RESOURCE DECISIONS

A Cost-Benefit Analysis of Flow Alternatives Associated with Pacific Gas & Electric's Rock Creek-Cresta Project Relicencing

ABSTRACT

In order to enhance non-power values such as recreation or habitat, Federal Energy Regulatory Commission (FERC) licensing conditions for hydroelectric facilities often require flow modifications. Part of the rationale for these modifications is to enhance recreational opportunities which might otherwise be limited by hydroelectric generation. This report summarizes efforts by PG&E and its consultant, Resource Decisions, to develop a comparison of power and non-power values in the form of an economic cost-benefit analysis.

A cost-benefit framework is described. Several flow or water temperature scenarios are described and contrasted with the Existing Conditions scenario. These alternative scenarios include Temperature Modification, alone and in combination with the 1991 Agreement scenario, and the proposal by California Department of Fish and Game (the CDFG scenario). In addition scenarios were developed to compare alternative whitewater boating flows on summer weekends.

Benefits quantified include angling and water-related general recreational activities and whitewater boating. Non-use values, were considered but deemed not significant because any possible non-use values would not significantly change with the flows under consideration. Local expenditures are discussed, but were not considered appropriate in this decision context, as they would simply displace expenditures made at other locations.

Costs quantified include foregone power costs, costs for physical facilities associated with Temperature Modification scenarios. Environmental externalities associated with substituting more polluting generation for the foregone hydro power is also quantified.

Based on this analysis, the benefits net of cost were calculated for all alternative scenarios. None of the alternatives to the Existing Conditions scenario were found to have positive net benefits, with the possible exception of recreational boating releases in the spring. For fishery enhancements the 1991 Agreement scenario is closest to being economically justified. Other scenarios were found to have costs which far exceed measurable benefits.

1.0 A Benefit-Cost Framework

1.1 Background and Purpose

The Electric Consumers' Protection Act of 1986 (16 USC 791a-825r, as amended) requires the Federal Energy Regulatory Commission (FERC) to give "equal consideration" to power and non-power values in considering hydroelectric licensing alternatives. FERC has not provided specific guidelines as to the precise meaning of "equal consideration". As part of its on-going efforts to assist FERC in its task of balancing power and non-power values associated with continued hydroelectric generation, Pacific Gas & Electric Company (PG&E) has sought to make economic estimates of non-power benefits associated with water resources used conjunctively for hydroelectric generation and recreation.

The purpose of this report is to further assist FERC in its balancing of power and non-power values. In this connection, we present an economic cost benefit analysis which is intended to address all relevant values associated with alternative uses of the flows of the North Fork of the Feather River (NFFR) affected by PG&E's Rock Creek and Cresta diversions. We have analyzed several alternatives to the existing flow regime on the river, attempting to include all reasonable flows.

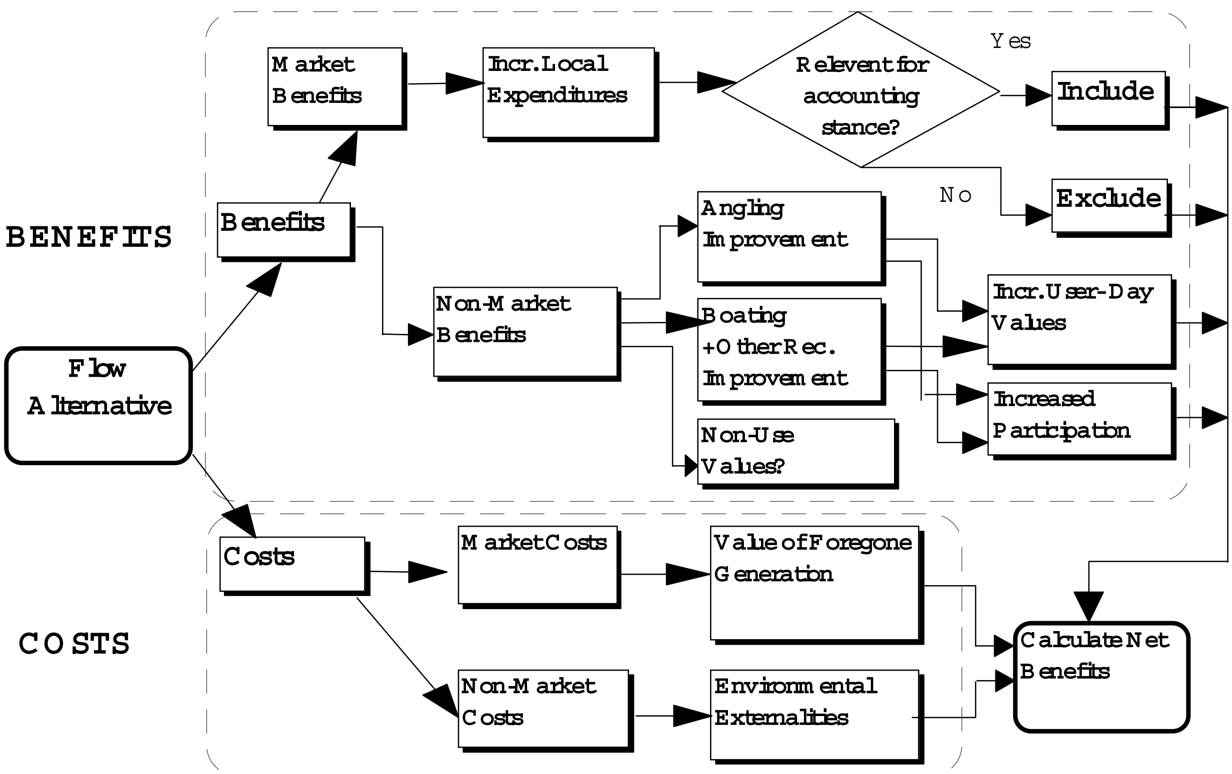
The values of NFFR flows through the project area can be categorized as costs or benefits to society of flow diversion alternatives. From this standpoint flow alternatives that provide more water in the river reaches between powerhouses can be viewed as having both positive effects (i.e. benefits) and negative effects (i.e. costs of the flow bypassing the powerhouse). The benefits category includes all the "non-power values". The "power values" can be viewed as the costs of the instream flow. Figure 1 illustrates the relationship between these costs and benefits.

In order to explicitly compare non-power values to power values, it is necessary to express monetary non-power benefits which are not directly bought and sold. As discussed in Section 2 of this report, well established and widely accepted procedure are used for this evaluation.

1.2 Objective of this Report

The objective of this report is to provide an economic estimate for each of the cost and benefit categories illustrated in Figure 1 for each flow alternative. By estimating total costs and benefits of each powerhouse by-pass alternative will provide a quantitative means of comparing the powerhouse by-pass alternative from an economic perspective. This should assist in the rational selection of the preferred alternative.

Figure 1:
Overview of Costs and Benefits associated with Alternative NFFR Flow Regimes



1.3. Underlying Assumptions

Time: To simplify the analysis, we have used current dollar costs and benefits for the first year of operation. This is consistent with FERC's current cost method. Current benefit values and visitation rates for recreation are also assumed.[1]

Inflation: All values are expressed in constant 1998 dollars. Implicitly this assumes that the escalation of electricity cost is equal to escalation of recreational values and all other goods.

Economic Impact Area: We have taken the entire United Sates economy to be the relevant area over which to evaluate impacts. Economic transactions within this area are not counted, as they are transfers, that is one person's revenue is another person's cost. The selection of this accounting stance reflects the federal jurisdiction of the FERC. Presumably the FERC attempts to balance power and non-power values on a national level.

Bias: There is a tendency to under value non-power benefits, simply because they are difficult to measure. To counteract that tendency, we have made every effort to resolve uncertainty in the direction of increasing the non-power benefit estimates.

1.4 Study Area

The study area includes the resources of the North Fork of the Feather River affected by the Rock Creek and Cresta Dams. These include the river reaches from the Rock Creek diversion dam to the Cresta powerhouse. This includes the Rock Creek and Cresta reservoirs.

