STATE WATER RESOURCES CONTROL BOARD
BOARD MEETING SESSION – DIVISION OF WATER QUALITY
AUGUST 4, 2015

ITEM 10

SUBJECT

CONSIDERATION OF A PROPOSED RESOLUTION DELEGATING AUTHORITY TO THE EXECUTIVE DIRECTOR TO APPROVE MEASURES THAT OWNERS OR OPERATORS OF ONCE-THROUGH COOLING FACILITIES SHALL UNDERTAKE TO COMPLY WITH INTERIM MITIGATION ON A CASE-BY-CASE BASIS.

DISCUSSION

This proposed Resolution would delegate authority to the Executive Director of the State Water Resources Control Board (State Water Board) to approve, on a case-by-case basis, mitigation measures that owners or operators of Once-Through Cooling (OTC) facilities shall undertake to comply with requirements for interim mitigation. On May 4, 2010, the State Water Board adopted the statewide Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling (Policy) to establish technology-based standards to implement the federal Clean Water Act Section 316(b) requirement that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact, and to otherwise reduce the harmful effects on marine and estuarine life that are associated with cooling water intake structures. The Policy applies to 13 existing power plants, including nuclear plants. It originally affected 19 power plants, but six of these plants have ceased all OTC operations since adoption of the Policy. Owners or operators of power plants are required to comply with one of two tracks that are defined in relation to the expected performance of closed-cycle wet cooling systems. Under Track 1, an owner or operator must reduce intake velocity to a level commensurate with that which can be attained by a closed-cycle wet cooling system, and a flow velocity of 0.5 feet per second. Under Track 2, conditioned upon a showing that Track 1 is not feasible, the owner or operator of an existing power plant must reduce impingement mortality and entrainment of marine life for the facility, on a unit-by-unit basis, to a comparable level to that which would be achieved under Track 1, using operational or structural controls, or both.

Per Section 2.C(3) of the Policy, owners or operators must implement measures to mitigate the interim impingement and entrainment impacts resulting from the cooling water intake structure(s), commencing October 1, 2015 and continuing up to and until the owner or operator achieves final compliance, including implementation of Track 1 or 2 as described above. Each power plant has an established compliance deadline in the Policy as set forth in Section E, Table 1: Implementation Schedule. The Policy offers the following options for demonstrating compliance:

- A: Demonstrate compensation for the interim impingement and entrainment impacts through existing mitigation efforts (Section 2.C(3)(a)).
- B: Provide funding to the California Coastal Conservancy (Coastal Conservancy) for an appropriate mitigation project (Section 2.C(3)(b)). The Policy states that it is the State Water Board's preference that funding be provided to the California Coastal Conservancy, working with the California Ocean Protection Council (Ocean Protection

Council), for mitigation projects directed toward increases in marine life associated with the State's Marine Protected Areas in the geographic region of the facility.

- C: Develop and implement a mitigation project for the facility to compensate for interim impingement and entrainment impacts (Section 2.C(3)(c)).

The majority of owners or operators have selected Option B to demonstrate compliance, but some have indicated they intend to comply using a combination of Options A and B. All three options are subject to the approval of the State Water Board. However, since all three options could include components that would vary by facility, mitigation efforts would need to be approved on an individual basis. Addressing approvals through individual amendments to the Policy would be onerous and would not result in significantly more protection for ocean resources. Instead, State Water Board staff proposes that the State Water Board delegate approval authority to the Executive Director, consistent with other delegations provided for in Resolution 2012-0061.

Section 2.C(3)(d) of the Policy requires that the habitat production forgone (HPF) method, or a comparable alternate method approved by the State Water Board, shall be used to determine the habitat and area, based on replacement of the annual entrainment, for funding a mitigation project. For Options A and C, mitigation efforts must compensate for an area of habitat equivalent to what would be created or restored if mitigation funding had been provided instead.

To comply with Option B, owners or operators of OTC facilities need to know the mitigation fee amount that must be paid. To convert the HPF into a dollar amount, the State Water Board contracted with Moss Landing Marine Laboratory to establish an Expert Review Panel (ERP II[1]). ERP II developed a scientifically defensible mitigation fee for power plant interim mitigation that would compensate for continued intake impacts due to impingement and entrainment. The mitigation fee calculation developed in ERP II comprises three components: an entrainment fee, an impingement fee, and a management and monitoring fee for implementation of the mitigation project. Calculations of the three amounts that together constitute the mitigation fee require input values that are unique to each facility.

