Memo to Record

Re: Diablo Canyon comments and data regarding "de minimis" exemption

Date: March 27, 2013

In EPA's Notice of Data Availability for impingement mortality control requirements for cooling water intake structures, EPA solicited comment and data on approaches to establishing standards for very low impingement rates. According to the Federal Register notice (77 FR34325) low rates of impingement was described as follows:

> This is usually due to intake location for the specific waterbody from which water is withdrawn for cooling, or the implementation of other technologies. For example, EPA is aware of a facility located on the inside bend of a large freshwater river which seasonally employs large mesh barrier nets. The facility impinges an average of several fish per month. In another case, the intake is located downstream of a dam, and the fish avoid the cold water coming from the dam. Recent data show the facility impinged one fish over two 24 hour periods. Under such low impingement rate conditions, technology performance is unlikely to be meaningfully evaluated. Moreover, in EPA's view, these facilities are not likely having an adverse effect on aquatic life. It is probable that in most cases requiring additional technology would not be necessary to further minimize adverse environmental impacts.

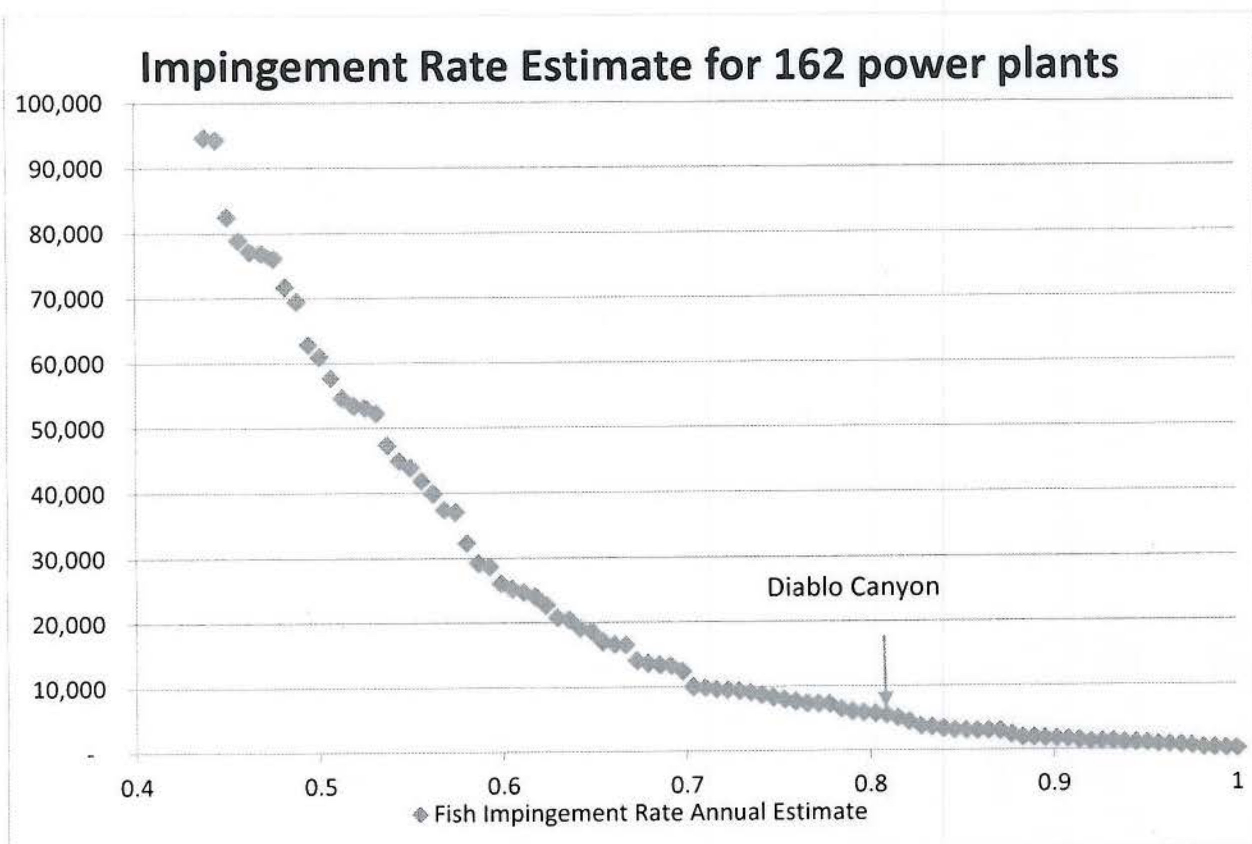
On July 11, 2012, PG&E Corporation submitted comments and data (Attachment 1) on EPA's Notice of Data Availability for impingement mortality control requirements for cooling water intake structures. EPA reviewed this data when considering possible approaches to setting standards for facilities with very low impingement rates. This memo summarizes the data provided by PG&E specific to Diablo Canyon, and compares the data to other data sources.

In their comment letter, item one on page 2, PG&E suggested Diablo Canyon is an example of very low impingement rates. Diablo Canyon reported an estimated 710 pounds of fish impinged annually. This approach to documenting a low rate of impingement was based on biomass; PG&E did not provide the counts of organisms impinged nor was the original data provided in their comment letter. Because biomass estimates are generally not available from other facilities, EPA first obtained rates of impingement from "Compilation of California Coastal Power Plant Entrainment and Impingement Estimates for California State Water Resources Control Board Staff Draft Issue Paper on Once-through Cooling" (Steinbeck 2008) (Attachment 2). EPA then compared the estimated impingement rates for Diablo Canyon to annual impingement rate data collected from 162 plants by EPRI and submitted to EPA as part of data and comments informing the proposed rule.

According to the California Water Board issue paper (Attachment 2), the impingement estimates are only presented for fishes because this is the only taxonomic group that was sampled consistently across all of the facilities. Table 2 of the document presents two sets of impingement estimates for both numbers and biomass of fishes. The first set is calculated using the annual average impingement rates during normal operations calculated from recent studies. The total annual normal operations impingement estimates were calculated by multiplying the impingement rates by the total annual design and average 2000–2005 flows. These impingement estimates for normal operations would be added to the average annual impingement during heat treatments for the plants where heat treatments are used for controlling biofouling inside the cooling system. For Diablo Canyon, the estimated count of annual impingement is 4,821 fish.

The annual impingement of 4,821 fish corresponds to approximately 402 fish per month, or a daily average count of approximately 13 fish. This rate of impingement appears to be considerably higher than the examples provided in EPA's NODA, i.e. an order of magnitude higher than the FR notice example of "several fish per month".

EPA compared this data to the ranked annual impingement rates submitted by EPRI (Attachment 3). Diablo Canyon ranks between 131 and 132 out of 162 plants. Thus Diablo Canyon's annual rate of impingement ranks at approximately the 19th percentile out of the available plant (see figure below).



Diablo Canyon's annual rate of impingement ranks between 32 and 33 out of the data for the 36 coastal plants. This corresponds to approximately the 12th percentile. It is unlikely that a rate of impingement that corresponds to 12% (coastal) or 19% (all) in ranking of all power plants represents an unusually low or very low rate of impingement.

Uncertainties

The raw data was not submitted by PG&E. The biomass cited by PG&E matches Table 2 of the California Water Board issue paper, therefore EPA assumes this is the source of the estimates. It is not clear what sized organisms were collected, nor how estimates were derived. For example, Table 1 (Attachment 2) shows 1.5 billion larval fishes are entrained by Diablo Canyon. In addition, according to the California Water Board issue paper (Attachment 2), the impingement estimates are only presented for fishes because this is the only taxonomic group that was sampled consistently across all of the facilities. The exclusion of shellfish from the counts suggests all estimates are potentially understated.

