Reliant Energy, Inc.

Oxnard, California

Proposal for Information Collection for Mandalay Generating Facility

ENSR International

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Proposal for Information Collection for Mandalay Generating Facility

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Prepared for

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EXECUTIVE SUMMARY

Reliant Energy Incorporated's (Reliant's) Mandalay generating station (Mandalay) is subject to both the impingement mortality and entrainment performance goals under the Section 316(b) Phase II Rule (Rule) that became effective in September 2004. The Rule generally requires the review and updating of past determinations of 316(b) compliance at this facility. This Proposal for Information Collection (PIC) has been developed as an early part of Reliant's obligations under the new Rule.

We have undertaken a substantial data collection and review effort in support of this PIC. The review has included evaluation of past and current biological, technical, and operational data. The data provide a detailed understanding of the ambient environment from which Mandalay draws its cooling water, the volumes of water withdrawn, and the levels of impingement and entrainment. In addition, we have reviewed the range of potential technologies that exist to reduce impingement mortality and entrainment and have evaluated the potential applicability of each of these technologies to Mandalay. We have also examined how the design and operation of the existing facilities relate to the calculation baseline defined in the Rule. By establishing a calculation baseline, the Rule allows credit for any actions taken previously in the design or operation of the facility to minimize the potential for adverse environmental impact.

The scope of this document extends beyond the direct requirements of the PIC as outlined within the Rule. We believe that this broader review was important to allow sharing of early findings on the practicable compliance alternatives and to clarify those that will be subject to detailed evaluation as part of the required Comprehensive Demonstration Study (CDS). This approach is consistent with the request by Los Angeles Regional Water Quality Board (LARWQCB) staff to report preliminary information and findings as part of the PIC. We therefore have identified the likely compliance alternatives to be pursued and the additional data and supporting reports required to comprehensively demonstrate that these alternatives, or combination of alternatives, are viable.

The Comprehensive Demonstration Study will consider all relevant factors, including:

- The specific mandates of the Rule;
- The feasibility, reliability, costs and effectiveness of alternative technologies and measures;
- The nature of the losses at the cooling water intake structure; and

* The potential to propose restoration measures to offset adverse environmental impact within the watershed.

ENSR International (ENSR), which has extensive biological and engineering qualifications relevant to this purpose, has provided the technical support for this assessment. The following paragraphs provide a general overview of the facility and highlight the key observations and current findings.

The Mandalay station consists of three generating units. Two of the units (Numbers 1 and 2) employ open cycle cooling while the third unit (Number 3) is a combustion turbine that does not require cooling water. The open cycle units obtain water from the Pacific Ocean through Edison Canal, a 2.5 mile long canal, which connects to the Channel Islands Harbor at its northern terminus approximately 1.3 miles from the harbor entrance. The cooling water intake structures (CWIS) are located in a small embayment at the end of Edison Canal. Units 1 and 2 have separate, but conjoined CWIS. Therefore, the Mandalay station has two CWIS regulated by the Phase II Rule.

Rates of impingement were evaluated during studies executed in the 1970s and 1980s and then renewed during the last five years. The CWIS configuration and operation during these studies was essentially the same as is in place today. Shiner surfperch dominated the impinged target organisms in the earlier studies with 41.2% of the impinged target species individuals.

We believe that the combined historical and ongoing more recent data represent a robust dataset to assess impingement rates and patterns at Mandalay. As noted, Reliant has been quantifying impingement rates for all species during the last five years. While the rates for those species targeted in the earlier efforts are similar, grunion, a species not previously targeted for quantification, currently dominates fish impingement. Grunion impingement is characterized by a small number of episodic events of high impingement during the spawning season.

The frequency and nature of entrained organisms were evaluated during the 1970s. The estimated entrainment rates were dominated by harbor residing species such as blennies and gobies. It should be noted that the entrainment dataset at Mandalay is not as comprehensive as the impingement dataset. This PIC proposes additional impingement and entrainment monitoring to augment both.

Two aspects of the operation and design of the Mandalay station's cooling water system suggest that existing impingement mortality and entrainment are less than the calculation baseline condition. These factors include: (1) the inclusion in the CWIS of a long canal and manufactured harbor complex, isolating it from the natural shoreline habitat of the Pacific Ocean; and (2) reduction in cooling water flow rate associated with the use of a combustion turbine at Unit 3. A preliminary assessment suggests that these factors may contribute toward meeting the relevant performance goals for impingement and entrainment imposed by the Phase II Rule.

In assessing the potential costs of the Phase II Rule, the US Environmental Protection Agency (EPA) assumed that the Mandalay station compliance costs could be as high as $2.3 million in additional capital and approximately $200,000 in annual operation/maintenance costs. For a variety of reasons (provided in Appendix C and discussed in Section 3 of this PIC), Reliant believes that many of the available control technologies are likely to have limited applicability to Mandalay and, even where suitable, that their costs may substantially exceed the threshold costs that EPA has identified. These EPA cost estimates serve as the benchmark should a site-specific Best Technology Available (BTA) assessment be undertaken, either though the cost/cost or cost/benefit provisions on the Rule.

As noted, this PIC provides a detailed review of available control technologies and concludes that most are not likely to be feasible or effective at significantly reducing impingement mortality and entrainment. This includes the technology anticipated by EPA during the rulemaking to achieve the performance goals, installation of fine-mesh panels on the existing traveling screens. Five technologies and operational measures will be retained for further analysis as part of the CDS: installation of a barrier net, installation of acoustic deterrence systems, reduction of pumping during grunion runs, reduction in heat treatment frequency and duration, and restoration. Based on our preliminary review, one or more of these measures have the potential to be demonstrated as practicable for minimizing adverse environmental impacts (AEI) at the Mandalay plant.

Reliant proposes to supplement the available impingement and entrainment dataset by intensive sampling in 2006 for both impingement and entrainment. The biological field data collection effort has been designed to explicitly address the requirements of the Rule to characterize baseline rates and to confirm the suitability of the candidate technology, operating and restoration alternatives.

The CDS will ultimately identify and demonstrate the appropriateness of the future proposed compliance path. Reliant is not in a position to select a final compliance alternative at this time. In fact, different alternatives or combination of alternatives are likely to manifest themselves as a result of these detailed research efforts. However, these candidate alternatives are defined generally as follows in the language of the Rule:

- <u>Compliance Alternative 2: Demonstration that the current technologies and measures achieve the performance goals.</u> The contributing factors may include the location of the CWIS and the reduction in flow associated with use of a turbine (Unit 3). These potential credits will be evaluated in combination with new measures adopted under Compliance Alternative 3, below.

- Compliance Alternative 3: Demonstrate that currently used and newly adopted technologies and measures achieve the performance goals. A number of potential technologies and measures (e.g., barrier net, restoration) will be evaluated further as part of the CDS and may be adopted to contribute toward additional control. Of the potential measures, we believe that restoration is likely to be the most cost-effective. Reliant has been an active participant in projects in the vicinity of our two Ventura County power plants. These projects have included efforts to preserve and restore coastal wetlands and to restock impacted white sea bass and white abalone. Based on our experience and understanding of the local environmental concerns, we believe that restoration would have substantial and continuing beneficial effects within the watershed that would be more effective than flow reduction and filtering technologies in minimizing adverse environmental impacts. While discretionary, restoration also offers the flexibility to address watershed priorities for critical species that are impacted by other factors, such as the noted efforts to restore white abalone and sea bass. We also recognize that the restoration provision is currently undergoing court challenge. The decision of the court on this matter is not expected until probably the middle of next year; therefore CDS development will be undertaken such that contingencies are identified in the event that the court acts to overturn the current restoration provision.

- Compliance Alternative 5: Define a site-specific Best Technology Available. This alternative is based on demonstrating that fully achieving the performance goals will be significantly more costly than EPA's estimate of the cost of compliance or of the determined monetized benefit of compliance. Consistent with the Rule, control measures will be identified under this alternative that achieve compliance as close as practicable to the performance benchmarks identified in the Rule.

Reliant and its technical consultants will continue to evaluate and update the alternatives as data and analyses become available. We view this PIC and related process to be an iterative process and, as such, we anticipate continuing our coordination with the LARWQCB, the LAR 316(b) stakeholder group, and others throughout this development process.

1.0 INTRODUCTION

Reliant Energy Incorporated's (Reliant) Mandalay generating station (Mandalay) is located approximately four miles west of the center of the City of Oxnard, two miles south from the mouth of the Santa Clara River, and 3.8 miles north of the entrance to the Channel Islands Harbor. The station consists of three units and has a combined rated capacity of 577 megawatts (MW). Because two of the facility's units use cooling water from the Pacific Ocean in excess of 50 million gallons per day (MGD), the facility is regulated by the recently finalized Phase II Rule developed under Clean Water Act Section 316(b). By virtue of its capacity utilization rate (i.e., greater than 15%) and its presence on an ocean, Mandalay station is subject to the Rule's performance goals for both impingement mortality and entrainment.

The goals of this Proposal for Information Collection (PIC) for Mandalay station include the following:

- Address the requirements of the Code of Federal Regulations (CFR), Title 40, Section 125.95(b)(1); and
- Facilitate the compliance process by describing Reliant's proposed approach.

40 CFR Section 125.95(b)(1) describes the PIC requirements as follows:

> "You must submit to the Director for review and comment a description of the information you will use to support your Study. The Proposal for Information must be submitted prior to the start of information collection activities, but you may initiate such activities prior to receiving comment from the Director. The proposal must include:
>
> (i) A description of the proposed and/or implemented technologies, operational measures, and/or restoration measures to be evaluated in the Study;
>
> (ii) A list and description of any historical studies characterizing impingement mortality and entrainment and/or 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 the extent to which the data are representative of current conditions and that the data were collected using appropriate quality assurance/quality control procedures;
>
> (iii) A summary of any past or ongoing consultations with appropriate Federal, State, and Tribal fish and wildlife agencies that are relevant to this Study and a copy of written comments received as a result of such consultations; and

(iv) A sampling plan for any new field studies you propose to conduct in order to ensure that you have sufficient data to develop a scientifically valid estimate of impingement mortality and entrainment at your site. The sampling plan must document the 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 cooling water intake structure(s)), and provide a taxonomic identification of the sampled or evaluated biological assemblages (including all life stages of fish and shellfish)."

The following tabulation provides the section of the PIC where each of the above-mentioned regulatory requirements are presented.

Regulatory Requirement	**PIC Section**
§ 125.95(b)(1)(i) – Review of Measures and Technologies	3.0
§125.95(b)(1)(ii) – Historical Studies	4.0
§ 125.95(b)(1)(iii) – Agency Consultations	5.0
§ 125.95(b)(1)(iv) – Proposed Sampling Plan	7.0

The Phase II Rule allows for significant discretion by the Los Angeles Regional Water Quality Control Board (LARWQCB) Director during the implementation process. In fact, the Rule allows for flexibility in the compliance approach taken at a facility by including several specific criteria associated with assessing compliance including:

- Which species and life stages on which to base the compliance assessment;
- Whether the assessment should be based on numbers of individuals or biomass;
- The specifics of estimating the Calculation Baseline condition;
- The averaging period to use in estimating the Calculation Baseline or assessing compliance;
- The ability to discount "unavoidable, episodic impingement or entrainment events" in the assessment of performance;
- The specific design parameters (e.g., slot size) for the cooling water intake structure (CWIS);

- The need for, and nature of, peer review for assessment of restoration and/or monetized benefits;
- The need for additional information collection to support the Comprehensive Demonstration Study (CDS);
- The nature of the Technology Installation and Operation Plan;
- The nature of Approved Technology (i.e., Compliance Alternative 4);
- The definition of "significantly greater" under site-specific Best Technology Available (BTA) (Compliance Alternative 5); and
- The timing of the component reports of the CDS.

Reliant believes that this level of discretion allows LARWQCB to oversee a focused and efficient compliance program to:

- Assess the current performance of the CWIS and operation/restoration measures;
- Review the alternative measures to determine those that are feasible and cost effective;
- If appropriate, implement cost-effective measures; and
- Develop a CDS within the context of one or more of the Rule's Compliance Alternatives.

Toward this end, Reliant has prepared this PIC that both addresses the requirements of the Rule and defines Reliant's recommended Phase II compliance program for the Mandalay station.

1.1 Goals, Process, and Timing of the Rule

The U.S. Environmental Protection Agency (EPA) has produced final regulations under Clean Water Act Section 316(b) that establish performance standards for existing CWIS for electricity generators using in excess of 50 million gallons per day (MGD) of cooling water. The Phase II Rule was published in the Federal Register on July 9, 2004 and became effective on September 7, 2004.

The Phase II Rule calls for a 60 to 90 percent reduction in entrainment and an 80 to 95 percent reduction in impingement mortality from the "calculation baseline," essentially the entrainment and impingement mortality rates at a similarly sized once-through shoreline (or other, worst-case location) CWIS with no impingement and/or entrainment reduction controls. These rates of protection are deemed by EPA to be "commensurate with closed cycle cooling." There is no requirement for power plants to adopt closed-cycle cooling. The Rule also provides for site-specific BTA in the event that site specific costs of compliance are "significantly greater" than either the costs estimated by EPA for the station or for the monetized benefits of compliance at the station.

The Rule allows for five different means of demonstrating compliance with the requirements of the Rule:

- Compliance Alternative 1: Flow Reduction. Under Option 1(a) the facility owner can demonstrate that it uses closed-cycle cooling to show compliance with the Rule. Alternatively, if the through-screen velocity can be shown to be less than or equal to 0.5 ft/s, the performance goals relative to impingement mortality will be deemed to be met under Option 1(b). This latter approach does not address the potential entrainment performance goals, if applicable.
- Compliance Alternative 2: Demonstrate that the current system achieves the relevant goals. Through the execution of a CDS, the plant can show that it is currently meeting the performance goals through some combination of technologies as well as operation and restoration measures.
- Compliance Alternative 3: Demonstrate that a newly installed and operated system (i.e., technology and operation/restoration measures) will meet the goals. Again, through development of a CDS, the plant can design and implement a set of controls estimated to achieve the performance goals.
- Compliance Alternative 4: Install and operate an approved technology. As part of the Rule, EPA designated wedge wire screens in a riverine environment as an approved technology. Proper installation and operation of this technology will meet the goals of the Rule. National Pollutant Discharge Elimination System (NPDES) Permit Directors have the ability to designate other technologies as “Approved.” Note that there is no currently approved technology applicable to Mandalay station
- Compliance Alternative 5: Site-Specific BTA. Under this option, the facility can show that the actual costs of compliance are “significantly greater” than either the costs or benefits assumed by the EPA. Under this option, the plant is still required to pursue “cost-effective measures.”

These various options are each associated with differing requirements relative to the CDS. Under Option 1(a), no CDS is required for assessment of impingement mortality, while under some of the other options, relatively extensive analyses may be required along with submittal of several documents.

1.2 CDS Schedule

The Mandalay station’s current NPDES permit expires on March 10, 2006. Thus, the NPDES permit renewal application was filed on September 10, 2005. Given Reliant’s proposed compliance approach, it is not possible that the CDS will be completed by that date. However, the

Rule allows for a request of a compliance schedule that partly decouples the NPDES permit application and the CDS. Under this scenario, Reliant can request a compliance schedule that allows the submission of the CDS no later than January 7, 2008. Reliant will request such a compliance schedule.

1.3 Specific Goals of this PIC

The Mandalay station is affected by both the impingement and entrainment performance goals of the Phase II Rule.

Two measures currently mitigate impingement mortality and entrainment at Mandalay station:

- The CWIS are located at the end of an intake canal/harbor complex that is approximately 3.8 miles long. This canal/harbor system provides a substantial buffer from the habitat of the Pacific Ocean and is likely to reduce the rates of both impingement and entrainment relative to a CWIS drawing water from the shoreline of the ocean itself.

- Unit 3 is a combustion turbine that does not use sea water for cooling. This configuration results in a reduction in cooling water flow relative to open cycle cooling of approximately 24% relative to the total hypothetical cooling water flow. This reduction can be attributed directly to both of the performance goals.

Reliant believes that no additional technology or operational measure available to reduce impingement mortality and/or entrainment is likely to be feasible and cost-effective at Mandalay. This conclusion is based on the analyses presented in the following sections of this document. There are substantial technical difficulties with many of the potential technologies, in particular the difficulty of returning impinged organisms to the ocean given the setting of the facility. Some technologies or actions may be cost-effective (e.g., restoration, barrier net installation) and Reliant has retained them for further assessment as part of the CDS.

Reliant proposes to evaluate the various Compliance Alternatives as more data and analyses become available. Reliant anticipates selecting some combination of Compliance Alternatives 2, 3, and 5 for reducing/mitigating impingement mortality and entrainment.

1.4 Review of Document Organization

Data on the physical configuration, flow, and water quality of the Pacific Ocean are presented in Section 2. Discussion of existing and potential additional technologies and measures to mitigate impingement mortality and entrainment are presented in Section 3. The nature of historical studies and the resulting data are summarized in Section 4. The potential utility of these data to support the CDS is also discussed. Section 5 presents a review of relevant agency consultations.

Reliant's proposed compliance approach is summarized in Section 6. Section 7 presents the proposed sampling workplan.

The PIC document is also supported by appendices that:

(1) Provides a general review of impingement mortality and entrainment mitigation measures (Appendix A);

(2) Reviews the general nature of the fisheries of Pacific Ocean including the station-specific data (Appendix B);

(3) Presents EPA's estimated cost of compliance as summarized in the Phase II Rule (Appendix C); and

(4) Presents the proposed sampling plan (Appendix D).

2.0 SOURCE WATER BODY INFORMATION

This PIC provides LARWQCB with information regarding the circumstances that affect operation and performance of the current Mandalay station CWIS, the potential additional measures Reliant may use to reduce impingement mortality and entrainment, and the compliance approach that Reliant proposes to pursue. Each of these three issues may be affected by either the source water body flow rate or the physical configuration of the source water. Reliant believes that it would be productive to consider the relevancy of these issues as part of the PIC, although the Rule anticipates their discussion either as a separate part of the CDS (i.e., the Source Water Body Flow Information – 40 CFR 125.95(b)(2) or the NPDES application itself (i.e., the Source Water Body Physical Data Report - 40 CFR 122.21(r)(2)). In order to facilitate LARWQCB evaluation of these data, Reliant has slightly expanded the scope of the PIC to include the discussion here.

2.1 Source Water Body Flow Information

The Phase II Rule requires consideration of Source Water Body Flow Information (40 CFR 125(b)(2)) under two circumstances:

(1) The CWIS is on a river or stream and the proportion of river flow taken in by the CWIS is an important potential threshold for the performance goals; and

(2) The CWIS is on a lake or reservoir and a proposed expansion of the CWIS flow might adversely impact the stratification of the water body.

Neither of these circumstances applies at Mandalay Station. It is located on an ocean and it is clearly affected by both of the Rule's performance goals. No expansion in the CWIS flow is anticipated at Mandalay.

2.2 Source Water Body Physical Data

The Phase II Rule requires, as part of the NPDES permit application submission, the following information to support Phase II compliance:

(1) A narrative description and scaled drawings showing the physical configuration of the source water bodies used by the facility, including aerial dimensions, depths, salinity and temperature regimes, and other documentation that supports the determination of the waterbody type where each CWIS is located;

(2) Identification and characterization of the source waterbody's hydrological and geomorphological features, as well as methods used to conduct physical studies to determine the intake's area of influence within the waterbody and the results of such studies; and

(3) Locational maps.

Mandalay station is located several hundred yards from the Pacific Ocean, approximately two miles south of the mouth of the Santa Clara River (see Figure 2-1). The Mandalay station CWIS is located at the end of a 2.5 mile intake canal originating from the upper end of the Channel Islands Harbor, itself a man-made structure approximately 1.3 miles in length. The cooling water discharge is to the Pacific Ocean across the beach via a 200-foot rock-lined canal.

The physical configuration of the CWIS, Edison Canal, the Channel Islands Harbor, and the local Pacific Ocean are well defined. The Edison Canal is excavated to approximately 30 feet below the existing land surface. The side walls are set at approximately 1:2 slope and the bottom of the canal is 40 feet wide. The canal is approximately 2.5 miles long and runs approximately parallel to the coast. The harbor is approximately 1.3 miles long from north to south and has a surface area of 110 acres. Slips are provided for several hundred boats. From the mouth of the Channel Islands Harbor to the Mandalay CWIS is approximately 3.8 miles.

The zone of hydraulic influence has been estimated to be that area in which the water velocity induced by the intake exceeds the ambient velocity. Given the low ambient velocity likely to occur within the canal and harbor, the zone of hydraulic influence is assumed to include their entire areas.

Maps of surficial ocean currents that were available for the western Santa Barbara Channel indicate a cyclonic, largely counterclockwise flow pattern that is strongest during the spring through fall and weakest during winter (Nishimoto and Washburn, 2002[1]). The current measurements, developed using high frequency radar to measure approximately the upper 1 meter of the water column, indicated nearshore velocities of approximately 10 cm/sec (0.32 ft/sec) during late spring and early summer. Surficial water velocities available from the Mandalay CODAR (Coastal Ocean Dynamics Applications Radar) station (longitude -119.2563, latitude 34.1978) indicate a similar velocity. Measurements at the station, located approximately 600

[1] Nishimoto, M.M. and Washburn, L., 2002. Patterns of coastal eddy circulation and abundance of pelagic juvenile fish in the Santa Barbara Channel, California, USA. Marine Ecology Progress Series. Vol. 241:183-199.

meters offshore, indicate an average surficial velocity of 0.16 ft/sec to the south-southeast during May 2003; however, deeper current velocities could be much less (personal communication, Brian Emery UCSB). These currents are assumed to represent the high end of the range of velocities in the vicinity of the Reliant facility. A substantially lower velocity of 0.05 ft/sec is assumed to represent wintertime conditions and therefore act as the low end of the range of velocities in the immediate vicinity of Reliant facility. This velocity of 0.05 ft/sec is used for comparison to induced intake velocities.

As the cross-sectional area available for the induced flow increases beyond the mouth of the harbor, the ambient velocity will tend to overcome the induced velocity. The estimated surface at which the ambient velocity of 0.05 ft/s exceeds the induced velocity is shown in Figure 2-2. This estimate is made at low tide with the assumption that the average water depth inshore of the breakwater is 14 feet.

Edison Canal is affected by tides and has ocean water quality. There is no significant source of freshwater to the harbor and canal. The harbor and canal are known to be subject to eutrophication and, as a result, have periods of low dissolved oxygen concentration. It is likely that the relatively shallow depth and long residence time in the harbor contributes to water temperatures above ambient coastal water temperatures. At this point, Reliant has been able to locate only limited site-specific water quality data but will continue to pursue such information and, if available, it will be presented in the CDS.

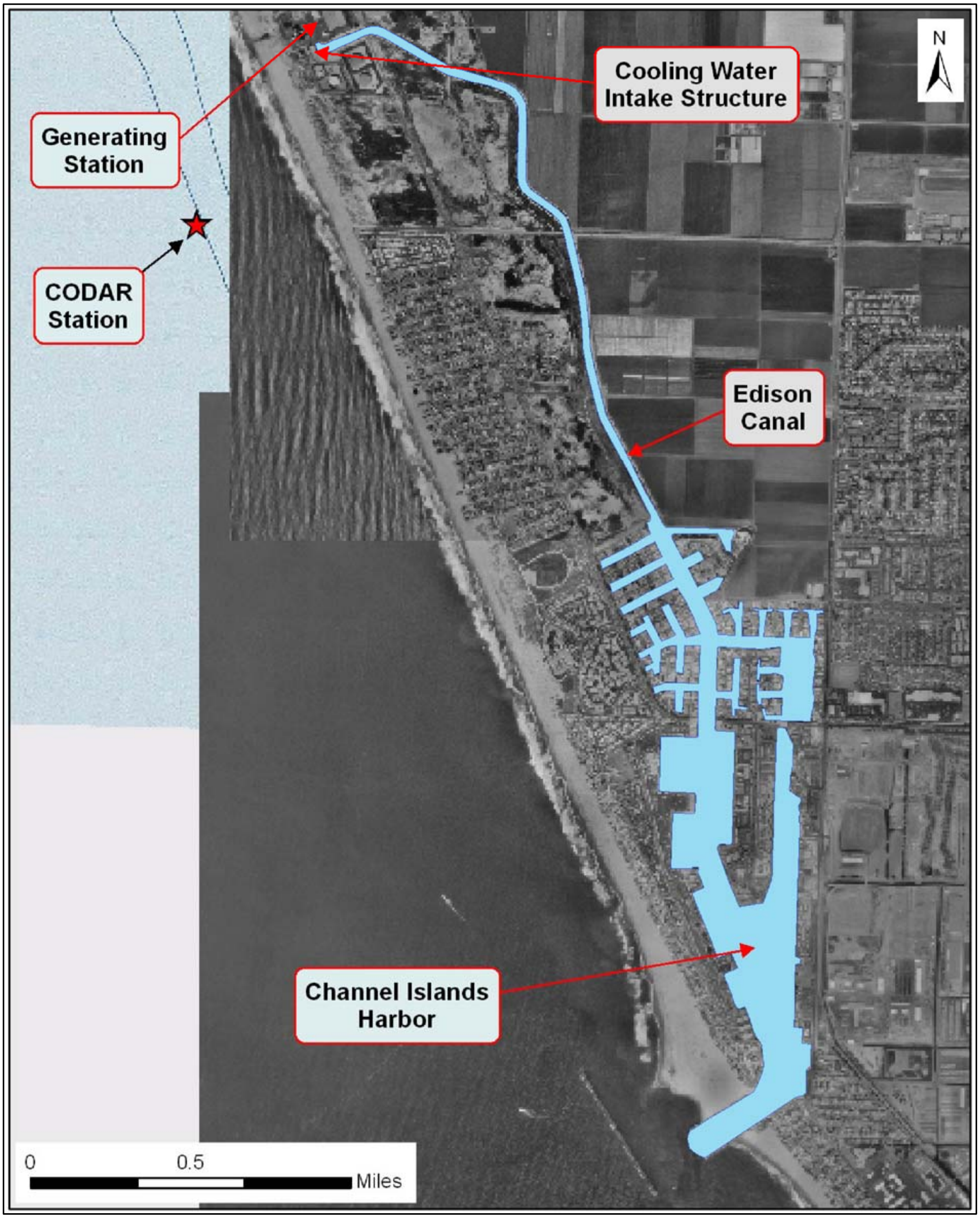

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FIGURE 1

STATION LOCATION

Mandalay Generating Station

393 N. Harbor Blvd.

Oxnard, CA 93035

DRAWN: M. SCOP	DATE: 10/5/2005	PROJECT NO.	REV.
FILE NO. figure 1	CHK BY: C. Mangiardi	10267–022–100	

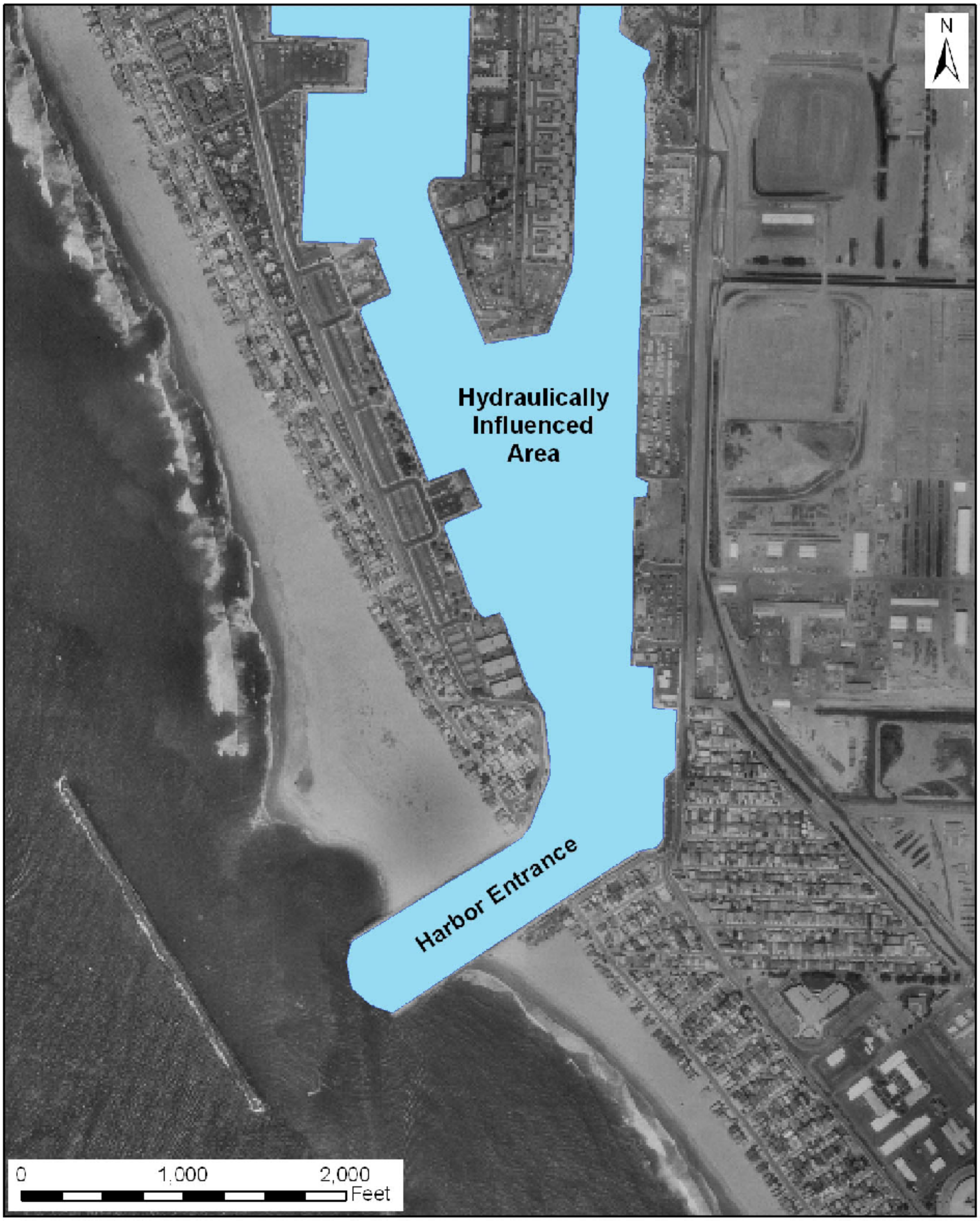

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FIGURE 2
ESTIMATED ZONE OF HYDRAULIC INFLUENCE
Mandalay Generating Station
393 N. Harbor Blvd.
Oxnard, CA 93035

DRAWN: M. SCOP	DATE: 10/5/2005	PROJECT NO.	REV.
FILE NO. figure 2	CHK BY: C. Mangiardi	10267-022-100	

3.0 TECHNOLOGIES, OPERATIONAL, AND RESTORATION MEASURES

This section reviews current and potential future technologies as well as operational and restoration measures relative to their potential to cost-effectively meet the performance goals of the Phase II Rule. This section begins with a comparison of the Mandalay station's CWIS relative to EPA's baseline configuration to be used for estimating the Calculation Baseline. This review, along with the historical data on impingement and entrainment at the Mandalay facility and available data on the Pacific Ocean presented in Section 4 and Appendix B, provide the rationale for the sampling plan presented in Section 7 and Reliant's proposed approach to compliance with the Phase II Rule.

The effectiveness of alternative technologies and operational measures at Mandalay has previously been evaluated as part of the original 316(b) evaluation (LMS, 1982[2]). The 316(b) Demonstration concluded that the existing technologies were BTA.

3.1 EPA's Baseline Configuration for Estimating the Calculation Baseline

The Phase II Rule's performance standards require reductions in impingement mortality and entrainment relative to the Calculation Baseline, defined as:

> "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."

As discussed in Section 3.2.3, two aspects of the CWIS are likely to contribute to reductions in impingement mortality and entrainment: 1) its location at the end of 3.8-mile long intake canal/harbor complex, isolated from the more productive coastal waters; and 2) generation by a combustion turbine that (Unit 3) which uses a closed circuit cooling system rather than sea water for cooling.

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[2] LMS. 1982. Intake technology review. Final Report to Southern California Edison Co. SCE Co. R&D Series: 82-RD-102. September 1982.

3.2 In-place Technologies, Operational Measures

This section describes the current CWIS as well as its apparent performance relative to the performance goals of the Rule.

A concise summary of the Mandalay station, its CWIS, and the available biological data is provided in Table 3-1. A narrative discussion of this information is provided below.

3.2.1 Review of Existing Technologies, Operational Measures, and Restoration Measures

Mandalay Generating Station has two natural gas-fired units that employ open-cycle cooling and one gas turbine unit. Once-through cooling water for Units 1 and 2 is withdrawn from the Pacific Ocean via the Edison Canal, a 2.5 mile long canal, which connects to the Channel Islands Harbor at its northern terminus approximately 1.3 miles from the harbor entrance. Unit 3 is a combustion turbine that does not use sea water for cooling. Water in the Edison Canal seldom exceeds 12 feet deep. The Edison Canal has a bottom width of 40 feet and 1:2 side slopes. The invert of the intake channel in front of Units 1 and 2 is 4 feet below mean lower low water (MLLW). The average water elevation is 2.8 feet (above MLLW); and high water elevation is 5.4 feet (above MLLW.)

The CWIS for Units 1 and 2 includes two angled 12 foot-wide intake bays. The intake configuration includes two pairs of trash racks (with 2 ¼ inch mesh) just in front of two pairs of vertical slide screens (with a ½ inch mesh). The sliding screens are 11.5 feet wide by 21 feet high. There is no traveling screen on the intake. The two ½-inch mesh screens in each intake bay are positioned parallel to one another and perpendicular to the intake flow. One screen is deployed as the other is cleaned. The vertical slide screens are equipped with high pressure wash and troughs which discharge into trash baskets. Screen movement and wash is triggered automatically by a head differential across the screens. No provisions exist for fish return. In fact, as described below, the simple and compact nature of the CWIS represents a significant constraint on potential retrofit. Any technological approach to remove fish from the screens and return of them alive to the ocean would require installation of traveling water screens, screen wash water systems, and a complex fish return system. No technology is in place to control entrainment.

The CWIS screens are periodically inundated with hot water from the condensers to reduce biofouling.

