Memorandum

To: Michael Thomas, California Central Coast Regional Water Quality Control Board

cc: Ron Rimelman and Blaine Snyder, Tetra Tech Inc.

From: Liz Strange, Bob Raucher, Dave Cacela, Dave Mills, and Tom Ottem, Stratus Consulting Inc.

Date: 1/22/2003

Subject: Review of PGE's Benefits Analysis for the Diablo Canyon Power Plant

This memorandum reviews the December 2002 draft report entitled "Estimation of Potential Economic Benefits of Cooling Tower Installation at the Diablo Canyon Power Plant" (ASA, 2002) that was prepared for Pacific Gas and Electric Company by ASA Analysis & Communication, Inc. and Professor Ivar Strand. The ASA (2002) report presents estimates of the potential economic benefits of installing cooling towers to reduce the entrainment of aquatic organisms at the Diablo Canyon Power Plant (DCPP). The report discusses four categories of benefits: market benefits, nonmarket direct use benefits, indirect use benefits, and nonuse benefits. Benefits were estimated according to methods used by the U.S. Environmental Protection Agency (EPA) in its benefits case studies for the proposed Phase II rulemaking under § 316(b) of the Clean Water Act (see Chapters A5, A9, and A10 of Part A of the Case Study Document available at: http://www.epa.gov/waterscience/316b/casestudy/).

Section 1 of this memorandum discusses the entrainment estimates provided in the ASA (2002) report, Section 2 discusses the benefits estimates, Section 3 discusses the net present value calculations, and Section 4 summarizes the conclusions of this review.

1. Entrainment Estimates

ASA (2002) applied EPA's general methods to express DCCP entrainment losses as numbers of adult equivalents, biomass production foregone, and foregone fishery yield. However, with the information available in the ASA (2002) report, it is not possible to verify ASA's calculations, since the life history data used and other details of their calculations are not presented. In general, a detailed assessment of the entrainment estimates in ASA (2002) would require a detailed assessment of the March 2000 Diablo Canyon Power Plant 316(b) Demonstration Report by Tenera Environmental Services (Tenera, 2000), which appears to be the source of the data used. Nonetheless, there are some points about the ASA (2002) analysis that can be made without further review.

First, ASA's (2002) estimates do not include all species that are entrained at DCCP, and therefore underestimate the total entrainment loss. Only 14 "target" species were evaluated, and ASA (2002) does not provide any information on the criteria used to select these species.

ASA's (2002) estimates of foregone yield were determined with a range of annual fishing mortality rates (F) that are not species specific, but which ASA (2002) believes are applicable for the species considered and sufficient for finding a range of foregone yield estimates. ASA (2002) does not report F values per se, but indicates that they used a range of lifetime exploitation rates of 0.10 and 0.50. If considered on an annual basis, these exploitation rates correspond to F values of 0.11 and 0.69, respectively. However, ASA (2002) does not consider exploitation rate on an annual basis, but instead applies the exploitation rate to the estimated total number of equivalent adults. This procedure is a shortcut method that obscures the effective annual fishing mortality rate. However, the practical effect of this approximation is probably minimal, though it could be important for long-lived species and those with high annual F rates.

ASA (2002) estimates foregone production using the same method as EPA and converts this into fishery yield using the conversion efficiency of 2.5% used by EPA in its § 316(b) benefits case studies. However, based on public comments and additional review of the scientific literature, EPA now believes that a conversion efficiency of 0.20 is more appropriate. Use of a 20% conversion efficiency would significantly increase ASA's (2002) production foregone estimates, and by extension would also increase estimates of foregone yield.

Finally, some aspects of ASA's (2002) analysis require additional clarification. For example, it is unclear what time periods of entrainment monitoring data ASA (2002) used for their calculations. Page 5 of the ASA (2002) report refers to three time periods of entrainment data that are not mutually exclusive. The time periods are the same ones used in Tenera (2000) and relate to different types of sampling programs. Tenera (2000) explains how Tenera integrated the multiple data time series, but it is unclear whether ASA (2002) relied on the same type of data integration.

2. Benefits Estimates

2.1 Market Benefits

In general, ASA (2002) applies the methods that were used by EPA to estimate market benefits for EPA's § 316(b) benefits case studies. However, ASA (2002) uses some assumptions and data sources that may result in underestimates of fishing benefits. For example, ASA (2002) assigns 5% of the estimated foregone yield of blue rockfish and KGB rockfish to the recreational fishery. However, based on 1991-2001 California landings data from the National Marine Fisheries Service, a value of 34% may be more appropriate. Because rockfish have a fairly high per fish recreational value, assigning 34% of the foregone yield to the recreational fishery would significantly increase ASA's (2002) benefits estimate.