There is also some uncertainty as to the extent to which the EPRI data is representative of all facilities. There are an estimated 20 to 30 plants withdrawing from an ocean, and an estimated 139 power plants with intakes on coastal, tidal, or estuarine waterbodies (see TDD Chapter 4). Therefore the EPRI data is likely a reasonable representation of all power plants.

Attachment 1: PG&E Comment Letter

Attachment 2: Compilation of California Coastal Power Plant Entrainment and Impingement Estimates for California State Water Resources Control Board Staff Draft Issue Paper on Once-through Cooling (Steinbeck 2008)

Attachment 3: EPRI Excel Spreadsheet with ranked impingement rate data for 162 power plants

Attachment 1

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July 11, 2012

U.S. Environmental Protection Agency
Water Docket
1200 Pennsylvania Ave., NW Mail Code: 4203M
Washington, DC 20460

Attention: Docket ID No. EPA-HQ-OW-2008-0667
Submitted via electronic mail (OW-Docket@epa.gov)

Re: National Pollutant Discharge Elimination System—Proposed Regulations to Establish Requirements for Cooling Water Intake Structures at Existing Facilities; Notice of Data Availability Related to Impingement Mortality Control Requirements

Pacific Gas and Electric Company (PG&E) appreciates the opportunity to provide comments on EPA's Notice of Data Availability (NODA) for impingement mortality control requirements related to its proposed regulations to establish standards for cooling water intake structures at existing facilities. PG&E provides electric and gas service to Northern and Central California, serving over 15 million people in our 70,000 square mile service area. We own and operate approximately 7,500 MWs of generating capacity, with one power plant that utilizes once-through cooling – our Diablo Canyon Power Plant in San Luis Obispo County. Diablo Canyon is a nuclear generating station and its two units together produce 2,300 net megawatts of greenhouse-gas-free electricity, accounting for 10 percent of all electricity generated in California, meeting the needs of over three million homes in Central and Northern California.

As stated in our April 2011 comments on EPA's proposed cooling water intake regulations, PG&E supports an orderly transition away from once-through cooling in situations where it makes economic and environmental sense, and maintains the stability and reliability of the electric grid. We have demonstrated our commitment to this principle through the construction of three new, dry-cooled facilities in our service area over the last several years; our Gateway, Humboldt, and Colusa generating stations. For existing facilities, PG&E strongly believes that the federal regulations must provide for flexible compliance options in situations where the installation of additional technologies may not be feasible, effective, or environmentally beneficial.

EPA's NODA requests comment on several specific proposals to revise the current draft regulation published in April 2011 as they pertain to impingement mortality control. PG&E appreciates EPA's willingness to consider options to increase compliance flexibility for impingement mortality control and is pleased that the Agency is requesting further input on approaches such as a low impingement exemption and a technology approach, combined with a site-specific assessment when a preapproved Best Technology Available (BTA) is not technically feasible or cost-effective, as opposed to a national numeric standard. PG&E supports these proposals as well as other approaches that provide for additional compliance flexibility. Our comments are detailed below.

Additionally, PG&E endorses the comments submitted by the Clean Energy Group's (CEG's) 316(b) Initiative, the Nuclear Energy Institute (NEI), the Edison Electric Institute (EEI), and the Utility Water Action Group (UWAG) UWAG. We urge EPA to consider these comments and incorporate flexible approaches, such as a low impingement exemption and site-specific assessments, when finalizing the proposed regulations.

I. Facilities with Low Impingement Rates ("de minimis" exemption)

We strongly agree with EPA's comment that some facilities have very low impingement rates and that, in these situations, it is unlikely that technology performance can be meaningfully evaluated or that the facility is having an adverse effect on aquatic life. Requiring the installation of additional technology at these facilities is not necessary to minimize adverse environmental impacts and existing technology can be considered BTA under the requirements of Section 316(b) of the Clean Water Act.

Our Diablo Canyon Power Plant in California is an excellent example of such a facility. The facility's intake structure and cove were designed to minimize impingement and the facility's annual impingement demonstrates its success – an estimated 710 pounds impinged annually, while circulating 2.5 billion gallons of water each day.[1] This total is less than 2 pounds per day - or to put it in another context, less than what one harbor seal will consume daily.[2] On-going monitoring in Diablo Canyon's intake cove indicates that between 10 and 20 harbor seals can be found in the cove on any given day.

The facility's impingement can also be compared to commercial nearshore rockfish landings from the ports in San Luis Obispo County, California. Although annual average nearshore rockfish landings totaled 79,608 between 2007-2011,[3] the annual impingement of these nearshore rockfishes at Diablo Canyon is estimated at 67 pounds per year -- just 0.08% of the local commercial landings for these species. Comparisons to recreational fishing are equally telling – a typical recreational charter fishing boat out

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[1] Annual impingement is based on average flows from 2000-2005. SWRCB, Draft Substitute Environmental Document for Once-Through Cooling Policy, March 2010, p.34.

[2] The mean daily per capita food requirement for a harbor seal is estimated at 4.2 pounds or 1,530 pounds annually (Olesuik 1993).

[3] Data downloaded from Pacific States Marine Fisheries Commission PacFin database. Data for San Luis Obispo County taken from report at http://pacfin.psmfc.org/pacfin_pub/all_species_pub/woc_cw_cnty_csv.php.

of Morro Bay carries 25 people and each typically makes the 10 fish limit,[4] which is primarily composed of nearshore rockfishes, but also other species. Assuming a conservative average size of 1.1 pounds per fish,[5] the boat yield is 275 pounds. Thus, Diablo Canyon's estimated total *annual* impingement of all fishes equates to the yield of 2.6 recreational charter fishing boats in a single day.

Further, Diablo Canyon's impingement has been reviewed on numerous occasions by state regulators and independent scientists, and all have reached the same conclusion: the facility's low impingement numbers do not warrant any further assessment or action.[6]

Without flexibility, Diablo Canyon would be required to make significant facility modifications to reduce a level of impingement, which both the local permitting authority and independent technical scientists find to be insignificant and unwarranted. PG&E has performed several assessments of alternative technologies to reduce both entrainment and impingement. Given the plant's coastal location and other site constraints, the only potentially feasible option is mechanical draft salt water cooling towers. Cooling towers face a myriad of challenges, including permitting, engineering, environmental impacts, post-retrofit reliability and operational concerns, and nuclear safety concerns. Installation is estimated to cost $4.5 billion dollars, and the construction timeline is estimated at four years, with a 17 month plant shutdown. Further, the costs of all alternative technologies evaluated to date vastly outweigh the environmental benefit of reducing impingement by two pounds per day.

Determination Should Be Made by Local Permitting Authorities

PG&E strongly supports providing local permitting authorities the discretion to assess the level of impingement at a facility and to determine that, if it is so low, no further technology would be reasonable and the existing technology achieves BTA. The level of impingement that warrants no further action likely varies significantly from site to site and depends on a variety of factors. The permitting authority should have significant flexibility to assess the biomass impinged and abundance numbers in context with local recreational or commercial fisheries, nuisance or invasive species, and locally important aquatic species, as well as other factors including intake design, location, facility capacity factor, and environmental benefits and impacts. This approach ensures that the determination accurately reflects site-specific characteristics. We believe this approach is best conducted at the local level.

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[4] California Department of Fish and Game 2012–2013 Ocean Fishing Regulations for Central Management Region at http://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=42130&inline=true.

[5] Average length of rockfish from recreational party boats estimated at 12 inch. Weight estimated from length-weight relationships for gopher rockfish in Love, M. S., M. Yoklavich, and L. Thorsteinson. 2002. The rockfishes of the northeast Pacific. University of California Press, Berkeley, CA. p. 405.

