Final Report
Minimizing Adverse Environmental Impacts from Cooling Water Intake Structures at Platform Intakes

Prepared for:
Beta Offshore

Prepared by:

TETRA TECH

3746 Mt. Diablo Blvd., Suite 300
Lafayette, CA 94549

February 17, 2015

Executive Summary

To comply with the terms of National Pollutant Discharge Elimination System (NPDES) General Permit No. CAG280000, offshore oil and gas platforms are required to conduct a three-part study to evaluate the potential for adverse environmental impacts (AEI) due to the operation of their cooling water intake structures (CWIS). This document is the result of five operators jointly commissioning such a study.

Section 316(b) of the Clean Water Act (CWA) has various statutory and regulatory aspects that are relevant to CWIS at offshore platforms. Section 316(b) has a long history, but has relatively few formal requirements for existing offshore platforms. As described in this report, the most relevant framework in considering whether an intake employs the best technology available (BTA) is likely the recently-promulgated 2014 existing facility rule. While existing platforms do not have any specific requirements under the rule (requirements are instead determined by a site-specific BTA determination by the Director), the 2014 rule was developed specifically for CWIS and has many relevant provisions.

This report presents summaries of the three-part study required in the General Permit. (Full versions of each of the three parts are provided as appendices to this document.) The first part involves compilation of basic information about each platform, such as location, intake flows, and any technologies present to minimize entrainment/impingement. This information was then used to develop the biological and technological analyses.

The second part provides an assessment of the environmental impacts from entrainment/impingement, given current practices. This involved characterization of the biological resources in the vicinity of each platform, estimating of the number of organisms impinged or entrained by each CWIS, and an analysis of the proportional withdrawals by each platform. Three approaches were used to evaluate the biological impacts; each of the three analytical approaches yielded a similar outcome—that the biological impacts of CWIS withdrawals from offshore platforms is extremely small.

The third part of the study presents a discussion of the potential technologies to address impingement and entrainment, the feasibility and likely effectiveness of these technologies at offshore platforms, and an estimated cost to install these compliance technologies. A number of technologies exist to address impingement and entrainment, but few are appropriate for use at existing offshore platforms. Four technologies (coarse mesh wedgewire screens, fine mesh wedgewire screens, intake relocation, and variable speed pumps) were found to be potentially feasible. For these technologies, estimated costs to retrofit the technology were calculated and found to be significant.

Finally, an analysis of the statutory and regulatory factors and how they could be applied in assessing CWIS at existing offshore platforms was performed and recommendations on how to proceed in making a BTA determination based on best professional judgment (BPJ) are provided. In summary, this analysis suggests that CWIS at existing offshore platforms already employ BTA and need not be subject to any additional requirements. A number of different approaches (e.g., assessment of biological resources affected, availability of appropriate technologies, consideration of costs and benefits) all arrive at the same conclusion.

Table of Contents

Executive Summary ..... **ii**

1 Introduction **1**

1.1 Section 316(b) 1

1.2 Regulatory Framework and the Role of BPJ 2

1.3 Definition of Key Terms 9

2 Facility Description **10**

3 Biological Characterization **10**

3.1 Available Biological Data 11

3.2 Analytical Approaches 11

3.3 Summary of Results 11

4 Analysis of Technologies **12**

4.1 Existing CWIS 12

4.2 Intake Technologies Considered 12

4.3 Estimated Technology Costs 14

5 Analysis **15**

5.1 Language of the CWA 15

5.2 NPDES Regulations on BPJ 17

5.3 316(b) Existing Facility Rule 18

5.4 316(b) Historical Documents 20

6 Conclusions and Recommendations **21**

6.1 Broadly Applicable Findings 22

6.2 Platform-Specific Findings 23

6.3 Consideration of Factors 23

6.4 Recommendation for BTA Determination 24

7 References **24**

Appendix A **Description and Evaluation of CWIS Information**
Appendix B **Evaluation of Entrainment Effects of Platform Intakes**
Appendix C **Evaluation of Feasibility, Cost, and Performance of Technologies for Reducing Environmental Impacts at Platform Intakes**

1 Introduction

The recently re-issued National Pollutant Discharge Elimination System (NPDES) General Permit No. CAG280000 for Offshore Oil and Gas Exploration, Development and Production Operations off Southern California requires an evaluation of the potential impacts of existing cooling water intake structures (CWIS) at the facilities that are currently operating and covered by this permit. Specifically, the permit requires each owner/operator to develop:

- A description of the current CWIS and existing measures to minimize entrainment/impingement
- An assessment of the environmental impacts from entrainment/impingement, given current practices
- An evaluation of the practicality of additional measures to reduce environmental impacts from entrainment/impingement

There are five companies operating a total of 13 platforms off the California coast that employ at least one CWIS.[1] These companies pooled resources and conducted a joint analysis, given that many of the important characteristics (e.g., the biological resources potentially affected, the types of CWIS at each platform) are generally very similar.[2] This report contains the results of this analysis. This report includes the site-specific data and analysis performed for Beta Offshore's two platforms along with the general analyses and conclusions that apply to all platforms evaluated in this study.

The remainder of this section provides the regulatory background for Clean Water Act (CWA) Section 316(b) and how it applies to the platforms. Section 316(b) has relatively few formal requirements for existing offshore platforms. The most relevant framework in considering whether an intake employs the best technology available (BTA) is likely the recently-promulgated 2014 existing facility rule. While existing platforms do not have any specific requirements under the rule (requirements are instead determined by a site-specific BTA determination by the Director), the 2014 rule has many relevant provisions.

Section 2 addresses the description of the CWIS, Section 3 discusses any potential environmental impacts, and Section 4 provides an assessment of potential intake technologies. Section 5 presents an analysis of the statutory and regulatory factors and how they could be applied in assessing CWIS at existing offshore platforms. Finally, a conclusion is provided in Section 6, including recommendations on how to implement 316(b) at these platforms.

1.1 Section 316(b)

Section 316(b) of the CWA requires that:

> "the location, design, construction and capacity of cooling water intake structures reflect the application of the best technology available to minimize adverse environmental impact."

[1] Three additional platforms owned by these firms are also operating in the area, but do not use a CWIS; as a result, they have been excluded from this report.

[2] In places, this report will make general statements that are applicable to all of the platforms in the joint study; in other places, the analysis will be specific to the platforms owned by the operator in this individual report.

Historically, permitting authorities have implemented permit requirements on a best professional judgment (BPJ) basis. However, beginning in the mid-1990s (in response to a consent decree that stemmed from litigation brought by several environmental groups), the Environmental Protection Agency (EPA) has engaged in rulemaking efforts to promulgate national requirements to regulate CWIS. To facilitate this effort, EPA split the scope into three separate rulemakings:

- Phase I addressed CWIS at new facilities
- Phase II addressed CWIS at large power plants
- Phase III addressed CWIS at manufacturers and small power plants

EPA promulgated Phase I in 2001 and included requirements for new offshore oil and gas facilities. However, since all of the platforms in this report are existing facilities, the Phase I rule is not applicable. EPA promulgated Phase II in 2004 and Phase III in 2006. The platforms described in this report would have been subject to the Phase III rule, but subsequent litigation led to EPA combining the Phase II and Phase III rulemakings into a single rulemaking that addresses all existing facilities, including existing offshore oil and gas platforms. The final existing facility rule was published August 15, 2014 (79 FR 48300).

1.2 Regulatory Framework and the Role of BPJ

The 2014 existing facility rule established national requirements for all existing facilities. In concept, this includes existing offshore oil and gas platforms. However, unlike land-based industrial facilities, existing offshore oil and gas platforms do not have any specific regulatory requirements under the rule. Instead, the Director (i.e., permitting authority) will apply BPJ on a site-specific basis to assess whether a platform is employing the best technology available (BTA) for minimizing adverse environmental impacts (AEI).[3,4]

As a result, the Director has significant flexibility in what information to consider in making a BTA determination and establishing 316(b) permit requirements. There are a number of resources that provide a framework for conducting such an assessment; this section provides an introduction to these resources, followed by a more detailed discussion in the conclusion.

Language of the CWA

The statute provides some guidance on what to consider by noting "location, design, construction and capacity" as relevant factors. While these terms are not specifically defined, broadly applicable definitions seem appropriate.

<u>Location:</u> The location of the CWIS can have a significant effect on the potential for environmental effects. A number of intake characteristics can be relevant—waterbody type (e.g., river versus ocean), depth of the intake opening, location within a waterbody (i.e., at the shoreline versus deep offshore), and proximity to important biological resources (e.g., spawning grounds or migratory pathways).

[3] See 40 CFR 125.91(d), which states "[t]his subpart does not apply to [...] offshore oil and gas extraction facilities that are existing facilities as defined in § 125.92(k). The owners and operators of such facilities must meet requirements established by the Director on a case-by-case, best professional judgment (BPJ) basis."

[4] Also see 79 FR 48310 for a description of EPA's rationale for not establishing nationally applicable requirements for existing offshore platforms.

Design: This factor relates to the design and configuration of the CWIS itself, including any technologies that may minimize impingement or entrainment. The most common design feature is a screen, but other technologies include reduced intake velocity, exclusion devices, diversions, and behavioral technologies. When properly selected and installed, some intake technologies can either 1) reduce the magnitude of impingement and entrainment or 2) improve the survival of organisms that are impinged or entrained. Both serve to mitigate any environmental impacts.

Construction: Generally, this refers to minimizing the environmental effects that result from the construction of the CWIS. An example might include dredging a lake bottom to prepare a site for an offshore intake. However, in the case of existing facilities, it is unlikely that there are any construction-related effects to consider, given that these facilities already exist. However, any construction to retrofit a technology could consider these construction effects.

Capacity: By reducing the intake flow or designing an intake to use smaller volumes of cooling water, a proportional number of organisms are never drawn into the intake structure. As EPA noted in the existing facility rule (See 79 FR 48331/1 and 48340/1), a reduction in the volume of cooling water withdrawn is the best-performing intake technology. While this conclusion specifically refers to closed-cycle cooling, other methods of flow reduction are also available, such as variable speed pumps or water reuse.

NPDES Regulations on BPJ

The regulations that establish the overall NPDES permitting program contain some guidance on what factors to consider when developing BPJ-based permit conditions. Specifically, 40 CFR 125.3(d) includes the factors shown in Table 1.

Table 1. Factors to Consider in Establishing BPJ Permit Conditions

Factor	Best Practicable Control Technology Currently Available (BPT)	Best Conventional Pollutant Control Technology (BCT)	Best Available Technology (BAT)
Cost to benefit ratio	Yes (total cost versus effluent reduction)	Yes (total cost versus effluent reduction, cost and benefits of treatment at a POTW versus at a facility)	No
Age of equipment and facility	Yes	Yes	Yes
Process involved	Yes	Yes	Yes
Engineering considerations of control measures	Yes	Yes	Yes
Process changes	Yes	Yes	Yes
Non-water quality impacts	Yes	Yes	Yes

Note: that these factors relate to BPT, BCT, and BAT, none of which is the regulatory standard for 316(b), Best Technology Available (BTA). The preamble to the 2014 final rule describes the relationship of 316(b) to the other elements of the CWA (which are generally focused on discharges, instead of withdrawals) at 79 FR 48313; in short, there are some aspects that are similar, but others that are not. Nonetheless, given that the CWA does not define factors specific to BTA, the factors for the other standards may provide useful context for what the Director could consider.

316(b) Existing Facility Rule

The 2014 existing facility rule was published in August 2014 and became effective October 14, 2014. The rule does not establish specific entrainment requirements for land-based facilities; the facility is required to submit various studies and the Director will make a BPJ-based, site-specific determination for entrainment.[5] However, there are several elements of the rule that can provide insight into how a BTA determination could be made.

Regulatory Factors

In considering entrainment requirements for land-based facilities, the final rule (at 40 CFR 125.98(f)) does provide several regulatory factors for the Director to consider:[6]

- Number and type of organisms entrained
- Impact to pollutant emissions
- Land availability for entrainment technologies
- Remaining plant useful life
- Social benefits and costs
- Entrainment impacts
- Thermal discharge impacts
- Prior flow reduction efforts
- Energy reliability
- Water consumption
- Availability of alternative water sources

While these factors are not directly linked to existing offshore platforms (i.e., the Director is under no obligation to consider them in determining BTA at platforms), they do offer a significant opportunity. These factors were developed specifically with 316(b) in mind and might be seen as more relevant to the permitting process than the BPT/BCT/BAT regulatory factors described above.

Applicability Criteria

The 2014 existing facility rule applies only to facilities that meet certain criteria, as listed at 40 CFR 125.91. While existing offshore platforms are specifically excluded from the impingement and entrainment requirements in the 2014 rule, they remain subject to BPJ-based permitting; some of the applicability criteria from the rule may yet be useful in considering BPJ-based requirements:

---

[5] The rule does contain a specific framework for impingement mortality for land-based facilities. However, since permit conditions for offshore platforms are to be developed on a BPJ basis for both impingement mortality and entrainment, that framework is not relevant for this report.

[6] Note that the first 5 bullets are factors that the Director must consider, while the latter 6 are factors that the Director may consider. For the purposes of this analysis, however, this distinction is not especially important, given the flexibility afforded to the Director in setting BPJ-based permit conditions for existing offshore platforms.

- Design intake flow (DIF) of 2 million gallons per day (mgd) or more
- Twenty-five percent or more of water withdrawn is used exclusively for cooling purposes

The DIF of a facility can be a useful screening criterion as to the level of potential impact. In general, a lower DIF is likely to correspond to a lower level of impact. As discussed in Section 3 below, these offshore platforms have intake flows that are also significantly less than most power plants or other industrial facilities. While "low impact" is not equal to "no impact," it can be helpful in weighing any potential BPJ-based requirements.

The criterion for the percentage of water used for cooling is useful in determining what intakes are truly cooling water intakes, as opposed to simply water intakes. Section 316(b) does not address non-cooling water withdrawals, nor does any other part of the CWA. As a result, the 2014 existing facility rule clarifies that water withdrawn for fire suppression, domestic uses, process water, and other non-cooling uses would not be subject to requirements. Additionally, EPA has, in effect, encouraged water reuse by allowing water that was used for a second purpose (in addition to cooling) be excluded from this calculation as well.[7] In some cases, entire intake structures maybe essentially exempt from consideration, given that most or all of the water withdrawn is for non-cooling or reuse purposes.

Intake Velocity

For land-based facilities, one of the compliance alternatives for minimizing impingement mortality under the 2014 existing facility rule is to reduce the intake velocity at the CWIS. (See 40 CFR 125.94(c)(2) and (3).) Data has shown that an intake velocity of 0.5 feet per second or less is highly protective of aquatic life (see 79 FR 48337), as the intake velocity is sufficiently low that species or life stages that are poor swimmers can escape the intake. This approach is directly transferrable to assessing impingement effects at offshore platforms. However, a reduced intake velocity has not been associated with a reduction in entrainment; as a result, this approach will only be discussed in reference to impingement mortality.

It is also worth noting that the 2014 rule's intake velocity threshold was set at 0.5 feet per second based on biological data showing that it would be protective of 96% of organisms expected to be in the area of an intake. On this basis, any intake with a velocity of 0.5 or less was deemed to meet the impingement requirements. However, an intake with a velocity above 0.5 may still offer some level of protection. As seen in EPA's analysis of fish swim speeds from the Phase I rule (see EPA-HQ-OW-2008-0667-3435), an intake velocity higher than 0.5 feet per second could still be protective of a substantial number of organisms. For this document, however, the analysis only focuses on discussing impingement reductions at those intakes that meet the 2014 rule's threshold as a compliance alternative for impingement.

De Minimis

For land-based facilities, another option to comply with the impingement mortality requirements in the 2014 existing facility rule is to demonstrate that the CWIS is impinging an unusually low number of individuals. As described in 40 CFR 125.94(c)(11), an intake that is having "de minimis" impingement effects would not warrant any additional controls. The facility would submit data supporting such a claim and the Director would make a site-specific determination. As with reduced intake velocity, this provision of the rule only applies to impingement mortality. The concept of de minimis may be useful, however, for considering both impingement and entrainment at existing offshore platforms.

[7] See 40 CFR 125.91(c).