1.5 Flow and Temperature Modification Scenarios

The flow and temperature modification scenarios whose costs and benefits are evaluated include:

0. Existing Conditions.
1. Temperature Modification Only
2. The "1991 Agreement" flows without temperature modification.
3. The "1991 Agreement" flows with temperature modification.

[1] FERC evaluates economic impacts (costs and benefits) for the first year of operation.

4. The "Fish and Game Draft recommendations flow
5. Boating flow A –800 cfs one weekend per spring/summer month.
6. Boating flow B –1200 cfs one weekend per spring/summer month.
7. Boating flow C –1600 cfs one weekend per spring/summer month.

The Temperature Modification Only scenario refers to methods, such as modification at the Prattville intake, which might reduce in-stream temperatures. They would also possibly reduce reservoir temperatures.

The "1991 Agreement" refers to an agreement[2] between PG&E and California Fish and Game (CDFG) regarding Rock Creek Crest instream flow conditions. This agreement stipulates that flows of 150 cfs (120 in dry years) will be maintained on the Rock Creek reach, and that flows of 140 cfs (120 dry years) will be maintained on the Cresta reach during the months of May through October. For the winter months (November to April), flows at least 110 cfs (90 in dry year) will be maintained on the Rock Creek reach and 100 cfs (80 cfs dry year) on the Cresta reach. The 1991 Agreement also provides for stocking 30,000 catchable trout per year in the reservoirs.

In addition, the agreement specified intake modifications at Lake Almanor (Project 2105) to reduce the average instream temperatures. At the suggestion of the USFS, CDFG and PG&E subsequently discussed whether alternatives to the intake modification measures might provide greater benefit to fish and wildlife habitat and beneficial uses within the watershed. While CDF&G ultimately decided not to pursue alternatives to the intake modification, for analytic purposes we have evaluated costs and benefits with and without these modifications for the "1991 Agreement" scenarios. Minor elements of the 1991 Agreement such as the requirement for potential flushing flows were not included in the analysis.

The "CDFG Recommendations" scenarios are based on a Draft Fisheries Management Plan prepared by CDFG in 1987[3]. This Plan recommends that Rock Creek instream flows be maintained at a minimum of 260 cfs all year. Cresta instream flows are recommended to be maintained at a minimum of 325 cfs all year. These flows are based on maintaining the optimum

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[2]Fish and Wildlife Agreement Between PG&E and State of California Concerning Rock Creek Crest project (FERC No. 1962), Contract Z12-1-712-91, 1991.

[3]CDFG, 1987, North Fork Feather River Fisheries Management Plan. CDFG Region 2, prepared by L. Wixom and Deborah Konnoff.

adult rainbow trout habitat predicted by the instream flow study conducted for CDFG by Hardin-Davis (1986).

The Boating Flow scenarios assume that the specified flow be maintained for one weekend (two days) in each month from April to September. The flows are to be maintained only during the 9 AM to 5 PM period with ramp-up and ramp-down periods. These are evaluated independently from the fish flow scenarios since they could be combined with any of these scenarios, or the Existing Conditions scenario.

2.0 Evaluation of Non-Power Benefits of Alternative Flow Regimes

As seen on Figure 1-1, non-power benefits can be associated with several values which are impacted by alternative flow requirements in the project area. With one exception, these benefits include changes in values which are not normally bought and sold in economic markets. Although these recreational and environmental values are clearly worth something, we cannot rely on an market price to establish their values. Section 2.1 introduces the economic concepts and methods which are used to estimate these values. Section 2.2 presents estimates of angling recreation changes. Estimates of recreational boating changes are presented in Section 2.3. Existence values are treated in Section 2.4. Changes in local expenditures are discussed in Section 2.5. Further details of this analysis are present in an earlier report to PG&E prepared by Prof. John Loomis[4].

2.1 A Brief Introduction to the Economic Valuation of Recreation

Many Federal agencies are required, under the U.S. Water Resources Council Principles and Guidelines (1983) to use the concept of net willingness to pay to measure the economic value of both marketed goods (e.g., agricultural commodities, hydropower, etc.) and non-marketed resources (e.g., recreation) in Benefit Cost Analysis or evaluation of Federal actions. When performing natural resource damage assessments, the U.S. Department of Interior regulations require that the calculation of economic values gained (or lost) to society be measured in terms of net willingness to pay (U.S. Department of Interior, 1986). Use of the net willingness to pay criteria is also recommended in textbooks on Benefit Cost Analysis (Sassone and Schaffer, 1978; Just, Hueth and Schmitz, 1982).

The U.S. Forest Service Manual and Handbook[5] provides a policy to integrate economic and social analysis into planning and decision-making. The policy also directs the use of economic and social analysis to determine costs, benefits and effects of proposed actions on the public including local, regional and national levels. The handbook specifies, in part, that the tradeoffs

[4] J. Loomis, 1987. An Economic Evaluation of Water-Based Recreation Within the Rock Creek-Cresta Project. With Appendix on Fisheries by E.J. Koford. Submitted to Pacific Gas & Electric, unpublished.

5 U.S. Forest Service Manual, Washington, 1992. Title 1900 Planning. Amendment No. 1900-92-2. Effective April 8, 1992.

among alternatives be evaluated. The methods used within this report are consistent with the direction and policy of the U.S. Forest Service.

It should be noted that the estimates of value of recreation were derived from studies that measured net willingness to pay using either the Travel Cost Method (TCM) or Contingent Valuation Method (CVM). The methods for measuring net willingness to pay are approved for use by Federal agencies (U.S. Water Resources Council, 1979, 1983; U.S. Department of Interior, 1986) when performing benefit-cost analysis or valuing natural resource damages. These two methods have been increasingly used to value fishing and wildlife by State fish and game agencies, including California, Idaho and Montana.

In general there is strong support among many Federal and State agencies for use of these methods, particularly the Travel Cost Method. The relevance of these non-market valuation methods has more recently been endorsed by a panel of Nobel Laureates convened by the U.S. Department of the Commerce[6]. The Travel Cost Method has particular support since the technique statistically estimates a demand curve for the recreation site based on visitors actual behavior. A real application of the Travel Cost Method to value fishing on the NFFR is presented in the next section of this report.

It is important to note that economic values derived from either the Travel Cost or Contingent Value Methods do not measure recreationist's expenditures. The increases or decreases in recreationist's expenditures associated with visiting the North Fork of the Feather River do not represent net changes in economic values within the nation as a whole or within the State of California. That is, if fishing or stream side recreation were to be lost at this river, the visitors would spend this same amount of money visiting some other recreation site or participating in some other recreation activity. The same level of spending would occur in the economy, it would just be transferred geographically to another location or to a different sector of the economy. (See Loomis, et al., 1984 for more details).

2.2 Angling and General Recreation Benefits Under Existing and Alternative Flow Scenarios

Improvements to existing minimum instream flow conditions can be expected to increase both the participation and the value of angling and general recreation uses. Section 2.2.1 presents the

[6]Arrow, et al, 1993.

methods and results used to estimate these participation changes. The changes in user-day values are presented in Section 2.2.2. The result of both these influences is estimated in section 2.2.3.

2.2.1 Angler and General Recreation *Use* Levels

In discussing angler use under existing conditions, available data are limited. The most recent published source is California Department of Fish and Game's (CDFG) Fisheries Study[7]. This study (funded by PG&E) covered years 1981 to 1985. More recent angler use data has been collected by the California Department of Fish and Game (CDFG) covering the period 1995 to 1997. However, the data from this study has not been compiled by CDFG at this time. The verbal description of these more recent data by CDFG personnel suggest that fishing recreation has declined somewhat since the 1981 to 1985 study period; therefore the earlier data represent an optimistic case for projecting the fishery restoration potential of increased flows.[8]

Several changes in fishery management have taken place since the 1981-1985 study period. Subsequent to this study period, fish planting efforts were terminated by CDFG. Also, catch limits, which had been two fish per day, were increased to five fish per day. These changes are likely associated with the recent decreased angler use suggested by CDFG compared to the 1981 to 1985 study period.[9] Although catch rates have likely also declined because of the above condition, we have assumed no diminution of catch rates as an optimistic basis for this analysis.