[6] See e.g. Tenera, Diablo Canyon Power Plant 316(b) Demonstration Report, March 2000, p. 1-2; Central Coast Regional Water Quality Control Board, Staff Testimony, July 10, 2003, pp. 6-7.

Biomass Should Be the Primary Basis for Determining a Low Level of Impingement
As discussed above, PG&E believes that the assessment of low impingement rates should be based on a variety of factors, with a primary focus on biomass, and be determined by local permitting authorities. However, if EPA decides to create a national standard, biomass would be the more appropriate measure than using absolute numbers of organisms impinged, as it is the standard measure of significance in fishery science. Using the absolute numbers of fish as a potential regulatory standard is misleading with regard to actual or potential impacts to fish populations. Adult reproductive individuals have a disproportionate contribution to population growth or stability. Loss of even large numbers of juvenile fish, which generally have very high natural mortality rates, may have very little to no impact on population growth or stability. Biomass inherently apportions the relative importance of impingement losses between those fewer, and large, reproductive adults in a local or regional population, with the much more numerous, but far less ecologically significant, juveniles of an equal weight.

II. Implementation of Technology-Based Impingement Mortality Approach and Site-Specific Determination

PG&E supports EPA's concept of a hybrid approach, which includes a site-specific assessment for some facilities. The first step in the analysis should be a determination of whether impingement levels are low enough to demonstrate that the existing technology/design constitutes BTA – essentially a low impingement rate exemption for facilities, where levels are so low that technology performance could not be meaningfully evaluated, and where it is unlikely that the facility is having an adverse effect on aquatic life.

If the local permitting authority cannot make a "low impingement" determination, the facility would then evaluate whether any pre-approved BTA are technically feasible and cost-effective. A pre-approved suite of technologies would include technologies and measures such as modified traveling screens with a fish return system, an approach velocity of 1.0 fps measured at the point of entry to the cooling water intake system, offshore velocity caps, and closed cycle cooling. Given the business certainty associated with installing and operating a preapproved BTA and being determined to be compliant with the impingement mortality requirements, this option is likely to appeal to a large number of plants.

However, if none of the pre-approved BTA technologies are cost-effective or feasible, impingement requirements would be established on a site-specific basis, evaluating comparable technologies and assessing a number of factors including existing technologies, facility design, affected species, local land uses, remaining facility life, energy reliability and delivery, environmental costs and benefits, and cost-effectiveness.

This process ensures a cost-effective and efficient approach to compliance and environmental benefits. Importantly, it also allows local permitting authorities significant discretion to establish impingement requirements for facilities that cannot install pre-approved technologies. Those facilities with minimal impingement do not require further assessment as the facility is already employing BTA. Those facilities able to install pre-approved BTA technologies can achieve compliance certainty and simplify on-going monitoring requirements. Lastly, those facilities that cannot install a pre-approved technology are reviewed on a site-specific basis that incorporates information unique to the individual facility to ensure that compliance is achieved in a reasonable manner.

For facilities where a site-specific assessment is required, PG&E agrees that the comprehensive study or other planning requirements could be enhanced to collect any additional information necessary to perform the site-specific analysis.

Further, PG&E believes this assessment should be integrated with any entrainment assessment in a single planning and decision-making framework. Where a site-specific assessment is triggered, it is entirely appropriate to coordinate such an assessment with the review of entrainment compliance options. There is no scientific or technical justification to separate the two analyses.

III. Conclusion

PG&E strongly supports the increased flexibility for impingement compliance proposed in the NODA. A *de minimis* exemption for facilities with low levels of impingement is clearly warranted in situations where impingement is so low that the performance of new technology could not be meaningfully measured, and where there is no evidence that the impingement is having an adverse effect. Additionally, a hybrid approach that incorporates a *de minimis* exemption, a suite of pre-approved BTA technologies, and a process to account for site-specific factors provides the most effective and efficient way to achieve compliance and ensure that adverse environmental impacts are minimized as required under Section 316(b) of the Clean Water Act.

Again, we appreciate the opportunity to provide comments on EPA's Impingement Mortality Control NODA. If you have any questions, please contact me at 202-638-1958 or Chris Foster at 202-638-3502 so that we may continue to discuss this important issue.

Sincerely,

Melissa Lavinson
Senior Director
Federal Affairs

Attachment 2

Compilation of California Coastal Power Plant Entrainment and Impingement Estimates for California State Water Resources Control Board Staff Draft Issue Paper on Once-through Cooling

Prepared for:

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Entrainment Estimates

The entrainment data presented in **Table 1** were mostly compiled from recent studies of cooling water systems at power plants in California. The design cooling water flows and actual average flows for the 2000–2005 period used in some of the calculations were compiled from several sources (**Appendix A**). Entrainment estimates are only presented for larval fishes because this is the only taxonomic group and life stage that was sampled consistently across all of the facilities. The table presents two sets of entrainment estimates. The first set is calculated using the annual average larval concentrations from the recent studies. The entrainment estimates were calculated by multiplying the larval concentrations by the total annual design and by the average 2000–2005 flows. The other set of entrainment estimates is from the published studies, which did not in all cases present estimates for both design and actual flows (shown as 'nc' in **Table 1**). The only plants where recent representative data were not available were the Contra Costa and Pittsburg power plants located in the Sacramento-San Joaquin Delta (Delta) system. The table does present annual entrainment estimates for those two plants from studies completed thirty years ago in 1978–1979; no estimates based on the larval concentration from those studies were calculated because there have been so many long-term changes in flows and species composition within the Delta system that the estimates are unlikely to be representative of current conditions.

The entrainment estimates calculated using the average annual larval concentrations are very similar to the published entrainment estimates for the two nuclear plants (SONGS and DCPP) and units at other plants that are operating at a high capacity factor. There are more differences between the two sets of estimates for plants and units that are operating at a low capacity factor. This is due to seasonal changes in larval concentrations that can significantly affect estimates of annual entrainment, especially when peak capacity is occurring during periods with high concentrations of larvae. The seasonality in larval abundances varies between central and southern California, and also between open coast and protected bays and harbors (**Figures 1** and **2**).

Impingement Estimates

Similar to entrainment, the impingement data presented in **Table 2** were mostly from recent studies at power plants in California using the same flow data used in **Table 1** and documented in **Appendix A**. Impingement estimates are only presented for fishes because this is the only taxonomic group that was sampled consistently across all of the facilities. The table presents two sets of impingement estimates for both numbers and biomass of fishes. The first set is calculated using the annual average impingement rates during normal operations calculated from the recent studies. The total annual normal operations impingement estimates were calculated by multiplying the impingement rates by the total annual design and average 2000–2005 flows. These impingement estimates for normal operations would be added to the average annual impingement during heat treatments for the plants where heat treatments are used for controlling biofouling inside the cooling system. The other set of impingement estimates is from published studies, which did not in all cases present estimates for both design and actual flows (shown as 'nc' in **Table 2**). These estimates include both normal operations and heat treatment impingement. The only plants where recent representative data were not available were the Contra Costa and Pittsburg power plants located in the Delta system. The table does present annual impingement estimates for those two plants from studies completed thirty years ago in 1978–1979.

Intake Structure

Information on the intake structures at the California power plants is presented in **Table 3**. The various fish protection measures are listed and details provided on the openings of the cooling water systems where they draw water. This information could be used in evaluating the potential for entrapment of marine mammals and reptiles into the systems. Note that the only plants with variable speed drives that allow flow to be adjusted to meet load capacity are installed at the Contra Costa and Pittsburg power plants in the Delta. San Onofre is the only plant with a sophisticated fish return system.