316(b) Historical Documents

Section 316(b) has a long regulatory history, dating back to just after the enactment of the CWA. (See 76 FR 22179, April 20, 2011.) While not necessarily directly applicable to existing offshore platforms, there are a number of support documents that can offer guidance as to how to make a site-specific BTA determination using BPJ.

1973 Proposed Development Document

As part of the initial rulemaking effort (the final rule was promulgated in 1976), EPA published a proposed rule and development document. The rule did not contain specific requirements, but did offer insight into the process. The document stated that "no technology can be presently generally identified as the best technology available," supporting the position that EPA has taken in the 2014 existing facility rule. The 1973 document also advocated conducting an "evaluation of corresponding available technologies, in accordance with generalized guidelines to identify the site specific best technology available for minimizing adverse environmental impact of cooling water intake structure." It provided discussion about each of the four statutory factors (location, design, construction and capacity; the discussion in this document was used in developing the broad definitions above) and also introduced the concept of assessing the relative costs and benefits of the potential alternatives.

1977 Draft 316(b) Guidance

After promulgation of the 1976 final rule, EPA developed draft guidance on implementing Section 316(b). In the most general terms, the guidance document outlines a site-specific process that uses the Director's BPJ to consider the biological information of the source water, the relative impacts due to impingement and entrainment at the intake, and a review of the existing intake design. The document notes that "[t]he environmental-intake interactions in question are highly site-specific and the decision as to best technology available for intake design, location, construction, and capacity must be made on a case-by-case basis." (USEPA 1977) Further, it states that:

> "The overall goal of conducting intake studies should be to obtain sufficient information on environmental impact to aid in determining whether the technology selected by the company is the best available to minimize adverse environmental impact. In the case of existing plants, this goal will be accomplished by providing reliable quantitative estimates of the damage that is or may be occurring and projecting the long-range effect of such damage to the extent reasonably possible."

The 2014 existing facility rule, in describing the 1977 guidance, noted that

> "This case-by-case approach was also consistent with the approach described in the 1976 Development Document referenced in the remanded regulation. The 1977 section 316(b) draft guidance suggested a general process for developing information needed to support section 316(b) decisions and presenting that information to the permitting authority. The process involved the development of a site specific study of the environmental effects associated with each facility that uses one or more cooling water intake structures, as well as consideration of that study by the permitting authority in determining whether the facility must make any changes for minimizing adverse environmental impact. Under this framework, the Director determined whether appropriate studies have been performed, whether a given facility has minimized adverse environmental impact, and what, if any, technologies may be required." [76 FR 22180]

The 1977 guidance also describes how to evaluate AEI:

> "Adverse aquatic environmental impacts occur whenever there will be entrainment or impingement damage as a result of the operation of a specific cooling water intake structure. The critical question is the magnitude of any adverse impact. The exact point at which adverse aquatic impact occurs at any given plant site or water body segment is highly speculative and can only be estimated on a case-by-case basis by considering the species involved, magnitude of the losses, years of intake operation remaining, ability to reduce losses, etc."

As described below, this approach is consistent with how EPA defined AEI in the subsequent 316(b) rulemakings as well.

The guidance provides further general guidance on how to evaluate the extent of AEI by "by assessing the relative biological value of the source water body zone of influence for selected species and determining the potential for damage by the intake structure," including evaluating historic spawning or nursery areas, migratory pathways, the number of individual organisms present, and other aspects that may be important to an organism's life history. It also presents a basic decision matrix that may help the Director in determining whether a CWIS is employing BTA, as shown in Table 2 below.

Table 2. Simple Decision Matrix for Determining BTA

	Cooling Water Flow Relative to Source	
Biological Value	High	Low
High	Not BTA	Possibly BTA
Low	Possibly BTA	Employs BTA

Adapted from 1977 Guidance, page 12.

Once biological data have been collected, the 1977 guidance outlines a stepwise process that considers a variety of elements for reducing impingement:

- Does the existing CWIS minimize AEI, or would additional modification further reduce AEI?
- Would reducing the intake velocity further reduce AEI?
- Would constructing a new intake in a different location further reduce AEI?
- Would a reduction in the intake capacity (e.g., closed-cycle cooling) further reduce AEI?

For entrainment, the 1977 guidance recognizes that there are limited options for reducing entrainment impacts. A reduction in intake capacity is clearly the most effective approach, with relocation of the

intake as somewhat less effective, and screening or exclusion technologies as the least effective method.

The 1977 guidance envisions that all of the information collected by the facility would be compiled into a comprehensive study that would provide the Director with sufficient information with which to make a BTA determination. Included in this study would be a detailed description of the facility and CWIS, a description of the source waterbody, identification of any monitoring programs for existing intakes, and an evaluation of impacts (including biological models).

In general, the process outlined in the general NPDES permit follows the same path laid out in the 1977 guidance, making this a valuable resource for evaluating BTA.

Modern Rulemaking Documents

Since restarting the rulemaking process in the 1990s, EPA has developed several documents that are relevant to making a BTA determination at oil and gas platforms.

Phase I Rule

The Phase I rule applies to new facilities, so it is of limited utility for this analysis. EPA postponed further evaluation of offshore industries to the Phase III rule.

Phase II Rule

The Phase II rule applies to large power plants and is generally not relevant. However, there is extensive technical discussion of the biological effects of CWIS withdrawals, intake technologies, and other topics that is indirectly transferrable to existing offshore platforms. These materials were subsequently used in developing the Phase III and 2014 rules.

Phase III Rule

The Phase III rule addressed small power plants and all sizes of manufacturers, including offshore industries such as oil platforms and seafood processing vessels. During the rulemaking, EPA developed a detailed analysis of offshore oil platforms, including the universe of potentially regulated facilities, potential technologies to minimize impingement and entrainment, compliance costs, estimates of the benefits of reducing impingement and entrainment, and the potential utility of a cost-cost test. The final rule only included requirements for new platforms, as existing platforms were not subject to any national, categorical requirements. (See 71 FR 35008, June 16, 2006.) The rule did not, however, include any formal guidance on how to develop BPJ-based permit conditions.

Existing Facility Rule

In combining the Phase II and Phase III rules, the 2014 existing facility rule is now the primary regulatory framework that addresses existing offshore oil and gas platforms. Consistent with the Phase III rule, existing offshore platforms are not subject to national requirements, and are instead subject to site-specific requirements as developed by the Director. (See 79 FR 48310, August 15, 2014.) Like the Phase III rule, the 2014 rule did not provide any formal guidance on how to develop BPJ-based permit conditions.

The preamble to the final rule does, however, provide some general insight as to how a site-specific entrainment BTA determination might be made. (See 79 FR 48350.) It notes that the facility will submit information that will help the Director to assess the need for entrainment requirements, and will result

in one of two outcomes: 1) the facility will install additional controls or 2) the facility's current configuration will be deemed to meet BTA.

1.3 Definition of Key Terms

To assist in evaluating BTA, it may be useful to clearly define certain terms. Multiple definitions for the terms used to describe the effects of CWIS have been developed over time. However, the 2014 existing facility rule should be viewed as the most relevant source, as this is the regulation that governs existing offshore oil and gas platforms (in addition to being the most recent, and therefore most likely to best reflect the state-of-the-science). The following text is taken from 40 CFR 125.92, except as noted.

- *Actual Intake Flow* (AIF) means the average volume of water withdrawn on an annual basis by the cooling water intake structures over the past three years.
- *Cooling water* means water used for contact or non-contact cooling, including water used for equipment cooling, evaporative cooling tower makeup, and dilution of effluent heat content.
- *Cooling water intake structure (CWIS)* means the total physical structure and any associated constructed waterways used to withdraw cooling water from waters of the United States. The cooling water intake structure extends from the point at which water is first withdrawn from waters of the United States up to, and including the intake pumps.
- *Design intake flow* (DIF) means the value assigned during the cooling water intake structure design to the maximum instantaneous rate of flow of water the cooling water intake system is capable of withdrawing from a source waterbody.
- *Entrainment* means any life stages of fish and shellfish in the intake water flow entering and passing through a cooling water intake structure and into a cooling water system, including the condenser or heat exchanger. Entrainable organisms include any organisms potentially subject to *entrainment.* For purposes of this subpart, *entrainment* excludes those organisms that are collected or retained by a sieve with maximum opening dimension of 0.56 inches. Examples of sieves meeting this definition include but are not limited to a 3/8 inch square mesh, or a 1/2 by 1/4 inch mesh. A facility must use the same mesh size when counting entrainment as is used when counting impingement.
- *Impingement* means the entrapment of any life stages of fish and shellfish on the outer part of an intake structure or against a screening device during periods of intake water withdrawal. For purposes of this subpart, *impingement* includes those organisms collected or retained on a sieve with maximum distance in the opening of 0.56 inches, and excludes those organisms that pass through the sieve. Examples of sieves meeting this definition include but are not limited to a 3/8 inch square mesh, or a 1/2 by 1/4 inch mesh. This definition is intended to prevent the conversion of entrainable organisms to counts of impingement or impingement mortality. The owner or operator of a facility must use a sieve with the same mesh size when counting entrainment as is used when counting impingement.
- *Adverse environmental impact (AEI)* is defined as <u>any</u> impingement or entrainment of individual organisms. (As discussed at 79 FR 48303 and Essay 16 in the Response to Comments Document for the Final Section 316(b) Existing Facilities Rule [EPA-HQ-OW-2008-0667-3679].)

2 Facility Description

This section summarizes information that describes the offshore platform, its location, the configuration of its CWIS, any intake technologies that are employed, and the intake flow. This description was derived from information provided by the operator, as well as publicly available information. The simplest way to present this summary is in tabular form; see Table 3 below. A complete discussion of this information is available in Appendix A.

Table 3. Summary of Cooling Water Intake Design Data

Platform Name	Distance Offshore (Miles)	Intake No.	Water Depth (Feet)	Intake Opening Depth (Feet)	Intake Pipe Diameter (Inches)	Type of Intake Inlet/Screen	Maximum Intake Flow Capacity (gpd)	Average Intake Flow Rate (gpd)	Calculated Maximum Capacity Intake Velocity (fps)
Ellen	9	1	265	-42	20	Open pipe with bars	1,728,000	1,728,000	1.4
Ellen	9	2	265	-42	20	Open pipe with bars	1,728,000	1,728,000	1.4
Eureka	9	1	700	-120	20	Open pipe with bars	2,880,000	2,880,000	3.0
Eureka	9	2	700	-120	20	Open pipe with bars	2,880,000	2,880,000	3.0

3 Biological Characterization

In the fact sheet for the General Permit, EPA acknowledged that an analysis of the biological resources would "not necessarily involve additional field work, but could consist of an assessment based on existing literature." The operators agreed that no field sampling was necessary and have conducted a thorough desktop-based analysis. This section summarizes that analysis of biological data which is described in detail in Appendix B.

The assessment begins by describing the general environment in which offshore platforms are located, including a description of the Southern California Bight, oceanic currents, and the organisms species present in the area (including protected species). In short, there are a large number of species found in the ocean waters near the platforms, but the distance from shore, water depths, changes in substrate, and other factors likely limit the abundance of organisms in the vicinity of the platforms. Of those organisms that are present, the numeric abundance is dominated by a few species. For this analysis, three of these most abundant species were selected for further study: northern anchovy, Pacific sardine, and queenfish.

3.1 Available Biological Data

Historically, impingement and entrainment data has not been collected at the platform CWIS. As a result, there is not a ready source of site-specific biological data to use in assessing potential biological impacts. However, several data sources exist that provide high quality data for the surrounding waters, allowing for a proxy analysis to be conducted.

The primary data source is the California Cooperative Oceanic Fisheries Investigations (CalCOFI) data set, which contains egg and larval density data for multiple species from offshore sampling locations in the Southern California Bight (Table 4). Data were obtained from 25 stations covering an area of 29,978 square kilometers, which were sampled on a quarterly basis between 1950 and 2011. Additional data on species life histories (e.g., mortality rates, fecundities) was gathered from EPA's rulemaking record, guidance documents, and online databases. The abundance of existing fishery stocks was derived from the literature.

Table 4. Species Life-History Data Used for Estimation of Entrainment Effects

Species	Total Mortality Rate for Egg, Larval, and Juvenile Stages (per year)	Fecundity (eggs/female/year)	Stock Size (number of females)
Northern Anchovy	10.78	30,000	6,450,856,204
Pacific Sardine	7.60	37,500	745,237,500
Queenfish	8.49	90,000	No data

3.2 Analytical Approaches

The analysis consisted of three separate approaches. First, a calculation of the loss of age-1 equivalent larvae, which uses life history information (natural mortality rates) and entrainment rate based on seasonal densities for each species to calculate the number of age-1 organisms that are lost to entrainment and that would have survived to age-1 had they not been entrained. By normalizing this information to a specific age-class, the analysis is able to better illustrate the effects of entrainment and allow comparisons between species. The results can also be compared to the entrainment losses at land-based CWIS. EPA has consistently used this approach in the 316(b) rulemaking, most recently in the final 2014 existing facility rule (see 79 FR 48403, August 15, 2014).

The second approach involved an analysis of the proportion of water withdrawn by the CWIS as compared to a reference volume of water passing the platform. Since larval densities are assumed to be homogeneous throughout the water mass, the ratio of water masses is equivalent to the fraction of the available larvae that are potentially entrained.

The third approach uses the age-1 equivalent losses and total stock sizes to derive a comparison of the loss of reproductive output relative to the total population size in the Southern California Bight. This approach estimates the number of females that would be required to produce the number of age-1 equivalent larvae that are lost to entrainment, then compares that value to the existing stock size.

3.3 Summary of Results

Each of the three analytical approaches yielded a similar outcome—that the biological impacts of CWIS withdrawals from offshore platforms is rather small, whether viewed in a direct biological light (e.g.,

annual age-1 equivalent losses) or a relative one (e.g., proportional withdrawals of the source water or of the local population). This information is summarized in Table 5 below.

Table 5. Summary of Biological Characterization Data

Platform	Annual Age-1 Equivalent Losses			Intake/ Passing Ratio (%)	Proportion of Population Lost (%)		
	Northern anchovy	Pacific sardine	Queenfish		Northern anchovy	Pacific sardine	Queenfish
Ellen	81	197	2	0.29	5.4E-06	3.77E-06	-
Eureka	136	329	3	0.06			

For example, at platform Ellen, approximately 0.29 percent of the water passing the platform is withdrawn by the CWIS. This implies that a similar percentage of the larvae passing the platform are potentially entrained.

As shown above, an estimate of 197 age-1 equivalent Pacific sardine larvae are entrained annually at platform Ellen. In order to place this number in perspective, the number of females (28) required to produce this many age-1 equivalent larvae was calculated. This value was then compared to the estimated number of females present in the Southern California Bight (745,237,500). This comparison indicates that the loss of 28 reproductive females represents 3.77E-06 percent of the total female population.

4 Analysis of Technologies

The third aspect of the analysis required by the General Permit is an assessment of the existing technologies employed by offshore platforms, as well as an evaluation of potential retrofit technologies to address impingement and entrainment. Included in this evaluation would be an assessment of technical feasibility, cost, and an estimated level of reduction of impingement and entrainment. The complete analysis is presented in Appendix C.

4.1 Existing CWIS

While all platforms and CWIS are different in some way or another, they do often share common design features. Each of the 13 platforms in this study employed a vertical pipe with opening(s) at the bottom as the primary intake design. The depths varied from 30 feet to 285 feet. Intake technologies varied from open pipes with crossbars (to exclude large debris) to slotted pipes to cylindrical wedgewire screens. Intake velocities also varied, from approximately 0.1 to 4.9 feet per second.

4.2 Intake Technologies Considered

A wide variety of technologies exist to address impingement and entrainment, as described in EPA's analysis for the 2014 existing facility and Phase III rules. However, the selection of a technology for a given CWIS often depends on a number of highly site-specific factors. These factors will determine

whether a technology is technically feasible and also affect how well the technology can be expected to perform.

A detailed analysis of feasibility was conducted to determine what technologies can be considered for use at existing offshore platforms. Given the somewhat unique nature of platforms, technologies that are most often developed or deployed at land-based intakes may not be appropriate. Table 6 lists the technologies that were considered as technically feasible and those that were not. (See Attachment 1 in Appendix C for an overview of these technologies.) In some cases, a technology may only be effective in reducing impingement, while others may reduce both impingement and entrainment.