Table 3-1:
Mandalay
Summary of Facility CWIS and Overall Information Collection Strategy

NPDES Permit No. CA0001180 (CI-2093)

NPDES Permit Application Dates	Current Permit Expires on April 26, 2006; Renewal Application Due October 1, 2005 - Compliance Schedule Likely Necessary
Setting	Pacific Ocean
Capacity Factor	>15%, base load facility
Number of Units	3 (2 [#1&2] open cycle; 1 [#3] closed cycle)
Performance Goals	Impingement Mortality; Entrainment
Summary of CWIS	The CWIS located on an embayment located at the end of a ~2.5 mile long intake canal at the upper terminus of the 1/3 mile long Channel Islands Harbor. Canal is 40 feet wide at bottom and ~12 feet deep. Units 1&2: Four pumps supply 176,000 gpm from the Edison Canal to the stations two condenser units, one for each generating unit. The approach velocity is ~1.4 ft/s. There is no fish return. Intake structure: The cooling water enters a screen structure at the end of the Edison Canal and passes through trash bars (2½" opening) which remove large debris. Four single entry traveling screens with ½" mesh are located behind the trash racks and remove smaller debris. Chlorine-based algaecide is sprayed into Edison Canal periodically during spring and summer to control undesirable algae growth that could clog intake screens and impede the pumping of cooling water through the generating stations. To control marine fouling, heat treatment is conducted every five weeks to control biofouling and lasts for approximately two hours for each CWIS. Debris that accumulates is disposed of by the City of Oxnard. Biological growth on the condenser tubes is controlled by intermittently injecting sodium hypochlorite. There are two chlorination cycles per day during November - Feb, and three chlorination cycles per day during March - October. Unit 3: Air-cooled combustion turbine, 140 MW capacity. Flow forgone estimated as (140 MW * (255 MGD/430 MW))*100% = 24%
Relationship to Baseline Condition	CWIS is located on a long canal that isolates it from shoreline habitat and populations.
Availability of Historical Data	**Biological Data:** 1) SCE, 1982a: Bight-wide plankton investigation. Extensive survey to estimate populations and age structure of ichthyoplankton of 14 target species. 2) SCE, 1982b: 316(b) demonstration. Focus on 14 target species. 154 24-hr samples of impingement over 2 years. Entrainment estimated based on one year of twice-monthly sampling at Haynes station. Estimated impacts on mortality due to both impingement and entrainment found to be small (generally less than 1%) and unlikely to affect local populations. 3) Proteus, 2005: Observations of 24-hour impingement during 22 episodes over 3+ years. Both fin- and shellfish and their biomass quantified. Nineteen finfish species observed with 10 species comprising 99.8% of the number impinged. Ten (slightly different species) comprise 99.4% of impinged biomass. Small schooling fish dominate numbers. 4) MBC, 2001, 2002, 2003, 2004. Monitoring of ambient fisheries and benthic communities near the outfall by 2000 foot trawls up to 6000 feet from the outfall. **Alternatives:** SCE (1982) summarizes alternative assessment performed by LMS. Of the 24 alternatives examined, 4 were deemed feasible but none were estimated to significantly reduce station-associated population impacts.
Applicability of Historic Data	Recent impingement data completely relevant. Older impingement data generally in agreement with more recent information but does not address some of current dominants (e.g., grunion). Older data useful for perspective and evaluation of inter-annual variation. Recent data near outfall may be useful in supporting Calculation Baseline. Historical entrainment data should be considered but is unlikely to fully support the goals of the rule. Evaluation of ichthyoplankton populations useful in assessing long-term trends as well as perspective on historical IM and E.
US EPA Compliance Cost and Technology Estimates	US EPA has estimated that the capital costs of compliance at Mandalay Station will be $2,336,881 based on installation of fine mesh panels on existing traveling screens. Annualized cost estimated at $504,000.
Outline of Compliance Strategy	1) Compliance Alternatives 2, 3 and/or 5. 2) A weight-of-evidence approach will be developed based on feasibility and costs of potential alternatives, level of apparent impacts, and benefits to water quality in Channel Island Harbor. 3) Restoration measures, including in coordination with Ormond Beach, will be considered. Difficulty in directly demonstrating benefits relative to the Calculation Baseline will be acknowledged. Focus of restoration will be improvement of biotic integrity rather than direct replacement of losses that might have relatively limited ecological value. 4) Collect one-year of data on entrainment and one additional year of impingement in order to support benefits or restoration assessment.
Approach to Estimating Calculation Baseline; Comprehensive Demonstration Study	1) Base the Calculation Baseline on historical, newly collected, and literature data. 2) Acknowledge high spatial and temporal variability in biological data and emphasize tangible measures for the Calculation Baseline. 3) Rely on the weight-of-evidence and de-emphasize direct measurement of the Calculation Baseline. 4) Discount impingement and entrainment of harbor species as they are artifacts of the man-made harbor and channel.

Cooling water from Units 1 and 2 is discharged to the Pacific Ocean across the beach via a rock-lined canal. Total permitted discharge from the plant through the canal (which includes other process waters) is approximately 255 MGD.

The station's Unit 3 is a combustion turbine with a capacity of 140 MW. This unit does not use sea water for cooling.

3.2.2 Restoration Measures

No restoration measure to directly replace impingement and entrainment loses at Mandalay Generating Station has been instituted. It should be noted that use of cooling water does result in improved flushing of the Channel Islands Harbor and Reliant has been asked by local authorities to pump water to improve water quality within the harbor. Reliant is also pursuing ecological improvement measures at its Ormond Beach Generating Station including propagation and stocking of white abalone and white seabass and wetlands restoration. These measures will be evaluated as means of improving the biological integrity of the area and represent potential "out-of-kind" restoration measures. Reliant will explore, as part of the CDS, integrating these measures, and potentially others, into a restoration strategy for Mandalay station.

3.2.3 Performance Estimates

Estimates of performance relative to the Rule's goals are contained in Table 3-2. The following paragraphs provide a discussion of data used to estimate the performance based on the CWIS's differences from the Calculation Baseline. The current CWIS includes two factors that are likely to reduce impingement mortality and entrainment: (1) location of the CWIS at the end of a 3.8-mile-long intake canal/harbor complex, and (2) reduction in cooling water demand because Unit 3 does not use sea water for cooling.

3.2.3.1 Isolation from the Pacific Ocean

The intake canal has the potential to substantially reduce impingement and entrainment effects on key fish and shellfish species common to the nearshore Pacific Ocean. The intake is at the end of the Edison Canal, which was dredged to provide access historically from Port Hueneme. As part of the construction of the Channel Islands Harbor, the southern portion of Edison Canal terminated at the northern end of the new harbor. Reliant did not identify studies on the biota inhabiting Channel Islands Harbor. We have assumed that it would be dominated by species characteristic of local harbors rather than providing habitat for nearshore species. While nearshore fish and active, pelagic invertebrates may enter the harbor, the narrow entrance, the boating traffic, shallow depths, and the minimal net inflow, are expected to limit that entry.

Neither the Edison Canal nor the Channel Island Harbor was developed from existing marine features such as a marsh or estuary. The Channel Islands Harbor is relatively long and narrow with no natural input of water other than through tidal flushing or the pumping of water through the Mandalay station. The habitats in the harbor are substantially different from the open coast and not particularly similar to nearby estuaries such as Mugu Lagoon. As such, the biota that developed within the canal/harbor complex developed from the opportunistic colonization of the new submerged substrate. Because the communities that have developed within the harbor did so under conditions of continual net movement of water through the harbor to the power plant, Reliant has assumed that an equilibrium has developed and relatively stable populations of the local biota have become established. Factors that would have resulted in loss of eggs, larvae, or adults would have included entrainment into the Mandalay station but also, and likely more importantly, from grazing by the many filter feeders and grazers inhabiting the hard substrates within the harbor and Edison Canal. In addition, over the past few years, Mandalay station has not served as a base load facility and has been operated much less often than the previous several decades. As a result, losses of productivity through entrainment would have been reduced, probably significantly.

The isolation of the canal/harbor and its relatively unique biota are expected to substantially reduce the impact that Mandalay may have. An estimate, utilizing “best professional judgment,” of the reduction of the canal location on impingement mortality and entrainment of 40% and 30%, respectively, relative to the Calculation Baseline is also presented in Table 3-2. Reliant acknowledges that this estimate is highly uncertain. In fact, rigorously defining the reduction is likely to be impossible even with an extensive data collection effort. For this reason, Reliant has developed a proposed compliance approach that does not rely on collection of ambient biological population data (see Sections 6 and 7).

3.2.3.2 Reduction in Cooling Water Flow

The combustion turbine generates electricity while forgoing cooling water demand. This reduction in cooling water flow can be credited relative to the Calculation Baseline as a contribution to the station’s performance goal. The flow forgone in millions of gallons per day for unit #3 (MGD_3) is estimated based on its electrical output (MW_3) as well as the cooling water demand per electrical output associated with Units 1 and 2 ($MGD_{1,2}/MW_{1,2}$):

$$\mathbf{MGD_3 = MW_3 \ X \ MGD_{1,2}/MW_{1,2} = 140 \ MW \ X \ 254 \ MGD/430 \ MW = 83 \ MGD.}$$

The percent reduction in flow (Q_r) and the credit relative to the Calculation Baseline is:

$$\mathbf{Q_r = 83 \ MGD/(83 \ MGD + 254 \ MGD) = 25\%.}$$

Table 3-2:
Mandalay
Estimated CWIS Performance Relative to Calculation Baseline
Performance Does Not Consider Committed Reductions in Capacity Factor

Performance Goal: 80 to 95% Reduction in Impingement Mortality (IM)
60 to 90% Reduction in Entrainment (E)

IM - Difference from Baseline	Estimated Reduction in IM (%)	Basis	Notes
Flow reduction associated with combustion turbine	25	Combustion turbine uses no cooling water. Flow forgone estimated based on CWIS Flow per MW of open cycle units.	
Long intake canal with likely isolation from shoreline habitat and populations.	40	Very approximate estimate based on likely ability of shoreline species to avoid canal.	Grunion is the most commonly impinged species suggesting that isolation is incomplete. Species considered more typical of channel substrate (e.g., gobies) are not commonly impinged perhaps due to their association with cover.
Total IM Protection	**55**	**Goal not achieved but impingement mortality significantly reduced.**	

E - Difference from Baseline	Estimated Reduction in E (%)	Basis	Notes
Flow reduction associated with combustion turbine	25	Combustion turbine uses no cooling water. Flow forgone estimated based on CWIS Flow per MW of open cycle units.	
Long intake canal with likely isolation from shoreline habitat and populations.	30	Very approximate estimate. Adults of open water species likely to avoid canal as spawning substrate.	
Total E Protection	**48**	**Goal not achieved but entrainment significantly reduced.**	

Based on this assessment, approximate combined reductions from the Calculation Baseline for the Mandalay station are estimated at 55% and 48% for impingement mortality and entrainment, respectively. Thus, while the current CWIS and station operation is estimated to result in significant reductions in impingement mortality and entrainment, neither of the Rule's performance targets (i.e., 80 to 95% reduction in impingement mortality and 60 to 90% reduction in entrainment) is likely to be achieved. This conclusion will be considered in defining both the compliance approach as well as the proposed field program.

3.3 Potential Technologies, Operational Measures, and Restoration Measures

The Rule requires that each facility evaluate the technologies and operational or restoration measures that either exist or could be incorporated to achieve compliance with the performance standards. A summary of general technologies and operational measures available to address impingement mortality and entrainment are presented in Table 3-3. This table presents the technology, its estimated effectiveness in addressing impingement mortality and entrainment, estimated technology cost, and notes on why or why not the technology was retained for further feasibility analysis as part of the CDS. Appendix A provides a more in-depth analysis of each technology and operational measure considered in Table 3-3. A specific discussion of those technologies that were considered most promising for the Mandalay station is provided in Section 3.3.1. A specific discussion on operational measures is provided in Section 3.3.2.

The potential effectiveness of alternative technologies and operational measures at Mandalay were evaluated in an earlier 316(b) Demonstration (SCE, 1982). This study evaluated the potential effectiveness at reducing losses of the following technologies: porous dike, offshore caissons, velocity cap, louvers, angled screens, modified vertical traveling screens, flow reduction and intake relocation. The evaluation determined that the existing system was BTA.

3.3.1 Review of Potential Technologies

3.3.1.1 Review and Evaluation Criteria

The following criteria are used to assess the technologies and operational measures presented in Table 3-3:

- Technical feasibility and reliability;
- Effectiveness in meeting the Rule's performance goals;
- Costs relative to EPA estimate developed as part of the Rule-making; and
- Potential for other adverse effects.

Table 3-3:
Assessment of Mitigation Measures
Mandalay

BTA Alternative	Cost (Capital) $M	Costs Significantly Greater than US EPA Estimate?	IM Benefits/ Effectiveness	E Benefits/ Effectiveness	Retained?	Basis of Decision
Traveling Screen Modifications						
Modified traveling screens (dual flow)	11	Yes	High if through-screen velocity <0.5 fps, meets alternative 1(b). Maybe reduced by trapping fish in canal.	0	No	Replacement of existing slide screens will require major reconstruction of the intake bays. Given the configuration of the intake canal, fish might be trapped in the forebay/canal. Complex hydraulics may lead to velocity hotspots and increased impingement under some circumstances. Sensitivity of impinged fish to handling should be investigated - grunion (of the silverside family) likely have low survival rates. Costs are significantly greater than US EPA's. A fish return system with sufficient structural integrity to withstand the surf zone will be necessary and will be very difficult to engineer and maintain. Fish should be returned to relatively deep water, affecting costs. Permitting costs for the return system due to CEQA could be extremely high.
Modified traveling screens (Ristroph Screens)	5.5	No	> 80% with frequency rotation, low pressure wash, and fish return. Reduced if grunion are very sensitive.	0	No	Potential to replace existing screens without a major retrofit (as assumed here) is highly uncertain. Cost estimate could be potentially doubled or more if retrofit required. Costs affected by need to install low-pressure wash and install fish return. Sensitivity of impinged fish to handling should be investigated - grunion (of the silverside family) likely have low survival rates. A fish return system with sufficient structural integrity to withstand the surf zone will be necessary and will be very difficult to engineer and maintain. Fish should be returned to relatively deep water, affecting costs. Permitting costs for the return system due to CEQA could be extremely high.
Fine Mesh Screens on traveling screen system	13	Yes	Assuming Ristroph modifications included >80% with frequency rotation, low pressure wash, and fish return. Reduced if grunion are very sensitive.	Maybe high but only if frequent rotation, low pressure wash, and return system	No	Existing conditions (limited space) preclude installation of new screens without major reconstruction of intake structure. Costs significantly greater than US EPA's. US EPA's costs likely neglect need to reengineer screen due to reduced open area, low pressure wash, and fish return. Losses by entrainment may be exceeded by losses to impingement with subsequent mortality. High potential for clogging. Very small installed base. A fish return system with sufficient structural integrity to withstand the surf zone will be necessary and will be very difficult to engineer and maintain. Fish should be returned to relatively deep water, affecting costs. Permitting costs for the return system due to CEQA could be extremely high.
Angled or modular inclined screens	6	No	May meet standard for certain species. Reduced if grunion are very sensitive.	none	No	Necessary fish bypass is not currently available and difficult to install. Limited available space in the intake bays. Application likely prohibited because of large screen heights and small angle achievable. Sensitivity of impinged fish to handling should be investigated - grunion (of the silverside family) likely have low survival rates. No full scale application has been constructed/evaluated so potential reduction in impingement is unknown. Similarly, the estimated cost is uncertain. If a complete retrofit of the intake structure is required, the cost would potentially double. A fish return system with sufficient structural integrity to withstand the surf zone will be necessary and will be very difficult to engineer and maintain. Fish should be returned to relatively deep water, affecting costs. Permitting costs for the return system due to C\EQA could be extremely high.
Fixed Screening Devices						
Wedgewire Screens	20	Yes	> 80% if through screen velocity is low.	Unlikely effective unless site in area with low ichthyoplankton density or high sweeping velocity is present.	No	Significant manifold and T-sceens would be required in source water. No location within harbor will be suitable. Any relocation is likely to be very costly due to dredging and pipe installation. There is a strong potential for navigation impacts. The permitting of the manifold, screens, and pipe will be challenging. Location offshore will eliminate flushing of the harbor. Slot size must be relatively large (i.e., 9.5 mm) in order to avoid clogging. This option is no more effective than current technology for entrainment unless located well offshore, which will substantially impact costs.
Barrier Net	0.5	No	> 80%	0	Yes	Net area must be large enough to allow fish avoidance. Given the large size of the net, there are navigation concerns and impacts. Net will require considerable maintenance due to fouling organisms. Potential for barrier net at northern end of harbor will be investigated. There is the potential for fish to be trapped in the upper (northern) end of the harbor.

Table 3-3:
Assessment of Mitigation Measures
Mandalay

BTA Alternative	Cost (Capital) $M	Costs Significantly Greater than US EPA Estimate?	IM Benefits/ Effectiveness	E Benefits/ Effectiveness	Retained?	Basis of Decision
Aquatic Filter Barrier (e.g., Gunderboom)	6.0	Yes	> 80% if through- fabric velocity is low	Maybe high but only with low through-fabric velocity	No	Very long barrier (>0.5 mile) required to meet hydraulic loading specifications. Impediment to boating. Performance is uncertain given small installed base. Susceptible to debris and wave damage. Severe spatial constraints within the harbor. High potential for long-term impingement of ichthyoplankton given low sweeping velocities. Maintenance (especially compressed air cleaning) difficult given distance to the plant.
Porous Dike	2	No	> 80% if behavioral measures perform	Uncertain	No	Potential clogging by algae and debris - significant maintenance issues. Placement within the harbor (as costed) or off-shore is essentially infeasible due to navigation and limited space. Significant impacts to benthic habitat.
New Intake Location						
Offshore Intake Structure (with velocity cap)	15	Yes	Likely high	Maybe high but only if well offshore	No	Potential for increased impediments to navigation. Significant permitting issues with pipe and intake construction. Entrainment benefits depend on location in habitat with low populations. Flushing to Channel Island Harbor would be lost. Extremely costly to move the intake an appreciable distance offshore.
Fish Diversion and Avoidance						
Diversion Devices: Louvers and Bar Racks	2	No	?	none	No	Fish behavioral avoidance; effective for some species but not others. Only effective when debris loading is low. Required by-pass system not feasible given facility configuration. Location before canal is navigation hazard.
Behavioral Barriers: Strobe Lights, acoustic deterrent, bubbles, chains	0.6	No	Uncertain	none	Yes - acoustic deterrence	Effectiveness highly uncertain and species-specific. Requires location that allows avoidance: difficult at the end of the canal and problematic at upper reaches of CI Harbor. Does not address entrainment.
Flow Reduction and Other Operational Measures						
Reduce frequency of heat treatment of CWIS	0	Uncertain	Minor, see Basis of Decision	none	Yes	Based on available data, total impingement loses during heat treatments are 0.13% of estimated total loses at Mandalay. Despite this, costs of the change could be relatively small. Therefore, this finding will be re-evaluated with newly collected data.
Minimize pumping during grunion spawning	0	Uncertain	Potentially significant reductions in high profile species.	Less certainty with entrainment reductions but some potential.	Yes	Grunion spawning can be predicted with high certainty and does not generally overlap with peak generation period. Potentially high cost associated with lost revenue during power turndown.
Variable Speed Pumps	2	No	Low depending on frequency of flow reduction.	Low depending on frequency of flow reduction.	No	Effectiveness is likely to be low given the nature of the station operation (i.e., four pumps are used as needed already).
Evaporative Cooling Towers	60	Yes	>90%	>90%	No	Costs significantly higher than US EPA's. Reduction in station efficiency. Visual impact from vapor plume. Discharge issues associated with blowdown. Challenge of using salt water towers (e.g., salt drift impacts to plants, arcing, etc.). Cost may be significantly greater if existing condensers not rated for additional pressure.
Dry Cooling Tower	100	Yes	>90%	>90%	No	Costs significantly higher than US EPA's. Significant reduction in station efficiency. Adverse visual impact large towers. Adverse noise impact. Cost may be significantly greater if existing condensers not rated for additional pressure.
Increased Fish Production						
Restoration	0.1 to 5	Uncertain	Uncertain	Uncertain	Yes	Restoration measures could be effective mitigation; Possible habitat restoration activities could include ongoing flushing of harbor and/or coordination with activities at Ormond Beach. Reliant advocates for measures that improve biotic integrity rather than simply replaces IM&E loses. This argues for out-of-kind restoration.

Note: Capital costs do NOT include outage costs, O&M, or efficiency penalties

Site-specific technologies considered for the Mandalay station included:

- Traveling screen modifications;
- Fixed screen devices;
- Offshore intake structure location; and
- Fish diversion and avoidance.

In Table 3-3, the capital costs for technology installation have been estimated for planning purposes. These costs are approximate but they do account for a number of site specific aspects (e.g., distance from the ocean to the plant, number and capacity of CWIS, etc.). Table 3-3 also provides a qualitative discussion of potential operation and maintenance costs. Costs associated with facility downtime during construction are also likely but have not been estimated here due to the uncertainty in construction timing and the need to suspend operations at a given unit. In the execution of the Cost-cost test, each of these issues will be revisited in a more formal fashion and their results expressed consistent with the requirement of the Rule.

The cost estimates for the various technologies were prepared by using the following resources:

- EPA Technical Development Document for the Final Section 316(b) Phase II Existing Facilities Rule, February 12, 2004. (EPA-821-R-04-007);
- EPA Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Proposed Rule, April 2002. (EPA-821-R-02-003);
- Cost estimates and/or installed costs for similar equipment obtained by ENSR from vendors and other operating facilities; and
- Brayton Point Station 316(b) Demonstration[3].

Available costs were adjusted to account for size/capacity differences as follows:

- proportionally for components/equipment whose costs were judged to be proportional to size (e.g. pipe length); and
- by the 6/10ths Rule for those components whose costs were judged to not be directly proportional to size (e.g. pumps).

[3] This document is a recent and detailed engineering assessment and costing of CWIS for a coastal power station. As such, it represents a reasonable basis for screening of likely costs of mitigation measures.

ENSR also applied the following factors, where appropriate:

- 10% Allowance for Indeterminants (AFI), a contingency on costs of the items included;
- 30% Contingency, to address unforeseen items, especially with regard to a facility retrofit; and
- Escalation based on the time frame of the basis cost estimate. Since the basis cost year varied, estimated costs were escalated based on 3% annual rate of inflation.

Traveling Screen Modifications

The intake structure for Units 1 and 2 has two 12-feet wide bays each containing a pair of 11.5-feet wide by 21-feet high vertical slide screens. The screens are equipped with ½ inch square mesh, and are located 34 feet upstream of the cooling water pumps. The two trash racks just upstream of the vertical screens have 2¼-inch spaced bars. Screen wash water is collected in a single sluice way which discharges to a trash container for disposal. This current CWIS configuration must be considered when evaluating alternative technologies. For example, and as described in Section 3.3.5, the EPA has assumed in developing its cost estimates that the CWIS includes traveling water screens enabling installation of fine mesh panels. In fact, no traveling water screen is present, making that approach much more costly than the EPA had assumed. Similar constraints are imposed on several screen technologies by the relatively simple and compact existing CWIS.

Several alternative technologies exist that are intended to reduce either impingement mortality and/or entrainment. Many of these technologies would require major changes to the structure of the screens to allow installation of traveling water screens, allow for suitable through-screen velocities, and provide for a return of captured organisms to the ocean. Major modifications to the intake screens (dual flow, angled, or inclined) to reduce through-screen velocity or improve impingement mortality performance may pose significant engineering challenges and likely require major modifications (i.e., expansion) to the intake structure.

Each of these technologies requires the installation of a fish return system, which would include a flume and a fish elevator. A potential flume to return the fish to the ocean would be complex at this facility because it would involve construction across the beach and well beyond the surf zone. For the purposes of this analysis, the flume is assumed to be a pipe that is directionally drilled across the beach, below the ocean bottom, to a location offshore. Due to the complexity of such construction, the estimated cost of the fish return system alone would be an additional $4.3M for each technological option requiring a fish return (i.e., those that rely on significant modification of the traveling screens – see discussion below and Table 3-3). The estimated cost of the fish return is added to the capital costs for any modification of the screens themselves in the cost estimate provided in Table 3-3. The Rule does not allow consideration of the permitting costs in the economic assessment of potential technologies under site-specific BTA based on the belief that permitting costs would be relatively constant regardless of compliance technology. Despite this, permitting the construction of a fish return flume or pipe across the beach would be complex and would substantially increase the cost of the screening technologies relative to other mitigation measures and Reliant believes that this should be considered. Finally, the rate of impingement survival may not be significantly improved by a fish handling and return system.

Prior to installation of a screening system, the ability of the impinged organisms to survive handling and return to the water should be evaluated. The resilience of the organisms to handling varies substantially by species, and several organisms common at this location are relatively intolerant to handling. In addition, there is a good chance that once deposited back to a concentrated area in the ocean, the fish disoriented by handling may be subject to high rates of predation. If such species are among the dominant organisms impinged, retrofitting with more sophisticated screening devices would yield limited beneficial effect. This conclusion is an important potential concern at Mandalay where grunion, a member of the Atherinidae or silverside family, may be poorly tolerant of handling. EPRI[4] provides a review of the literature on impingement survival. While there are no data specific to grunion, 24 separate studies of species of the silverside family indicate an average extended survival of only 22%. Given that grunion are expected to be in the area during spawning runs which may be a more stressful time, they may be more fragile at that period in their life cycle and may be even more susceptible to handling than other species in this family at this time. Alternatively, since they survive beaching themselves repeatedly during this time, their survival may be substantially greater than the related species. As noted below, Reliant does not believe that modifications to the traveling screens and installation of a fish handling and return system is an effective option for reducing impingement mortality so the potential survival of grunion upon handling need not be resolved during the CDS. Similar issues should be considered with the impingement and subsequent wash off of ichthyoplankton from fine mesh screens.

There are no site specific data on entrainment, but Reliant expects that, as was found for the Haynes station, there would be more harbor-species ichthyoplankton due to the presence of these species in Channel Islands Harbor. Even if they survived being removed from the screen and transported for release, they would be relocated into the open water rather than in the protected harbor. Survival in this environment would likely be lower. This reduced survival may be exacerbated by the presence of opportunistic predators that may take up residence at the

[4] EPRI, 2003. Evaluating the Effects of Power Plant Operations on Aquatic Communities. Summary of Impingement Survival Studies. EPRI Document No. 1007821.

discharge point preying on dead or stunned fish or larvae and by their presence increase the potential for healthy individuals being consumed.

Dual flow screens: The dual flow screen option would, by design, reduce the through screen velocity to 0.5 ft/s. To achieve this velocity, the existing flow through screens would be replaced with new 12-ft dual flow, 3/8-inch mesh screens. The replacement will require a complete retrofit of the existing structure to ensure sufficiently low through-screen velocity. The cost for dual flow screens was estimated to be $11M. The cost includes the intake reconstruction, Ristroph features and a 2000-ft fish return flume. Again, the effectiveness of such a technology is highly suspect given the potential poor survival of the dominant impinged species, grunion. This technology was not retained due to elevated costs associated with the reconstruction of the intake and the potential low effectiveness of the technology for impingement and ineffectiveness for entrainment.

Ristroph screens: Ristroph-type screens (for reduction of impingement mortality only) are feasible but would require the installation of traveling water screens as well as the addition of a low pressure wash system and a fish return system. The design of the fish return will be critical to ensure survival of the fish being returned, yet would be problematic. There is a strong potential that the CWIS bays would need to be entirely reconfigured in order to accommodate new traveling screens with smooth top mesh and other Ristroph features. The cost of these modifications (screen modifications, low pressure wash, and new fish return system) is estimated to be $5.5M, assuming a 2000-foot fish return flume. The costs would increase substantially if the CWIS requires a major retrofit. Given the potential for poor grunion survival, the effectiveness of this technology for impingement is suspect. The technology would ineffective for entrainment. The technology was not retained because the estimated cost would be significantly greater than the EPA cost and would be minimally effective.

Angled or Inclined screens: Assuming that angled or inclined screens could be installed in the screen house with minor intake structure modifications, the cost for either the angled or inclined screens with the fish return system is estimated to be $6M. For the reasons presented above, the ability to provide an effective fish by-pass is highly suspect. This technology would be ineffective for entrainment. Because the angled/inclined screens have not been installed and demonstrated feasible in full-scale applications at power stations and significant engineering constraints would be present in the Mandalay CWIS, this technology was not retained.

Fine mesh screens: The addition of fine mesh screens would require major reconstruction of the intake structure to install traveling water screens as well as decrease the through-screen velocity and provide the organism handling capacity. The potential survival of impinged ichthyoplankton has not been well defined in any application. Such technology is highly susceptible to clogging and in most applications is only deployed on a seasonal basis. Even in those circumstances, clogging is common and the screens must be removed during "debris events". In addition, the Channel Island Harbor and the Edison Canal are subject to eutrophication and the resulting algal blooms are very likely to result in clogging of fine-mesh screens. The cost of the installation of fine mesh screens including a completely reconstructed intake and fish return system is estimated to be $13 M. Because the cost estimate for the fine mesh screens is significantly greater than the EPA estimate and there are significant issues of effectiveness and feasibility, this option was not retained.

Fixed Screening Devices

Installation of a fixed screen in the water body can, under certain conditions, provides effective reduction in both impingement and entrainment. Installation of fixed screening device within the canal would be a poor solution as fish that had migrated into the canal would have no escape route. Therefore, placement of a fixed screening device would need to be at the entrance to the harbor. Aside from the practical difficulties of anchoring and maintaining such a structure, it would pose a sufficient impediment to navigation to make it impractical.

Wedgewire screens: Application of wedgewire screens would only be feasible with movement of the CWIS to an offshore location. There is insufficient space within the harbor and canal for the installation of a CWIS. In addition, some coastal species (notably grunion) are likely to orient their movement to intake flow and simply be lured to the vicinity of the CWIS without a reasonable chance of escape back to the ocean. A simpler offshore CWIS based on a velocity cap is described below. Cylindrical wedgewire screens with a 3/8-inch slot size could be considered for Mandalay Station. For a through screen velocity of 0.5 ft/s, at the design flow rate, a possible configuration would include six 72-inch diameter T-screens on a manifold located on the ocean bottom 3000 feet from the existing intake. Clogging may be problematic as location offshore complicates the use of an airburst system. This issue drives the selection of a relatively coarse screen which eliminates potential reductions in entrainment. Assuming that the wedgewire screen could be installed in the ocean without major challenges, the cost of this alternative is estimated to be $20M. This technology was not retained due to high cost, limitations on effectiveness, and environmental impacts associated with construction and reduction in harbor flushing.

Barrier net: A 180-ft long by 15-ft deep coarse mesh barrier net could be installed with pilings at the entrance to the intake canal. The through-net velocity would be less than 0.1 ft/s at normal water level in order to allow fish escape and reduce hydraulic stress. Fouling of barrier nets significantly affects operation and maintenance costs in marine settings and will have to be investigated further. Given the nature of the impinged species such a system may simply trap fish at the head of the harbor. For example, grunion may run with the current and upon encountering the net may not run back to the ocean against the current. In addition, this technology may pose issues with marine mammals such as harbor seals and California sea lions that may be present in the area. The estimated capital cost for the barrier net is $0.5M. This technology is retained for further analysis as part of the CDS.

Aquatic filter barrier (i.e., Gunderboom): The aquatic filter barrier would require significant and complex installation at the entrance to the intake canal. The hydraulic loading parameters of an aquatic filter barrier demand a barrier length that is essentially infeasible to deploy in the harbor. Offshore placement is not feasible given the wave energy present. A barrier in either location would pose navigation issues. The estimated cost of such a barrier would be $6M. This technology was not retained due to the high cost, issues of feasibility, maintenance concerns, and navigation issues.

Porous dike: A porous dike constructed around the intake canal entrance would be of massive size with a 20+-ft depth. The dike would also be an obstruction to navigation. A conceptual design would require a dike 20 feet high, 60 feet wide at the base, and 1500 feet long. The estimated capital cost for this option is $2M. In addition, the dike would likely be subject to fouling and clogging. Because of the high costs, impracticality, and uncertain performance, this technology was not retained.

Offshore Intake Structure

The conceptual design of the installation of new offshore submerged intakes would include extending two new submerged intake pipes to a location 1500 feet offshore with the expectation that biological diversity would be lower in the deeper waters of the Pacific Ocean. Assuming a 3000 ft intake pipe (laid on ocean bottom) that would bring this deeper water to the intake and installation of a new intake structure with velocity cap, the estimated cost is $15M. This option is not retained due to its high cost, the environmental permitting issues, and uncertainties regarding system performance.

Fish Diversion and Avoidance Devices

Louvers and bar racks can be effective in reducing impingement with a consistent sweeping flow of the current. They have not been demonstrated to be effective in the ocean setting especially in the absence of a bypass system. If a set of louvers were installed to enclose the intake canal, the estimated cost would be $2M. This option was not retained because of cost, likely difficulties in implementation, and navigation considerations.

Other behavioral barriers such as strobe lights, acoustic deterrent, bubbles, and chains have been used as fish deterrents. Their effectiveness is highly uncertain and species-specific. While acoustic deterrence systems have been shown to be effective in certain settings for certain species, the other mechanisms are largely ineffective. As a result, only acoustic deterrence has been retained. Vendors of acoustic deterrence systems have indicated to Reliant that the likely sensitivity of the dominant species to sound (i.e., their ability to be deterred) are likely to be low to moderate and that laboratory and pilot testing of such systems would be necessary with the relevant species. If acoustic deterrents were installed at the entrance to the intake canal, the estimated cost would be approximately $0.5M. It should be noted that, even if the system was effective at deterring the relevant species, they would likely tend to congregate at the head of the harbor and not return to the ocean. In addition, sound generators may be of significant concern to the Department of Defense due to the site's proximity to naval testing grounds as well as resource agencies concerned with marine mammals that might be adversely affected.

3.3.2 Review of Operational Measures

Flow Reduction

Variable speed pumps: Variable speed pumps are most effective for those facilities located in areas where intake water temperatures vary significantly because of season. If variable speed drives were installed on the cooling water pumps, the estimated cost is $2M. Mandalay currently experiences periods of no or reduced operation during which flow is greatly reduced. While flow reduction during these periods could be credited toward the Rule's performance goals, Reliant is not prepared to propose extensive flow reduction associated with reduced operation since operation of the facility is largely determined by the California Independent System Operator.

Evaporative cooling towers and dry cooling: Evaporative cooling towers and dry cooling are much more costly than EPA's estimate for compliance. In addition, space constraints greatly complicate their installation. Finally, both technologies are likely to result in other environmental issues (e.g., water consumption by evaporative towers, salt drift, visual and noise impacts). For these reasons, installation of cooling towers will not be considered further.

At the Mandalay plant, impingement mortality is greatly dominated by episodes of grunion impingement. Grunion runs are highly seasonal and are predictably aligned with phases of the moon and tide. As importantly, the grunion spawning season (early spring to early summer) is a period that typically experiences low power demand. For these reasons, the potential to reduce or curtail cooling water flow during grunion runs will be evaluated further as part of the CDS by evaluating the timing of runs and assessing the potential for lost generation.

Other Operational Measures – Reduction of Heat Treatment Frequency

Reliant subjects its cooling water intake structure to heat treatment by circulating hot water from the condensers back to the screens on a periodic basis in order to reduce biofouling. Per the requirements of the NPDES permit, impingement rates are monitored throughout the entire duration of this process. While it is conceivable that heat treatment may cause a significant fraction of the annual impingement mortality, this has not been observed to be the case in the last several years. In fact, heat treatment is associated with only 0.13% of the estimated impingement mortality during that period. Despite this, it may be possible to reduce the frequency of heat treatment or pursue an alternative mechanism to control biofouling. This potential will be evaluated further as part of the CDS and will include evaluation of impingement data in the future in the event that heat treatment-associated impingement mortality is found to be more significant.

3.3.3 Review of Restoration Measures

Restoration can be a cost-effective measure for mitigating losses of aquatic organisms and is allowed under the Phase II Rule. Under some circumstances (i.e. when loses are to commercially/recreationally important and/or special status species) it may be possible to affect in-kind replacement. On the other hand, in some cases it may be more appropriate to pursue “out-of-kind” restoration (i.e., restoration through ecosystem or watershed-based resource management approaches with a focus on resources other than those lost at the CWIS). This approach is explicitly allowed by the Rule. Both “in-kind” and “out-of-kind” restoration has been pursued as a mitigation strategy at a number of generating stations in California, most notably at the San Onofre Nuclear Generating Station.

Possible restoration methods generally include:

- Fish or shell-fish restocking programs;
- Habitat creation;
- Habitat restoration;
- Habitat enhancement;
- Acquisition and protection of habitat;
- Watershed management and protection to reduce sedimentation or improve water quality; and
- Support of a state or locally-sponsored restoration program.

Of these measures: four have some degree of precedent in the area of the Mandalay station: (1) wetland restoration; (2) wetland enhancement; (3) acquisition of wetland habitat; and (4) fish restocking programs.

Fish restocking programs are a way of directly restoring species populations impacted by impingement and entrainment. Restocking programs have proven successful in increasing specific species populations in Southern California. However, the dominant species involved in impingement and potentially entrainment at Mandalay are not species of significant commercial or recreational importance. Thus, direct replacement of the most commonly impinged species may not be the most ecologically or commercially/recreationally beneficial approach. Alternatively, Reliant believes that taking an ecosystem perspective and participating in restocking programs that target at-risk, rare, threatened, and/or endangered fish and invertebrate species such as white seabass, rockfish, and abalone may yield valuable benefits on multiple fronts. Proteus Sea Farms, which is in close proximity to Mandalay at a marine laboratory located on Reliant's Ormond Beach facility, currently raises white seabass and white abalone as part of an ongoing restoration program. Reliant anticipates continuing its support of Proteus for this demonstrated successful restocking program.