The ERP II final report contains a discussion about the entrainment fee calculation by Dr. Peter Raimondi of the University of California, Santa Cruz. Dr. Raimondi used empirical transport models coupled with HPF, as required by the Policy, to determine the cost of creating or restoring habitat that replaces the production of marine organisms killed by entrainment. The key components for calculating the entrainment fee (cost per million gallons) are a facility's intake volume, the HPF (in acres), and a cost estimate for creating or restoring the HPF acreage. Originally, a half-life component also was included to account for degradation of the mitigation project over time, under the assumption that there will be no monitoring or maintenance of the project. However, as described below, the proposed mitigation fee calculation includes a cost for management and monitoring of the mitigation project. Therefore, the half-life component is not necessary in the entrainment fee calculation because the management and monitoring cost help ensure that the mitigation project will be successful and compensatory.

[1] This Expert Review Panel is referred to as ERP II because it was the second in a series of three Expert Review Panels established to address a number of scientific questions about the Once-Through Cooling Policy and amendments to the California Ocean Plan to address desalination activities.

The process for determining HPF-based cost estimates for entrainment for each facility could be complex and expensive. Many facilities do not have entrainment studies, which would require both sampling efforts and modeling, and therefore do not have the data necessary to calculate HPF. Suitable entrainment studies could take at least a year to generate the data needed to estimate HPF. Additionally, when the cost of creating habitat equivalent to HPF was determined using existing examples of mitigation for power plant entrainment, the range of entrainment fees was relatively small. Therefore, ERP II concluded that applying an average cost estimate for entrainment (cost per million gallons) to all intakes is the simplest approach for entrainment mitigation. The average cost estimate is based on the costs of previous mitigation projects already calculated using the HPF for some power plants (ERP II final report, Appendix 1), and this average would need to be adjusted annually for inflation. Basically, the average cost estimate and a facility's intake volume would be used to determine the amount that owners or operators would need to pay on an annual basis to compensate for resources lost due to entrainment.

As an example of calculating the entrainment fee, it could be estimated that the longevity of the mitigation project and the period of continued operation of the facility are both 30 years. Assuming that the mitigation project will not be initiated until 5 years after payment of the fee, the cost projection value is 5 years. Plugging these input values into ERP II's calculation yields an average cost estimate for entrainment of $5.17 per million gallons (Appendix 1). Then, this average cost estimate for entrainment and a facility's annual intake volume would be multiplied to calculate the entrainment fee for the facility. Owners or operators would need to measure their intake volumes for each year of interim mitigation so that these values are available for use in their annual entrainment fee calculations.

Since impingement varies widely among power plants, ERP II determined that it would be inappropriate to apply a fixed impingement fee to all intakes. Instead, the panel advised determining the impingement fee on a case-by-case basis, using each plant's annual estimate of fish impingement together with the value for fishes estimated from catch totals and the average indirect economic value of the fisheries as determined in the ERP II final report ($0.80 per pound). Consistent with the ERP II recommendation, the following equation could be used to calculate the impingement fee for each facility:

Impingement fee = $0.80 per pound X average annual impingement of fishes (in pounds)

Appendix 2 of the ERP II final report is an example costing of impingement and entrainment losses at the Huntington Beach Generating Station. This facility had 2,686 pounds as an average annual impingement of fishes from normal operations and heat treatments. Inserting this value into the above equation results in an impingement fee of $2,148.80.

Finally, ERP II recommended management and monitoring fees on the typical range of 10-25 percent of the project's costs. Monitoring and assessment of the mitigation project are critical for guaranteeing that the project is truly compensating for the resources lost due to intakes. Therefore, it is critical to ensure that some fees are dedicated toward these activities.

Assuming a 20 percent management and monitoring fee and applying this to a facility with an annual intake volume of 500 million gallons per day and 3000 pounds of average annual impingement of fishes, the first annual payment for interim mitigation would be $1,135,853.

Per the Policy, it is the State Water Board's preference that funding from interim mitigation is provided to the Coastal Conservancy, working with the Ocean Protection Council. State Water Board staff is working with the Coastal Conservancy and the Ocean Protection Council to determine how the mitigation fees will be received and how they will be applied toward increases in marine life associated with the State's Marine Protected Areas in the geographic regions of the facilities.

Since all mitigation options include components that would vary by facility, State Water Board staff proposes that authority be delegated to the Executive Director of the State Water Board to approve the mitigation measures on a case-by-case basis.

POLICY ISSUE

Should the State Water Board delegate authority to the Executive Director to approve the measures that owners or operators of OTC facilities undertake to comply with interim mitigation on a case-by-case basis?

FISCAL IMPACT

No fiscal impact.

REGIONAL BOARD IMPACT

No Regional Board impact.

STAFF RECOMMENDATION

State Water Board staff recommends delegating authority to the Executive Director of the State Water Board to approve measures that owners or operators of OTC facilities undertake to comply with interim mitigation on a case-by-case basis.