It also appears that there is an error in the way the results for white croaker and KGB rockfish were calculated in Table 3. We could not replicate the values reported in Tables 2 and 3 and note that the list of species is not in the same order in the two tables. As a result, the wrong losses, weights, or values may have been applied to one or both of these species.

2.2 Nonmarket Direct Use Benefits

ASA (2002) uses a Random Utility Model approach like that used by EPA in its § 316(b) benefits case studies to develop $/fish values for recreational fish, but applies this approach only to rockfish. However, several other species entrained at DCCP have recreational importance, including cabezon, white croaker, and California halibut. ASA (2002) considers only commercial values for these species, which are much lower than their recreational values. ASA's rationale for excluding these species from their recreational analysis is that these species are caught by fishermen only incidentally while targeting other species. Even if this rationale is supportable, it is unreasonable to apply high recreational values only to the rockfish yield, which is assumed to be 5% recreational, but not to develop a better recreational value for croaker yield, which is assumed to be 45% recreational.

In addition, there appears to be an error in the way the results for white croaker, blue rockfish, and KGB rockfish are calculated in Table 5 of ASA (2002). As noted above, the list of species is not in the same order in Tables 2 and 3, and therefore it appears that the wrong losses, weights, or values were being applied to one or more of these species.

It is also unclear how ASA (2002) calculated the "Increased Benefit to Fishermen" in Table 5. It seems that the calculation should be:

Total Harvest, Lower * Percent Recreational * Rec Value, Lower = Increased Benefits, Lower

Total Harvest, Higher * Percent Recreational * Rec Value, Higher = Increased Benefits, Higher

However, this calculation results in values that are much higher than the values reported in ASA (2002). As an example, according to this calculation, the upper bound for sanddabs is:

948 fish * 5.16% * $0.36/fish = $17.61

However, ASA (2002) reports an estimate of $8 for sanddabs. This difference isn't critical for sanddabs, which have low entrainment losses, but it could be significant for other species with relatively high losses, such as white croaker, blue rockfish, and KGB rockfish.

2.3 Indirect Use Benefits

The logic underlying ASA's (2002) estimate of indirect use benefits appears to be sound and most likely presents a conservative estimate.

2.4 Nonuse Benefits

There may be important unquantified and nonmonetized benefits beyond the modest recreational and commercial fishing benefits presented in ASA (2002). Ideally, such potential benefits should be evaluated using stated preference methods (e.g., contingent valuation, conjoint analysis, contingent ranking) to calculate willingness-to-pay (WTP) values, including the nonuse portion of total value. However, as ASA (2002) acknowledges, conducting primary research on nonuse values is often not practical or feasible given time and budgetary constraints, requiring alternative approaches, as discussed in the following sections.

2.4.1 Estimates of nonuse benefits using the 50% rule

An approach adopted by ASA (2002) to estimate the potential nonuse benefits of cooling towers is the "50% rule of thumb" used by EPA in its § 316(b) benefits case studies. The 50% rule is based on a 1984 study by Fisher and Raucher, which found that nonuse benefits typically amount to one-half (or more) of recreational use benefits. More recently, Carson and Mitchell (1993) found a ratio of nonuse to use value ranging from one-fourth to two-thirds. The 50% assumption may be considered conservative because it falls in the middle of this range. The 50% rule is also conservative because it may reflect only the nonuse component of the total value of a fishery to recreational users; it does not reflect any nonuse benefits to nonusers. Thus, ASA's (2002) use of the 50% rule to estimate the nonuse benefits most likely results in an underestimate of nonuse benefits.

2.4.2 Habitat-based replacement cost analysis

Dr. Pete Raimondi of UC Santa Cruz notes that, in the absence of direct information on nonuse values, it is useful to consider the habitat that would be required to offset entrainment losses.[1] The habitat-based replacement (HRC) method estimates the cost of restoring habitat to the level necessary to offset losses. The method is related to Habitat Equivalency Analysis, which is used by federal and state agencies to monetize damages in cases where resource injuries are otherwise difficult to value.

---

1. P. Raimondi, 1/13/03 e-mail to Michael Thomas of the California Central Coast Water Quality Control Board.

As ASA (2002) notes, replacement cost methods like the HRC are *not* true benefits "valuation" methods, and therefore replacement cost estimates cannot be taken as measures of economic benefits. However, replacement costs can be used in a policy context or in permit negotiations as a point of reference for evaluating technology costs.