2.2.1.1 Angler Use under Existing Conditions

According to the California Department of Fish and Game's 1987 Fisheries Study[10] the number of angler-days in the Rock Creek-Cresta river reaches and reservoirs ranged from a high of 13407 in 1981 to a low of 6478 in 1984 (Conversion of angler hours to angler-days based on CDFG average of 2.23 fishing hours per angler-day; pg. 14-7). The annual average over the five year study period was 9559 angler-days. While 1984 was the low point in visitation, 1985's visitation

[7] CDFG, 1987.

[8] Gene Geary, PG&E, personal communication to M. Feldman, April, 1999.

[9] IBID.

[10] CDFG, 1987. Additional data regarding breakdown of data by river reach was obtained from PG&E, 1984.

was up again. The specific figures are provided in Table 2-1 below. It should be noted that angler-days data does not seem to be systematically related to instream flow releases. The overall trend in angler use is generally negative and a doubling the minimum July-August instream flows in 1984 and 1985 did not immediately change visitation levels. Overall, this may be due to lags in angler's behavior, whereby it takes several years of changes in instream flow to change perceptions and then for anglers to adjust their visitation rates in response to changes in perception. The data in Table 2-1 is consistent with the view of lags in behavior, as visitation did turn back up in 1985.

Table 2-1 Recent Angler Use for Project Area

Year	1981	1982	1983	1984	1985	5-Yr Avg
Angler-days	13407	10855	9529	6478	7522	9558

This trend in angler-days generally follows the trend in total recreation use within the NFFR drainage including Lake Almanor, Ponderosa Flat and Last Chance. In these areas there has been little net change in recreation use, with a slight downward trend in overall recreation use (Visitation figures from Ross-Leech, PG&E). The decrease in use in the Rock Creek & Cresta section by anglers has been steeper than in the project area overall. The decreases in the NFFR study area does not appear to be closely related to visitation at these other recreation sites in the NFFR.

Given the lack of a demonstrated site-specific angler response to increasing instream flow levels, the benefit transfer approach was used. This approach uses evidence on reaction of anglers to changes in instream flow on other Western Rivers for which such site surveys have been performed, and is described in Section 2.2.1.2.

The angler-days presented in Table 2-1 are not evenly distributed between reservoir and stream fishing. Over the five year period, Table 2-2 indicates that approximately 50% of the angler use days occurs on the Rock Creek by-pass reach, 24% on the Cresta by-pass reach of the NFFR, with the other 26% occurring at the reservoirs. As discussed below, stream angling days are valued differently than reservoir angler-days. The specific angler-day estimates to be used for valuing current use levels are provided in Table 2-2.

Table 2-2:
Angler-day Figures by Project Area Segment

Rock Creek Reservoir	Rock Creek Reach	Cresta Reach	Cresta Reservoir	Total
1,612	4,788	2,256	903	9559
16.9%	50.1%	23.6%	9.5%	100%

As Table 2-2 indicates, about 7044 (73.7%) of the 9559 angler-days occurs on the two river by-pass reaches with the remaining 2515 angler-days being reservoir fishing. These figures serve as a basis for calculating expected angler-days under alternative flow levels and fish catch rates.

2.2.1.2 Estimates of the Rate of Change in Angler Use under Alternative Scenarios

This section addresses the relationship between minimum instream flow (or reservoir levels) and angler use as well as fish catch and angler use. The rate of change in angler use has historically been disaggregated into three components: (1) probability a person will be an angler; (2) the probability an angler will visit a particular fishing site such as the North Fork of the Feather River; and (3) given that a person is an angler at the NFFR, how often will they visit[11]. All three factors can be influenced by instream flows. For example, if instream flows are known to be extremely low, an angler may discontinue their preferred activity (say, stream fly fishing) and take up their second choice recreation activity (say, reservoir fishing). Secondly, if instream flows are low or fluctuate frequently at a particular river, a person might stop visiting this site and drive further to some more distant site. Thirdly, if the instream flow fluctuations are relatively minor or there are few nearby substitute sites to engage in stream trout fishing, the angler might simply reduce the number of visits to the site when river flows are expected to be low. In addition, for many rivers, low flows reduce the recreational carrying capacity by concentrating anglers closer together[12].

[11]Bishop, et al., 1986:6.35.

[12]Walsh, et al., 1980a.

Existing Instream Flows, Reservoir Levels and Fish Catch Rates

Based on the 1987 CDFG study, the angler catch rate (catch per angler-hour) is highest in the Rock Creek reach (0.214 fish per hour), followed by the Cresta reach. The fish catch rates at Cresta and Rock Creek reservoirs are substantially lower (0.17 and 0.056, respectively) as the relatively small forebays associated with this Project , make poor trout habitat as compared to streams/rivers. This catch rate is based on existing- condition flow rates of 50-100 cfs and summer water temperatures generally in the range of 20-21^{o}C.

Relationship Between River Levels and Angler Use

According to a relevant study, at very low instream flows (i.e. existing conditions) doubling flow, by itself, would almost double angler-days[13]. The increase in instream flow would not only increase the aesthetics to the angler but also increase the riverine habitat (weighted useable area) for fish and have some small temperature reducing feature as well. This in turn is assumed to raise the catch rate and is a secondary influence on the relationship between flow and angler use. At higher flows the incremental change in use rate in response to flows declines.

Based on this relationship, increasing the nominal 50 cfs[14] average annual instream flow release under Existing Conditions to the average annual 119 cfs cfs under the 1991 Agreement scenario, is estimated to increase flow by 91 % for the Cresta reach and 67 % for the Rock Creek reach,[15] based on increased carrying capacity and improved aesthetics. Further increase in flow to the 260 to 325 cfs range of the CDFG Draft Recommendations would cause a lower proportionate flow to use elasticity. Added to the flow response are the effects due to improved catch rates which are discussed below.

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[13]Ibid. Walsh expresses use relationship in terms of "bank-full". For the NFFR, we assume that a flow of 1600 cfs represents 100% bank-full and 350 cfs represents 35% bank-full. For increases from 50-150 cfs, Walsh's result implies a 67% elasticity. For 150 to 260 cfs, the implied elasticity is 23 percent. For 150 to 325 cfs, the implied elasticity is 20%. These elasticities are the basis of the use estimate increases for the 1991 Agreement and CDFG scenarios.

[14]Actually, PG&E estimates that the average flow under Existing Conditions is 67 cfs. However, we have used the nominal 50 cfs estimate to provide an upward bias to the benefits of increasing instream flow.

[15]Based on Walsh 1980, the increase from 50 to 105 average cfs from the Rock Creek reach has a flow elasticity of use of 91 %. For the greater change in the Cresta reach (50 to 145

Relationship Between Reservoir Level and Angler Days

Anticipated modifications to flows will not affect the existing conditions draw-down of reservoir levels. Therefore, modifications to flow will not alter the number of reservoir angler days due to water level fluctuation (flow).

Relationship between River Catch Rates and Angler-days

Trout do best in temperatures less than $20^{O}C$, with optimum temperatures around $15\text{-}17^{O}C$. For our purposes, we used this temperature range to establish some simple crude relationships between temperature and fish populations. Absent better information Loomis relied on a report by Koford[16] which included potential response of fish populations to stream temperature and flow.

Modifying intake structures or other techniques to reduce stream temperature alone (without changing flow rates) has been projected to decrease the in-stream temperature from $20\text{-}21^{O}C$ under Existing Conditions to the $19\text{-}20^{O}C$ range (Lifton, et al, 1987, WCC 1986). If this cuts mortality rates, it is reasonable to assume a 10% increase in trout catch. Based on catch elasticities in the literature[17], a 10% catch increase would result in a 4% change in angler use-days solely due to temperature.

Increasing flow also increases catch rates due to both the improved flow conditions and the decreased temperatures, which in turn increases angler use. Based on optimistic assumptions, Koford suggested a $1^{O}C$ decrease might result in increasing catchable trout populations by 20%. This 20% increase in catch would add about an 8% increase in angler-days (in addition to any direct flow-related increase in angler-days). This increase would apply to the Temperature Modification Only scenario. For the 1991 Agreement Scenario (without the intake modification) the temperatures would be reduced about $0.5^{O}C$ raising use by 4%. The 1991 Agreement with Temperature Modification scenario would decrease temperatures by about 1.5 ^{O}C, thus increasing use by an estimated 10%. The CDFG scenario flows might decrease temperature a full degree, so use is estimated to increase by 8%.