References (see Appendix B)

Ecological Analysts. 1981a. Contra Costa Power Plant cooling water intake structure 316(b) demonstration. Prepared for Pacific Gas & Electric Co., San Francisco, CA.

Ecological Analysts. 1981b. Pittsburg Power Plant cooling water intake structure 316(b) demonstration. Prepared for Pacific Gas & Electric Co., San Francisco, CA.

ENSR Corporation. 2008a. Draft Impingement Mortality and/or Entrainment Characterization Study-Reliant Energy Mandalay Generating Station (NPDES Permit No.CA0001180). Prepared for Reliant Energy.

ENSR Corporation. 2008b. Draft Impingement Mortality and/or Entrainment Characterization Study-Reliant Energy Ormond Beach Generating Station (NPDES Permit No. CA0001198). Prepared for Reliant Energy.

MBC Applied Environmental Sciences. 2008. San Onofre Nuclear Generating Station Clean Water Act Section 316(b) impingement mortality and entrainment characterization study. In EPRI. 2008. Comprehensive Demonstration Study for Southern California Edison's San Onofre Nuclear Generating Station. Prepared for Southern California Edison, San Clemente, CA.

MBC Applied Environmental Sciences and Tenera Environmental. 2005. AES Huntington Beach Generating Station entrainment and impingement study final report. Prepared for AES Huntington Beach L.L.C. and California Energy Commission, Sacramento, CA.

MBC Applied Environmental Sciences and Tenera Environmental. 2008a. Alamitos Generating Station Clean Water Act Section 316(b) impingement mortality and entrainment characterization study. Prepared for AES Alamitos L.L.C., Long Beach, CA.

MBC Applied Environmental Sciences and Tenera Environmental. 2008b. Redondo Beach Generating Station Clean Water Act Section 316(b) impingement mortality and entrainment characterization study. Prepared for AES Redondo Beach L.L.C., Redondo Beach, CA.

MBC Applied Environmental Sciences, Tenera Environmental, and URS Corp. 2008a. Haynes Generating Station Clean Water Act Section 316(b) impingement mortality and entrainment characterization study. Prepared for City of Los Angeles Dept. of Water and Power, Los Angeles, CA.

MBC Applied Environmental Sciences, Tenera Environmental, and URS Corp. 2008b. Harbor Generating Station Clean Water Act Section 316(b) impingement mortality and entrainment characterization study. Prepared for City of Los Angeles Dept. of Water and Power, Los Angeles, CA.

MBC Applied Environmental Sciences, Tenera Environmental, and URS Corp. 2008c. Scattergood Generating Station Clean Water Act Section 316(b) impingement mortality and entrainment characterization study. Prepared for City of Los Angeles Dept. of Water and Power, Los Angeles, CA.

Tenera Environmental. 1988. Diablo Canyon Power Plant. Cooling Water Intake Structure, 316(b) Demonstration. Prepared for Pacific Gas & Electric Co., San Francisco, CA.

Tenera Environmental. 2000a. Diablo Canyon Power Plant. 316(b) Demonstration report. Prepared for Pacific Gas & Electric Co., San Francisco, CA.

Tenera Environmental. 2000b. Moss Landing Power Plant modernization project 316(b) resource assessment. Prepared for Duke Energy Moss Landing LLC, Oakland, CA.

Tenera Environmental. 2001. Morro Bay Power Plant modernization project: 316(b) resource assessment. Prepared for Duke Energy Morro Bay LLC, Oakland, CA.

Tenera Environmental. 2004. South Bay Power Plant cooling water system effects on San Diego Bay, Volume II: Compliance with Section 316(b) of the Clean Water Act for the South Bay Power Plant. Prepared for Duke Energy South Bay LLC, Chula Vista, CA.

Tenera Environmental. 2005. Potrero Power Plant. 316(b) Entrainment Characterization Report for Potrero Power Plant Unit 3. Submitted to Mirant Potrero LLC, San Francisco, CA.

Tenera Environmental. 2007a. Potrero Power Plant. Impingement Mortality Study Data Report. Submitted to Mirant Potrero LLC, San Francisco, CA.

Tenera Environmental. 2007b. Moss Landing Power Plant Units 1&2 and Units 6&7 Impingement Study Data Report. Prepared for Moss Landing Power Plant, Moss Landing, CA.

Tenera Environmental. 2008. Cabrillo Power I LLC, Encina Power Station Clean Water Act Section 316(b) impingement mortality and entrainment characterization study. Effects on the biological resources of Agua Hedionda Lagoon and the nearshore ocean environment. Prepared for Cabrillo Power I LLC, Carlsbad, CA.

Tenera Environmental and MBC Applied Environmental Sciences. 2008. El Segundo Generating Station Clean Water Act Section 316(b) impingement mortality and entrainment characterization study. Prepared for El Segundo Power LLC, El Segundo, CA.

Table 1. Entrainment estimates for larval fishes from California coastal power plants. Estimates include calculated values from design and average annual 2000–2005 flows using larval concentrations from recent studies and also estimates from recently published entrainment studies. Studies where entrainment estimates were not calculated for design or actual flow conditions during the study are indicated as "nc". References used in compiling the information in the table are provided in Appendix B.

Plant	Design Flow (mgd)	Average Flow (mgd) based on 2000-2005 data	Average Larval Fish Concentration (# per m^3)	Annual Larval Entrainment Estimate: Based on Average Concentration and Design Flow	Based on Average Concentration and Average Flow	Based on Study Results (Design flow)	Based on Study Results (Actual flow)
Alamitos Generating Station Units 1&2	207	121	2.6096	748,143,755	437,759,583	nc	121,970,937
Alamitos Generating Station Units 3&4	392	281	2.6096	1,414,663,347	1,013,512,946	1,109,972,442	728,944,910
Alamitos Generating Station Units 5&6	674	413	2.6338	2,454,486,046	1,503,067,179	nc	835,841,962
Contra Costa Power Plant Units 6&7	440	257	no recent representative data available			nc	95,110,000
Diablo Canyon Power Plant	2,528	2,287	0.5051	1,765,532,613	1,596,971,533	nc	1,481,948,383
El Segundo Generating Station Units 1&2	207	69	0.5160	147,937,420	49,426,499	nc	35,743,328
El Segundo Generating Station Units 3&4	399	265	0.5160	284,368,596	189,249,580	276,934,913	186,532,003
Encina Power Plant	857	621	3.6844	4,365,717,854	3,161,960,103	4,494,849,115	3,627,641,744
Harbor Generating Station	108	59	1.0464	156,251,732	85,429,045	153,331,013	65,298,000
Haynes Generating Station	968	258	3.2500	4,348,289,797	1,159,409,807	4,527,644,084	3,649,208,392
Huntington Beach Generating Station	514	179	0.4216	299,581,897	104,316,376	344,570,635	nc
Mandalay Generating Station	253	234	0.4000	140,164,653	129,172,964	141,736,337	33,422,317
Morro Bay Power Plant	668	257	0.8991	830,359,489	318,873,127	859,337,744	nc
Moss Landing Power Plant Units 1&2	361	193	1.1700	583,974,343	311,469,330	522,319,740	nc
Moss Landing Power Plant Units 6&7	865	387	0.7813	934,455,149	418,259,815	888,204,836	nc
Ormond Beach Generating Station	685	521	0.0446	42,267,607	32,126,547	40,810,043	6,351,783
Pittsburg Power Plant Units 5&6	462	274	no recent representative data available			nc	175,230,000
Potrero Power Plant	231	193	0.9490	303,453,048	252,788,154	289,731,811	nc
Redondo Generating Station Units 5&6	217	51	1.1847	354,625,241	83,019,162	356,000,276	101,659,379
Redondo Generating Station Units 7&8	675	254	0.8276	772,030,657	290,738,095	744,808,585	189,537,344
San Onofre Nuclear Generating Station Unit 2	1,219	1,139	1.9649	3,310,586,813	3,094,578,330	nc	3,555,787,272
San Onofre Nuclear Generating Station Unit 3	1,219	1,154	1.9649	3,310,586,813	3,136,241,271	nc	3,261,783,562
Scattergood Generating Station	495	309	0.7387	505,973,132	315,565,914	524,202,652	365,258,133
South Bay Power Plant	601	417	2.8925	2,403,523,588	1,667,044,144	2,420,527,779	nc