Table 6. Assessment of Technical Feasibility for Various Intake Technologies

Feasible[1]	Not Feasible
Velocity cap (I only)	Closed-cycle cooling
Low intake velocity (I only)	Screen and return system
Coarse mesh wedgewire screen (I only)	Dry cooling
Fish avoidance technology (I only)	Aquatic fish barrier or net
Fine mesh wedgewire screen (I and E)	
Intake relocation (I and E)	
Cooling water reuse (I and E)	
Variable speed pump (I and E)	

[1]I=Impingement and E=Entrainment

After determining what technologies are feasible at offshore platforms, the next step is to assess how effective these technologies may be in reducing impingement or entrainment. A large body of literature exists that documents the performance of these technologies (see the 2014 rule's Technical Development Document for more information; EPA-HQ-OW-2008-0667-4138). However, most of these technologies have not been employed at offshore platforms. In most cases, the technology can be expected to perform at an equivalent level, as there is little difference in how it would operate at a platform as opposed to a land-based facility. In other cases, feasible technologies may be difficult to retrofit. Table 7 provides estimated reductions in impingement and entrainment for each feasible technology.

After examining the performance of these technologies, several no longer appear to be logical alternatives for existing offshore platforms. Velocity caps have not been deployed in a downward-facing configuration (as they would be at a platform) and the performance is equivalent to wedgewire screens. Low intake velocity is a highly effective impingement control measure, but is unlikely to be a logical choice at existing intakes; simply installing larger pipe openings (to expand the intake opening and reduce the intake velocity) was not considered to be as effective as installing coarse mesh wedgewire screens, which rely upon both low velocity and exclusion. Cooling water reuse is conceptually feasible, but simply unlikely to provide any alternative sources of process water. Fish avoidance technology is also conceptually feasible but performance is very species-specific, requiring on-site, full-scale testing to evaluate performance. There is no indication that on-site conditions are favorable for this technology.

Table 7. Assessment of Performance for Various Intake Technologies

Technology	Estimated Impingement Mortality Reduction	Estimated Entrainment Reduction	Notes
Velocity cap	Up to 97%	None	Performance based on existing installations. Has not been deployed in downward-facing orientation.
Low intake velocity	Up to 96%	None	-
Coarse mesh wedgewire screen	Up to 100%	None	-
Fine mesh wedgewire screen	Up to 100%	0-52%	-
Intake relocation	Not determined	Not determined	Organism density varies with depth. Performance may vary significantly depending on site-specific details, such as exact depth, season, species present, etc.
Cooling water reuse	Minimal	Minimal	While feasible, few opportunities exist to reuse other process water.
Variable speed pump	0-30%	0-30%	-
Fish avoidance technologies	Very limited and is species specific	None	Effectiveness very species-specific and would require site-specific testing

4.3 Estimated Technology Costs

After an examination of the feasibility and performance, the list of technologies was narrowed to four: course mesh wedgewire, fine mesh wedgewire, intake relocation, and variable speed pumps. Estimated capital and operations and maintenance (O&M) costs were derived for these technology options, and are presented for each of Beta Offshore's platforms in Table 8 below. A detailed description of the cost methodology can be found in Appendix C.

Table 8. Estimated Costs for Various Intake Technologies

Platform	Coarse Mesh Wedgewire		Fine Mesh Wedgewire		Relocate Intake 100 ft Deeper		Variable Speed Pumps	
	Capital Cost ($)	O&M Cost ($)	Capital Cost ($)	O&M Cost ($)	Capital Cost ($)	O&M Cost ($)	Capital Cost ($)	O&M Cost ($)
Ellen	760,000	6,000	760,000	56,000	1,110,000	12,000	96,000	32,000
Eureka	760,000	6,000	760,000	56,000	0	0	160,000	54,000

5 Analysis

The sections above present the building blocks for making a BPJ-based BTA determination. This section compiles and evaluates information from each platform in the context of the analytical factors, enabling conclusions about BTA to be reached.

5.1 Language of the CWA

The statutory language of the CWA provides perhaps the most basic framework for evaluating BTA. An assessment of each of the regulatory factors is below.

Location

The location of a CWIS can have a significant effect on its biological footprint. Conceptually, the CWIS should be located where it will be withdrawing from waters that are relatively unproductive, biologically speaking. This would suggest that, to the extent possible, intakes should avoid being located in an estuary or tidal river, near a historic spawning ground or wetland, in a migratory pathway, or in the vicinity of critical habitat for rare species.

To that end, the CWIS at the offshore platforms are generally sited at very desirable locations, especially in comparison to the vast majority of industrial CWIS. By virtue of being located several miles offshore, the CWIS are located in areas of much lower biological productivity. EPA's analysis of intake location in the Phase III rule and the 2014 existing rule supports this assessment as well. In Phase III, EPA noted that "densities are highest at sampling stations in the shallower regions of the Gulf of Mexico and lowest at sampling stations in the deepest regions." (See 70 FR 71059, November 25, 2005.) In the 2014 rule, the Technical Development Document for the final rule (EPA-HQ-OW-2008-0667-4138), Section 6.5.1 describes how an offshore intake is less likely to be in a biologically productive area. It also describes an analysis of data from offshore sampling in the Gulf of Mexico that shows a marked drop in the density of organisms with distance from shore and water depth. EPA's regulatory framework also recognized the value of an offshore location by establishing a regulatory provision (40 CFR 125.94(c)(4)) for existing intakes a minimum of 850 feet offshore that employ a velocity cap and designates them as employing BTA for impingement mortality.

A separate analysis of entrainment at offshore platforms in the Gulf of Mexico also supports the conclusion that offshore CWIS are located in areas of lower organism density. Offshore Operators Committee (OOC) (2014) found that larval densities near the platforms were far less than densities

observed in sampling closer to shore. Additionally, densities in the surface layer in deeper waters (i.e., at locations further offshore) were approximately one-sixth of the densities of shallower locations.

Intake depth is also an important factor in evaluating location. Typically, an intake located in the upper portion of the water column (i.e., in the photic zone) will withdraw from more biologically productive waters. As noted above (especially in the Phase III analysis), organism density decreases markedly with depth. While the photic zone (or some other measure of productive waters) can extend several hundred feet in the open ocean (in many cases, beyond the location of the CWIS), withdrawals from a location at such a large distance offshore and at substantial depth generally reduce the organism density to an extremely low level. The average intake depth for the 13 platforms studied is nearly 120 feet, with a range of 30 feet to 285 feet.

Design

The primary method to assess this factor is to examine any intake technologies in place. As discussed in Section 4 above, intake screens can significantly reduce impingement and, in some cases, entrainment. When properly selected and installed, some screens can virtually eliminate impingement. The use of a low intake velocity or a velocity cap are other design features that can be very effective in reducing impingement effects. However, many of the technologies that are feasible at land-based CWIS are not available for use at an offshore intake, for a variety of technical reasons.

As described in Section 2, the 13 platforms reviewed in this study employ a range of intake technologies. Most intakes employ slotted pipes or a simple pipe or opening with a basic trash rack screen. Some intakes employ cylindrical wedgewire screens, a highly effective technology for impingement. Several intakes also withdraw cooling water at a low velocity, resulting in a high level of reduction in impingement mortality.

As noted above, there are relatively few technology options available to reduce entrainment at a CWIS, including those at offshore platforms.

Construction

As noted in Section 1.2, this factor is irrelevant for existing CWIS.

Capacity

EPA has consistently recognized that reducing the volume of water withdrawn is generally the most effective method to minimizing impingement and entrainment effects. For large flow intakes (such as those at land-based industrial sites), this may involve retrofitting closed-cycle cooling systems or increasing the reuse of internal process flows. But for smaller intakes, such as those at existing offshore platforms, the capacity of those intakes is already at a reduced level. Some degree of flow reduction may be possible, but the magnitude of any reduction (and the associated benefit) would likely be small.

Section 3 above also describes a methodology to analyze the proportion of the CWIS' withdrawals in relation to the size of the source waterbody. This approach is consistent with previous EPA analyses; the Phase I rule included a provision to limit intake flows to less than 1% of the tidal excursion, a very similar measure to that analyzed in Section 3. (See 40 CFR 125.84(b)(3)(iii) and 125.84(c)(2)(iii).) In the Phase II rule, EPA considered regulatory options that incorporated this concept as well; see 67 FR 17156, April 9, 2002.

5.2 NPDES Regulations on BPJ

As described in Section 1, other sections of the NPDES regulations provide several explicit regulatory factors that are to be considered when evaluating BPJ-based permit conditions. An assessment of the applicability of these factors may be useful in making a site-specific determination of BTA as well. EPA has not developed any general guidance for how to interpret these factors, the discussion below makes a reasonable attempt to define them.

Cost to Benefit Ratio

While this document does not attempt to develop a formal cost to benefit analysis (such a step would likely be resource-intensive), the discussion above does establish a framework for generalized assessment of the relative costs and benefits, as well as some sense of the cost-effectiveness of the technology options. Overall, the compliance costs for potentially feasible technologies (at all 13 of the platforms studied) range from approximately $40,000 to $854,000 per intake.

From a benefits perspective, there are two relevant analyses. First (as described in Section 3), the overall abundance of organisms in the vicinity of the platforms (and being drawn into the CWIS) is relatively low. As a result, there is likely to be only a small benefit to be realized, even under optimal circumstances. Second (as described in Section 4), there is considerable uncertainty as to the performance for many of the potentially feasible technologies, suggesting that installing a new technology may only result in minimal reductions in impingement and entrainment.

Cost-effectiveness is another, similar comparison that may be useful. Instead of calculating a ratio of costs to benefits, cost-effectiveness examines the incremental improvements for a given increase in cost. Similar to the above discussion, there would likely be fixed, significant costs for most platforms but with an uncertain reduction in impingement and entrainment.

Age of Equipment and Facility

Generally speaking, it is less efficient to impose rigorous requirements on a facility (or its equipment) if that facility is approaching the end of its useful life. Existing facilities will face more challenges in adapting or retrofitting compliance technologies, as compared to a new facility (which can incorporate the requirements into its design). Older facilities also have a shorter period over which to recover any expenditures related to compliance. In a worst case scenario, a facility may even be forced to close when faced with an economic choice of meeting new permit requirements.

Each of the 13 platforms in this study have been in operation for decades. Offshore platforms have a typical lifespan of 25-50 years, which can vary depending on a number of economic and other factors, such as the viability of the oil field, the costs of production, and the replacement of production equipment. While these platforms likely have a number of remaining years of active production remaining (most began operations in the 1980s), they are certainly nearing the later stages of useful life.

Process Involved

This regulatory factor is more relevant for industrial discharges than for water withdrawals. In some cases, a unique industrial process may merit special consideration in determining BPJ-based requirements. An example might be a one-of-a-kind facility. In the case of offshore platforms, there are no industrial processes that are especially unique or otherwise deserving of consideration under this factor.

Engineering Considerations of Control Measures

Section 4 above describes the feasibility of potential control measures. To a certain degree, this document has already considered this factor in evaluating control technologies and has eliminated a number of them from consideration due to engineering considerations. Even among the remaining technologies considered as feasible, however, there remain concerns about the engineering challenges for installing the technology, as well as the efficacy of the technology in reducing impingement and entrainment.

Process Changes

This regulatory factor is more relevant for industrial discharges than for water withdrawals. One possible application for offshore platforms might be to change the industrial process in a way that it requires less cooling water. However, none of the compliance options considered in this document would lead to significant changes in the industrial process or operations of offshore platforms; as a result, this factor is not a consideration in making a BTA determination.

Non-water Quality Impacts

Non-water quality impacts might include increased air emissions, generation of solid waste, impacts to energy consumption, socioeconomic impacts, or other effects. In general, the technologies under consideration in this document would be expected to have very small non-water quality effects; this factor is not a consideration in making a BTA determination.

5.3 316(b) Existing Facility Rule

The 2014 rule, while not containing any specific requirements for existing offshore platforms, does provide perhaps the most appropriate framework for evaluating BPJ-based permit conditions. First, the final rule is the only framework that was developed with Section 316(b) specifically in mind; any guidance or other analyses would inherently consider the unique aspects of addressing intake structures as opposed to industrial discharges. Second, the rule is also the most recent resource available, suggesting that it reflects EPA's most current data and methods for assessing BTA and BPJ permitting. Several provisions of the rule are applicable for offshore platforms.

Regulatory Factors

Much like the NPDES regulations, the 2014 rule includes a number of factors that the Director can consider for land-based facilities. It seems reasonable to also consider these factors for existing offshore platforms, since the platforms are industrial facilities within the scope of the rule, have somewhat similar CWIS, and other similarities.

<u>Number and Type of Organisms Entrained</u>

As discussed in Section 3 and elsewhere above, the magnitude of entrainment at offshore platforms is relatively small, both in an absolute sense and in comparison to land-based CWIS. As to the type of organisms entrained, platform CWIS entrain a typical cross-section of open ocean pelagic species.

<u>Impact to Pollutant Emissions</u>

As discussed above, non-water quality impacts are not expected to be a significant consideration.

Land Availability for Entrainment Technologies

The parallel for offshore platforms would be available space on the platform to house new technologies. For land-based facilities, this is usually most relevant when considering closed-cycle cooling, as it requires a relatively large area for the construction of cooling towers. As discussed in Section 4 above, space is extremely limited on existing platforms.

Remaining Plant Useful Life

As discussed above, existing platforms are likely to remain in operation for a number of years to come, but are aging and have a finite remaining useful life.

Social Benefits and Costs

EPA and permitting authorities have a clear authority to consider costs and benefits in establishing permit requirements; as part of the litigation resulting from the 2004 Phase II rule, the United States Supreme Court decided in *Entergy v. Riverkeeper* (decided April 1, 2009) that consideration of costs is permissible. The weight given to considering costs and benefits (as part of the overall decision-making process) is a decision that remains with the permitting authority, however, as part of the BPJ process.

The distinction between the above discussion on cost-benefit and *social* costs and benefits is to clarify that costs and benefits should be viewed from the societal perspective. If viewed only from the platform or parent firm's perspective, it is possible that some costs or benefits may not be considered. Regardless of the methodology, as discussed above, the compliance options under consideration carry significant costs and have uncertain (and likely small) benefits.

Entrainment Impacts

As discussed in Section 3, entrainment effects are expected to be small.

Thermal Discharge Impacts

Thermal discharges have not been identified as a concern at existing platforms and the compliance alternatives under consideration would not affect the thermal load of any discharges.

Prior Flow Reduction Efforts

Some platforms have reduced the size of their cooling water pumps since the original design. This flow reduction effort reduces impingement and entrainment.

Energy Reliability

In the 2014 rule, this factor was largely intended to address extended outages at power plants or other facilities, such as an outage to retrofit to closed-cycle cooling. These outages could directly impact the availability of electricity to the grid, possibly affecting the reliability and delivery of power to consumers. While that aspect is not relevant here, the continued production of petroleum resources from the existing platforms is a highly valuable source of energy for the economy and provides energy security. Any potential requirements should consider possible energy-related effects.

Water Consumption

Water consumption has not been identified as a concern at existing platforms and the compliance alternatives under consideration would not affect the consumption rates.

Availability of Alternative Water Sources

This factor is related to identifying alternative sources of water to replace water withdrawn through the CWIS. Typically, a land-based facility might use treated effluent from a wastewater plant, reject water

from a desalinization plant, or other sources. Given the location of offshore platforms, there are no other sources of cooling water.

Applicability Criteria

All 13 of the platforms discussed in this study meet the minimum flow threshold established in the 2014 rule. As discussed in Section 2, the analysis of these facilities also considers intake structures that are exclusively used for fire water or other non-cooling uses and has excluded them.

In the future, existing platforms could consider reducing the design intake flow or the percentage of water withdrawn for cooling as a way to further demonstrate compliance, but at this time this factor is not relevant to making a BTA determination, as all of the facilities meet the generic criteria associated with the 2014 rule.

Intake Velocity

An intake velocity of 0.5 feet per second or less is a simple, clear way to meet impingement mortality requirements under the 2014 rule. Several platforms have CWIS that meet this criterion and should be considered as compliance with impingement requirements.