Habitat restoration and enhancement as well as acquisition of nearshore, coastal wetland, and coastal watershed habitats are indirect methods of mitigating impacts to nearshore fish populations that may be associated with impingement and entrainment at Mandalay. Nearshore habitats are hydrologically connected to and thus are part of the same coastal watershed, a requirement for restoration under the Rule. As such, restoration of coastal watersheds can lead to improvement of nearshore habitats. Coastal wetlands can serve as spawning, nursery, and feeding grounds for fish and invertebrates that are integral to the local marine ecosystem. Thus, restoration and/or protection of coastal watersheds are good focal points for managing coastal resources as these restoration activities will contribute to the long-term health of the ecosystem.

Reliant believes that embracing a watershed approach and pursuing "out-of-kind" restoration efforts that increase the biological, physical, and chemical quality of the coastal watersheds influenced by the Mandalay station (including Ventura River, Santa Clara River, and Calleguas Creek Watersheds) are appropriate potential mitigation measures under the Rule. While there is little opportunity for intertidal restoration at and in the vicinity of Mandalay facility, there are numerous restoration projects currently underway in Ventura County which Reliant could contribute to including:

- **Ormond Beach Wetland Restoration Project (Mugu Lagoon)** wetland restoration, enhancement, and acquisition projects of the Ormond Beach wetlands;
- **The Nature Conservancy:** wetland restoration, enhancement, and acquisition projects along the lower and upper Santa Clara River Watershed;

- **Southern California Wetlands Restoration Project:** wetland restoration, enhancement, and acquisition projects at Ormond Beach and along the lower and upper Santa Clara River Watershed;
- **Santa Clara River Wildlands Protection Project:** enhancement and acquisition projects along the lower and upper Santa Clara River Watershed;
- **Grunion Greeter Program**: research projects including a long-term grunion population assessment and an assessment of the usefulness of grunion as an environmental indicator for sandy beach habitats;
- **McGrath State Beach**: threatened and endangered species habitat protection;
- **Proteus SeaFarms/Channel Islands:** restocking program for white abalone and white seabass with the opportunity for expansion to include additional species;
- **Water Quality Improvement Projects:** agricultural and non-point source stormwater runoff; and
- **Matilija Coalition:** wetland restoration and enhancement projects along the Ventura River including removal of Matilija Dam, recovery of Southern Steelhead trout and, restoration of the natural sediment supply to the beaches of Ventura

As part of the CDS, Reliant will evaluate these and other restoration measures as means of cost-effectively restoring impingement and entrainment loses while improving the biotic integrity of the local coastal ecosystem. The evaluation will consider the findings and goals of relevant resource agencies as well as the interested public.

3.3.4 Estimate of Technology and Operational Measures Costs and Effectiveness

The estimated costs and effectiveness of the evaluated technologies and operational measures are summarized in Table 3-3.

3.3.5 EPA's Appraisal of Technologies

As part of the Rule making process, EPA developed an estimate of the cost of compliance with the Phase II Rule at each of the affected plants. These data are provided for the Mandalay station, with some slight modification to their presentation, as Appendix C.

The EPA lists the design flow at Mandalay as 201,295 gpm and has assumed that the addition of fine-mesh screens to existing traveling screens would be sufficient to achieve the Rule's performance goals. The total capital cost of this system is estimated at $2,336,881. No net revenue loss is estimated to be associated with construction. The total annualized cost of the additional technology is estimated to be $485,416. A pilot study involving the $236,083 is anticipated.

Given that the actual flow rate at Mandalay is less than EPA assumed, 176,000 gpm vs 201,295 gpm, the Rule allows for a reduction in the estimated capital costs. Estimated reduction in cost is not one-to-one with flow. In fact, using the Rule's cost-adjustment algorithms, the 14% reduction in flow is estimated to only reduce costs by approximately 1%. Given that the reduction in capital costs associated with the reduced flow is relatively minor, Reliant has not included those costs Appendix C or in this discussion.

For several reasons, Reliant does not believe that affixing fine mesh panels to the existing screens represents a cost effective measure:

- The installed base of fine mesh panels is very small and their operation has been problematic due to clogging by algae and debris. Edison Canal poses a particular problem due to the growth of algae enhanced by the runoff from the adjacent agricultural fields and housing complexes;

- Fine mesh screens reduce entrainment but result in impinged eggs and larvae. Successfully removing the organisms from the screens and returning them alive to the source water is highly uncertain. It is also likely to be very costly at Mandalay due to the distances involved. In particular, returning them to the canal is likely to result in re-impingement while returning them to the ocean would involve a very costly system to transport them across the beach and beyond the surf zone. In addition, relocating species characteristic of the harbor into open water would put them into an inhospitable environment;

- An important aspect of maximizing organism survival is to ensure that the through-screen velocity is low to avoid extrusion through the screen. While there is no consensus on a maximum velocity, 0.5 ft/s is a commonly cited target velocity. Placement of the fine mesh panels actually reduces the available through screen area by approximately 50%. Thus, in order to ensure an adequate through-screen velocity, the screen area at Mandalay would have to be increased substantially. In fact, it would likely have to increase well beyond the approximate doubling of area associated with the dual-flow screens;

- Retrofit of the existing intake bays with dual-flow screens, a common technique to reduce through-screen velocity, may result in significant hydraulic issues including velocity hot-spots and eddies that can adversely affect the performance of the screens;

- The current screen system includes neither traditional traveling screens, a continuous screen-wash system, nor a fish return system. In fact, the current sliding screen system has a relatively small footprint. This result suggests that the EPA costs, which assume a relatively simple program of fitting fine mesh screens on the existing traveling screens are grossly underestimated. In fact, a fine mesh screen system would require retrofitting with traveling screens, a wash water, and fish return system as well as an increase in the number of CWIS bays in order to achieve target through-screen velocities. Given the existing sliding screen system, many of these issues are common to technologies that rely on traveling water screens and relatively low through-screen velocities; and

- Finally, Reliant believes that the costs of the retrofit have been significantly underestimated and that a more realistic estimate of the likely cost is $13M.

In the final Rule, EPA does not present facility-specific estimates of the benefit of compliance to area fisheries. Instead, EPA requires that the benefits of potential technologies and measures be estimated based on likely technology effectiveness and those benefits expressed as a monetized value using procedures defined in the Rule. The monetized value will be compared to the costs of the potential technology or measure. Under the Rule, if the costs are "significantly greater" than the estimated benefits, a site-specific BTA can be issued.

In summary, addition of fine mesh panels to traveling screens is likely to be very costly with highly uncertain effectiveness and feasibility. Reliant anticipates that no entrainment technology is likely to be cost-effective at Mandalay; therefore, it is likely that Compliance Approach #5 based on the Cost-cost test or Cost-benefit tests will be part of its compliance strategy.

3.4 Selection of Proposed Technologies, Operational and Restoration Measures

Based on our review of the technologies available and the circumstances at the Mandalay station we conclude that five technologies or operational measures should be retained for additional consideration: installation of a barrier net, installation of acoustic deterrence systems, reduction of pumping during grunion runs, reduction in heat treatment frequency and duration, and restoration. Technologies to further reduce the rate of impingement mortality are subject to significant issues of performance and cost. No technology to minimize entrainment directly has been demonstrated to be either reliable or effective especially in circumstances like those at Mandalay Generating Station. There is a good potential that restoration measures could improve the local environment, especially if they are focused on important biological resources (i.e., potentially out of kind restoration).

4.0 HISTORICAL STUDY REVIEW

Several studies were conducted by MBC during 1979-1980 to assess the Mandalay Generating Station under Sections 316(a) and 316(b) of the Clean Water Act (thermal discharge and intake-related effects, respectively). Relevant impingement and entrainment studies have been conducted at Mandalay station as well as other, similar power stations in the area. The studies performed at Mandalay are briefly presented in Section 4.1.

A more complete discussion of these studies as well as data from other sources and their implications are presented in Appendix B. The ability of the combined data set to support the requirements of the Phase II Rule, in particular the Impingement Mortality and Entrainment Characterization Study (IMECS), is discussed in Section 4.2. Studies performed in the Pacific Ocean and available in the literature were reviewed for additional information that could help characterize physical and biological conditions near the facility (Section 5.2)

4.1 Historical Biological Data

The following provides a citation to the relevant study followed by a brief summary of the documents scope and findings.

SCE, 1982. Mandalay Generating Station 316(b) Demonstration. Prepared for LARWQCB. 82-RD-97.

- Focus on Impingement Characterization
- Newly collected data (October 1979 - September 1980)
- Study focuses on a 14 target species.
- Species list shows dominance of impingement by 65% shiner surfperch; 11.4% queenfish; 10.8% anchovy: 5.1% white surfperch; and 4.1% walleye surfperch
- Annual rates of impingement estimated
- Summary of zooplankton entrainment (taken at Los Angeles Department of Water and Power’s Haynes Generating Station)
- Impact assessment model for each species
- Intake technology evaluation

SCE, 1982. 316(b) Demonstration Technical Appendix: Impact Assessment Model, Bight-Wide Plankton Investigations. Prepared for LARWQCB, SDRWQCB, and SARWQCB.

- Evaluation of impingement and entrainment losses
- Evaluation of icthyoplankton densities in the Southern California Bight

Data from several physical, hydraulic, and biological studies at coastal generating stations and source waters were utilized to develop the Impact Assessment Model

MBC, 2001. National Pollutant Discharge Elimination System 2001 Receiving Water Monitoring Report, Reliant Energy Mandalay Generating Station. Prepared for Reliant Energy

24-hour monitoring of impingement – summarized in Proteus (2005). Monitoring of fisheries resources in the vicinity of the outfall and at reference locations.

MBC, 2002. National Pollutant Discharge Elimination System 2002 Receiving Water Monitoring Report, Reliant Energy Mandalay Generating Station. Prepared for Reliant Energy

24-hour monitoring of impingement – summarized in Proteus (2005). Monitoring of fisheries resources in the vicinity of the outfall and at reference locations.

MBC, 2003. National Pollutant Discharge Elimination System 2003 Receiving Water Monitoring Report, Reliant Energy Mandalay Generating Station. Prepared for Reliant Energy.

24-hour monitoring of impingement – summarized in Proteus (2005). Monitoring of fisheries resources in the vicinity of the outfall and at reference locations.

MBC, 2004. National Pollutant Discharge Elimination System 2004 Receiving Water Monitoring Report, Reliant Energy Mandalay Generating Station. Prepared for Reliant Energy.

24-hour monitoring of impingement – summarized in Proteus (2005). Monitoring of fisheries resources in the vicinity of the outfall and at reference locations.

Proteus SeaFarms, 2005. Summary of Fish Impingement at Reliant Energy's Mandalay Generating Station. Oxnard, CA. 2001-2004.

Presentation of impingement data collected by Proteus and included in MBC reports, above

22 monitoring episodes over 3+ years. Both fish and shellfish numbers and biomass were quantified

19 fish species observed with 10 comprising 99.8% of the numbers. Small schooling fish typical of coastal waters dominate impingement. Fish typical of harbors and estuaries (e.g., blennies) are notably absent

4.2 Summary of Historic Impingement and Entrainment Rates

As noted above, SCE evaluated impingement and entrainment at Mandalay during the development of the original CDS in the early 1980s. This included measurement of impingement and extrapolation of entrainment measurements from those at another similar station. Further efforts to track impingement since 1980 have been documented in annual monitoring reports since the condition to collect such data was included in the latest NPDES permit (i.e., since 2001). No site-specific effort was undertaken to evaluate entrainment at Mandalay in recent years.

These studies used standard sampling and analysis techniques that are appropriate for quantifying impingement and entrainment under the Rule. These data are expected to be useful within the context of the goals of the Rule as well as in providing a broad understanding of the fisheries of the Southern California Bight. The following is a brief discussion of the overall trends observed in the two data sets and their implications for the PIC. Information on the fishery of the Southern California Bight is also considered. A more extensive discussion of site-specific observations as well as the more general literature is presented in Appendix B.

Based on the available data, several generalities regarding impingement and entrainment are possible:

- The more recent survey of impingement is of very high quality. Several samples are available over a number of years. The methods are standard ones and the full suite of fish and shellfish are enumerated, weighed, and measured for length. These data, which will continue to be collected, fully address the goals of the IMECS as articulated in the Rule.

- A relatively small number of species are subject to impingement at Mandalay. These species are typical of coastal environment. Few species that favor harbor or estuary habitats are impinged. A much larger number of species are impinged at Ormond Beach including those from coastal and estuarine environments. Most of the impinged fish at both stations are schooling species. The overall rate of impingement (i.e., fish/10,000 m3) is far lower at Ormond Beach than at Mandalay.

- The older surveys of impingement mortality and entrainment at both stations used appropriate methods but suffer from a focus on 14 target species. The target species do not include the dominant species in the most recent data at Mandalay, grunion. The older data on entrainment at Mandalay is collected at another facility.

- The overall pattern of impingement of the 14 target species is similar between the two surveys (r2 = 0.93 for Mandalay, r2 = 0.80 for Ormond Beach). This similarity includes overall species composition as well as the number and biomass of fish impinged.

- The impinged species in the two surveys include several but not all of those that are common in embayment or nearshore habitat of the Pacific Ocean.

- Grunion and other schooling species show significant periodicity in impingement at Mandalay but far less so at Ormond Beach. This result leads to very high inter-sample variation in impingement rates at Mandalay. This apparent periodicity is likely due to a combination of factors including the normal periodicity in the presence of the species (e.g., grunion runs on spring tides in March through June) and the irregular schedule of operation of the plant. For example, 2004 surveys indicate that few grunion were collected during the survey, yet they were the species with the highest rates of collection during sampling in 2002 and 2003. These results may indicate that grunion were not impinged in 2004, although it is more likely that the sampling in 2004 did not occur while the grunion were spawning.

- Recent surveys of ambient fish populations have occurred offshore of the Mandalay station for several years and historic fish populations were sampled in the late 1970s off both Mandalay and Ormond, located a relatively short distance up the coast. The species encountered during these sampling events have been relatively consistent over the last 20+ years and are very similar in composition to the fish impinged at Ormond. In sharp contrast, the most important components of the ambient population are impinged very infrequently at Mandalay and the dominant species impinged are very poorly represented in the ambient population.

- At Mandalay, the set of observations above suggest that coastal species, especially grunion, may run into the Channel Island Harbor and the Edison Canal. This movement may be encouraged, in part, by the induced flow velocity into the canal. If these coastal species orient their movement to flow while harbor residences do not, this may help to explain the importance of coastal species among impinged fish. No such behavior is apparent in the Ormond Beach impingement data set.

- The flow normalized rate of fish impingement during normal operation is far lower at Ormond Beach (0.09 fish/10,000 m3) than at Mandalay (4.96 fish/10,000 m3). This difference is likely associated with the location and configuration of the Ormond Beach CWIS (e.g., the velocity cap) including the absence of major impingement events associated with spawning fish.

- Both stations use heat treatment to control biofouling of the CWIS. Total impingement is monitored during the entire duration of any heat treatment event and tallied separately from impingement during normal operations. Impingement during heat treatment was compared to the annual rate of impingement estimated by extrapolating 24-hour sampling events to the full year. At Mandalay, heat treatment losses were found to be only 0.13% of the total estimated annual loses. At Ormond Beach, the relative losses during heat treatment were far higher: 53.6% of estimated annual losses.

- No listed Threatened or Endangered species or other special status species have been affected by impingement. Only special-status marine mammals and reptiles (i.e., sea turtles) are believed to be present in the area, they have not been encountered during impingement surveys.

- The monthly rates of impingement are highly variable but exhibit only slight seasonal patterns. This variability is likely due to the periodicity of plant operation as well as the coordination of the schooling and spawning behavior of the fish species located in the intake canal with relatively short-term tidal events at Mandalay.

- The two most frequently impinged fish species, the California grunion and shiner perch, are large for the species (i.e. more than a couple grams) indicating that they are adult and young of year.

- The fish species (i.e. gobies and blennies) assumed to be affected by entrainment at Mandalay (based on the data from Haynes) were not generally the same ones affected by impingement (i.e. grunion and shiner perch). However, since entrainment data were only collected from Haynes, it is difficult to compare this data directly to entrainment data from the impingement surveys at Mandalay. Supplemental data on entrainment at Mandalay is proposed. There is a strong seasonality in the rate of entrainment of fish with the great majority occurring in the late spring months, May and June (which correspond to grunion spawning); minimum entrainment occurred during December and January.

- The original demonstrations in 1983 concluded that the operation of the CWISs did not result in an Adverse Environmental Impact on the fisheries in the vicinity. The LARWQCB concurred with this decision.

- Shifts in the populations of some fish species are expected since the completion of the demonstrations in 1983. In particular, the populations of rock fish are expected to have decreased. Despite this change in populations for some fish species, significant changes in the patterns of impingement and entrainment are not expected. Importantly, the two dominant impinged species and entrained species are expected to continue to be most important at both stations.

- Based on the historic and recent data collected in support of the demonstrations and NPDES monitoring, fish populations within the Southern California Bight that have shown substantial population changes are different from the species impinged and (presumed to be) entrained at Mandalay.

4.3 Assessment of Data Sufficiency

Among the requirements of the CDS is the performance of a study of impingement mortality and entrainment. The results of this study may be used to assess the performance of the current CWIS as well as evaluate additional potential technologies and measures. The Rule sets out specific requirements for this study and addressing these requirements is an important aspect of the PIC. The Rule anticipates that it may be possible to base the CDS completely or in part on existing data. For these reasons, Table 4-1 presents the specific data requirements for the study and reviews the relevance of available data to these requirements. The table also comments on the potential necessity of additional field data.

Table 4-1 Assessment of Data Sufficiency

Rule Citation	*Requirement*	*Historical Data Source*	*Notes*	*Additional Data Proposed?*
125.95(b)(3)(i)	*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.*	*Site-Specific; Regional Literature*	*Historic data at the plant provide information on rates of impingement and entrainment of aquatic organisms. This can be confirmed by comparison to rates at other stations. Surveys of extant populations and reference materials can be used to assess historical trends and current populations in the area.*	*Yes*

Rule Citation	*Requirement*	*Historical Data Source*	*Notes*	*Additional Data Proposed?*
125.95(b)(3)(ii)	*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 pursuant to paragraph (b)(3)(i) of this section, 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 annual, seasonal, and diel variations in impingement mortality and entrainment.*	*Site-Specific; Regional Literature*	*Station-specific data will be used and supplemented by more recent data from other stations as well as surveys of extant populations and the general literature.*	*Yes*
125.95(b)(3)(iii)	*Documentation of the current impingement mortality and entrainment of all life stages of fish, shellfish, and any species protected under Federal, State, or Tribal Law (including threatened or endangered species) identified pursuant to paragraph (b)(3)(i) of this section and an estimate of impingement mortality and entrainment to be used as the calculation baseline. Impingement mortality and entrainment samples to support the calculations required in Section 125.95(b)(4)(i)(C) and 125.95(b)(5)(iii) of the Rule must be collected during periods of representative operational flows for the cooling water intake structure and the flows associated with the samples must be documented.*	*Site-Specific; Regional Literature*	*Historic rates of impingement mortality and entrainment are believed to be representative of current conditions based on comparison to more recent data at other stations as well as surveys of extant populations.*	*Yes*

4.3.1 Impingement Data

Significant data are available on the impingement mortality patterns at the Mandalay station over the last three years as well as when the 316(b) evaluations were first done in the 1980s. These data have been collected as part of the NPDES permit monitoring program, use good Quality Assurance/Quality Control Practices, and provide an excellent record of the rates of impingement at the station. Reliant believes that the historic record on impingement is likely to be representative of current conditions given that operation of the facility has not changed substantially. Despite this consistency, we acknowledge the potential utility of updating information to both address potential changes in the fishery as well as identify routine inter-annual variation. Collection of these data will continue as required by the NPDES permit.

4.3.2 Entrainment data

Entrainment data were also considered during studies performed in the early 1980s. However, as part of the "representative site concept" used at the time of the original study, direct entrainment sampling was not performed at Mandalay. Rather based on presumed similarities of intakes in 'bays and harbors', the sampling and results from Haynes Generating Station reported by IRC (1981) were used to estimate entrainment impacts by simply scaling to the Mandalay flow rates. These surveys were relatively comprehensive and conform to current practices of sampling and enumeration and, if they were deemed to be representative of current conditions, would help to meet the requirements of the IMECS set out in the Rule. However, given the potential for changes to the fishery since these data were collected as well as the questions raised by their collection at a different stations in a different location, Reliant proposes to collect entrainment data at Mandalay Generating Station.

Appendix B discusses the data available at Mandalay within the context of other relevant data including:

- Data on impingement and entrainment collected at other power stations in the area (Ormond and Haynes). The other stations are in similar settings and the data were collected in the 1970s as well as more recently;

- Ongoing, consistent surveys of the fisheries of the Southern California Bight; and

- The general literature on fisheries including habitat preferences and seasonality of important species.

As importantly, Reliant believes that it will be productive to asses the spatial variation in ichthyoplankton density as it relates to the CWIS relative to the Calculation Baseline.

Reliant also acknowledges that the actual applicability of the Haynes study is unknown because the Haynes station is a considerable distance south of Mandalay, and there is little information to indicate that the abundance of plankton communities at the two locations are similar enough to provide an accurate assessment of entrainment impacts. For these reasons, the entrainment studies are unlikely to be deemed representative of current conditions and current entrainment data will need to be collected.

As described in Section 6 of this PIC, Compliance Alternative #2 under the Phase II Rule allows a facility to demonstrate that the existing CWIS meets the performance standards' required reductions relative to the Calculation Baseline. Compliance Option #3 includes demonstrating compliance with additional technological, operational, or restoration measures. Compliance Option #5 provides for a demonstration that cost-effective reductions are not feasible. While understanding current rates of impingement mortality and entrainment rates is important for each of these compliance approaches, the need for data on ambient populations is likely to vary significantly.

40 CFR 125.93 defines the Cooling Water Intake Structure as "the total physical structure and any associated constructed waterways used to withdraw cooling water from waters of the U.S." The mouth of the Channel Islands Harbor (including the 2.5 mile Edison Canal and the 1.3 mile harbor) is considered the "point at which water is withdrawn from the surface water source". The Calculation Baseline would therefore be an estimate of the impingement mortality and entrainment of a once-through intake structure with "the opening of the CWIS…located at, and the face of the standard ½-inch mesh traveling screen…oriented parallel to, the shoreline near the surface of the source waterbody".

An intake at this location would withdraw water from the Pacific Ocean at a location along the shoreline. Figure 2-2 illustrates the estimated area of hydraulic influence for the once-through intake at that location with a 285.1 MGD capacity. While the hydraulic influence of the CWIS is expressed along the shoreline (specifically near the mouth of the Channel Islands Harbor), the induced velocity through the harbor is likely to be relatively low (i.e., far less than 0.5 ft/s). In addition, the harbor consists of habitat favorable for many non-shore line species (e.g., blennies). Thus, it is likely that the rates of impingement of shoreline species is reduced by the CWIS location relative to the Calculation Baseline condition. Similarly, more harbor-dwelling organisms might be expected to be impinged.

Having inspected the available data and based on information collected in the literature, Reliant has concluded that collection of ambient data in order to define the differences between the current CWIS and the Calculation Baseline is not likely to be productive. Most importantly, the temporal and spatial variation in populations is significant and is likely to overwhelm, at least periodically, potential differences associated with CWIS configuration, location, and operation. For this reason, Reliant proposes to base the estimate of the Calculation Baseline on the available data (from the literature as well as the site), tangible factors such as flow reduction, and Best Professional Judgment. In addition, Reliant is likely to pursue, at least in part site-specific BTA alternatives, as well as restoration measures, both of which are less dependent upon the Calculation Baseline.

In summary, Reliant believes that the Mandalay Generating Station partly meets the performance standard for impingement mortality and entrainment relative to the Calculation Baseline. Reliant proposes to collect data to support this demonstration by characterizing the existing impingement mortality and entrainment rates at the facility and to rely on the literature and Best Professional Judgment to estimate the rates for the Calculation Baseline. The collection of impingement mortality and entrainment data will also support a potential demonstration of compliance under Option #3 by providing current, site-specific data that would identify the optimal selection of technological, operational, or restoration measures to meet the performance standards. In particular, the rate of losses could be used to establish performance goals for selected restoration measures. The data would further support a demonstration under Option #5 by providing a basis for estimating monetized benefits of mitigation measures. Section 7 provides an overview of Reliant's approach to collecting biological data. A more detailed sampling plan is provided as Appendix D.

4.4 Physical and Water Quality Data

Reliant has not collected a substantial amount of physical or water quality data and does not anticipate that these data will be critical to the execution of the CDS. As noted above, it has been possible to estimate the zone of hydraulic influence of the CWIS based on along-shore current velocities from the literature. Similarly, the water used for cooling is clearly well above the Rule's threshold for seawater of 0.5 parts per thousand (ppt) salinity. It is likely that water that is drawn through the harbor is subject to increases in temperature and decreases in dissolved oxygen. This impairment provides a motive for the Channel Islands Harbor Master's office (the authority that controls daily activities within the harbor) to periodically request that Reliant pump cooling water in order to flush the harbor. On the other hand, such potential impairment may limit the nature of the fishery community in the harbor and affect the nature of the Calculation Baseline. These issues will be explored further during the CDS.

5.0 AGENCY CONSULTATIONS

The Rule requirements for the PIC ask for a summary of past or ongoing consultations with appropriate Federal, State, and Tribal fish and wildlife agencies that are relevant to this Study and a copy of written comments received as a result of such consultations. Reliant believes that the goals of this summary are to provide LARWQCB with full perspective on the historical permitting of the CWIS as well as potential concerns raised by relevant fisheries management or other natural resources agencies. Such a summary has been prepared from the records retained by the facility and by Reliant corporate offices as well as the collective memories of the station and environmental staffs.

5.1 Section 316(b)-Specific Consultations

Reliant has been unable to find specific correspondence from LARWQCB or EPA regarding the Section 316(b) compliance status of the Mandalay station in the late 1970s and early 1980s. We infer from the presence of several studies performed during the 1970s that analysis under Section 316(b) was performed and likely reviewed by the NPDES permitting agency. From the history of operation at the facility, we believe that the NPDES agency generally concurred with the conclusion that no Adverse Environmental Impacts were being caused by the CWIS at the plant.

The current NPDES permit does not mention conclusions by LARWQCB relative to the BTA status of the CWIS at the Mandalay station.

Reliant has been participating in the LARWQCB stakeholder group meetings that have been convened periodically since 2003.

5.2 Other Relevant Consultations

Reliant has had no consultations with fisheries or other agencies relative to impingement and entrainment of fisheries at the Mandalay station. Communications with the California Department of Fish and Game (CDFG) and the US Fish and Wildlife Service (USFWS) have indicated that there are no state- or federally-listed species in the vicinity of the CWIS and therefore no potential impacts to protected species (see Appendix B).

6.0 PROPOSED COMPLIANCE APPROACH

At this point in the 316(b) compliance effort, it is not clear which Compliance Alternative(s) will ultimately be selected during the completion of the CDS. Based on information reviewed above, some combination of Compliance Alternatives 2, 3, and 5 will be pursued. Thus, the PIC has been written to collect data relevant to each of these three approaches. The following is a brief summary of the potential application of the three compliance alternatives at Mandalay:

- Compliance Alternative 2: Demonstration that the current technologies and measures achieve the performance goals. The contributing factors may include the location of the CWIS and the reduction in flow associated with use of a turbine (Unit 3). As noted below, preliminary estimates of the effectiveness of these measures indicate that the CWIS does not fully meet either of the full performance goals. Despite this result, this conclusion will be re-evaluated and benefits from the existing CWIS may be considered in conjunction with new measures adopted under Compliance Alternative 3, below. The evaluation of current performance will be based on relatively tangible factors (e.g., flow reduction associated with Unit 3) as well as available data and Best Professional Judgment.

- Compliance Alternative 3: Demonstrate that currently used and newly adopted technologies and measures achieve the performance goals. A number of potential technologies and measures (e.g., barrier net, restoration) will be evaluated further as part of the CDS and may be adopted to contribute toward additional mitigation. As noted in Section 3, potential measures include some additional technologies but are likely to rely heavily on restoration measures. Again, the combined performance of the existing and newly pursued technologies and measures will be evaluated based on a weight-of-evidence including biological data, engineering data, and Best Professional Judgment. The nature of potential restoration measures will be considered relative to the quantified losses at the station as well as those measures that are likely to have significant biological benefit.

- Compliance Alternative 5: Define a site-specific Best Technology Available (BTA). This alternative will be based on showing that fully achieving the performance goals will be significantly more costly than EPA's estimate of the cost of compliance or the monetized benefit of compliance. Reliant notes that the Rule requires that any cost-effective measures should be pursued even under the adoption of a site-specific BTA. For this reason, restoration of losses is likely to play a role under this option. Therefore, observed rates of losses are likely to be used to support design of restoration measures as well as estimate the monetized benefits of potential mitigation measures.

As stated earlier in this PIC, fine mesh panels added to the existing traveling water screens were selected by EPA as the compliance technology for this station to meet both the impingement mortality and entrainment reduction goals. For the reasons discussed in Section 3.3.5, Reliant does not believe that this is a cost-effective or feasible measure.

6.1 Outline of CDS Activities

According to 40 CFR Section 125.95(b), the "Comprehensive Demonstration Study (The Study) is to characterize impingement mortality and entrainment, to describe the operation of your cooling water intake structures, and to confirm that the technologies, operational measures, and/or restoration measures you have selected and installed, or will install, at your facility meet the applicable requirements of §125.94." Under the provisions of the Rule (40 CFR 125.95(b)), the composition of the CDS will depend on the specific Compliance Alternative selected. In fact, there is a possibility that one Compliance Alternative will be selected to address impingement mortality and another one for entrainment. Thus, a CDS intended to support a combination of Compliance Alternatives 2 (or 3) and 5 that is based, at least in part, on restoration would include the following components:

- Proposal for Information Collection
- Source Waterbody Flow Information
- Impingement Mortality and/or Entrainment Characterization Study
- Technology and compliance assessment information
    - Design and Construction Technology Plan
    - Technology Installation and Operation Plan
- Restoration Plan
- Information to support site-specific determination of best technology available for minimizing adverse environmental impact
    - Comprehensive Cost Evaluation Study
    - Valuation of Monetized Benefits of Reducing IM&E
    - Site-Specific Technology Plan

- Verification Monitoring Plan

The documents required for Compliance Alternative 3 are the same as those required by Compliance Alternative 2. In the event that only Compliance Alternative 5 is selected, Design and Construction Technology Plan would not be required[5]. As appropriate to the selected Alternative, Reliant will prepare each of these documents and submit them to LARWQCB for review.

6.2 Review of CDS Approach

As noted above, the specific Compliance Alternative to be pursued at Mandalay Station has not yet been selected. It is expected that some combination of Alternatives 2, 3, and/or 5 will be pursued. The activities performed as part of the CDS will help to evaluate these Alternatives and select the most appropriate one(s).

The CDS approach for the Mandalay station includes providing the required information and submittals so that:

- Rates of impingement mortality will continue to be quantified at the Mandalay Generating Station consistent with the program currently in place;
- Rates of entrainment will be quantified for one year;
- The Impingement Mortality and Entrainment Characterization Study will summarize the full range of available data in order to estimate the extent of mitigation from the Calculation Baseline as well as estimate the current losses;
- Existing technologies and operational measures to achieve the impingement mortality and entrainment goals will be described and their effectiveness estimated based on available data. The assessment will consider the feasibility and reliability of the technology as well as its likely effectiveness and cost. The additional measures of barrier net deployment, installation of acoustic deterrence systems, reduction in the frequency and duration of heat treatment of CWIS, reduction of pumping during grunion runs, and restoration will also be assessed as potentially cost-effective measures to further reduce impingement mortality and/or entrainment;

[5] Reliant notes that the nature of the Design and Construction Technology Plan is very similar to that of the Site-Specific Technology Plan so that LARWQCB will have an opportunity to review the relevant information under either circumstance.

- Following assessment of the biological and engineering data, the final Compliance Alternative will be selected for impingement mortality and entrainment. As noted above, while it is not possible to select the final alternative at this time, it is likely that it will rely on an approach that credits existing mitigation measures, proposes adoption of cost-effective additional measures, and, to the extent that the performance goals are not fully achieved, proposes a site-specific BTA;

- The technology assessment and discussion of the installation and operation of selected measures will be presented in the Design and Construction Technology Plan, the Site-Specific Technology Plan, and/or the Restoration Plan, as appropriate; and

- The nature of the proposed ongoing compliance activities including their timing will be outlined in the Technology Installation and Operation Plan.

6.3 Schedule

The following is a tentative schedule for the execution of the Phase II process at Mandalay based on target dates for submission of the PIC and the completed CDS. The following is a proposed Rule compliance schedule for Mandalay that incorporates these two milestones:

- PIC submittal by October 15, 2005;

- Submission of a request for compliance schedule consistent with the Rule's provisions by August 15, 2005;

- Submission of the application of NPDES permit renewal and, potentially, materials called for under Section 122.216 by October 1, 2005;

- LARWQCB comments on the PIC, within 60 days of submittal – October 15, 2005;

- Field work for Impingement Mortality and Entrainment Characterization Study Report begins by January 1, 2006 and is completed one year later;

- Compilation and analysis of the impingement mortality and entrainment data will be complete by approximately March 1, 2007 and the balance of the CDS will begin in earnest at this time;

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[6] Reliant believes that those materials called for under 40 CFR 122.21 related to Section 316(b) are most useful when reviewed in the context of the CDS. For this reason, Reliant believes that it is logical to delay their submission until the completion of the CDS and Reliant will request this strategy as part of its Compliance Schedule.

- Submit Comprehensive Demonstration Study, including items identified below by a date consistent with the compliance schedule (i.e., January 7, 2008);
  - Impingement Mortality and Entrainment Characterization Report;
  - Technology and compliance assessment, including the Design and Construction Technology Plan (DCTP) and the Technology Installation and Operation Plan (TIOP);
  - Information to support the site-specific best technology available (BTA), potentially including the Comprehensive Cost Evaluation Study (CCES), Valuation of Monetized Benefits (VMB), and the Site-Specific Technology Plan (SSTP); and
  - Verification Monitoring Plan (VMP).
- Negotiation of the TIOP as part of the LARWQCB determination of Section 316(b) BTA;
- LARWQCB BTA determination and CDS approval completed by approximately June, 2008; and
- Implementation of additional remedies under the schedule defined in the TIOP.

Reliant notes that this schedule is only an approximation. The CDS is due to LARWQCB by October 1, 2005 (the NPDES permit renewal application date) unless a compliance schedule is requested in which case LARWQCB can extend the due date to as late as January 7, 2008. Reliant has requested, under a separate cover, such a compliance schedule. We view the PIC and related process to be an iterative process and, as such, we anticipate continued discussions and interactions with the LARWQCB on this process.

7.0 PROPOSED SAMPLING PLAN

The Proposed Sampling Workplan, as presented below, will provide a basis for current impingement and entrainment estimates at Mandalay. Such estimates, when combined with the existing site-specific data and information available from the literature, will allow Reliant to complete the IMECS as required by the Rule. In addition to addressing the requirements of the IMECS, the data will be useful in defining the rate of loses in order to evaluate the monetized benefits of additional mitigation measures as well as developing restoration targets. These data will also support, in part, definition of the Calculation Baseline relative to current rates of impingement mortality and entrainment.

The following section presents a brief overview of the proposed scope of field work. The proposed workplan itself is provided as Appendix D to this document. Section 3 and Appendix D provide background information on the likely nature of the impingement and entrainment at Mandalay. These sections also provide a brief summary of the data available on fisheries in the area including monitoring of ambient conditions. These data will be collected and more formally reviewed as part of the IMECS.

Three types of biological sampling could be included as part of the field work to support the IMECS: 1) quantification of impingement mortality; 2) quantification of entrainment; and 3) sampling of ambient populations of fish and/or ichthyoplankton. Consistent with the anticipated compliance alternatives, Reliant has proposed to characterize impingement mortality and entrainment but not to perform sampling of ambient populations of ichthyoplankton or adults. These two potential activities are discussed separately below.

7.1 Impingement Sampling Plan

The Mandalay Generating Station currently quantifies impingement as required by its NPDES permit. Sampling is done approximately monthly, as plant operations allow, during normal operation. Finfish and shellfish that are impinged are characterized to species, enumerated, and weighed. Consistent with the operation of the CWIS, impinged fish are assumed to be subject to mortality. The CWIS flow rate is recorded during each sampling event. The daily rate of impingement and the CWIS flow rate are used to extrapolate from the measured daily impingement to an integrated annual impingement rate.