nc = not calculated in report

Table 2. Impingement estimates for fish numbers and biomass (lb) from California coastal power plants. Estimates include calculated values for normal operations for design and average annual 2000–2005 flows using impingement rates from recent studies. For plants using heat treatments these calculated estimates would need to include an estimate of the total impingement during heat treatment events calculate using the average annual impingement and the average numbers of heat treatments. The impingement estimates from recently published impingement mortality studies include heat treatment. Studies where impingement estimates were not calculated for design or actual flow conditions during the study are indicated as "nc". References used in compiling the information in the table are provided in Appendix B.

					Annual Normal Operations Impingement Estimate				Heat Treatments (HT)			Reported Values			
Plant	Design Flow (mgd)	Average Flow (mgd) based on 2000-2005 data	Average # fish per million gal	Average Biomass (lbs) fish per million gal	Based on Count and Design Flow	Based on Biomass (lbs) and Design Flow	Based on Count and Average Flow	Based on Biomass (lbs) and Average Flow	Average # per HT	Average Biomass (lb) per HT	Average Number of HT per year (2000-2005)	Design Flow Total # Estimate	Design Flow Total Biomass (lb) Estimate	Actual Flow Total # Estimate	Actual Flow Total Biomass (lb) Estimate
Alamitos Generating Station Units 1&2	207	121							n/a	n/a	n/a				
Alamitos Generating Station Units 3&4	392	281	0.1750	0.0076	81,419	3,514	52,106	2,249	n/a	n/a	n/a	nc	nc	29,013	1,252
Alamitos Generating Station Units 5&6	674	413							n/a	n/a	n/a				
Contra Costa Power Plant Units 6&7	440	257	no recent representative data available						n/a	n/a	n/a	—	—	107,621	2,741
Diablo Canyon Power Plant	2,528	2,287	0.0058	0.0009	5,330	785	4,821	710	n/a	n/a	n/a	nc	nc	nc	nc
El Segundo Generating Station Units 1&2	207	69	0.0103	0.0035	779	265	260	89	227.25	72.18	1.3	nc	nc	186	63
El Segundo Generating Station Units 3&4	399	265	0.0220	0.0068	3,209	995	2,136	662	229.00	94.60	3.7	2,521	542	1,527	473
Encina Power Plant	857	621	0.6128	0.0256	191,824	8,016	138,932	5,806	15,831.83	747.70	6	289,562	12,878	215,583	9,609
Harbor Generating Station	108	59	0.4945	0.1622	19,508	6,399	10,666	3,498	n/a	n/a	n/a	19,861	6,478	8,851	2,903
Haynes Generating Station	968	258	0.1893	0.0041	66,901	1,462	17,838	390	n/a	n/a	n/a	56,613	1,227	53,442	1,168
Huntington Beach Generating Station	514	179	0.4079	0.0227	76,582	4,270	26,666	1,487	5,887.00	338.70	4.8	nc	nc	51,082	2,848
Mandalay Generating Station	253	234	0.7940	0.0299	73,497	2,771	67,733	2,553	101.90	4.20	1.4	30,347	1,308	8,979	199
Morro Bay Power Plant	668	257	0.3497	0.0140	85,315	3,419	32,763	1,313	n/a	n/a	n/a	nc	nc	78,139	2,957
Moss Landing Power Plant Units 1&2	361	193	0.5804	0.0058	76,526	762	40,816	406	n/a	n/a	n/a	75,133	804	57,554	600
Moss Landing Power Plant Units 6&7	865	387	1.7895	0.0287	565,390	9,071	253,067	4,060	n/a	n/a	n/a	135,699	2,297	118,778	2,033
Ormond Beach Generating Station	685	521	0.0711	0.0164	17,806	4,094	13,534	3,112	677.80	87.20	4.5	7,821	844	517	76
Pittsburg Power Plant Units 5&6	462	274	no recent representative data available						n/a	n/a		nc	nc	220,364	2,580
Potrero Power Plant	231	193	1.5090	0.0337	127,464	2,847	106,182	2,371	n/a	n/a	n/a	146,098	3,035	108,727	2,446
Redondo Generating Station Units 5&6	217	51	0.0075	0.0034	593	268	139	63	10.08	7.32	2	263	71	133	60
Redondo Generating Station Units 7&8	675	254	0.0240	0.0085	5,913	2,084	2,227	785	157.50	37.90	4.8	2,910	1,315	1,101	388
San Onofre Nuclear Generating Station Unit 2	1,219	1,139	1.5787	0.0335	1,405,342	29,854	1,322,490	28,094	2,494.00	627.80	7.5	nc	nc	1,353,158	28,746
San Onofre Nuclear Generating Station Unit 3	1,219	1,154									7.8				
Scattergood Generating Station	495	309	0.8226	0.0814	148,840	14,727	92,829	9,185	10,155.00	788.40	5.2	108,843	11,619	95,241	9,422
South Bay Power Plant	601	417	1.5921	0.0049	349,490	1,082	242,401	751	n/a	n/a	n/a	385,588	1,226	nc	nc

nc = not calculated in report
n/a = not applicable

Table 3. Information on cooling water intake system design at California power plants. Acronyms used for the various intake components and fish protection systems and provided below the table.

Region	Plant	Intake Location	Type of Intake	Screening or Fish Protection Devices*	Size of openings at Entrance to Intake	Vertical Distance from Riser to VC	Mammal Exclusion Bars Offshore?
NoCal	Contra Costa Power Plant	tidal river	shoreline	BR-TS-VFD	Bar racks 3.5" spacing	n/a	n/a
NoCal	Pittsburg Power Plant	tidal river	shoreline	BR-TS-VFD	Bar racks 3.5" spacing	n/a	n/a
NoCal	Potrero Power Plant	bay/harbor	shoreline	BR-TS	Bar racks 3.5" spacing	n/a	n/a
NoCal	Moss Landing Power Plant Units 1&2	bay/harbor	shoreline	BR-TS	Bar racks 3.5" spacing	n/a	n/a
NoCal	Moss Landing Power Plant Units 6&7	bay/harbor	shoreline	BR-TS	Bar racks 3" spacing	n/a	n/a
NoCal	Morro Bay Power Plant	bay/harbor	shoreline	BR-TS	bar racks 4" on center	n/a	n/a
NoCal	Diablo Canyon Power Plant	ocean	shoreline	BR-TS	bar racks 3" on center	n/a	n/a
SoCal	Mandalay Generating Station	bay/harbor	canal	BR-SS	bar racks 2.5" spacing	n/a	n/a
SoCal	Ormond Beach Generating Station	ocean	offshore	VCap-BR-TS	4' at VCap with bars every 18"	4'	18" spacing
SoCal	Scattergood Generating Station	ocean	offshore	VCap-BR-TS	5' at VCap with bars every 9"	5'	9" spacing
SoCal	El Segundo Generating Station Units 1&2	ocean	offshore	VCap-BR-TS	2' at VCap	2'	?
SoCal	El Segundo Generating Station Units 3&4	ocean	offshore	VCap-BR-TS	3' at VCap	3'	?
SoCal	Redondo Generating Station Units 5&6	bay/harbor	offshore	VCap-BR-TS	4' at VCap with bars every 18"	4'	18" spacing
SoCal	Redondo Generating Station Units 7&8	bay/harbor	offshore	VCap-BR-TS	4' at VCap with bars every 18"	4'	18" spacing
SoCal	Harbor Generating Station	bay/harbor	shoreline	BR-TS	bar racks 4.5" on center	n/a	n/a
SoCal	Haynes Generating Station	tidal river	canal	BR-TS/SS	bar racks 6" on center	n/a	n/a
SoCal	Alamitos Generating Station Units 1&2	bay/harbor	shoreline	BR-TS	bar racks 3" spacing	n/a	n/a
SoCal	Alamitos Generating Station Units 3&4	bay/harbor	shoreline	TS	no bar racks	n/a	n/a
SoCal	Alamitos Generating Station Units 5&6	bay/harbor	shoreline	BR-TS	bar racks 3" spacing	n/a	n/a
SoCal	Huntington Beach Generating Station	ocean	offshore	VCap-BR-TS	5' at VCap with bars every 18"	5'	18" spacing
SoCal	San Onofre Nuclear Generating Station Unit 2	ocean	offshore	VCap-Vanes-Fish Elevator-BR-TS	7' at VCap	7'	No
SoCal	San Onofre Nuclear Generating Station Unit 3	ocean	offshore	VCap-Vanes-Fish Elevator-BR-TS	7' at VCap	7'	No
SoCal	Encina Power Plant	bay/harbor	shoreline	BR-TS	bar racks 3.5" on center	n/a	n/a
SoCal	South Bay Power Plant	bay/harbor	shoreline	BR-TS	bar racks 3" spacing	n/a	n/a