An analysis of intake velocity in OOC (2014) indicates that intake velocity presents a small risk to nearby organisms, as the intake velocity for a 0.5 feet per second intake dissipates to approximately 0.05 feet per second within one pipe diameter of the intake. The caisson openings for the 13 platforms in this study ranged from 26 to 42 inches, suggesting that the area of influence for intake velocities would be very localized and affect few organisms. Non-motile organisms (i.e., eggs) and poor-swimming larvae may pass by the intake unaffected, even at relatively close distances. As a result, the intakes appear to have a minimal area of influence for both impingement and entrainment.

De Minimis

The 2014 rule does not define the term "de minimis" but does provide some general guidance as to how it may be interpreted. The rule language states that de minimis impingement rates are so low that "additional controls may not be justified." (See 40 CFR 125.94(c)(11).) In the NODA (77 FR 34324, June 11, 2012), EPA used an example of a several fish per month to illustrate de minimis impingement rates. As discussed in Section 3, the abundance of organisms at the CWIS is quite low. Also, as discussed in Section 4, anecdotal information from the platform operators regarding the absence of organisms observed during intake pump cleaning suggests that few organisms are being impinged or entrained. While not a substitute for a rigorous biological sampling effort, this information is valuable in determining the likely rates of impingement and entrainment at the platform CWIS.

Given the low flow volume, low organism abundance, and combination of screens and low intake velocity at many platform intakes, an overall conclusion that most (or even all) platform intakes exhibit a de minimis effect for impingement is warranted. While the 2014 rule did not extend this provision to address entrainment, for offshore platforms, it seems reasonable to do so, as the same factors arguing for de minimis impingement effects also apply to entrainment.

5.4 316(b) Historical Documents

Most of the discussion regarding historical documents in Section 1 above was to provide context for how to develop a BPJ-based determination of BTA, given that few of these documents provided actual

guidance, definitions, or other information to make the determination. However, the 1977 guidance did provide a significant amount of information that can be applied in assessing a BPJ-based determination.

1977 Draft 316(b) Guidance

The 1977 guidance document described a framework for collecting information that the Director could use to make a BTA determination. The requirements in the General Permit follow the tenets of this framework and resulted in this document.

The next step is to evaluate this information and assess what impacts, if any, are caused by the operation of the CWIS at existing offshore platforms. As discussed above, these platforms are generally located in areas of low biological productivity, have relatively small withdrawals, and often utilize effective technologies to further reduce impingement and entrainment. Using the decision matrix provided in the guidance and presented previously in Section 1 (Table 9), a reasonable conclusion is that existing offshore platforms are located in areas of low biological value and withdraw low volumes of cooling water relative to the source waterbody. This simplified approach suggests that existing platforms already employ BTA. Such a conclusion is supported by each of the other aspects of the analysis presented in this document.

Table 9. Simple Decision Matrix for Determining BTA

	Cooling Water Flow Relative to Source	
Biological Value	High	Low
High	Not BTA	Possibly BTA
Low	Possibly BTA	**Employs BTA**

As suggested by the analysis above and the decision matrix, significant adverse environmental impacts do not appear to be occurring as a result of the operation of the platform CWIS.

6 Conclusions and Recommendations

As discussed above, existing offshore platforms are subject to the 2014 existing facility rule, but do not have any categorical requirements. Instead, the Director will use BPJ to develop a site-specific determination of BTA. Section 1 laid out a variety of potential factors that could be used in defining and analyzing BTA. Section 2 presented basic information on each of the platforms, including engineering data that forms the foundation for evaluating the CWIS. Section 3 described the biological resources in the vicinity and the potential effects of withdrawals by the platforms. Section 4 analyzed the possible

technologies that could be utilized to minimize impingement and entrainment. Section 5 synthesized the data with the various regulatory frameworks.

Some elements of the analysis are broadly applicable to all of the platforms, while others are more specific to individual platforms. As discussed in more detail below, information from a biological, technical, and policy perspective, these analyses consistently and collectively suggest that the CWIS at existing offshore platforms already employ BTA.

6.1 Broadly Applicable Findings

As discussed above, there are a number of analyses presented in this document that are broadly applicable to all of the offshore platforms studied. Collectively, these analyses suggest a consistent theme; that existing offshore platforms are not causing adverse environmental impacts. These findings are summarized in general categories below.

Biological Findings

Some degree of AEI (as defined by the 2014 rule and the 1977 guidance) is occurring, given that impingement and entrainment of organisms occurs. But the scale of these impacts is not significant. As discussed above, existing platforms withdraw from waters that are relatively less biologically productive and from a location in the water column that is reasonably protective of even those organisms that are present. As discussed in Section 3, the resulting impacts from the operation of the CWIS is very small, especially when compared to existing fishery stocks and impingement and entrainment rates at other CWIS. Additionally, platform CWIS are relatively small withdrawals, in terms of absolute magnitude and in comparison to land-based intakes. Observations from platform operators also suggest that few organisms are being impinged or entrained on pump screens. Section 3 also describes how the proportion of water being withdrawn by platform intakes is extremely small in relation to the size of the source waterbody; these ratios are far below the threshold of concern that appears to have been established in the Phase I rule (1%). Additionally, while it has been speculated that the platforms can act as artificial reefs and attract associated fish (who may then be subject to impingement or entrainment), the available information suggests that, if present, these fish may be large enough or exhibit behavior that enables them to avoid being drawn into the intakes. As noted above, intakes also exhibit a very small area of influence (approximately one intake pipe diameter for an intake velocity of 0.5 feet per second), suggesting that even those organisms using the platform as a reef are unlikely to be significantly affected by the CWIS.

Technical Findings

As discussed in Section 4, while a number of intake technologies that can minimize impingement and entrainment exist, many of these technologies are not feasible on offshore platforms. Of those that are feasible, there remain significant uncertainties in terms of how effective these technologies may be in further reducing impingement and entrainment.

Policy Findings

The most relevant policy-based analysis is an assessment of cost-benefit. Regardless of the specific metric used, the end result is the same for offshore platforms; the benefits are expected to be very small in comparison to the costs. Similarly, applying a "de minimis"-like approach would suggest the same outcome—that the expected impacts are very small and do not outweigh the costs of any potential new requirements. Lastly, the findings under different regimes (i.e., the 1977 guidance and the

2014 rule) are consistent, despite using somewhat different analytical approaches; this consistency implies minimal variability in the analysis, further enhancing the findings.

6.2 Platform-Specific Findings

Each individual platform also exhibits certain characteristics that support the premise that no significant adverse environmental impacts are occurring. It is also worth noting that some platforms have technologies or configurations that are more effective in reducing impingement and entrainment; however, the overall conclusion remains that, as a whole, all 13 of the existing offshore platforms in this study (even under a "baseline" configuration with the least number of technologies) still exhibit very low impacts, especially in the context of the biological resources being affected and the cost-benefit considerations. Table 10 below provides a summary of the most relevant factors, with platform-specific information for Beta Offshore's platforms to demonstrate how each platform exhibits many features that suggest that it already employs BTA. The table also indicates whether a given factor is relevant to only impingement (I) or to both impingement and entrainment (I & E).

Table 10. Platform-specific Data for Most Relevant BTA Factors

Platform	BTA Factors						
	Far offshore location	Intake depth >100 feet	Low number of organisms entrained	Highly effective intake screens[1]	Intake velocity ≤0.5 fps	Questionable cost/benefit ratio	De minimis
	I & E	I & E	I & E	I	I	I & E	I & E
Ellen	Yes	-	Yes	-	-	Yes	Yes
Eureka	Yes	Yes	Yes	-	-	Yes	Yes

[1] Screens (such as wedgewire screens) that could be considered as compliant with impingement mortality requirements.

6.3 Consideration of Factors

Several groups of regulatory factors are presented in the text above. In the absence of specific regulations for existing platforms, the Director must assemble a variety of resources and then consider these various factors in making a site-specific, BPJ determination of BTA.

In the sections above, these factors are presented in the order of most broad to most specific, primarily to allow the reader a better opportunity to digest the information. However, the Director is empowered to choose which of these factors will be used to form the basis for a BTA determination. It would appear that the most logical approach for how to weigh these factors against one another would be to consider the relevancy of each factor. The most relevant factors would be those associated with the 2014 existing facility rule, as they were specifically developed with section 316(b) in mind. The factors listed in the NPDES regulations would likely be next most relevant; these were written for use in NPDES permits, but lack the specificity of applicability to CWIS. Lastly, the CWA language provides a broad framework, but minimal detail on how to implement the Act. As a whole, however, these factors generally do not conflict or otherwise lead to the potential for disparate analyses. In fact, the collective analysis surrounding intakes at existing platforms is very consistent, regardless of the regulatory factor or analytical method. This is a positive sign, suggesting that any subsequent findings have a high degree of certainty.

6.4 Recommendation for BTA Determination

This document follows the suggested approach outlined in the general permit (as well as several similar permitting documents) and collects information on biological and technological resources, then assesses the viability of a variety of policy options. The cumulative effect of the analyses presented in this document are clear, as each facet of the analysis points to the same conclusion; that CWIS at existing offshore platforms already employ BTA and need not be subject to any additional requirements. This conclusion can be reached using any number of the approaches described above; the preponderance of evidence and analyses suggests a singular endpoint.

7 References

Offshore Operators Committee (OOC), CWIS Steering Group. 2014. Gulf of Mexico Cooling Water Intake Structure Entrainment Monitoring Study: Final Report. March 2014. Prepared by CSA Ocean Sciences Inc. and LGL Ecological Research Associates, Inc.

United States Environmental Protection Agency (USEPA). 1973. Draft development Document for Proposed Best Technology Available for Minimizing Adverse Environmental Impacts of Cooling Water Intake Structures. December 1973.

United States Environmental Protection Agency (USEPA). 1977. Draft Guidance for Evaluating the Adverse Impact of Cooling Water Intake Structures on the Aquatic Environment: Section 316(b) P.L. 92-500. Available at www.regulations.gov, document ID EPA-HQ-OW-2002-0049-2210.

Appendix A: Description and Evaluation of CWIS Information

Technical Memorandum
Task 1: Description and Evaluation of CWIS Information

Prepared for:
Beta Offshore

Prepared by:

TETRA TECH

3746 Mt. Diablo Blvd., Suite 300
Lafayette, CA 94549

October 24, 2014

Table of Contents

1 Platform CWIS Descriptions (Task 1) 1

1.1 Baseline Intake 1

1.2 Platform: Ellen 1

1.3 Platform: Eureka 2

1.4 Summary 3

1.5 References 3

1 Platform CWIS Descriptions (Task 1)

The following is a description of the offshore oil and gas platforms.

In September 2014, a survey requesting current cooling water intake design and operating data was sent to the operators of the offshore oil and gas platforms. Below is a summary of the information contained in the responses, along with some descriptive information concerning the platforms obtained from public sources (BOEM 2014). The discussion below also contains a summary of the existing technologies employed at each platform, including some discussion as to whether the technology may qualify as capable of reducing impingement and entrainment when compared to a baseline intake.

1.1 Baseline Intake

For the purposes of evaluating technologies employed, intakes can be compared to a generic baseline intake that does not employ potential 316(b) technologies beyond what would be built using engineering and costs considerations only. A baseline intake is assumed to be an open pipe intake that is facing down located at a depth of 50 ft. (or less), which is roughly the minimum depth needed to maintain sufficient suction head for submersible pumps. The inlet to the open pipe normally has one to two bars across the inlet to prevent large objects from entering the intake. This results in an intake opening velocity that is not much greater than the internal pipe velocity. In general, when only engineering and costs are considered, the optimal pipe size selected for conveying water (i.e., one that balances the cost of materials with the pumping energy costs) typically corresponds to pipe velocities in the range of 3 to 5 feet per second (fps) or more. Thus, intake pipes with sizes corresponding to velocities near the 3 to 5 fps range represent what would be built if engineering and costs were the only considerations. For this evaluation, an average inlet (or through-screen) velocity of greater than 2 fps is considered as being baseline. A baseline cooling system is one that employs no flow reduction technology.

1.2 Platform: Ellen

Description

The Ellen facility is a fixed-leg oil and gas drilling and production platform located at latitude 33°-34′-56″ N and longitude 118°-07′-39″ W near San Pedro Bay, 9 miles offshore from Huntington Beach, California. The platform was installed on January 15, 1980 and has produced a cumulative volume of 43.9 million barrels of oil and 15.1 million cubic feet of natural gas (BOEM 2014).

The platform operates two cooling water intake structures with similar design and operating characteristics. Each intake consists of a single 20 inch diameter pipe which is open at the bottom with bars across the opening to prevent large objects from entering. The calculated average intake velocity is 1.4 fps. The intake openings are located at a depth of 42 ft. and the total water depth at the platform is 265 ft.

Each intake has a current design and average flow rate while operating of 1,728,000 gallons per day (gpd). The two intakes combined have a total current design flow rate of 3,456,000 gpd. Normally, both intakes are operated continuously resulting in a total daily average intake flow rate of 3,456,000 gpd.

The majority of the water withdrawn is used for cooling purposes with a small portion used for domestic waste.

Technologies Employed

The calculated average intake velocity of 1.4 fps is lower than baseline but not low enough to be comparable to a low velocity intake under the final 316(b) existing facility rule (§ 125.94(c)(2)). The low current pipe velocity may be the result of a reduction in pumping capacity or the overdesign of the original system to handle higher flow rates as a contingency. As such, the low intake velocity may represent a potential reduction in mortality of impingeable organisms compared to the baseline intake. The intake depth of 42 ft. is within the depth range of a baseline intake. The platform employs a baseline cooling system.

1.3 Platform: Eureka

Description

The Eureka facility is a fixed-leg oil and gas drilling and production platform located at latitude 33°-33'-50" N and longitude 118°-07'-00" W near San Pedro Bay, 9.0 miles offshore from Huntington Beach. The platform was installed on July 8, 1984 and has produced a cumulative volume of 37.9 million barrels of oil and 8.2 million cubic feet of natural gas (BOEM 2014).

The platform operates two cooling water intake structures with similar design and operating characteristics. Each intake consists of a single 20 inch diameter pipe which is open at the bottom with bars across the opening to prevent large objects from entering. The calculated average intake velocity is 3.0 fps. The intake openings are located at a depth of 120 ft. and the total water depth at the platform is 700 ft.

Each intake has a current design and average flow rate while operating of 2,880,000 gpd. The two intakes combined have a total current design flow rate of 5,760,000 gpd. Normally, both intakes are operated continuously resulting in a total daily average intake flow rate of 5,760,000 gpd. The majority of the water withdrawn is used for cooling purposes with a small portion used for domestic waste.

Technologies Employed

The calculated average inlet velocity of 3.0 fps is within the range of a baseline intake. One technology employed at platform Eureka that may result in a minor reduction in mortality for both impingeable and entrainable organisms is the placement of the intake at a lower depth of 120 ft. It is possible that entrainable organism densities may be somewhat lower at the lower depth resulting in a possible minor reduction in mortality of entrainable organisms. The platform employs a baseline cooling system.

1.4 Summary

Table 1 below presents a summary of platform intake design data.

Table 1. Summary of Cooling Water Intake Design Data

Operator	Platform Name	Intake No.	Water Depth (Feet)	Intake Opening Depth (Feet)	Intake Pipe Diameter (Inches)	Type of Intake Inlet/Screen	Maximum Intake Flow Capacity (gpd)	Average Intake Flow Rate (gpd)	Calculated Maximum Capacity Intake Velocity (fps)
Beta Offshore	Ellen	1	265	-42	20	Open pipe with bars	1,728,000	1,728,000	1.4
Beta Offshore	Ellen	2	265	-42	20	Open pipe with bars	1,728,000	1,728,000	1.4
Beta Offshore	Eureka	1	700	-120	20	Open pipe with bars	2,880,000	2,880,000	3.0
Beta Offshore	Eureka	2	700	-120	20	Open pipe with bars	2,880,000	2,880,000	3.0

1.5 References

BOEM. Pacific Platform Operators. Accessed on October 8, 2014 at http://www.boem.gov/BOEM-Newsroom/Offshore-Stats-and-Facts/Pacific-Region/Pacific-Platform-Operators.aspx.