State Water Board action on this item will assist the Water Boards in reaching 6 of the Strategic Plan Update: 2008-2012 to narrative of goal(s). In particular, approval of this item will assist in fulfilling Objective 6.2 to targeting consistency improvements in program delivery identified through past input, and solicit input to identify consistency issues as they arise.

APPENDIX 1: Entrainment fee calculation
Adapted from ERP II Final Report Appendix 1

					Annual Cost Escalator	3.00%		Estimated total cost per MG	$155.20	up front							
					Estimated Life of mitigation Project	30		Estimated total cost per MG	$5.17	First year of annual	additional years should be adjusted for inflation						
					continued operation	30											
					Cost projection (year)	5											
					Cost of assessment (%)	20.00%											
This model based on pay as you go - with cost escalator built in.															This is the up front cost		This is the first year of the annual cost
Facility	**Intake Volume (MGD)**	**APF (acres)**	**Mitigation Type**	**Cost estimate**	**cost per annual intake (MG)**	**Notes**	**Years between assessment and 2015**	**Cost escalator**	**total escalator**	**2015 cost per MG**	**estimated of mitigation project (years)**	**estimated period of continued operation**	**Prorated 2015 cost per MG**	**Cost projection year**	**Estimated cost at time of projection (per MG,)**		**Estimated annual cost at time of projection (per MG,)**
Moss Landing Combined cycle	360	840	wetland	$15,100,000	$115	based on max larval duration,	15	3.00%	$1.56	$179.04	30	30	**$179.04**	**5**	**207.55**		**$6.92**
Morro Bay	371	760	wetland	$13,661,905	$101	based on max larval duration,	14	3.00%	$1.51	$152.60	30	30	**$152.60**	**5**	**176.91**		**$5.90**
Poseidon	304	37	wetland	$11,100,000	$100	based on max larval duration,	6	3.00%	$1.19	$119.45	30	30	**$119.45**	**5**	**138.47**		**$4.62**
Huntington Beach	126.5	66	wetland	$4,927,560	$107	based on max larval duration,	6	3.00%	$1.19	$127.43	30	30	**$127.43**	**5**	**147.73**		**$4.92**
Diablo	2670	543	Rocky reef	$67,875,000	$70	based on125K per acre	9	3.00%	$1.30	$90.87	30	30	**$90.87**	**5**	**105.35**		**$3.51**
						Average		**3.00%**					**$133.88**		**155.20**		**5.17**

D R A F T

STATE WATER RESOURCES CONTROL BOARD
RESOLUTION NO. 2015-

DELEGATES AUTHORITY TO THE EXECUTIVE DIRECTOR OF THE STATE WATER RESOURCES CONTROL BOARD (STATE WATER BOARD) TO APPROVE MEASURES THAT OWNERS OR OPERATORS OF ONCE-THROUGH COOLING (OTC) FACILITIES SHALL UNDERTAKE TO COMPLY WITH INTERIM MITIGATION ON A CASE-BY-CASE BASIS

WHEREAS

1. The State Water Board is designated as the state water pollution control agency for all purposes stated in the Clean Water Act, including water quality control planning and waste discharge regulation.

2. The State Water Board is responsible for adopting state policy for water quality control, which may consist of water quality principles, guidelines, and objectives deemed essential for water quality control.

3. On May 4, 2010, the State Water Board adopted the statewide "*Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling"* (Policy) under Resolution No. 2010-0020. The Policy was approved by the Office of Administrative Law on September 27, 2010 and became fully effective on October 1, 2010.

4. The Policy establishes uniform, technology-based standards to implement federal Clean Water Act section 316(b), which requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact.

5. The Policy applies to thirteen existing power plants located along the California coast and is implemented through National Pollutant Discharge Elimination System (NPDES) permits, issued pursuant to Clean Water Act Section 402, which authorize the point source discharge of pollutants to navigable waters. The Policy originally affected nineteen OTC power plants, but six of these plants have ceased all OTC operations since adoption of the Policy.

6. The Policy was amended through Resolution 2011-0033 on July 19, 2011, making changes to existing Policy compliance dates for the Los Angeles Department of Water and Power (LADWP) on a unit by unit basis rather than facility-wide basis.

7. The Policy was amended through Resolution 2013-0018 on June 18, 2013, making changes to the existing Policy by authorizing the Regional Water Quality Control Boards (Regional Water Boards) to issue NPDES permits to point source dischargers in California, including power plants subject to the Policy.