* - VCap = velocity cap, BR = bar racks, TS = traveling screens, SS = Slide screens, Vanes = structures inside intake to divert fishes, VFD = variable frequency drive pumps

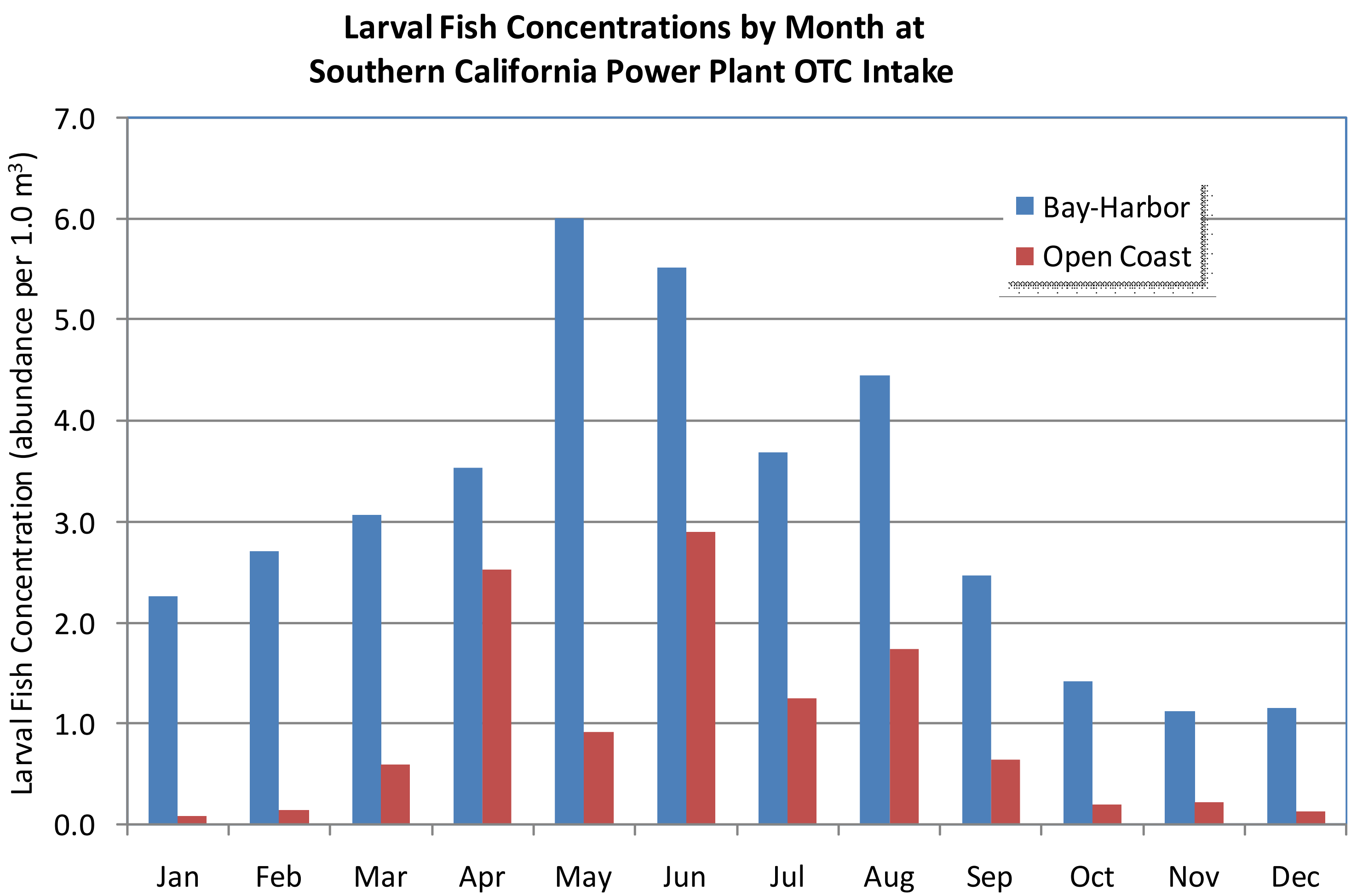

Figure 1. Total concentration of larval fishes by month at OTC intakes in southern California. Data sources based on most recent 316(b) sampling conducted at each power facility. Plants combined for bay-harbor concentrations were South Bay, Encina, Haynes, Alamitos, and Harbor, and the plants combined for the open coast concentrations were San Onofre, Huntington Beach, Redondo Beach, El Segundo, and Scattergood.