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cfs), the use elasticity is 67 %.

[16]Koford report is included with Loomis's 1987 report in Appendix A.

[17]Sorg, et al.,1985 Duffield et al, 1987, and Loomis, 1987.

Relationship between Reservoir Catch Rates and Angler-days

Reservoir fishing is sensitive to catch (and thereby temperature) but not to flows. It is assumed that the same temperature decreases estimated for the stream reaches would apply to the reservoirs. Consistent with the stream estimates above, the 0.5^{O}C decrease expected under the Temperature Modification Only scenario would result in 4%[18]increase in use and user-day value above Existing Conditions. Similarly, lowering temperatures by 1.0^{O}C as in the CDFG scenario would result in 8% increases in use and value.

Under the 1991 Agreement, the number of stocked catchable trout would increase from an average of 5,275 per year during the baseline survey years to 30,000 per year. Based on the 40% catch to use elasticity discussed above, an increase of 470% in stocked fish would result in a 190% increase in use. Because food and not temperature is probably the limiting factor[19], the additional temperature decrease of 1^{O}C due to temperature modification would not have any further effect on use.

2.2.2 Non-Angler Use Levels Under alternative Scenarios

2.2.2.1 Existing Non-Angler Use:

Table 2-3 estimates recent annual recreation use by activity for the two reservoirs. This is based on distribution of activities from the PG&E recreation use survey conducted in 1984 as part of the boating safety study (PG&E, 1984:18). The total use figures were calculated by calibrating the distribution mix to California Department of Fish and Game's independent estimates of angler-days for the reservoirs. These figures for total reservoir use are roughly consistent with total use estimates developed from PG&E's figures of number of people per day stopping at the reservoirs (PG&E, 1984:20; adjusted to the five year average use level) and a 180 day recreation season (mid-April through mid-October).

[18]Loomis, 1987 incorrectly used 5%.

[19] Curtis, 1955.

Table 2-3:
Reservoir Use Distribution

Activity	Rock Cr. Reservoir		Cresta Reservoir		Total
Swimming & Boating	2888	43%	2337	44%	5225
Picnicking	1008	15%	319	6%	1326
Passive/Travel Rest	1209	18%	1753	33%	2962
Fishing	1612	24%	903	17%	2515
Estimated Total	6717	100%	5312	100%	12028
	56%		44%		

Estimates of non-angling stream-side recreation use were also developed from PG&E data collected as part of the Boater Safety Survey. PG&E[20] provided summer 1984 sampling data on visitor use by area. This use was expanded from the sample period to the entire recreation season. Total stream-side recreation use was apportioned by the percentage of swimming and boating recreation use to eliminate visitor days that were associated with fishing (since they have already been accounted for above). Since a great deal of the visitor use was associated with the now defunct James Lee Campground, total visitor use estimates are calculated with and without the replacement of the James Lee Campground.

Total stream-related recreation estimated with the presence of the James Lee Campground is 4625 visitor days per summer season. If the campground is not replaced and the assumption that previous visitors to that campground will no longer stop and use the river at that location, we estimate that there will be 2110 visitor days per summer season. The percentage distribution of this stream-side use within the project area changes depending on the assumption about the presence of James Lee Campground. With the campground, nearly 80% of the use occurs between Rock Creek and Cresta Reservoirs. Without the campground, 56% of the visitor use occurs in this stretch. The differing distributions of use is used to estimate the use and value of stream-side recreation and how the value changes with alternative flow levels.

[20]Ross-Leech, PG&E, personal communication to J. Loomis, 1987.

2.2.2.2 Estimates of Change in Non-Angler Use with Alternative Flow Scenarios

The existing visitor days for non-fishing related recreation on reservoirs is drawn from Table 2-3. Non-angling recreation is expected to remain the same as existing use, because modified flows are not expected to modify reservoir fluctuations beyond those experienced under existing conditions.

Stream-side Recreation Use:

Boating and other stream side recreation will be affected by flows. The use impacts of alternative flow scenarios draws on Daubert et al and Hyra and Walsh, et al (1980a). The relative proportion of non-angler visitors in each stretch of the NFFR varies depending on the assumption about whether James Lee Campground is replaced and the extent that former visitors continue to stop at the NFFR at the former location of the Campground. As discussed earlier, without the campground a 56%-44% split between the two sections of the NFFR is expected as compared to the current 80%-20% split occurring in 1984 when the campground was present.

Stream-side recreation use is estimated to increase in proportion to the increases in flows under the alternative scenarios. This is a very conservative (high benefit) estimate. Accordingly, the average flow change in each of the two river reaches was used to estimate a 245 % increase in use for the 1991 Agreement scenarios and a 378 % increase for the CDFG scenario—see Table 2-4.

2.2.3 User-day *__Values__* for Fishing under Existing and Alternative Flow Scenarios

Several approaches were used to estimate the value per user-day for angling and non-angling recreation. For angling, we used Loomis 1986 travel cost analysis of existing CDFG five year fisheries study[21] data on the NFFR. The results of this analysis were consistent with a contingent valuation method analysis published by the U.S. Fish and Wildlife Service (USFWS). For non-angling use values, a combination of benefit-transfer sources were used. These estimates are summarized in the following sections and explained in more detail in Loomis' 1986 report which constitutes Appendix A of the present report.

[21]CDFG, 1987.

2.2.3.1 Stream Fishing User-Day Values

Existing Angler User-Day Values

A travel cost method (TCM) analysis was conducted by Prof. Loomis based on the CDFG, 1987 fisheries study. Summarized briefly, Loomis regressed trips per capita of angling recreation as a function of log travel costs (based on distance traveled to the NFFR), wild trout caught and trout stocked. The sample was stratified based on distance classes: complete sample, 200 miles or less (round trip) and 150 miles or less. The willingness to pay, based on the TCM analysis for visitors who traveled 200 miles or less, was estimated to be $21.99 dollars per user-day[22]. A higher value ($30.68) was estimated by including the full sample (travel up to 400 miles). The lower value is interpreted as reflecting the willingness to pay under the existing somewhat degraded fishing conditions. The higher figure is interpreted as reflecting a willingness to pay for improved conditions, where anglers would be willing to travel in excess of 200 miles to fish the NFFR.

An independent estimate of willingness to pay for trout fishing in California was derived from the U.S. Fish and Wildlife Service's (USFWS) National Survey of Fishing and Hunting[23]. Using the contingent valuation method, this study estimates a value of $31.58 which is quite close to Loomis' full sample NFFR estimate ($30.68). This statewide value is taken as the base value for the NFFR under improved flow conditions. This value is adjusted up or down from the statewide average conditions based on instream flows and water temperatures.

Angler Values per User-day Under Alternative Flow Scenarios

Four survey-based studies provide elasticities of willingness to pay as a function of instream flows and water temperatures[24]. Taking a simple average of the four low-flow elasticities of these studies suggests that under the present low flow and high temperature conditions of the NFFR,

[22]The survey data upon which the TCM was based did not indicate whether angling at the NFFR was the primary purpose of travel. It is assumed that users traveling in excess of 200 mile had other travel purposes in addition to angling. Attributing the full travel cost only to angling would overstate their willingness to pay.

[23]Brown and Hay, 1987

[24]Daubert and Young, 1981, Walsh et al, 1980a, Ward, 1985 and Bishop et al, 1986

should be 69% of the state-wide average conditions, or \$21.80 per day. Under the Temperature Modification Only scenario the value per user-day would be increased by 5% due to improved fish catch[25].

The value per day could be expected to more than double (increase by 205%) if with the flow increases under the 1991 Agreement. Flows account for the vast majority of this increase, but 4% could be expected to result from the slight decrease in temperature caused by the higher flows[26] due to lower temperatures increasing catch[27] (see use vs. temperature above).[28].