8. The Policy was amended on April 7, 2015, providing a compliance deadline extension for Moss Landing Power Plant.

9. Section 2.C(3) of the Policy requires the owner or operator of an existing power plant to implement measures to mitigate the interim impingement and entrainment impacts resulting from their cooling water intake structure(s), commencing October 1, 2015 and continuing up to and until the owner or operator achieves final compliance. An owner or operator may comply with this requirement by:

    a. Demonstrating to the State Water Board's satisfaction that the owner or operator is compensating for the interim impingement and entrainment impacts through existing mitigation efforts, including any projects that are required by state or federal permits as of October 1, 2010; or

    b. Demonstrating to the State Water Board's satisfaction that the interim impacts are compensated for by the owner or operator providing funding to the California Coastal Conservancy, which will work with the California Ocean Protection Council, to fund an appropriate mitigation project; or

    c. Developing and implementing a mitigation project for the facility, approved by the State Water Board, which will compensate for the interim impingement and entrainment impacts. Such a project must be overseen by an advisory panel of experts convened by the State Water Board.

    d. The habitat production foregone (HPF) method, or a comparable alternate method approved by the State Water Board, shall be used to determine the habitat and area, based on replacement of the annual entrainment, for funding a mitigation project.

    e. It is the preference of the State Water Board that funding is provided to the California Coastal Conservancy, working with the California Ocean Protection Council, for mitigation projects directed toward increases in marine life associated with the State's Marine Protected Areas in the geographic region of the facility.

10. The State Water Board contracted Moss Landing Marine Laboratory to establish an Expert Review Panel on minimizing and mitigating intake impacts from power plants and desalination facilities (ERP II). ERP II developed a scientifically defensible mitigation fee for power plant interim mitigation that would compensate for continued intake impacts due to impingement and entrainment. During a public meeting on March 1, 2012, the panel presented their recommendations, and the public asked questions and provided comments on the panel's draft report. The panel submitted the final report with their findings and recommendations on March 14, 2012 (Appendix 1).

    a. The mitigation fee calculation developed in ERP II comprises an entrainment fee, an impingement fee, and a management fee for implementation and monitoring of the mitigation project. The entrainment fee calculation utilizes empirical transport models coupled with the HPF method, as required by the Policy, and is based on the cost of creating or restoring habitat that replaces the production of marine organisms killed by entrainment.

i. The process for determining HPF-based cost estimates for entrainment for each facility could be complex and expensive, especially if suitable entrainment studies are not currently available for facilities. Additionally, when the cost of creating habitat equivalent to HPF was determined using existing examples of mitigation for power plant entrainment, the range of mitigation fees was relatively small. Therefore, ERP II concluded that using an average cost estimate for entrainment (cost per million gallons), based on the costs of mitigation already calculated using HPF for some power plants, and applying this average to all intakes is the simplest approach for entrainment mitigation. This average value and the facility's specific intake volume (million gallons) would be used to determine how much shall be paid for the entrainment fee on an annual basis. Owners or operators would need to measure their intake volumes for each year of interim mitigation so that these values are available for use in their annual entrainment fee calculations. The average cost estimate for entrainment would need to be updated annually to account for inflation.

ii. Since impingement varies widely among power plants, ERP II determined that it would be inappropriate to apply a fixed impingement fee to all intakes. Instead, the panel advised determining the impingement fee on a case-by-case basis, using each plant's annual estimate of fish impingement together with the value for fishes estimated from catch totals and the average indirect economic value of the fisheries as determined in the ERP II final report.

iii. ERP II recommended management and monitoring costs on the typical range of 10-25% of the project's costs.

b. Determining the mitigation fee for each facility requires calculating the entrainment fee, impingement fee, and management and monitoring fee. The sum of these three fees constitutes the interim mitigation fee in units of cost per million gallons. Since the calculations for the fees require input values from each OTC facility, the interim mitigation fee will vary by facility.

c. State Water Board staff is working with the California Coastal Conservancy and the Ocean Protection Council to determine how the OTC mitigation fees will be received and how they will be applied toward increases in marine life associated with the State's Marine Protected Areas in the geographic regions of the facilities.

11. For owners or operators who have selected to comply through existing mitigation efforts or by developing and implementing mitigation projects, mitigation efforts would need to be approved on an individual basis as they would vary by facility.

THEREFORE BE IT RESOLVED THAT:

1. The State Water Board hereby authorizes the Executive Director of the State Water Board to approve, on a case-by-case basis, mitigation measures that owners or operators of OTC facilities shall undertake to comply with requirements for interim mitigation.

2. This authorization shall not be construed to eliminate the necessity of required approval or concurrence of any other state agency.

3. This authorization shall remain in full force and effect until modified or revoked by the SWRCB.

CERTIFICATION

The undersigned Clerk to the Board does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on August 4, 2015.