Appendix B: Evaluation of Entrainment Effects of Platform Intakes

Technical Memorandum
Task 2: Evaluation of Entrainment Effects of Platform Intakes

Prepared for:
Beta Offshore

Prepared by:

TETRA TECH

3746 Mt. Diablo Blvd., Suite 300
Lafayette, CA 94549

December 12, 2014

Table of Contents

1 Background 1

2 Introduction 2

3 Methods 4

3.1 Calculation of Age 1-equivalent losses 5

3.2 Proportional Water Use 6

3.3 Loss of Reproductive Output 6

4 Results 7

4.1 Northern Anchovy 7

4.2 Pacific Sardine 7

4.3 Queenfish 8

4.4 Volume comparison 11

4.5 Reproductive equivalents 13

5 Discussion 14

5.1 Northern Anchovy 14

5.2 Pacific Sardine 15

5.3 Queenfish 15

6 References 16

List of Tables

Table 3-1 Species Life-History Data Used for Estimation of Entrainment Effects.....5
Table 4-1 Estimated Northern Anchovy Entrainment Mortalities and Year-1 Equivalents lost at Beta Offshore Platforms 9
Table 4-2 Estimated Pacific Sardine Entrainment Mortalities and Year-1 Equivalents lost at Beta Offshore Platforms.....10
Table 4-3 Estimated Queenfish Entrainment Mortalities and Year-1 Equivalents lost at Beta Offshore Platforms.....11
Table 4-4 Estimates of Intake and Reference Volumes at Platforms Ellen and Eureka.....13
Table 4-5 Calculation of Estimated Equivalent Females and Proportion of Population Affected by Entrainment at Beta Offshore Platforms.....13

1 Background

Section 316(b) of the Clean Water Act (CWA) requires that the location, design, construction and capacity of cooling water intake structures ("CWIS") reflect the application of the best technology available in order to minimize adverse environmental impacts. The current NPDES General Permit No. CAG280000 for Offshore Oil and Gas Exploration, Development, and Production Operations off Southern California requires an evaluation of the potential impacts of existing CWIS. The objective of the analyses presented in this report is to evaluate the potential effects and the magnitude of those effects from CWIS at existing oil and gas platforms to the most abundant fish populations and to protected invertebrates and fish.

2 Introduction

Oil and gas platforms are located between 4.7 and 10.5 miles offshore from the southern California coastline at depths ranging from 63 meters to 400 meters and with intake structures at depths ranging from 9 meters to 87 meters. The majority of oil and gas platforms occurring off southern California are located within the Southern California Bight (SCB). The SCB includes offshore areas from Point Conception south to the United States Mexican Border (Dailey et al. 1993, Love et al. 2009). The current system in this area, which at the surface, includes the California Current, the California Countercurrent, the Southern California Eddy and beneath the surface includes the California Undercurrent (Dong et al. 2009). The California Current, a southward flowing eastern boundary current that carries cold low salinity water, branches shoreward and northward near the southern-most end of the SCB to create the northward flowing inshore Southern California Countercurrent that carries warm saline water (Dong et al. 2009). The combination of the California Current and the Southern California Countercurrent creates the counter-clockwise flowing Southern California eddy (Dong et al. 2009). The current system, in conjunction with offshore wind patterns that displace the surface layer in this area, results in coastal upwelling and high productivity (Carr et al. 2003, Santoro et al. 2010).

Protected marine species occurring in this area include white abalone (*Haliotus sorenseni*), black abalone (*Haliotus cracherodii*), tidewater goby (*Eucyclogobius newberryi*), Coho salmon (*Oncorhynchus kisutch*), Chinook salmon (*Onchorhynchus tshawytscha*), and steelhead trout (*Oncorhynchus mykiss*). These species were not considered in the 2013 NPDES permit for Offshore Oil and Gas Exploration, Development and Production off Southern California for effects from effluent. The effects from entrainment to these species also appear low based upon various factors including distribution (black abalone occur in up to 6 meters of water and the tidewater goby occurs nearshore whereas the platforms are more than 4.7 miles offshore), lack of larvae present (i.e. Coho and chinook salmon and steelhead trout larvae and juveniles rear in streams for 1 to 7 years). White abalone occur in this area at water depths between 5 and 60 meters. However, in platform areas, 90% of substrate around platforms is sandy whereas abalone occur on hard substrate with limited larval dispersal distances and settlement within 9 days (Hobday and Tegner 2000).

Fish occurring in the SCB include at least 481 species (Dailey et al. 1993), over 151 of which occur nearshore (Lavenberg et al. 1986). The most abundant fish larvae and eggs in the SCB that were common to three California Cooperative Oceanic Fisheries Investigations (CALCOFI) surveys from 1977-1979 (Barnett et al. 1983), in 1978-1984 (Lavenberg et al. 1986), in 2004-2005 (Watson et al. 2007) included the northern anchovy (*Engraulis mordax*), Pacific Sardine (*Sardinops sagax*), the queenfish (*Seriphus politus*), the white croaker (*Genyonemus lineatus*), California halibut (*Paralichthys californicus*), and seabasses (*Paralabrax* spp.). From 2004-2005, the northern anchovy made up 76.1% of fish eggs and 70.9% of fish larvae (Watson et al. 2007). These species typically produce large numbers of eggs per female (30,000 to over 90,000; Froese and Pauly 2014) and have high rate of natural mortality in the egg and juvenile stages (U.S. EPA 2006). To place the estimates of entrainment losses into perspective, they are compared to the total population size in the Southern California Bight (SCB).

The most abundant fish species entrained at California power plant intake structures typically included the northern anchovy and queenfish (MBC Applied Environmental Sciences and Tenera Environmental 2005, Tenera Environmental 2005, Tenera Environmental 2008). The Pacific

sardine was less commonly among the most abundant species impinged/entrained at California power plant intake structures. However, given that northern anchovy and Pacific sardine populations undergo large-scale temporal population shifts during cold and warm water ocean regimes, the Pacific sardine is expected to account for the largest proportion of fish eggs and larvae during cold regimes (Butler et al. 1993, Schwartzlose et al. 1999, Hsieh et al. 2005, U.S. EPA 2006). Therefore, eggs and larvae of the northern anchovy, the Pacific sardine, and the queenfish appear to dominate in this area and their populations were selected to evaluate potential impacts from CWIS.

3 Methods

Three methods were used in this evaluation to assess the effects of entrainment of eggs and larval fishes in cooling water intakes of offshore oil and gas platforms, including:

- Calculation of Age-1 equivalent losses (U.S. EPA 2006);
- Proportional water use approach (Galloway et al. 2007); and
- Comparison of loss of reproductive output (# females) to total female population size in the SCB (Galloway et al. 2007).

No site-specific data are available for use in the evaluation of entrainment effects. Therefore, this evaluation relies on available data from the literature. Long-term data sets were used to derive average values for all parameters which were then used in the calculations. Therefore, the results presented in this evaluation should be considered as conservative approximations of likely effects.

Egg and larval densities for the three target species were obtained from the CalCOFI data set for stations adjacent to the platforms. Data were obtained from 25 stations covering an area of 29,978 square kilometers surrounding oil and gas platforms in the Southern California bight. These stations were sampled on a quarterly basis between 1950 and 2011. The egg and larval data originate from the NOAA National Marine Fisheries Service, Southwest Fisheries Science Center (SWFSC), and were collected by NOAA CalCOFI survey teams. Ichthyoplankton data were identified by the SWFSC ichthyoplankton laboratory. The species (northern anchovy, Pacific sardine, and queenfish) selected for this analysis typically produce large numbers of eggs per female (30,000 to over 90,000; Froese and Pauly 2014) and have high rates of natural mortality in the egg and juvenile stages (U.S. EPA 2006).

Egg and larval density data for the northern anchovy, Pacific sardine, and queenfish collected from 1951-2011 were extracted from the CalCOFI data set by season. Winter was defined as December through February (90 days); spring was defined as March through May (92 days); summer months included June through August (92 days); and fall months included September through November (91 days). Seasonal average densities were calculated for each species. The seasonal egg and larval densities are used as the basis for all calculations in this report. Annual effects were estimated by weighting the seasonal values by the number of days in each season.

Life history data for the three target species are presented in Table 3-1. Natural egg, larval, and juvenile mortality rates were obtained from U.S. EPA (2006) for the California region. Mortalities are expressed as the cumulative stage-specific mortalities for the egg, larval, and juvenile (to Age 1) stages for the northern anchovy, for the Pacific sardine based upon the Herring complex, and for the queenfish based upon the Drums/Croakers complex. These mortality rates are used to estimate the number of Age 1-equivalents that are lost due to entrainment.

Annual fecundities of the species were obtained from the online FishBase (Froese and Pauly, 2014). Fecundities are expressed as the average number of eggs produced per female per year. Age or size-specific fecundities were not obtained.

Table 3-1
Species Life-History Data Used for Estimation of Entrainment Effects

Species	Total Mortality Rate for Egg, Larval, and Juvenile Stages (per year)	Fecundity (eggs/female/year)	Stock Size (number of females)
Northern Anchovy	10.78	30,000	6,450,856,204
Herring Complex / Pacific Sardine	7.60	37,500	745,237,500
Drums&Croakers / Queenfish	8.49	90,000	No data

The numbers of female northern anchovy and Pacific sardine in the SCB were estimated from stock sizes obtained from the literature. Information on stock sizes of queenfish was not identified. Stock sizes for northern anchovy were obtained from Bergen and Jacobson (2001) based on 21 years of data collected between 1963 and 1994. The average stock size for northern anchovy during this period was estimated at 392,857 tons. To allow comparison to the loss of individuals, the stock size (tons) must be converted to a corresponding number of females. The northern anchovy becomes sexually mature at 2 years of age and rarely survive beyond Age 4 (Bergen and Jacobson 2001). Therefore, the average weight of an Age 3 individual (0.061 pounds, U.S. EPA, 2006) was used to estimate the number of females. The stock size, in pounds, was divided by the average weight of an Age 3 individual, and then divided by 2 based on the assumption of equal numbers of males and females to estimate the number of females (Table 3-1).

The number of Pacific sardine females was based on a 10-year (2004-2013) average of annual recruitment provided in Hill (2013) for the entire west coast population (Canada to Mexico). Since landings in the SCB comprised 17.5 percent of the total landings in the west coast population, this fraction was used to adjust the west coast stock size to approximate the stock present in the SCB. Assuming an equal sex-ratio, the number of recruits was divided by 2 to obtain numbers of females. Since this estimate is based on annual recruitment to the adult population, it may underestimate the total number of females actually present.

3.1 Calculation of Age 1-equivalent losses

The Equivalent Adult Model (EAM) approach allows entrainment losses to be expressed as an equivalent number of individuals at some other life stage. In the Regional Benefits Analysis for the Final Section 316(b) Phase III Existing Facilities Rule, U.S. EPA (2006) expressed losses as Age 1-equivalents. That approach is used here. This approach relies on estimates of the stage-specific mortality rates of the selected species and estimates of the density of eggs and larvae of the target species.

The overall methodology for assessing the equivalent Age-1 individuals lost was as follows:

- Estimates of seasonal ichthyoplankton (egg and larval) densities were obtained from the CalCOFI data. The CalCOFI density data are given as the total density of eggs and larvae.
- The egg and larval densities were then multiplied by the intake volumes of each platform to estimate the total number of eggs and larvae entrained. Mortality of entrained individuals is assumed to be 100% (U.S. EPA 1977).

- The number of Age-1 individuals that would have survived had they not been entrained was then calculated using the sum of the stage-specific mortalities for eggs, larvae, and juveniles using the following equation:

$$N_1 = N_0 * e^{(-M)}$$

where:

N_1 = number of individuals that would have survived to Age 1

N_0 = total number of eggs and larvae entrained

M = total mortality rate for egg, larval, and juvenile stages (see Table 3-1)

3.2 Proportional Water Use

The proportional water use approach allows comparison of the platform intake volume to a reference volume of water (Galloway et al. 2007). Daily intake volumes were obtained from the platform operator.

The reference volume of water is estimated by calculating the volume of a cylinder of water that flows past the intake per day. The length of the cylinder (meters) was assumed to be the distance a parcel of water would travel in one day based on the average current velocity. The average current speed in the Southern California Countercurrent (0.1 m/s; Dong et al. 2009) was multiplied by the number of seconds in a day (86,400 seconds) to determine the cylinder length. The radius of the cylinder was set equal to the depth of the intake structure (in meters). Therefore, in this analysis, the reference volume is proportional to the depth of the intake, with deeper intakes having larger reference volumes. It is assumed that the density of ichthyoplankton is constant throughout the water mass. Hence the proportion of eggs and larvae entrained is equivalent to the ratio of the intake volume to the reference volume.

3.3 Loss of Reproductive Output

The third approach to assessing population level impacts due to entrainment is to estimate the number of females required to produce the number of eggs and larvae that were entrained.

It was assumed that the total annual loss of eggs at each platform was approximated by the number of eggs and larvae calculated to have been entrained. This assumption likely underestimates the number of eggs lost as it does not account for the natural mortality from egg to larva. This number of eggs was then divided by the average fecundity of the species as reported in FishBase (see Table 3-1) to determine the number of females required to produce that number of eggs. Once the number of females required to produce the eggs that were lost was determined, that number was then compared to the estimated number of females in the stock.

4 Results

Estimated entrainment mortalities at platform Eureka are higher than those at Ellen as a result of higher intake volumes (Table 4-1).

4.1 Northern Anchovy

Average northern anchovy densities from 1951-2011 were highest in the spring (1.47 individuals/m^3) compared with winter (1.04 individuals/m^3) and summer (0.56 individuals/m^3), with the lowest densities in the fall (0.21 individuals/m^3) (Table 4-1).

Estimates of Age-1 equivalents lost, assuming natural mortality rates and based upon actual intake volumes at Platform Ellen ranged from 0.06 individuals/day to 0.40 individuals/day resulting in annual Age-1 equivalents lost of 81 individuals.

Estimates of Age-1 equivalents lost, at Platform Eureka ranged from 0.10 individuals/day to 0.67 individuals/day resulting in annual Age-1 equivalents lost of 136 individuals.

The total estimated annual Age-1 equivalent loss at Beta Offshore platforms was 217 individuals.

4.2 Pacific Sardine

Average Pacific sardine densities from 1951-2011 were highest in the spring (0.13 individuals/m^3) compared with summer (0.12 individuals/m^3) and winter (0.06 individuals/m^3), with the lowest densities in the fall (0.02 individuals/m^3) (

Table 4-2).

Estimates of Age-1 equivalents lost at Platform Ellen ranged from 0.13 individuals/day to 0.85 individuals/day resulting in an annual Age-1 equivalents lost of 197 individuals. Estimates of Age-1 equivalents lost at Platform Eureka ranged from 0.22 individuals/day to 1.41 individuals/day, yielding annual Age-1 equivalents lost of 329 individuals. The total estimated annual Age-1 equivalent loss at Beta Offshore platforms was 526 individuals.

4.3 Queenfish

Average queenfish densities from 1951-2011 were highest in the summer (0.0056 individuals/m^3) compared with spring (0.0010 individuals/m^3) and fall (0.00005 individuals/m^3), with the lowest densities in the winter (0.00001 individuals/m^3) (

Table 4-3).

Estimates of Age-1 equivalents lost, assuming natural mortality rates and based upon actual intake volumes at Platform Ellen ranged from 0.00003 individuals/day to 0.01506 individuals/day and resulted in annual Age-1 equivalents lost of 2 individuals.

Estimates of Age-1 equivalents lost, assuming natural mortality rates and actual intake volumes at Platform Eureka ranged from 0.00004 individuals/day to 0.02509 individuals/day resulting in annual Age-1 equivalents lost of 3 individuals.

The total annual Age-1 equivalent loss at Beta Offshore platforms, based upon actual intake volumes, was 4.