In addition, fish impinged during heat treatment of the CWIS are sampled, enumerated, and characterized as described above. Loses during heat treatment are typically higher than during normal operation. Because of the comprehensive nature of the sampling activities for the heat treatments, no extrapolation to annual conditions is necessary.

Reliant believes that the current sampling program is sufficient to support the goals of the IMECS and its compliance approach. In particular, the relatively extensive data set collected over the last four years, combined with data collected in the next year will provide an excellent record of the rate of impingement mortality.

It should be noted that, over the last few years, the Mandalay Generating Station has operated on an intermittent basis. For this reason, scheduled sampling events have not occurred due to the lack of plant operation. Reliant believes that it is inappropriate (and costly) to operate the CWIS pumps simply to sample and LARWQCB has concurred. While this results in less data on an annual basis, over the duration of the program, seasonal and interannual trends can be defined. Reliant plans to continue this practice of sampling as scheduled when the plant is operational.

Impingement data will be reported on a per survey, per season, per sampled volume, and estimated annual basis. The raw data will be included as an Access® database.

7.2 Entrainment Sampling Plan – In-Plant

Reliant proposes to sample for entrainment at a one month frequency throughout the year. Given the relatively limited nature of available data and the relatively short duration of the sampling period (i.e., a few hours versus 24 hours for impingement), determined efforts will be made to collect a sample during each month. This may include rescheduling events, collection of a second daily sampling early in the following month, and/or pursuing the day-time and night-time sampling events on different days. Running of the cooling water pumps for the sole purpose of sampling will not be pursued.

Samples will be collected by deploying a 333 µm plankton net with a 0.5 m diameter mouth in the cooling water intake flow in front of the sliding screens. The net will be equipped with an impeller to allow estimation of the filtered volume. The target filtered volume will be 100 m^3. The actual sampled volume as well as the plant cooling water flow rate will be recorded. Separate samples will be collected beginning at sunrise and sunset in order to evaluate diel variation.

Each sample will be preserved in 10% formalin, stored, and analyzed separately. Fish eggs and larvae will be identified to lowest distinguishable taxonomic category and counted. When a species is especially abundant, subsamples will be obtained by a plankton splitter. Specimens will be measured for definition of length frequencies. Common and scientific names will be those established by the American Fisheries Society. Counts will be expressed relative to 10,000 m^3 of water.

Entrainment data will be summarized and expressed on a per survey, per flow volume, and estimated annual basis. Diel and seasonal trends will be evaluated. Raw data will be available as an Access® database.

7.3 Ambient Sampling Plan

Reliant does not propose to perform sampling of ambient populations of either fish or ichthyoplankton. This decision is driven by four factors:

- The candidate compliance alternatives can be developed without ambient data. We believe that the effectiveness of in-place or planned mitigation measures can be estimated based on a weight-of-evidence approach. Our analysis will include an assessment of the feasibility and cost-effectiveness of alternative measures. Data on the actual rates of impingement mortality and entrainment potentially necessary to support the estimation of monetized benefits of mitigation measures or the extent of restoration measures will be collected;

- Ambient population densities of fish are a poor predictor of impingement rates. Fish species vary dramatically in their susceptibility to impingement. Schooling fish that live in the water column tend to be more vulnerable than bottom-dwellers, as are fish that are relatively slow swimmers. Fish that tend to orient their travel parallel to water flow (i.e., grunion during spawning episodes) are likely to be more susceptible than other species. Smaller fish, even within a given species, tend to be weaker swimmers and may be impinged more readily. Thus, a comprehensive sample of the fishery population in a given area may say little about the number or type of organisms susceptible to impingement. This is a important issue for the concept of the Calculation Baseline as defined by the Rule.

- The Channel Island Harbor is essentially man-made habitat and the community that resides there has developed during the operation of the CWIS. For this reason, impingement mortality and entrainment of harbor-residents should be discounted when considering the Calculation Baseline as well as any impacts of the CWIS; and

- Ambient densities of fish, shellfish, and ichthyoplankton are highly variable in time and in space limiting their utility in supporting the Calculation Baseline. Rates of impingement have been observed to vary dramatically at Mandalay and similar variation is likely in rates of entrainment. Much of this variation is due to variation in the ambient conditions including on a relatively fine time or space scale. For example, movement of large schools of fish, including their movement into the harbor and their encountering the area proximal to the CWIS, may have a quasi-random nature. Such variation may overwhelm changes that might occur with installation of mitigation measures. This is illustrated by the fact that the Rule calls for reductions in impingement mortality by 80 to 95% yet the variation in impingement rates without a change in technology may be two orders of magnitude or more. In short, defining changes relative to the Calculation Baseline based on biological data is likely to be fraught with uncertainties and may lead to an ambiguous compliance status.

APPENDIX A

TECHNOLOGY REVIEW

APPENDIX A

TECHNOLOGY REVIEW

General Technology Overview

This section provides a general review of a comprehensive list of potential mitigation methods to reduce impingement mortality and entrainment. The nature of the technology is briefly reviewed and its approximate costs[1] are presented. The effectiveness under the conditions at the Reliant plant is discussed and factors affecting performance, reliability, and other environmental issues are reviewed. In addition to CWIS technologies, plant operation and restoration measures are considered.

The following list of CWIS alternatives have been evaluated in this screening assessment:

Alternative 1 - Traveling Screen Modifications
- 1a - Dual Flow Screens (Impingement)
- 1b - Ristroph Screens (Impingement)
- 1c - Fine Mesh Screens (Impingement and Entrainment)
- 1d - Angled and modular inclined screens (Impingement)

Alternative 2 – Fixed Screening Devices
- 2a - Wedgewire Screens (Impingement and possibly entrainment)
- 2b - Perforated Pipes (Impingement)
- 2c – Barrier Net (Impingement)
- 2d – Aquatic Filter Barrier (Impingement and Entrainment)
- 2e – Porous Dike/Leaky Dam (Impingement and Entrainment)

Alternative 3 - Offshore Intake (Impingement and Entrainment)

Alternative 4 – Fish Diversion and Avoidance
- 4a – Louvers and Bar Racks (Impingement)
- 4b – Velocity Cap (Impingement)
- 4c – Strobe lights, acoustic deterrent, bubbles, chains (Impingement)

[1] This report presents estimates of the capital costs of potential mitigation measures as a means of illustrating their potential cost-effectiveness. The estimates should be considered approximate and final costs may vary by as much as factor of two or more. Cost estimates for mitigation measures do not account for facility down-time associated with construction nor operation/maintenance. These costs will be estimated with input from Entergy and included in the final CDS document especially in the information to support the Site-specific BTA. Costs will be annualized according the procedures defined in the rule.

Alternative 5 – Flow Reduction

- 5a - Variable Speed Pumps (Impingement and Entrainment)
- 5b - Capacity Factor Reduction (Impingement and Entrainment)
- 5c - Evaporative Cooling Towers (Impingement and Entrainment)
- 5d - Dry Cooling (Impingement and Entrainment)

Alternative 6 – Restoration (Impingement and Entrainment)

Table A-1 provides a brief review of ENSR's findings relative to the various technologies. The findings are supported by a more detailed evaluation below.

Alternative 1 - Traveling Screen Modifications with Fish Removal and Return System

– ***1a - Dual Flow Screens***

Description:

This discussion evaluates the Beaudry-type dual-flow screen system, which is commonly used for new or retrofit applications. With dual-flow, single-exit screen, incoming water is filtered with both the upward and downward moving parts of the screen, and the water flows toward the pump from the interior through the open side of the screen. The screen faces are oriented parallel to the direction of flow. If space is available, the screen length can be extended outward such that the area of the screens can be greater than the area of a conventional flow-through screen in the same location. Therefore, the dual-flow design has the potential to reduce through-screen velocity compared to flow-through (single entry, single exit) design.

The dual-flow design also provides an advantage of eliminating the potential for debris that is stuck on the screen to be dislodged on the downstream side of the screen. This feature may have the added benefit of lower wash water pressure requirements depending on the configuration.

Technical Feasibility and Reliability:

For retrofit applications, the space available to install may be limited by the existing structure (trash racks upstream and pump vault downstream) and water body constraints (navigation). Such limitations would limit the ability to increase screen surface area, thereby limiting the ability to reduce through-screen velocity.

Hydraulic issues with a dual-flow screen are commonly encountered. One of the common limitations is the flow disruption that is caused by the two 90-degree turns that cooling water must undergo to pass through the system. These issues can be minimized (but not eliminated) by proper hydraulic analysis and design.

Dual flow screen are commercially available and have been in use for years.

For the site-specific evaluations, the dual-flow screens with conventional mesh are assumed to provide adequate screen area to reduce through-screen velocity to 0.5 feet per second (ft/s). Otherwise, there would be no advantage to changing from a through-flow screen to a dual-flow screen. In some cases, the required screen area may result in the need for additional new intake structures to accommodate the screens.

Cost Considerations:

The cost of dual-flow screens is expected to be up to 20% higher than comparable through-flow screens.

Effectiveness:

Dual-flow screens have the potential to reduce through-screen velocities and therefore impingement mortality, with the addition of an appropriate fish handling and return system. However, depending on the proximity of other screens and structures, the full screen area may not be effectively used, and through-screen velocities on parts of the screen may be substantially higher than design, thereby reducing the potential to reduce impingement. In fact, if dual-flow screens are placed in relatively narrow intake bays, the approach velocity to the screen will likely increase and the impingement rate could increase. In general, space constraints would limit effective application of this technology.

Potential for Other Adverse Effects:

An intake structure that is reconstructed to accommodate a larger dual-flow screen may interfere with navigation.

Overall Assessment of Alternative:

Installation of dual-flow screens could result in a reduction of impingement mortality but would not reduce entrainment. Site-specific constraints may limit effectiveness of this technology to reduce through-screen velocity.

- ***1b - Ristroph Screens***

Description:

This alternative would involve modification of the traveling screens so that fish which are impinged on the screens could be removed and returned to the source water body with minimal stress and mortality.

A range of measures could be pursued to optimize fish handling and return. This might include more frequent rotation of the screens, re-fitting the screen with fish buckets, institution of low-pressure wash, replacement of the fish return trough, and rerouting of the fish return to a more suitable location. A complete refurbishment might consist of the following measures: A low-pressure spray would be used for fish removal prior to the high-pressure debris removal spray wash. Fish would be carried in fish buckets – i.e. water-filled lifting buckets designed such that they will hold approximately 2 inches of water once they have cleared the surface of the water during the normal rotation of the traveling screens. The fish bucket would be designed to hold the fish in water until the screen reaches the point where the fish are washed by the low pressure spray onto a sluiceway. The modified traveling screens would be operated continuously during periods when fish are being impinged. Removed fish would be returned to the source water body by a sluiceway wide a smooth surface and sides that retain water such that organisms are gently returned to a location removed at least 100 feet from the intake structure such that the potential for re-impingement would be minimized. All surfaces of the fish handling and return system would be smooth to minimize abrasion damage to organisms.

Technical Feasibility and Reliability:

The technology proposed for this alternative is well known and has been implemented for numerous power plants. However, a separate collection and piping system may need to be constructed to provide a separate return path for fish to the river or lake. This piping system would have to be constructed within the existing power plant footprint which could present engineering, construction, and logistics problems. Routine maintenance, primarily consisting of inspection and cleaning of the fish handing and return system, would be required but not expected to be extensive. Maintaining the system during icing conditions is likely to be complicated. The modified fish troughs extend farther out from the screens than conventional troughs. Therefore, space limitations may affect the cost and feasibility of installation.

Cost Considerations:

The retrofit of a fish removal and return system should consider complete replacement of the existing traveling screens. Installation of an effective fish return system can be complex and expensive. Operation and maintenance activities include frequent, if not continuous, screen operation and power costs for screen and water spray operation.

Effectiveness:

Modified screens and fish handling and return systems have been used to minimize impingement mortality at a wide number of plants throughout the United States. Studies have demonstrated survival of impinged fish over a wide range. Survival rates of 70-80% are typically achieved for some species. It is notable that many small schooling species (e.g., anchovies) suffer from high mortality at traveling screens, even those with Ristroph-type modifications.

Potential for Other Adverse Effects:

No adverse effects are expected from this alternative.

Overall Assessment of Alternative:

Modification to traveling screens would likely result in a reduction of impingement mortality and would not reduce entrainment.

- ***1c - Fine Mesh Traveling Screens***

Description:

Typical vertical traveling screens, with mesh sizes ranging from 1/8-inch to ¾-inch, are not designed to screen ichthyoplankton or eggs from the intake water. This alternative would involve replacement of the existing traveling screens with fine mesh screens having mesh spacing as small as one millimeter. This mesh spacing would result in a reduction of entrainment of fish eggs and larvae. In addition, an intake approach velocity of 0.5 ft/s or less would be necessary to minimize physical damage to plankton that would be impinged on the fine mesh screens.

Because of flow area for a screen with one-mm (about 1/32-inch) mesh is approximately two thirds that of a 3/8-inch mesh, the screen area would have to be increased by nearly 50% to maintain the same through-screen velocity. For most plants, the screen area would have to be further increased to maintain a 0.5 ft/s velocity to reduce mortality of impinged fish or shellfish. In most cases, the area around the existing pump house/screen house structure is not sufficient to allow for the increased number of fine mesh screens without substantial modification to the plants. The screens would be operated continuously to prevent excessive accumulation of debris and organisms.

The fine mesh screen structure would include curtain walls to protect against floating debris, bar racks to prevent submerged debris from damaging the fine mesh screens, and a screen wash and marine biota removal and open sluice biota return system (similar to that described for the Ristroph screen).

Technical Feasibility/Reliability:

The technology and construction techniques required for this option have been used at a limited number of power plants, often with limited reliability. At two power plants, Millstone and Brayton Point, the fine mesh screens were replaced with standard screen mesh after clogging incidents. Based on the available information, it is concluded that there is a relatively high potential for fouling of the intake screens and that extensive maintenance would likely be required.

In conclusion, because of the potentially large increase in screen area required, site-specific conditions may preclude the installation of a modified intake structure of sufficient size.

Cost Considerations:

The capital cost of the fine mesh screen alternative should include any necessary modifications to the intake structure, as well as construction of an effective fish return system to handle the more sensitive species or life stages of fish and shellfish. Operation and maintenance costs include one maintenance episode (6 days) each year, replacement parts, system monitoring by plant staff (10 hours per week), and power costs.

Effectiveness:

Fine mesh screens, with a low pressure wash and return system, have not been demonstrated to result in consistent effectiveness in reducing mortality at early life stages. This is a significant concern because organisms that are entrained and discharged may have a far greater chance of survival than if such organisms are impinged and subsequently washed back to the receiving water. Therefore, even though entrainment reductions of 50% to over 90% have been achieved at number of power plants using fine mesh screens, compliance with the impingement mortality performance standard could be in jeopardy. Because the calculation baseline levels of entrained organisms are typically far greater than the levels of impinged organisms, the reduction in impingement mortality will likely need to be nearly 100% for the early life stages to meet the 80-95% performance standard.

Potential for Other Adverse Effects:

The major potential adverse effect associated with the technology is the potential unreliability of the cooling water flow associated with clogging events.

Overall Assessment of Alternative:

Fine mesh screens can meet performance requirements for entrainment, but impose a relatively high potential for operational issues associated with screen clogging. Mortality of ichthyoplankton removed from the screens is likely to be high. The cost of the screen panels, as well as the cost of a revamped intake structure to accommodate the additional screen area required, is extremely high. Space limitations may preclude the installation of adequate screen area.

- ***1d - Angled and Modular Inclined Screens***

Description:

Angled and inclined screens use standard flow-through traveling screens set at an angle to the incoming flow. With these screens, the angle causes the fish to move toward the end of the screen, where a bypass facility returns the fish to the water body.

Technical Feasibility/Reliability

Angled screens have been used at Brayton Point. The installation requires considerably more space than conventional screens. Retrofit applications would likely require substantial modifications to the existing intake structure. The fish handling and return system requires independently induced flow, adding to the complexity of the system.

Cost Considerations:

Retrofit of angled or inclined screens should include the need to revamp the intake structure, as well as the installation of an effective fish return system.

Effectiveness:

Brayton Point has had mixed results with both diversion and latent survival, depending on fish species. EPA reports survival efficiency ranging from 0.1% for bay anchovy to 97% for tautog. The difference in effectiveness between angled screens and conventional screens with fish return is not evident.

Potential for Other Adverse Effects:

The bypass flow can be substantial, resulting in additional operating costs.

Overall Assessment of Alternative:

Angled or inclined screens are in limited use. Although they may be effective in reducing impingement mortality, it is not clear whether their performance differs from a conventional screen. Because there is no apparent advantage, angled or inclined screens are not considered further in this analysis.

Alternative 2 – Fixed Screening Devices

- ***2a – Wedgewire Screens***

Description:

Wedgewire screen is constructed of wire of triangular cross section such that the surface of the screen is smooth while the screen openings widen inwards. Fine mesh screens have slot spacing of less than 9.5 mm (3/8 inch) and are typically less than 3 mm. Slot size for coarse mesh screens is 9.5 mm or greater. The cylindrical screen design has been used at several power plant applications. However, most of these applications have been for closed-cycle cooling systems.

A typical installation would include an array of tee shaped cylindrical screens. If 1-mm slot size were required, a plant with a 500 MGD cooling water flow would require approximately 15 7-foot diameter by 23-foot long screens. The screens would be placed in the intake water body at a depth such that it would not present a hazard to navigation.

The screens would be cleaned periodically with an automatic compressed air system when located near shore. A large plenum structure would be added to the front of the intake structure to distribute the flow from the intake array. The existing intake structure would remain intact and functional. It could be used as a backup to the wedgewire screen system. The plenum structure would have openings that would allow flow to pass in case of screen clogging. Alternatively, wedgewire screen must be sized to minimize clogging and is subject to periodic manual cleaning.

For far-offshore applications, a compressed air cleaning system is not practical. Under such conditions, the reliability of fine mesh screens is highly uncertain due to debris loading as well as fouling with in situ growth. Therefore, in these circumstances, only coarse mesh wedgewire screens should be considered.

Technical Feasibility/Reliability:

Wedgewire screens have been widely used for hydropower diversion structures. The cylindrical screen structures have been used successfully for many years for water withdrawals up to 100,000 gpm. Withdrawals of larger quantities are rare. The wedgewire cylindrical screens have been implemented at only two relatively large power plants with once-through cooling systems: Campbell Unit 3 on Lake Michigan, and Eddystone Unit 1 on the Delaware River. The high number of wedgewire screens required for many plants is higher than has been previously used and likely poses impractical logistical issues associated with placement in an off-shore environment.

The long-term reliability of the wedgewire screens of the one-millimeter size is unknown. Although some vendors have proposed construction materials which would prevent mussel or other biological growth on the screens, the requirements for biofouling control are uncertain and differential pressures across the screens could create substantial unit reliability issues. The automatic back flushing would reduce screen fouling from both biological growth and suspended particulate matter. However, to be effective for screen cleaning, this system requires an ambient current to transport the removed particles from the vicinity of the screens. In waters with minimal current, debris accumulation may be excessive and backwashing ineffective. Small or negligible currents in the intake water body could make wedgewire screens impractical, especially fine-mesh screens.

In addition, if the screens were to be located at a distance from the shore, considerable length of large diameter piping would be necessary to connect the screens to the existing cooling water system. Installation of such a system will result in significant cost as well as potential disruption of the site and the waterbody.

Cost:

The cost for the wedgewire screen alternative should consider the distance offshore, needed piping, and air-burst cleaning system. Operation and maintenance costs include two maintenance dives (6 days each) each year, replacement parts, and system monitoring by plant staff (10 hours per week).

Effectiveness:

Wedgewire screens have been demonstrated to essentially eliminate impingement and, for smaller slot sizes, reduce larval entrainment. The 1-mm slot size has been demonstrated to reduce entrainment by over 80 percent at some plants. However, achievement of such results is dependent on the presence of relatively high ambient currents that can sweep the plankton along past the screens.

Potential for Other Adverse Effects:

The primary adverse effect associated with this alternative is the potential for obstruction to navigation caused by multiple submerged structures in the waterbody near the plant. In addition, the presence of rock rip-rap around a large number of screen structures can result in a “reef effect,” causing the fish population density to increase in the vicinity of the screen structure. This phenomenon is more likely in cases where there is very little spawning habitat near the intake location. As previously mentioned, the engineering requirements for biofouling control are uncertain and differential pressures across the screens could cause cavitation of circulating water pumps creating substantial unit reliability issues.

Overall Assessment of Alternative:

Wedgewire screens have the potential for clogging and interference with navigation. Without adequate sweeping velocity, a small enough slot size to reduce entrainment is not recommended. The cost of this alternative is high and is strongly dependent on the number of screens needed and the length of new pipeline construction needed to interconnect all of the screens and to build a common tunnel to the shoreline.

– ***2b – Perforated Pipes***

Description:

With perforated pipes, water is drawn through perforations or slots in a pipe located in the waterbody. EPA included this technology in its discussion of intake technologies. However, perforated pipes have been used only in small water withdrawal applications. It is also subject to clogging and fouling. It is also similar in principal to wedgewire screens. Therefore, this technology alternative will not be discussed further.

– ***2c - Barrier Nets***

Barrier nets are wide-mesh nets that are placed in front of the intake structure entrance. The nets are sized to prevent the fish to pass through, and low velocities are maintained at the net to allow affected fish to swim away. Barrier nets would be mounted on a frame that would allow ease of cleaning or replacement.

Technical Feasibility and Reliability:

Barrier net systems involve technologies that are in widespread in freshwater systems but less so in marine settings. Construction techniques that would be used for these systems are commonplace but would have to be engineered to withstand wave and current energies. Maintenance requirements, include routine cleaning of debris and/or net replacement, are far higher in marine settings than in freshwater ones. Finally, placement of a barrier net at the intake has the potential to adversely affect boat traffic. Placement typically involves suspension from existing pylons or walls. Creation of a new set of anchors, etc. will complicate installation and increase costs.

Cost Considerations:

For typical power plants, the estimated capital cost for installation of barrier nets is $0.5M to $1.5M. The estimated operation and maintenance cost is approximately $50,000 per year for freshwater deployments. Operation and maintenance costs include monthly change out and deployment and removal.

Effectiveness:

Barrier nets have been shown to be effective for impingement reduction at a number of plants, and greater than 90% reduction in impingement has been realized at a number of plants. However, they are not effective in deterring fish eggs and larvae, or other planktonic organisms. There is the potential for clogging with debris; hence a routine cleaning operation is essential. Adequate area to allow low through net velocity (<0.5 ft/s, often <0.1 fps) is important to prevent clogging and collapse.

Potential for Other Adverse Effects:

This alternative could pose limitations on navigation in the vicinity of the intake.

Overall Assessment of Alternative:

There have been a number of positive experiences with barrier nets for reduction in impingement, and the cost is very low compared to other technologies. Barrier nets will not address entrainment, routine cleaning is essential, and removal during the winter is necessary to avoid serious damage to the nets.

– ***2d - Aquatic Filter Barrier System***

Description:

Aquatic filter barrier systems are designed to completely enclose an existing intake structure and essentially filter the water drawn through the fabric to the intake structure. The best known manufacturer of aquatic filter fabric systems for power plant intake applications is Gunderboom. The Gunderboom system is a double panel, full water depth fabric curtain suspended from flotation billets at the water surface and secured in place by an anchoring system. The system includes mooring lines, ballast chain, anchoring system and an automated compressed air cleaning system. Automatic alarms and monitors may be installed in an appropriate control room to monitor the fabric alignment and system operation.

The standard design hydraulic loading rate of the Gunderboom fabric is 3-5 gpm per square foot with a generally recommended maximum range of 10-12 gpm per square foot. At the recommended design hydraulic loading and an assumed water depth of 15 feet, a length of fabric of more than one mile would be required for a 500 MGD cooling water flow. Therefore at a minimum, this alternative would require that a large area around the intake structure be encompassed by the fabric for most large power plants with once-through cooling.

Technical Feasibility/Reliability:

The technology and construction techniques required for this option have been fully implemented only at the Lovett Power Plant in New York State. Clogging of the Gunderboom is a routine maintenance issue. The length of fabric required would encompass a large area around an intake structure. Aquatic filter barriers are not likely to stand up to high energy environments such as those offshore of the California coast. Fouling and impacts of debris are also likely to be an issue.

Cost Considerations:

The estimated capital cost of the Gunderboom alternative is high compared to other near-shore technologies. The operation and maintenance costs include the mobilization and installation/ demobilization and removal of the system each year. They also include regular underwater inspections of the filter curtain each month and one thorough underwater inspection each year.

Effectiveness:

Aquatic filter barriers have been demonstrated to be effective in substantially reducing larvae entrainment and fish impingement losses at power plant intakes on the Hudson River. As a result, the New York State DEC is a strong advocate of this technology for entrainment and impingement reduction. However, clogging and ambient conditions can increase the risk of fabric failure, rendering the system ineffective.

Potential for Other Adverse Effects:

Because this aquatic filter barrier application would require closing off much of the waterbody near the plant, marine navigation would be restricted. The potential for aquatic organisms to be impinged in the fabric is a concern.

Overall Assessment of Alternative:

Based on the logistical and potential navigation issues associated with the extensive area of the waterbody that would be encompassed by the aquatic filter fabric, and operational issues associated with potential clogging of the fabric, it is not likely that this alternative would be practical in any once-through application with large flow rates.

– ***2e - Porous Dams/Leaky Dikes***

Description:

Porous dams, also known as leaky dams or leaky dikes, are filters constructed of stones surrounding the cooling water intake. The core of the dike is composed of gravel or stone which allows water to be drawn through it. The exterior of the dike is armored with larger rocks. The dam serves as a behavioral and physical barrier to aquatic organisms. The reduced flow rate across the full face of the dam greatly reduces impingement; however, “hot spots” of high velocity may be present in local areas of high porosity, and its effectiveness in screening fish eggs and larvae is not well established.

Technical Feasibility and Reliability:

Because of its size, a porous dam constructed around an intake structure may not be practical in waterbodies of limited size, because of potential impacts to navigation.

Cost Considerations:

Because of its large size, a large part of the capital cost of a porous dam is materials (stone and gravel). Operation and maintenance would include routine maintenance and potentially heavy cleaning or dredging every five years.

Effectiveness:

If the surface area is sufficiently large, the porous dam intake structure could result in a lower impingement rate, but may not decrease the entrainment rate. The porous dam would decrease impingement due to low intake velocity across the dam face and the physical barrier created by the stones used in the dam. The dam structure would need to be located such that its construction does not impact known spawning beds. The presence of the stone could create spawning areas where there were none and could actually serve to increase entrainment. Alternatively, potential spawning areas created by the porous dam may act as a restoration measure and increase the production of fish in the water body.

Potential for Other Adverse Effects:

Significant biofouling could be expected due to algae, aquatic weeds (e.g., watermilfoil), and zebra mussel. Biofouling of the porous dam would reduce plant cooling water intake rate. The size of the porous dam is large, and its construction has the potential to damage fish spawning areas. In smaller waterbodies, a dam of sufficient size to effectively reduce intake velocity could impede marine navigation.

Overall Assessment of Alternative:

A porous dam will likely be effective for reduction in impingement if designed for low intake velocity. Entrainment performance is uncertain. Reliability of water flow is uncertain because of the potential for fouling.

Alternative 3 - Submerged Offshore Intake Structure

Description:

An offshore intake structure alternative would consist of a structure with velocity cap (or other technology such as wooden cribs or wedgewire screens), and a single pipeline into the plant. The size of the structures would be designed to achieve a nominal intake velocity of 0.5 ft/s. The velocity cap on the structure provides horizontal flow that reduces the potential for fish impingement. The intake structures would be located in the water body at a water depth of at least 20 feet. The intake pipeline would be placed by either trenching or tunneling.

Technical Feasibility/Reliability:

The technology and construction techniques required for installation of submerged intake structures are well known and understood. Submerged intakes have been constructed at several plants and have been shown to be reliable in the long term. Considerations for designing and constructing the alternative include (1) technology associated with sub-surface placement of the pipe and potential impacts to the bottom along pipeline route, (2) the length of pipeline needed to reach sufficient depth, (3) prevention of fouling on the structure, (4) the potential for adverse impacts due to debris, and (5) the need to avoid obstruction of navigable waters.

Another technical consideration for the offshore intake structure alternative is that the intake water could have a reduced temperature which would potentially improve power plant performance.

Cost Considerations:

The estimated capital cost of submerged offshore intake is highly dependent on the length of new pipeline needed. One 6-day dive per year would be required for maintenance.

Effectiveness:

The offshore intake structures could result in a lower impingement rate if designed with low intake velocity and velocity cap. Suitable placement of the intake off-shore may reduce the density of eggs and larvae subject to entrainment relative to an on-shore location. The intake structure construction could impact spawning beds. The presence of the intake structure and associated anchor stone and rip-rap could create new spawning areas that did not previously exist and could actually act to increase entrainment.

Overall Assessment of Alternative:

The submerged offshore intake has the potential for reducing impingement and entrainment, if the intake can be located where the density of eggs and larvae is low. Cost is high, and will depend on the required distance offshore. However, potentially cooler intake water temperature may improve power plant performance.

Alternative 4 – Fish Diversion and Avoidance

- ***4a – Louvers and Angled Bar Racks***

Description:

Diversion devices are physical structures intended to guide fish away from and out of the intake flow. Examples of such devices include angled bar racks and louvers, which are made of a series of evenly spaced, vertical slats placed across a channel at an angle leading to a bypass area. The louvers create localized turbulence that the fish detect and avoid. The louver systems have been tested at hydroelectric plants on rivers.

Typically, angled bar racks and louvers would be in semicircular fashion around a shoreline intake or placed across the mouth of an intake canal. Louvers would be constructed of material compatible with the environment (for example, polyethylene slats for louvers and nylon for nets), and would be mounted on a stainless steel frame, approximately 12 inches apart.

Technical Feasibility/Reliability:

Louver systems involve technologies that are in widespread use. Construction techniques that would be used for these systems are commonplace. Maintenance requirements could be potentially extensive. Divers will likely be required to routinely clean and/or replace the bar racks or louvers. The potential for damage and clogging from debris is real. Finally, placement of a louver at the intake has the potential to adversely affect boat traffic.

Cost Considerations:

The capital cost for installation of louvers should include consideration for debris loading and damage. Operation and maintenance costs include two 6-day dives per year to clean and maintain the louvers.

Potential Effectiveness:

These diversion devices are not effective in deterring fish eggs and larvae, or other planktonic organisms. Louvers have been tested only in rivers with a substantial current velocity along the bank. They are most effective in diverting migratory fish from intakes in confined river channels, and therefore would be less effective in lakeside applications.

Potential for Other Adverse Effects:

This alternative could pose limitations on navigation in the vicinity of the intake.

Overall Assessment of Alternative:

Louvers/bar racks can effectively reduce impingement of some species of fish, but would not be effective for reducing entrainment. This technology would be effective only with an ambient current. This alternative has relatively high probability of clogging associated with debris, and biological growth and in some settings could impact navigation.

- ***4b – Velocity Caps (installed on existing offshore intake)***

Description:

A velocity cap is a cover placed on a vertical inlet of an offshore intake structure. The cover results in a horizontal flow to the intake, and may reduce impingement because fish tend to avoid rapid changes in horizontal flow. Intake velocities of 0.5 to 1.5 ft/s are common.

Technical Feasibility/Reliability:

Installation of a velocity cap on an existing offshore intake may be limited because of water depth and potential interference with navigation. For some applications, a velocity cap may require routine inspection and maintenance to remove accumulated debris.

Cost Considerations:

Costs of installation of a velocity cap on an existing offshore intake should consider intake modifications and materials of construction.

Potential Effectiveness:

Although velocity caps in new offshore intakes have been shown to result in reduced impingement, it is uncertain whether the reported reductions are due to the velocity caps or the new offshore locations. Velocity caps should be designed to minimize intake velocity through the intake structure openings; a maximum intake velocity of 0.5 feet per second should be considered to meet the Phase II intake velocity threshold. In some cases, additional measures (e.g. intake screen improvements, deterrent systems) may be needed to meet impingement performance goals. Velocity caps have no impact on entrainment, although the off-shore location may result in lower entrainment levels compared to an on-shore calculation baseline intake configuration.

Potential for Other Adverse Effects:

The addition of a velocity cap to an existing intake may interfere with navigation.

Overall Assessment of Alternative:

Velocity caps may reduce impingement, but have no effect on entrainment. If the maximum intake velocity is 0.5 feet per second, the Phase II velocity threshold in Compliance Option 1(ii) would be met. As noted above, the offshore location may result in compliance with the entrainment reduction standard.

– ***4c - Strobe Lights, Acoustic Deterrent, Bubbles, Chains***

General Description:

Behavioral barriers are intended to cause fish to actively avoid entry into the intake flow. Examples include sound barriers, light barriers, air bubble curtains, chains and cables, and electrical barriers. They are often implemented in combination with other devices such as physical barriers (e.g., fish nets). The potential behavioral barriers are briefly described below.

Sound barriers consist of devices located at the intake structure, which create sound that repels the fish. Three types of underwater sound have been tested for this application: low-frequency infra-wave sound, low-frequency sound generated by pneumatic/mechanical devices, and transducer-generated sound covering a wide range of frequencies. Low frequency, high-intensity devices have been shown to be effective. High frequency (125 kHz) devices have been reported to be effective in the Great Lakes. Pneumatic impact devices, "poppers", and "hammers" are examples of devices that have been effective in reducing impingement of some fish such as alewife at power plant intakes. There is some concern that pressure waves from pneumatic devices may be harmful to nearby organisms. In most cases, the use of high-intensity, multi-frequency sound has not been effective in repelling a wide range of fish species from intakes due to the diversity of species and sizes of species in the receiving water.

Light barriers consist of a series of underwater lamps that emit a constant or intermittent (strobe) beam of light. The effectiveness of light barriers as a deterrent has been variable, and even contradictory, in many studies. In some studies fish have been attracted to light while in others they have been repelled. Constant light has been more effective than strobe light in guiding young salmon whereas strobe light has been effective in repelling alewife and gizzard shad. Filtered mercury vapor light has been found to attract certain species of fish away from strobe lights in field studies in Europe. At the Nanticoke Generating Plant on Lake Ontario, smelt, shad, white bass and shiner have been successfully guided away from intake trash racks using mercury vapor light. However, evidence of consistently reliable effectiveness for a wide range of fish species does not exist.

Air bubble curtains or screens consist of a series of diffuser pipes mounted on the base of the intake structure. The diffusers create a continuous, dense curtain of bubbles, which can repel fish. Generally, the air bubble screens have not been successful. They are not effective at night and in turbid water. In one case, at Indian Point Generating Plant on the Hudson River, the air bubble screen actually attracted fish at night.

Chains or cables can be hung vertically from the top of the intake structure to form a physical, visible barrier to fish. The results of studies of this behavioral barrier have been contradictory. The effectiveness of chain barriers is dependent on flow velocity, turbidity and illumination. Debris buildup on hanging chains can disrupt hydraulic flow patterns at the intake.

Electrical barriers consist of a series of electrodes at either side of the intake structure. These barriers have had limited success and can present a safety threat.

Technical Feasibility/Reliability:

All of the behavioral barrier systems are technically feasible and reliable from the perspective of construction, operation, and maintenance. The behavioral barrier systems that have been implemented with the greatest frequency are sound and light barrier type systems. Each of these potential alternatives would consist of a metal support structure constructed at the front of the intake, sound or light emitting devices mounted on the supports, a power supply, controllers, power cables and mounting hardware. The construction and technology used for these alternatives have been regularly applied. To ensure long-term reliability of these systems, ongoing maintenance will be required. Maintenance of the systems would include cleaning and replacement of light bulbs (for light barrier systems) and prevention of corrosion of the supporting structure.

Cost:

The estimated capital cost of behavioral barriers (e.g. a strobe light barrier system) is generally lower than other technologies. Operation and maintenance costs include items such as the replacement of strobe lights each year using divers, and 10 hours per week of on-site monitoring by plant staff. Costs for other behavioral barrier systems would be similar.