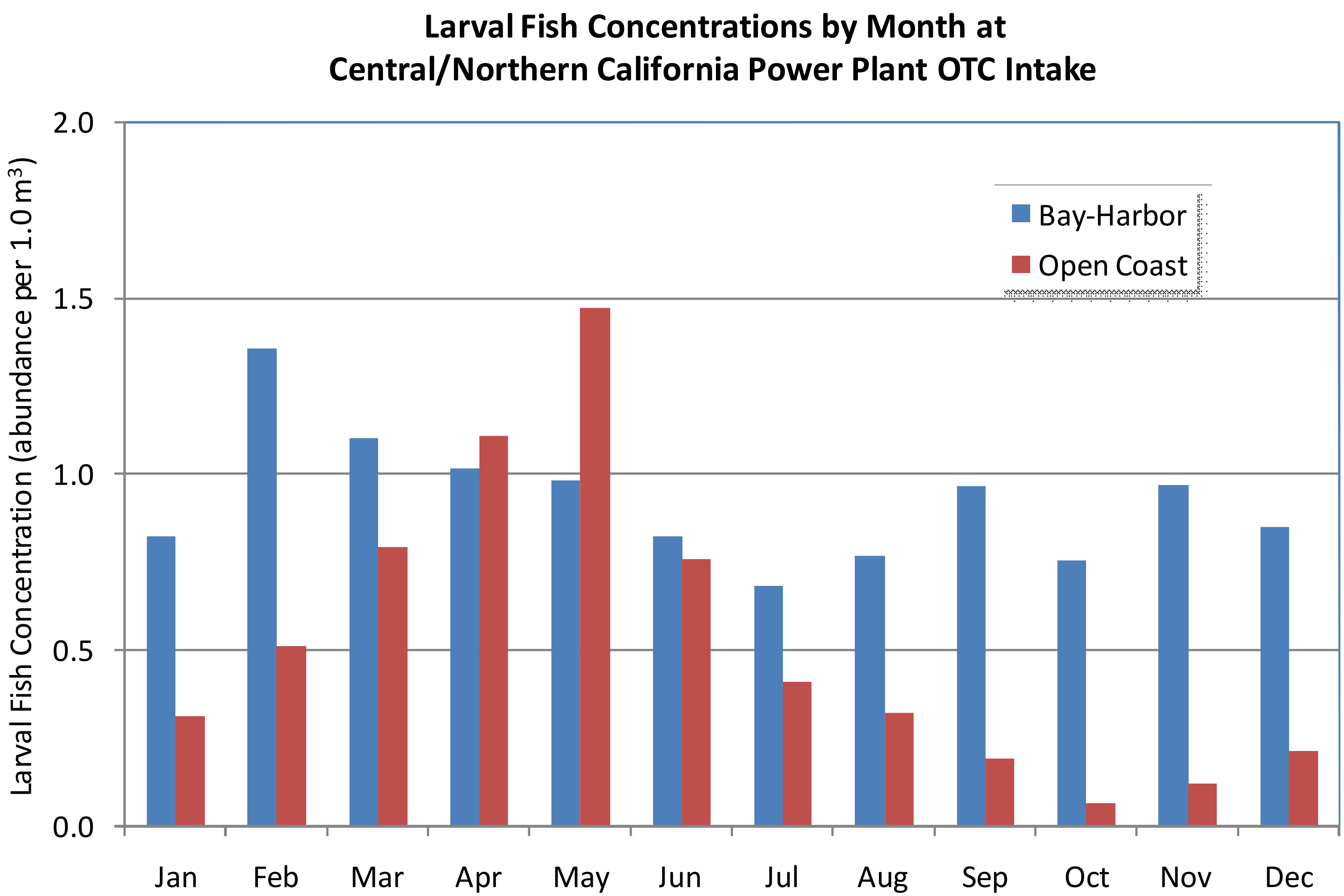

Figure 2. Total concentration of larval fishes by month at OTC intakes in central California. Data sources based on most recent 316(b) sampling conducted at each power facility. Plants combined for bay-harbor concentrations were Morro Bay, Moss Landing, and Potrero, and the plants used for the open coast concentrations was Diablo Canyon.

Appendix A. Sources for cooling water data used in calculations of entrainment and impingement estimates.

Plant	Design Flow (mgd)	Average Flow (mgd) based on 2000-2005	Data Sources
Alamitos Generating Station Units 1&2	207	121	data from SWRCB staff - 2000-05 actual monthly flows
Alamitos Generating Station Units 3&4	392	281	data from SWRCB staff - 2000-05 actual monthly flows
Alamitos Generating Station Units 5&6	674	413	data from SWRCB staff - 2000-05 actual monthly flows
Contra Costa Power Plant Units 6&7	440	257	data from plant staff - daily flows for 2000-2005
Diablo Canyon Power Plant	2,528	2,287	flows from plant source complete for 2000-05
El Segundo Generating Station Units 1&2	207	69	data from SWRCB staff - daily flows for 2000-2005
El Segundo Generating Station Units 3&4	399	265	data from SWRCB staff - daily flows for 2000-2005
Encina Power Plant	857	621	flows from plant source complete for 2000-05
Harbor Generating Station	108	59	data from SWRCB staff - 2000-01 actual monthly flows, 2002-05 daily flows
Haynes Generating Station	968	258	data from SWRCB staff - 2000-01 actual monthly flows, 2002-05 daily flows, 2005 missing for Units 3&4
Huntington Beach Generating Station	514	179	data from SWRCB staff - 2004-05 actual monthly flows, 2000-03 calculated from megawatt output
Mandalay Generating Station	253	234	data from SWRCB staff - 2000-05 actual monthly flows
Morro Bay Power Plant	668	257	flows from plant source complete for 2000-05
Moss Landing Power Plant Units 1&2	361	193	flows from plant source complete for 2000-05
Moss Landing Power Plant Units 6&7	865	387	flows from plant source complete for 2000-05
Ormond Beach Generating Station	685	521	data from SWRCB staff - 2000-05 actual monthly flows
Pittsburg Power Plant Units 5&6	462	274	data from plant staff - 2000-05 daily flows
Potrero Power Plant	231	193	data from SWRCB staff - 2000-05 actual monthly flows - also plant data provided same average
Redondo Generating Station Units 5&6	217	51	data from SWRCB staff - daily flows for 10/1/01-9/30/02 and 1/1/03-12/31/05
Redondo Generating Station Units 7&8	675	254	data from SWRCB staff - daily flows for 10/1/01-9/30/02 and 1/1/03-12/31/05
San Onofre Nuclear Generating Station Unit 2	1,219	1,139	data from SWRCB staff - 2004-05 actual monthly flows, 2000 and 2003 calculated from megawatt output
San Onofre Nuclear Generating Station Unit 3	1,219	1,154	data from SWRCB staff - 2004-05 actual monthly flows, 2000 and 2003 calculated from megawatt output
Scattergood Generating Station	495	309	data from SWRCB staff - 2000 -2005 actual monthly flows
South Bay Power Plant	601	417	flows from plant source complete for 2000-05

Appendix B. References and information on studies used in compiling the data presented in Tables 1 and 2.

