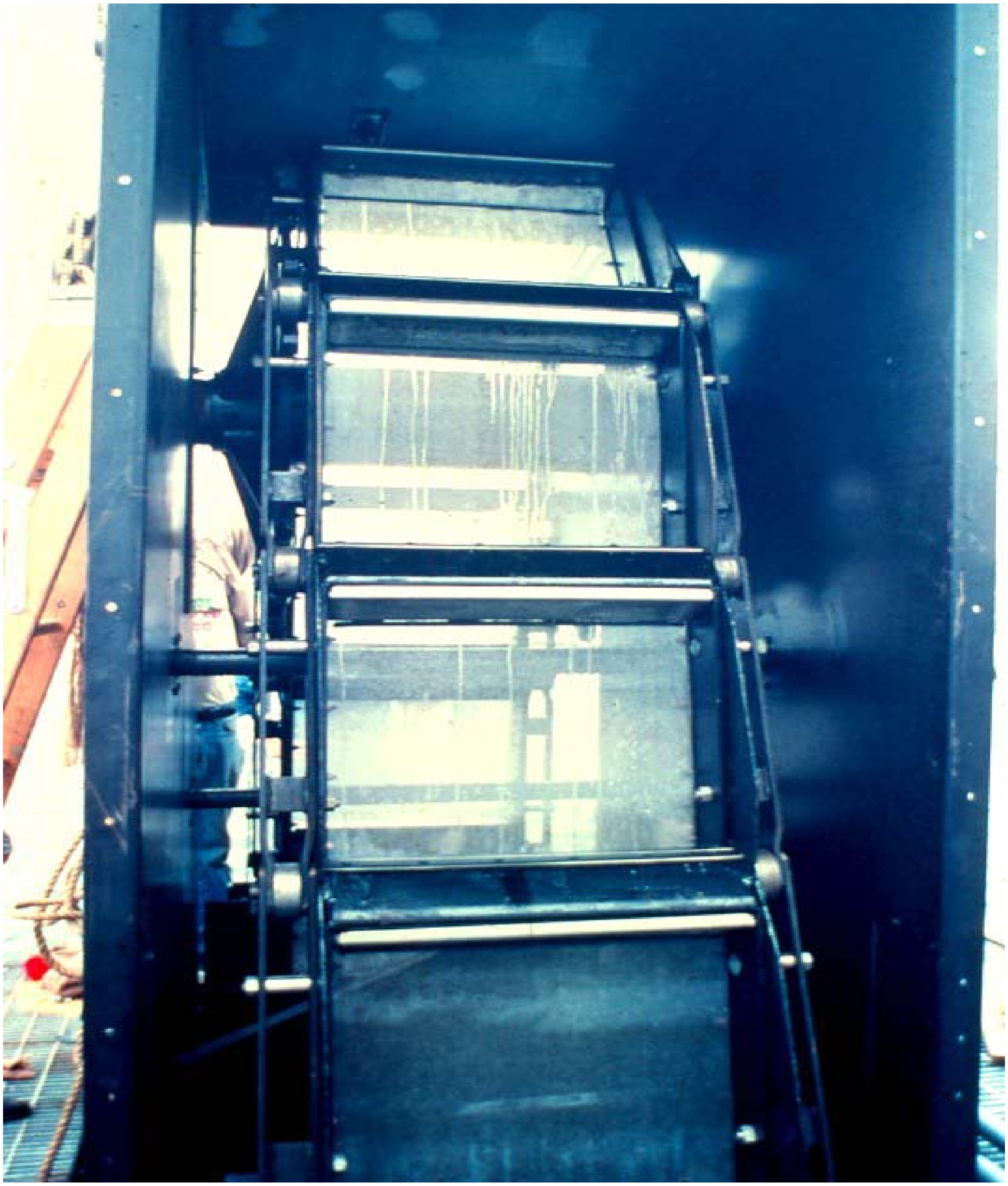

Figure 10 Example of fine mesh screen panels used in a test set up at Alden Research Laboratory

Use of a Barrier Net for Units 1&2 – Since Units 1&2 are only subject to the IM performance standard it may be feasible to deploy a barrier net to meet the IM performance standard for this intake. The current approach velocity for this intake is 2.2 fps. A barrier net could be used to lower this velocity to equal the velocity in the intake canal of approximately 0.8 fps. The greater flow generated by Units 3&4 may help reduce the debris loading on the barrier net. Results of the IM study planned for Units 1&2 will be used to evaluate the potential benefit of this option.

Use of Wide Slot (3/8 in. or 9.5 mm) Cylindrical Wedgewire Screens for Units 1&2 – Due to the greater intake flow of Units 3&4 downstream of Units 1&2 in the intake canal, it may be possible to install wide slot wedgewire screens in the intake canal for Units 1&2. This technology is designed to work by reducing the through-screen velocity to not exceed 0.5 fps. A schematic of this technology is shown in Figure 11. This technology is designed to work by using a low through-screen velocity relative to the ambient water current velocity. Protection of entrainable organisms is a function of the sweeping velocity of the water current past the screens relative to the through-screen velocity. Since the maximum through-screen velocity would not exceed 0.5 fps this technology would qualify for use under Compliance Alterative 1 and no CDS would be required.

While these screens have been deployed at a number of freshwater facilities, they have not yet been deployed in marine environments such as the Pacific Ocean. The high biofouling environment in the Pacific may present feasibility issues for this technology. The technology employs use of compressed air released in a manner to cause a blast of air through the screens to control fouling and debris buildup. However, testing in ocean environments will be important to determine if the air blast system is adequate to ensure an uninterrupted supply of cooling water for Alamitos. This may include conducting pilot studies.

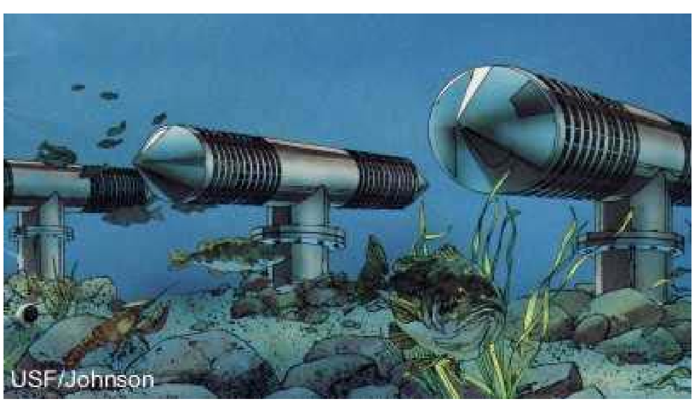

Figure 11 Cylindrical Wedgewire Screens

- **Use of an Approved Technology under Compliance Alternative 4**. Currently use of wedgewire screens in rivers that meet certain criteria is the only named EPA pre-approved technology. However, the Rule provides a process that allows additional technologies to become listed as pre-approved. New technologies can be so designated by providing information to demonstrate that if installed in the waterbody type the technology would have little trouble meeting performance standard for which they are pre-approved.

When results of the proposed IM&E sampling are available in 2006, if use of restoration measures are not available and AES decides to comply using one or a combination of technology and/or operational measures, it may propose pilot studies in the 2006/2007 time frame to verify feasibility, effectiveness and cost of the technologies proposed for evaluation.

Now that the final 316(b) Rule is in place, a good deal of interest has been generated in developing new fish protection technologies. AES plans to monitor the development and testing of new technologies for potential use. If other technologies more effective in terms of fish protection efficacy and cost-effectiveness become available, AES will inform the Board that the new technology may be added to the PIC for evaluation at Alamitos.

3.3 Use of Site-specific Standards under Compliance Alternative 5

AES plans to evaluate potential use of both the cost-cost and cost-benefit tests under Compliance Alternative 5. Use of these alternatives are provided to allow Phase II facilities to not pay costs that would be considered significantly greater than either the costs estimated by EPA for facilities in the Rule or the economic value of the site-specific environmental benefits that will be achieved. Should the evaluation of the current impingement reduction technologies and operational measures determine that the IM&E performance standards are either not achieved or require unreasonable costs, or use of restoration for offsetting entrainment losses is not available, these tests will be used in conjunction with the evaluation of technologies and operational measures discussed in the previous section of the PIC.

Evaluation of Cost-Cost Test - EPA, in developing the national cost of implementing the Rule, considered the cost for each Phase II facility to comply. If the actual cost estimated for a facility to meet the performance standard, based on a site-specific analysis, is determined to be significantly greater than the cost estimated by EPA for the facility to comply, the facility can apply for a site-specific standard under the Cost-Cost Test using Compliance Alternative 5. The site-specific standard would be that achieved by use of the best performing technology (i.e. achieve the highest level of protection) or operational measure that would pass the Cost-Cost test. Alamitos is identified as facility number AUT0609. Due to a flow reporting error, Alamitos is not currently listed in

Appendix A of the Rule. However, AES has written to EPA correcting the error and requesting EPA to provide a cost estimate for Alamitos for use in evaluating the Cost-Cost Test.

Evaluation of Cost-Benefit Test - The economic value of the environmental benefit of meeting the performance standards will also be evaluated. This evaluation will be based on the results of proposed IM studies to be conducted at all six units and the entrainment studies planned for Units 3 through 6. The approach for this analysis is further discussed in Attachment C of the PIC.

4 BIOLOGICAL STUDIES

The Rule requires that a summary of historical IM and/or physical and biological studies conducted in the vicinity of the CWIS be provided, as well as plans for any new IM&E studies.

One year of entrainment sampling was conducted at the nearby Haynes Generating Station from October 1979 through September 1980. The sampling was conducted bimonthly with 2 replicate samples collected over a 24 hr period during the daytime and at night. Combtooth blennies and several gobies were the most commonly entrained species. Impingement samples were collected on approximately a weekly (samples were collected twice per week from August 1979 through July 1980) basis from October 1978 through September 1980 at Alamitos. Three species, Pacific butterfish, shiner perch and queenfish made up more than 85% of the impingement during this period. Another year of biweekly impingement sample took place for July 1992 through July 1993. In addition, from 2002 through 2004 sampling was conducted periodically during both normal operations and heat treatments. The most commonly impinged fish in the 1992/93 study were topsmelt and Pacific sardines.

Due to the age of the previously collected entrainment data, a year of new IM&E monitoring is proposed to characterize entrainment of fish and shellfish. Impingement sampling will be conducted on a weekly basis while entrainment sampling will be conducted on a biweekly basis. In addition, a source waterbody study of entrainable life stages is a component of the overall study plan for use in scaling a restoration project to offset the estimated proportional loss, since this is currently the preferred compliance alternative. Final data analysis decisions will be made as appropriate to support the compliance alternative(s) and option(s) selected. A detailed description of the existing IM&E data, biological and physical information, and plans for new biological studies and analytical approaches is provided in Attachment B.

5 SUMMARY OF PAST OR ONGOING CONSULTATION WITH AGENCIES

The Rule requires that "a summary of any past or ongoing consultations with appropriate Federal, State, and Tribal fish and wildlife agencies that are relevant to the CDS and a copy of written comments received as a result of such consultations be provided".

There have been no consultations with federal or state fish and wildlife agencies regarding Alamitos relative to 316(b).

6 SCHEDULE FOR INFORMATION COLLECTION

The Rule allows facilities with NPDES permits that expire within four years of the date of publication of the Rule in the Federal Register (July 9, 2004), up to three years and six months to submit the CDS (125.95(2)(ii)). AES submitted a letter dated November 2, 2004 requesting approval of a schedule to prepare and submit the PIC, conduct necessary studies and information to prepare and submit the CDS.

As noted in Section 4, AES is planning to initiate new IM&E studies in 2006. Assuming that the Board provides comments within the 60 day period suggested in the Rule, AES will make any necessary changes to modify the PIC within 30 days and provide a revised PIC to the Board. The first major task will be to complete the IM&E Characterization Study proposed for 2006, process the samples and analyze the data. Completing this analysis is critical in order for AES to make a final decision on compliance alternatives. It is anticipated this analysis will require approximately 4 months to complete (second quarter of 2007). Upon PIC approval, AES will also initiate work and discussions with appropriate State and Federal Agencies to identify potential restoration projects of interest for use under Compliance Alternatives 3 and/or 5. It is expected that based on the final Rule litigation schedule that the Court will issue a decision on the on-going Phase II litigation around the end of the second quarter of 2006. This will allow AES to reassess available compliance alternatives and options based on the Court's decision. If AES's preferred use of restoration is not available for compliance, it is anticipated a more detailed evaluation of alternative technologies including pilot studies may be initiated in the latter part of 2006. Based on completion of analysis of the biological data in 2007, if restoration is available AES should be in a position to make a final compliance decision in mid 2007 in terms of project details to be incorporated into the CDS. If restoration is not available, the CDS is anticipated to focus on use technologies and/or operational measures under Compliance Alternatives 1 (i.e. use of 0.5 fps for Units 1&2), 3, 4 and/or 5.

Preparation of the CDS will depend on the final compliance alternative(s) selected as follows:

- Use of Technologies or Operational Measures - It is anticipated that it will require approximately 6 months to review and complete a draft and final CDS based on the technology and compliance assessment information (i.e. Design and Construction Technology Plan and Technology Installation and Operation Plan). Since a year of pilot studies would be required for use of technologies and/or operational measures and pilot studies are likely to be required the results of such studies will not be available until mid-2007. Therefore, a CDS based on this option would not be completed until January, 2008.

- Use of Restoration - If AES's preferred approach of using restoration measures is available, work will be initiated to prepare a restoration plan. It is anticipated that preparation of this plan and providing the information necessary to address the requirements necessary for this plan will also require 6 months. It is therefore likely that a final CDS based on restoration can be submitted on or before the end of 2007.
- Use of Site-specific Standards - Should use of Compliance Alternative 5 be a component of the CDS, it will be necessary to prepare a Comprehensive Cost Evaluation Study and if the Cost-Benefit test is used, a Benefit Valuation Study will be required. In addition, if a technology or operational measure is used as part of Compliance Alternative 5, the technology and compliance assessment information documents will also be required. Thus, the full allowable schedule will be necessary. However, assuming an entrainment reduction technology or operational measure is not identified that would pass the site-specific standards; the final CDS could be submitted before the end of 2007.

The Rule recognizes that the CDS studies are an iterative process[5] and allows facilities to modify the PIC based on new information. AES may request Board approval of an amendment to this PIC, based on new information relative to technologies and operational measures, use of restoration measures, Phase II Rule litigation or subsequent Agency guidance. Such information may require modification of the currently proposed schedule.

[5] See Rule preamble first column pg 41235 of Federal Register/Vol. 69, No. 131/Fri 7/9/04.