Under the 1991 Agreement with Modified Temperature scenario, an additional 5 % in user-day value is expected due to the further decrease in temperature to $19^{O}C$.[29] Finally, if flows are increased to the CDFG scenario levels angler user-day values would increase to \$71.23 which is 327 % of the Existing Conditions scenario use value. Again the vast majority of this effect is due to flow increases with a minor contribution from additional catch due to temperature decline. These benefit changes are summarized in Table 2-4.

2.2.3.2 Reservoir Fishing User-Day Values

Walsh, 1980 found a user-day value of \$17.44 for a pristine mountain reservoir. Based on the less desirable characteristics of the Rock Creek and Cresta reservoirs, a value equal to half of Walsh's (\$8.72) is assumed for existing conditions. As discussed in Section 2.2.1.2, temperature decreases of $0.5^{O}C$ cause an estimated 4% increase in user-day value for the Temperature Modification Only scenario. The decrease of $1.0^{O}C$ associated with the CDFG scenario would cause an estimated 8% increase in user-day values.

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[25] Sorg et al, 1985.

[26] Ibid.

[27] Sorg et al, 1985.

[28] Loomis 1987 erroneously used 4%. This is corrected in the present report.

[29] Ibid.

Under the 1991 Agreement scenario, it is assumed that the marked increase in fish stocked would raise the user-day value to the full amount reported by Walsh for pristine conditions i.e. $17.44. Because food and not temperature is the limiting factor, the addition of Temperature Modifications is not expected to further increase user-day values.

2.2.4 Non-Angling Use and User-Day Values

Non-angler Reservoir User-Day Values:

Estimates of the economic value of water sports at reservoirs in New Mexico and Texas was determined by Ward (1978) and Grubb and Goodwin, respectively, using the Travel Cost Method. The average of the values estimated by these authors is $18.00 per-user day. These values are reduced by 53 percent due to the minimal facilities at Rock Creek and Cresta reservoirs ($8.48 per user-day). This reduction is based on a U.S. Forest Service methodology[30]. Decreased temperature and higher stream flows would not affect this estimate.

Stream-side Recreation Values:

Under the Existing Conditions scenario, the value per user-day of $4.03 is based on a survey-based study's estimate for low flow stream side recreation[31], assuming that the James Lee Campground is not replaced. Temperature Modification alone would not affect this value. Increasing flows to the 100 to 150 cfs range under the 1991 Agreement and the CDFG scenarios are estimated to increase user-day values in proportion to flow. Thus values would average $9.89 for the 1991 Agreement and $20.02 for the CDFG scenario User-days are expected to increase in the same proportion. Both angling and stream-side recreation values are summarized on Table 2-4.

[30]USFS, 1985.

[31]Daubert et al, 1980

Table 2-4

Stream Fishing and Stream-side Recreation Under Alternative Flow Scenarios

Alternative	Flow	Temp	Value per User Day	# of User Days	Total Value	Change From Existing
Stream-side Fishing:						
Existing Conditions	**50 cfs**	**20.5 °C**	**$21.80**	**7044**	**$153,594**	
Temp. Modif. Only	**50 cfs**	**19.5 °C**	**$22.90**	**7,608**	**$174,176**	**$20,582**
1991 Agree.-RC	140-150cfs	20 °C	$53.75	10,102		
1991 Agree.--Cresta	110-100 cfs	20 °C	$40.67	4,026		
Total Agreement			**$44.71**	**14,127**	**$631,635**	**$478,041**
Vs. Existing:			205%	201%	411%	
1991 Agreement						
1991 Agree+Temp-RC	140-150cfs	19 °C	$55.06	10,364		
1991 Agree+Temp--Cresta	110-100 cfs	19 °C	$41.97	4,144		
Total Agreement			**$45.89**	**14,507**	**$665,724**	**$512,130**
Vs. Existing:			210%	206%	433%	
CDFG				8,923		
CDFG Rec-Rock Ck	260 cfs	19.5 °C	$70.82	12,348		
CDFG Rec-Cresta	325 cfs	19.5 °C	$72.11	5,873		
Total CDFG			**$71.23**	**18,222**	**$1,297,999**	**$1,144,405**
Vs. Existing:			327%	259%	845%	
CDFG + Temperature Modification						
CDFG Rec-Rock Ck	260 cfs, Temp	18.5 °C	$76.95	13,498	$1,038,613	
CDFG Rec-Cresta	325 cfs, Temp	18.5 °C	$77.79	6,378	$496,130	
Total CDFG + Temp			**$77.22**	**19,875**	**$1,534,743**	**$1,381,149**
Vs. Existing:			354%	282%	999%	
Stream-side Recreation						
Existing Conditions	**50 CFS**		**$4.03**	**2110**	**$8,513**	
1991 Agreement						
1991 Agree.-RC	140-150cfs		$11.70	2,692	$31,500	
1991 Agree.--Cresta	110-100 cfs		$8.47	2,481	$21,023	
Total 1991 Agreement			**$9.89**	**5,174**	**$52,523**	**$44,011**

Vs. Existing:		245%	245%	617%	
CDFG					
CDFG Rec-Rock Ck	260 cfs	$18.07	3831	$69,253	
CDFG Rec-Cresta	325 cfs	$21.56	4142	$89,285	
Total CDFG		**$20.02**	**7974**	**$158,538**	**$150,025**
Vs. Existing:		496%	378%	1862%	

Notes on Table 2-4:

1.Value per day uses average of Daubert, et al. & Walsh, et al. At 100-160cfs range(.75) and the average in the 200-320 cfs range for the next increment in value (.35). Source is Loomis PGE report Tables 5&6.

2. Scenarios with temp decrease uses the elasticity relationship between increase in value due to a increase in catch. A 1.5 ^{O}C decrease in temperature is associated with a 305 increase in catch (Koford). At a 40 percent catch elasticity, this results in a 12% increase in value (0.4-0.3). Other temperature decreases (1 ^{O}C or 0.5 ^{O}C) thus result in 8% and 4 % increases in value, respectively. Source Loomis 1986 PGE report)

3. Change in Use: nearly proportional relationship of flow & angler use (.91) and increased fish catch rates for 50--> 100cfs range.
Change in angler use with higher flows is .67 for 50-->150 cfs, incremental elasticity .23 for 150-->260. Source is Loomis 1986 PG&E report, and Walsh, et al.,1980 Table 7, page 51.

4. Rock Creek has 68% of river use, Cresta has 32% of river use.

5. Streamside Recreation Value relationship from Loomis, PGE Report Table 8 (updated for inflation) and reflects weighted average of recreation use and flows between the two reservoirs and below Cresta. Visitor use is proportional to flow

2.2.5 Whitewater Boating Benefits

The project area has had relatively little documented recreational boating use (rafting, kayaking, canoeing). This is due to the variability and unpredictability of the flows, and because typical summertime flow are too low to make the river navigable, even by kayak. However, interest in boating has increased in recent years, possibly due to recent wet years that have provided more spring spill flows and interest generated by recent relicensing discussions.

WRC Environmental, a firm specializing in whitewater evaluation was asked to characterize the river reaches based on comparison with other whitewater rivers in California. Although their time and budget was very limited, WRC did conduct a brief site visit and contacted several commercial whitewater guides using somewhat comparable resources. The following analysis is based on their observations and conclusions,[32] except for the user-day value estimates which were made by Resource Decisions.

2.2.5.1 The Whitewater Resource

From a whitewater boating perspective the project area can be divided into three reaches:

- Rogers Flat class III/IV-4.3[33] miles
- Tobin class IV-V3.5 miles
- Cresta 4.3mile[34] class II-III miles

The following descriptions are based on an assumed adequate flow of about 1000 cfs. The characteristics of these reaches are not ideally suited to whitewater boating due to their short length and their uneven gradient. The Rogers Flat reach begins with a short (about 0.2 mile) class II/III dam plunge pool and pool/drop. The remainder of the reach is a not very interesting (albeit scenic) class I-II. With a few short class III segments. This reach would be of slight to moderate interest to intermediate paddles in kayaks or paddle rafts, or for commercial rafting trips.