Effectiveness:

Because these barriers rely on the ability of the organism to respond to a stimulus, they are not effective in protecting fish eggs and larvae, or other planktonic organisms. In addition, the effectiveness of these barriers varies among species and across age groups within species. These barriers are most effective when a single species of fish of the same size and age is to be protected. Many the behavioral barriers have not been field-tested so their effectiveness has been extrapolated from laboratory studies. None of these devices has been demonstrated to be consistently reliable in obtaining an avoidance response from a wide range of fish species. Therefore, installation of behavioral barriers would not result in reduction of entrainment, and a reduction in impingement is possible but uncertain.

Potential for Other Adverse Effects:

A potential adverse effect of the behavioral barrier alternative is a slight potential for increased attraction of fish to the intake structure. Also, any structure installed near the intake has the potential to disrupt navigation.

Overall Assessment of Alternative:

Behavioral barrier technology will not reduce entrainment. However, the technology may effectively divert specific fish species and therefore could be a component of an overall impingement mortality reduction. Based on site- and species-specific variation in response, pilot testing is likely to be necessary.

Alternative 5 - Flow Reduction

– ***5a - Variable Speed Pumps***

Description:

Variable speed cooling water intake pumps are potentially useful for reducing cooling water flow and the associated entrainment and impingement during peak periods of biological activity. The decrease in cooling water flow results in an increase in plant condenser ΔT (temperature increase through the condenser) and discharge temperature. Therefore, variable speed pumps are most appropriate during cold water periods of the year (winter and spring) in temperate climates where an increase in discharge temperature will not cause a significant increase in biological effects or cause discharge temperatures in excess of maximum acceptable levels.

For other plants, this alternative was considered with the assumption that variable speed pumps would be installed to decrease the cooling water flow by 25% during periods of potentially high entrainment and impingement. This alternative would require replacement of existing single speed drives with adjustable speed drives (ASD) on the circulating water pumps. An on-line condenser tube cleaning system is included in this alternative to alleviate tube fouling which could potentially occur because of lower water flow rates.

Technical Feasibility and Reliability:

The replacement of the existing single speed drives with ASDs is a technically feasible and reliable alternative. However, under full power production conditions using the existing condensers for the units, this alternative, specifically a 25% reduction in flow, could reduce the reliability and efficiency of the entire system. Specifically, the reduction in flow through the condensers could cause operational difficulties (i.e, condenser tube fouling), cause decreased thermal efficiency in the turbines, limit or reduce maximum power production, require condenser replacement, and alter the thermal plume effects at the discharge.

Cost:

The estimated capital cost of the variable speed pump alternative is $0.5M per cooling water pump. This capital cost assumes that replacement of the existing condensers would not be required. Operation and maintenance costs are difficult to estimate without input from the individual plants regarding thermal efficiency as well as market rates. It should be noted that costs associated with loss of thermal efficiency are likely to be partially offset by the gain in not operating the pumps at full capacity. This cost assumes that the plant could be operated at full capacity during reduced cooling water flow.

Effectiveness:

The use of variable speed pumps to decrease the flow of cooling water through the intake would effectively reduce the entrainment and impingement in the system; however, the resulting increase in temperature in the discharge could increase thermal plume effects. The alternative would amount to a relatively small reduction in flow – and corresponding reduction in impingement and entrainment effects – of approximately 25% for the entire plant during periods of time when the ASDs are in operation. Since the ASDs would not be used during the entire year, the overall reduction in impingement and entrainment would be substantially less than 25%.

Potential for Other Adverse Effects:

As noted above, reduction in cooling water flow during normal plant output would result in an increased discharge ΔT value which could, in turn, cause altered thermal plume effects.

Overall Assessment of Alternative:

By itself, this alternative will not likely achieve performance goals for impingement and entrainment reduction. However, it may be considered as one component of an overall compliance.

– ***5b – Capacity Factor Reduction***

Description:

A power plant can reduce impingement and entrainment by reducing cooling water requirements through reduced capacity factor of the plant. This approach would require a commitment on the part of the plant to limit cooling water flow to a level below the design flow rate. Unless a very low capacity factor is intended, this approach will likely be used in conjunction with other technologies to meet performance goals.

There is the potential that regulatory agencies will limit the applicability of this approach for plants with historically low capacity factor. Although the calculation baseline is based on design capacity, the commitment to set a capacity factor limit by a plant with historically low capacity factor may be viewed as an inappropriate approach to meeting the performance goals unless a restriction is included in the plant NPDES permit.

Technical Feasibility and Reliability:

Reduced water flow rate will limit the power production rate based on thermodynamics as well as the thermal discharge limits for the plant.

Cost Considerations:

Reduction on capacity of a plant will have very large financial impact on the ability of a plant to generate revenue. The capital cost to implement this approach could involve installation of equipment to limit operations; however, recordkeeping may be all that would be required to demonstrate the flow reduction achieved.

Effectiveness:

A capacity factor reduction and resulting reduced flow rate should at least reduce impingement and entrainment in proportion to flow reduction. Seasonal differences in density of aquatic life would need to be considered to determine the overall annual reductions in impingement and entrainment from the calculation baseline.

Potential for Other Adverse Effects:

This approach reduces power generation capacity, which would have to be made up elsewhere.

Overall Assessment of Alternative:

If acceptable to the regulating agencies, this alternative may be an important component of a well balanced compliance program.

– ***5c - Evaporative Cooling Towers***

Description:

The existing cooling water systems use of seawater pumped through a steam condenser and discharged back to the source water body. These systems are generally referred to as open cycle or once-through cooling system because the water simply passes through the condenser (no recirculation) where heat is transferred from the steam to the cooling water prior to discharge. Closed cycle systems recirculate the cooling water in a closed piping system. The heated water from the condenser is cooled down in each cycle using evaporative cooling. This cooled water is then recirculated to the condenser to cool and condense the steam from the turbine. In the mechanical draft-cooling tower, fans are used to circulate air that flows against the heated water sprayed inside the tower. Cooled water is collected in the tower basin and returned to the condenser. Water must be introduced into the system at regular intervals to make up for losses due to blowdown and evaporation. The closed cycle evaporative cooling systems require a water withdrawal rate that is about 3 to 5% of the amount of water required in once-through cooling systems.

The makeup water flow for a mechanical draft-cooling tower is typically less than 5 percent of the flow required for once-through cooling. The makeup flow would be pumped to the circulating water system from the current intake structure. Blowdown would be discharged from the tower basin to the discharge canal.

<u>Technical Feasibility and Reliability:</u>

The technology proposed for this alternative is well known and has been implemented for similar power plants. However, this alternative requires substantial open space, consumes a substantial amount of electricity, and reduces the thermal efficiency of the system. In addition, the ability of the existing condensers to handle the higher pressures associated with the recirculating system is uncertain and could have a large effect on the costs for this alternative.

<u>Costs:</u>

The capital cost of the mechanical cooling tower alternative is very high. Operation and maintenance costs are typically estimated to be in the millions of dollars per year, primarily due to additional fan and pump power demands and water treatment requirements. Finally, the increased temperature of cooling water in the steam condensers will results in both efficiency and capacity loss for the generating units. During the hottest summertime conditions when electricity demand is highest, the efficiency and capacity losses could be as high as 10%. This results in the need to purchase replacement power at a premium because a public utility has an obligation to serve its customers and will be required to bear that expense.

Effectiveness:

The mechanical draft cooling tower alternative would effectively reduce both impingement and entrainment in proportion to the flow reduction, typically 95% or more. This technology meets both the impingement mortality reduction and entrainment reduction performance standards set by the 316(b) Phase II rule for existing plants.

Other Potential Adverse Effects:

The primary adverse effects for the mechanical draft cooling tower alternative are associated with increased water vapor content in the immediate area of the cooling towers. This will result in a visible plume for some periods and has the potential to result in fogging impacts. To reduce the potential for these effects, a plume abatement system would be employed. Because cooling tower drift cannot be eliminated completely, the tower would be located as far as possible from electrical equipment, off-site receptors, and sensitive vegetation. Space limitations may make it difficult to locate the cooling towers to minimize these effects. A cooling tower also imposes noise and aesthetic impacts. Another significant environmental effect is that the decrease in efficiency means that more fuel is burned per unit of electrical energy output. Therefore, a plant with cooling towers will have more emissions than a plant utilizing an open cycle system. The increase in emissions will be proportional to the decrease in plant efficiency. Depending on the weather conditions, the negative effect on efficiency could be anywhere from 1% to 10%.

Overall Assessment of Alternative:

A cooling tower alternative would be effective for reduction of both entrainment and impingement mortality; however, due to the very high costs and limited space available for construction, this alternative is not considered as a part of the compliance.

- ***5d – Dry Cooling***

Description:

With a dry cooling system air is used as a heat sink to condense steam in the system. Cooling water is essentially eliminated. However, a dry cooling system requires a large cooling surface, many cooling fans, and a more sophisticated steam ducting system, which would require extensive modifications to an existing plant. In addition, an annual average thermal efficiency penalty of 2% to 5% is likely for the power plant. During the hottest summertime conditions when electricity demand is highest, the efficiency and capacity losses could be well over 10%. Because of these high costs, dry cooling is not considered a part of the compliance for any existing plant.

Alternative 6 - Restoration

Description:

Restoration can be a cost-effective measure for mitigating losses of aquatic organisms and is allowed under the Phase II rule. Under some circumstances (i.e. when loses are to commercially or recreationally important and/or to special status species) it may be possible to affect in-kind replacement. On the other hand, in some cases it may be more appropriate to pursue "out-of-kind" restoration (i.e., restoration through ecosystem or watershed-based resource management approaches with a focus on resources other than those lost at the CWIS). This approach is explicitly allowed by the rule. Both "in-kind" and "out-of-kind" restoration has been pursued as a mitigation strategy at a number of generating stations in California, most notably at the San Onofre Nuclear Generating Station.

Possible restoration methods generally include:

- Fish or shell-fish restocking programs;
- Habitat creation;
- Habitat restoration;
- Habitat enhancement;
- Acquisition and protection of habitat;
- Watershed management and protection to reduce sedimentation or improve water quality; and;
- Support of a state or locally-sponsored restoration program.

Of these measures: four have some degree of precedent in the area of the two Reliant stations: (1) wetland restoration; (2) wetland enhancement; (3) acquisition of wetland habitat; and (4) fish restocking programs.

Fish restocking programs are a way of directly restoring species populations impacted by impingement and entrainment. Restocking programs have proven successful in increasing specific species populations in Southern California. However, the dominant species involved in impingement and potentially entrainment at both plants are not species of significant commercial or recreational importance. Thus, direct replacement of the most commonly impinged species may not be the most ecologically or commercially/recreationally beneficial approach. Alternatively, Reliant believes that taking an ecosystem perspective and participating in restocking programs that target at-risk, rare, threatened, and/or endangered fish and invertebrate species such as white seabass, rockfish, and abalone may yield valuable benefits on multiple fronts. Proteus Sea Farms, which is a marine laboratory facility located at Reliant's Ormond Beach generating station, currently raises white seabass and white abalone as part of an ongoing restoration program. Reliant anticipates continuing its support of Proteus for this demonstrated successful restocking program.

Habitat restoration and enhancement as well as acquisition of nearshore, coastal wetland, and coastal watershed habitats are indirect methods of mitigating impacts to nearshore fish populations that may be associated with impingement and entrainment at both stations. Nearshore habitats are hydrologically connected to and thus are part of the same coastal watershed, a requirement for restoration under the rule. As such, restoration of coastal watersheds can lead to improvement of nearshore habitats. Coastal wetlands can serve as spawning, nursery, and feeding grounds for fish and invertebrates that are integral to the local marine ecosystem. Thus, restoration and/or protection of coastal watersheds are good focal points for managing coastal resources as these restoration activities will contribute to the long-term health of the ecosystem.

Reliant believes that embracing a watershed approach and pursuing "out-of-kind" restoration efforts that increase the biological, physical, and chemical quality of the coastal watersheds influenced by both stations (including Ventura River, Santa Clara River, and Calleguas Creek Watersheds) are appropriate potential mitigation measures under the rule. While there is little opportunity for intertidal restoration at and in the vicinity of either facility, there are numerous restoration projects currently underway in Ventura County to which Reliant could contribute including:

- **Ormond Beach Wetland Restoration Project (Mugu Lagoon)** wetland restoration, enhancement, and acquisition projects of the Ormond Beach wetlands;
- **The Nature Conservancy:** wetland restoration, enhancement, and acquisition projects along the lower and upper Santa Clara River Watershed;
- **Southern California Wetlands Restoration Project:** wetland restoration, enhancement, and acquisition projects at Ormond Beach and along the lower and upper Santa Clara River Watershed;
- **Santa Clara River Wildlands Protection Project:** enhancement and acquisition projects along the lower and upper Santa Clara River Watershed;
- **Grunion Greeter Program**: research projects including a long-term grunion population assessment and an assessment of the usefulness of grunion as an environmental indicator for sandy beach habitats;

- **McGrath State Beach**: threatened and endangered species habitat protection;
- **Proteus SeaFarms/Channel Islands:** restocking program for white abalone and white seabass; opportunity for expansion to include additional species;
- **Water Quality Improvement Projects:** agricultural and non-point source stormwater runoff;
- **Matilija Coalition:** wetland restoration and enhancement projects along the Ventura River including removal of Matilija Dam, recovery of Southern Steelhead trout and, restoration of the natural sediment supply to the beaches of Ventura

As part of the CDS, Reliant will evaluate these and other restoration measures as means of cost-effectively restoring impingement and entrainment loses while improving the biotic integrity of the local coastal ecosystem. The evaluation will consider the findings and goals of relevant resource agencies as well as the interested public.

Technical Feasibility/Reliability:

Each of the potential restoration methods has been used with success in a number of applications. Each of the restoration methods would require an assessment of whether any conditions in the water bodies would preclude long-term success. The potential for court-remanding of the restoration measures should be considered.

Cost Considerations:

The capital costs of this alternative as well as ongoing operational and/or monitoring costs are expected to range widely depending on the number and type of restoration efforts selected. Reliant is committed to cooperating with local, regional, state, and federal agencies to leverage funds they provide to secure matching funds thereby maximizing the overall benefit to the environment.

Effectiveness:

There is little existing quantitative information on increases in biological production at habitat areas to offset impingement and entrainment losses. However, restored habitat areas have been demonstrated to result in an increase in biota and spawning. Additionally, a well-designed stocking program would provide a direct replacement of important species on an adult-equivalency basis, although the replacement would be out of kind from those removed by the CWIS.

The out of kind restoration discussed above would have a high potential to be effective in restoring important local habitats, however, these benefits would not readily equated to losses from the CWIS.

Other Adverse Effects:

There are no likely adverse effects of the restoration alternative.

Overall Assessment of Alternative:

This alternative is technically feasible, may have relatively low costs, and is likely to be effective (though at this point it is difficult to quantify the degree of mitigation that would be obtained). The alternative would also provide an overall environmental benefit to the affected water bodies.

APPENDIX B

REVIEW OF PACIFIC OCEAN FISHERIES

APPENDIX B
REVIEW OF IMPINGEMENT AND ENTRAINMENT AT RELIANT'S PHASE II ASSETS

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EXECUTIVE SUMMARY

The Phase II rule developed under Section 316(b) of the Clean Water Act requires consideration of the fishery of the cooling water source. The specific make up of a portion of the Comprehensive Demonstration Study (CDS), the Impingement Mortality and Entrainment Characterization Study (IMECS) is outlined by the rule. This Appendix will review these requirements within the context of the available literature for Reliant's Ormond Beach (Ormond) and Mandalay (Mandalay) generating stations located on the Pacific Ocean. The literature reviewed includes data collected at the Ormond and Mandalay stations as well as the more general literature. This Appendix will evaluate whether these data are sufficient to support development of the IMECS and will also evaluate several important issues relative to the assessment and mitigation of impingement and entrainment at the stations.

Two efforts have been made to characterize impingement and entrainment at the two stations:

- Section 316(b) Demonstrations studies developed in the late 1970s; and
- Ongoing studies of impingement at both stations.

As shown below, Reliant has drawn the following conclusions based on the review of available literature:

- The more recent survey of impingement is of very high quality. Several samples are available over a number of years. The methods are standard ones and the full suite of fish and shellfish are enumerated, weighed, and measured for length. These data, which will continue to be collected, fully address the goals of the IMECS as articulated in the rule.
- A relatively small number of species are subject to impingement at Mandalay. These species are typical of coastal environment. Few species that favor harbor or estuary habitats are impinged. A much larger number of species are impinged at Ormond Beach including those from coastal and estuarine environments. Most of the impinged fish at both stations are schooling species. The overall rate of impingement (i.e., fish/10,000 m^3) is far lower at Ormond Beach than at Mandalay.
- The older surveys of impingement mortality and entrainment at both stations used appropriate methods but suffer from a focus on 14 target species. The target species do not include the dominant species in the most recent data at Mandalay, grunion. Entrainment was measured at Ormond Beach. The older data on entrainment at Mandalay was collected at another facility.

- The overall pattern of impingement of the 14 target species is similar between the two surveys (r^2 = 0.93 for Mandalay, r^2 = 0.80 for Ormond Beach). This similarity includes overall species composition as well as the number and biomass of fish impinged.

- The impinged species in the two surveys include several but not all of those that are common in embayment or nearshore habitat of the Pacific Ocean.

- Grunion and other schooling species show significant periodicity in impingement at Mandalay but far less so at Ormond Beach. This results in very high inter-sample variation in impingement rates at Mandalay. This apparent periodicity is likely due to a combination of factors including the normal periodicity in the presence of the species (e.g., grunion runs on spring tides in March through June) and the irregular schedule of operation of the plant. For example, 2004 surveys indicate that few grunion were collected during the survey, yet they were the species with the highest rates of collection during sampling in 2002 and 2003. These results may indicate that grunion were not impinged in 2004, although it is more likely that the sampling in 2004 did not occur while the grunion were spawning. No large-scale impingement events are apparent in the record at Ormond Beach.

- Recent surveys of ambient fish populations have occurred offshore of the Mandalay station for several years and historical fish populations were sampled in the late 1970s off both stations. The species encountered during these surveys have been relatively consistent over the last 20+ years and are very similar in composition to the fish impinged at Ormond station which is located a relatively short distance down the coast from Mandalay. In sharp contrast, the most important components of the ambient population are impinged very infrequently at Mandalay and the dominant species impinged are very poorly represented in the ambient population.

- At Mandalay, the set of observations above suggest that coastal species, especially grunion, may run into the Channel Island Harbor and the Edison Canal. This movement may be encouraged, in part, by the induced flow velocity into the canal. If these coastal species orient their movement to flow while harbor residences do not, this may help to explain the importance of coastal species among impinged fish. No such behavior is apparent in the Ormond Beach impingement data set.

- The flow normalized rate of fish impingement during normal operation is far lower at Ormond Beach (0.09 fish/10,000 m^3) than at Mandalay (4.96 fish/10,000 m^3). This is likely associated with the location and configuration of the Ormond Beach CWIS (e.g., the velocity cap) including the absence of major impingement events associated with spawning fish.

- Both stations use heat treatment to control biofouling of the CWIS. Total impingement is monitored during the entire duration of any heat treatment event and tallied separately from impingement during normal operations. Impingement during heat treatment was compared to the annual rate of impingement estimated by extrapolating 24-hour sampling events to the full year. At Mandalay, heat treatment losses were found to be only 0.13% of the total estimated annual loses. At Ormond Beach, the relative losses during heat treatment were far higher: 53.6% of estimated annual losses. This suggests that management of heat treatment at Ormond Beach could significantly reduce annual impingement losses.

- No listed Threatened or Endangered species or other special status species have been affected by impingement. Only special-status marine mammals and reptiles (i.e., whales and sea turtles) are believed to be present in the area. They have not been encountered during either impingement survey.

- The monthly rates of impingement are highly variable but exhibit only slight seasonal patterns. This variability is likely due to the periodicity of plant operation as well as the coordination of the schooling and spawning behavior of the fish species located in the intake canal with relatively short-term tidal events at Mandalay.

- At Mandalay, the two most frequently impinged fish species, the California grunion and shiner perch, are large for the species (i.e. more than a couple grams) indicating that they are adult and young of year.

- At Ormond Beach, two of the most frequently impinged fish species, queenfish and Northern anchovy, are large for the species (i.e. more than a couple grams) indicating that they are adult and young of year.

- The fish species (i.e. gobies and blennies) affected by entrainment at Mandalay (based on the data from Haynes) were not generally the same ones affected by impingement (i.e. grunion and shiner perch). However, since entrainment data were only collected from the Haynes station, it is difficult to compare this data directly to entrainment data from the impingement surveys at Mandalay. Supplemental data on entrainment at Mandalay is proposed. There is a strong seasonality in the rate of entrainment of fish with the great majority occurring in the late spring months, May and June (which correspond to grunion spawning). Minimum entrainment occurred during December and January.

- The fish species (i.e. northern anchovy, queenfish, white croaker) affected by entrainment at Ormond were generally the same ones affected by impingement (i.e. queenfish, Pacific sardine, and northern anchovy).   Supplemental data collection on entrainment at Ormond is proposed. There is a strong seasonality in the rate of entrainment of fish with the great majority occurring in the early spring, February through May and August through October (which corresponds to northern anchovy spawning); minimum entrainment occurred during summer months.

- The original demonstrations in 1983 concluded that the operation of the CWIS did not result in an Adverse Environmental Impact on the fisheries in the vicinity. The LARWQCB concurred with this decision.
- Shifts in the populations of some fish species are expected since the completion of the demonstrations in 1983. In particular, the populations of rock fish are expected to have decreased. Despite this change in populations for some fish species, significant changes in the patterns of impingement and entrainment are not expected. Importantly, the two dominant impinged species and entrained species are expected to continue to be most important at both stations.
- Based on the historical and recent data collected in support of the demonstrations and NPDES monitoring, fish populations within the Southern California Bight that have shown substantial population changes are different from the species impinged and entrained at either station.

1.0 INTRODUCTION

The Section 316(b) Phase II rule requires consideration of several biological issues during the evaluation of current and potential measures to mitigate impingement mortality and entrainment. This Appendix represents the first step in that process: a review of the fishery resources of the Pacific Ocean off the coast of Southern California, specifically the Southern California Bight and its implications for rule compliance.

1.1 Goals

This Appendix was generated to support the submittal of the Proposal for Information Collections (PICs) for Reliant's Mandalay and Ormond stations. Much of this information will be incorporated into the Impingement Mortality and Entrainment Characterization Studies (IMECS), part of the Comprehensive Demonstration Study (CDS) required in the Phase II Section 316(b) rules. This document will be prepared for each facility and will include an expanded discussion of the data as well as a more complete discussion of the data's implications at the plants. The goal of this Appendix is to review fisheries-related data available for the Southern California Bight. This review is intended to support the compliance options Reliant has elected to pursue in response to the regulations that pertain to the reduction of impingement mortality (IM) and entrainment (E) at electric power generating stations. In particular, this Appendix will address whether sufficient data are available to address the goals of the rule within the context of the compliance strategies outlined in the PIC. In addition, the data will be reviewed for their utility to support assessment of potential mitigation measures as well as in the design of biological sampling programs. The rates of impingement and entrainment at each facility are considered within the context of our understanding of the biological resources of the Southern California Bight in order to address several important questions relevant to the assessment of current and potential controls on IM and E. Potentially relevant questions are presented in Section 2.0 (below).

The aquatic biology of the Southern California Bight is relatively well characterized by various agencies as well as private entities. In an effort to determine species that may be subject to impingement or entrainment at the two Reliant facilities, a literature review was conducted.

This Appendix reviews impingement data collected at the Mandalay and Ormond stations. These data provide important perspective on the biological performance of the CWIS and, when coupled with other literature data, may provide a sufficient basis for the IMECS called for by the rule. The absolute rates of impingement will be considered relative to the location, design, and operation of the CWIS, and temporal trends will be discussed. The frequency of the species impinged will be discussed relative to population surveys of the Southern California Bight. Finally, a brief discussion of habitats of the most commonly impinged species is provided.

Although many relevant data sources were obtained during the literature review, it should be noted that several sources have collected a considerable amount of data but these data have not yet been collated and evaluated. Such a review is beyond the scope of the PIC but review of this information will occur during the preparation of the IMECS for each of the Reliant facilities.

1.2 Organization of Document

A review of the Rule's goals is provided outlining the requirements for the IMECS. A general review of the fisheries resources of the Southern California Bight is then presented. Taxonomic identification of the most common species impinged or entrained is provided. A summary of the fisheries in the ambient water follows with species-specific discussions including habitat preference, spawning habits, and food preference. Species with clear economic benefit and recreational importance are discussed.

Documentation of current IM and E at Ormond and Mandalay follows, focusing on actual measurements. The representativeness of historical data are addressed considering potential fisheries trends in the Southern California Bight and whether the impingement data were collected under normal operating conditions. Available data were analyzed to determine their sufficiency to estimate the Calculation Baseline. The sufficiency of the data is also discussed as it pertains to supporting the other goals of the each CDS.

Lastly, a discussion is presented that addresses whether the available data are sufficient in supporting the IMECS. The most common species impinged and entrained are listed in this section. Implications for CWIS placement, design, and operation are discussed as well. References cited are found at this end of this Appendix as are Tables and Figures.

2.0 REVIEW OF THE RULE'S GOALS

The Phase II rule provides relatively specific requirements for the IMECS in amendments to 40 CFR 125.95(b)(3) (see excerpt, below). Reliant understands that these requirements are intended to support the assessment of the current CWIS as well as its alternatives within the context of the various Compliance Strategies. Among the specific questions that might be relevant are:

- What are the species potentially affected by the CWIS? Do they include species of potential concern such as those with high commercial or recreational value or those receiving special protections?

- Do the characteristics of the relevant species (e.g., temporal and spatial distributions, size of larvae and eggs, swimming speed) provide a basis for selection and design of mitigation technologies or measures?

- What are the actual rates of impingement and entrainment in order to calculate the monetized benefit of potential mitigation measures?

- How do the current rates of impingement and entrainment relate to those of the hypothetical Calculation Baseline? That is, what is the effect of mitigation measures expressed as a percent reduction, relative to the Calculation Baseline, in impingement mortality and entrainment?

As noted in the PIC, the relative importance of these questions will vary significantly depending on the Compliance Strategy selected. Although current data on the rates of impingement mortality and entrainment may be more useful to the Cost-benefit test than to the Cost-cost test, available data are likely to allow a conservative estimate of potential monetized benefits. Similarly, it is likely to be much simpler to demonstrate consistency for some mitigation technologies than for others and the nature of the necessary data collection will vary accordingly. For example, the EPA and other literature estimate that the use of a velocity cap reduces impingement by 90 percent, providing a tangible basis for estimation of its efficacy. On the other hand, reliance on differences in population densities at two different locations is fraught with uncertainties.

The following is the Rule's requirements for the IMECS:

a) *125.95(b)(3)(i). 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.*

b) *125.95(b)(3)(ii). 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 pursuant to paragraph (b)(3)(i) of this section, 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 annual, seasonal, and diel variations in impingement mortality and entrainment.*

c) *125.95(b)(3)(iii). Documentation of the current impingement mortality and entrainment of all life stages of fish, shellfish, and any species protected under Federal, State, or Tribal Law (including threatened or endangered species) identified pursuant to paragraph (b)(3)(i) of this section and an estimate of impingement mortality and entrainment to be used as the calculation baseline. Impingement mortality and entrainment samples to support the calculations required in Section 125.95(b)(4)(i)(C) and 125.95(b)(5)(iii) of the Rule must be collected during periods of representative operational flows for the cooling water intake structure and the flows associated with the samples must be documented.*

Within the context of the selected Compliance Strategies, these requirements will serve as the basis for assessing the sufficiency of the existing data to support the IMECS (see Section 4 of the PIC).

The following three sections of this Appendix are organized consistent with the three separate provisions of the rule relative to the IMECS.

3.0 TAXONOMIC IDENTIFICATIONS [125.95(B)(3)(I)]

40 CFR 125.95(b)(3)(i) sets out the requirements of the IMECS relative to identification of fish and shellfish taxa potentially affected by impingement mortality and entrainment. The goals of this effort are to identify these species that are likely to dominate impingement mortality and entrainment with a special focus on those that have commercial or recreational importance. In addition, any species subject to special protections (e.g., state- or federally-listed threatened or endangered species) must be noted.

This section will review the available information in order to identify the relevant species and will provide a brief review of the nature of several important species. The discussions rely on station-specific data as well as the more general literature, including scientific literature on the fishery of the Southern California Bight.

3.1 Pacific Ocean/Southern California Bight Species Composition

The fishery of the Pacific Ocean changes with progression from shore to open ocean. The change is driven by several factors including age, habitat preference, ocean currents, and water temperature. For the purposes of this document, nearshore fishery resources are discussed exclusively.

The nearshore ocean zone extends from the shoreline (including sandy beaches, boulder fields and rocky outcroppings, as well as associated kelp beds, sandy and muddy bottoms), to the boundary between the continental shelf and continental slope (depths range from 100 to 300 meters, depending on the location). Waters of this zone are rich in nutrients primarily from upwelling currents.

Upwelling provides essential nutrients needed to support vast populations of microscopic organisms collectively known as plankton and thus stimulates biological productivity and diversity in both nearshore and offshore ocean waters. Plankton are the basis of the food chain and a vital component of numerous food webs supporting important fish, mammal and bird populations.

Interactions between offshore currents influence temperature, nutrients, and distribution of organisms and their offspring and create a distinct biogeographical region (or bioregion) extending from the Mexican border to near Point Conception. This biogeographic region is known as the Southern California Bight, which primarily supports temperate and warm water fish and invertebrate species.

The Southern California Countercurrent, a portion of the California Current, is a cold water current that carries cold waters from northern California to the coast of Southern California. Surface speeds in the counter current ranges between 5 and 10 cm/s. In contrast, the Davidson Current is a periodic, nearshore current that flows in a northerly direction, carrying warm waters from semitropical seas to Southern California.

Nearshore, coastal currents are strongly influenced by a combination of wind, tides and local topography. When wind-driven currents are superimposed on tidal motions, a strong diurnal pattern is usually apparent. Therefore, short term observations of currents near the coast often vary in both direction and speed.

Interannual variability in the California Current influences distribution and abundance of plankton, invertebrates, and fish. Periodic disruptions of the California Current, often associated with El Niño-Southern Oscillation (ENSO) events, affect available nutrients and zooplankton in central and southern California.

3.1.1 Summary of Literature

This section will review the available information in order to identify the relevant species and will provide a brief review of the nature of several important species. The discussions rely on station-specific data as well as the more general literature, including scientific literature on the fishery of the Pacific Ocean. A more in-depth profile of the status of fisheries in the Southern California Bight as well as the biology of species subject to impingement and entrainment at will be included with the IMECS submittal.

3.1.1.1 Southern California Bight

The Pacific Ocean is a dynamic and diverse ecosystem. The near shore ecosystem along the Southern California coast is composed of several habitats including kelp forests, rocky intertidal, sandy and muddy bottoms, and open water that allow a diverse assemblage of organisms to persist. Over 500 species of fishes have been recorded to occur in the Pacific Ocean off the coast of Southern California.

Common species with commercial importance in the nearshore ecosystem of the Southern California Bight include a variety of rockfish species (*Sebastes sp.),* cabezon (*Scorpaenichthys marmoratus*), sheephead (*Semicossyphus pulcher*), kelp bass (*Paralabrax Clathratus)*, Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), jack mackerel (*Trachurus symmetricus*), northern anchovy (*Engraulis mordax*), California corbina (*Menticirrhus undulates*), surfperches (*Amphistichus sp*.), croakers (Family Sciaenidae), California halibut (*Paralichthys californicus)*, sanddabs (Citharichthys sp.), and skates and rays are also fairly common. In addition to the fish, several commercially important invertebrate species are abundant including market squid (*Loligo opalescens*), purple sea urchin (*Strongylocentrotus purpuratus*), spiny lobster (*Panulirus interruptus)*, red rock shrimp (*Lymata californica*), and spot prawn (*Pandalus platycerus*).

3.1.1.2 Ormond

Southern California Edison (SCE) the original owners of the Ormond and Mandalay facilities, collected data on fisheries populations for the 316(b) demonstration and NPDES monitoring for Ormond in the mid 1970s and early 1980s (MBC 1975 and 1981). Fish collected included northern anchovy, queenfish, white croaker, white surfperch and shiner surfperch. The data were representative of the dominant nearshore species in the Southern California Bight.

SCE and Reliant have conducted impingement monitoring at Ormond between 1980 and 2004 as part of their CDS and subsequent annual receiving water NPDES monitoring program. These data characterize the species and their relative abundance impinged at Ormond during both normal operations and heat treatments. The sampling data have been extrapolated to monthly impingement rates based on flow (Table B-1). Queenfish, Pacific sardine, northern anchovy, and shiner surfperch are the long-term dominants, comprising over 90 percent of the individuals impinged at Ormond. These data are consistent with the fish species and relative abundance historically impinged at Ormond during the original 316(b) demonstration (Figure B-1). In addition, the data are consistent with the ambient fish data collected for the Mandalay NPDES ambient biological monitoring discussed in the next section.

3.1.1.3 Mandalay

SCE collected data on fisheries populations for NPDES monitoring in the late 1970s and early 1980s (MBC 1979 and 1981). Fish collected included northern anchovy, queenfish, white croaker, white surfperch and walleye surfperch. The data were representative of the dominant nearshore species in the Southern California Bight. Reliant's more recent sampling offshore of Mandalay between 1980 and 2004 continued to find white croaker, queenfish and northern anchovy as the long-term community dominants, comprising over 90 percent of the individuals collected offshore of Mandalay.

SCE and Reliant have also conducted impingement monitoring at Mandalay between 1980 and 2004 as part of SCE's original CDS and the subsequent annual receiving water monitoring programs. These data characterize the species and their relative abundance impinged at Mandalay during both normal operations and heat treatment. The sampling data have been extrapolated to monthly impingement rates based on flow (Table B-2). Grunion, shiner perch, topsmelt and Pacific sardine are the long-term dominants, comprising over 98 percent of the individuals impinged at Mandalay. Additionally, the current (2001-2004) fish impingement data and relative abundance is consistent with historical data (1979-1980) as shown in Figure 2.

In comparing the ambient biological data (Table B-3) to the impingement data at Mandalay it should be noted that of the ten most abundant species in ambient surveys off Mandalay only one was among the top ten species most commonly impinged at the facility. Thus, although the species mix observed in the impingement samples taken at Mandalay is generally similar in composition and relative abundance to the species mix found in the Southern California Bight itself, some species are noticeably absent or under-represented from the impingement samples. For example, one of the most common fish in the ambient samples, queenfish, is rarely observed in the impingement samples at Mandalay (0.001% of total impingement). Similarly, white croaker, are common in the ambient samples, but are not among the fish species impinged. Conversely, California grunion account for the largest number of individuals impinged but account for less than 0.1% of the individuals observed in the offshore biological monitoring surveys. This trend is confirmed by four years of impingement data conducted by Reliant at the Mandalay station (see Table B-3). While quantitative comparisons are difficult, it is apparent that several species that dominate the impingement samples are poorly represented in biological monitoring performed offshore of Mandalay. The differences in composition and frequency of fish known to be common in the Southern California Bight and those observed in the impingement samples is likely to be strongly influenced by the location of the CWIS in the Edison Canal as well as by habitat preferences and/or escape potential.

3.1.2 Species-Specific Discussion

The following is a brief summary of the primary marine species observed and/or expected to be impinged in Ormond and Mandalay's CWIS. These species were those most commonly observed in ambient data taken at Mandalay and in impingement data taken at both facilities. A more in-depth biological profile will be included with the IMECS submittal. General biology is discussed as well as habitat and feeding preferences.

California grunion

California grunion (*Leuresthes tenuis*) is a non-migratory species which occurs primarily in the surf zone off sandy beaches to a depth of 60 feet. Adult grunion range in size from five to six inches and the normal life span is two to three years. Grunions have the water to spawn in wet sand on beaches typically two to six nights after the full and new moon from March through August. Spawning occurs during high tide events with the female grunion swimming up onto the sandy with incoming waves, the females depositing and the males fertilizing eggs approximately 4 inches under the sand, and then retreating back into the water with an outgoing wave. Eggs typically hatch 10 days later. Grunion food habits are not known.