A RESTORATION MEASURES

Restoration Measures to be Evaluated for 316(b) Compliance at AES's Alamitos Generating Station

The final Phase II Rule provides that applicants may use restoration measures in addition to, or in lieu of, technology measures to meet performance standards or in establishing best technology available (BTA) on a site-specific basis. Specifically, EPA's final Phase II Rule states the following requirement relative to the use of the restoration approach:

> *Facilities that propose to use restoration measures must demonstrate to the permitting authority that they evaluated the use of design and construction technologies and operational measures and determined that the use of restoration measures is appropriate because meeting the applicable performance standards or requirements through the use of other technologies is less feasible, less cost-effective, or [emphasis added] less environmentally desirable than meeting the standards in whole or in part through the use of restoration measures***.***

Types of Restoration Applicable to §316(b)

The Rule does not specify the types of restoration measures that can be used. This lack of specification provides flexibility in developing/proposing a restoration approach. Restoration measures that have been used at other power stations to meet §316(b) requirements include:

- Wetland restoration (e.g., Public Service Electric & Gas (PSEG) Delaware Bay wetland restoration program for the Salem Generating Station)(Weinstein et al. 2001).
- Fish stocking (e.g., Mirant Mid-Atlantic fish hatchery at the Chalk Point Station (Bailey et al. 2000); Exelon's (formally Commonwealth Edison) walleye hatchery at Quad Cities Station on upper Mississippi River (LaJeone and Monzingo 2000); and Southern California Edison's white sea bass hatchery.
- Submerged aquatic vegetation (SAV) restoration (e.g., Southern California Edison's kelp restoration for the San Onofre Nuclear Generating Station) (Deysher et al. 2002).
- Provision of fish passage (e.g., fish ladders or dam removal) at non-hydropower projects (e.g., PSEG fish ladders in Delaware Bay tributaries for the Salem Generating Station).
- Contribution to, or maintenance of, a restoration fund related impacts associated with the re-powering of the Moss Landing Station on Elkhorn Slough near Monterrey Bay,

California – see http://www.duke-energy.com/businesses/plants/own/us/western/morrobay/reports/

- Water quality improvements (e.g., riparian area protection or implementation of non-point source best management practices) that minimize sediment/pollutant runoff thereby resulting in fishery habitat improvements, and practices that increase dissolved oxygen content in waterbodies thereby increasing available habitat for fish spawning and survival. While this approach is plausible, there are no known existing examples of such a 316(a) or 316(b) restoration project.

Potential Restoration Measures for AES California Facilities

AES may wish to consider the following example restoration projects[6] to attain the impingement mortality and entrainment reduction performance standard or as part of a site-specific standard developed by the permit director. These projects are listed because of their known interest to fish and wildlife agencies in California and because design and implementation information is readily available:

- Fish stocking – While forage species (e.g., gobies, blennies, topsmelt and Pacific sardines) are the most common species impacted at Alamitos, stocking of these species to compensate for the losses would not be of interest to any of the federal and state fish and wildlife agencies. The objective of a supplementation program would be to identify a 'species of concern', the stocking of which would compensate ('comparable to, or substantially similar to') the production foregone as measured by a game fish's consumption (e.g., X northern anchovy are equivalent in energy or food consumption to Y white seabass or other recreational or commercial fishes of concern). This is the approach used by Potomac Electric Power Company for estimating annual hatchery production of striped bass to compensate for bay anchovy (a forage species) losses at their Chalk Point Generating Station on the Patuxent River in Maryland.

  Fish stocking involves the direct supplementation (stocking) of a fish species of concern to aid restoration efforts for that species. Restoration stocking (as opposed to recreational gamefish stocking) is generally pursued where the species of interest has been completely extirpated or where associated habitat restoration is unlikely to contribute to stock restoration. For example, the Georgia Department of Natural Resources (GDNR), following six years of study, recently initiated a long-term effort to restore lake sturgeon to the Coosa River system in Georgia/Alabama. This species is listed as threatened throughout the U.S. and has disappeared completely from much of its original range, including the Coosa River. Through a collaborative effort

[6] Projects listed are examples – opportunities for creative restoration projects are unlimited and depend upon corporate interests and negotiations with state and federal resource agencies.

between several state and federal agencies, GDNR released 1,100 fingerlings to the Coosa River in December 2002 as the first step towards returning lake sturgeon to a healthy, self-sustained population in the river (see: http://georgiawildlife.dnr.state.ga.us/content/displaycontent.asp?txtDocument=305). A similar program may be of interest in California, particularly for the southern steelhead salmon or coastal rockfishes (*Sebastes* spp.), both of which are federal and state listed endangered and threatened species along the California coast (see: http://ecos.fws.gov/tess_public/TESSWebpageUsaLists?state=CA). CDFG and RWQCB (and USFWS/NMFS) may support AES's participation in a program to restore rare, threatened, and endangered fish to native habitat. Mirant Mid-Atlantic Inc. currently raises and stocks Atlantic sturgeon at its Chalk Point Hatchery Facility on the Patuxent River for the State of Maryland, Department of Environmental Protection. American shad restoration to the Susquehanna River basin in Maryland/Pennsylvania has been accomplished in part via stocking of juvenile shad and via provision of fish passage (St. Pierre 2003; Hendricks 1995). Restoration stocking (e.g., for southern steelhead) could also be combined with provision of fish passage (i.e., dam removal or fish ladders). This form of restoration is discussed further below.

Fish stocking program support could be via hatchery operation developed on or off plant property (e.g., SCE funds the operation of a fish hatchery in Carlsbad, CA for culturing and stocking California sea bass – see http://www.sce.com/sc3/006_about_sce/006b_generation/006b1_songs/006b1c_env_prot/006b1c3_songs_miti/default.htm). Such a hatchery would be operated and maintained under state and federal oversight. Alternatively, AES could possibly negotiate a direct annual contribution of funds to a state and federal hatchery supplementation program or a private foundation. For example, the Hubbs/Sea World Research Institute operates the SCE fish hatchery for SONGS mitigation. While hatchery or stock supplementation programs can be controversial due to concerns over protection of natural genetic integrity, California resource agencies, based on their approval and development of SCE's SONGS Mitigation Project, supported stocking as compensation for fish losses. CDFG and NMFS also have a long-term fish hatchery program to support maintenance and restoration of anadromous salmonids in California coastal rivers (CDFG/NMFS 2001). California resource agencies' experience with hatchery supplementation may mean that they could be receptive to a hatchery program established by AES as compensation for impingement and entrainment losses at AES power plants in southern California. For example, when operating at design capacity, the SCE funded hatchery is expected to exceed compensation for the total SONGS fish losses estimated by an expert panel created by the California Coastal Commission.

For approximate cost references, SCE provided $4.7 million in funding for the white seabass hatchery which began operation in late 1996. Similarly, the Potomac Electric Power Company (PEPCO) established an aquaculture facility at their Chalk Point Station at a capital cost (1990 dollars) of $1 million. Annual O&M has been approximately $175,000 to $250,000 depending on the species and number of organisms raised and stocked in Maryland waters.

- Habitat Protection Program Participation – The importance of wetlands, in-stream habitat, and riparian areas as aquatic habitat for fish and invertebrates, and as habitat for wildlife is reviewed in EPRI (2003). Wetland restoration or habitat restoration in general, is becoming increasingly popular across the U.S. and there is a growing case history with use of habitat restoration as a 316(b) mitigation approach (EPRI 2003). In California, over 90% of its historic wetlands and 95% of historic streamside trees, shrubs, and ground vegetation has been lost from urbanization, agricultural conversion, logging, and flood control (USFWS 2001). Habitat restoration, therefore, should be a major interest to federal and state resource agencies and non-governmental organizations (NGOs) in California. The following identifies federal, state, and private restoration programs that provide information which AES may find of value for establishing their own restoration program or offer opportunities to collaborate on potential restoration projects.

  Example programs include:

  - *SCE's SONGS Mitigation* (see: http://www.sce.com/sc3/006_about_sce/006b_generation/006b1_songs/006b1c_env_prot/006b1c3_songs_miti/default.htm): the proximity of SONGS and its ongoing restoration program is a key starting point relative to any restoration project initiated by AES for impacts at its southern California generating stations. The California resource agencies and local non-governmental organizations will likely heavily rely on lessons learned during the negotiation and development of the SONGS Program. The San Onofre Nuclear Generating Station Marine Mitigation Program is a multi-faceted environmental enhancement program intended to mitigate unavoidable impacts to the marine environment resulting from operation of the SONGS Units 2&3 cooling water systems. The program includes:
    1. restoring 150 acres of degraded wetlands at San Dieguito Lagoon to mitigate impacts to marine fish populations caused by estimated mortality to fish eggs and larvae;
    2. improving the in-plant fish protection systems to increase survival of adult fishes which enter the cooling water systems;

3. constructing an artificial kelp reef to mitigate impacts to the San Onofre Kelp Bed (note this project was done to offset thermal impacts);
4. co-funding a marine fish hatchery program intended as supplementary mitigation for kelp impacts; and
5. funding for Coastal Commission staff oversight and monitoring of these mitigation projects.

SCE is managing the overall mitigation program. Through its Conservation Financing Corporation (CFC) subsidiary, the two largest elements of the mitigation program, the wetlands restoration project at San Dieguito Lagoon and the artificial reef at San Clemente, are being addressed by an equity alliance with CH2MHILL, an environmental management services consulting firm. CFC finances and oversees implementation of these two mitigation projects.

SCE is the plant operator and majority owner of SONGS. SONGS is jointly owned by SCE, San Diego Gas and Electric, and the cities of Anaheim and Riverside, which are funding the mitigation work.

SONGS' owners want to keep interested parties informed about this program, which will significantly enhance the region's marine resources. Through meetings, discussions, newsletters, a Web site, and the public hearing process, SCE expects to inform and involve the largest possible number of interested parties in the development and implementation of the mitigation/enhancement plans. Detailed technical progress on implementing and monitoring the SONGS mitigation effort can be found in the Proceedings from the Second Annual Public Workshop for the SONGS Mitigation Project (Reed et al. 2002).

- *Duke Energy's Morro Bay Modernization Project Habitat Enhancement Program* (see: http://www.duke-energy.com/businesses/plants/own/us/western/morrobay/reports/) – as part of the station modernization, Duke Energy has volunteered to fund a program that would reduce sedimentation and the other major factors undermining the Bay's productivity. The concerns for Morro Bay and the target of Duke's proposal are the issues identified by the Morro Bay National Estuary Program's (MBNEP) Comprehensive Conservation Management Plan (CCMP). Those issues include sedimentation, loss of habitat, and nutrient pollution. Duke's proposal is their preferred alternative to CEC requesting dry cooling operation. The Regional Water Quality Control Board (RWQCB) staff agrees with Duke's proposal and believes that habitat enhancement would yield greater long-term benefits for the Bay. Duke Energy's proposal would fund habitat enhancement projects authorized by the RWQCB and managed through professional groups like the

MBNEP, which have plans and programs to reduce sedimentation and other factors undermining the Bay's productivity. The special value of habitat enhancement is that it not only addresses marine biology, but also protects and enhances habitat for birds and other animals and sustains important recreational resources for the community. Documents describing the program in detail can be downloaded from the noted website. Because of recent economic conditions across the U.S., Duke has canceled plans for modernizing the Morro Bay Power Station and, as a result, their habitat enhancement project has not been implemented.

- *PSEG's Delaware Bay Estuary Enhancement Program* This is the largest restoration program the U.S. implemented as compensation for impingement and entrainment losses at a power station. Established in 1995, this program was negotiated with NJDEP as a mitigative action for fish losses at the Salem Nuclear Generating Station in lieu of implementing a closed-cycle cooling system. Principally focused on the restoration of approximately 10,000 acres of former salt hay farms to natural estuarine salt marsh in the lower Delaware Estuary, the program also includes provision of fish passage in combination with some limited fish stocking to support restoration of anadromous (American shad and river herring) fish stocks. Details of the program can be found in Weinstein et al. (2001). In a following section, the method used by PSEG to scale (i.e., convert fish loss to acres of equivalent wetland habitat) the size of the requisite restoration project is demonstrated. The PSEG incurred costs to date for the ongoing restoration project, including capital, O&M, and monitoring exceed $100 million or $9,350/acre (EPRI 2003).

- *Santa Monica Bay Restoration Commission (see:* http://www.santamonicabay.org/site/aboutus/layout/index.jsp) - In recognition of the need to restore and protect the Santa Monica Bay and its resources, the State of California and the U.S. Environmental Protection Agency established the Santa Monica Bay Restoration Project (SMBRP) as a National Estuary Program in December of 1988. The Project was formed to develop a plan that would ensure the long-term health of the 266 square mile Bay and its 400 square mile watershed, located in the second most populous region in the United States. That plan, known as the Santa Monica Bay Restoration Plan, won State and Federal approval in 1995. Since then, the SMBRP's primary mission has been to facilitate and oversee the implementation of the Plan.

  On January 1st, 2003, the Santa Monica Bay Restoration Project formally became an independent state organization and is now known as the Santa Monica Bay Restoration Commission (SMBRC). The Santa Monica Bay Restoration Commission continues the mission of the Bay Restoration Project and the collaborative approach of the National Estuary Program but with a greater ability to accelerate the pace and effectiveness of Bay restoration efforts. Restoration activities are based on a comprehensive plan of action for Bay protection and management, known as the Bay Restoration Plan, that was approved by Governor Pete Wilson in December of 1994 and by USEPA Administrator Carol Browner in 1995. The Plan identifies almost 250 actions, including 74 priority actions, that address critical problems such as storm water and urban runoff pollution, habitat loss and degradation, and public health risks associated with seafood consumption and swimming near storm drain outlets. The Plan outlines specific programs to address the environmental problems facing the Bay and identifies implementers, timelines, and funding needs.

Implementation of the Plan is the focus of current efforts. Securing and leveraging funding to put solutions into action, building public-private partnerships, promoting cutting-edge research and technology, facilitating a stakeholder-driven consensus process, and raising public awareness in order to restore and preserve the Bay's many beneficial uses are key objectives of the SMBRC.

- *National Oceanic and Atmospheric Administration (NOAA) Community-based Restoration Program (CRP)(see: http://www.nmfs.noaa.gov/habitat/restoration/*: This program applies a grass-roots approach to restoration by actively engaging communities in on-the-ground restoration of fishery habitats around the nation. The CRP emphasizes partnerships and collaborative strategies built around restoring NOAA trust resources and improving the environmental quality of local communities. The program is: (1) providing seed money and technical expertise to help communities restore degraded fishery habitats, (2) developing partnerships to accomplish sound coastal restoration projects, and (3) leveraging resources through national, regional, and local partnerships. This program is one of the services of the NOAA Restoration Center. This Center's mission is to enhance living marine resources to benefit the nation's fisheries by restoring their habitat. Working with others, the Center achieves its mission by (1) restoring degraded habitats, (2) advancing the science of coastal habitat restoration, (3) transferring restoration technology to the private sector, the public, and other government agencies, and (4) fostering habitat stewardship and a conservation ethic. Recently, under the community-based program, NOAA awarded $250,000 to the Gulf of Mexico Foundation for habitat restoration in the five states bordering the Gulf of Mexico. EPA, under their Gulf of Mexico Program (see following) similarly awarded $90,000 to the Foundation. These awards launch a major new effort to reclaim essential fish habitats of the Gulf of Mexico by implementing field efforts to restore and improve marine and coastal habitats that have been degraded or lost.