Table 4-1
Estimated Northern Anchovy Entrainment Mortalities and Year-1 Equivalents lost at Beta Offshore Platforms

Platform/Season	Average Northern Anchovy Ichthyoplankton Density 1951-2011 (indiv./m^3)	Actual intake volume (m^3/d)	Daily entrainment Mortality (indiv./day)[1]	Number of Year 1 Equivalents Lost (indiv./day)[2]
Ellen				
Winter	1.04	13,082	13,605	0.28
Spring	1.47	13,082	19,231	0.40
Summer	0.56	13,082	7,326	0.15
Fall	0.21	13,082	2,747	0.06
Annual Losses			**3,917,812**	**81**
Eureka				
Winter	1.04	21,804	22,676	0.47
Spring	1.47	21,804	32,052	0.67
Summer	0.56	21,804	12,210	0.25
Fall	0.21	21,804	4,579	0.10
Annual Losses			**6,529,686**	**136**
Total Annual Losses			**10,447,498**	**217**

1. Assuming 100% mortality of entrainment individuals (U.S. EPA, 1977).

2. Assuming a mortality rate of 10.78 for northern anchovy (U.S. EPA 2006).

3. Annual losses at each platform were calculated by multiplying the daily mortality by the seasonal duration (winter = 90 d; spring = 92 d; summer = 92 d; fall = 91 d) and summing.

Table 4-2
Estimated Pacific Sardine Entrainment Mortalities and Year-1 Equivalents lost at Beta Offshore Platforms

Platform/Season	Average Pacific Sardine Ichthyoplankton Density 1951-2011 (indiv./m^3)	Actual intake volume (m^3/d)	Daily entrainment Mortality (indiv./day)[1]	Number of Year 1 Equivalents Lost (indiv./day)[2]
Ellen				
Winter	0.06	13,082	785	0.39
Spring	0.13	13,082	1,701	0.85
Summer	0.12	13,082	1,570	0.78
Fall	0.02	13,082	262	0.13
Annual Losses			**395,353**	**197**
Eureka				
Winter	0.06	21,804	1,308	0.65
Spring	0.13	21,804	2,835	1.41
Summer	0.12	21,804	2,616	1.31
Fall	0.02	21,804	436	0.22
Annual Losses			**658,921**	**329**
Total Annual Losses			**1,054,274**	**526**

1. Assuming 100% mortality of entrainment individuals (U.S. EPA, 1977)

2. Assuming a mortality rate of 7.60 for the Pacific sardine (U.S. EPA 2006)

3. Annual losses at all platforms were calculated by multiplying the daily mortality by the seasonal duration (winter = 90 d; spring = 92 d; summer = 92 d; fall = 91 d) and summing.

Table 4-4). The volume of the intake water ranged from 0.06 to 0.29 percent of the total volume of water that would pass the intake daily. Since ichthyoplankton densities are assumed to be homogeneous through the water this ratio also indicates the proportion of the available ichthyoplankton larvae that may be entrained. This comparison indicates that a negligible portion of the ichthyoplankton larvae present near the platforms are likely to be entrained.

Table 4-4
Estimates of Intake and Reference Volumes at Platforms Ellen and Eureka

Platform	Current Speed (m/sec)	Length of water passing intake/day (m)	Intake depth (ft)	Intake depth (m)	Volume passing per day (m^3/d)	Intake Volume (gal/d)	Intake Volume (m^3/d)	Intake/Passing Ratio
Ellen	0.100	8,640	42	12.80	4,447,846	3,456,000	13,082	0.29%
Eureka	0.100	8,640	120	36.57	36,308,946	7,488,000	28,345	0.060%

4.5 Reproductive equivalents

The annual loss of eggs and larvae at the Beta Offshore platforms and the number of females required to produce them are provided in Table 4-5. 348 female northern anchovy are required to produce the eggs and larvae that are estimated to have be entrained. 28 female sardines are required to make up for the entrainment losses in this species. In contrast, less than one female queenfish could produce sufficient eggs to account for entrainment losses. However, because of the large number of females in the anchovy and sardine stocks, the number of females required to replace the lost larvae comprises a negligible portion of the total population in the SCB.

Table 4-5
Calculation of Estimated Equivalent Females and Proportion of Population Affected by Entrainment at Beta Offshore Platforms

Species	Annual Larval Loss at all Platforms(# eggs)	Fecundity (eggs/female /year)	Equivalent Females	Females in Stock	Proportion of Population	Percent of Total Larval Production Lost[1]
Northern anchovy	10,447,498	30,000	348	6,450,856,204	5.40E-08	0.0001
Pacific sardine	1,054,274	37,500	28	745,237,500	3.77E-08	0.0001
Queenfish	21,405	90,000	0.2	-	-	0.02

[1]Percent of total annual losses compared to spring abundance in the SCB.

5 Discussion

Three methods were used to evaluate entrainment mortalities at CWIS:

- Calculation of Age-1 equivalents lost (U.S. EPA 2006);
- Proportional water use (Galloway et al. 2007); and
- Comparison of loss of reproductive output (# females) to total female population size (Galloway et al. 2007).

Three species (northern anchovy, Pacific sardine, and queenfish) were selected for detailed evaluation because they have been identified as dominant components of the ichthyoplankton in the SCB (Barnett et al. 1983, Lavenberg et al. 1985, Watson et al. 2007).

CALCOFI data from 1951-2011 indicate that in the SCB, total ichthyoplankton densities are highest in the spring and lowest in the fall. Entrainment mortalities were assumed to be 100% (according to U.S. EPA's 1977 Guidance for Evaluating the Adverse Environmental Impact of Cooling Water Intake Structures on the Aquatic Environment: Section 316(b) P.L. 92-500) in an effort to be conservative and show a "worst case scenario". Larval densities are generally greatest in spring when the total population of larvae within the study area includes $8.8*10^{12}$ northern anchovy, $779.4*10^{9}$ Pacific sardine, and $0.1*10^{9}$ queenfish.

Daily average intake volumes at Platform Ellen was 3.456MGD, respectively. The corresponding volume at Platform Eureka was 7.488 MGD, respectively. In comparison, California power plants have design intake flows ranging from 108 MGD to 2,528 MGD and average flows ranging 51 MGD to 2,287 MGD (Steinbeck 2008). Therefore, design and actual intake flows at Platforms Ellen and Eureka are 14 to 730 times lower than intake flows at California power plants. When the actual intake volumes at these offshore platforms were compared to the volume of water passing the platforms, the amount of water that is taken in by the cooling water pumps comprises less than 0.29 percent.

5.1 Northern Anchovy

The annual estimated entrainment mortality for Platforms Ellen and Eureka is presented in Table 4-1. Compared to peak population in the spring, the losses due to entrainment represent less than 0.0001% of the available larvae. Compared with annual entrainment estimates for northern anchovy at the Huntington Beach Generating Station (54,349,017 individuals/year) which has an ocean intake 457 m off of Huntington Beach, the annual entrainment mortalities at Platform Ellen and Eureka are 8 to 13 times lower (MBC Applied Environmental Sciences and Tenera Environmental 2005).

The combined estimated annual Age-1 equivalents lost at Platform Ellen and Eureka was 217 individuals. Based on a fecundity estimate of 30,000 eggs per female per year, it would require 348 females to replace the lost larvae. However, it is estimated that over 6.45 billion females are present in the SCB. Therefore the 348 females comprise a negligible loss of reproductive output to the population as a whole.

5.2 Pacific Sardine

The annual estimated entrainment mortality at Platforms Ellen and Eureka is presented in Table 4-2. Compared to peak population in the spring, the losses due to entrainment represent less than 0.0001% of the available larvae. The combined annual Age-1 equivalents lost at Platform Ellen and Eureka was 526 individuals. Based on a fecundity estimate of 37,500 eggs per female per year, it would require 28 females to replace the larvae lost to entrainment. Based on estimates of stock size, it is estimated the over 745 million female sardines are present in the SCB. Therefore the 28 individuals comprise a negligible loss of reproductive output to the population as a whole.

5.3 Queenfish

The annual estimated entrainment mortality at Platforms Ellen and Eureka is presented in Table 4-3. Compared to peak population in the spring, the losses due to entrainment represent less than 0.02% of the available larvae. Compared with annual entrainment estimates for queenfish at Huntington Beach Generating Station (17,809,864 individuals/year), the annual entrainment mortalities at Ellen and Eureka platforms are more than 3 orders of magnitude lower (MBC Applied Environmental Sciences and Tenera Environmental 2005).

The total annual Age-1 equivalents lost at Platform Ellen and Eureka was 4 individuals. Assuming a fecundity of 90,000 eggs per female per year, it would require significantly less than 1 female to replace the larvae lost to entrainment. Although no estimates of queenfish stock size were found, these losses appear insignificant to the entire population.

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

Santoro, A.E., Nidzieko, N.J., G.L. van Dijken, Arrigo, K.R., and Boehm, A.B. 2010. Contrasting spring and summer phytoplankton dynamics in the nearshore SCB. Limnology and Oceanography 55(1):264-278.

Schwartzlose, R.A., Alheit, J., Bakun, A., Baumgartner, T.R., Cloete, R., Crawford, R.J.M., Fletcher, W.J., Green-Ruiz, Y., Hagen, E., Kawasaki, T., Lluch-Belda, D., Lluch-Cota, S.E., MacCall, A.D., Matsuura, Y., Nevárez-Martínez, M.O., Parrish, R.H., Roy, C., Serra, R., Shust, K.V., Ward, M.N., and Zuzunaga, J.Z. 1999. Worldwide large-scale fluctuations of sardine and anchovy populations. South African Journal of Marine Science 21(1):289-347.

Tenera Environmental. 2005. Scattergood Generating Station: Summary of existing physical and biological information and impingement mortality and entrainmenta characterization study sampling plan. Prepared for: Los Angeles Department of Water and Power, Los Angeles, CA.

Tenera Environmental. 2008. Clean Water Act Section 316(b) impingement mortality and entrainment characterization study: Effects on the biological resources of Agua Hedionda Lagoon and the Nearshore Ocean Environment.

U.S. Environmental Protection Agency (U.S. EPA). 1977. (Draft) Guidance for Evaluating the Adverse Impact of Cooling Water Intake Structures on the Aquatic Environment: Section 316(b) P.L. 92-500. U.S. Environmental Protection Agency, Washington, DC.

U.S. Environmental Protection Agency (U.S. EPA). 2006. Regional Benefits Analysis for the Final Section 316(b) Phase III Existing Facilities Rule. U.S. Environmental Protection Agency, Washington, DC. EPA-821-R-04-007.

Watson, W., Manion, S.M. and Charter, R.L. 2007. Ichthyoplankton and station data for oblique (bongo net) plankton tows taken during a survey of shallow coastal waters of the SCB in 2004 and 2005. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-410. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. National Marine Fisheries Service, Southwest Fisheries Science Center, La Jolla, California, USA.

Appendix C: Evaluation of Feasibility, Cost, and Performance of Technologies for Reducing Environmental Impacts at Platform Intakes

Technical Memorandum
Task 3: Evaluation of Feasibility, Cost, and Performance of Technologies for Reducing Environmental Impacts at Platform Intakes

Prepared for:
Beta Offshore

Prepared by:

TETRA TECH

3746 Mt. Diablo Blvd., Suite 300
Lafayette, CA 94549

January 20, 2015

Table of Contents

_Toc409782784

1 Introduction 1

2 Technology Discussion 1

2.1 Existing Intake Technologies 1

2.2 Entrainment versus Impingement 1

2.3 Technologies Considered 2

2.4 Technologies for Reducing Mortality of Impingeable Organisms Only 3

2.5 Technologies for Reducing Mortality of Entrainable Organisms 5

2.6 Infeasible Technologies 9

2.7 Summary of General Feasibility 10

3 Evaluation of Platform Intakes 12

3.1 Platform Ellen 12

3.2 Platform Eureka 13

4 References 14

Attachment 1: Intake Technologies 15

1 Introduction

Tetra Tech was tasked with evaluating potential technologies or operational measures to reduce environmental impacts from entrainment and impingement. This evaluation of technologies and measures includes:

- An assessment of their technical feasibility
- A cost estimate
- An estimate of the level of reduction in impingement and entrainment

Using information from the data collected from individual operators under Task 1 and incorporating our engineering experience with cooling water intakes, recommendations were made regarding the feasibility of implementing the various technology options.

2 Technology Discussion

2.1 Existing Intake Technologies

The existing intake technology at most offshore oil and gas platform intakes generally involves one of a few intake designs: downward facing open pipes, cylindrical wedgewire wire mesh screens, or slotted pipes with slot widths ranging from 0.5 inches to 4 inches. The intake type, in addition to the size and orientation of the intake openings and the intake velocity, will affect whether swimming organisms are able to detect and swim away, are impinged on the screen, or pass through and are entrained into the cooling water system. Differences in intake location (including the depth of the intake) may also affect the density of organisms in the water that is drawn into the intake.

2.2 Entrainment versus Impingement

For regulatory purposes, the 316(b) final existing facility rule (79 FR 48300, August 15, 2014) identifies fish and organisms passing through a 3/8 in mesh screen as "entrainable" and generally assumes that all entrainable organisms drawn into an intake die as a result passing through the cooling system (i.e., 100% entrainment mortality). The rule identifies larger fish and organisms that are retained on a 3/8 in screen as "impingeable." Mortality of impingeable organisms is variable and will depend on the fish's capability to detect and swim away from the intake. Impingeable organisms that pass through a screen or intake with openings larger than 3/8 inch ultimately die via entrainment but are defined as impingement mortality in the rule. To be consistent with the 316(b) regulatory definitions and requirements, in this analysis technologies are assessed on their capabilities to reduce mortality of impingeable organisms (IM) and mortality of entrainable organisms (EM).

The memo for Task 2 describes a biological approach to assessing the degree of impingement and entrainment at offshore platforms. From an engineering perspective, the operational data supplied by several platforms also indicate that the amount of impingeable fish and larger entrainable fish drawn

into the intakes at the existing offshore platforms is relatively low. Many platforms with large open pipe or slotted openings use pump strainers located on the platform to prevent fish and debris from clogging the downstream heat exchangers. The reported mesh on these strainers ranged from 3/64 inch (1.2 mm) to 1/8 inch (3.2 mm), which is much smaller than the 3/8 inch (9.5 mm) mesh typically used at industrial shoreline intakes. Operators were asked about the operation of the strainers and none reported the need to frequently clean or backwash the strainers. The most frequent reported backwash rate was monthly for 3.2 mm strainers; this was part of routine maintenance where two intakes were alternately used on a monthly basis and there was no indication that this frequency was driven by fish or debris buildup on the strainers. Another operator originally used 1/32 inch (0.8 mm) mesh strainers, but discontinued their use when the backwash system failed and explained that fixing the strainer system was uneconomical. This suggests that the volume of fish passing downstream to the heat exchangers was not large enough to create a frequent plugging problem for the heat exchangers. This operational data indicates that mortality rates of impingeable fish and larger entrainable fish (i.e., those not passing 1/8 inch mesh) are very low at these intakes. This is presumably due to the fact that the intakes are located greater than 5 miles offshore with intake openings 30 ft. or more below the surface. Additionally, while it has been speculated that the platforms can act as artificial reefs and attract associated fish (who would then be subject to impingement or entrainment), the available information suggests that, if present, these fish may be large enough to avoid being drawn into the intakes.

2.3 Technologies Considered

EPA considered a wide range of intake technologies in the existing facility final rule, as well as the Phase III rule (71 FR 35006, June 16, 2006). The latter regulation specifically examined offshore industries, including offshore oil and gas exploration facilities. This analysis is derived from this initial set of technologies. Attachment 1 to this report includes a brief description of these technologies.

Candidate technologies for reducing IM and EM were evaluated with regard to the technology's physical and operational requirements, limitations on their ability to function as intended, and compatibility with the general site conditions at the offshore oil and gas platforms. Those technologies that are potentially compatible with platform conditions and able to function as intended are considered potentially technically feasible. This evaluation identified the following technologies as potentially technically feasible:

- Velocity caps
- Low intake velocity
- Wedgewire screens
    - Coarse mesh
    - Fine mesh
- Alternate intake location
- Behavioral barriers
- Flow Reduction – cooling water reuse
- Flow reduction - variable speed pumps

This evaluation identified the following technologies as potentially technically infeasible (for either impingement or entrainment):

- Aquatic fish barriers and nets
- Screens with return systems (e.g., traveling screens)

- Flow reduction – closed-cycle cooling
- Flow reduction – dry cooling

A detailed discussion of each technology considered is below. Some technologies are only effective in reducing impingement and will not reduce entrainment. Other technologies are capable of reducing both impingement and entrainment.

2.4 Technologies for Reducing Mortality of Impingeable Organisms Only

Technologies that reduce IM only tend to rely upon the principles of exclusion (e.g., screens) or fish behavior. Those that rely upon fish behavior rely upon the ability to detect and avoid being drawn into the intake and swimming away.