Jeanine Townsend
Clerk to the Board

APPENDIX 1: Expert Review Panel II on Intake Impacts and Mitigation
Excerpt from the Final Report (pgs 1-9)
March 14, 2012

14 March 2012

Mitigation and Fees for the Intake of Seawater by Desalination and Power Plants

Final report submitted to Dominic Gregorio, Senior Environmental Scientist, Ocean Unit, State Water Resources Control Board (SWRCB) in fulfillment of SWRCB Contract No. 09-052-270-1, Work Order SJSURF-10-11-003

By: Michael S. Foster, Moss Landing Marine Laboratories
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Background

Raw seawater is used for a variety of purposes, including as source water for desalination plants and to cool coastal power plants. Raw seawater is, however, not just cold and salty but an ecosystem that contains diverse and abundant organisms including the young stages of numerous invertebrates and fishes. Whether impinged (large individuals stuck on screens prior to entering the plant or killed during other plant processes such as heat treatment) or entrained (small individuals carried into the plant with the water) the organisms are killed, essentially eliminating the living production in the water used (review in York and Foster 2005). Considerable research has have been done in California to better estimate losses to this ecosystem by coastal power plant intakes (York and Foster 2005, Steinbeck et al. 2007), and to determine how these losses can be mitigated (Strange et al. 2004).

The information from this research has contributed to State of California policy regulating water used by power plants (policy at http://www.waterboards.ca.gov/water_issues/programs/ocean/cwa316/docs/policy100110.pdf). The policy now applies only to power plants but the intent to protect marine organisms is also broadly applicable to desalination plants and other users of large volumes of seawater. The State's Once-through Cooling Policy (Policy) states that plants must implement measures to mitigate interim impacts occurring after October 1, 2015, and until the plant comes into full compliance through conversion to closed cycle cooling or by using operational controls and/or structural control technology that results in comparable reductions in impingement and entrainment (IM&E).

The SWRCB is currently developing a policy for addressing desalination plant intakes and discharges which will be instituted through amendments to the Ocean Plan and Enclosed Bays and Estuaries Plan (statewide water quality standards). The California Water Code currently requires new or expanded industrial facilities (e.g., desalination plants) to use the "best available site, design, technology, and mitigation measures feasible" to minimize the intake and mortality of marine life (see the Ocean Plan Triennial Review 2011-2012 Work-plan at http://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2011/rs2011_0013_attach1.pdf.

The panel's assumption, based on SWRCB direction, is that the "best site, design and technology" would be employed prior to mitigation measures. Mitigation measures would be applied to compensate for any the residual impacts.

The staff of the SWRCB requested the formation of an expert review panel (chaired by Foster and composed of the authors of this report) to assist in answering questions related to present policy concerning interim mitigation for impacts from power plant intakes and future policy concerning mitigation for impacts caused by the intakes of desalination plants. The issues and questions for the panel to address were:

A. Power Plants: Provide a scientifically defensible basis and unit cost for a fee paid by power plants based on the volume of cooling water used. This fee would be used for mitigation projects to compensate for continued impacts due to IM&E during the interim period after October 1, 1015 and until a plant comes into full compliance with the Policy.

B. Desalination Plants: How should any remaining IM&E be mitigated after the best site, design and technology are determined for a new desalination plant intake?

C. Desalination Plants: Are there desalination intake technologies and designs that can reduce IM&E?

The panel met twice to discuss the questions and possible answers, and panel members Steinbeck and Raimondi prepared three reports as Appendices 1, 2 and 3 to this report. Appendix 1 develops a fee-based approach to questions A. and B. based on the cost of replacing the habitat production lost due to entrainment. Appendix 2 develops a fee-based approach to questions A. and B. based on the loss of adult equivalent fish due to entrainment. Appendix 3 addresses question C. with a review of the efficacy of desalination plant intake technologies and designs in reducing IM&E. The panel recommendations below are based on these reports, discussions and experience from prior assessments and mitigation for power plant intake impacts in California. The panel also held a public meeting on March 1, 2012, presented their recommendations, and received comments, some of which were incorporated into this report.

Alternatives and Recommendations

A. Interim Mitigation for Power Plants

1. Given uncertainties about the length of time for interim impacts and amount of water a particular power plant may use while in interim operation, interim mitigation should be fee-based according to the amount of water used ($/Million Gallons (MG)).

2. One alternative is a fee based on Adult Equivalent Loss (AEL), the number of adult fishes eliminated by the entrainment of larval fishes plus fish losses due to impingement (Appendix 2). This fee was estimated for comparison to the APF-based fee (see 3. below) using data and analyses for the Huntington Beach Generating Station (HBGS). The average fee using this estimate and including indirect economic losses is $0.77/MG. This fee, however, only compensates for economic losses of adult fishes and is, therefore, not recommended.