Boaters who are not highly skilled would need to take out before the Tobin reach, which is a challenging and potentially dangerous class V. This reach would probably be of limited use to commercial rafters, but would possible be of interest to expert kayakers who are willing to accept high risks. By putting in at river mile 3.6 (in the Rogers Flat reach) this could be a 5.3 mile run.

The Cresta reach begins with about 1 mile of class III/IV rapids. The remainder of the reach is fairly uninteresting class I and II paddling except for a 0.1 mile class III just before the takeout at the Cresta Powerhouse.

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[32] WRC, 1999. Chuck Watson, Water Resource Consultants, Sacramento, personal communication to M. Feldman, 8/99.

[33] This reach is actually 5.0, but the longest run is limited by reasonable put-in an take-out spots.

[34] Similarly, actual reach 4.9 miles but only 4.3 using reasonable put in an take out spots.

2.2.5.2 Use Values with Boating Flows

The value per user-day is difficult to estimate because the river conditions, even with adequate flows is unlike that of any other California river. The shortness of the interesting runs and the need to break up the trip into at least one difficult vehicular portage make the trip less attractive. However, the river does have very good scenic value and could be made available late in the summer, when most alternative rivers flows are too low.

Based on a careful analysis of the available survey-based valuations, a range of values from $44 to $74 per user day was found for Pit 1. The higher value was assigned to a very scenic and challenging reach of the Pit. In the interests of avoiding understating benefits, we have assumed that this high value would apply to the Rock Creek-Cresta[35]

2.2.5.3 Whitewater Use Estimates

Because of the shortness of the interesting runs, fairly low usage is predicted, even if sufficient flows are provided and there is adequate advance notice to the boating community. There are several roughly comparable rivers with available capacity which have greater whitewater recreation potential. These include the Pit River and the Burnt Ranch Gorge.

In order to provide a sufficiently long recreation experience, a commercial trip would probably consist of running both the Rock Creek and Cresta reaches with a portage in between. This means that the commercial user-day would include both reaches (excludes the Tobin reach), and therefor a trip consisting of the Roger Flat and the Cresta reaches should be counted as one user-day.

At the 800 cfs flows there would probable be very little usage, except by non-commercial kayakers. WRC estimates between 0 to 10 boaters would use the river on any day these flows were provided. At 1200 to 1600 cfs, flows would be sufficient to permit commercial and non-commercial paddle rafting as well as kayaking and canoeing. WRC assumes that from 15 to 30 boaters per day would use the river at these flows.

In order to get a rough comparison of costs and benefits, we have assumed the highest reasonable usage: 10 kayaks per day at 800 cfs, 30 assorted commercial and non-commercial users at 1200

[35] With the exception of the Class V part of the Tobin reach, the remaining reaches are more similar to the reaches assigned a lower value on Pit 1.

cfs. At 1600 cfs we have arbitrarily doubled WRC's maximum estimate to 60 users per day. According to WRC, the South Fork of the American River is a much more interesting and longer white-water run. It is also at least an hour closer to the Bay area and Sacramento.

The bottom of Table 2-5 shows the benefits associated with these user-day values and use rates. With these assumptions benefits are between $4,000 and $27,000 per day that boating flows are provided.

2.2.3 Summary of Recreational Use Values

Table 2-5:
Summary of Recreational Values Associated with the Rock-Creek-Cresta Project

	Value per User-Day	# of User-Days	Total Value	Change vs. Existing
Stream Fishing:	**1998 $**		**Thousand 1998 $**	
Existing Conditions	$21.80	7,044	$154	
Temp Modification Only	$22.90	7,326	$168	$14
1991 Agreement	$44.71	14,127	$632	$478
1991 Agree +Temp	$45.89	14,507	$666	$512
CDFG Recommendation	$71.23	18,222	$1,298	$1,144
Reservoir Fishing:				
Existing Conditions	$8.72	2,515	$21.9	
Temp Modification Only	$9.07	2,615	$23.7	$1.8
1991 Agreement	$17.44	4,715	$82.2	$60.3
1991 Agree +Temp	$17.44	4,715	$82.2	$60.3
CDFG Recommend	$9.42	2,716	$25.6	$3.6
Reservoir Recreation:				
Existing Conditions	$8.48	9,513	$80.7	$0.0
Temp Modification Only	$8.48	9,513	$80.7	$0.0
1991 Agreement	$8.48	9,513	$80.7	$0.0
1991 Agree +Temp	$8.48	9,513	$80.7	$0.0
CDFG Recommend	$8.48	9,513	$80.7	$0.0
Steamside Recreation:				
Existing Conditions	$4.03	2,110	$8.5	
Temp Modification Only	$4.03	2,110	$8.5	$0.0
1991 Agreement	$11.70	2,692	$31.5	$23.0
1991 Agree +Temp	$11.70	2,692	$31.5	$23.0
CDFG Recommend	$20.02	7,974	$159.7	$151.1

	Value per User-Day	# of User-Days	Total Value	Change vs. Existing
Boating Recreation:				
800 cfs	$74	120	$8.8	$8.8
1200 cfs	$74	360	$26.5	$26.5
1600 cfs	$74	720	$53.0	$53.0
Total Recreational Benefits of Modifications:				
Existing Conditions		21,182	$264.8	$0.0
Temp Modification Only		21,565	$280.7	$15.9
1991 Agreement		31,048	$826.1	$561.3
1991 Agree +Temp		31,428	$860.2	$595.4
CDFG Recommend		38,425	$4,254.4	$3,989.6
Boating Flows Only:				
800 cfs		120	$8.8	$8.8
1200 cfs		360	$26.5	$26.5
1600 cfs		720	$53.0	$53.0

2.3 Non-Use Values

In addition to the benefits associated with the use values of fishing, boating and general recreation described above, there is also a category called "non-use values". These include existence values, option values, quasi-option values and bequest values. Definitions of these values will help to evaluate whether these values are applicable to the resource in question. ***It is important to keep in mind that we are evaluating flow alternatives, not total environmental restoration or restoring the river to pre-project conditions.***

Existence values are associated with places and species from which people derive satisfaction, even though they do not use it. This generally applies to unique or rare environments, plants and animals. For example, even though one might never want to visit the Arctic National Wildlife Refuge, one might derive satisfaction from knowing that it exists in a pristine state. In the NFFR, one might ascribe values to the existence of the trout habitat which would be improved by the higher flows of the 1991 Agreement or the CDFG scenarios. But, to the best of our knowledge, the flow alternatives will not affect any rare or endangered species, nor will it restore or create a unique environment. While there might be some existence value that could be ascribed to the cumulative effects of healthy fish habitats in all trout streams, this benefit would not likely result in significant benefits attributable to the alternatives under consideration.

According to Randall and Stoll, 1983, "**Option value** is applied to circumstances in which individuals may be willing to pay a premium to ensure the future availability of an amenity. This scenario, in which significant option value emerges for environmental amenities, is analogous to purchase options in real estate and financial instruments." [36] In the case of the NFFR flow alternatives, no future options are being precluded by deciding on any of the alternatives.

"**Quasi-option value** concerns unique natural terrain, species and ecosystems, and their susceptibility to irreversible change. Some economists argue that a complete account of preservation benefits must include a benefit associated with the possibility that future discoveries will make the fragile natural resource more or less valuable than they seem to be now."[37] Again, while this might have been a consideration when the dams were first built, there are not likely any unique values which will be irreversibly affect by the flow alternatives.

Bequest value refers to actions which might preclude the present generation from passing on uniquely valuable natural resources to future generations. Again, this might have been a consideration when the dams were first built, but does not apply among the possible alternatives in relicensing.

In conclusion, there do not seem to be any significant changes in non-use values under any of the scenarios under consideration.

[36] Braden and Kolstad, 1991, page 303.

[37] Ibid., page 304.

2.4 Local Expenditures Related to Use of the Project Area

Higher flows would undoubtedly have the effect of bringing additional visitors to the region surrounding the project area. These visitors will spend money in the local economy. While this is of some importance to local business which might profit from this additional trade, it is not appropriate to include these expenditure in a cost-benefit analysis which encompasses the entire U.S. These expenditure are transfer payments. If the travel dollars were not spent in the project area, they would be spent on travel elsewhere or on non-travel related goods and services. From a national or even a state perspective, it is merely shifting economic activity from one pocket to another. This accounting stance is consistent with the federal standards for evaluating water resource studies. [38]

Even from the local perspective, it would be appropriate to consider only the part of the expenditure which remain in the area as profits or wages. Thus only a percentage of the expenditure ultimately matter to the local area.