Velocity Caps

As water approaches an intake opening, a large component of the inlet flow is oriented perpendicular to the plane of the intake opening. For intakes where the intake opening is horizontal (such as in the case of open vertical pipes), the majority of the inlet flow will be oriented in the vertical direction (Turnpenny 1988). Swimming fish are more able to sense horizontal changes in currents than vertical changes in currents. Thus, fish approaching the inlet from below (or above) are sucked upward (or downward) and are less likely to exhibit an avoidance response in time to escape the rapid increase in velocity at the intake opening. Velocity caps are structural measures that alter the configuration of the intake flow such that nearly all of the increase in the velocity of water approaching the pipe inlet occurs in a horizontal direction, making it more likely to elicit an escape response. The cap itself also presents an additional visual cue.

The installation of velocity caps at the intake inlet is a potentially effective technology for reducing impingement of fish capable of swimming away but only for existing intakes where the opening is horizontal. The three fundamentals for exclusion of swimming fish at an open intake can be summarized in three words; detection, velocity, and direction (Turnpenny 1988).

Detection - In order to escape, fish must be able to detect its approach to the intake, including visual cues in the case of velocity caps. But may be inhibited under low light conditions such as at night.

Velocity – The approach velocity at the point of detection should not exceed the fish's maximum swimming speed.

Direction – The direction of flow must be in a horizontal direction in order for fish to detect and resist being drawn in.

A review of existing performance data indicate that known existing velocity caps have only been installed on open pipes in which the original inlet opening orientation was facing upward. Each of these technologies was installed on the intake for a large industrial facility and generally are located on the floor of the source waterbody, pointing upwards. This configuration is not feasible for offshore platforms; instead, the velocity cap would be installed "upside down" on the bottom of a vertical pipe. No comparative performance data is available concerning reductions in the reverse orientation. While theoretically the differences in fish response to changes in vertical velocity compared to changes in horizontal velocity should be similar for each direction (downward versus upward), the technology is somewhat unproven for platform intakes since there is no available data concerning relative

performance of this orientation. Additional research and/or testing should be conducted before this technology is considered for implementation at offshore platforms.
In general, the performance of velocity caps is expected to be marginal at most platform intakes and benefits would be limited to intakes with only an open pipe inlet. The direction of inlet flow for intakes with vertical slots is already horizontal and thus the only potential benefit of a velocity cap would be if it were capable of reducing the approach velocity. It is not clear whether there would be any benefit for installing a velocity cap on intakes with slotted pipe and open pipe inlets and there would be no benefit for installing a velocity cap on a screened inlet.

EPA has estimated that velocity caps alone has the potential to reduce IM by 50% to 97% (EPA 2014) when compared to a vertical open pipe. However, the estimated costs are similar in magnitude to coarse mesh wedgewire screens which have an estimated reduction of IM of close to 100%. Thus, while installation of velocity caps is technically feasible, there appears to be little benefit to choosing them over already demonstrated coarse mesh wedgewire screens and therefore no further consideration is warranted.

Low Intake Velocity

As noted above in order for a fish to avoid being drawn into an intake the approach velocity at the point of detection should not exceed the fish's maximum swimming speed. Under the final 316(b) existing facility rule at § 125.94(c)(2), any intake with an average design intake velocity (or through-screen where intake screens are employed) that is less than 0.5 fps are considered as compliant with the BTA requirements for mortality reduction of impingeable organisms. Some of the intakes at the offshore oil and gas platforms appear to meet this requirement. This threshold was selected because available data indicated that the swim speed of a majority of impingeable fish is greater than 0.5 fps. It is reasonable to apply this same standard to offshore platform intakes as well. Simply installing larger pipe openings was not considered nearly as effective as installing coarse mesh wedgewire screens which rely upon both low velocity and exclusion. For this reason, the only low velocity technologies evaluated in this analysis are the existing slotted and open pipe intakes and wedgewire screens.

Coarse Mesh Wedgewire Screens

Wedgewire screens consist of wedge-shaped wires welded to an internal cylindrical frame which is then mounted on the intake. These screens can be coarse mesh (typically 3/8-inch mesh), such as those in use at Platform Harvest, or fine mesh, which may be capable of excluding fish eggs and larvae. Wedgewire screens are usually designed with a through-screen velocity of 0.5 fps or less. This velocity is compliant with the 316(b) existing facility rule BTA standard for impingement mortality at § 125.94(c)(2), regardless of the screen slot size. Entrainment mortality reduction is mostly dependent on screen slot size and would require fine mesh screen slot sizes in the 1 mm or less range (see fine mesh wedgewire screens below).

Clearly, the use of coarse mesh screens at Platform Harvest demonstrates the feasibility of these screens at an offshore platform. No operational problems were reported and plugging of screens with debris (a common concern in maintaining this type of screen) does not appear to be a problem. The lack of screen blockage is consistent with the experience of other platforms that employ strainers with somewhat finer mesh downstream of the pumps. Periodic backwash with water (as opposed to air, which is more effective in clearing blockages) appears to provide for sufficient cleaning of debris. Biofouling also does not appear to be a significant problem since the reported frequency of physical cleaning is once every five years. Biofouling is minimized by using screens constructed of a Cu/Ni alloy.

EPA estimates that IM may be reduced by up to 97% compared to a baseline intake. However, since the existing impingement rates at unscreened platform intakes are expected to be low and some intakes may already have relatively low intake velocities, the actual reduction may be somewhat limited.

A platform operator reported that their approach to installing wedgewire screens would involve replacement of the entire intake pipe with a new pipe with a screen attached to the bottom. Using this approach as the basis, capital cost estimates for coarse mesh wedgewire screens are based on estimates for replacing a 50 ft section of the existing intake pipe with a wedgewire screen attached at the bottom.[8] The capital costs of coarse mesh screens are assumed to be similar to fine mesh screens described below since the screen sizes selected for each pipe size result in through-screen velocities that are much lower than 0.5 fps. Thus, the differences in screen percent open area between different mesh sizes does not affect screen size or cost. A platform operator reported that the O&M cost for inspection and cleaning of the entire intake without a screen was $30,000. It is assumed that the addition of a screen will increase this cost by 50%. The frequency of cleaning was reported to be once every 5 years and is not expected to change. Dividing this cost over a 5 year period results in a net increase in the annual O&M cost of $3,000 per year ($30,000 x 0.5 / 5 = $3,000).

Fish Avoidance Technologies

Fish avoidance technologies can include sound barriers, air bubbles curtains, strobe or colored lights, chain link walls, and electric barriers. These systems rely on various cues to induce an avoidance response in fish to prevent fish from venturing close enough to be drawn into the intake. Clearly these technologies will be effective only on fish capable of swimming (as opposed to free-floating or poor swimming organisms, eggs, etc.) and studies of the effectiveness of these technologies have found that the response of fish to different cues (e.g., different sound frequencies) varies from species to species. As such, the application of these technologies is most appropriate for site-specific instances where certain species of fish are being impinged/entrained in large numbers and where studies have demonstrated that the avoidance technology being considered has been demonstrated to be effective on these species. The available data suggest that these conditions do not apply to the platform cooling water intakes and therefore the effectiveness of these technologies are expected to limited and unpredictable for the range of fish species present.

2.5 Technologies for Reducing Mortality of Entrainable Organisms

In order to reduce entrainment of fish eggs, larvae, and other non-motile organisms, technologies need to do one or more of the following:[9]

- Exclude these organisms by employing a screening technology such as very fine (e.g., 1 mm or less) mesh screens;
- Reduce the intake flow volume; or
- Relocate the intake to a location where organism densities are lower.

[8] In instances where existing intakes are deeper than 50 ft. a different approach may be employed but in such instances, it is assumed that the overall costs would be similar in magnitude to replacing a 50 ft. section of pipe plus a screen. Various other factors such as pump submergence, entrainment, and water temperature may affect the decision regarding selected intake screen depth.

[9] Note that the reduction of entrainment may also result in a reduction in impingement. For example, using a fine mesh screen designed to exclude eggs and larvae will also exclude larger organisms.

Such technologies deemed potentially feasible are discussed below.

Fine Mesh Wedgewire Screens

Wedgewire screens using fine mesh (e.g., 1.0 mm or smaller slots) can be employed to reduce EM by excluding these organisms from being drawn into the intake. Screens can be attached to flanges on the bottom of the intake pipe and, where no flanges exist, a fitting can be fabricated and connected to the end of the intake pipe. Compared to coarse mesh, the use of fine mesh creates a much greater potential for blockage with organisms and debris than the coarser mesh used in the platform strainers and the wedgewire screens at Platform Harvest. Typical fine mesh wedgewire installations include the use of an air backwash system to address debris loading. However, all platform operators reported that there was little to no space available for the additional equipment that would be required for an air backwash. Therefore, only a water backwash can be used. Use of a water backwash can rely upon backflow of water contained within the elevated portion of the intake pipe and is therefore feasible since it does not require space for additional equipment. However, water backwash is not nearly as effective as an air backwash system. No examples can be found where fine mesh wedgewire screens have been installed that do not rely upon an air backwash system. Thus, it is reasonable to assume that use of fine mesh screens may create operational and intake reliability problems and may require frequent cleaning by divers. As with coarse mesh screens, biofouling is minimized by using screens constructed of a Cu/Ni alloy.

Even though most fish eggs and larvae are excluded from entrainment using properly sized fine mesh, eggs and particularly larvae impinged on the screens are subject to potentially high rates of mortality. The degree to which eggs and larvae become impinged is affected, in part, by the sweeping velocity of the ambient current. Thus, while the exclusion of organisms using fine mesh may approach 100%, the actual survival may be substantially less. Based on available data, EPA estimated that fine mesh screens can reduce the rate of EM by only 0% to 52% (EPA 2014).

A platform operator reported that their approach to installing wedgewire screens would involve replacement of the entire intake pipe with a new pipe with a screen attached to the bottom. Using this approach as the basis, capital cost estimates for fine mesh wedgewire screens are based on estimates for replacing a 50 ft section of the existing intake pipe with a wedgewire screen attached at the bottom.[10] The capital costs of the wedgewire screens are based on costs developed by EPA for the 316(b) Phase III rule for fine mesh screens (Hatch Associates 2003). The capital costs include replacing a 50 ft. section of intake pipe with a similar size pipe plus material costs for a wedgewire T-screen that is sized based on the diameter of the intake pipe. The majority of the total installation costs are based on intake pipe replacement costs described in the Intake Location section below using a pipe length of 50 ft. The net increase in O&M cost are based on the costs of more frequent cleaning of the screens by divers. The fine mesh screens are assumed to require water jet cleaning twice per year at a cost of $14,000 for each screen. The cost for diver cleaning of intakes deeper than 200 ft. are increased by 50%.

Intake Location

Siting an intake in a less productive location can provide significant reductions in the density of organisms that may be impinged or entrained. Typically, intake locations that are deeper and further

[10] As with coarse mesh screens, in instances where existing intakes are deeper than 50 ft. a different approach may be employed but in such instances, it is assumed that the overall costs would be similar in magnitude to replacing a 50 ft. section of pipe plus a screen.

offshore tend to be less biologically productive. While intake location is a criterion best evaluated when considering the initial design or construction of the facility or intake, there also may be opportunities to relocate an intake to less productive areas as a way to reduce impingement and entrainment.

The intake depths of the offshore oil and gas platforms covered by the general permit range from around 30 ft. to 285 ft. and generally fell into three groups; 30 to 50 ft. (8 platforms); 96 to 120 ft. (3 platforms); and 285 ft. (2 platforms). At two of the platforms (Irene and Gail) with current intake depth near 100 ft., the intake openings had been lowered from depths that were previously around 40 to 50 ft. In one case, this was performed to eliminate a pump cavitation problem that was caused by the water level fluctuating within the intake due to wave action resulting in insufficient depth of water to maintain necessary pump suction head for the submersed pumps. While the pumps were kept at the same depth, the increase in depth of the intake reduced the influence of the waves and eliminated the problem. At this intake, water is passed through 3/64 inch strainers located on the platform. This facility alternated the use of two intakes on a monthly basis and cleaned the strainers during the switchover. The facility indicated that the strainers did not collect enough debris or organisms to affect operation and that the increase in intake depth had no apparent impact on the amount of material captured on the strainers. The strainer surface area was not much larger than the cross-section of the intake pipe and the mesh size of 3/64 inches is one eighth the size of conventional 3/8 inch mesh typically used for shoreline intakes such as power plants. No explanation was provided regarding the reason for lowering the other intake.

As indicated by the two platforms that have done so, changing the intake depth is feasible but the effectiveness of increasing the depth by 50 ft. is unknown and the available information suggest that, at least with respect to organisms captured on a 3/64 inch screen, the differences in performance between these two depths is minimal. In general, the density of organisms may vary with depth and where differences do exist, higher densities are expected to occur closer to the ocean surface (less than 125 m or 410 ft; Ahlstrom 1959) and also closer to the ocean floor. Water depths at the platforms range from around 200 ft. to over 1,000 ft. The two platforms in the deepest water (over 1,000 ft.) have the deepest intake openings located at a depth of 285 ft.

As a point of comparison, for conventional shoreline-based intakes, the relocation of the intake involves moving the intake offshore where water is deeper and the densities of organisms is lower. In one example, the Seabrook Nuclear Power Station estimated that the 7,000 ft. offshore location in water that is 62 ft. deep resulted in a reduction in entrainment of about 50% based on entrained organism densities when compared to the nearby Pilgrim Nuclear Power Station, which employs a shoreline intake in water that is approximately 24 feet deep (Normandeau 2006).

As a result, there is significant variability in the potential organism density at any given platform intake structure, given the varying depths, patchiness of ocean life, the influence of currents, and other factors. Given that the organism density at a specific platform is not known, it is difficult to develop a specific estimate of how effective this technology may be in reducing IM and EM. These intakes may not experience any significant benefit from extending to a lower depth, as the density at the new depth may not be appreciably different. Additionally, the platforms are already located several miles offshore, so any benefit resulting from a far offshore location may already be realized, as is apparent from the generally lower estimated rates of entrainment. Therefore, there is insufficient data available to determine whether, and to what degree, there would be a significant entrainment reduction resulting from relocating an intake to a greater depth.

While the potential reduction in IM and EM with increasing depth cannot be estimated without additional data, costs are presented for an increase of 100 ft. (twice that for Irene and Gail) for illustrative purposes. The operator of Platform Irene reported a total capital cost of $318,000 for relocating the intake opening approximately 50 ft. deeper for one 19-inch inner diameter intake pipe, with the majority of the costs being for labor. This cost serves as the basis for estimating the costs of installing 100 ft deeper intakes with different diameters. The costs are adjusted for inflation, length (100 ft deeper rather than 50 ft) by increasing costs by a factor of 50%, and adjusted for differences in intake pipe size by applying the ratio of the different pipe circumferences. Note that the operator of Platform Gail reported a relatively lower actual capital cost of $100,000 for installing a 50 ft. deeper intake pipe of similar size but this involved inserting a smaller 20 inch pipe within the existing 24 inch intake pipe. Since it was not clear whether this potentially lower cost option would be available at other platforms, the higher of the two actual costs reported for Platform Irene is used in deriving the estimates.

Extending the depth of intakes where the existing depth is approximately 100 ft. or greater is assumed to result in a minimal reduction in entrainment. Therefore, costs are applied only to intakes where the existing intake depth is less than approximately 100 ft. A platform operator reported that the O&M cost for inspection and cleaning of an entire shallow intake without a screen was $30,000. The addition of 100 ft. intake pipe increases the total pipe length and depth by 200%. It is assumed that this increase in pipe length and diving depth will increase the cost by half of the length increase (100%) because some of the costs (such as mobilization) are fixed. The frequency of cleaning was reported to be once every 5 years and is not expected to change. Dividing this cost over a 5 year period results in a net increase in the annual O&M cost of $6,000 per year ($30,000 X 1 /5 = $6,000).

Flow Reduction – Cooling Water Reuse

Water reuse is a potential flow reduction technology. For example, heated cooling water could be re-routed from the discharge line and serve as feed water for other uses such as desalination. However, the flow volume data indicate that the cooling water volume comprises a very large portion of the sea water intake capacity with the exception of capacity dedicated for emergency use as firewater. Therefore, the opportunity to reuse cooling water is available for only a small proportion of the cooling water volume. While feasible, such a modification would require a considerable amount of rerouting of piping and pumping modifications within the confines of the existing platform.