3. The other alternative is a fee for interim mitigation based on the costs of mitigation already determined for some power plants using Area of Production Foregone (APF; Appendix 1). This fee is based on the cost of creating or restoring habitat that replaces the production of marine organisms killed by entrainment. The APF method is preferred because creation and restoration of coastal habitats compensates for all organisms impacted by entrainment, not just select groups such as fishes. The average fee, based on existing examples of mitigation for power plant entrainment, adjusted for inflation, and assuming a 50 year half- life for the habitat produced, is $2.45/MG (range: $1.66 - $3.28; Appendix 1). The fee is linearly proportional to half-life so, for example, if the half- life of a project was 25 years the fee would double. This fee does not include the cost of management and monitoring after implementation. Management and monitoring costs typically range from 10 - 25% of projects costs (Appendix 1). The fee also does not account for impacts due to impingement. These could be determined using the value (cost/pound) of fishes impinged/MG plus the indirect economic value of the fisheries (see Appendix 2). For example, average annual impingement of fishes from normal operations and heat treatments at HBGS from 2000-2010 was 2,686 lbs. (Appendix 2, Tables 1 and5). Using the value for fishes estimated from catch totals plus the average indirect economic value (see Appendix 1) yields a total value of ~ $0.80/lb., and an average annual value of fishes impinged of ~ $2,150.00. Divided by the average annual intake flow of 92,345 MG (Appendix 2, Table 5), the average annual mitigation fee for impingement at HBGS during this period would be ~ $0.023/MG.

Creating open coast soft bottom habitat as mitigation for impacts is unreasonable given the ubiquity of such habitat and that other habitat types provide more biodiversity value. In such cases restoration or creation of estuarine or rocky habitat would be more beneficial, and this was done for the HBGS case study used in the above analyses (for further information on this approach see http://www.energy.ca.gov/sitingcases/huntingtonbeach/compliance/2006-07-14_staff_analysis.pdf).

4. An APF-based fee for entrainment could be determined for each plant but the process could be complex and expensive, especially if a suitable entrainment study is not available. Moreover, while the amount of habitat required to be directly compensatory can be estimated for intakes entraining or impinging mainly estuarine or rocky reef species (examples in Appendix 1), impacts to open coast soft bottom species are more difficult to deal with using habitat restoration or creation. Given the relatively small range of fees based on power plants for which the cost of creating habitat equivalent to APF has been determined (see 3. above) the simplest approach for entrainment mitigation would be to use the average fee and apply it to all intakes. Impingement, however, varies greatly among power plants so one fee for all is inappropriate for this impact. The interim mitigation fee for impingement could be determined from ongoing impingement/heat treatment monitoring at each plant, modified as necessary to insure the weight of fishes impinged is determined.

5. The fees, either from individual power plants or groups of power plants, should be used for habitat creation, restoration, protection or other projects that best compensate for the impacts in the region where they occur. In cases where habitat creation or restoration is not feasible, alternatives could include implementation of marine protected areas with limited or no take; such areas may produce healthy, fecund adult populations which, in turn, can produce and provide more offspring to the greater marine environment. Alternatives could also include potentially in-kind but indirect mitigation such as clean-up or abatement of contaminants, and restoration or creation

of habitat critical to other marine species (e.g. rocky reef or estuarine) based on habitat-specific larval productivity; for example, mitigation that is viewed as critical to the State's resources such as funding for white abalone restoration. One potential advantage of the fee based approach is that funds could more easily be aggregated if more costly projects are likely to provide the highest mitigation value.

6. Costs associated with the planning and management of mitigation projects should be minimized to achieve maximum compensation for impacts.

B. Mitigation for Desalination Plants

7. Ocean intakes at desalination plants can cause IM&E impacts like those of a power plant intake. The primary difference is in magnitude; desalination plants generally use less water than power plants. Therefore, a similar, fee-based approach to mitigation for such desalination plants is appropriate and could use the same fee/MG based on APF (3. and 4. above) for any impacts that remain after the best site, design and technology have been used. The fee should be used as for power plants (5. and 6. above).

C. Intake Designs and Technologies for Impact Reduction at Desalination Plants

8. This report does not address biological impacts that may be associated with the variety of subsurface intake technologies, some of which are described in the intake technology review (Appendix 3). However, any biological impacts associated with a properly designed, constructed, and operated subsurface intake should be minimal since the withdrawal velocity through the sediment is very low. Such intakes, however, may not be feasible at some locations and for large plants (Appendix 3). Large beach galleries or seabed filtration systems may have low IM&E impacts but large construction impacts on benthic organisms. Such construction impacts should be thoroughly evaluated for any projects proposing such intakes.