38 U. S. Water Resource Council, 1983.

3.0 Costs of Flow Alternatives

The benefits of Alternative flow modifications have their corresponding costs. These costs fall into three categories:

- Foregone Power
- Environmental Externalities
- Capital and operating costs

These three cost categories and the estimates of their values are discussed in sections 3.1, 3.2, and 3.3, respectively. Section 3.4 deals with the costs associated with providing whitewater boating flows.

3.1 Foregone Power

When the decision is made to by-pass some or all of the water which has been previously diverted, this water is lost to power generation and is instead put to recreational and environmental uses. By allocating this water for non-power uses, electricity generation is reduced. There is a cost to replace this foregone power. The replacement power cost can be obtained from the price that is published by the California Power Exchange (PX). The price at which electricity is sold is specified on an hourly basis. This value is ideal for determining the replacement power cost of foregone generation, since it is objectively established by a free market. During the first year of PX operation the prices ranged from zero during some nighttime hours in the spring to over $180 per megawatt-hour during some peak summer hours.

PG&E calculated the amount of hydropower which would be reduced by modeling the operation of the Rock Creek-Cresta Project under the changed conditions and comparing these to operation under the existing conditions. This foregone energy is based on a long-term average hydrology. Using actual 1998 PX prices, PG&E calculated the value of foregone energy under each of the scenarios..[39] The foregone energy revenue that would result from increasing minimum instream flows over existing conditions as calculated by PG&E's model is shown in Table 3.1.

[39]The year for which price are available, 1998 was actually an above average hydrology (wet) year. However, this would cause PX prices to be lower than they would be during a normal year, and thus understates foregone power cost.

Table 3-1
Costs for Flow and Temperature Modification Scenarios

Flow Alternative	Av. Annual CFS By-Passed /1	Generation	Change in Generation vs. Existing	Avg. Value per Lost mWh	Value of Lost Generation	Environmental Externality Cost	Capital & Operating Cost\4	Total Cost
	CFS	gWh/yr	gWh/yr	$/mWh	Thousand 1998$\2			
Existing Flow	67	863.8	0.0	0	$0.0	$0.0	$8.8	$8.8
Decreased Temp	67	863.8	0.0	0	$0.0	$0.0	$750.0	$750.0
1991 Agreement	119	838.3	25.5	$43.94	$1,122.7	$143.0	$41.3	$1,307.0
1991 Agree+Temp	119	838.3	25.5	$43.94	$1,122.7	$143.0	$791.3	$2,057.0
CDFG Recomend	293	780.3	83.5	$29.99	$2,504.6	$467.4	$0.0	$2,972.0
800 cfs\3	5.6	860	3.6	$32.39	$116.9	$20.2	$0.0	$137.1
1200 cfs\3	9.7	856	7.7	$30.73	$237.9	$43.3	$0.0	$281.2
1600 cfs\3	15.0	852	11.9	$33.64	$399.7	$66.5	$0.0	$466.2

Source: Power values and lost generation--PG&E. Other computations by Resource Decisions.

Notes:
1. **Based on a normal rainfall year.**
2. **Based on the 1998 published California PX prices.**
3. **Based on one weekend with specified flows for each month April to September.**
4. **Based on $1.67 per stocked fish (Loomis & Fix, 1999) and 5,275 fish per year under Existing Scenario and 30,000 fish per year under 1991 Agreement scenarios.**

PG&E's model calculates the impacts of various instream flow requirements using a theoretical power model, and hydro power value program. The Power model can be described in two general sections; the powerhouse performance section, and the hydrological and powerhouse operation simulation section. In the powerhouse performance section, the powerhouse output vs. flow relationship, or duty curve, is developed for the entire operating range of the facility. This reflects the relationship between powerhouse output, powerhouse flow, net head, and turbine and generator efficiency for each unit in the powerhouse. The powerhouse performance parameters are consistently used for the various instream flow and powerhouse operation alternatives studied.

The bulk of the power model contains the hydrologic data and powerhouse operation simulation. Long term theoretical flow data is used to represent the amount of water available at the project. The theoretical monthly flow data is based on historical flow records that are adjusted to reflect the current operation and facilities of the watershed. The theoretical available flow data is consistently used for all alternatives.

The variables in the model include the instream flow requirements, the flow capacity of the powerhouse, the type of powerhouse operation (base loaded or peaked), and if peaked, the typical peaking operation patterns. Instream flow requirements are modeled as releases from the forebay that bypass the powerhouse, and are specified by month. The flow capacity of the powerhouse is the maximum amount of flow that can pass through the powerhouse to generate electricity; flow in excess of this capacity is spilled from the forebay. If the powerhouse operation is specified as peaked, the monthly powerhouse flow is allocated into "blocks" to simulate the peaking operation. The average monthly flow is used to simulate the powerhouse flow for base-loaded projects.

The value of energy is based on the historic hourly energy prices from the PX's first year of operation (April 1998 through March 1999). These hourly PX prices are correlated to project specific generation patterns to estimate the overall value of energy from a specific project. A significant parameter that impacts the value of a hydroelectric project is how the project is operated. Hydro projects can be operated as base-loaded or peaking resources. Base-loaded hydro resources that cannot re-regulate the flow of water through the powerhouse to match system demands, receive lower energy values since they displace lower cost resources which operate 24 hours a day. Peaking powerhouses, which have the capability to match output with the system demands, displace higher cost resources during the peak periods of the day and, thus, receiver higher energy values. The energy values of a peaking resource increase as the capacity factor decreases. The Rock Creek - Cresta Project typically operates in a peaking mode.

With this disaggregation of power values, it is possible to more accurately estimate the value of a flow scenarios. The resulting foregone energy revenue not only captures the daily time of use variations in power values, but it also captures the seasonal and hydrological year type variations as well. This seasonal differentiation is particularly useful when estimating the costs of instream flows that vary from month to month, and year to year (normal year vs. dry year criteria).

For recreation flows, a recommendation does not exist on what level of flows would be appropriate. To consider the value of foregone energy from possible recreational releases, various flow levels were studied by PG&E using its operations model. Table 3.2 (on page 35) shows the value of foregone energy in providing a single weekend release (two days) with ramp-up and ramp-down, during each month April through September. As can be seem, the value varies widely from the spring when natural spill is often available and the value of energy is low to summer when spill no longer occurs and the value of energy is very high.

Under normal conditions, the flow in the NFFR between the Rock Creek intake and the Cresta power house averages 67 cfs under the Existing Conditions scenario. Under the 1991 Agreement scenario, the average annual flow would be 119 cfs, while under the CDFG scenario average annual flows through the entire diverted reach would average 293 cfs.

3.2 Environmental Externalities

In addition to the foregone power values describe above there is an addition cost associated with the decision to bypass generation. These are the environmental externalities of alternative generation. During bypass, other generation resources must be called upon to provide the power which would otherwise have come from hydroelectric generation. Most often this substitute power is obtained by fossil-fueled generation. These substitute sources create more pollution than the foregone hydroelectric power, which creates no air pollution. Because these cost are outside of the producer's normal decision process, they are termed "externalities. The cost which pollution imposes on society is termed an "environmental externality".

This section briefly summarizes the results of a study to determine the economic value of the environmental externalities associated with bypassing generation facilities on the North Fork of the Feather River in Northern California. This report, which describes the data sources, assumptions and methods used to derive this estimate is included as Appendix A.

Although many assumptions had to be made to derive this estimate, it is believed to be a good approximation of the true costs to society. To estimate the externality cost, it was necessary to determine what the substitute resource would be, how much pollution it would emit, and what the damage from this emission would be. Fortunately, the California Energy Commission (CEC) has recently published the methods and results of a major effort to place a value on air quality[40]. This report provided data on emissions by generic power plant type. The substitute resource for replacing the foregone power resource was determined from an unpublished data set used to support the 1996 Energy Report.[41] The damage associated with each pound of pollution in

[40] RER, 1994.