The commercial use of grunion is limited with most grunion taken as by catch. The grunion are however part of the recreational fishery. Because of their unique spawning behavior "grunion hunting" has become a popular event in southern California. In the 1920s, the recreational fishery showed signs of depletion and a regulation was passed establishing a hunting season. Once the fishery improved, the closed season was shortened to April through May (which is still in effect today). Additionally, no appliances may be used to catch grunion and no holes may be dug in the beach to entrap them. Today the most critical problem facing the grunion is reduction of spawning habitat, due to beach erosion, harbor construction, and pollution.

Queenfish

Queenfish (*Seriphus politus*) occur from Oregon to Baja California. This species grows to a length of approximately 10 inches and are considered habitat generalists but are most commonly found during summer in shallow sandy-bottom environments such as bays, tidal sloughs, and around pilings. Queenfish are nocturnal in nature, aggregating in dense schools during daylight hours then disbursing and move to deeper water at night (Chao, 1995; MBC, 2004). Queenfish feed on small, free swimming crustaceans, small crabs, and fishes. Adult queenfish spawn in the summer. The eggs are free floating. Young queenfish, less than 1 inch long, appear in late summer and fall; first at depths of 20 to 30 feet, gradually moving shoreward until they enter the surf zone when 1 to 3 inches long. Queenfish are of minor commercial importance but are most commonly caught fish by recreationally from piers.

Topsmelt

Topsmelt (*Atherinops affinis*) is a nearshore species which inhabits a variety of habitat including kelp beds, harbor areas, and sandy beach areas. They usually form loose schools but will congregate while feeding. Topsmelt reach a maximum size of 14 inches and live to seven or eight years old. Their spawning period is from April through October. Topsmelt larvae are particularly abundant in tidal basins and the shallow edges of coastal bays. Juvenile topsmelt generally move into the open water of estuaries, bays, and coastal kelp beds. The food of topsmelt consists primarily of plankton.

Topsmelt are part of both the commercial and recreational fisheries. The commercial fishery is comprised of fish marketed for human consumption or bait. Topsmelt also make up a significant portion of the pier and shore sport catch throughout California. While the stock size of topsmelt has not been determined, at present there are no indications that this species is being overfished in California. The greatest risk to this species is pollution and loss of habitat through development.

Pacific Sardine

Pacific sardine (*Sardinops sagax*) is a pelagic fish which inhabits the coastal areas of warm temperate zones of nearly all ocean basins. The northern subpopulation ranges from northern Baja California to Alaska with sardines migrating north in the summer months and returning south to southern California and northern Baja in the fall. Pacific sardines are roughly 12 inches in size and live to eight years old. They spawn in loosely aggregated schools in the upper 165 feet of the water column and in Southern California their spawning peaks between April and August. Sardines are filter feeders and feed on plankton.

The Pacific sardine has historically been an important commercial fishery, supporting the largest fishery in the Western Hemisphere during the 1930s and 1940s. The fishery collapsed the 1940s due to overfishing and natural changes in the environment. The population has since recovered due to closure of the fishery and development of favorable environmental conditions. Currently, Pacific sardines are processed mainly for human consumption, pet food, or export.

Northern Anchovy

Northern anchovy (*Engraulis mordax*) is a small, short-lived species typically found in schools near the surface. Adults are typically found offshore whereas juveniles are found in nearshore areas. This species is typically seven inches long and lives to an approximate age of four years old and feeds on plankton. Northern anchovy are distributed from British Columbia to Baja California. The population is divided into three subpopulations. The central subpopulation ranges from San Francisco to Baja California with the bulk of the population located in the Southern California Bight.

Live baitfish for the sportfishing community is the principle fishery for northern anchovy within southern California, with only a limited reduction fishery (i.e. use as fish meal, oil, or soluble protein) currently operating (MBC, 2004). Biomass estimates of the central subpopulation of northern anchovy have been declining slowly since the 1970s. It is believed that the Northern anchovy population is currently determined by natural influences, such as ocean temperatures rather than fishery influences.

Shiner Surfperch

Shiner surfperch (*Cymatogaster aggregata*) occur primarily in shallow water, around eelgrass beds, piers and pilings. They are also commonly found in bays and quiet back waters and calm areas of exposed coast. The species is most often found in loose schools or aggregations. Surfperch reproduction is viviparous, their young being highly developed and free swimming at birth. The young feed on copepods, while adults eat various small crustaceans, mollusks, and algae. Shiner surfperch generally grow to 7 inches. While surfperch as a whole comprise a commercial and recreational fishery, as a species shiner surfperch have little commercial or recreational importance. Total commercial surfperch landings have declined over the long-term by 25 percent since the 1950s. Research has indicated that some of the decline is associated with the increases in water temperature. Additionally, pollution and habitat destruction are threats to the population.

Walleye Surfperch

Walleye surfperch (*Hyperprosopon argenteum*) occur primarily along sandy beaches, jetties, kelp beds, and other habitat rich in invertebrate life. This species is most often found in large schools. Surfperch reproduction is viviparous, their young being highly developed and free swimming at birth which typically occurs in mid-April. Similar to the shiner perch young feed on copepods, while adults eat various small crustaceans, mollusks, and algae. Walleye surfperch are 1.5 inches at birth and can grow to 12 inches. While surfperch as a whole comprise a commercial and recreational fishery, as a species walleye surfperch are most notable for their importance to the recreational fishery. Recent recreational take has averaged 112,000 individuals per year (CDFG, 2001). However, the total stock size is unknown at this time. As noted for the shiner surfperch, total commercial surfperch landings have declined over the long-term by 25 percent since the 1950s. Research has indicated that some of the decline is associated with the increases in water temperature. Additionally, pollution and habitat destruction are threats to the population.

Pacific Staghorn Sculpin

Pacific staghorn sculpin (*Leptocottus armatus*) is a nearshore species which inhabits sandy bottoms of shallow subtidal waters, but may be found as deep as approximately 500 meters (Eschmeyer et al., 1983) (Froesce & Pauly, 2005). They are occasionally found in the lower reaches of freshwater streams (Tenera, 2000). Adults tend to live in the shallow lower estuary and further offshore whereas juveniles recruit to shallow inshore waters and sloughs (Tenera, 2000). This species is typically 17 inches long and lives to an approximate age of 10 years. They feed primarily on crabs, shrimps and amphipods, but also take larval, juvenile and adult fishes, as well as polychaete worms, mollusks and other invertebrates (Fitch & Lavenberg, 1975). Pacific staghorn sculpin are distributed from Alaska to Baja California. Spawning takes place from October through April in shallow coastal bays, inlets, sounds, and sloughs (Tenera, 2000). This species is not an important species to either the recreational or commercial fisheries (Emmett et al., 1991). This species is widespread and abundant. It does not appear that there are any immediate threats to this population however long-term threats are relatively unknown.

Diamond Turbot

Diamond turbot (*Hypsopsetta guttulata*) is a flat-fish species which inhabits muddy and sandy bottoms of shallow waters, often of bays and estuaries, but may be found as deep as 164 feet (Froesce & Pauly, 2005). The species is typically 18 inches long and lives to approximately eight years of age (Fitch and Lavenberg, 1975). The range of the diamond turbot extends from Cape Mendocino in northern California south to Baja California (Miller & Lea, 1972).

Diamond turbot have negligible commercial value, but are taken incidentally in commercial ground fisheries (CDFG, 2001). However, this species is part of the recreational fishery and are often taken by sport fishermen from Point Conception southward along the California coast (Fitch and Lavenberg 1975). The status of this population is unknown.

Bay Pipefish

Bay pipefish (*Syngnathus leptorhynchus*) is a nearshore species which inhabits eelgrass beds of bays and estuaries, but is sometimes found in shallow offshore waters (Dawson 1985). This species ranges from Alaska to southern Baja California in Mexico with the southern population extending from Morro Bay southward. This species is typically 12 inches long and feeds on crustaceans (Froesce & Pauly, 2005). The bay pipefish is ovoviviparous and the male carries the eggs in a brood pouch which is found under the tail (Breder & Rosen, 1964). This species is not part of either the commercial or recreational fishing industry. The status of this population is unknown.

Pacific Pompano

Pacific Pompano (*Peprilus simillimus*) is a benthopelagic species which commonly inhabits sandy bottom and shallow nearshore waters of exposed coasts in depths up to 300 feet (Fitch and Lavenberg 1975). This species occurs in small, but fairly dense, schools. The range of the Pacific pompano extends from British Columbia south to Baja California. This species typically reaches

11cm long (Ahlstrom, 1965). Pacific pompano is a valuable commercial species as well as a recreational species (Hart 1973). The status of this population is unknown.

3.2 Historical Patterns

The marine ecosystem of the Southern California Bight has been impacted by many factors over the past decades. Populations of several key fish species including rockfish, California halibut, and abalone have decreased recently in the Southern California Bight (CDFG 2001). Factors that have been identified as potentially contributing to changes in the local ocean's flora and fauna (CDFG 2001) include:

- Habitat loss and degradation;
- Point and non-point pollution;
- Toxic substances;
- Commercial and recreational fishing;
- Interannual variability in sea surface temperature due to El Nino-Southern Oscillation events;
- Reduced availability of key plant and invertebrate food sources; and
- Invasion of nonindigenous species.

3.3 Commercial and Recreational Species

Several of the most commonly impinged species at the Reliant facilities have substantial recreational or commercial value, including the grunion, shiner perch, Pacific sardine, northern anchovy and topsmelt species. Despite this removal, adverse impacts to their populations or to the commercial harvest are not expected since the annual impingement rates associated with Reliant's two CWIS are relatively low.

Commercial harvest in the Pacific Ocean off the coast of Ventura and Santa Barbara Counties is dominated by three general types of fishes including groundfish (rockfish, cabezon, and sheephead), sand bass, and ocean white fish, as well as three invertebrate species including market squid, red sea urchin, and California spiny lobster (CDFG, 2003). The fishery for Southern California as a whole is dominated by four types of fishes including groundfish, albacore and other tunas, coastal pelagics, and shark and swordfish, as well as the three invertebrate species mentioned above. Together these fisheries represent 90% of the total commercial catch (CDFG, 2001). Because none of these commercially harvested fishes or invertebrates are commonly represented in impingement samples, these species are expected to have a minimal potential to be impinged at either Ormond or Mandalay. Based on their life histories it similarly unlikely that they would be subject to substantial entrainment at either facility.

Recreational species targeted most often in the Pacific Ocean off of the coast of Santa Barbara, Ventura, and Los Angeles Counties include the rockfish, calico and sand bass, Pacific mackerel, and bonito species. As with the commercial species, based on historical impingement data, there is minimal potential for these species to be impinged in the CWIS at either Ormond or Mandalay (MBC, 2001). Based on their life histories it is similarly unlikely that they would be subject to substantial entrainment at either facility.

3.4 Threatened and Endangered Species

There are several federal and/or state listed threatened or endangered marine mammals, reptiles, fish and invertebrate species located in the marine waters of the Southern California Bight. Marine mammals include: southern sea otter (*Enhydra lutris neresis*), blue whale (*Balaenoptera musculus*), finback whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), right whale (*Balaena glacialis*), sperm whale (*Physeter catodon*), and sei whale (*Balaenoptera borealis*). Marine turtles are rare visitors to the Southern California Bight including: olive Ridley sea turtle, (*Leptdochelys olivacea*), leatherback sea turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*), and green sea turtle (*Chelonia mydas*). Only one marine fish, the Federally endangered tidewater goby (*Eucyclobobius newberryi*) and one marine invertebrate, the federally endangered white abalone (*Haliotis sorenseni*) occur in the vicinity of the Reliant Plants. However, based on their biology, known locations of populations (tidewater goby), and current structure of the CWIS, these species do not have the potential to be impinged or entrained at either facility.

Marine mammals are also protected under the Marine Mammal Protection Act. The waters along the Southern California Bight support a variety of species of marine mammals including many of those discussed above that are listed as threatened or endangered. For the same reasons as presented above, these species are not expected to be affected by the operation of the CWIS for either facility.

4.0 CHARACTERIZATION OF LIFE STAGES [125.95(B)(3)(II)]

The rule calls for the characterization of all stages that might be subject to impingement and, if appropriate, entrainment. This characterization is necessary to ensure the full scope of potential impacts is understood and that implications for selection of mitigation measures are known. Reliant believes that the general literature, the original demonstrations, and ongoing/proposed data collection collectively support a sufficient understanding of the potential impacts to the different life stages of the main species affected by entrainment or impingement at the two generating stations. The impingement studies that were performed in support of the original demonstration evaluated spatial and temporal (diel and annual) variations. This section presents a summary of this life stage information. The results of the investigations relevant to IM and E assessments are presented in Section 5.0. As noted in Section 7.0, additional characterization of entrainment, including diel and annual variation, is proposed as part of the CDS. More detailed review of the integrated data set will be provided in the IMECS submittal.

Life stages subject to entrainment are determined primarily by intake screen mesh size. A life stage of an organism less than the screen mesh size is subject to entrainment (including egg and post-larval individuals) while those larger than the mesh size are subject to impingement. Eggs are more susceptible than larvae since eggs lack swimming capabilities. Post-larval organisms do have some swimming capabilities, although limited, and can at times escape the approach velocity associated with CWIS. As the organism grows larger than the mesh size of the CWIS screens, they become subject to impingement. Both Reliant stations are subject to performance goals for impingement and entrainment mortality.

4.1 Entrainment

The 316(b) demonstration reports did not enumerate larvae but focused entirely on larval fish. No effort was undertaken to discriminate larval stages. The proposed assessment of entrainment will include characterization of eggs as well as, when feasible, larval stage/size.

4.2 Impingement

Length and weight data, surrogates of individual age, have been collected as part of the earlier demonstrations as well as the current, on-going program. The size of impinged individuals varies with species. Length data collected in the impingement monitoring studies at Ormond between 2001 and 2004 demonstrate that impingement is typically dominated by Age 0 to Age 3 size classes depending on the species. Average age classes for impinged individuals are as follows: queenfish (Age 1 to Age 3); Northern anchovy (Age 1 and Age 2); shiner surfperch (Age 0 to Age 3).

Length data collected in the 2002 and 2004 impingement monitoring studies at Mandalay demonstrate that adult and young of year (YOY) California grunion and shiner perch typically dominate impingement. Average lengths for impinged individuals are as follows: California grunion (4 inches) and shiner perch (3.5 inches).

5.0 DOCUMENTATION OF CURRENT IMPINGEMENT MORTALITY AND ENTRAINMENT [125.95(B)(3)(III)]

The rule requires the estimation of current rates of impingement mortality and, when appropriate, entrainment. These data may be necessary to support three potential activities:

- Estimation of the CWIS performance relative to the Calculation Baseline;

- Assessment of additional mitigation measures; and

- Estimation of the monetized benefit of potential mitigation measures under the Cost-benefit test.

5.1 Current Status of Fishery Population and Representativeness of Historical Data

The population dynamics of marine species within the Southern California Bight have shown a diversity of patterns over the past decades ranging from substantial losses (e.g., many rock fish species and abalone), to losses and recoveries (e.g., grunion, sardines, and market squid), to little documented changes (e.g., many of the non-commercial fishes). A variety of factors have been implicated as affecting these population changes, including both human influences, such as fishing pressures, changes in water quality, and loss of habitat, and natural variations, such as changes in water temperature such as that associated with El Nino.

A key driver for the development and implementation of the rule is to determine how much, if any, the operation of CWIS contributes to the observed losses of local fish and invertebrate species. Based on the data collected over the past decades documenting the species affected by their two coastal plants, Reliant believes that the available data on the local fisheries will be adequate to support the goals of the rule and the development of an IMEC.

5.2 Review of Impingement and Entrainment Data at Reliant Facilities

Historic impingement and entrainment data from Ormond and Mandalay are summarized in Tables B-1, B-2, and B-4 through B-9. Impingement and entrainment rates were calculated based on abundance of individuals collected during monthly sampling events. These observed rates were then adjusted for the total flow for the month to produce extrapolated monthly impingement and entrainment rates. Annual impingement rates were the sum of monthly extrapolated impingement plus impingement during heat treatment events.

5.2.1 Ormond

SCE and Reliant have collected data to evaluate impacts of both impingement and entrainment from the operation of Ormond. The studies are discussed below.

5.2.1.1 Ormond 316(b) Demonstration & Technical Appendix

The 316(b) Demonstration originally prepared for Ormond included sampling in support of both impingement and entrainment impacts. The results of each evaluation are considered in the following sections.

Entrainment

Entrainment monitoring occurred between August 1979 and July 1980 at Ormond. Monthly samples were taken at six periods (two day, two night, and two crepuscular[1]) of a 24 hour day. Samples were collected following standard ichthyoplankton sampling protocols. Entrainment mortality was assumed to be 100%. As shown in Table B-6 target species comprised approximately 84% of the total daily entrainment during the one-year period; of these 41.8% were northern anchovy; 33.8% white croaker; and 8.2% queenfish. The balance of non-target species were dominated by gobies, and unidentified and other miscellaneous larvae.

Bight-wide Plankton Investigation

To supplement the site-specific data, SCE participated in a more comprehensive data collection effort in the Southern California Bight. Data were collected along 20 transects with stations at 8 and 22 meter contour depths for the majority of transects. Plankton samples were collected with Bongo nets, Manta nets and Auriga nets depending on the depth of the sample. Net mesh was 335 micron on all nets. Ichthyoplankton data collected included larval stage, area (transect location), depth, sampling method, and year class.

The raw data for each sample were scaled to reflect ichthyoplanton densities in numbers per $1000 m^3$ in the portion of the water column sampled by each device. Mean density through the water column was determined by proportionally summing the densities according to the amount of water column sampled and dividing by total depth. Density was then multiplied by the estimated percentage of the Southern California Bight volume occupied by water of that depth. Using the volume weighting factors for each depth range, densities were determined independently for each 1mm size class for each depth range. Density throughout the Bight was then calculated for each size class by summing densities from each depth range then dividing the number of depth ranges considered. The results were incorporated into the Impact Assessment Model as the term defining abundance and distribution of offshore stocks for key target species.

Impingement

Impingement monitoring data were taken between October 1978 and July 1980. Data taken in August and September 1980 were taken twice per week while the remaining data were taken once per week. All screen/trash basket washings collected during normal operations. Species were grouped into algal, invert, & fish categories. The following data was calculated: (1) number of fish species; (2) number of individuals per species; and (3) weight per species. Up to 200 individuals of the target species were measured for length and up to 50 individuals were sexed. Non-target species found in large numbers were also counted and sexed. Oceanographic, climatological, and plant operational parameters were measured during each sampling period.

[1] Period of twilight between day and night

Daily impingement rates were averaged across the sample size of 154 samples. Target species comprised 63.6% of total daily impingement during the two-year period; of these 41.2% were shiner surfperch; 7.2% queenfish; 6.8% anchovy; and 3.2% white surfperch.

Heat treatment data was collected at approximately four to six week intervals. Fish were separated by species, counted and weighed. Select species were measured for length frequency distributions. Normal operation fish losses were estimated by multiplying the mean daily impingement loss times the number of days that circulating water pumps were in operation during the period. Heat treatment fish loss was added to the estimated normal operation fish loss to determine total annual fish loss.

Daily impingement rates were averaged across the sample size of 163 normal operation samples and 20 heat treat samples. Target species comprised 98.8% of total daily impingement during the two-year period; of the fish collected 54.2% were queenfish; 14.9% white croaker; 7.1% walleye surfperch; and 6.7 % northern anchovy.

Impact Assessment Model

The purpose of the assessment was to compare cooling system intake fish losses (entrainment and impingement) to offshore larval and adult stocks and determine the impact of station operation on fish resources in the nearshore of the Southern California Bight. The data collected included estimates of field population abundance, distribution, and age structure of selected 316(b) target species. A database of offshore ichthyoplankton stocks was developed during a one year sampling program by the Los Angeles County Museum of Natural History. The estimates were compared to entrainment and impingement losses resulting in a probability (Rc) of survival for individuals of each species over a five-year period (Table B-7). The statistic (1-Rc) indicated the percent probability of mortality due to station operation. This study indicated that no significant adverse effect on the nearshore populations of target species was expected.

The conclusion of this series of investigations was that the operation of Ormond would not make a significant or substantial impact to the local marine species.

5.2.1.2 Ormond Receiving Water Monitoring Reports

Ormond conducts a marine monitoring program in order to comply with specifications set forth by the Los Angeles Regional Water Quality Control Board, (LARWQCB) as part of NPDES Permit Number CA0001198 dated June 28, 2001. This program includes physical monitoring of the receiving waters and underlying sediments, and biological sampling of the benthic infaunal assemblages and mussels. Fish and macroinvertebrate impingement studies were also conducted periodically throughout the year. Results of the impingement reports submitted to the LARWQCB between 2001 and 2004 are discussed below. Each of the reports concludes that fish and macroinvertebrate species collected were typical of the nearshore environment from which the generating station withdraws its cooling water.

Impingement

Impingement sampling was conducted during representative periods of normal operation and during all heat treatment operations. A normal operation survey was defined as a sample of all fish and macroinvertebrates impinged onto traveling screens during a 24 hour period with all circulating pumps operating, if possible. Normal operation abundance and biomass for the year were estimated by extrapolating the monitored abundance and biomass based on the percentage of the annual flow into the plant on the days sampled. During heat treatment sessions impinged fish and macroinvertebrates were collected, sorted by species, counted and weighed. Data were combined with the estimated normal operation data to determine the total impingement loss for the year. The reports concluded that the operation of the Ormond station had no detectable adverse effects on the beneficial uses of the receiving waters.

2004

A total extrapolated count of 5,000 individual fish representing 42 species weighing over 1,100 kg were impinged at the generating station in 2004 during heat treatment and normal operations. Northern anchovy, shiner perch, and Pacific sardine were the most abundant species taken. Abundance of impinged macroinvertebrates totaled 17,000 individual of 19 species. Normal operations yielded 70% of the fish impinged, whereas 30% were taken during heat treatments. Species composition and abundance were similar to those noted during the previous ten years. The macroinvertebrate population was also abundant and diverse, with red jellyfish, sheep crab, and Pacific rock crab most abundant.

2003

A total extrapolated count of 11,132 individual fish representing 53 species weighing over 770 kg were impinged at the generating station in 2003 during heat treatment and normal operations. Queenfish, northern anchovy, and shiner perch were the most abundant species taken. Abundance of impinged macroinvertebrates totaled an estimated 11,132 individual of at least 20 species. Normal operations yielded 47% of the fish impinged, whereas 53% were taken during heat treatments. Species composition and abundance were similar to those noted during the previous ten years. The macroinvertebrate population was also abundant and diverse, with Pacific rock crab, California two-spot octopus and purple-striped jellyfish most abundant.

2002

A total extrapolated count of 16,209 individual fish representing 54 species weighing over 440 kg were impinged at the generating station in 2002 during heat treatment and normal operations. Queenfish and northern anchovy were the most abundant species taken. Abundance of impinged macroinvertebrates totaled 16,958 individual of 19 species. Normal operations yielded 77.5% of the fish impinged, whereas 22.5% were taken during heat treatments. Species composition and abundance were similar to those noted during the previous ten years. The macroinvertebrate population was also abundant and diverse, with common salp and red rock crab most abundant.

2001

A total extrapolated count of 15,583 individual fish representing 47 species weighing over 2,687 kg were impinged at the generating station in 2001 during heat treatment and normal operations. Pacific pompano and queenfish were the most abundant species taken. Abundance of impinged macroinvertebrates totaled 11,225 individual of at least 19 species. Normal operations yielded 78.3% of the fish impinged, whereas 21.7% were taken during heat treatments. Species composition and abundance were similar to that noted in the previous ten years, but much greater than that seen in the unusually low years of 1999-2000. MBC indicated that the changes seen were likely due to the abundance of recently departed La Nina, a cooler-than-normal oceanographic perturbation that is known to shift population centers. Especially significant was that this phenomenon followed a two-year long El Nino that brought warmer-than-normal waters to southern California. The macroinvertebrate population was also abundant and diverse, with the Pacific rock crab most abundant species.

5.2.2 Mandalay

SCE and Reliant have collected data to evaluate impacts of both impingement and entrainment from the operation of Mandalay. The studies are discussed below:

5.2.2.1 Mandalay 316(b) Demonstration & Technical Appendix

Site-specific data for the original 316(b) Demonstration were collected only for impingement. Impacts on entrainment were inferred from entrainment impacts at Los Angeles Department of Water and Power's Haynes Generating Station (HGS). The conclusions were based on the assumption that generating stations with CWISs in similar habitats, in this case in a channel/embayment environment, along the Southern California Bight would have similar entrainment impacts.

Entrainment

Entrainment monitoring occurred between October 1979 and September 1980 at the HGS. Day and night samples were taken approximately two times per week Samples were collected near the entrance of the intake conduit structure. Day samples were collected from the midwater with a high volume pump. Night samples were collected from discrete water column levels. Mean daily larval entrainment densities for each month were calculated from larval abundance, day length, and station flow volume. Entrainment mortality was assumed to be 100%. Estimates of entrainment at Mandalay were developed by applying a factor (0.3286) to HGS entrainment levels based on Mandalay's lower flow volumes roughly 1/3 as much. As shown in Table B-8 target species comprised 16.20% of the total daily entrainment during the two-year period; of these 8.6%

were of the Engraulid sp. complex; 5.7% white croaker; and 1.9% queenfish. The balance or non-target species were dominated by gobies and blennies.

Bight-wide Plankton Investigation

The Bight-wide plankton investigation is described above in section 4.2.1.1.

Impingement

Impingement monitoring data were taken between October 1979 and September 1980. Data taken between August 1979 and July 31 1980 were taken twice per week while the remaining data were taken once per week. All screen/trash basket washings were collected during normal operations. Heat treatment was unnecessary with the configuration of the CWIS at that time. Species were grouped into algal, invertebrate, and fish categories. The following data were calculated: (1) number of fish species; (2) number of individuals per species; and (3) weight per species. Up to 200 individuals of the target species were measured for length and up to 50 individuals were sexed. Non-target species found in large numbers were also counted and sexed. Oceanographic, climatological, and plant operational parameters were measured during each sampling period. Daily impingement rates were averaged across the sample size of 154 samples. Target species comprised 63.6% of total daily impingement during the two-year period; of these 41.2% were shiner surfperch; 7.2% queenfish; 6.8% anchovy; and 3.2% white surfperch.

Impact Assessment Model

The Impact Assessment Model is described above in section 4.2.1.1. The statistic (1-Rc) shown in Table B-9 indicates the percent probability of mortality due to station operation. This study indicated that no significant adverse effect on the nearshore populations of target species was expected.

The conclusion of this series of investigations was that the operation of Mandalay would not make a significant or substantial impact to the local marine species.

5.2.2.2 Mandalay Receiving Water Monitoring Reports

Mandalay conducts a marine monitoring program in order to comply with specifications set forth by the LARWQCB as part of NPDES Permit Number CA0001180 dated April 26, 2001. This program includes physical monitoring of the receiving waters and underlying sediments, and biological sampling of the benthic infaunal, fish, and macroinvertebrate assemblages. Results of the impingement and biological monitoring reports submitted to the LARWQCB between 2001 and 2004 are discussed below. Each of the reports concludes that fish and macroinvertebrate species collected were typical of the bay/nearshore environment from which the generating station withdrawals its cooling water.

Impingement

Fish impingement sampling was conducted during representative periods of normal operation and during all heat treatment operations. A normal operation survey was defined as a sample of all fish and macroinvertebrates impinged onto sliding screens during a 24 hour period with all circulating pumps operating, if possible. The yearly abundance and biomass of impacted species under normal operation are estimated by multiplying the daily mean catch per unit effort by the annual total cooling water flow. During heat treatment sessions impinged fish and macroinvertebrates were collected, sorted by species, counted and weighed. Data were combined with the estimated normal operation data to determine the total impingement loss for the year. The reports indicated that the operation of the Mandalay station had no detectable adverse effects on the beneficial uses of the receiving waters.

2004

A total extrapolated count of 23,053 individual fish representing 13 species were impinged at the generating station in 2004. Abundance of impinged macroinvertebrates was much lower, totaling 190 individuals of eight species. Annual impingement estimates were derived by combining the loss during the one heat treatment with the extrapolating results of the five normal operation surveys over the entire year. Two species accounted for over 80% of impingement abundance: shiner perch and California grunion. These two species have been the most abundant species impinged since 2002. The most abundant macroinvertebrates impinged were the purple shore crab and the nudibranch, navanax, which were collected only during normal operation surveys.

2003

A total extrapolated count of approximately 7,500 individual fish representing 11 species were impinged at the generating station in 2003. Abundance of impinged macroinvertebrates was much lower, totaling 20 individual of four species. Annual impingement estimates were derived by combining the loss during two heat treatments and extrapolating the results of the four normal operation surveys over the entire year. Over 500 California grunion were recorded during the February 2003 normal operation survey. The February 2003 survey coincided with a full moon and expected spawning event of the California grunion. Alternatively, the sampling event two months later, April 9, 2003, coincided with a neap tide and only 1 grunion individual was impinged in the sampling event on June 18, 2003, which again coincided with a neap tide, resulted in the impingement of 2 individual grunion. Given that grunion activities are typically highest in the April through June time frame yet the data document low impingement during this time frame for 2003, it is apparent that calculating an annual impingement rate of California grunion is open to considerable uncertainty. As shown by these results, the biology of the grunion will strongly affect the magnitude of the impact on this species from impingement. Aside from the many grunion, the other dominant fish and macroinvertebrate species collected were typical of a bay-type environment from which the generating station withdrawals its cooling water.

2002

A total extrapolated count of 136,749 individual fish representing 20 species were impinged at the generating station in 2002. Abundance of impinged macroinvertebrates was much lower, totaling 46 individual of three species. Annual impingement estimates were derived by extrapolating the results from one heat treatment and five normal operation surveys over the entire year. Over 4,000 California grunion were recorded during the March 2002 normal operation survey, and over 800 shiner perch were impinged during the May 2002 survey. The March 2002 survey coincided with a full moon and expected spawning event of the California grunion.

2001

A total extrapolated count of 186 individual fish representing 6 species was impinged at the generating station in 2001. Abundance of impinged macroinvertebrates totaled 154 individuals of five species. Annual impingement estimates were derived by combining the loss during one heat treatment and extrapolating the results of the two normal operation surveys over the entire year. Three species accounted for over 70% of impingement abundance: Pacific staghorn sculpin, shiner perch and California halibut. The most abundant macroinvertebrates impinged were the California squid and the purple shore crab. Of particular note is the absence of grunion, although the limited number of samples likely missed times that the species might have been present.

5.2.3 Discussion of IM and E Data at Reliant Facilities

Ambient data collected for the original 316(b) Demonstrations and the recent data collected for the NPDES permits show a consistency in major species composition of the nearshore fish community adjacent to these two facilities. In addition, the impingement data for Ormond, shows a similar consistency and close correlation with the existing data on the local fish populations. While the data are insufficient to identify if there have been any changes in population densities of the impinged species, the consistency of the data (Figure B-1) coupled with the low absolute rate of impingement suggests that the operation of the Ormond CWIS has not affected the local fish community. In contrast, the frequency of species impinged at Mandalay differs substantially from both the ambient populations and those impinged at Ormond.

The average impingement rate at Ormond was 0.09 fish per 10,000 cubic meters (m^3) of seawater pumped and at Mandalay was 4.96 fish per 10,000 m^3 of seawater. The monthly and yearly impingement rates for each facility are shown in Figures B-3 through B-6.

5.2.3.1 Temporal variations in IM and E

Temporal variations in IM and E are the result of both biological factors (e.g., spawning season, migrations, ocean productivity etc.) and non-biological factors (e.g., sea surface temperature, tidal height, plant operational status, etc.). Due to the multitude of factors that can potentially affect impingement mortality and entrainment at a given location, temporal variations may difficult to ascertain unless they are substantial.

Understanding of the temporal variations in impingement and entrainment is important for two potential reasons:

- In order to characterize accurately impacts of impingement mortality and entrainment. For example, if impingement events were significantly more common during the night, failure to sample during both day and night would bias the daily estimates of impingement. Reliant believes that the existing data sets have addressed this issue by inclusion of sampling over a 24-hour period and throughout the year.

- In order to assess whether periodic flow reduction might serve as a mitigation measure. For example, if it can be demonstrated that impingement mortality occurs during a specific season and the plant can be idled or run with reduced cooling water flow during that period, this might present an effective mitigation strategy.

As discussed earlier, impingement at Mandalay is highly episodic, primarily due to impingement of grunion during their spawning events or as schooling events (i.e. schooling of shiner perch and topsmelt). These observations suggest that coastal species, especially grunion, may run into the Channel Island Harbor and move to the Edison Canal in response to the induced flow velocity into the canal. These coastal species would be expected to orient their movement to flow more strongly than resident harbor species because the former species would be responding to longer period currents while the latter species would be used to responding to tidal ebb and flow and other regular shallow water movement.

These observations may help to explain the importance of coastal species among impinged fish and harbor species among entrained fish. Reliant recognizes that this pattern can be used to manage the impacts to grunion since the occurrence of grunion follows a highly predictable cycle. Both Ormond and Mandalay are presently on a "peaking reserve" status and operate on a limited basis, only when energy production is needed. Typically power demand increases in mid to late summer, thus increasing impingement mortality and entrainment rates during the warmer months due to the increase in water withdrawal. Locally, energy demand also peaks at the end of the year as residents use more electricity during the holidays. Based on recent operating history, both facilities have shown this pattern of use.

By limiting generation and therefore water flow at Mandalay during peak grunion spawn season (March to June) to times when grunion are not spawning, impingement to grunion could be greatly reduced. The primary limitation in implementing this management practice is in Reliant's contractual requirements to deliver power. Due to the seemingly ever changing demands for power generation in California, Reliant can not commit to not running the plant during spring tides between March and June. However, by planning ahead and limiting the time that Mandalay would be operation during the peak grunion spawning months of March through June, impacts could be minimized.

As characterized by the grunion, spawning season is one of the most important biological factors affecting impingement mortality and entrainment rates. The primary period of reproduction and peak abundance of most Southern California Bight taxa is during the months of spring (typically March through May). The peak time of egg recruitment is during early spring, while larval recruitment is primarily late spring and early summer. Spring and summer therefore appear to be the most important seasons in the Southern California Bight in regards to entrainment, as this is the time eggs and larval organisms are most abundant. Many of these organisms will be able to avoid entrainment later in the year as they grow larger, and increase their swimming ability.

Monthly impingement data collected for receiving water monitoring at Ormond demonstrate that fish abundance was somewhat episodic with more fish being taken during fall and winter months. This observation is in line with the annual impingement trends demonstrated in the CDS.

The original 316(b) Demonstration at Ormond indicated that larval entrainment peaked in the spring months, March through May, and again in the late summer/fall period during September and October. Minimum entrainment of larval fish occurred during June and July. The peak periods entrainment for commonly entrained species are as follows: anchovy (Feb-May and August-October); white croaker (correspond to periods of reduced water temperature in November-April); queenfish (April-September).

Biological monitoring offshore of the Mandalay station indicated that fish species abundance and richness were generally highest during the summer months. MBC speculated that this increase is likely due to increased day length, water temperatures and productivity during the summer (MBC 2004).

Entrainment sampling for the 1983 CDS at Ormond was conducted four times throughout a 24 hour period (day, night, sunrise, and sunset). The magnitude of daily ichthyoplankton entrainment at this facility was directly related to the time of day. Entrainment densities were highest between dusk and early morning hours, prior to sunrise, and were observed to be lowest near mid-day.

Additionally, day and night entrainment samples were collected for the Mandalay 1982 CDS. While these samples were collected at the HGS they provide useful information. The magnitude of daily ichthyoplankton entrainment was directly related to time of day. The majority of larvae of all taxa taken during the study were collected at night in the middle and lower water column.

The primary value of this information is to ensure that ichthyoplankton sampling be completed during a full 24-hour cycle rather than simply as a day and night sampling events.

5.2.3.2 Spatial Differences in IM and E

Spatial differences in population densities are caused by many factors including habitat, water depth, and velocity. During the development of the Phase I 316(b) rules, the EPA specifically noted that the selection of the location of the CWIS is one construction and design technology which can be used to minimize the impact of impingement mortality and entrainment. The Phase II 316(b) rule also allows the highest density of organisms in the vicinity of the CWIS to be used as the Calculation Baseline. Using the reasoning for the Phase I rule and the Phase II Calculation Baseline, the location of *existing* intake structures could be used to "claim" credit for the reduction of impingement mortality and entrainment.