9. Wedge wire screens and a variety of other passive and active devices have been used or proposed for use on surface intakes to reduce IM&E (Appendix 3). Initial pilot studies of wedge wire screens indicate they have little effect on the number of small fish eggs and larvae entrained, but reductions in entrainment of larger larvae may provide some benefit by protecting older larvae that have a greater likelihood of becoming adults (see analyses in Appendix 3). A more thorough assessment of the effectiveness of wedge wire screens is underway in Redondo Beach for the West Basin Municipal Water District, including observations on impingement and behavior of larvae that encounter the screens but are not entrained, but the results are not yet available. While their effects on entrainment may be small, such screens have potential to eliminate impingement of juvenile and adult fishes if properly designed and located. Other entrainment reduction technologies for surface intakes have not been evaluated in the coastal waters of California.

Some desalination projects are considering deep water surface intakes as a possible way to reduce entrainment. If a deep water intake is proposed, suitable, site- specific studies of shallow versus deep water larval abundance and species composition must be done to determine differences in entrainment.

10. Some desalination projects are considering augmenting their intake of seawater for the sole purpose of diluting the discharged brine to meet toxicity objectives. Entrainment mortality of organisms in the intake water used solely for dilution purposes should be assumed to be 100% (unless suitable studies demonstrate otherwise) and fully mitigated, if allowed. However, this scenario is not recommended as many more organisms may be killed through entrainment and impingement than saved from exposure to high brine concentrations.

Literature Cited

Strange, E., Allen, D., Mills, D., and Raimondi, P. 2004. Research on estimating the environmental benefits of restoration to mitigate or avoid environmental impacts caused by California power plant cooling water intake structures. CEC Report 500-04-092. California Energy Commission, Sacramento

Steinbeck, J., Hedgpeth, J., Raimondi, P., Cailliet, G., and Mayer, D. 2007. Assessing power plant cooling water intake system entrainment impacts. CEC Report 700-2007-010. California Energy Commission, Sacramento.

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Attachments

Appendix 1. What should be the cost per million gallons for power plant once-through cooling interim mitigation, using entrainment weighted flow and examples of existing mitigation projects? By Peter Raimondi. 4 pages.

Appendix 2. Example of Costing IM&E Losses from Huntington Beach Generating Station. By John Steinbeck. 8 pages + Attachments.

Appendix 3. Desalination Plant Intake Technology Review. By John Steinbeck. 12 pages + Attachments

Appendix 1

11 November 2011

What should be the cost per million gallons for power plant once-through cooling interim mitigation, using entrainment weighted flow and examples of existing mitigation projects?

By: Peter Raimondi (University of California, Santa Cruz)

Although I will discuss entrainment in this document, the logic should apply directly to impingement as well. I reviewed a series of mitigation or proposed mitigation projects that have resulted from estimation of impacts resulting from entrainment (Table 1). In all cases I relied on Empirical Transport Models (ETM), coupled to the use of Area of Production Forgone (APF – sometimes called HPF) to calculate the area of habitat that would need to be created to compensate for resources lost to entrainment. In all cases resource loss was based on larval fish loss (note that a similar approach has been used for adult fish that were impinged). In all cases, I used information that was either in the assessment documents, the findings or the permits.

The key assumption of APF

The key assumptions of APF that makes it useful in estimating the fee that should be applied per million gallons of water are: (1) it should reflect impacts to measured and unmeasured resources (e.g. to invertebrate larvae). This is because its calculation assumes that those species assessed are representative of those not assessed. Practically this means that should the amount of habitat calculated using APF be created or substantially restored, the habitat will support species that were assessed as well as those that were not assessed in the ETM. Importantly that amount of habitat will also compensate for impacts to species only indirectly affected. For example, species feeding on larval fish will be positively affected by the creation of habitat that will produce more larval fish, even if those species are not affected directly by entrainment. (2) The losses are directly compensated in time. This means that should the mitigation take place according to APF estimates there will be no net impact. Importantly (for calculations that occur later), benefits do not need to accrue to be compensatory.

Assessment of cost per million gallons of water

The key components of the calculation were Intake Volume, APF (in acres), and the cost estimate for the creation or restoration of acreage. In addition I made the (very) simplifying assumption that the half- life of the restoration or mitigation project was 50 years. (Note that this assumption, along with discounting rate is adjustable in the model). Half-life is the midpoint in the expected life of the restoration project and is the point where the resource value conveyed is expected to be 50% of as-built, in the absence of

further funding. This is an important assumption and one that should be discussed. The main implication of this assumption is that it affects the discounting of the fee.

As noted, the general goal of APF is to determine the amount of habitat that would immediately compensate for losses due to entrainment (or any other sort of impact). When once through cooling (OTC) was considered to be ongoing and the life of the power plant was considered to be long, there was the expectation that the full cost of mitigation should be borne by the plant operator, *even though the benefits of the mitigation might last longer than the plant operations.* Given that the proposed fee structure is intended to operate for a period much shorter than the life of the plant, there needs to be a way to discount the cost of the mitigation. I modified the approach to one that is simpler and I think more reasonable. Looking at the table below will help with the following explanation.