Replacement costs based on fish hatchery and stocking costs are used routinely to estimate the economic damages associated with fish kills, including fish losses resulting from impingement and entrainment (e.g., by the Maryland Power Plant Program). While all parties acknowledge that these hatchery-based replacement "costs" are not true "benefits values" per se, in the absence of information on public values, these are accepted and used as the only available alternative for monetizing damages. In fact, in its publication presenting estimates of fish replacement costs, the American Fisheries Society states that such costs can be considered a "proxy for value."

Moreover, although ASA (2002) asserts that "the costs of habitat replacement . . . have little relationship to actual value," there are certain conditions under which replacement or avoidance costs can be appropriately used as a lower bound measure of value, such as when actions are undertaken voluntarily. In fact, many habitat restoration programs are voluntary actions and therefore indicate "value."

3. Net Present Value Calculations

The ASA report calculates a range of net present value (NPV) estimates for the expected benefits of a cooling tower. For these calculations, ASA (2002) used the same method and discount rates being used by EPA in its ongoing § 316(b) benefits analysis. ASA (2002) assumes that the cooling tower would come on line in 2008, making this the first year in which avoided losses are realized. An earlier "on line" date or an increase in the expected facility life would result in an increase in the NPV results.

Dr. Pete Raimondi of UC Santa Cruz has suggested that ASA (2002)'s NPV is incorrect if one assumes that resource values increase with scarcity and that the species entrained at DCPP are likely to be less abundant in the future (i.e., more scarce).[2] On this basis, Dr. Raimondi argues that future losses should be valued as equal to present losses of the same magnitude or at an increased value relative to current losses. Technically, this is equivalent to arguing for a future scarcity valuation premium that is equal or larger in magnitude, and opposite in sign, to the discount rates used in ASA (2002). While such an argument might be supported with a stated preference survey, it is inconsistent with generally held economic principles that hold that

2. P. Raimondi, 1/13/03 e-mail to Michael Thomas of the California Central Coast Water Quality Control Board.

individuals prefer to realize a beneficial outcome (e.g., receiving money or natural resources, or reducing resource losses) sooner rather than later. In NPV calculations, this underlying economic assumption is incorporated by using a discount rate that is greater than 0%.

Finally, it is interesting to consider how NPV results for a habitat program might compare to results for a cooling tower. For example, assume that a habitat program (1) would increase fish production by the same 80% by which a cooling tower would reduce entrainment, (2) would start generating this increase in the same year that the cooling tower comes on line, and (3) provides benefits in perpetuity. Using a 7% discount rate, with ASA's (2002) low fish valuation, the estimated NPV for a cooling tower is $51K, whereas the NPV estimate for the habitat program is $71K. Using a 2% discount rate and high fish valuation, the estimated NPV for a cooling tower is $1,098K and the NPV estimate for the habitat program is $3,964K. Thus, given the higher NPV for a habitat program, it may be useful to consider habitat restoration as an alternative to a cooling tower from both a cost-effectiveness and valuation perspective.

4. Conclusions

In general, ASA (2002) appears to have appropriately applied EPA's § 316(b) case study methods for evaluating entrainment losses and estimating economic benefits. However, a thorough review of the ASA (2002) analysis would require a careful review of the Tenera (2000) § 316(b) demonstration report that provides details on the methods and data which underlie the ASA (2002) analysis. Alternatively, the ASA (2002) report could be revised to include these details. However, in the absence of this information, it is not possible to know if the entrainment numbers that are used for ASA's (2002) benefits analysis are reasonable and scientifically defensible estimates.

In addition, the benefits estimates provided in the ASA (2002) report could be improved by a number of modifications to ASA's analysis. First, the report's benefits estimates are incomplete because only 14 taxa were considered. Adding the dozens of other species that are entrained at DCCP could potentially significantly increase the loss estimate. In addition, production foregone estimates would increase if the recommended 20% conversion efficiency were used, thereby increasing estimates of foregone fishery yield. Benefits would also increase if recreational species that were omitted from the analysis were included. There is also a need to verify that the partitioning of yield estimates into commercial and recreational components reflects the best data available. Finally, ASA's (2002) use of the 50% rule to estimate nonuse benefits most likely results in an underestimate of nonuse benefits. This is particularly important since the majority of species lost to entrainment have no direct market value, and therefore the benefits of reducing their losses are dependent solely on their nonuse value and their indirect value as forage for commercial and recreational species. While any one of these proposed modifications to the analysis may make little difference, collectively they could potentially make a significant difference to the final benefits estimate.