This feature of the Rule is an important consideration at the Mandalay facility since the CWIS is situated at the end of the 2.5 mile long Edison Canal, which originates at northern terminus of the 1.3 mile long Channel Islands Harbor and is thus substantially removed from the Southern California Bight. Notably the species composition of impinged fishes at Mandalay differs greatly from the fish species composition found in the nearshore habitat right off Mandalay. Table B-10 outlines the habitats of commonly impinged species at both facilities as well as species observed in ambient sampling at Mandalay. Additionally, it suggests strongly that the ichthyoplankton species entrained at Mandalay would be different from those seen offshore of the facility, since it would be unlikely that significant numbers of eggs and larvae of those nearshore species would selectively travel into Mandalay via the harbor and Edison Canal. The net flow into the harbor and canal is considerably smaller than the longshore current affecting the nearshore species.

5.3 Sufficiency of Data to Estimate Calculation Baseline

Reliant reviewed current and historical data to assess the quantitative value of existing data and to determine if the data were sufficient to support estimating calculation baseline for Mandalay and Ormond. This review was conducted in light of the compliance alternative that Reliant anticipates pursuing for each station.

Data currently available in the literature suggests that existing research provides an adequate quantitative assessment of the status of the main fisheries in the Southern California Bight. These data when combined with the available data from the impingement and entrainment studies conducted at Mandalay and Ormond, provides a good qualitative assessment of the fish diversity and relative abundance in the Southern California Bight.

Data collected in the previously discussed impingement and entrainment studies were initially evaluated based on operating condition at the time the study was conducted. These operating conditions are estimated to be at or near maximum operating capacity. Evaluating these data and applying it to current operating conditions requires several assumptions:

- Approach velocities and through screen velocities are assumed to be the same;

- Intake structures have not undergone of retrofits or other changes in operation; and

- Densities of local fish and invertebrates and their diversity have not changed significantly.

Based on the available information, we believe that each of these assumptions is valid. However, of particular note is that as compared to when the original 316(b) assessment was completed, both plants are now operated as peak load facilities, not base load facilities. From this standpoint alone, these plants have reduced their impingement and entrainment substantially. However, because Reliant cannot commit to operating these facilities at less than their historical capacity, they have prepared this data review and will prepare the IMECS. Based on these considerations, Reliant feels that the historical data can be deemed to be representative of current conditions.

Reliant does note, however, that the lack of entrainment data at Mandalay is a limitation that should be addressed. While minimal entrainment rates are expected at Mandalay, and the entrainment study (1979-80) conducted at SCE's Haynes Generating Station showed that goby and blenny species dominated the samples (Table B-4) Reliant recognizes the need to verify these assumptions.

Reliant has proposed a data collection program that will support the various potential compliance alternatives including the estimation of the Calculation Baseline (see Section 6, above).

6.0 SUFFICIENCY OF DATA IN SUPPORTING THE IMECS

6.1 Data Quality Assurance/Quality Control

Data collection and analysis has been completed for the past 30 years by a small number of firms with MBC Applied Environmental Sciences (MBC) having been actively involved with the bulk of the sampling, and data analysis as well as the data interpretation and reporting. MBC has followed standard operating procedures (SOPs) that are well documented and well known. The more recent impingement studies at both stations has been conducted by Proteus Sea Farms, which has been located on the Ormond Beach generating station for over two decades, again using well documented and widely accepted SOPs. This continuity of data collection efforts as well as the adherence to SOPs ensures that the data that have been collected are of appropriate consistency and quality.

6.2 Most Common Species Impinged/Entrained

The most commonly entrained species are listed in Table B-6 (Ormond) and B-8 (Mandalay) and included gobies and blennies at Mandalay, and northern anchovy and white croaker at Ormond. Reliant acknowledges that the data upon which these determinations were made is relatively old (Ormond and Mandalay) and not site specific (Mandalay). It is within that context that Reliant has proposed ichthyoplankton sampling within the intake bays of the two plants.

The most abundantly impinged species are the California grunion and the shiner perch at Mandalay and queenfish, Pacific sardine, northern anchovy, and shiner perch at Ormond. Based on the quality of the impingement data, Reliant believes that these data are sufficiently robust to support the IMECS. However, to complement these data and consistent with the on-going requirements of their existing NPDES permits, Reliant will continue to collect impingement data on a regular basis for development of the IMECS.

6.3 Implications for CWIS Placement, Design, and Operation

Reliant believes that the data available on the fisheries of the Southern California Bight provides a sufficient perspective on the existing fisheries potentially affected by impingement or entrainment at Ormond and Mandalay. Reliant has reviewed three primary sources of information in for this PIC and will continue to acquire and evaluate additional information for the IMECS. These data sources include:

- <u>Site-specific data collected by SCE during the late 1970s and early 1980s.</u> The data in these reports will be compared to recently collected data to try to assess if there are changes that can be identified.

- <u>Data collected by Reliant during from the late 1990s on impingement rates and ambient populations as required by the NPDES permits</u>. The general patterns of impingement (e.g., relative frequency of species) are consistent with those observed from impingement studies conducted at the facility in the 1970s. These patterns will be compared to the new data to be collected for the IMECS.

- <u>The general literature on fisheries of the Southern California Bight</u>. Reliant will continue to mine this literature to document important background regarding the behaviors of important species such as the timing and distribution of their eggs and larvae, their likely survival upon impingement, their habitat preferences.

When this literature is considered as a whole and the studies proposed in this PIC are completed, we believe that there will be sufficient data to complete an IMECS consistent with the goals of the rule (see Section 4.2).

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Table B-1

Ten Most Abundant Fish Species Impinged During Normal Operations and Heat Treatment at Ormond 1980-2004

Species	1980	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004*	Total	Total %
queenfish	7,460	43,501	16,697	82,521	16,382	24,008	4,218	4,725	6,632	161	361	3,057	11,089	2,684	375	223,872	61.1
Pacific sardine	322	86	110	1,643	362	1,056	197	2,921	21,434	24	89	295	483	107	632	29,760	8.1
northern anchovy	301	365	891	631	2,022	1,600	2169	4,329	73	177	564	1,144	2,095	4,076	1,395	21,833	6.0
shiner perch	278	270	997	1,333	1,023	8,830	503	2,423	891	8	366	542	532	1,397	1,113	20,506	5.6
walleye surfperch	1,506	1,521	3,942	550	126	616	10	1,353	431		2	611	432	266	11	11,376	3.1
white seaperch	1,606	987	1,054	1,019	1,169	2,454	395	926	158		35	36	75	86	55	10,056	2.7
plainfin midshipman	1,844	1,484	999	490	336	432	11			46	58	1	172	2		5,874	1.6
Pacific pompano	1	157	72	738	22	16	4	1	1		5	3,350	186	280	8	4,841	1.3
white croaker	14	707	149	2,506	58	679	50	4	433			101	65	5		4,771	1.3
speckled sanddab		390	230	504	60	240					461	1,330	102	454	40	3,811	1.0
Total Number of Individuals	14,680	51,860	28,796	94,602	23,403	41,996	8,664	19,266	31,545	761	3,078	10,467	16,209	11,132	4,987	**366,361**	**90.5%**
Number of Species	54	65	54	60	59	48	41	38	47	28	42	49	54	53	43		

*2004 normal operation surveys based on estimated annual abundance, derived by multiplying mean annual CPUE by total report flow (152,367.48 mg).

Taken from MBC 2004 NPDES Receiving Water Monitoring Report, Ormond Generating Station

Table B-2

Twenty Most Abundant Fish Species Impinged During Normal Operations and Heat Treatment at Mandalay 2001-2004

	Species Abundance	
Common Name	**Total**	**Percent of Total**
California grunion	372,755	74.72
Shiner Perch	98,125	19.67
Topsmelt	16,032	3.21
Pacific sardine	3,121	0.63
Pacific staghorn sculpin	2,858	0.57
Northern anchovy	2,840	0.57
Diamond turbot	1,021	0.21
bay pipefish	803	0.16
Pacific pompano	290	0.06
Pacific halibut	218	0.04
California halibut	149	0.03
Pacific jack mackererl	146	0.03
bat ray	145	0.03
white surfperch	74	0.02
crevice kelpfish	73	0.02
bay goby	73	0.02
specklefin midshipman	73	0.02
round stingray	73	0.02
spotted kelpfish	6	0.00
queenfish	3	0.00

Table B-3

Twenty Most Abundant Fish Species Taken During Trawl Surveys at Mandalay 1978-2004

Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1999	2000	2001	2002	2003	2004	Total	Total %
white croaker	6,713	8,446	1,464	1,150	1,592	2,291	2,756	3,043	7,237	20	363	5,363	1,033	9,342	0	16	50,829	48.8%
queenfish	966	4,889	830	195	957	1,341	6,049	3,009	5,483	0	76	1,352	4,630	3,971	8	138	33,894	32.5%
northern anchovy	1,476	494	2	52	88	359	1,469	159	115	0	640	256	383	1,216	9	3,322	10,040	9.6%
speckled sanddab	36	8	40	64	76	217	4	75	16	7	143	219	38	224	51	476	1,694	1.6%
shiner perch	107	24	0	4	33	63	4	58	88	17	190	42	11	529	18	118	1,306	1.3%
barred surfperch	210	172	46	223	38	95	29	115	41	18	1	33	9	42	0	20	1,092	1.0%
white seaperch	245	321	2	17	18	26	5	5	80	12	25	0	1	225	0	0	982	0.9%
walleye surfperch	335	340	8	18	0	50	5	26	28	1	1	16	37	28	1	9	903	0.9%
kelp pipefish	0	0	0	0	0	0	0	0	0	0	80	149	104	179	3	118	633	0.6%
thornback	27	21	12	16	6	56	4	167	2	3	13	14	6	52	0	2	401	0.4%
California halibut	25	54	66	58	21	27	1	8	11	0	2	5	1	4	0	0	283	0.3%
California corbina	15	3	79	0	0	3	2	33	19	0	2	73	24	9	0	8	270	0.3%
California lizardfish	17	5	0	0	8	0	1	2	4	0	1	1	26	115	0	1	181	0.2%
yellowfin croaker	2	0	11	1	0	1	0	79	50	0	0	0	3	0	0	0	147	0.1%
barcheek pipefish	3	0	0	77	5	0	0	0	58	0	0	0	0	0	0	0	143	0.1%
fantail sole	0	10	17	10	1	3	1	1	5	1	39	27	1	16	0	0	132	0.1%
English sole	22	8	5	49	7	0	0	1	4	1	7	0	0	15	0	1	120	0.1%
basketweave cusk-eel	1	3	9	0	8	45	0	28	4	0	1	5	0	0	0	0	104	0.1%
shovelnose guitarfish	6	11	6	22	13	18	0	19	2	0	1	2	0	2	0	0	102	0.1%
Pacific pompano	2	23	0	6	0	1	7	0	3	0	0	30	2	20	0	1	95	0.1%
Total Number of Individuals	10,299	14,986	2,648	2,009	2,896	4,674	10,399	6,892	13,296	89	1,597	7,616	6,324	16,056	91	4,304	**104,176**	**99.2%**
Number of Species	41	35	29	24	23	30	21	28	33	10	25	22	24	27	7	23		
Total Number of Trawls	28	24	12	12	16	16	16	16	16	8	16	16	16	16	4	16		
Seasons Sampled	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2		

Taken from MBC 2004 NPDES Receiving Water Monitoring Report, Mandalay Generating Station

Table B-4
Impingement Data For Ormond 1997-2004

Species	Common Name	Species Abundance: Heat Treatment	Monitored	Extrapolated	Total	Percent of Total
Seriphus politus	queenfish	12438	814	21007.94	33445.94	29.99
Sardinops sagax	Pacific sardine	23535	130	3355.08	26890.08	24.11
Engraulis mordax	Northern Anchovy	9809	133	3432.50	13241.50	11.87
Cymatogaster aggregata	shiner perch	3226	184	4748.72	7974.72	7.15
Atherinops affinis	topsmelt	3898	41	1058.14	4956.14	4.44
Hyperprosopon argenteum	walleye surfperch	2784	16	412.93	3196.93	2.87
Peprilus simillimus	Pacific pompano	155	109	2813.10	2968.10	2.66
Citharichthys stigmaeus	speckled sanddab	2	92	2374.36	2376.36	2.13
Phanerodon furcatus	white surfperch	1148	23	593.59	1741.59	1.56
Platyrhinoidis triseriata	thornback ray	4	47	1212.99	1216.99	1.09
Porichthys myriaster	specklefin midshipmen	17	43	1109.76	1126.76	1.01
Parophrys vetulus	english sole	0	43	1109.76	1109.76	1.00
Leptocottus armatus	Pacific staghorn sculpin	10	40	1032.33	1042.33	0.93
Syngnathus leptorhynchus	bay pipefish	15	33	851.67	866.67	0.78
Myliobatis californica	bat ray	11	33	851.67	862.67	0.77
Leuresthes tenuis	California grunion	7	28	722.63	729.63	0.65
Pleuronichthys verticalis	hornyhead turbot	3	26	671.02	674.02	0.60
Paralabrax nebulifer	barred sandbass	597	1	25.81	622.81	0.56
Genyonemus lineatus	white croaker	411	8	206.47	617.47	0.55
Torpedo californica	torpedo ray	8	21	541.97	549.97	0.49
Rhacochilus toxotes	rubberlip surfperch	264	6	154.85	418.85	0.38
Sebastes auriculatus	brown rockfish	272	4	103.23	375.23	0.34
Synodus lucioceps	California lizardfish	1	14	361.32	362.32	0.32
Amphistichus argenteus	barred surfperch	241	3	77.42	318.42	0.29
Pleuronichthys decurrens	curlfin sole	1	12	309.70	310.70	0.28
Psettichthys melanostictus	sand sole	0	9	232.27	232.27	0.21
Citharichthys sordidus	Pacific sanddab	1	8	206.47	207.47	0.19
Scorpaenichthys marmoratus	cabezon	130	3	77.42	207.42	0.19
Otophidium scrippsi		0	8	206.47	206.47	0.19

Table B-4
Impingement Data For Ormond 1997-2004

Species	Common Name	Species Abundance				
		Heat Treatment	Monitored	Extrapolated	Total	Percent of Total
Paralichthys californicus	California halibut	9	7	180.66	189.66	0.17
Paralabrax clathratus	kelp bass	138	1	25.81	163.81	0.15
Porichthys notatus	plainfin midshipman	5	6	154.85	159.85	0.14
Symphurus atricauda	California tonguefish	0	5	129.04	129.04	0.12
Rhinobatos productus	Shovelnose guitarfish	22	4	103.23	125.23	0.11
Trachurus symmetricus	Pacific jack mackerel	19	4	103.23	122.23	0.11
Brachyistius frenatus	kelp perch	44	3	77.42	121.42	0.11
Urolophus halleri	round stingray	7	4	103.23	110.23	0.10
Scorpaena guttata	scorpion fish	23	3	77.42	100.42	0.09
Paralabrax maculatofasciatus	spotted sand bass	59	1	25.81	84.81	0.08
Heterostichus rostratus	giant kelpfish	7	3	77.42	84.42	0.08
Pleuronichthys ritteri	spotted turbot	0	3	77.42	77.42	0.07
Triakis semifasciata	leopard shark	0	3	77.42	77.42	0.07
Oxyjulis californica	seniorita	48	1	25.81	73.81	0.07
Rhacochilus vacca	pile surfperch	43	1	25.81	68.81	0.06
Chromis punctipinnis	blacksmith	42	1	25.81	67.81	0.06
Scomber japonicus	chub mackerel	37	1	25.81	62.81	0.06
Embiotoca jacksoni	black surfperch	62	0	0.00	62.00	0.06
Menticirrhus undulatus	California king croaker	3	2	51.62	54.62	0.05
Syngnathus californiensis	kelp pipefish	1	2	51.62	52.62	0.05
Mustelus californicus	grey smooth-hound	0	2	51.62	51.62	0.05
Pleuronichthys coenosus		0	2	51.62	51.62	0.05
Raja inornata		0	2	51.62	51.62	0.05
Xenistius californiensis		48	0	0.00	48.00	0.04
Atherinopsis californiensis		32	0	0.00	32.00	0.03
Sebastes paucispinis		3	1	25.81	28.81	0.03
Agonopsis sterletus		1	1	25.81	26.81	0.02
Anisotremus davidsonii		1	1	25.81	26.81	0.02
Cephaloscyllium ventriosum		0	1	25.81	25.81	0.02
Citharichthys xanthostigma		0	1	25.81	25.81	0.02

Table B-4
Impingement Data For Ormond 1997-2004

Species	Common Name	Species Abundance				
		Heat Treatment	Monitored	Extrapolated	Total	Percent of Total
Gibbonsia elegans		0	1	25.81	25.81	0.02
Hydrolagus colliei		0	1	25.81	25.81	0.02
Hypsopsetta guttulata		0	1	25.81	25.81	0.02
Lepidogobius lepidus		0	1	25.81	25.81	0.02
Mola mola		0	1	25.81	25.81	0.02
Squalus acanthias		0	1	25.81	25.81	0.02
Hexagrammos decagrammus		16	0	0.00	16.00	0.01
Sebastes serranoides		16	0	0.00	16.00	0.01
Oxylebius pictus		15	0	0.00	15.00	0.01
Cheilotrema saturnum		14	0	0.00	14.00	0.01
Atractoscion nobilis		13	0	0.00	13.00	0.01
Chinocottus embryum		12	0	0.00	12.00	0.01
Sebastes rastrelliger		9	0	0.00	9.00	0.01
Ophiodon elongatus		7	0	0.00	7.00	0.01
Sebastes caurinus		7	0	0.00	7.00	0.01
Halichoeres semicinctus		6	0	0.00	6.00	0.01
Embiotoca lateralis		5	0	0.00	5.00	0.00
Hypsurus caryi		5	0	0.00	5.00	0.00
Hermosilla azurea		4	0	0.00	4.00	0.00
Hypsoblennius gilberti		4	0	0.00	4.00	0.00
Heterodontus francisci		3	0	0.00	3.00	0.00
Hypsoblennius gentilis		3	0	0.00	3.00	0.00
Medialuna californiensis		3	0	0.00	3.00	0.00
Sebastes flavidus		3	0	0.00	3.00	0.00
Amphistichus koelzi		2	0	0.00	2.00	0.00
Sebastes atrovirens		2	0	0.00	2.00	0.00
Umbrina roncador		2	0	0.00	2.00	0.00
Apodichthys flavidus		1	0	0.00	1.00	0.00
Aulorhynchus flavidus		1	0	0.00	1.00	0.00
Gibbonsia montereyensis		1	0	0.00	1.00	0.00

Table B-4 **Impingement Data For Ormond 1997-2004**						
		Species Abundance				
Species	**Common Name**	**Heat Treatment**	**Monitored**	**Extrapolated**	**Total**	**Percent of Total**
Girella nigricans		1	0	0.00	1.00	0.00
Mustelus henlei		1	0	0.00	1.00	0.00
Neoclinus blanchardi		1	0	0.00	1.00	0.00
Sebastes goodei		1	0	0.00	1.00	0.00
Sebastes hopkinsi		1	0	0.00	1.00	0.00
Sebastes serriceps		1	0	0.00	1.00	0.00
Sebastes wilsoni		1	0	0.00	1.00	0.00
Semicossyphus pulcher		1	0	0.00	1.00	0.00
Sphyraena argentea		1	0	0.00	1.00	0.00
Survey totals		**59,805**	**2,004**	**51,720**	**111,525**	
Number of species		**81**	**62**	**62**	**98**	

Table B-5

Impingement Data For Mandalay 2001-2004

		Species Abundance				
Species	**Common Name**	**Heat Treatment**	**Monitored**	**Extrapolated**	**Total**	**Percent of Total**
Leuresthes tenuis	California grunion	32	5,138	372,723	372,755	74.72
Cymatogaster aggregata	Shiner Perch	555	1,345	97,570	98,125	19.67
Atherinops affinis	Topsmelt	0	221	16,032	16,032	3.21
Sardinops sagax	Pacific sardine	2	43	3,119	3,121	0.63
Leptocottus armatus	Pacific staghorn sculpin	29	39	2,829	2,858	0.57
Engraulis mordax	Northern anchovy	11	39	2,829	2,840	0.57
Hypsopsetta guttulata	Diamond turbot	5	14	1,016	1,021	0.21
Syngnathus leptorhynchus	bay pipefish	5	11	798	803	0.16
Peprilus simillimus	Pacific pompano	0	4	290	290	0.06
Hippoglossus stenolepis	Pacific halibut	0	3	218	218	0.04
Paralichthys californicus	California halibut	4	2	145	149	0.03
Trachurus symmetricus	Pacific jack mackererl	1	2	145	146	0.03
Myliobatis californica	bat ray	0	2	145	145	0.03
Phanerodon furcatus	white surfperch	1	1	73	74	0.02
Gibbonsia montereyensis	crevice kelpfish	0	1	73	73	0.02
Lepidogobius lepidus	bay goby	0	1	73	73	0.02
Porichthys myriaster	specklefin midshipman	0	1	73	73	0.02
Urolophus halleri	round stingray	0	1	73	73	0.02
Gibbonsia elegans	spotted kelpfish	6	0	0	6	0.00
Seriphus politus	queenfish	3	0	0	3	0.00
Umbrina roncador	yellowfin croaker	3	0	0	3	0.00
Hyperprosopon argenteum	walleye surfperch	2	0	0	2	0.00
Paralabrax nebulifer	barred sand bass	2	0	0	2	0.00
Cheilotrema saturnum	black croaker	1	0	0	1	0.00
Heterostichus rostratus	giant kelpfish	1	0	0	1	0.00
Hexagrammos decagrammus	kelp greenling	1	0	0	1	0.00
Paralabrax clathratus	kelp bass	1	0	0	1	0.00
Survey totals		**665**	**6868**	**498,222**	**498,887**	
Number of species		**19**	**18**	**18**	**27**	

Table B-6

Historical Entrainment Data for Ormond (1979-1980)

Species	Daily Larval Entrainment (number entrained x10^5)	Rank	% of Total
Target Species			
Northern anchovy	22.07	1	41.8
White croaker	17.84	2	33.8
Queenfish	4.33	3	8.2
Kelp bass	0.03	19	0.1
Barred sand bass	0.05	20	0.1
Pacific pompano	0.03	22	0.1
Black croaker	0.01	37	<0.1
Yellowfin croaker	<0.01	42	<0.1
Sargo	<0.01	47	<0.1
Total target species	**44.39**		**84.1**
Non-target Species			
Pices larvae. Unid	5.5	4	5.5
Bay goby	1.63	5	3.1
Pices yolk sac larvae	1.12	6	2.1
Cheekspot goby	1.03	7	2.0
Goby type D	0.35	8	0.7
Goby	0.27	9	0.5
California halibut/fantail sole	0.15	10	0.3
Other	0.92		1.7
TOTAL	52.75		100

Table B-7

Estimated Impact of Ormond Station Operation on Fish Resources

	% Contribution to Total Losses				
Species	**Egg-10mm**	**10mm-30mm**	**30mm-90mm**	**> 90mm**	**Probability of survival**
Northern anchovy	4.73	77.22	16.30	1.75	99.64
White croaker	49.30	17.49	5.60	27.62	99.48
Queenfish	8.29	3.10	2.99	85.62	95.90
Kelp bass	10.63	6.42	79.39	3.56	99.60
Shiner surfperch	NA	NA	24.55	75.44	96.21
White surfperch	NA	NA	0.49	99.51	95.77
Data Taken from 1983 CDS for Ormond					

Table B-8

Historical Entrainment Data for Mandalay (taken at Haynes Generating Station 1979-1980)

Species	Base Daily Entrainment (LADWP)	Daily Larval Entrainment Mandalay	% Total
Target Species			
Engraulid sp. Complex[1]	16.30	5.36	8.60
White croaker	10.71	3.52	5.70
Queenfish	3.67	1.21	1.90
Total Target Species	**30.68**	**10.09**	**16.20**
Other Species			
Atherinid sp. Complex[2]	0.88	0.29	0.50
Gobiid sp. Complex[3]	72.02	23.67	38.1
Blennies	82.60	27.14	43.7
Diamond turbot	0.17	0.06	0.10
Other miscellaneous	2.77	0.89	1.40
Total larvae	**189.12**	**62.14**	**100.00**

[1]includes northern anchovy, deepbody anchovy, and slough anchovy
[2]includes California grunion, topsmelt, and jacksmelt
[3] includes cheekspot, arrow, and shadow gobies

Table B-9

Estimated Impact of Mandalay Station Operation on Fish Resources

Species	% Contribution to Total Losses				Probability of survival
	Egg to 10mm	10mm-30mm	30mm-90mm	> 90mm	
Northern anchovy	3.24	50	45	0.26	99.89
White croaker	95.49	2.29	1.56	0.65	99.97
Queenfish	19.98	61.20	13.44	5.38	99.56
Kelp bass	NA	NA	NA	99.99	99.99
Shiner surfperch	NA	NA	98.57	95.22	93.87
White surfperch	NA	NA	99.99	99.91	99.91
Data Taken from 1982 CDS for Mandalay					

Table B-10

Habitat Description for Commonly Impinged Fish Species at Reliant's Ormond & Mandalay Stations

Common Name	Scientific Name	Habitat	Habitat description
Topsmelt	*Atherinops affinis*	pelagic; brackish; marine	Common in bays, muddy and rocky areas and kelp beds, also in estuaries
Shiner perch	*Cymatogaster aggregata*	demersal; non-migratory; freshwater; brackish; marine ; depth range - 146 m	Usually in shallow water, around eelgrass beds, piers and pilings and commonly found in bays and quiet back waters. Also in calm areas of exposed coast. Enters brackish and fresh waters.
Californian anchovy	*Engraulis mordax*	pelagic; marine ; depth range 0 - 300 m	Usually found in coastal waters within about 30 km from shore, but as far out as 480 km
Crevice kelpfish	*Gibbonsia montereyensis*	demersal; marine ; depth range - 21 m	Occurs in inshore rocky areas in algae, usually on exposed coast
Pacific Halibut	*Hippoglossus stenolepis*	demersal; oceanodromous; marine ; depth range 0 - 1200 m	Found on various types of bottoms. Young are found near shore, moving out to deeper waters as they grow older. Older individuals typically move from deeper water along the edge of the continental shelf where they spend the winter, to shallow coastal water for the summer
Diamond turbot	*Hypsopsetta guttulata*	demersal; brackish; marine ; depth range 1 - 50 m	demersal; brackish; marine ; depth range 1 - 50 m
Bay goby	*Lepidogobius lepidus*	demersal; marine ; depth range - 201 m	Found mostly on mud bottom; from intertidal to 201 m depth.
Pacific staghorn sculpin	*Leptocottus armatus*	demersal; amphidromous; brackish; marine ; depth range 0 - 156 m	Commonly found near shore, especially in bays and estuaries; most frequently on sandy bottom
California grunion	*Leuresthes tenuis*	pelagic; marine ; depth range - 18 m	Adults inhabit inshore waters, usually at or near surface along open coast and in bays
Bat eagle ray	*Myliobatis californica*	demersal; marine ; depth range 1 - 46 m	Commonly found in sandy and muddy bays and sloughs, also on rocky

Common Name	Scientific Name	Habitat	Habitat description
			bottom and in kelp beds
California flounder	*Paralichthys californicus*	demersal; oceanodromous; brackish; marine ; depth range 0 - 183 m	Lives mostly on sandy bottoms. Common beyond surf line, also in bays and estuaries. Occurs from near shore to 183 m depth.
Pacific pompano	*Peprilus simillimus*	benthopelagic; marine ; depth range 9 - 91 m	Commonly found on sand bottom of exposed coasts. Usually occurs in shallow water near shore
White seaperch	*Phanerodon furcatus*	demersal; marine ; depth range - 43 m	Often occurs near piers, docks, in bays and sandy areas, but usually in quiet water and offshore areas near rocks.
Specklefin midshipman	*Porichthys myriaster*	demersal; marine ; depth range 0 - 126 m	Inhabits rocky areas and soft bottom, common in bays. Ranges from the intertidal zone to 126 m depth
South American pilchard	*Sardinops sagax*	pelagic; oceanodromous; marine ; depth range 0 - 200 m	Neritic. A coastal species.
Bay pipefish	*Syngnathus leptorhynchus*	demersal; brackish; marine	Common in eelgrass of bays and estuaries, sometimes taken in shallow offshore waters
Pacific jack mackerel	*Trachurus symmetricus*	pelagic; oceanodromous; marine ; depth range 0 - 400 m	Often found offshore, up to 500 miles from the coast. Young frequently occur in school near kelp and under piers
Haller's round ray	*Urolophus halleri*	demersal; marine ; depth range - 91 m	Occurs in sand or mud bottom off beaches and in bays and sloughs, sometimes around rocky reefs

Figure B-1

Correlation between Impingement Data Sets for Ormond SCE (1979-1980) and Proteus (1997-2004) For 14 Target Species

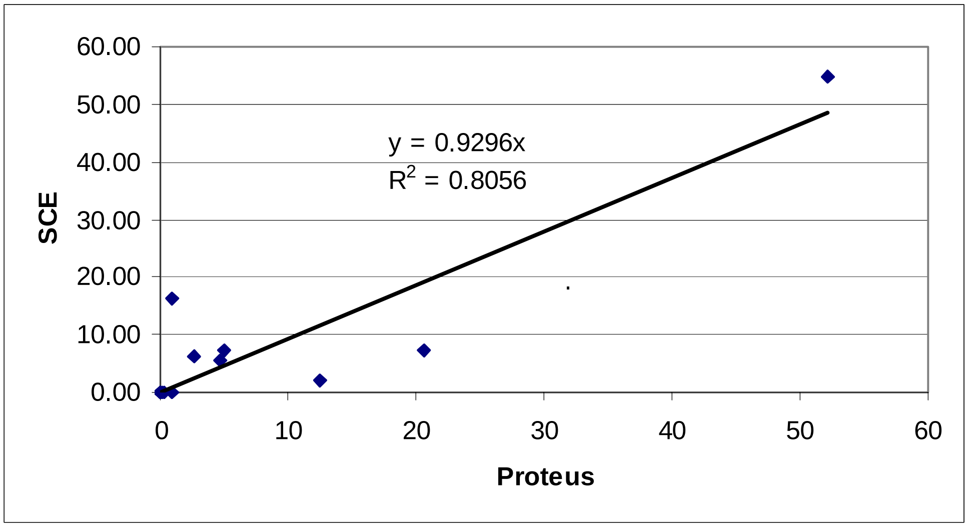


Figure B-2

Correlation between Impingement Data Sets for Mandalay SCE (1979-1980) and Proteus (2001-2004) For 14 Target Species

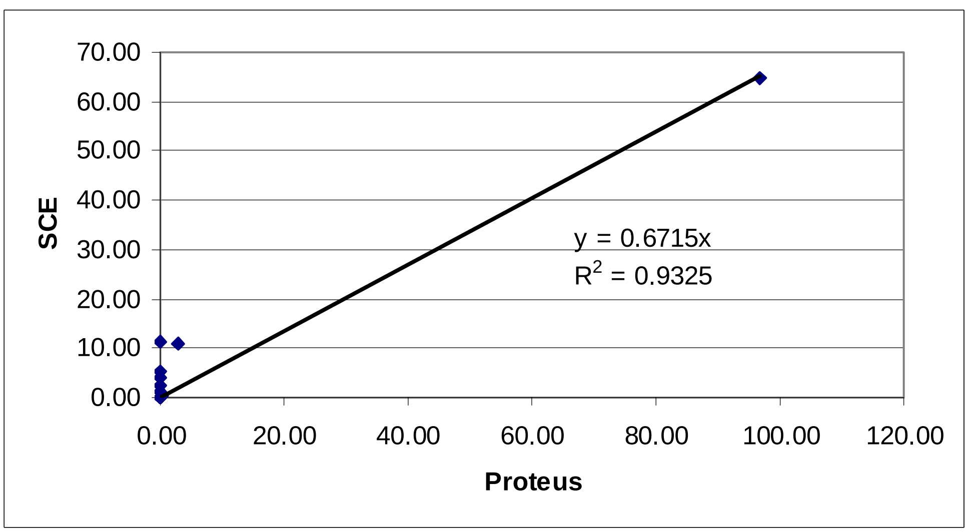


Figure B-3

Number of Fish Impinged Yearly at Ormond per 10,000m^3 during Normal Operations (1997-2004)

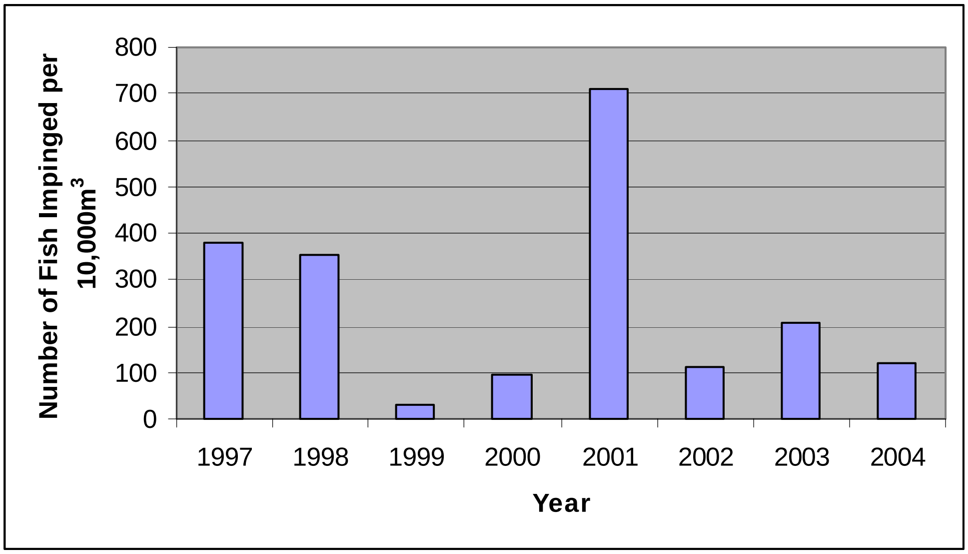


Figure B-4

Average Number of Fish Impinged Monthly at Ormond per 10,000m^3 during Normal Operations (1997-2004)

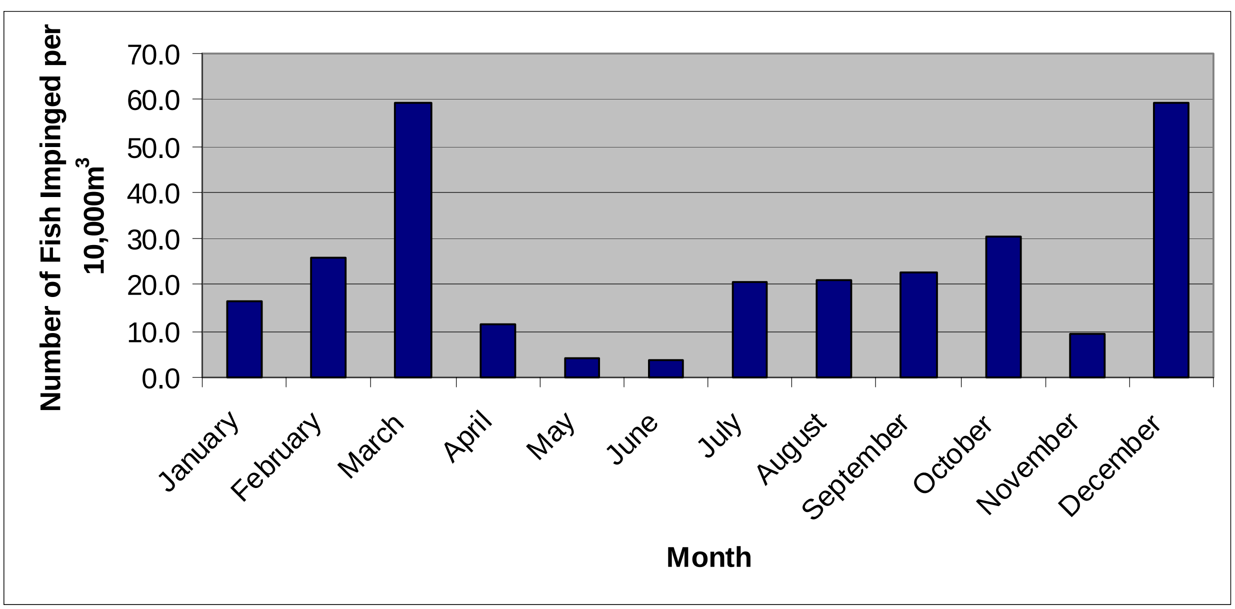


Figure B-5

Number of Fish Impinged Monthly at Mandalay per 10,000m3 during Normal Operations (2001-2004)

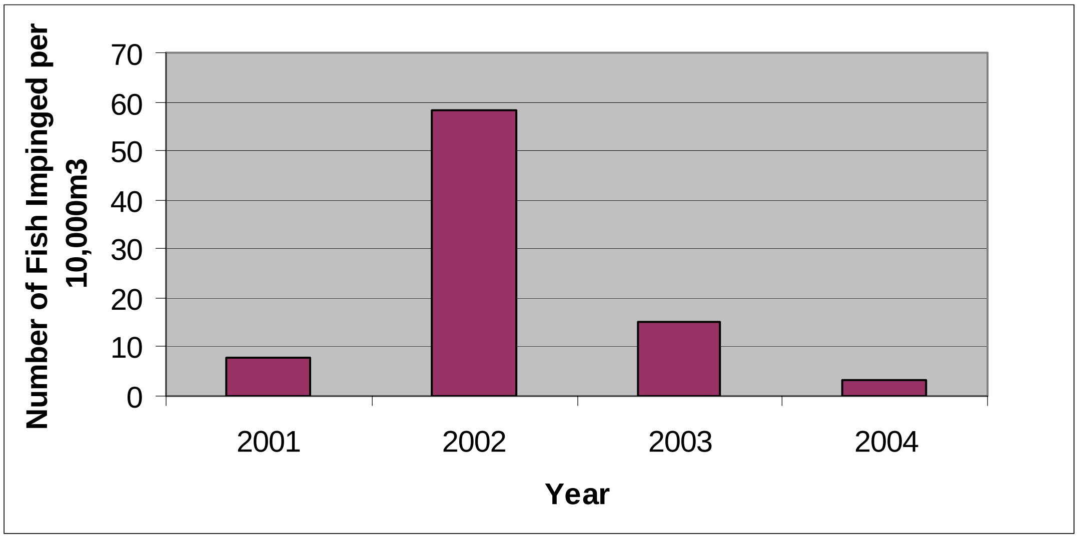
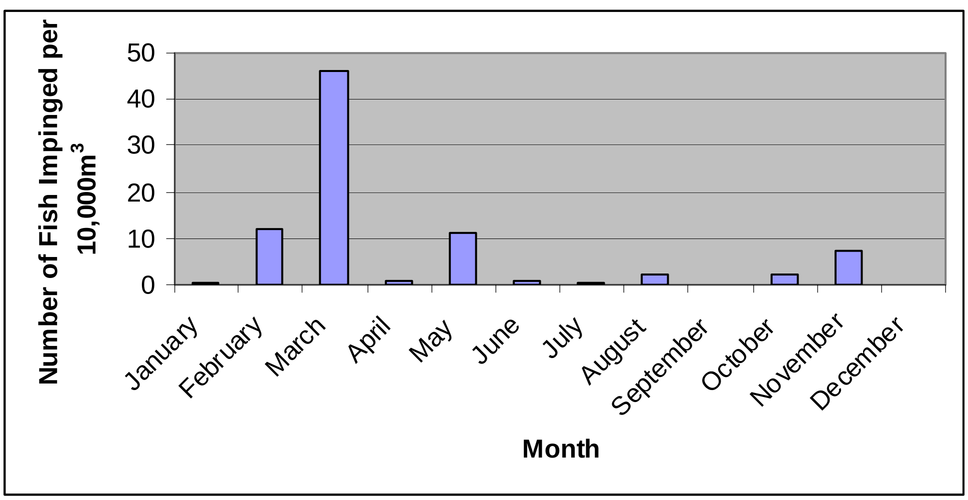


Figure B-6

Number of Fish Impinged Yearly at Mandalay per 10,000m^3 during Normal Operations (2001-2004)



APPENDIX C

EPA COST ESTIMATE

APPENDIX C

EPA COST ESTIMATE

Summary of US EPA-Estimated Compliance Costs based on the Model Facility Approach for the Section 316(b) Phase II Final F

Source: Appendices A and B of the Phase II Final Rule

Column 1 Facility Name	Column 2 Facility ID	Column 4 EPA Assumed Design Intake Flow, gpm (x_{epa})	Column 4a EPA Assumed Design Intake Flow, MGD (x_{epa})	Column 5 Capital Cost	Column 6 Baseline O&M Annual Cost	Column 7 Post Construction O&M Annual Cost	Column 8 Annualized Capital + Net O&M Using EPA Design Intake Flow[2] (y_{epa})	Column 9 Net Revenue Losses from Net Construction Downtime	Column 10 Pilot Study Costs	Column 11 Annualized Downtime and Pilot Study Costs[2,4]	Column A Total Annualized Costs[2,4]
Mandalay	AUT0638	201,395	290	$2,336,881	$50,154	$202,851	$485,416		$236,083	$18,832	$504,248

[1] The design flow adjustment slope (m) represents the slope that corresponds to the particular facility using the technology in column 3.