- *U.S. Fish & Wildlife Service Partnership for Fish & Wildlife* (see: http://partners.fws.gov/index.htm) - This program is supported by funds from federal and state agencies, private landowners, and non-governmental organizations (e.g., Ducks Unlimited, CDFG, The Nature Conservancy). The program is a voluntary partnership program with a goal to restore wetlands and other vital habitats on private land with 70% of the current funding coming from private sources. The remaining funds, along with restoration design and technical assistance is provided by USFWS. State resource agencies, such as CDFG, work with the FWS to help establish priorities and identify focus areas. The restoration of degraded wetlands, native grasslands, streams, riparian areas, and other habitat to conditions as close as possible to natural is emphasized. The Partnership for Fish and Wildlife Program is important for restoration of critical habitats in California (USFWS 2001). AES financial support to the program and potential in-kind service could potentially be negotiated as compensation for impingement mortality and entrainment at their power plants in southern California.

- *Coastal America's Corporate Wetland's Restoration Partnership (CWRP)*(see: http://www.coastalamerica.gov/text/cwrpoperating.html) - is a program designed to foster collaboration between the federal government, state agencies, and private corporations. Private corporations that participate in this national program will donate funds for either site-specific wetland or other aquatic habitat restoration projects or provide matching funds to a national or regional effort in support of aquatic ecosystem restoration activities. Projects that will receive funds from the CWRP will all be approved Coastal America projects while federal agencies will assist in their proper execution. The Coastal America Partnership will coordinate among all of its Regional Implementation Teams to identify the appropriate private foundation or state trust fund that will receive funds from the CWRP. This organization will not likely accept support in response to regulatory requirements. However, the organization is a source of wetland restoration information and unique partnerships may be arranged.

- Alternative restoration measures – the above measures have been identified as the most likely restoration approaches that would be receptive to RWQCB and other federal and state resource agencies. Other potential approaches include nonpoint source pollutant runoff abatement programs and contaminated sediments restoration. While these types of efforts focus on water quality improvements, the long-term benefit is improved fish and shellfish habitat. Such efforts would have to demonstrate a clear linkage between the two as compensation for impingement mortality and entrainment losses at AES's southern California power stations. The California Coastal Commission is implementing a statewide Nonpoint Source (NPS) Program (see: http://www.coastal.ca.gov/nps/npsndx.html). Elements of the plan include management measures for reducing runoff pollution from agriculture, silviculture, urban areas, marinas and recreational boating, and via hydromodification (includes modification of stream and river channels, dams and water impoundments, and streambank/shoreline erosion). CCC, therefore, is a source of information for developing a potential nonpoint source runoff abatement program or implementing best management practices (BMPs) to meet the goals of the State's plan in the Los Angeles urban and suburban areas. RWQCB may welcome direct support by AES toward implementing some of the BMPs as compensation for the impingement (and entrainment losses) at AES power plants.

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B DESCRIPTION OF ALAMITOS HISTORICAL STUDIES, PHYSICAL AND BIOLOGICAL INFORMATION

See following pages.

AES ALAMITOS GENERATING STATION

SUMMARY OF EXISTING PHYSICAL AND BIOLOGICAL INFORMATION AND IMPINGEMENT MORTALITY AND ENTRAINMENT CHARACTERIZATION STUDY SAMPLING PLAN

September 28, 2005

Prepared for:

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA) published Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities on July 9, 2004. These §316(b) requirements went into effect in September 2004, and apply to existing generating stations with cooling water intake structures that withdraw at least 50 million gallons per day (mgd) from rivers, streams, lakes, reservoirs, oceans, estuaries, or other waters of the United States. The Alamitos Generating Station (AGS) consists of six steam boiler generating units (Units 1–6) with a station capacity of 1,950 megawatts (MW). All units withdraw cooling water from Los Cerritos Channel, which extends from the northern portion of Alamitos Bay. One intake canal branches off of Los Cerritos Channel to serve Units 1–4, and another canal serves Units 5&6. The maximum cooling water flow is 104 mgd per unit at Units 1&2, 194.5 mgd per unit at Units 3&4, and 337 mgd per unit at Units 5&6. The total design station flow is approximately 1.271 billion gallons per day. As part of the Proposal for Information Collection (PIC), Phase II facilities are required to provide:

- *A list and description of any historical studies characterizing impingement mortality and entrainment (IM&E), and /or the physical and biological conditions in the vicinity of the cooling water intake structures and their relevance to this proposed Study. If you propose to use existing data, you must demonstrate that the data are representative of current conditions and were collected using appropriate quality assurance/quality control procedures.*
- *A sampling plan for any new studies you plan to conduct in order to ensure that you have sufficient data to develop a scientifically valid estimate of IM&E at your site. The sampling plan must document all methods and quality assurance/quality control procedures for sampling and data analysis. The sampling and data analysis methods you propose must be appropriate for a quantitative survey and include consideration of the methods used in other studies performed in the source waterbody. The sampling plan must include a description of the study area (including the area of influence of the CWIS), and provide taxonomic identification of the sampled or evaluated biological assemblages (including all life stages of fish and shellfish).*

This document provides this information. As part of the §316(b) Comprehensive Demonstration Study (CDS) required under the new regulations, a facility may be required to submit an Impingement Mortality and Entrainment Characterization Study depending on the chosen compliance pathway. The Impingement Mortality component is not required if a facility's through-screen intake velocity is less than or equal to 0.5 ft/s (15 cm/s). The Entrainment Characterization component is not required if a facility: (a) has a capacity utilization rate of less than 15 percent; (b) withdraws cooling water from a lake or reservoir, excluding the Great Lakes; or (c) withdraws less than five percent of the mean annual flow of a freshwater river or stream. Based on previously collected intake velocity measurements and plant operating characteristics, both the Impingement Mortality and Entrainment components of the Study would be required at the AGS.

According to the §316(b) Phase II Regulations, the Impingement Mortality and Entrainment Characterization Study must include the following (for all applicable components):

- Taxonomic identifications of all life stages of fish, shellfish, and any species protected under Federal, State, or Tribal Law (including threatened or endangered species) that are in the vicinity of the cooling water intake structure(s) and are susceptible to impingement and entrainment;
- A characterization of all life stages of fish, shellfish, and any species protected under Federal, State, or Tribal Law (including threatened or endangered species) identified in the taxonomic identification noted previously, including a description of the abundance

and temporal and spatial characteristics in the vicinity of the cooling water intake structure(s), based on sufficient data to characterize the annual, seasonal, and diel variations in impingement mortality and entrainment; and

- Documentation of current impingement mortality and entrainment of all life stages of fish, shellfish, and any protected species identified previously and an estimate of impingement mortality and entrainment to be used as the calculation baseline.

The Rule allows facilities to use four sources of information to developing the Impingement Mortality and Entrainment Characterization Baseline. These include:

- Use of historical studies
- Use of source waterbody biological information
- Use of data from other facilities
- Results of new studies

As discussed below, AES plans to use a combination of these sources of information to prepare the AGS Impingement Mortality and Entrainment Characterization Study Report. Under the new 316(b) regulations the impingement mortality component of the IM&E studies is not required if a facility's through-screen intake velocity is less than or equal to 0.5 ft/s (15 cm/s). The cooling water intake flow at the AGS exceeds this value so impingement mortality studies will be conducted. The entrainment characterization component is not required if a facility: (a) has a capacity utilization rate of less than 15 percent; (b) withdraws cooling water from a lake or reservoir, excluding the Great Lakes; or (c) withdraws less than five percent of the mean annual flow of a freshwater river or stream. Units 1&2 have capacity factors less than 15 percent; therefore, an entrainment study is proposed for Units 3 through 6.

1.1 Environmental Setting

The AGS (33°46.08' N, 118°05.59' W) is located in the city of Long Beach on the western side of the San Gabriel River flood control channel (**Figure 1-1**). All units at the AGS withdraw cooling water from the Los Cerritos Channel, which is hydraulically connected to Alamitos Bay. The Los Angeles Department of Water and Power (LADWP) Haynes Generating Station (HnGS) withdraws cooling water from a single bulkhead intake in Long Beach Marina within Alamitos Bay. Both facilities discharge cooling water into the lower San Gabriel River flood control channel.

Alamitos Bay is a man-made, small-vessel harbor that was constructed at the mouth of the San Gabriel River (Figure 1-1). It was once an estuary with tidal marshes and mud flats. It is relatively shallow with water depths throughout most of the Bay between 12 and 18 ft (3.6 and 5.5 m). Depth at the intake canals is approximately 12 to 14 ft (3.5 to 4.2 m). Sediments within the Bay consist of sand, silt, and clay. Eelgrass (Zostera marina) is present at locations near the entrance channel, near the west end of Naples Island, and in the Marine Stadium arm of the Bay (Valle et al. 1999).

Detailed circulation studies were performed within the Bay and nearshore areas of San Pedro Bay during the original HnGS 316(b) Demonstration (IRC 1981). Recirculation of discharged cooling water at the HnGS was estimated to be about 4%. This relatively low value was attributed to predominant downcoast currents which transport discharged waters away from Alamitos Bay. It was concluded that "*very little of the water entrained into the Haynes Generating Station resided within Alamitos Bay more than five days*." Due to the predominant downcoast water movement, the immediate oceanic source waters for Alamitos Bay were determined to lie in the northern lees of the Long Beach and Middle Breakwaters (Outer Long Beach Harbor), with minor amounts derived from downcoast between Alamitos and Anaheim Bays.

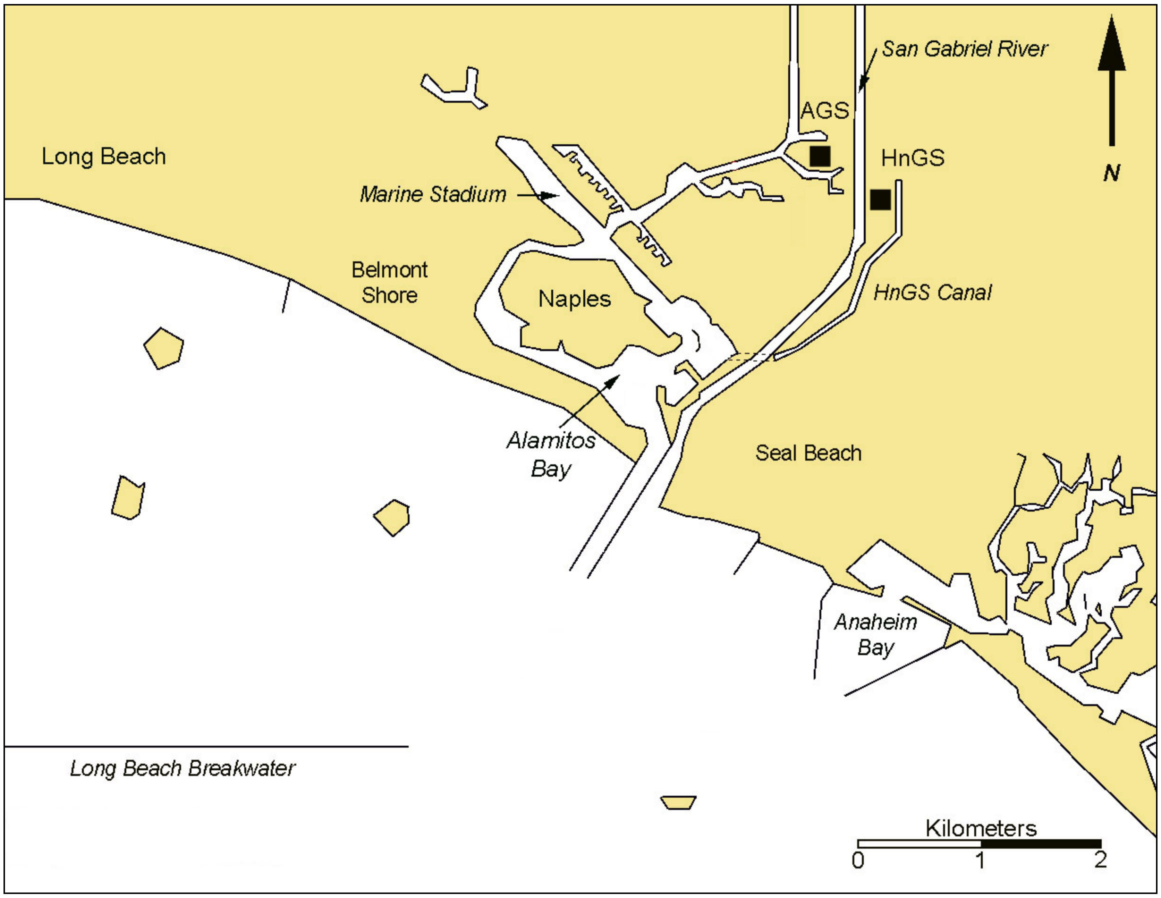

Figure 1-1. Location of the Alamitos Generating Station (AGS).

Larval fishes were sampled at the AGS from June through July 2004 (MBC 2005). Unidentified gobies (Gobiidae) and combtooth blennies (*Hypsoblennius* spp) comprised 56% and 41%, respectively, of the total abundance. The unidentified gobies were comprised of up to three species that cannot be distinguished during the earliest larval stages: arrow goby (*Clevelandia ios*), cheekspot goby (*Ilypnus gilberti*), and/or shadow goby (*Quietula y-cauda*). Clingfishes (*Gobiesox* spp) and labrisomid blennies (Labrisomidae) each contributed 1% to the total abundance, and the remaining 10 taxa collectively accounted for 1% of the total abundance. A similar program was carried out at the HnGS intake structure in Alamitos Bay from April to June 2004 (MBC 2004a). Densities were dominated by combtooth blennies (54%), unidentified gobies (26%), and silversides (Atherinopsidae; 14%). Larval fish densities at the Haynes intake were nearly four times higher than at the Alamitos intake canals, and larval decapod densities were almost five times greater at Haynes than at Alamitos.

The juvenile fishes of Alamitos Bay were studied monthly or bimonthly for approximately three years (1992–1995) (Valle et al. 1999). Nearly 53,000 individuals representing 46 taxa were collected in the 435 beam trawl tows equipped with 0.12-inch (3-mm) mesh. The most common taxa collected were cheekspot goby (*Ilypnus gilberti*), unidentified goby larvae (Gobiidae), California halibut (*Paralichthys californicus*), bay pipefish (*Syngnathus leptorhynchus*), and diamond turbot (*Pleuronichthys guttulatus*). Species diversity decreased with distance from the bay entrance, and more species were collected in eelgrass beds (42) than in unvegetated areas (26).

Fishes impinged at the AGS in 2004 consisted primarily of northern anchovy (*Engraulis mordax*), topsmelt (*Atherinops affinis*), and shiner perch (*Cymatogaster aggregata*) (MBC 2004b). The most abundant invertebrates impinged at the AGS included the mollusks angular unicorn (*Acanthina spirata*) and two-spotted octopus (*Octopus bimaculatus/bimaculoides*), and the crustacean striped shore crab (*Pachygrapsus crassipes*).

2.0 HISTORICAL IMPINGEMENT AND ENTRAINMENT STUDIES

The following identifies and summarizes previous entrainment and impingement studies conducted at the AGS and relevant studies from Alamitos Bay. Many studies were performed in cooperation with the LADWP HnGS, which also withdraws cooling water from Alamitos Bay.