For each of the Facilities shown in the table I show the intake volume that was used to estimate APF and note the type of mitigation that was used to estimate he compensatory costing (e.g. wetland restoration, rocky reef). Also shown is the cost estimate at the time of the assessment and the year of the assessment. The cost escalator is essentially the average inflationary rate that is applied to produce costs in 2012 dollars. This rate can be adjusted. The estimated half-life of the project is used to discount the cost. The half-life is used to estimate the accrued resource value of the project. For example if the mitigation project is for 200 acres and the half-life is 50 years, the accrued resource value is 10000 acre years (generally the formula is acres*half-life, based on a linear decrease of value with time). This can be used to determine the annual cost to the operator. For 2012 the estimate would simply be $1/50^{th}$ of the 2012 cost per MG (in the table). That value is called the prorated 2012 cost. If the plant operated in 2013, then the cost would the 2012 cost plus an increase due to cost escalation. This approach allows for easy estimation of cost per MG that is linked to cost of compensation of impacts due to use water.

One key consideration is how to use the results. For specific projects (eg Moss Landing) where APF estimation has occurred, very specific costing can be done. Alternatively, we could use the average cost per MG as the basis for all projects, large and small. Using data from Moss landing, Morro Bay, Poseidon, Huntington Beach and Diablo Canyon, I estimated the cost per Million Gallons (MG) of water used based on the best estimate of the total cost of habitat creation or restoration that would be compensatory based on APF calculations. The table below has these values. Based on this calculation (half-life = 50 years and cost escalator of 3%) the estimate of the annual fee ranged between $1.66 and $3.28 per MG. Two types of restoration were included: estuarine/wetland and rocky reef. The average cost was $2.45 per MG. I included a column of estimated annual fee based on the intake volume for each power plant and the average cost per MG. These ranged from $113,139 to $2,387,994. These values are less than half of earlier estimates.

To provide some context for these values I used all information that was available related to larval entrainment to derive the average concentration of larval fish that are entrained due to power plant operations. That value is ~ 6000/MG. At a cost of $2.45 per MG the cost per larval fish is ~ 0.05 cent. Note this is only to provide context as vast numbers of fish eggs ad invertebrate eggs and larvae are also lost due to entrainment.

Another way to provide context is through comparison to the cost of water. One possibly relevant comparison is to well water. Using Pajaro Valley Water Management District as an example, the cost is ~$500 per MG. Such water is delivered through user provided infrastructure and therefore its cost is not tied in any way to delivery. Even water that is massively subsidized for use in agriculture costs on the order of $30 dollars per MG.

The straw method under discussion allows for context dependent adjustment of fee. One example is described above and can be easily seen in the worksheet. The estimated fee per MG is considerably less for construction of artificial reef than for wetland. Other adjustments could be made for region specific cost of land acquisition. One extremely important caveat is that the fee structure shown is based only on the creation/restoration of habitat. No adjustments have been made to cover the cost of assessment of the effectiveness of the projects. Such an adjustment should be incorporated.
On possible approach would be to determine a reasonable percentage of restoration cost that should be used for assessment. I think that the range is somewhere between 10% and 25%. From a base cost of say $2.45 per MG, the cost including funding that would be used for assessment would range from $2.70 (10%) to $3.06 (25%).

			Annual Cost Escalator	3.00%		average cost per MG	$2.45			
			Estimated Half-Life of Project	50						
			Cost projection (year)	5						
t escaletor built in.										
APF (acres)	Mitigation Type	Cost estimate	cost per annual intake (MG)	Notes	Years between assessment and 2012	Cost escalator	total escalator	2012 cost per MG	estimated half-life fo project (years)	Prorated 2012 cost per MG
840	wetland	$15,100,000	$115	based on max larval duration, dollars in year 2000	12	3.00%	$1.43	$163.84	50	**$3.28**
760	wetland	$13,661,905	$101	based on max larval duration, dollars in year 2001 and cost per acre = Moss Landing)	11	3.00%	$1.38	$139.65	50	**$2.79**
37	wetland	$11,100,000	$100	based on max larval duration, dollars in year 2009 and cost per acre =300K (SONGS cost)	3	3.00%	$1.09	$109.31	50	**$2.19**
66	wetland	$4,927,560	$107	based on max larval duration, dollars in year 2009 and cost per acre =74.66K (from Davis et al report and final permit (acres)	3	3.00%	$1.09	$116.62	50	**$2.33**
543	Rocky reef	$67,875,000	$70	based on125K per acre (SONGS) in 2006	6	3.00%	$1.19	$83.16	50	**$1.66**
				Average		**3.00%**				**$2.45**