[2] Discount rate = 7%.

[3] Amortization period for capital costs = 10 years.

[4] Amortization period of downtime and pilot study costs = 30 years.

Depending

[5] EPA Technology Codes:

1. Addition of fish handling and return system
2. Addition of fine mesh screens to an existing traveling screen system.
3. Addition of a new, larger intake with fine-mesh screens and fish handling and return system in front of existing screen.
4. Addition of passive fine-mesh screen system (cylindrical wedgewire) near shoreline with mesh width of 1.75 mm.
5. Addition of fish net barrier system.
6. Addition of an aquatic filter barrier system.
7. Relocation of existing intake to a submerged offshore location with passive fine-mesh screen inlet with mesh width of 1.75 mm
8. Addition of a velocity cap inlet to an existing offshore intake.
9. Addition of passive fine-mesh screen to an existing offshore intake with mesh width of 1.75 mm
10. Not used
11. Addition of a dual-entry, single-exit traveling screen (with fine mesh) to a shoreline intake system.
12. Addition of passive fine-mesh screen system (cylindrical wedgewire) near shoreline with mesh width of 0.76 mm
13. Addition of a passive fine mesh screen to an existing offshore intake with a mesh width of 0.76 mm
14. Relocation of an existing intake to a submerged offshore location with passive fine-mesh screen inlet with mesh of 0.76 mm.

APPENDIX D

SAMPLING PLAN

APPENDIX D- SAMPLING PLAN

Southern California Edison (SCE) and Reliant Energy Incorporated (Reliant) have been collecting data on impingement and entrainment at the Mandalay Generating Station (Mandalay) for approximately the past 30 years. This data collection effort has been completed in support of Mandalay's original 316(b) demonstration as well as per Mandalay's current National Pollutant Discharge Elimination System (NPDES) permit conditions. SCE evaluated impingement in the 1970s and early 1980s, and since 2001 Reliant has been assessing impingement at Mandalay on an approximately monthly basis. Entrainment was also assessed in the 1970s and early 1980s. The conclusion of both the entrainment and impingement assessments is that operation of the cooling water intake structure (CWIS) does not substantially affect the local fish populations. Although the entrainment data are somewhat dated, Reliant believes that since there have been no significant changes in plant operation and the CWIS that would negatively affect the validity of historical data these data represent a comprehensive assessment of the impacts of operation of the Mandalay facility. Therefore, we believe these data are suitable for inclusion in the Impingement Mortality and Entrainment Characterization Study (IMECS). Reliant plans to undertake an additional one year of sampling to supplement and validate historical data and obtain facility–specific entrainment data.

40 CFR § 125.94(b)(1)(iv) specifies that the PIC should include: 90

> "A sampling plan for any new field studies you propose to conduct in order to ensure that you have sufficient data to develop a scientifically valid estimate of impingement mortality and entrainment 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 cooling water intake structure(s)), and provide a taxonomic identification of the sampled or evaluated biological assemblages (including all life stages of fish and shellfish)."

40 CFR § 125.94(b)(3) describes the requirements of the IMECS as follows:

> "You must submit to the Director an Impingement Mortality and/or Entrainment Characterization Study whose purpose is to provide information to support the development of a calculation baseline for evaluating impingement mortality and entrainment and to characterize current impingement mortality and entrainment. The Impingement Mortality and/or Entrainment Characterization Study must include the following, in sufficient detail to support development of the other elements of the CDS:

(i) 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;

(ii) 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 pursuant to paragraph (b)(3)(i) of this section, 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 annual, seasonal, and diel variations in impingement mortality and entrainment (e.g., related to climate and weather differences, spawning, feeding and water column migration). These may include historical data that are representative of the current operation of your facility and of biological conditions at the site;

(iii) Documentation of the current impingement mortality and entrainment of all life stages of fish, shellfish, and any species protected under Federal, State, or Tribal Law (including threatened or endangered species) identified pursuant to paragraph (b)(3)(i) of this section and an estimate of impingement mortality and entrainment to be used as the calculation baseline. The documentation may include historical data that are representative of the current operation of your facility and of biological conditions at the site. Impingement mortality and entrainment samples to support the calculations required in paragraphs (b)(4)(i)(C) and (b)(5)(iii) of this section must be collected during periods of representative operational flows for the cooling water intake structure and the flows associated with the samples must be documented."

The Final Rule Preamble states that this information must be provided in sufficient detail to support development of the other elements of the CDS and notes that while the taxonomic identification in item 40 CFR § 125.94(b)(3)i will need to be fairly comprehensive, the quantitative data required in items § 125.94(b)(3)ii and § 125.94(b)(3)iii may be more focused on species of concern, and/or species for which data are available.

This Sampling Plan presents Reliant's efforts to collect additional data to update and validate the historical impingement and entrainment assessments, and comply with the requirement of the regulations. Section 2.0 and 3.0 of Reliant's Proposal for Information Collection (PIC) for 316(b) compliance (of which this Appendix is a part) describe the CWIS and its zone of influence and Section 4.0 describes the historical data and provides the rationale for the selection of sampling methods and data analyses presented here.

Reliant plans to collect data on the existing impingement mortality and entrainment rates at the Mandalay facility. Sections E.1 and E.2 provide our approach to collect data sufficient to determine rates of impingement mortality and entrainment, respectively. Section E.3 provides more specific information on the field and laboratory protocols for each type of sampling.

D.1 Impingement

As required by its NPDES permit, Mandalay currently quantifies impingement during normal operation approximately monthly, as plant operations allow. Impingement during heat treatments is evaluated for every heat treatment episode. The methodology for the collection of the samples as well as the characterization of the species and the treatment of the data are presented below.

D.1.1 Historical and Current Impingement Sampling

Monthly sampling to characterize impingement during normal operations was done both initially and more recently. The current sampling is contingent upon facility operating normally. Sampling dates are randomly selected during a month, although at present, impingement sampling only occurs when the facility is generating electricity. If the facility is not running during a day scheduled for the impingement sampling to occur, the sampling event is moved to the next feasible date the facility is operating. The days that Mandalay operates are dependent upon electrical demand and maintenance outages; as compared to when the original impingement sampling was completed, currently the station does not operate continuously throughout the year. Also, the number of seawater circulation pumps in operation ranges from one to four and, consequently, the rate of seawater intake by the station vary daily, monthly, and seasonally.

For each impingement sampling event, fish, macroinvertebrates, and plants impinged on the intake screens during the sampling period have been collected, characterized to species, counted, and weighed. At the beginning of a 24-hour count, the screens are cleared to remove accumulated materials. At the end of the 24-hour period, organisms that have accumulated on the screen and in the collection basket are separated from debris and sorted by species. The standard lengths of bony teleost fish (subclass Osteichthyes) and the total lengths of all cartilaginous fish (subclass Chondrichthyes) are recorded. Lengths of the first 200 individuals for each species are recorded. Abundance and biomass for all fish and invertebrates of each species are recorded in kilograms.

Impingement sampling is also conducted during all heat treatments. A heat treatment is an operational procedure to eliminate fouling organisms, predominantly mussels and barnacles, from the seawater cooling system. Unchecked growth of these organisms reduces the operational efficiency of the station. During a heat treatment, the temperature of the seawater within the seawater cooling system is elevated to a range of 38˚- 40.5˚C. This temperature rise is accomplished by recirculating warm discharge water back into the station, increasing the seawater temperature within the forebay. By adjusting the position of the gates that control seawater flow within the seawater cooling system, the mix of recirculating seawater and incoming seawater can be controlled to achieve the desired heat treatment temperature while still allowing the plant to function. The elevated seawater temperature results in the mortality of marine organisms within the system. These organisms are impinged upon the removable screens, removed from the system, and deposited in containers where they are counted. The duration of the heat treatment sampling is typically three to six hours and coincides with the heat treatment period. The necessary duration of the heat treatment is inversely proportional to the seawater temperature.

D.1.2. Quantification of Impingement Losses

Impingement is primarily dependent upon the flow of seawater into Mandalay's seawater cooling system. Currently, seawater flow varies according to the number of seawater circulation pumps in operation, the tides, and the level of biofouling.

Historical studies calculated annual impingement rates by extrapolating from the daily impingement rates. Extrapolated monthly impingement rates were estimated by multiplying the measured 24-hour impingement counts by the ratio of the total cooling water flow for the month and dividing by the cooling water flow during the 24-hour count. Annual impingement for normal operations is the sum of the extrapolated monthly impingement values. Raw data are available to allow for alternative methods of estimation for comparison to newly collected data.

Total annual impingement loss is a combination of losses during normal operations and heat treatments for the year.

The following formula was used to estimate impingement:

$$\left[\frac{F_o - F_h}{F_{sa}}\right] N_{na} + N_{ha}$$

Where: I_a = Estimated total impingement during interval, of species "a"

F_o = Operational Flow during interval

F_h = Operational Flow during heat treatment

F_{sa} = Flow during sample day(s) (24-Hour fish counts) during interval

N_{na} = Number of fish "a" taken during 24-Hour sampling during interval

N_{ha} = Number of fish "a" taken in heat treatments during interval

Flow data for Mandalay were calculated based on the number of seawater circulation pumps in operation each day.

Nominal flows are:

Number of Seawater Circulation Pumps	Flow	
	gpm	mgd
1	44,000	63.3
2	88,000	126.7
3	132,000	190.0
4	176,000	253.4
gpm = gallons per minute mgd = million gallons per day		

Earlier estimates of fish impingement were based on a simple multiplier that assumed that the seawater rate of flow through the power plant remained constant during fish counts and the intervening periods of normal operations (SCE, 1983). This assumption was somewhat conservative although basically valid since the plant operated as a base-load facility and its pumps were operating nearly all of the time. In recent years, efforts to reduce operational expenses and conserve energy have resulted in operating procedures where seawater circulation pumps are routinely shut down when not needed. Seawater flow varies from day to day and month to month. Flow is the determining factor in impingement, so the original formula to estimate impingement has been modified from one that uses operational days to one that uses actual flow.

Data from the fish count records are entered into an on-line database management system. This database system enables personnel to enter data and download results through the internet. Queries were performed to provide the required information on the fish counts.

D.1.3. Impingement Sampling Plan

Reliant plans to conduct the same type of sampling of impingement rates as has been conducted over the past four years. Sampling will occur monthly unless Mandalay is not generating electricity for an entire month. Sampling dates will be determined randomly. However, when the facility is not operating during a pre-determined date; the next day the facility is operating normally impingement sampling will be completed. If, based on advance notice, the facility will be generating electricity prior to the pre-selected sampling date and not on the identified sampling day or for the subsequent week or more, the sampling will be advanced to capitalize on the earlier opportunity. The objective of the scheduling of the sampling will be to collect as many months of data as possible. Running of the cooling water pumps for the sole purpose of sampling will not be pursued in general, although Reliant may elect to do so where extended shutdown is anticipated during a critical sampling period.

The days that Mandalay station operates are dependent upon electrical demand and maintenance outages. Currently the station does not operate continuously throughout the year. Also, in some cases only one of the two circulation pumps per unit is in operation or only one of the units is in operation and, consequently, the rate of water intake by the station varies daily, monthly, and seasonally. Number of units, pumps and screens in operation will be noted.

Specimens collected will be identified to lowest practical taxonomic level, counted, measured and weight as described below in Section E.3.3. Samples will be visually assessed at the time of sampling to determine if the sample appears to have been affected by an episodic event (e.g., impingement of significantly larger than normal numbers of fish). Historical data as well as data collected during the current sampling program will be used to establish a reference. If the sampling team believes that a sample may have been affected by an unavoidable episodic impingement event, another day or night sample may be collected in the next 1 to 4 days and analyzed for verification purposes.

Impingement data will be summarized and expressed on a per survey, per flow volume, and estimated monthly and annual basis. Diel and seasonal trends will be evaluated. Raw data will be available as an Access® or comparable database.

D.1.4. Data Sufficiency

Reliant believes that the historical samples and analyses are of acceptable quality for inclusion in the IMECS. In particular, the data set available from past studies, combined with data that will be collected in the next year will provide a sufficient record of the rate of impingement mortality to support the analysis and selection of appropriate technologies and/or operational or restoration measures. Together these data will be sufficient to support the regulatory requirements of the IMECS and Reliant's anticipated compliance approach. Should additional data be deemed useful to support pre- versus post-implementation comparisons after approval of the CDS by LARWQCB, such additional sampling will be incorporated into the verification monitoring program.

Calculation baseline will be determined using existing and new data in combination with existing and historical data on standing stocks of ambient fish populations near the Mandalay CWIS, plant operation data, and other information available in the scientific or "gray" literature regarding potential reductions in impingement mortality for selected technologies and operational measures.

D.2 Entrainment

The effect of entrainment on local fish populations was assessed during the late 1970s and early 1980s but has not subsequently been reevaluated. Reliant plans to supplement the previous data with one year of site-specific entrainment sampling data.

D.2.1. Historical Entrainment Sampling

During the late 1970s and early 1980s, SCE and the Los Angeles Department of Water and Power (LADWP) undertook a comprehensive system-wide effort to assess entrainment losses for their stations along the Southern California Bight. LADWP's Haynes Generating Station was selected as representative of a facility drawing water through a harbor embayment and associated with a long intake canal. Entrainment samples were collected by two methods from the harbor just before the water entered the intake canal. Samples were collected on a bi-weekly basis and two replicate samples were collected by pumping a standard volume (approximately 60 cubic meters) from mid-depth. For night sampling, two replicate samples were taken at each of three depths, surface, mid-water, and just above the bottom by either 333 µm or 202 µm plankton nets.

D.2.2. Quantification of Entrainment Losses

SCE estimated daily larval entrainment densities for Mandalay based on larval abundance at Haynes scaled to reflect the much lower intake flow volume at Mandalay than at Haynes. Periodicity of the abundance was based on sampling times and day length. The significance of entrainment losses was estimated based on a comparison of the calculated entrainment loss against the assumed population of each species within the project area. These losses were evaluated for each life stage for each species where data were available to complete the analyses to yield an overall estimate of impacts to each species under consideration.

D.2.3. Entrainment Sampling Plan

Reliant plans to sample for entrainment once a month throughout the year. Sampling will be completed using a 333 µm plankton net with a 0.5 m diameter mouth deployed in the cooling water intake flow in the forebay in front of the removable screens. The net will be equipped with an impeller to allow estimation of the filtered volume. The target filtered volume will be 100 m^3. The actual sampled volume as well as the plant cooling water flow rate will be recorded. Samples will be collected beginning at each of four periods: sunrise, mid-day, sunset, and midnight in order to evaluate diel variation.

Samples will be visually assessed at the time of sampling to determine if the sample appears to have been affected by an episodic event (e.g., entrainment of significantly larger than normal numbers of ichthyoplankton). Historical data as well as data collected during the current sampling program will be used to establish a reference. If the sampling team believes that a sample may have been affected by an unavoidable episodic entrainment event, a second day or night sample may be collected within the next 1 to 4 days and analyzed for verification purposes.

Samples will be collected on a randomly selected weekday each month. Reliant will make the same determined effort as described in Section E.1.3 to rearrange sampling to ensure at least one sample will be collected during each month. This extra sampling effort may include rescheduling events, collecting a second daily sampling early in the following month, and/or pursuing the day-time and night-time sampling events on different days. Running of the cooling water pumps for the sole purpose of sampling will not be pursued in general, although Reliant may elect to do so where extended shutdown is anticipated during a critical sampling period.

Each sample will be preserved, stored, and analyzed separately in the lab (Section E.3.3). Fish eggs and larvae will be identified to lowest distinguishable taxonomic category and counted. When a species is especially abundant, subsamples will be obtained by a plankton splitter. Specimens will be measured for definition of length frequencies. Common and scientific names will be those established by the American Fisheries Society. Counts will be expressed relative to 10,000 m^3 of water.

Entrainment data will be summarized and expressed on a per survey, per flow volume, and estimated annual basis. Diel and seasonal trends will be evaluated. Raw data will be available as an Access® or comparable database.

D.2.4. Data Sufficiency

Because Mandalay was not one of the base cases that SCE evaluated for system-wide entrainment studies, there are no site-specific data for this facility. The data for the Haynes station were collected using two different methods, pumping and plankton nets, and evaluated for diel variations. The samples were sorted and identified using standard methods and the data were evaluated based on standard methods employed at the time. While the samples and analyses likely represented conditions at the mouth of the intake canal at the Haynes facility, the lack of site-specific data necessitates that Reliant collect such data for Mandalay.

Samples will be collected on a randomly selected day each month. Given the relatively limited nature of available data, Reliant will make the same determined effort as described in section E.1.3 to rearrange sampling to ensure at least one sample will be collect during each month. This extra sampling effort may include rescheduling events, collecting a second daily sampling early in the following month, and/or pursuing the day-time and night-time sampling events on different days. Running of the cooling water pumps for the sole purpose of sampling will not be pursued.

D.3. Quality Assurance/Quality Control

The sampling program will be completed in accordance with the Quality Assurance/Quality Control (QA/QC) procedures described below. This QA/QC program will ensure that accurate, consistent and traceable data are collected for the duration of the project.

Elements of the QA/QC Plan can roughly be broken into five categories:

- Roles and responsibilities;
- Mobilization for field work;
- Sample Collection;
- Sample Processing;
- Data Management; and
- Sample Tracking

D.3.1. Roles and Responsibilities

The Project Manager will be responsible for the overall performance of the project including budget, schedule and quality control. The Project Manager will serve as the primary point of contact with Reliant Corporate and Station personnel. The Project Manager will assign a Sampling Team and designate a Field Manager for the sampling effort. It will be the responsibility of the Field Manager to ensure that all needed equipment and supplies are readied for each sampling event and that the gear is in proper operating condition. The Field Manager will develop a checklist of primary and backup equipment, supplies, datasheets, tools, field repair kits, safety equipment, and other necessary items for each type of sampling activity.

D.3.2. Mobilization

Sampling will be conducted in accordance with the schedule contained in the approved PIC. A matrix will be developed showing target dates for conducting each component of the program. The matrix will include the time(s) of day sampling is to be performed.

Designated Reliant contacts will be notified one week prior to each sampling event, with confirmation provided 24 to 48 hours in advance if weather conditions remain favorable.

Twenty-four hours prior to each sampling event, field gear will be assembled and verified against the checklist for primary and backup equipment, supplies, datasheets, and other required gear. The Field Manager will inspect each piece of equipment to ensure that it is in good condition and fully functional. Any damaged equipment will be repaired or replaced prior to deployment. Sample containers will be inspected to ensure that they are clean, in good physical condition, and that lids fit tightly. To the extent practical, backup gear, replacement parts, and spare batteries will be included in the gear assembled for each sampling event. Primary and backup electronic equipment will be calibrated, as applicable, in accordance with manufacturer's recommendations.

The Sampling team will review field safety issues and protocols prior to embarking on each trip and sampling personnel will participate in an on-site safety briefing as may be required by the station. It is the responsibility of the Field Manager or his/her designee to ensure that all assembled equipment is transported to the project site and properly stored and handled for the duration of the trip.

Upon return from each sampling event, the Field Manager will ensure that all gear is cleaned, inspected, stored, repaired when necessary, and otherwise readied for the next event. Post-sampling equipment calibrations will be performed and documented, as appropriate. A maintenance report describing problems encountered and corrective action taken will be completed for damaged or malfunctioning equipment. Supplies will be restocked, as necessary. A copy of the post-sampling calibration and maintenance report will be provided to the Project Manager to assist in his/her assessment of the reliability of reported field data.

D.3.3. Sample Collection

The Field Manager will be responsible for ensuring that all field activities are conducted in conformance with the established QA/QC program and safety procedures.

D.3.3.1. Recording Data

Recorded data represent the results of long hours spent in the field and are the first step in a lengthy analytical process. All field and laboratory personnel will adhere to the basic rules for recording information as described below:

- Legible writing with no erasures, write-overs, or cross-outs;
- Correction of errors with a single strike-out line followed by the recorder's initials and date; and
- Cross-outs on incomplete pages with an initialed and dated diagonal line.

D.3.3.2. Datasheets

All data will be entered on pre-printed, standardized, datasheets at the time of sampling. Generic information, such as date, type of sampling, field team members, weather conditions, and tidal stage will be included at the top of the form. Site-specific conditions, such as time of collection, gear type, water depth, physical parameters, and sample ID, will be recorded at the beginning of sample collection. Upon completion of sample collection, any unusual conditions that might have affected the quality of the sample will be documented. An explanation will be provided for any missing data. The datasheet will then be checked for accuracy by a second member of the field team prior to obtaining additional samples or moving to the next station.

D.3.3.3. Container Labeling

Biological samples will be placed in appropriate containers. A label will be affixed to each sampling container. The label will be filled in with the date, station ID, sample type, sample number, replicate number, and sampler's initials. A waterproof internal label with the same information will be placed inside the container with the sample, and the lid tightly secured. The internal label will be composed of an appropriate material and ink to withstand any preservative used in the collection.

D.3.3.4. Sample Containers

Containers used to temporarily store live specimens or used to transfer preserved specimens from the field to the lab will be made of appropriate materials. Nalgene or comparable plastic bottles will be used for storing field samples.

D.3.3.5. Physical Data

A suite of standard water quality measurements (DO, salinity, temperature, pH, etc.) will be taken at each sampling station. Meters will be field calibrated, as applicable, prior to data collection. Surface, mid-depth, and bottom conditions will be recorded where water depths permit. In depths of six feet or less, only mid-depth measurements will be taken.

D.3.3.6. Safety Precautions

Appropriate safety gear will be worn and utilized for all field activities in accordance with established safety plans. Any field chemical transfers will be made using secondary containment to prevent spills in the boat or adjacent waters. Gloves and eyewear will be worn at all times when handling chemicals.

D.3.3.7. Field Sampling

All biological sampling will be conducted in accordance with the QA/QC program described herein. Field sampling procedures for entrainment and impingement mortality sampling are described below.

Entrainment sampling

Sampling will be completed using a 333-µm plankton net with a 0.5 m diameter mouth deployed in the forebay in front of the removable screens. The net will be equipped with an impeller to allow estimation of filtered volume. The target filtered volume will be 100 m^3. Duplicate samples will be collected at each time frame. Upon retrieval of the net, the cod end will be inspected to ensure that it can be safely detached without losing any of the sample. The net will be rinsed to transfer organisms that may be attached to the net into the cod end. The cod end will then be removed and the contents carefully poured into the sample container. Following this initial step, the cod end will be inverted over the sample container and gently rinsed with a squirt bottle containing filtered seawater to ensure that all contents have been transferred. Collections will initially be preserved in 10% formalin solution with rose Bengal stain. Containers that will hold preserved specimens will be prepared in advance by adding formalin to the sample container at the lab. An appropriate amount of seawater will be added to the container in the field prior to adding the collected sample. After 48 hours all liquid will be discarded and 40-percent isopropyl alcohol or 70-percent ethanol added to the collection container for permanent preservation. Samples will be analyzed in the laboratory as described in Section E.3.3.

Impingement sampling

Reliant will continue the same type of sampling of impingement rates as has been conducted over the past four years as outlined in Section E.1.1. Sampling will occur monthly unless Mandalay in not generating electricity for an entire month. Sampling dates will be determined randomly. When the facility is not operating during a pre-determined date, the next day the facility's operating normally impingement sampling will be completed. If, based on advance notice, the facility will be generating electricity prior to the preselected sampling date and not on the identified sampling day or for the subsequent week or more, the sampling will be advanced to capitalize on the earlier opportunity. The objective of the scheduling of the sampling will be to collect as many months of data as possible.

For each impingement sampling event, fish and invertebrates impinged on the intake screens during the sampling period will be collected, identified to the lowest practical taxonomic level, counted, and measured (total length and fork length) as described in Section E.3.3. The condition (live, freshly dead, or dead) of each specimen collected will also be determined.

Representative specimens of difficult to identify species will be identified to the lowest practicable taxon and preserved for more thorough identification at the lab. A reference collection will be developed and will contain sufficient material to represent each major life stage and/or size class. For fish greater than 150 mm that are being preserved, an incision about 30 mm in length will be made along the abdominal body wall on the right side of the fish to ensure penetration of fixative into the body cavity. Fish will remain in buffered formalin for several days to ensure adequate fixation of tissues. After the fish have been thoroughly fixed, the buffered formalin will be removed and the specimens soaked in fresh water for 48 hours with at least one change of water. After 48 hours all water will be discarded and 40-percent isopropyl alcohol or 70-percent ethanol added to the collection container for permanent preservation.

All biological sampling will be conducted in accordance with the QA/QC Plan and applicable conditions of regulatory sampling permits issued for project.

D.3.3.8. Deviations from QA/QC Plan

Examples of failures in sampling methods and/or deviations from sampling requirements include but are not limited to such things as sample container spillage or breakage, gear malfunction, equipment failure, and unusual site conditions that prevent sampling. Failures or deviations from the QA/QC Plan will be fully documented on the field datasheet and reported to the Project Manager. The Project Manager will determine if the deviation from established protocol compromises the validity of the resulting data. The Project Manager will decide whether to accept or reject data associated with the sampling event based on his/her best professional judgment and will determine whether the absence of specific data will significantly affect analytical objectives of the project. In cases where missing data are likely to impact the ability of the project team to draw reliable inferences regarding plant effects, the Project Manager will require that sampling be repeated.

Modifications to the sampling program and/or methods may be made as appropriate based on the review of data as it becomes available. Reliant will provide written notification to LARWQCB of any significant deviations from the sampling program described herein.

D.3.9. Sample Processing and Analysis

Entrainment Sample and Processing Analysis

At the lab, field samples will be logged in, sorted by date and type, and stored in a safe, secure location for processing. Entrainment samples may require subsampling when large numbers of organisms have been collected. In those cases, the raw sample will be split with a Folsom plankton splitter after most of the debris and vegetative matter has been removed. Care will be taken to assure that no organisms are inadvertently removed with the discarded matter. Splitting may be required multiple times until a target number of specimens is reached. The number of times each sample is split will be recorded to allow for extrapolation of data from the split sample to the original sample composition.

Whole or split samples will be transferred to petri dishes for examination under a dissecting microscope. All organisms will be identified to the lowest practicable taxon. Measurements appropriate for the life stage will be recorded as well as physical characteristics relevant to life stage (oil drop present, size of oil drop, pigmentation, ocular development, presence of byssal threads, etc).

Appropriate reference literature and electronic databases will be made available to assist in taxonomic determinations. A random subset of all identified organisms will be reviewed by a second qualified taxonomist to ensure consistency in identifications. Should there be disagreement between the two taxonomists, supporting confirmation from outside experts will be sought. Samples of all problematic taxa will be delivered to independent experts for identification/verification.

Additionally, a reference collection of specimens will be maintained for the life of the project and made available for examination by outside parties. The reference collection will contain sufficient material to represent each major life stage and/or size class. In addition to the preserved specimens, a representative photo record of both larval and juvenile/adult fishes will be established and maintained in an electronic database. Availability of photographs and key taxonomic characters of species will ensure accuracy and consistency in identifications throughout the life of the project.

All data generated during the processing of samples will be recorded on standardized lab bench sheets. Prior to processing each sample, pertinent information on the container labels will be transferred to the bench sheet to ensure proper sample tracking. Numbers of individuals for each life history stage of each species processed will be recorded on the bench sheet. If performed, sub-sampling information will also be entered on the form.

Each processed sample will be labeled with a discrete sample number and the name of the processing taxonomist and stored for QA purposes. Reexamination of a representative number of previously identified samples will be made by a different taxonomist to verify previous identifications and numerical information. Greater than 5% discrepancy between initial and QA analyses will require reexamination of all samples analyzed since the last QA check. Following each QA analysis specimens not being retained for the reference collection will be properly disposed of.

<u>Impingement Sample Processing and Analysis</u>

Length measurements of impinged fish will be made using a measuring board consisting of a linear metric scale secured to a flat wooden or plastic base with a fixed head piece. Fish will be measured by positioning the body on the right side, head facing the observer's left, and fish mouth closed. Total length will be measured as the distance from the anterior-most portion of the head or jaws to the extreme tip of the caudal fin. If the caudal fin is bi-lobed, the lobes will be squeezed together and measured to the posterior-most tip of the combined lobes. Fork length will be measured from the tip of the jaw or tip of the snout with closed mouth to the center of the fork in the tail. Length measurements will be collected for the first 25 individuals of a species from each sampling unit, consistent with EPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition*. The 25 individuals will be randomly selected for measurement from the total number of individuals for each species. The condition of measured specimens (live, freshly dead or dead) will be noted. Total number of individuals impinged within several pre-determined size classes, based on visual classification. The specimens collected will be weighed as a batch for each species identified; where more than 25 individuals have been collected for a given species, a subsample will be weighed to obtain an average weight of specimens impinged.

D.3.10. Data Management

Field datasheets and lab bench sheets will be placed in labeled folders for input into an electronic database maintained by the identification lab. Prior to processing the data, the Field Manager or assignee will review the forms for completeness and accuracy. Each form will have a signature and date block to track data processing. After the data have been entered into the database, the data forms will be signed, dated, and returned to the folder for verification. Printouts of entered data will be verified against corresponding field datasheets and lab bench sheets to ensure that all information has been accurately transferred. For large datasets entered (e.g., more than 100 entries), a subset of 20 percent of the data entries selected at random will be checked. If errors are detected in more than 10 percent of the subset, then corrections will be made and another subset will be checked. Missing information will be added and wrong information corrected. The forms will then be initialed and dated by the verifying party. Following data verification the original data forms will be segregated by sampling date and type and archived for the life of the project.

D.3.11. Sample Tracking

Proper sample handling and custody procedures are required to ensure the integrity of samples from sample collection through data analysis. A number of forms will be used for chain-of-custody documentation. Upon arrival at the laboratory, all samples will be received and logged in using a Sample Receipt Log, which will include the following information:

- Project Name;
- Field Team Leader;
- Date of Collection;
- Time of Collection;
- Site Identification;
- Type of Sample;
- Replicate Number;
- Preservative Used;
- Name of collector(s);
- Name of Recipient; and
- Time/Date of Receipt.

The Project Manager or assignee will develop a master list of all samples, which will be used to track the progress of the field sampling program. Appropriate blocks for each sample will be checked off as each sample is collected, processed, analyzed, and the data entered into the computer. Each month, the Project Manager will review the master list and evaluate whether sample collection and processing is progressing in conformance with established schedules. Missing information will be reconciled and appropriate corrective measures taken, where warranted.

All failures associated with sample receipt procedures will be immediately reported to the Project Manager. These include but are not limited to things such as lost samples, deviations from QA/QC requirements, incomplete documentation, possible tampering of samples, and broken or spilled samples. The Project Manager will determine if these issues have compromised the validity of the resulting data or will impede analytical objectives. The Project Manager will decide how best to address identified problems. Possible courses of action include, document and proceed, redo the entire sampling event, or selectively analyze the samples. The effect(s) of all identified problems on project objectives and any related corrective measures will be documented in QA reports furnished to Reliant.