Plant	Entrainment collection period & frequency / Reference	Impingemement collection period & frequency / Reference
Alamitos Generating Station Units 1&2	Jan-Dec 2006, bi-weekly / MBC and Tenera 2008a	Jan 2006 - Dec 2006; weekly / MBC and Tenera 2008a
Alamitos Generating Station Units 3&4	Jan-Dec 2006, bi-weekly / MBC and Tenera 2008a	Jan 2006 - Dec 2006; weekly / MBC and Tenera 2008a
Alamitos Generating Station Units 5&6	Jan-Dec 2006, bi-weekly / MBC and Tenera 2008a	Jan 2006 - Dec 2006; weekly / MBC and Tenera 2008a
Contra Costa Power Plant	Apr 1978 - Apr 1979, weekly / Ecological Analysts 1981a	Apr 1978 - Apr 1979; weekly sampling / Ecological Analysts 1981a
Diablo Canyon Power Plant	Oct 1996 - Jun 1999, weekly / estimates from Oct 96-Oct 98 Tenera 2000a	Feb 1985 - Mar 1986; weekly sampling / Tenera 1988
El Segundo Generating Station Units 1&2	Jan-Dec 2006, monthly / Tenera and MBC 2008	Jan 2006 - Dec 2006; monthly / Tenera and MBC 2008
El Segundo Generating Station Units 3&4	Jan-Dec 2006, monthly / Tenera and MBC 2008	Jan 2006 - Dec 2006; monthly / Tenera and MBC 2008
Encina Power Plant	Jun 2004 - May 2005, monthly / Tenera 2008	Jun 2004 - Jun 2005; weekly / Tenera 2008
Harbor Generating Station	Jan-Dec 2006, bi-weekly / MBC, Tenera, and URS 2008b	Jan 2006 - Dec 2006; weekly / MBC, Tenera, and URS 2008b
Haynes Generating Station	Jan-Dec 2006, bi-weekly / MBC, Tenera, and URS 2008a	Jan 2006 - Dec 2006; weekly / MBC, Tenera, and URS 2008a
Huntington Beach Generating Station	Sep 2003 - Aug 2004, weekly / MBC and Tenera 2005	Jul 2003 - Jul 2004; weekly / MBC and Tenera 2005
Mandalay Generating Station	Feb 2006 - Feb 2007; biweekly / ENSR Corp. 2008a	Feb 2006 - Feb 2007; biweekly / rates and totals from ENSR Corp. 2008a; average rates and HT data from NPDES data supplied by MBC
Morro Bay Power Plant	Jan 2000 - Dec 2000, weekly / Tenera 2001	Sep 1999 - Sep 2000; weekly / Tenera 2001
Moss Landing Power Plant Units 1&2	Mar 1999 - Feb 2000, weekly / Tenera 2000b	Nov 2005 - Nov 2006; weekly / Tenera 2007b
Moss Landing Power Plant Units 6&7	Mar 1999 - Feb 2000, weekly / Tenera 2000b	Nov 2005 - Nov 2006; weekly / Tenera 2007b
Ormond Beach Generating Station	Feb 2006 - Feb 2007; biweekly / ENSR Corp. 2008b	Feb 2006 - Feb 2007; biweekly / rates and totals from ENSR Corp. 2008b; average rates and HT data from NPDES data supplied by MBC
Pittsburg Power Plant Units 5&6	Mar 1978 - Mar 1979, weekly; Ecological Analysts 1981b	Mar 1978 - Mar 1979; weekly sampling / Ecological Analysts 1981b
Potrero Power Plant	Jan 2001 - Feb 2002, weekly (Dec-Mar) or monthly Apr-Nov) / Tenera 2007a	May 2006 - May 2007; weekly / Tenera 2007a
Redondo Generating Station Units 5&6	Jan 2006 - Jan 2007, monthly / MBC and Tenera 2008b	Jan 2006 - Jan 2007; weekly / MBC and Tenera 2008b
Redondo Generating Station Units 7&8	Jan 2006 - Jan 2007, bi-weekly / MBC and Tenera 2008b	Jan 2006 - Jan 2007; weekly / MBC and Tenera 2008b
San Onofre Nuclear Generating Station Un	Mar 2006 - Apr 2007; biweekly inside plant, monthly at offshore intakes /	Mar 2006 - May 2007; biweekly / MBC 2008
San Onofre Nuclear Generating Station Un	Mar 2006 - Apr 2007; biweekly inside plant, monthly at offshore intakes / MBC	Mar 2006 - May 2007; biweekly / MBC 2008
Scattergood Generating Station	Jan 2006 - Jan 2007, bi-weekly / MBC, Tenera, and URS 2008c	Jan 2006 - Jan 2007; weekly / MBC, Tenera, and URS 2008c
South Bay Power Plant	Feb 2001 - Jan 2002, monthly / Tenera 2004	Dec 2002 - Nov 2003; weekly / Tenera 2004

Attachment 3

Total Fish and Shellfish Impingement Estimates (Actual Flow Basis) for All Plants

Plant Rank	;tile of 162 plant	IM Estimate	2-Year Average	monthly
1	0.00617284	69,000,000		5750000
2	0.012345679	46,000,000		3833333
3	0.018518519	25,446,729		2120561
4	0.024691358	17,389,480		1449123
5	0.030864198	15,300,000		1275000
6	0.037037037	12,166,737	X	1013895
7	0.043209877	8,686,463		723871.9
8	0.049382716	6,800,000		566666.7
9	0.055555556	4,200,000		350000
10	0.061728395	2,947,532	X	245627.7
11	0.067901235	2,897,362		241446.8
12	0.074074074	2,430,313	X	202526.1
13	0.080246914	2,231,952	X	185996
14	0.086419753	1,916,528		159710.7
15	0.092592593	1,902,950		158579.2
16	0.098765432	1,708,209		142350.8
17	0.104938272	1,622,741	X	135228.4
18	0.111111111	1,616,703		134725.3
19	0.117283951	1,610,224		134185.3
20	0.12345679	1,498,515	X	124876.3
21	0.12962963	1,441,832		120152.7
22	0.135802469	1,287,411		107284.3
23	0.141975309	1,122,518		93543.17
24	0.148148148	1,006,238		83853.17
25	0.154320988	620,595	X	51716.21
26	0.160493827	601,345		50112.08
27	0.166666667	535,930		44660.83
28	0.172839506	522,156		43513
29	0.179012346	486,926		40577.17
30	0.185185185	481,568		40130.67
31	0.191358025	435,613	X	36301.04
32	0.197530864	416,500		34708.33
33	0.203703704	409,190		34099.17
34	0.209876543	399,490		33290.83
35	0.216049383	389,838	X	32486.46
36	0.222222222	374,000		31166.67
37	0.228395062	325,116		27093
38	0.234567901	305,855		25487.92
39	0.240740741	297,424		24785.33
40	0.24691358	288,240		24020
41	0.25308642	273,291		22774.25
42	0.259259259	230,534		19211.17
43	0.265432099	228,357		19029.75

91	0.561728395	39,924		3327
92	0.567901235	37,433	X	3119.375
93	0.574074074	37,063	X	3088.583
94	0.580246914	32,343		2695.25
95	0.586419753	29,270	X	2439.125
96	0.592592593	28,705		2392.083
97	0.598765432	26,136		2178
98	0.604938272	25,309		2109.083
99	0.611111111	24,754		2062.833
100	0.617283951	24,081		2006.75
101	0.62345679	22,713		1892.75
102	0.62962963	20,796		1733
103	0.635802469	20,468		1705.667
104	0.641975309	19,108		1592.333
105	0.648148148	18,633		1552.75
106	0.654320988	17,025		1418.75
107	0.660493827	16,593	X	1382.708
108	0.666666667	16,542		1378.5
109	0.672839506	14,092		1174.333
110	0.679012346	13,656		1138
111	0.685185185	13,421		1118.417
112	0.691358025	13,337		1111.417
113	0.697530864	12,445		1037.083
114	0.703703704	9,984		832
115	0.709876543	9,817		818.0833
116	0.716049383	9,601		800.0833
117	0.722222222	9,491		790.9167
118	0.728395062	9,365		780.4167
119	0.734567901	9,087		757.25
120	0.740740741	8,714		726.1667
121	0.74691358	8,328		694
122	0.75308642	7,996		666.3333
123	0.759259259	7,639		636.5833
124	0.765432099	7,343		611.9167
125	0.771604938	7,314		609.5
126	0.777777778	7,271		605.9167
127	0.783950617	6,477		539.75
128	0.790123457	6,065		505.4167
129	0.796296296	5,900		491.6667
130	0.802469136	5,708		475.6667
131	0.808641975	5,492		457.6667
132	0.814814815	5,088		424
133	0.820987654	4,466		372.1667
134	0.827160494	3,777		314.75
135	0.833333333	3,620		301.6667
136	0.839506173	3,384		282
137	0.845679012	3,159		263.25

Total Fish and Shellfish Impingement Estimates (Actual Flow Basis)
for All Coastal Plants

Plant Rank	IM Estimate	2-Year Average
1	17,389,480	
2	12,166,737	X
3	1,441,832	
4	1,287,411	
5	416,500	
6	409,190	
7	374,000	
8	305,855	
9	182,440	
10	181,727	
11	178,865	
12	155,745	X
13	149,992	
14	125,301	X
15	78,914	
16	77,151	
17	76,104	
18	71,725	
19	60,949	X
20	26,136	
21	25,309	
22	20,796	
23	19,108	
24	18,633	
25	14,092	
26	9,817	
27	9,601	
28	9,491	
29	8,328	
30	7,639	
31	6,477	
32	5,900	
33	3,159	
34	3,087	X
35	2,976	
36	1,971	