2.1 1978-1980 AGS 316(b) Demonstration

From 1978 through 1980, SCE studied entrainment and impingement at the AGS cooling water intake systems as part of a 316(b) Demonstration Program. Target species analyzed in the report were selected in consultation with the California Regional Water Quality Control Board and the California Department of Fish and Game. Impacts of cooling water system entrainment and impingement on fishery resources were determined by comparison of losses to available fishery stocks, which were estimated from collections of ichthyoplankton in the Southern California Bight and long-term adult fish monitoring at the generating stations.

Entrainment samples were collected bimonthly at the Haynes Generating Station (HnGS) intake structure from October 1979 through September 1980 (SCE 1982a). The HnGS intake structure is approximately 0.3 mi (0.5 km) from the AGS intake canals, and the HnGS also withdraws cooling water from Alamitos Bay. Daytime samples were collected from mid-depth by pump and filtered through (0.013 in.) 335 μm mesh during the first seven surveys and through (0.008 in.) 202 μm mesh during the remaining surveys. Nighttime samples were collected using Manta nets (surface), bongo nets (mid-depth), and epibenthic bongo nets (near-bottom) with the same mesh dimensions described for daytime sampling. During each sampling period, two replicates of approximately (16,000 gal.) 60 m^3 were collected. Entrainment estimates were derived by adjusting daily entrainment estimates from the HnGS for the difference in maximum flow volume between the intakes. Mortality of entrained larvae was assumed to be 100%.

Larval entrainment at the AGS was dominated by combtooth blennies (44%) and the Gobiid species complex (38%), which was comprised of cheekspot goby, arrow goby, and shadow goby (Table 2-1). The Engraulid species complex was comprised of northern anchovy, deepbody anchovy (*Anchoa compressa*) and slough anchovy (*Anchoa delicatissima*). Entrainment was highest at Units 5&6 and lowest at Units 1&2 due to differences in cooling water flow volume. Larval entrainment peaked in late spring (May and June) and remained high through October, while the lowest entrainment was recorded in winter (December and January). Most larvae were collected at night in the middle and lower water column.

Impingement samples were collected at the AGS from October 1978 through September 1980 (SCE 1982a). Twenty-four-hour normal operation sampling was done at all cooling water intakes. Samples were collected approximately weekly at all intakes, though samples were collected twice per week from August 1979 through July 1980. During normal operation surveys, traveling/slide screens and collection baskets were initially cleared, and impinged organisms were allowed to collect for a 24-hr period. Estimated annual normal operations totals were calculated by multiplying the mean daily impingement loss by the number of operational days during each study period. The study periods were stratified by month for purposes of analysis. Heat treatments were not performed during the study.

Table 2-1. Estimates of daily average larval fish entrainment at the AGS from October 1979 through September 1980.

Target Fish Taxa		Daily Average Larval Entrainment Units 1&2	Units 3&4	Units 5&6	Percent of Total
anchovies	*Engraulid sp. complex*	424,000	818,000	1,294,000	8.6
white croaker	*Genyonemus lineatus*	279,000	537,000	850,000	5.7
queenfish	*Seriphus politus*	95,000	184,000	291,000	1.9
Other Species					
blennies	*Hypsoblennius* spp	2,147,000	4,143,000	6,557,000	43.7
gobies	Gobiid sp. complex	1,873,000	3,613,000	5,717,000	38.1
miscellaneous		72,000	139,000	220,000	1.4
silversides	Atherinid sp. complex	23,000	44,000	70,000	0.5
diamond turbot	*Pleuronichthys guttulatus*	4,000	8,000	13,000	0.1
Total		4,917,000	9,486,000	15,012,000	100.0

Pacific butterfish (*Peprilus simillimus*) and shiner perch (*Cymatogaster aggregata*) were the dominant species in the impingement study, comprising 84% of impingement abundance at Units 1–6 (**Table 2-2**). Pacific butterfish, which accounted for 74% of abundance, was most abundant from October 1978 to February 1979. Target species impingement averaged about 203 fish per day, with 79% occurring at Units 5&6, 18% at Units 3&4, and 3% at Units 1&2. Impingement of target species accounted for 50% of total impingement.

Table 2-2. Estimates of daily average fish impingement at the AGS from October 1978 through September 1980.

Target Species		**Daily Average Impingement** (number of fishes impinged per day) Units 1&2	Units 3&4	Units 5&6	Percent of Total
Pacific butterfish	*Peprilus simillimus*	2.63	27.96	118.84	73.7
shiner perch	*Cymatogaster aggregata*	1.25	4.3	16.16	10.7
queenfish	*Seriphus politus*	0.61	2.6	13.17	8.1
white seaperch	*Phanerodon furcatus*	0.35	0.67	3.62	2.3
white croaker	*Genyonemus lineatus*	0.11	0.51	2.94	1.8
northern anchovy	*Engraulis mordax*	0.09	0.81	1.77	1.3
walleye surfperch	*Hyperprosopon argenteum*	0.05	0.18	1.62	0.9
black perch	*Embiotoca jacksoni*	0.11	0.28	1.28	0.8
barred sand bass	*Paralabrax nebulifer*	0.01	0.01	0.24	0.1
yellowfin croaker	*Umbrina roncador*	0	0.01	0.27	0.1
black croaker	*Cheilotrema saturnum*	0.02	0.02	0.04	<0.1
kelp bass	*Paralabrax clathratus*	0	0.01	0.03	<0.1
sargo	*Anisotremus davidsonii*	0.01	0.01	0.03	<0.1
bocaccio	*Sebastes paucispinis*	0	0	0	0.0
spotfin croaker	*Roncador stearnsii*	0	0	0	0.0
Total		5.24	37.37	160.01	100.0

Impact analyses were based on the proportional entrainment approach of MacCall et al. (1983) which estimates the probability of mortality due to entrainment and impingement by the cooling water intake systems at the AGS. Mortality estimates were calculated through the first five years of each target species' life cycle for a source water population that was considered to reside in the Southern California Bight between shore and the 75-m isobath (SCE 1982b). Due to the low abundance of many of the species from the study, the probability of mortality values could only be calculated for six of the target species. At Units 1&2, probability of mortality values ranged from 0% (white seaperch [*Phanerodon furcatus*]) to 0.29% (queenfish). At the AGS Units 3&4, probability of mortality values ranged from 0% (kelp bass [*Paralabrax clathratus*] and barred sand bass [*Paralabrax nebulifer*]) to 0.59% (queenfish). At Units 5&6, probability of mortality values ranged from 0% (kelp bass and barred sand bass) to 1.02% (queenfish). Impacts to shiner perch were restricted to impingement, since this species is viviparous. The report concluded that the operation of the cooling water system at the AGS did not result in any significant effects on the long-term abundance or distribution of nearshore fish populations. Regardless, SCE examined nine alternative cooling water intake technologies and/or devices potentially applicable at Alamitos (LMS 1982). It was determined that the canal/forebay cooling water intakes in place at the time represented the best technology available.

2.2 1992–1993 and 2000–2004 Fish and Macroinvertebrate Impingement Monitoring

Composition, abundance, and biomass of juvenile and adult fish and macroinvertebrates entrapped and impinged on traveling/slide screens at the AGS have been studied for many years as part of a continuing National Pollutant Discharge Elimination System (NPDES) monitoring program. From July 1992 to July 1993, fish and macroinvertebrate impingement sampling was conducted biweekly during representative periods of normal operation. From 2000–2004, normal operation and heat treatment impingement surveys occurred periodically as required by the AGS NPDES permit. A normal operation survey is defined as a sample of all fish and macroinvertebrates entrained by water flow into the generating station intake and subsequently impinged and removed by traveling screens during a 24-hr period.

Methods

During normal operation surveys, the traveling/slide screens were rotated/removed for an approximate 10-minute rotation, and the impingement collection basket was cleared of accumulated debris. If this was not possible, a tarp was laid across the debris to separate it from the subsequent collection. Approximately 24 hr later, the screens were rotated/removed again, and all material that accumulated from that screen wash, and any other washes that occurred in the prior 24 hr, was considered part of that normal operation sample. All fish and macroinvertebrates were separated from incidental debris, identified, and counted. Up to 200 individuals of each fish species were measured, examined for external parasites, anatomical anomalies, and other abnormalities. Aggregate weights were taken for each fish and macroinvertebrate species. Flow during each ~24-hr survey, as well as annual flow, was provided by plant personnel.

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 recirculated to the intake until the water temperature rises to approximately 105°F (40.5°C) in the screenwell area. This temperature is maintained for at least one hour, during which time all biofouling organisms succumb to the heated water. Fish that are upcurrent of the screens in the intake canals could potentially avoid the areas of higher temperature, however. During heat treatment surveys, all material impinged onto traveling/slide screens was removed. Fish and macroinvertebrates were separated from incidental debris, identified, and counted. Up to 200 individuals of each species were measured, examined for external parasites, anatomical anomalies, and other abnormalities. Aggregate weights were taken by species.

Results

A summary of results from the 1992–1993 impingement study is presented in **Table 2-3**. A total of 76 surveys was performed during the one-year study. The number of fishes impinged at the AGS was substantially lower than in 1978–1980, but impingement was still highest at Units 5&6. However, invertebrate impingement was highest at Units 3&4. Impingement abundance was largely influenced by the 13 January 1993 survey, where fish impingement was equivalent to 42% of the study total at Units 1&2, 25% at Units 3&4, and 56% at Units 5&6. During that survey, impingement was comprised of primarily topsmelt (*Atherinops affinis*) at Units 1–4 and Pacific sardine (*Sardinops sagax*) and topsmelt at Units 5&6.

Table 2-3. Summary of fish and macroinvertebrate impingement abundance at the AGS, 1992-1993.

Parameter	Units 1&2	Units 3&4	Units 5&6	Total
Average # of fish per survey	1.0	10.3	18.3	29.6
Avg. # of macroinvertebrates per survey	2.5	53.1	7.2	62.8
Number of surveys	25	24	27	76

A summary of results from the 2001–2004 impingement monitoring is presented in **Table 2-4**. Results from the 2000 study years were not included in the impingement database. The NPDES monitoring period spanned from October through September each year. During the three years, daily normal operation impingement averaged about one fish at Units 1&2, three fish at Units 3&4, and 21 fish at Units 5&6. Invertebrate impingement was highest at Units 5&6, averaging six individuals per normal operation survey. A total of seven heat treatment surveys were performed at Units 3&4 and two heat treatments at Units 5&6 during the three-year period; no heat treatments occurred at Units 1&2. Heat treatment impingement averaged about 74 fish and 13 invertebrates at Units 3&4, and 43 fish and 81 invertebrates at Units 5&6.

Table 2-4. Summary of fish and macroinvertebrate impingement abundance at the AGS, 2001-2004.

Parameter	Units 1&2	Units 3&4	Units 5&6	Total
Average # of fish per normal operation survey	0.7	2.5	20.5	23.7
Average # of fish per heat treatment survey	-	73.5	43.0	
Avg. # of macroinvertebrates per normal op. survey	2.7	3.5	6.0	12.2
Avg. # of macroinvertebrates per heat treatment survey	-	13.3	81.0	
Number of normal operation surveys	3	2	6	11
Number of heat treatment surveys	-	7	2	9

2.3 2004 AGS Larval Characterization Study

In preparation for potential 316(b) field studies, a preliminary larval sampling program was conducted to document the composition and density of larval fishes and target invertebrates in the vicinity of the AGS cooling water intakes (MBC 2005). Samples were collected during eight surveys from June 2004 through July 2004. Collections were made from the in-plant footbridges spanning the Units 1–4 intake canal and the Units 5&6 intake canal. The sampling net was a 20 in. (50 cm) inside diameter by 71 in. (180 cm) long plankton net with 0.012 in. (303 μm) mesh. The net was equipped with a General Oceanics flowmeter to allow the calculation of the volume of water sampled by the net. Samples were collected during daytime and nighttime by towing the net across the canals from the footbridges. The tow was performed in an oblique fashion by raising the net slowly during sampling from near-bottom to the surface. All fish larvae were sorted from the samples and identified to the lowest practical taxon. Target larval invertebrates were also removed from the samples and quantified.

A summary of results is presented in Table 2-5. Mean density at Units 5&6 was approximately 1.7 times higher than that at Units 1–4. Species composition was similar between the two canals, and the dominant taxa at each were CIQ gobies and combtooth blennies, similar to the results from 1979–1980. The CIQ goby complex is comprised of three species which are morphologically similar during early larval stages: arrow goby, cheekspot goby, and shadow goby. Densities were higher at nighttime than daytime during all eight surveys. Mean densities were higher at the Units 5&6 intake canal than at the Units 1–4 canal during six of the eight surveys.

Table 2-5. Densities (#/1,000 m^3) of the ten most abundant larval fish taxa collected during eight surveys at the AGS intake canals, June–July 2004. (1,000 m^3 = 265,000 gal.).

		Mean Density (No./1,000 m^3)	
Taxon		**Units 1–4**	**Units 5&6**
CIQ gobies	Gobiidae	1,825	2,909
combtooth blennies	*Hypsoblennius* spp.	1,194	2,306
clingfishes	*Gobiesox* spp.	29	74
labrisomid blennies	Labrisomidae	39	41
silversides	Atherinopsidae	4	28
topsmelt	*Atherinops affinis*	-	18
cheekspot goby	*Ilypnus gilberti*	2	15
unidentified larvae		2	11
bay pipefish	*Syngnathus leptorhynchus*	3	4
tube blenny	Chaenopsidae	3	-
	Total:	3,111	5,405
	Number of taxa	14	14

A set of four target invertebrate taxa were selected prior to initiation of the surveys: California spiny lobster (*Panulirus interruptus*), market squid (*Loligo opalescens*), sand crab (*Emerita analoga*), and decapod zoea/megalopae larvae. California spiny lobster and market squid were not collected during the eight-week study. Decapod zoea were collected in higher numbers at Units 5&6 (4,669 zoea/1,000 m^3) than at Units 1–4 (2,968/1,000 m^3). Only seven decapod megalopae (13/1,000 m^3) and eight sand crab zoea (9/1,000 m^3) were collected during the study.

2.4 Studies on the Physical Environment in the Vicinity of the AGS

The AES Alamitos Generating Station (AGS) withdraws cooling water from Long Beach Marina in Alamitos Bay. Cooling water is withdrawn from Los Cerritos Channel via two cooling water canals. Waters within Alamitos Bay are primarily marine (30–35 practical salinity units [PSU]) with water temperatures ranging from about 55°F (13°C) in winter to 77°F (25°C) in summer (Allen and Horn 1975, IRC 1981). The Bay has undergone extensive changes in the last 100 years. Originally an estuary and wetland system, it is now highly developed.

Temperature and Salinity of Source Waters

The temperature and salinity of the waters offshore Alamitos Bay have been measured semiannually or annually for many years as part of the AGS NPDES monitoring program. The monitoring program consists of 9 stations in the nearshore waters off Alamitos Bay and the mouth of the San Gabriel River flood control channel, from depths of 12 to 40 ft (3.6 to 12.2 m). Three additional stations are monitored within the San Gabriel River. From 2000 through 2004, all stations were sampled during both ebb and flood tides during five winter surveys and five summer surveys. Salinity is not a required monitoring component but results have been measured and reported since 2001. Results are summarized in **Table 2-6.**

Table 2-6. Temperature and salinity of surface and bottom waters off Alamitos Bay, 2000–2004.