Flow Reduction – Variable Speed Pumps

Replacing fixed speed pumps with variable speed pumps can be an effective technology for reducing cooling water flow volume in situations where the flow requirements are variable over time. The percent of intake water used for cooling purposes ranged from 89% to 100%. For platform intakes where the cooling water use is continuous and the flow volume requirement does not change significantly from day to day such as where cooling water is used for production equipment cooling, there may be little benefit to installing variable speed pumps. For platform intakes where the total design flow volume includes a significant component that is used in a cyclic or intermittent manner such as for drilling, completion, and workover operations, there is be an opportunity for flow reduction during periods when these uses are reduced or inactive.

Given that flow reduction is assumed to have a 1:1 ratio of units of flow reduced to units of entrainment and impingement reduced, the potential reduction in IM and EM will be directly related to the variability of water requirements. Insufficient data was available to estimate flow reductions associated with replacing the fixed speed pumps currently in use with variable speed pumps. These reductions will be

platform specific and may range from 0% to 30%. Intakes where cooling water is used for cooling production equipment only are unlikely to achieve significant flow reductions. The cooling water intakes examined in this analysis tend to have relatively constant heat loads, and therefore relatively constant flows, reducing the potential utility of a variable speed drive.

Replacing the existing fixed speed pumps with variable speed pumps will involve replacing the pump power supply, instrumentation, and control systems with variable frequency drives. The pump motors and pumps may also require replacement depending on existing pump and motors specifications and compatibility with variable speed operation. Capital costs are based on an assumed installed costs of $40 per gpm. A minimum of $40,000 is assumed for smaller pump systems. A platform operator agreed that variable speed pumps can result in a significant reduction in pumping costs in situations where flow requirements vary over time. However, it has been their experience that the variable speed drives must be replaced every two to three years due to the harsh conditions (e.g., high temperatures and humidity) present on the platforms due in part to the fact that the existing HVAC system is not sized to handle the added heat generated by the equipment. In addition, variable speed drives are best utilized on cooling systems with a variable heat load and, in many cases, have already been installed on those cooling systems.

The variable frequency drives account for the majority of the variable speed pump equipment cost but a portion of the initial installation costs is not expected to be incurred during replacement. To account for frequent replacement of the variable frequency drives and the fact that replacement costs will be lower than initial installation, the annual O&M costs are assumed to be one third of the initial technology installation cost of the variable speed pump system.

2.6 Infeasible Technologies

Flow Reduction – Closed-cycle Cooling

Significant flow reduction could be achieved through the retrofit of the cooling loop with a closed-cycle cooling system that rejects waste heat to the air through evaporative cooling. Land-based retrofits from once-through cooling to closed-cycle cooling have yielded reductions in flow as high as 98 percent. Given that flow reduction is assumed to have a 1:1 ratio of units of flow reduced to units of entrainment reduced, EPA has recognized closed-cycle cooling as the best performing intake technology. (See 79 FR 48331/1 and 48340/1.) However, such a system would require considerable space that is not available in the already congested platform. This technology is expensive to construct and operate and would require platform space that is unavailable without a major modification to the existing platforms. Therefore, closed-cycle cooling is not feasible on offshore platforms.

Screen and Return Systems

By far, the most commonly used screen and return technology in land-based intake systems is the traveling screen. Modified Ristroph traveling screens with fish returns and similar technologies are candidate BTA technologies for reducing IM, as well as EM if fine mesh screens are used. However, conventional traveling screens require an open channel configuration and are not feasible with the intake configuration of offshore platforms. Still, a modified version similar in concept to the Beaudrey Water Intake Fish Protection Screen (WIP) could conceivably be placed within a pipe or vessel located on the platform. Such a system would replace the function of strainers located on the platform and would require a small volume of water to backwash the screen and a fish return pipe to return the backwash to

the source water would need to be installed. While such a system is theoretically feasible, it has a major drawback in that survival of captured and returned organisms would likely be low. Fish captured and returned through the system would be subject to mechanical injury while passing through the intake pump and then through the fish return system pump and piping. Fish passing through the system are also subject to rapid changes in water pressure. Most intakes inject chlorine near the intake as a biofouling control measure which would increase mortality as well. For these reasons, all technologies located downstream of the submersible intake pumps are considered unlikely to be effective in reducing fish mortality.

Aquatic Fish Barriers and Nets

Fish barrier nets and aquatic fish barriers consist of finer barrier fabrics placed some distance from the intake inlet and must encapsulate the intake in order to be effective. In shoreline and shallow water applications, this can be done through the use of barriers that extend from the bottom to the water surface. However, problems associated with storms, wave action, and currents generally prevent the use of such configurations in ocean applications. The only feasible application at platform intakes would be a fully submerged barrier supported by a cage or other rigid-frame structure that fully encloses the intake opening. Such a structure would need to be anchored to the platform support structure and would need to be placed deep enough to avoid damage by wave action, possibly requiring the intake opening to be lowered as well. These types of typically collect debris and attached biological growth over time, requiring maintenance using divers or ROVs; this would be particularly true in an open water marine environment. Regardless of the method employed, the barriers would be difficult to clean, replace or repair. Coarse mesh applications would provide little benefit compared to fixed wedgewire screens. Fine mesh applications would be subject to significant biofouling. Fine mesh barriers have not been demonstrated in any existing ocean applications. Therefore, barrier nets and aquatic fish barriers are considered as impractical for application at offshore platform intakes.

Dry Cooling

Dry cooling refers to the use of water to air heat exchangers. Like closed-cycle evaporative cooling, dry cooling offers a significant reduction in flow and IM and EM. A very limited amount of dry cooling is employed at the existing platforms, resulting in minor reductions in IM and EM. Only Platform Harvest reported using air-cooled heat exchangers which were employed for an oil cooler and three air coolers for air compressors. These are generally small sources of heat compared to heat generated by processing of sales gases and drilling operations that passes through the cooling water system. Retrofitting water to air or gas to air heat exchanges would require a substantial amount of platform space that is unavailable and would be very costly to implement.

2.7 Summary of General Feasibility

Table 2.1 below summarizes the technical feasibility and estimated reduction in mortality of impingeable and entrainable organisms. Based on this evaluation, the following technologies are considered for further assessment at each platform:

Table 2.1. Technology Summary

Technology	Technical Feasibility	IM Reduction	EM Reduction	Comment
Low Intake Velocity	Yes	Up to 96%	No reduction	A technology attribute rather than a specific technology
Wedgewire Screens – Coarse Mesh	Yes	Very effective – nearly 100% reduction. Net impact is low due to very low initial impingement.	No reduction	Demonstrated at an existing platform.
Wedgewire Screens – Fine Mesh (<1.0 mm)	Yes	Very effective – nearly 100% reduction. Net impact is low due very low initial impingement.	Potentially effective. 0% to 52% based on survivability of impinged organisms.	Requires the use of a backwash system. Platform space availability is very limited making air backwash unavailable. Effectiveness of water backwash is limited requiring more frequent cleaning by divers.
Velocity Caps	Yes	Limited effectiveness and performance is uncertain. Net impact is low due very low initial impingement.	No reduction	Has not been demonstrated on a downward facing intake.
Relocate Intake Deeper	Yes	Potentially effective. Degree of reduction, if any, is uncertain and requires further study.	Potentially effective. Degree of reduction, if any, is uncertain and requires further study.	Technically demonstrated at several platforms.
Flow Reduction – Closed-cycle Cooling	No	NA	NA	No available space to install technology. High costs.
Flow Reduction – Cooling Water Reuse	Yes	Very limited effectiveness due to minimal availability of reuse capacity. Net impact is low due very low initial impingement.	Very limited effectiveness due to minimal availability of reuse capacity.	Opportunity is very limited since cooling water comprises majority of water used onsite
Flow Reduction – Variable Speed Pumps	Yes	Variable (0% to 30%) – depends on degree of cyclic intermittent and water use	Variable (0% to 30%) – depends on degree of cyclic intermittent and water use	More likely to be effective where water use includes cyclic and intermittent components such as drilling operations
Fish Avoidance Technologies	Yes	Effectiveness is very limited and is species specific. Net impact is low due very low initial impingement.	No reduction	Effectiveness very species specific – would require site-specific testing.
Aquatic Fish Barriers and Nets	No	NA	NA	Incompatible with intake configuration.
Screen and return system	No	NA	NA	Incompatible with intake configuration. Installation downstream of submersible pumps

				results in substantial mortality.
Dry cooling – water to air heat exchanger	No	NA	NA	No available space to install technology. High costs.

- Coarse mesh wedgewire screens
- Fine mesh wedgewire screens
- Relocate the intake to a deeper location
- Variable speed pumps

3 Evaluation of Platform Intakes

This section presents the results of an evaluation of the site-specific technical feasibility, estimated IM and EM reductions, and costs of the three technologies identified for further consideration at each platform. The first table presents a summary of the technical feasibility and the estimated IM and EM reductions. The second table presents a summary of the estimated technology capital and net O&M costs in 2014 dollars. Note that the expected life of the platforms is not known but it is reasonable to assume that the period over which costs should be amortized is somewhat shorter compared to an intake at a typical shoreline-based industrial facility.

3.1 Platform Ellen

Platform Ellen operates two cooling water intakes that employ intake pipes with open bottoms located at a depth of 42 ft. The calculated average design intake velocity is 1.4 fps.

Table 3.1. Platform Ellen Technology Feasibility and Performance

Technology	Technical Feasibility	Estimated IM Reduction	Estimated EM Reduction
Coarse Mesh Wedgewire	Feasible. Would require installation of pipe flange fitting.	Up to 100%. Net impact is low due to very low initial impingement.	None
Fine Mesh Wedgewire	Feasible. Would require installation of pipe flange fitting.	Up to 100%. Net impact is low due to very low initial impingement.	0% to 52%
Relocate Intake Deeper	Feasible	Cannot be determined without additional data.	Cannot be determined without additional data.
Variable Speed Pumps	Feasible	Unknown. Likely to be low since reported cooling water use was for production equipment	Unknown. Likely to be low since reported cooling water use was for production equipment

Table 3.2. Summary of Estimated Technology Capital and O&M Costs for Platform Ellen

Platform ID	Intake No.	Coarse Mesh Wedgewire		Fine Mesh Wedgewire		Relocate 100 ft Deeper		Variable Speed Pumps	
		Capital Cost	O&M Costs	Capital Cost	O&M Costs	Capital Cost	O&M Costs	Capital Cost	O&M Costs
Ellen	1	$380,000	$3,000	$380,000	$28,000	$555,000	$6,000	$48,000	$16,000
Ellen	2	$380,000	$3,000	$380,000	$28,000	$555,000	$6,000	$48,000	$16,000
Ellen	Total	$760,000	$6,000	$760,000	$56,000	$1,110,000	$12,000	$96,000	$32,000

3.2 Platform Eureka

Platform Eureka operates two cooling water intakes that employ intake pipes with open bottoms located at a depth of 120 ft. The calculated average design intake velocity is 2.3 fps.

Table 3.3. Platform Eureka Technology Feasibility and Performance

Technology	Technical Feasibility	Estimated IM Reduction	Estimated EM Reduction
Coarse Mesh Wedgewire	Feasible. Would require installation of pipe flange fitting.	Up to 100%. Net impact is low due to very low initial impingement.	None
Fine Mesh Wedgewire	Feasible. Would require installation of pipe flange fitting.	Up to 100%. Net impact is low due to very low initial impingement.	0% to 52%
Relocate Intake Deeper	Feasible but moderate depth increase already in-place	Cannot be determined without additional data.	Cannot be determined without additional data.
Variable Speed Pumps	Feasible	Unknown. Likely to be low since reported cooling water use was for production equipment	Unknown. Likely to be low since reported cooling water use was for production equipment

Table 3.4. Summary of Estimated Technology Capital and O&M Costs for Platform Eureka

Platform ID	Intake No.	Coarse Mesh Wedgewire		Fine Mesh Wedgewire		Relocate 100 ft Deeper		Variable Speed Pumps	
		Capital Cost	O&M Costs	Capital Cost	O&M Costs	Capital Cost	O&M Costs	Capital Cost	O&M Costs
Eureka	1	$380,000	$3,000	$380,000	$28,000	NA	NA	$80,000	$27,000
Eureka	2	$380,000	$3,000	$380,000	$28,000	NA	NA	$80,000	$27,000
Eureka	Total	$760,000	$6,000	$760,000	$56,000	$0	$0	$160,000	$54,000

4 References

Ahlstrom, E.H. Vertical distribution of pelagic fish eggs and larvae off California and Baja California. Fishery Bulletin 161. 60: 107-146. 1959.

Hatch Associates. "Off Shore and Coastal Oil and Gas Extraction Facilities Sea Water Intake Structure Modification Cost Estimate: Caisson and Simple Pipe" EPA-HQ-OW-2004-0002-0042. March 12, 2004.

Normandeau Associates. Seabrook Nuclear Power Station EPA 316(B) Phase II Rule Project Proposal for Information Collection. May 2006.

Turnpenny, A.W.H. The behavioral basis of fish exclusion from coastal power station cooling water intakes. CEGB Internal Publication No. RD/L/3301/R88. 1988.

USEPA. Technical Development Document for the Final Section 316(b) Existing Facilities Rule. EPA-821-R-14-002. May 19, 2014.

Attachment 1: Intake Technologies

A variety of technologies have been developed to address impingement and entrainment at CWIS. This attachment is intended to provide a brief overview of the technologies under consideration for existing offshore platforms; see Table A.1 below. A comprehensive description of these technologies is available in EPA's Technical Development Document for the 2014 existing facility rule.

Table A.1. Description of CWIS Technologies

Technology	Description
Velocity cap	Fish experience difficulty in detecting changes in flow in a vertical orientation. A velocity cap changes the direction of the flow on an open pipe to horizontal, enabling fish to better avoid the intake.
Low intake velocity	Low intake velocity has been shown to provide motile organisms with the opportunity to detect the intake flow and escape.
Wedgewire screens (coarse or fine mesh)	Wedgewire screens are cylindrical screens made of a wedge-shaped wire mesh. The design takes advantage of physical and hydrologic conditions to minimize the intake velocity and, under certain conditions, to sweep organisms away from the screen. The slot (i.e., mesh) size can vary. Coarse mesh (intended to address impingement only) is typically 9.5 mm spacing, while fine mesh (to address entrainment) is usually 0.5-2 mm.
Alternate intake location	Relocating an intake can involve moving an intake laterally (i.e., offshore) or vertically (i.e., to a deeper location). For offshore platforms, a deeper intake location may withdraw from less biologically productive waters.
Behavioral barriers	A variety of behavioral barriers have been developed to discourage organisms from approaching an intake, including noise, lights, and bubble barriers.
Aquatic fish barriers and nets	Barriers and nets are simple nets intended to exclude organisms from the vicinity of the intake. Depending on the mesh size, entrainable organisms may also be excluded.
Screens with return systems (e.g., traveling screens)	The most common screen type at land-based facilities is a traveling screen, which is a band screen that rotates through the water. Debris and fish are washed off the screen face and returned to the source waterbody.
Flow reduction – closed-cycle cooling	Closed-cycle cooling systems recirculate cooling water within the condenser and transfer heat to the surrounding environment, as opposed to discharging heated effluent. For offshore platforms, the most relevant configuration would be the use of wet, mechanical draft cooling towers. This technology results in a significant reduction in flow, as only makeup water (for losses due to evaporation and blowdown) is withdrawn.
Flow reduction – dry cooling	Dry cooling is similar to the use of cooling towers, but transfers heat without evaporation, eliminating the need for makeup water withdrawals.
Flow Reduction – cooling	In some cases, a facility may be able to reuse a separate wastewater

water reuse	stream as cooling water, or vice versa. For example, a facility might use cooling water, then use the heated effluent as part of a desalinization process. This reuse decreases the overall withdrawals by the facility.
Flow reduction - variable speed pumps	Most water pumps are single speed, meaning that they operate at only one flow rate, regardless of the cooling water needs of the facility. Variable speed pumps are pumps that can vary the pumping rate to match the cooling needs, resulting in a reduced intake flow.