Season	Parameter	Surface	Bottom
Winter	Minimum temperature °F (°C)	58.2 (14.5)	56.3 (13.5)
	Average temperature °F (°C)	62.1 (16.7)	58.3 (14.6)
	Maximum temperature °F (°C)	74.2 (23.5)	61.9 (16.6)
Summer	Minimum temperature °F (°C)	65.3 (18.5)	57.1 (13.9)
	Average temperature °F (°C)	70.4 (21.3)	64.6 (18.1)
	Maximum temperature °F (°C)	81.3 (27.4)	71.2 (21.8)
Winter	Minimum salinity (PSU)	28.8	32.4
	Average salinity (PSU)	32.1	33.2
	Maximum salinity (PSU)	33.4	33.6
Summer	Minimum salinity (PSU)	32.3	33.2
	Average salinity (PSU)	33.2	33.5
	Maximum salinity (PSU)	33.6	33.9

In general, temperatures in the study area are usually several degrees warmer in summer than in winter, with bottom waters consistently colder than surface waters. Temperatures throughout the water column in the study area are usually warmest in the afternoon due to solar heating, and the formation of a thermocline is especially common during summer, though thermoclines may also develop in winter. Salinity in the study area is relatively uniform, ranging from 28.8 to 33.9 practical salinity units (PSU), typical for nearshore waters of southern California. Salinity is usually slightly higher near bottom than at the surface. Lowest salinity typically occurs directly offshore the mouth of the San Gabriel River.

Additional water quality monitoring was performed at the AGS intake structure during summer (June–July) 2004 (MBC 2005). Average water temperatures at the intake sampling stations ranged from about 67.6°F (19.8°C) to 71.6°F (22.0°C) during sampling. Salinity consistently ranged between 33.2 and 34.5 practical salinity units (PSU). There are no other known temperature/salinity data for Alamitos Bay or Los Cerritos Channel. It is likely that there is a large influx of fresh water into Alamitos Bay from Los Cerritos Channel only when it rains.

3.0 PROPOSED NEW BIOLOGICAL STUDIES

The proposed impingement mortality and entrainment (IM&E) studies will examine losses at AGS resulting from both impingement of juvenile and adult fish and shellfishes on traveling screens at the intake during normal operations and during heat treatment operations and from entrainment of larval fishes and invertebrates into the cooling water intake system. Proposed sampling methodologies and analysis techniques are designed to collect the data necessary for compliance with the §316(b) Phase II Final Rule and are similar to recent impingement and entrainment studies conducted for the AES Huntington Beach Generating Station (MBC and Tenera 2005), the Duke Energy South Bay Power Plant (Tenera 2004), and the Cabrillo Power I LLC, Encina Power Station (Tenera, in progress). The studies at Huntington Beach were performed as part of the California Energy Commission CEQA process for permitting power plant modernization projects, while the South Bay and Encina projects were for §316(b) compliance.

Under the new 316(b) regulations the impingement mortality component of the IM&E studies is not required if a facility's through-screen intake velocity is less than or equal to 0.5 ft/s (15 cm/s). The through-screen velocities at the AGS exceed this value (SCE 1982a), so AES is proposing to conduct a yearlong impingement monitoring study at the AGS intakes. The goal of the proposed impingement study is to characterize the fishes and shellfishes affected by impingement by the cooling water intake structures (CWIS). The §316(b) Final Regulations allow "historical data that are representative of the current operation of your facility and of biological conditions at the site." Therefore, historical impingement data may be used to supplement results from the 316(b) study for the impingement mortality characterization.

The proposed 316(b) entrainment study plan incorporates design elements that reflect the present uncertainties surrounding the use of restoration for compliance with the new rule. The use of restoration in offsetting IM&E losses under the new 316(b) rules is currently being challenged in the courts. If the use of restoration is not allowed as a result of the court decision, only an estimate of entrainment losses would be required to calculate the commercial and recreational values of adult fish losses in a cost benefit analysis of various technology and operational alternatives to comply with required reductions in entrainment mortality. Larval fish and invertebrate abundances can vary greatly through the year and therefore biweekly sampling is proposed for characterizing entrainment. If the restoration option is upheld in the court decision, models of the conditional mortality due to entrainment would be used in designing appropriate restoration projects for offsetting entrainment losses. These models are based on proportional comparisons of entrainment and source water abundances and are theoretically insensitive to seasonal or annual changes in the abundance of entrained species. Therefore, source water sampling is being proposed monthly which is consistent with the sampling frequency for recently completed studies in southern California. The frequency of the entrainment sampling and the continuation of source water sampling may change depending on the outcome of the court decision. Similar to impingement, historical entrainment data may be used to supplement results from the 316(b) study for the entrainment characterization.

The sampling efforts conducted for this study may be coordinated with similar studies at the LADWP HnGS since it also withdraws cooling water from Alamitos Bay. Coordinating the entrainment and source water sampling will allow for a more comprehensive characterization of the source water and the organisms potentially affected by the CWISs at both facilities.

3.1 Impingement Study

Impingement sampling has been conducted every year at the AGS since 2000. The existing NPDES permit for the plant requires impingement sampling semiannually at each intake pair (Units 1&2, 3&4, and 5&6), coincident with all heat treatments. Heat treatments are operational procedures designed to eliminate mussels, barnacles, and other fouling organisms growing in the cooling water conduit system. During heat treatments the cooling water is backflushed through the system until it reaches a temperature of 115°F (46°C). This temperature is maintained for a sufficient period of time such that all biofouling organisms, as well as fish and invertebrates living within the cooling water system, succumb to the heated water. During heat treatment impingement surveys, all material impinged onto the traveling/slide screens is removed from the screen area, identified, counted, and measured using the same procedures used for normal operations surveys. If heat treatments are not scheduled on a frequency sufficient to comply with the NPDES permit, samples are also collected during normal operations. Fish and invertebrate impingement data from the 2001 through 2004 NPDES annual reporting periods (October 2000 through September 2004) are summarized in Section 2.2.

3.1.1 Impingement Sampling

The purpose of the proposed 316(b) impingement study will be to characterize the juvenile and adult fishes and shellfishes (e.g., rock crabs, lobsters, and squid) impinged at each of the AGS cooling water intakes. The sampling program is designed to provide current estimates on the abundance, biomass, taxonomic composition, diel periodicity, and seasonality of organisms impinged at the AGS. In particular, the study will focus on the rates (i.e., number and biomass of organisms per water volume flowing per time into the plant) at which various species of fishes and shellfishes 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.

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 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 will be divided into four 6-hour cycles. The traveling screens will remain stationary for a period of 5.5 hours then they will be rotated and washed for a period of time sufficient to collect all impinged organisms. The impinged material from the screens will be rinsed into the collection baskets associated with each set of screens. If during the 24-hour sampling an extreme event occurs resulting in the impingement of a large number of fishes or macroinvertebrates, sampling may continue for one or two additional days to obtain a more representative estimate of the impingement rate for the sampling period. Based on historical impingement data, an extreme impingement event during normal operation impingement sampling at the Units 1&2 and 3&4 intakes would be defined as a sample comprised of greater than 100 fishes and/or 200 shellfishes impinged in a 24-hr normal operation survey, and at the Unit 5&6 intake a sample of greater than 500 fishes and/or 500 shellfishes impinged in a 24-hr normal operation survey. Large numbers of organisms in impingement samples could potentially result from the entrainment of a school of fish (such as anchovies or sardines) that would not necessarily reflect impingement for the sampling period.

If the traveling screens are operating in the continuous mode, then sampling will be coordinated with plant personnel 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.

Impingement sampling will also be conducted during heat treatment operations. Procedures for heat treatments 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 will be resumed and the traveling screens rinsed until no more dead fish are collected on the screens. Processing of the samples will occur using the same procedures used for normal impingement sampling. Heat treatments have not occurred at the AGS since 2004.

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. (See Section 4.1 for a description of target taxa.) Each of these procedures involves the following measurements and observations:

1. The appropriate linear measurement for individual fish and shellfish will be determined and recorded. These measurements will be recorded to the nearest 0.04 inch (1 mm). The following standard linear measurements will be used for the animal groups indicated:

    - Fishes - Total body length for sharks and rays and standard lengths 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.

    - Octopus - Maximum “tentacle” spread, measured from the tip of one tentacle to the tip of the opposite tentacle.

    - Squid – Dorsal mantle length, measured from the edge of the mantle to the posterior end of the body.

2. The wet body weight of individual animals will be determined after shaking loose water from the body. Total weight of all individuals combined will be determined in the same manner. All weights will be recorded to the nearest 0.035 ounce (1 g).

3. The qualitative body condition of individual fishes and shellfishes will be determined and recorded, using codes for decomposition and physical damage.

4. Shellfishes and other macroinvertebrates will be identified to species and their presence recorded, but will not be measured or weighed. Rare occurrences of other impinged animals, such as dead marine birds, will also be 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 will be noted by writing specific comments in the “Notes” section of the data sheet. Information on weather, tide and sea conditions will also be recorded during each collection.

The following specific procedures will be used for processing fishes and shellfishes when the number of individuals per species in the sample or subsample is < 30:

- For each individual of a given species the linear measurement, weight, and body condition codes will be determined and recorded.

The following specific subsampling procedures will be used for fishes and shellfishes when the number of individuals per species is >30:

- The linear measurement, individual weight, and body condition codes for a subsample of 30 individuals will be recorded individually on the data sheet. The individuals selected for measurement will be 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 will not be measured.

- The linear measurements of up to 200 individuals of each taxon will be recorded.

- The total number and total weight of all the remaining individuals combined will be determined and recorded separately.

3.1.2 Quality Assurance/Quality Control Program

A quality assurance/quality control (QA/QC) program will be implemented to ensure that all of the organisms are removed from the debris and that the correct identification, enumeration, length and weight measurements of the organisms are recorded on the data sheet. Random cycles will be chosen for QA/QC re-sorting to verify that all the collected organisms were removed from the impinged material. Quality control surveys will be done on a quarterly or more frequent basis if necessary during the study. If the count of any of individual taxon made during the QA/QC survey varies by more than 5 percent (or one if the total number of individuals is less than 20) from the count recorded by the observer then the next three sampling cycles for that observer will be checked. The survey procedures will be reviewed with all personnel prior to the start of the study and all personnel will be given printed copies of the procedures that will also be included with the final IM&E study report.

3.2 Entrainment Study

The proposed entrainment study plan incorporates two design elements 1) cooling water intake system sampling and 2) source water sampling, because of the present uncertainties surrounding the use of restoration for compliance with the new rule. If restoration is not upheld by the court as an alternative to comply with entrainment mortality reduction requirements, then the number of larval fish collected in the entrainment sampling would be used with various demographic modeling techniques to estimate the theoretical loss of adult fish. In this case, the commercial and recreational values of adult fish losses would be calculated and compared in a cost benefit analysis to the cost of various technology and operational alternatives to comply with required reductions in entrainment mortality. The source water populations of entrained fish larvae are sampled to estimate the proportional entrainment losses, using a conditional mortality model that could be used to determine appropriate restoration projects for offsetting entrainment.

The study plan also incorporates a sampling frequency strategy that recognizes the basic difference in the statistical uncertainty of the two design elements. Entrainment of larval fishes and invertebrates varies throughout the year due to changes in composition and the oceanographic environment. The models used to estimate adult equivalents from larval entrainment vary directly with these natural changes in abundance. Estimates of conditional mortality, using the *ETM* or other proportional loss models, are theoretically less sensitive to seasonal or annual changes in the abundance of entrained species. Therefore, entrainment sampling has been proposed to occur biweekly, while source water sampling is proposed to be conducted less frequently on a monthly basis. The monthly sampling frequency is consistent with other recently completed entrainment studies conducted for the AES Huntington Beach Generating Station (MBC and Tenera 2005), the Duke Energy South Bay Power Plant (Tenera 2004), and the Cabrillo Power I LLC, Encina Power Station (Tenera, in progress).

The continuation of the proposed source water sampling and the frequency of the entrainment sampling will depend on the court decision regarding the use of restoration for compliance with the new rule. If restoration is not upheld by the court as an alternative to comply with entrainment mortality reduction requirements, then a decision may be made to discontinue the source water sampling since it would be primarily used in scaling restoration projects. If the use of restoration is upheld, the frequency of entrainment sampling may be reduced so that only the surveys that occur concurrently with source water sampling are continued.

3.2.1 Cooling-Water Intake System Entrainment Sampling

Ocean water for cooling purposes is conveyed to the generating station from the Los Cerritos Channel via two intake canals, one serving Units 1–4 and one serving Units 5&6. The Units 1–4 canal has an average width of 30 m, and the Units 5&6 canal has an average width of 34 m. Depth in the intake canals is approximately 12 to 14 ft (3.5 to 4.2 m). After passing through the condensers, cooling water is discharged through three discharge structures (Units 1&2, Units 3&4, and Units 5&6) located on the western bank of the San Gabriel River.

To determine composition and abundance of ichthyoplankton and target invertebrates entrained by the generating station, sampling in the Units 1-4 (E1) and Units 5&6 (E2) intake canals is proposed to be conducted every two weeks from January through December 2006 (**Figure 3-1**). Entrainment samples will be collected using an oblique tow through the water column. Two replicate tows will be performed with a target volume of 2,600 to 5,200 gal (10 to 20 m^3) per tow. Sampling will be conducted four times per 24-hr period--once every six hours.

Entrainment samples will be collected with a single 333-μm mesh plankton net. The net will be fitted with a Dacron sleeve and a cod-end container to retain the organisms. The net will be equipped with a calibrated General Oceanics flowmeter, allowing the calculation of the amount of water filtered. At the end of each tow, the contents of the net will be gently rinsed into the cod-end with seawater. Contents will be washed down from the outside of the net to avoid the introduction of plankton from the wash-down water. Samples will then be carefully transferred to prelabeled jars with preprinted internal labels. Samples from one of the two nets will be preserved in 4 to 10 percent buffered formalin-seawater, while contents of the other net will be preserved in 70 to 80 percent ethanol. Larvae preserved in ethanol can be made available for genetic and/or otolith analysis, if required. Genetic analyses have been performed in recent studies in attempts to validate the identity of certain species.

3.2.2 Source Water Sampling

The source water study area is designed to 1) characterize the larvae of fishes and target invertebrates potentially entrained by the AGS cooling water intakes, and 2) be representative of the habitats in Alamitos Bay and the nearshore waters just outside Alamitos Bay.

To determine composition and abundance of ichthyoplankton in the source water, sampling will be done monthly on the same day that the entrainment stations are sampled. The source water sampling design is being proposed because of the need to extrapolate densities offshore to determine the appropriate source water area during each survey. IRC (1981) estimated that 32% of the water passing through the Alamitos Bay entrance is entrained in the HnGS intake system. Since the design cooling water flow at the AGS is approximately seven percent higher than that at the HnGS, it is reasonable to assume that a similar percentage is likely entrained at the AGS. Therefore, the source water sampling area extends into the nearshore waters of San Pedro Bay. Besides the entrainment stations (E1 and E2), we propose that source water sampling occur at ten additional source water stations: one within Los Cerritos Channel (A4), three within Alamitos Bay (A1-A3) and six in the nearshore waters of San Pedro Bay (N1-N6) (**Figure 3-1**). In the previous HnGS 316(b) demonstration, current measurements from 0.9 mi (1.5 km) off the bay entrance at mid-depth indicated a mean downcoast flow of approximately 0.63 in./s (1.6 cm/s), or about 0.9 mi./d (1.4 km/day). The six nearshore source water stations (N1-N6) are positioned to sufficiently characterize the waters within 0.9 mi. (1.4 km) of the bay entrance and could allow for extrapolating the sampled source water data over a larger area.

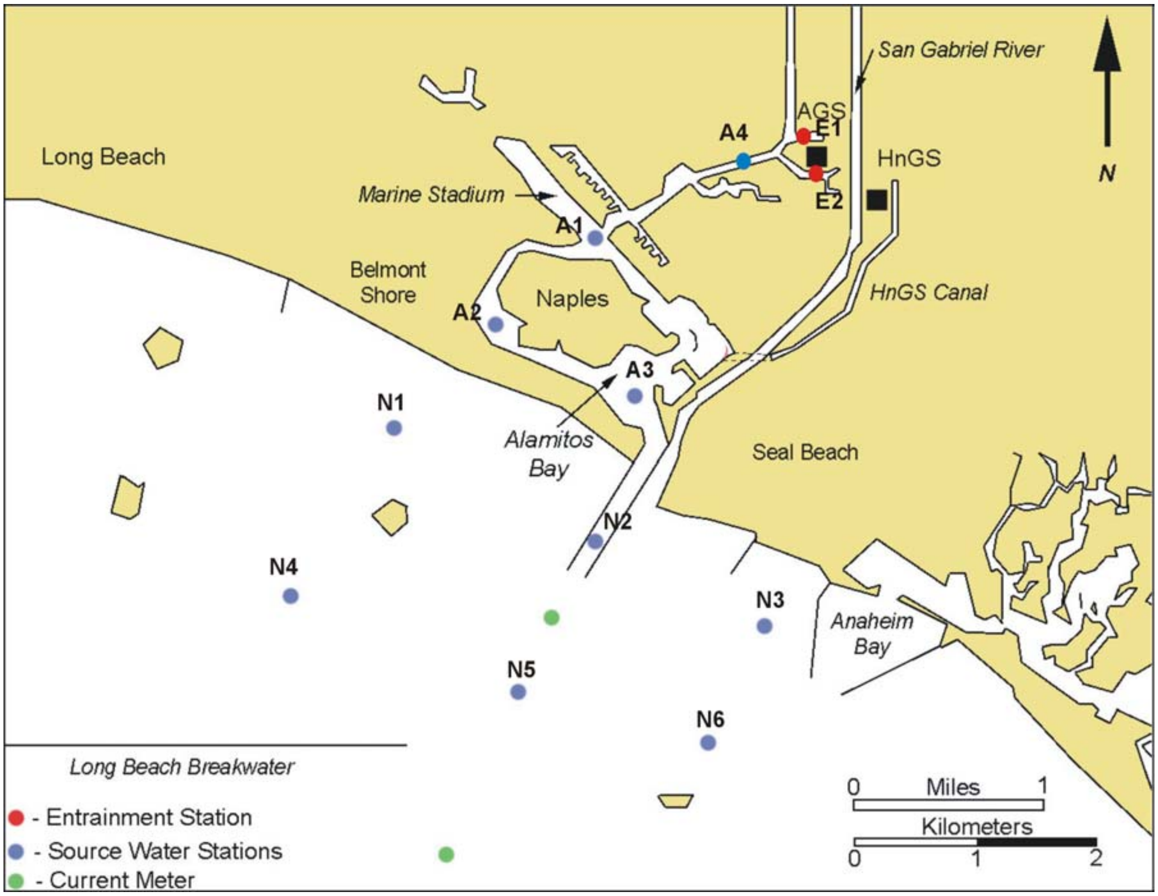

Figure 3-1. Location of the AGS, the entrainment sampling stations (E1 and E2), source water stations (A1-A4 and N1-N6), and current meter locations (green dots).

The bongo or wheeled bongo frame proposed for source water sampling has 24-in. (60 cm) diameter net rings with plankton nets constructed of 0.013-in. (333-µm) Nitex® nylon mesh, similar to the nets used by the California Cooperative Oceanic Fisheries Investigations (CalCOFI). Each net will be fitted with a Dacron sleeve and a plastic cod-end container to retain the organisms. Each net will be equipped with a calibrated General Oceanics flowmeter, allowing the calculation of the amount of water filtered. If the target volume (7,900 to 10,570 gal [30 to 40 m^3] per net) is not met with one oblique tow, subsequent tows will be performed at the station until the target volume is collected. Coordinates of each sampling station will be determined using a differential global positioning system (DGPS). Samples will be preserved and handled using the same procedures used for entrainment sampling (Section 3.2.1).

During each source water survey, the additional 10 source water stations (plus the entrainment stations) will be sampled four times per 24-hr period--once every six hours. This allows adequate time to conduct all source water and entrainment sampling. During each sample cycle the order that the stations are sampled will be varied to avoid introducing a systematic bias into the data.

To determine composition and abundance of ichthyoplankton in the source water, sampling will be done monthly on the same day that the entrainment stations are sampled. The source water sampling design is being proposed because of the need to extrapolate densities offshore to determine the appropriate source water area during each survey. IRC (1981) estimated that 32% of the water passing through the Alamitos Bay entrance is entrained in the HnGS intake system. Since the design cooling water flow at the AGS is approximately seven percent higher than that at the HnGS, it is reasonable to assume that a similar percentage is likely entrained at the AGS. Therefore, the source water sampling area extends into the nearshore waters of San Pedro Bay. Besides the entrainment station, we propose that source water sampling occur at ten additional source water stations: one within Los Cerritos Channel, three within Alamitos Bay and six in the nearshore waters of San Pedro Bay (**Figure 3-1**). In the previous HnGS 316(b) demonstration, current measurements from 0.9 mi (1.5 km) off the bay entrance at mid-depth indicated a mean downcoast flow of approximately 0.63 in./s (1.6 cm/s), or about 0.9 mi./d (1.4 km/day). The six nearshore source water stations are positioned to sufficiently characterize the waters within 0.9 mi. (1.4 km) of the bay entrance and could allow for extrapolating the sampled source water data over a larger area.

3.2.3 Laboratory Processing

Ichthyoplankton samples will be returned to the laboratory; after approximately 72 hours the samples preserved in 4 to 10 percent buffered formalin-seawater will be transferred to 70 to 80 percent ethanol. All entrainment and source water samples will be processed. Samples will be examined under dissecting microscopes and all fish larvae and targeted invertebrate larvae will be removed from debris and other zooplankton and placed in labeled vials. (See Section 4.1 for a description of target taxa.) Larvae will be identified to the lowest practical taxonomic level and enumerated. Fish eggs will not be sorted or identified because a full assessment of their abundance would require different sampling techniques and they cannot be identified to the same taxonomic levels as fish larvae.

Normally the data from the two nets will be combined for analysis, but if the quantity of material in the two samples is very large only one of the two samples will be processed and analyzed. The samples from the two nets are normally preserved in separate 400 ml jars. If the quantity of material in a jar exceeds 200 ml then the sample will be split into multiple jars to ensure that the material is properly preserved. When this quantity of material is collected, only the material from one of the nets would be processed depending upon the nature of the material. In some cases ctenophores, salps, and other larger planktonic organisms may result in samples with large volumes of material, but these can be separated from other plankton and may not be split depending upon the final volume of the material.

A maximum of 200 representative fish larvae from each of the target taxa will be measured using a dissecting microscope and image analysis system. Larvae will be measured to the nearest 0.02 inch (0.5 mm).

3.2.4 Quality Assurance/Quality Control Program

A QA/QC program will be implemented for the field and laboratory components of the study. Quality control surveys will be done on a quarterly or more frequent basis to ensure that the field sampling is properly conducted. The field survey procedures will be reviewed with all personnel prior to the start of the study and all personnel will be given printed copies of the procedures that will be included with the final IM&E study report.

A more detailed QA/QC program will be applied to all laboratory processing. The first ten samples sorted by an individual will be resorted by a designated quality control sorter. A sorter is allowed to miss one target organism when the total number of target organisms in the sample is less than 20. For samples with 20 or greater target organisms the sorter must maintain a sorting accuracy of 90 percent. After a sorter has ten consecutive samples with greater than 90 percent accuracy, the sorter will have one of their next ten samples randomly selected for a QA/QC check. If the sorter fails to achieve an accuracy level of 90 percent their next ten samples will be resorted by the QC sorter until they meet the required level of accuracy. If the sorter maintains the required level of accuracy one of their next ten samples will be resorted by QC personnel.

A similar QA/QC program will be conducted for the taxonomists identifying the samples. The first ten samples of fish or invertebrates identified by an individual taxonomist will be completely re-identified by a designated QC taxonomist. A total of at least 50 individual fish larvae from at least five taxa must be present in these first ten samples; if not, additional samples will be reidentified until this criterion is met. Taxonomists are required to maintain a 95 percent identification accuracy level in these first ten samples. After the taxonomist has identified ten consecutive samples with greater than 95 percent accuracy, they will have one of their next ten samples checked by a QC taxonomist. If the taxonomist maintains an accuracy level of 95 percent then they will continue to have one of each ten samples checked by a QC taxonomist. If they fall below this level then ten consecutive samples they have identified will be checked for accuracy. Samples will be re-identified until ten consecutive samples meet the 95 percent criterion. Identifications will be cross-checked against taxonomic voucher collections maintained by MBC and Tenera Environmental.

Field and laboratory data will be recorded on preprinted data sheets formatted for entry into a computer database for analysis and archiving. On a monthly basis these data will be transmitted to Tenera Environmental for entry into the project database and eventual analysis. Printed spreadsheets will be checked for accuracy against original field and laboratory data sheets.

4.0 ANALYTICAL METHODS

Power plant intake effects occur due to impingement of larger organisms onto the intake screens and entrainment of organisms into the CWIS that are smaller than the screen mesh on the intake screens. Consistent with the Phase II regulations, we assume for purposes of the entrainment characterization that all entrainable organisms do not survive. 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. The variety of approaches developed reflects the many differences in power plant locations and resource settings. MacCall et al. (1983), in their review of the various approaches, divided them 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 that may be used to estimate impingement and entrainment effects at the AGS. Impact assessment approaches that will be considered in the final evaluation in the CDS include:

Methods used in estimating the calculation baseline:

- Annual estimates of total individuals impinged and entrained
- Annual estimates of total biomass impinged

Methods for evaluating impacts for calculation baseline and cost benefit analysis:

- Adult-equivalent loss (*AEL*) (Horst 1975; Goodyear 1978)
- Fecundity hindcasting (*FH*) proposed by Alec MacCall, NOAA/NMFS, which is related to the adult-equivalent loss approach
- Production Foregone (*PF*) (Rago 1984)

Methods for evaluating population-level impacts and estimating appropriate restoration efforts:

- Empirical transport model (*ETM*), which is similar to the approach described by MacCall et al. (1983), and used by Parker and DeMartini (1989).

The Rule provides flexibility in terms of demonstrating compliance and therefore the need for and nature of additional analysis that may be conducted will be based on the compliance alternative and options selected by AES. Consistent with the regulatory requirements, impingement mortality and entrainment estimates for all fish and shellfish species for each life stage will be generated based on cooling water volumes representative of operations during the past five years.

The assessment approach used in the final report that will be submitted as part of the Comprehensive Demonstration Study (CDS) for the AGS will also depend upon the facility's baseline calculations and its method(s) of compliance with the new §316(b) rule's performance standards for reductions in impingement mortality and entrainment. Compliance at the AGS may be achieved singly, or in combination, by technological or operational changes to the CWIS (TIOP), restoration methods, and site-specific BTA standards. In order to demonstrate compliance through the TIOP it is only necessary to analyze entrainment data to determine baseline entrainment 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, entrainment data may also be adequate to assess the levels of restoration necessary to offset entrainment and impingement 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-use species in addition to the losses of recreational and commercial species it is necessary to assess the entrainment and impingement losses 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 both use and non-use entrainment losses. Source water data would not be necessary for cost-benefit analysis based simply on the value of commercial and recreational species losses.

4.1 Target Organisms and Selection of Taxa for Assessment

The proposed impingement mortality and entrainment (IM&E) studies are designed to optimally sample particular groups of organisms that have historically been the focus of 316(b) assessments and have been used in recent IM&E studies in southern California, including the AES Huntington Beach Generating Station (MBC and Tenera 2005), the Duke Energy South Bay Power Plant (Tenera 2004), and the Cabrillo Power I LLC, Encina Power Station. The groups of organisms were selected because of their ecological roles or commercial and/or recreational fisheries importance. They can also be sampled effectively using one method. This is especially critical for the entrainment and source water sampling where sampling other invertebrate larvae may require the use of smaller mesh nets, which could lead to sampling error due to net clogging, and would add significant labor and costs to the study. Based on studies conducted since the 1970's, no threatened or endangered fish or shellfish species have been entrained or impinged at the AGS.

Consistent with the regulatory requirements, impingement mortality and entrainment estimates for all fish and shellfish species for each life stage will be generated based on cooling water volumes representative of operations during the past five years.

The specific taxa (species or group of species) that will be analyzed in the assessment will be limited to the taxa that are sufficiently abundant to provide reasonable assessment of impacts. For the purposes of this study plan, the taxa analyzed in the assessment will be limited to the most abundant taxa that together comprise 90-95 percent of all larvae entrained and/or juveniles and adults impinged by the generating station. The most abundant taxa are used in the assessment because they provide the most robust and reliable estimates for the purpose of scaling restoration projects or quantification of the ecological benefits under the cost-benefit test. 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 taxa to determine if additional taxa should be included in the assessment. This may include commercially or recreationally important taxa, and taxa with limited habitats.

4.1.1 Impingement

All fishes and shellfishes will be collected from impingement samples and identified, but the following groups of marine organisms, that include the most important commercial and recreational species, will be enumerated, weighed, and measured:

Vertebrates
- fishes

Shellfishes
- crabs
- shrimp
- octopus
- squid
- California spiny lobster

These same target groups have been used in other recent impingement studies in southern California. Estimates of annual impingement will be calculated for all the target organisms, but a detailed assessment will only be conducted on the most abundant organisms in the samples. The assessment may also include other commercially or recreationally important taxa from the samples.

4.1.2 Entrainment

The following groups of marine organisms will be sorted, identified and enumerated from entrainment intake and source water plankton samples:

Vertebrates
- fishes (all life stages beyond egg)

Shellfishes
- rock crab megalopal larvae
- market squid hatchlings [paralarvae]
- California spiny lobster phyllosoma larvae

These same groups of organisms were also analyzed in most of the recent entrainment studies in southern California and are being proposed in the study plans for several generating stations in southern California. Fishes and rock crab larvae were selected because of their respective ecological roles or commercial and/or recreational fisheries importance. Market squid and California spiny lobster were selected because of their commercial and/or recreational importance in the area. All the target organism groups (fishes, rock crabs, squid, and lobster) will be counted and identified to the lowest taxonomic level possible.

The power plant also entrains numerous other planktonic and larval life forms that will not be specifically included in the study. These other groups, potentially including the larvae of other shellfish (shrimp, clams, etc.), are not included because they are smaller than the larvae from the target organism groups and would require separate sampling efforts and equipment to collect. In addition, the identification of many of these other larvae to the species level is problematic and would likely lead to uncertainty in the estimates of their abundance. The *ETM* model provides a means of examining the potential effects on these other organisms by assuming that they are uniformly distributed in the source water area and are withdrawn at a rate equal to the volumetric ratio of the cooling water flow to the source water volume. The effect of entrainment on these organisms also depends on their larval duration or the time period they are exposed to entrainment.

Fish eggs will not be sorted or identified because a full assessment of their abundance would also require different sampling techniques and they also cannot be identified to the same taxonomic levels as fish larvae. In addition, recent studies at the AGS and other coastal power plants near estuarine or harbor areas similar to Alamitos Bay have shown that entrainment is largely dominated by fishes that do not have an entrainable planktonic egg stage. Even though egg life stages will not be quantified from the entrainment and source water samples, entrainment effects on fishes with planktonic egg stages will be accounted for in the assessment models. For organisms with available life history information, estimates of larval and egg survival can be used to estimate the number of eggs that would have been entrained from abundances of larvae in the samples. Egg mortality can be accounted for in the *ETM* model by adding the time period that eggs are planktonic to the estimate of the time period that larvae of that species are at risk of entrainment. This approach assumes that the proportional mortality estimate used in the modeling of larval entrainment also applies to egg mortality and that mortality on passage through the cooling system is 100% for both egg and larval stages.

4.2 Impingement Assessment

The impingement mortality study will estimate the rates (i.e., number and biomass of organisms per water volume flowing per time into the plant) at which various species of fishes and shellfishes are impinged. Annual impingement estimates will be calculated by extrapolating the impingement rates measured during normal operations over the weekly survey periods. The impingement mortality estimates for each period will be added to provide annual estimates of impingement for each species. These estimates would be added to the heat treatment totals to provide estimates of the total annual impingement mortality.

The estimates of total annual impingement can be combined with estimates of equivalent adults from entrainment to provide total impact assessment for a taxon. The demographic models used to calculate these estimates (described below) are limited to taxa that have sufficient life history information available.

4.3 Entrainment Assessment

Estimates of daily and annual larval entrainment at the AGS will be calculated from data collected at the entrainment station. Estimates of entrainment loss, in conjunction with available demographic data collected from the fisheries literature, will permit modeling of adult equivalent loss (*AEL*) and fecundity hindcasting (*FH*). Data from sampling of the potential source populations of larvae will be used to calculate estimates of proportional entrainment (*PE*) that are used to estimate the probability of mortality due to entrainment using the Empirical Transport Model (*ETM*). In the AGS entrainment and impingement studies we will use each approach (i.e., *AEL*, *FH*, and *ETM*) as appropriate to assess power plant losses.

The various modeling approaches that will be considered for the assessment at the AGS can be placed under the umbrella of two general approaches: demographic models that rely on species life history information such as the equivalent adult model (*EAM*; Horst 1975; Goodyear 1978) which includes adult equivalent loss (*AEL*) and fecundity-hindcasting (*FH*); and models that estimate the conditional mortality on a population resulting from power plant CWIS operations such as the empirical transport model (*ETM*; Boreman et al. 1978).

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 may be used at AGS and has been applied in other 316(b) demonstrations (PSE&G 1993; Tenera 2000a; Tenera 2000b). The advantage of these demographic modeling approaches, which includes production foregone (*PF*), is that they translate losses into adult fishes that are familiar units to resource managers, but they require life history data that are not available for many species. These estimates can be also combined with estimated losses to adult and juvenile organisms due to impingement to provide combined estimates of cooling water system effects.

The empirical transport model (*ETM*) was proposed by the U.S. Fish and Wildlife Service to estimate mortality rates resulting from cooling water withdrawals at power plants (Boreman et al. 1978, 1981). Variations of this model were discussed in MacCall et al. (1983) and used to assess impacts at the San Onofre Nuclear Generating Station (Parker and DeMartini 1989). The *ETM* has also been used to assess impacts at the Diablo Canyon Power Plant and Huntington Beach Generating Station in California (Tenera 2000a, MBC and Tenera 2005), and 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 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 *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.

The results of the *ETM* modeling provide the best and most direct estimates of the effects of entrainment on source water populations since the effects are estimated on the larval populations being affected. The *ETM* estimates can be used to appropriately scale restoration projects that might be used to help offset entrainment losses. The estimates can also be used to provide a context for demographic model estimates that are based solely on entrainment estimates. For example, especially in estuarine systems, entrainment estimates may show large losses of fish larvae that are sometimes difficult to interpret and put in context without estimates of the adult or larval source water populations. The *ETM* provides a context for these estimates that can account for some of the uncertainty associated with determining an appropriate level of entrainment reduction.

4.3.1 Demographic Approaches

Adult equivalent loss models evolved from impact assessments that compared power plant losses to commercial fisheries harvests and/or estimates of the abundance of adults. In the case of adult fishes impinged by intake screens, the comparison was relatively straightforward. To compare the numbers of impinged sub-adults and juveniles and entrained larval fishes to adults, it was necessary to convert all these losses to adult equivalents. Horst (1975) provided an early example of the equivalent adult model (*EAM*) to convert numbers of entrained early life stages of fishes to their hypothetical adult equivalency. Goodyear (1978) extended the method to include the extrapolation of impinged juvenile losses to equivalent adults.

Demographic approaches, exemplified by the *EAM*, produce an absolute measure of loss beginning with simple numerical inventories of entrained or impinged individuals and increasing in complexity when the inventory results are extrapolated to estimate numbers of adult fishes or biomass. We propose the potential use of two different but related demographic approaches in assessing entrainment effects at the AGS: *AEL*, which expresses effects as absolute losses of numbers of adults, and *FH*, which estimates the number of adult females whose reproductive output has been effectively eliminated by entrainment of larvae. Both estimates require an estimate of the age at entrainment. These estimates will be obtained by measuring a random sample of up to 200 larvae of each of the target taxa from the entrainment samples and using published larval growth rates to estimate the age at entrainment. The age at entrainment will be calculated by dividing the difference between the size at hatching and the average size of the larvae from entrainment by a growth rate obtained from the literature.

Age-specific survival and fecundity rates are required for *AEL* and *FH*. Adult-equivalent loss estimates require survivorship estimates from the age at entrainment to adult recruitment; *FH* requires egg and larval survivorship until entrainment. Furthermore, to make estimation practical, the affected population is assumed to be stable and stationary, and age-specific survival and fecundity rates are assumed to be constant over time. Each of these approaches provides estimates of adult fish loss, which will still need to be placed into context regarding standing stocks of adult fishes.

Species-specific survivorship information (e.g., age-specific mortality) from egg or larvae to adulthood is limited for many of the taxa likely to be considered in this assessment. Thus, in many cases, these rates must be inferred from the literature along with their measures of uncertainty. Uncertainty surrounding published demographic parameters is seldom known and rarely reported, but the likelihood that it is very large should be considered when interpreting results from the demographic approaches for estimating entrainment effects. For some well-studied species (e.g., northern anchovy), portions of early mortality schedules and fecundity have been reported (e.g., Parker 1980; Zweifel and Smith 1981; Hewitt 1982; Hewitt and Methot 1982; Hewitt and Brewer 1983; Lo 1983, 1985, and 1986; McGurk 1986). Because the accuracy of the estimated entrainment effects from *AEL* and *FH* will depend on the accuracy of age-specific mortality and fecundity estimates, lack of demographic information may limit the utility of these approaches.

The precursor to the *AEL* and *FH* calculations is an estimate of total annual larval entrainment. Estimates of larval entrainment at the AGS will be based on the biweekly sampling where E_T is the estimate of total entrainment and E_i is the biweekly entrainment estimate. Estimates of total entrainment are based on two-stage sampling designs, with days within each sampling period and cycles within days. The within-day sampling is based on a stratified random sampling scheme with four temporal cycles and two replicates per cycle.

Adult Equivalent Loss *(AEL*)

The *AEL* approach uses estimates of the abundance of the 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 numbers of adult fishes that are familiar units to resource managers. Adult equivalent loss does not require source water estimates of larval abundance in assessing effects. 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).

Starting with the number of age class j larvae entrained, $P_M = 1 - \sum_{i=1}^{N} f_i \left(1 - PE_i\right)^q$, it is conceptually easy to convert these numbers to an equivalent number of adults lost (AEL) at some specified age class from the formula:

$$AEL = \sum_{j=1}^{n} E_j S_j \tag{1}$$

where

n = number of age classes;

E_j = estimated number of larvae lost in age class j ; and

S_j = survival probability for the j th class to adulthood (Goodyear 1978).

Age-specific survival rates from larval stage to recruitment into the fishery must be included in this assessment method. For some commercial species, natural survival rates are known after the fish recruit into the commercial fishery. For the earlier years of development, this information is not well known and may not exist for non-commercial species.

Fecundity Hindcasting (*FH*)

The *FH* approach compares larval entrainment losses with adult fecundity to estimate the amount of adult female reproductive output eliminated by entrainment, hindcasting the numbers of adult females effectively removed from the reproductively active population. The accuracy of *FH* estimates, as with those of the *AEL* above, is dependent upon accurate estimates of age-specific mortality from the egg and early larval stages to entrainment and accurate estimates of the total lifetime female fecundity. If it can be assumed that the adult population has been stable at some current level of exploitation and that the male:female ratio is constant and 50:50, then fecundity and mortality are integrated into an estimate of loss by converting entrained larvae back into females (i.e., hindcasting).

A potential advantage of *FH* is that survivorship need only be estimated for a relatively short period of the larval stage (i.e., egg to larval entrainment). The method requires age-specific mortality rates and fecundities to estimate entrainment effects and some knowledge of the abundance of adults to assess the fractional losses these effects represent. This method assumes that the loss of a single female's reproductive potential is equivalent to the loss of an adult fish.

In the *FH* approach, the total of larval entrainment for a species E_T will be projected backward to estimate the number of breeding females required to provide the numbers of larvae entrained at the AGS. The estimated number of breeding females FH whose fecundity is equal to the total loss of entrained larvae would be calculated as follows:

$$FH = \frac{E_T}{TLF \bullet \prod_{j=1}^{n} S_j} \tag{2}$$

where

E_T = total entrainment estimate;

S_j = survival rate from eggs to entrained larvae of the j th stage ;

TLF = average total lifetime fecundity for females, equivalent to the average number of eggs spawned per female over their reproductive years.

The two key input parameters in Equation (2) are total lifetime fecundity TLF and very early survival rates S_j from spawning to entrainment. Descriptions of these parameters may be limited for many species and are a possible limitation of the method.

4.3.2 Empirical Transport Model (*ETM*)

The *ETM* calculations provide an estimate of the probability of mortality due to power plant entrainment. The calculations require not only the abundance of larvae entrained but also the abundance of the larval populations at risk of entrainment. Sampling at the cooling water intake is used to estimate the total number of larvae entrainment for a given time period, while sampling in the bay/nearshore waters around the AGS intake is used to estimate the source population for the same period.

On any one sampling day, the conditional entrainment mortality can be expressed as

$$PE_i = \frac{E_i}{R_i} \tag{3}$$

where

E_i = total numbers of larvae entrained during the *i* th survey; and

R_i = numbers of larvae at risk of entrainment, i.e., abundance of larvae in source water.

The values used in calculating *PE* are population estimates based on the respective densities and volumes of the cooling water system flow and source water areas. The abundance of larvae at risk in the source water during the *i* th survey can be directly expressed as

$$R_i = V_i \overline{\rho}_{S_i} \tag{4}$$

where V_S denotes the static volume of the source water (S_i), and $\overline{\rho}_{S_i}$ denotes an estimate of the average density in the source water.

Regardless of whether the species has a single spawning period per year or multiple overlapping spawnings the estimate of total larval entrainment mortality can be expressed by

$$P_M = 1 - \sum_{i=1}^{n} f_i (1 - PE_i)^q \qquad (5)$$

where

q = number of days that the eggs and larvae are susceptible to entrainment, and
f_i = estimated annual fraction of total larvae hatched during the i th survey period.

To establish independent survey estimates, it is assumed that during each survey a new and distinct cohort of larvae is subject to entrainment. Each of the monthly surveys is weighted by f_i and estimated as the proportion of the total source population present during the i th survey period.

As shown in Equations 3 and 4 the estimates of *PE* are based on population estimates of specific volumes of water. While a reasonably accurate estimate of the volume of the cooling water intake flow can be obtained, estimating the volume of the source water is more difficult and will vary depending upon oceanographic conditions and target taxon. Source water volumes will be estimated separately for each taxon during each survey. Onshore and alongshore current vectors measured during each survey period will be used to determine if it is justified to use a fixed source water volume for the calculations or whether the offshore portion of the source water should be based on the current data and the distance a larva could travel based on the estimated maximum larval duration for each taxon. The maximum age at entrainment will be calculated using the lengths of a random sample of up to 200 larvae from the entrainment samples for each target taxon. The maximum age will be calculated based on the upper 95th percentile value of the lengths measured from the samples. The maximum age at entrainment will be calculated by dividing the difference between the upper 95th percentile value of the lengths measured from the samples minus the hatch length by the growth rate.

Alongshore and onshore current velocities off Alamitos Bay will be measured using current meters positioned within and just offshore the entrance channel. The direction in degrees true from north and speed in cm per second will be estimated for each hour of the source water survey periods. The hourly current meter data will be analyzed by rotating the current vectors so that they are orthogonal to the coast and then tracking the movement of water during each survey period. A total alongshore length or displacement in kilometers will be calculated from these data using the range of both upcoast and downcoast movement over the larval duration period prior to each survey period. The maximum upcoast and downcoast displacement measured prior to each survey period will be added together to obtain an estimate of total alongshore movement. Onshore movement, excluding periods of offshore movement, will be similarly calculated for the egg and larval duration periods for each species. In the nearshore, the distance upcoast will be limited by the Los Angeles - Long Beach Harbor complex, while offshore, current movement is limited by the San Pedro, Middle, and Long Beach breakwaters. These physical measurements will be used to determine the source water estimate.

5.0 REPORTING

Tenera Environmental and MBC Applied Environmental Sciences will produce a final Impingement Mortality and Entrainment Characterization Report on the findings from the entrainment and impingement studies. The report will include results from field surveys, and loss estimates derived from one or more of the assessment methods will be presented for each of the selected target taxa. The report will be submitted as part of the Comprehensive Demonstration Study for the AGS. Depending on the final compliance alternative(s) selected, additional analysis as described in Section 4 will be provided in support of the necessary CDS documents (i.e. Restoration plan, Benefit Valuation Study, etc).

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C PROPOSED METHOD FOR EVALUATION OF ENVIRONMENTAL BENEFITS

See following pages.

Proposal for Information Collection (PIC): Deriving Economic Benefits of Reduced Impingement and Entrainment at AES's Alamitos L.L.C. Generating Station

Background

For use of the Cost-Benefit test under the site-specific standards, AES is required to have a Benefits Valuation Study prepared. The final 316(b) Phase II Final Rule (herein after referred to as the Rule) requires use of a comprehensive methodology to value fully the impacts of impingement and entrainment mortality at the Alamitos L.L.C. Generating Station. Other requirements for use of the test include:

- A description of the methodology(ies) used to value commercial, recreational, and ecological benefits (including non-use benefits, if applicable);
- Documentation of the basis for any assumptions and quantitative estimates. If the valuation includes use of an entrainment survival rate other than zero, a determination of entrainment survival at the facility based on a study approved by the NPDES permitting authority must be submitted;
- An analysis of the effects of significant sources of uncertainty on the results of the study;
- If requested by the NPDES permitting authority, a peer review of the items you submit in the Benefits Valuation Study. You must choose the peer reviewers in consultation with the Director who may consult with EPA and Federal, State, and Tribal fish and wildlife management agencies with responsibility for fish and wildlife potentially affected by your cooling water intake structure. Peer reviewers must have appropriate qualifications depending upon the materials to be reviewed.
- A narrative description of any non-monetized benefits that would be realized at your site if you were to meet the applicable performance standards and a qualitative assessment of their magnitude and significance.

All benefits, whether expressed qualitatively or quantitatively, should be addressed in the Benefits Valuation Study and considered by the NPDES permitting authority and in determining whether compliance costs significantly exceed benefits.

The benefits assessment begins with an impingement and entrainment (IM&E) mortality study that quantifies both the baseline mortality as well as the expected change from rule compliance. Based on the information generated by the IM&E mortality studies, the benefits assessment includes a qualitative and/or quantitative description of the benefits that would be produced by compliance with the applicable performance standards at the facility site. To the extent feasible, dollar estimates of all significant benefits categories would be made using well-established and generally accepted valuation methodologies.

In order to have the appropriate information if the benefit/cost option is chosen, we propose a strategy for the collection and analysis of economic information. It should be noted that one particular benefit category, benefits accruing to individuals even if they have no plans ever to use resources associated with Alamitos L.L.C. Generating Station (non-use benefits), are to be estimated only

> "In cases where the impingement or entrainment study identifies **substantial harm** to a threatened or endangered species, to the sustainability of populations of important species of fish, shellfish or wildlife, or to the maintenance of community structure and function in a facility's water body or watershed ." (Final Rule, Federal Register page 41648).

"Substantial harm" is a stringent requirement to necessitate estimation of non-use values and thus non-use values usually would not be included in the final analysis. However, because the Final Rule does raise the potential for estimation of non-use values, we do provide some contingency for their estimation.

Description of Methodologies to Determine Benefits

The 316(b) rule defines a performance standard that the EPA has established for all existing power plant facilities to meet. The Alamitos L.L.C. Generating Station is located on the San Gabriel River but withdraws water from the Long Beach Marina off of the Alamitos Bay. It may be subject to the impingement mortality (IM) performance standard (requiring a reduction in IM of 80% to 95%) and the entrainment (E) reduction performance standard (requiring a reduction in E of 60% to 90%). However, the Final Rule states that facilities do not have to meet the IM and E performance standard if it can be shown that the costs of achieving the performance standard are significantly greater than the benefits. Therefore we are providing a plan to collect information in case it is necessary to determine whether the benefits of the identified technology are significantly less than costs.

Entrainment studies were conducted at Alamitos in 1979-1980. The predominant species entrained were blennies and gobies and there were much smaller numbers of anchovies, white croaker and queenfish entrained. Impingement studies were conducted in 1978 through 1980 and indicated that Pacific butterfish, shiner perch, white seaperch, white croaker, queenfish and northern anchovies were impinged. During 1992 and 1993, an impingement showed substantially lower impingement than the earlier study and the primary species present were topsmelt and Pacific sardine. At this point in time it is difficult to say which of the many species will be selected as representative for the analysis. The species chosen will be based on the planned IM& E studies. When the impingement and entrainment studies are done, we will know which species are directly or indirectly (through forage fish changes) affected. For now, we consider the typical recreational and commercial species that are caught in and around Long Beach, California. When better information is available, more specification will be possible and be made. It is possible although highly unlikely, that non-use values will need to be addressed.

The EPA examined a technology (closed-cycle cooling) to achieve a national standard for entrainment and impingement mortality. In determining benefits at a national level, EPA used certain economic concepts of benefits associated with using the assets that cooling water adversely effects and methodologies to estimate the benefits (U.S. EPA, 2004a; U.S. EPA 2004b; U.S. EPA 2004c). In order to make the benefits comparable to costs, they presented benefits in a monetary unit, dollars. Their benefit estimates reflected the willingness to pay of individuals to go from the current environmental status to one associated with an identified technology. All of the methods proposed in this PIC were also used in EPA's national analysis.

More specifically, this benefit analysis will seek to provide a unit value per fish caught ($/fish) for recreational and commercial species affected by the new technology. With this information, total recreational and commercial benefits can be determined by multiplying the unit value times the expected increase in recreational and commercial catch arising from the identified technology. In addition, some information will be provided with respect to non-use values.

Recreational Angling

For the recreational anglers, there are two potential ways to proceed:

1.) Benefit Transfer- the application of benefit estimates provided in other studies to the Alamitos L.L.C. Generating Station situation;
2.) Primary research- collection and/or assemblage of data on recreational fishing on the Southern California area and using the data to derive an estimate of the value per fish for the important species.

While the two approaches initially will be discussed independently, there is a sound reason to consider them in concert with one another. That is, the benefit transfer information provides a reality check for any values derived in the primary research. Any primary research effort should contain a thorough literature review, a component that would have information very similar in nature to the benefits transfer analysis. Also, the benefit transfer approach may provide a fallback position if the primary research is unsuccessful in providing benefit estimates. After both have been discussed independently, a strategy that integrates them will be offered.

A Benefit Transfer Approach

The use of benefit transfers requires finding a previous economic study (or studies) that considers a comparable situation to fishing near Alamitos L.L.C. and contains dollar values per unit fish caught or a value function for dollar values per unit fish caught. Particularly important would be having species similar to the effected species and a fishing population similar to the Alamitos L.L.C. situation. Although there are numerous other aspects of the fishing situation that might be important, these two are the most critical.

In order to identify an appropriate study or studies, it would be essential to visit the site to examine first-hand the type of recreational fishing that is occurring. At the same time, contact with key people in the area will be made to determine if any relevant studies or data do exist (see references for some articles). We would consider it essential that the following sources be contacted or examined:

1. State or Federal Hearings on previous Alamitos L.L.C. station's license renewal.
2. State or Federal Hearings on previous power plant facilities in the general southern California area.
3. Authors of EPA "in-house" studies associated with the Final Rule. In particular, EPA's RUM analysis of the California region (U. S. EPA. 2004d) should be considered.
4. Personnel from California Fish and Game.
5. Key Informants at universities or other research facilities
    a. University of California, San Diego
    Dr. Richard Carson (Department of Economics) is an expert in contingent valuation and non-use valuation.
    b. University of California, Berkeley
    Dr. Michael Hanneman (Department of Agricultural and Resource Economics) is an expert in economic valuation and has studied sportfishing in southern California
    c. University of California, Los Angeles
    Dr. Trudy Cameron is an expert in econometrics and has studied sportfishing in California.
    d. Southwest Fisheries Science Center, National Marine Fisheries Service
    Drs. Dale Squires, Cynthia Thompson and Sam Herrick are experts in fisheries economics and management.
    e. Local Consulting firms. Jones and Stokes Inc. (particularly Thomas Wegge) of Sacramento completed numerous sportfishing studies in California.
6. Existing bibliography sources available by internet
    a. National Marine Fisheries Service, Southeast Fisheries Center
    b. Sportfishing Values Database
    c. Environmental Valuation Reference Inventory (EVRI): Canadian based.
    d. Beneficial Use Values Database (BUVD)
    e. Regulatory Economic Analysis Inventory, (REAI) maintained by the U.S. EPA
    f. ENVALUE, an environmental value database maintained in Australia.
7. *Investigation and Valuation of Fish Kills* (American Fisheries Society, 1992) Excerpt: "Chapter 4 ("Monetary and Economic Valuation of Fish Kills") dates back to the Pollution Committee's *Monetary Values of Fish* booklets of 1970 and 1975, which dealt with southern U.S. species. In 1978, the AFS North Central Division's Monetary Values of Fish Committee published *Reimbursement Values for Fish,* addressing species in 12 northern states and 2 Canadian provinces. To integrate these and other regional values, a special AFS Monetary Values of Freshwater Fish Committee collected values from 135 federal, state, provincial, and private agencies and hatcheries. These data were published in 1982 as Part I of AFS Special Publication 13. For the present book, the Socioeconomics Section has repeated the earlier survey to update replacement costs for killed fish and

summarized procedures for estimating the broader economic losses resulting from a fish kill."

These potential sources will be used to obtain "off-the-shelf" values that could possibly be relevant to the effected species at the Alamitos L.L.C. Generating Station. In addition, some of these contacts may be useful as researchers, data sources, and/or witnesses for any hearings that evolve. They may also be useful as peer reviewers or as sources to identify peer reviewers.

Primary Research

There are several other methodologies that could be used to estimate economic values for the species considered, but they will require some level of primary research.

Data and programs could be obtained from the U.S. EPA and examined to see if the results reported in USEPA (2004d) are defensible. If they are not, a new RUM model could be estimated with the data. The major changes introduced in the research would be to consider:

1.) correcting (if necessary) problems associated with the original analysis;
2.) the RS species rather than in a grouping[1];
3.) the Alamitos, Redondo Beach and Huntington Beach sites would be delineated rather that using aggregate sites used in the USEPA study (Southern California counties were used as sites).

The analysis would also update the angling activity and possible generalized the RUM model in ways that current research is including.

Strategy to Obtain Recreational Unit Values per Fish Caught

The initial portion of the study would be to complete a benefits transfer analysis and determine whether or not the values obtained were reasonable for the purposes of the decisions to be made. That is, if the mitigation strategy returned recreational benefits that were approximately equal to the costs, it may be unwise and inefficient to move onto primary research because in all likelihood the estimate of costs would not be "significantly larger" than the benefits. If however, the benefit transfer method suggested that the benefits were to be small relative to costs, it may or may not be useful to do one of the primary research plans suggested in the previous section. The quality of existing studies would also be a determinant.

Discussions with key informants in the benefit transfer work would determine the availability and reliability of data from the previous studies of recreational fishing. In

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[1] For example, white croaker and queenfish are considered in the category "bottomfish" in previous studies. If there were sufficient anglers targeting them, then a category "queenfish and white croaker" could be designated.

addition, some notion of the potential improvement in estimates from using new data and a new model would be obtained.

With this information and a better understanding on the costs of doing the primary research studies, decisions regarding what combination of benefit transfer and primary research would be most advantageous. The primary research would in all likelihood provide better estimates of value but may be more costly. Given the present information, it is likely that the analysis performed by the U.S. EPA in 2004 could be used. Additional effort would be devoted to determining whether the aggregation of sites and species could cause the estimated values to be biased.

Commercial Fishing

The first determination would be whether commercial fishing is affected by reduced mortality to effected species. California Fish and Game and the National Marine Fisheries Service would be consulted regarding species that the impingement and entrainment studies identified. Both producers and consumers could gain from increases in commercial catch, but the assessment would likely only estimate the gains to direct producers, i.e. commercial fishermen. This is based on the expectation that relatively small changes in commercial landings result from reduced IM&E mortalities. This is the approach that EPA took in the 2004 study.

The approach that EPA uses for assessing commercial benefits to producers bases the unit value on the ex-vessel price (sometimes referred to as dockside price) of the species under consideration. The logic of the approach begins with an assumption that harvest increases do not induce effort (inputs used in harvesting) to increase in the short-run after the reductions of entrained and/or impinged organisms. If this were entirely true, then the ex-vessel price times the increase in quantity harvested would represent producers surplus. However, EPA appreciates that this would not likely be true and that effort and costs would undoubtedly increase in the long run in response to increased commercial profits (i.e. producer surplus). In the absence of property rights to the harvest, one would expect the producer surplus to be eliminated. Recognizing this and allowing for uncertainty in effort response, the EPA proposes using a range of 0-40% of the ex-vessel price times the increase in harvest as a measure of the increase in producers' surplus.

Additional economic information on coastal pelagic species (sardine, anchovy, squid and mackerel) and groundfish may be available through the fisheries management groups. For example, anchovy has been managed for some time and more recently a management plan for the small coastal pelagic species has been developed (Bargmann et al. 1998).

In the unlikely event that the change in landings would be relatively large and cause a change in commercial fisheries prices, we would need to collect information on commercial harvests and prices. There is not a good way to use benefit transfer methods for the consumers' surplus although EPA is exploring one proposed by Bishop and Holt (2003). This approach at present does not look that promising. At present, it does not appear that the change in commercial landings will be sufficiently large to cause prices changes.

However, if additional information suggests price changes, existing data from California Fish and Game and the National Marine Fisheries Service could be sufficient to estimate an inverse, general equilibrium demand curve (see Just, et al. for a description) for the species in question. With these estimates, the benefits to consumers could be calculated.

Non-use Valuation

Based on current knowledge, it does not appear necessary to estimate non-use values. That is, the criteria EPA proposed in the final ruling for their estimation does not appear to be met.

But, in the unlikely event that non-use values will have to be estimated, we would look to using a benefit transfer approach or doing primary research for Alamitos L.L.C Generating Station. However, we do not believe that the magnitude of the non-use values would justify undertaking a primary research study for non-use values associated with the Alamitos station.

Thus, if non-use values were needed, we would suggest using a benefit transfer method in all likelihood. There have not been any studies of non-use values associated with power plant activities *per se.* People have had to rely on studies associated with other types of activities. For example, EPA used a benefit transfers approach in their Proposal for the 316(b) regulations and in the NODA. EPA (Tudor et al., 2003) reviewed numerous studies of use and nonuse values that were associated with surface water improvements (their Appendix A). Of those shown, only three address both changes in fish populations and non-use values associated with them (Huang, et al. 1997; Whitehead and Groothuis, 1992; Olsen, et al. 1991).

We propose considering these three studies in addition to doing a review of the recent literature. The recent literature may be important because EPA has placed some emphasis on this ecological valuation recently. For example, there is a meeting entitled “Improving the Valuation of Ecological Benefits, a STAR Progress Review Workshop” that was held in Washington in October, 2004. The papers presented at that workshop are now available on the internet. One of them is directly related to California.

The results of this activity would likely be the development of a relationship (specifically a ratio) between use values and non-use values. For years, EPA used the 50% rule, a practice that implied that nonuse values were 50% of use values. Our approach, just like some of their 316(b) efforts (Tudor 2003), would be to refine this ratio for situations more akin to the changes associated with power plant operations.

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