[41] Jerry Green, CEC Analysis Division, personal communication to M. Feldman, 4/99 ELFIN, an electricity planning model developed by the Environmental Defense Fund was used for this purpose. Part of the output of Elfin includes the percentage of time during the specified year that each generating unit is on the margin. The analysis relied on an unpublished data set of

California was established by the California State Legislature. These damage estimates are binding on the California Public Utilities Commission (CPUC).[42]

Based on these source, Resource Decisions estimates that each megawatt-hour of foregone generation imposes an externality cost of $5.60 on society. This value was used in the estimates of externality costs in Table 3-1.

3.3 Capital and Operating Costs

Certain scenarios involve capital an operating costs which must be factored in the cost analysis. These costs are incurred due to fish stocking and, in the Temperature modification scenarios, capital and operating costs.

Fish stocking averaged 5275 fish in the two reservoirs over the baseline survey period (1981-1985)[43] . These are adult catchable fish. The cost per fish stocked is $1.67[44]. On this basis, the Existing conditions scenario costs $8.8 thousand per year. Under the 1991 Agreement scenarios 30,000 fish will be stocked, at an annual cost of $41 thousand.

The Temperature Modification scenarios involve both capital and operating costs. Based on estimates for a Prattville temperature modification project, capital costs are estimated by PG&E to be roughly $5 million. Based on the FERC methodology of capitalizing costs at an annual 10% of capital costs, the annualized capital costs would be $500,000. In addition, costs for operating the temperature modification facilities are estimated by PG&E to be 5% of the initial capital cost, i.e.$250 thousand per year, for a total annualized cost of $750,000.

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an ELFIN run used to support the CEC ER-94.

[42]Based on the values per ton mandated by the California State Legislature (binding on CPUC, PRC Section 25000.1(c)). Reported in Lee and Stevenson, 1994, Table 1.

43 Personal communication G. Geary, PG&E, 1999.
44 Loomis and Fix, 1999.

3.4 Costs of Providing Whitewater Boating Flows

Whitewater boating flows are a special case because they require especially high flows. In order to present the most realistic scenario, the cost of providing these flows is presented on a weekend "event" basis. An event is defined a s a weekend in which the specified flows are provided from 9:00 AM to 4:00 PM on both Saturday and Sunday. By modeling only these periods we limit the cost of the scenarios. However, for safety reasons, the flows cannot be raised instantaneously, but must be ramped up at a rate of 200 cfs per hour. The costs for foregone power generation for the ramp up and ramp down periods, as well as the specified flow periods are included in the cost.

Costs for providing boating flows vary greatly by month for two reasons. First, in April and May, by-pass flows are normally high because of spring run-off. The normal by-pass flows are not counted against the cost of providing boating flows. Second, the California Power Exchange price varies greatly by month. Exchange prices are lower in early spring months when hydroelectric power is plentiful and system loads are relatively low. In the late summer months Exchange prices are high due to low hydroelectric power availability and high loads. These factors are reflected in Table 3-2 which breaks out the costs of providing boating flows by month.

Table 3-2
Cost For Whitewater Boating Flow (Per Weekend Event)
(Thousand 1998 $ excluding externalities)

Scenario (cfs)	April	May	June	July	August	Sept	Total
800	$0.0	$0.2	$9.1	$37.6	$36.5	$33.5	$116.9
1200	$5.9	$3.4	$20.2	$72.8	$70.7	$64.9	$237.9
1600	$17.4	$8.4	$35.3	$118.3	$114.8	$105.4	$399.7

Whitewater By-pass Flow Scenarios: Foregone Generation: per weekend event

Scenario (cfs)	mWh April	May	June	July	August	Sept	Total
800	0	20	590	1,000	1,000	1,000	3,610
1200	250	380	1,320	1,930	1,930	1,930	7,740
1600	800	980	2,300	3,200	3,200	1,400	11,880

Source: Power values and lost generation-PG&E.
Notes:
1. Power values based on historic weekend on-peak prices from California's Power Exchange first year in operation (April 1998 to March 1999).
2. Specified flow provided from 9:00 AM to 4:00 PM on Saturday and Sunday.

4.0 Conclusions Summarizing Economic Estimates of Net Economic Value under Current and Alternative Conditions

We have described and estimated all quantitative aspects of costs and benefits of alternative flow scenarios for the Rock Creek and Cresta Reaches of the NFFR. When costs are compared to benefits, as seen in Table 4-1, the Existing Conditions scenario has the most favorable net benefits. For all other scenarios which involve addition in-stream flows to support recreation or habitat, costs are not commensurate with benefits.

This finding of no net benefits for additional instream flows can be explained by considering the nature of the resource. The costs of foregone power (in FERC's terminology the "power benefits") are quite high. The hydraulic head is high which means that each cfs diverted has a high opportunity cost as lost energy. Specifically, each cubic-foot per second flowing through the turbines for one year yields over 500 mWh of energy. Furthermore, this energy is not uniformly distributed over the year, but can be used at times of peak demand, when energy prices are highest. These factors make the flow through the powerhouses especially valuable.

On the benefit side, recreational values associated with by-passed flows are significant but are not commensurate with foregone power costs. We have estimated fairly large benefits for angling and other water related activities due to increased flows, which are based on a very generous assessment of empirical data. We have not, however, ascribed value to the improved habitat per se. Non-use values for improved habitat are too small to be measurable within the range of alternatives under evaluation. Other beneficial water uses are already protected by the project's compliance with Clean Water Act.

Whitewater boating flows are possibly economic, depending on what month they are provided. In April and May, when the costs of providing these flows is low, it would appear beneficial to provide at least the 1200 cfs flows. However, this conclusion depends on the demand for the resource in these months being quite high. This assumption is questionable given the abundance of alternative whitewater recreation destinations in those months. Unfortunately, in August and September, when dearth of other destinations would make the NFFR attractive, the foregone power costs are much higher.

The 1991 Agreement scenario (without temperature modifications) appears to be the most cost-efficient alternative to Existing Conditions. To justify selecting this scenario on an economic basis, one would have to assume that there are about $260,000 in annual benefits which were not included in the instant estimate. For example, one could possibly ascribe this benefit to the existence of improve fish habitat that would occur as a result of this alternative.

The Temperature Modification proposal, does not come close to justifying its cost, as calculated by FERC methods. Whether it is considered as a self-standing option or in combination with the 1991 Agreement, or the CDFG proposal, the annual cost of $1.9 million is not a cost-effective way to spend ratepayers money.

Table 4-1:
Rock-Creek Cresta Project: Benefit-Cost Summary
(Thousand 1998 $)

	BENEFITS (non-power values)				COSTS (power values)				
Flow Alternative/4	**Stream +Reservoir Angling Improvement**	**Boating Improve-ment**	**Reservoir +Streamside Recreation Improvement**	**Benefit Change vs. Existing**	**Foregone Generation**	**Environ mental Externality**	**Annualized Capital + O&M/1,2,3**	**Cost Change vs. Existing**	**Net Benefit vs Existing**
Existing Conditions:	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0		$0.0	$0.0
Temp Modification	$15.9	$0.0	$0.0	$15.9	$0.0	$0.0	$750.0	$750.0	($734.1)
1991 Agreement	$538.4	$0.0	$23.0	$561.3	$1,122.7	$143.0	$41.3	$1,307.0	($745.6)
1991 Agree +Temp	$572.4	$0.0	$23.0	$595.4	$1,122.7	$143.0	$791.3	$2,057.0	($1,461.5)
CDFG Recommend	$1,148.1	$0.0	$151.1	$1,299.2	$2,504.6	$467.4		$2,972.0	($1,672.8)
800 cfs boating flows	$0.0	$8.8	$0.0	$8.8	$116.9	$20.2		$137.1	($128.3)
1200 cfs boating flows	$0.0	$26.5	$0.0	$26.5	$237.9	$43.3		$281.2	($254.7)
1600 cfs boating flows	$0.0	$53.0	$0.0	$53.0	$399.7	$66.5		$466.2	($413.1)

Notes:
1. Based on FERC methodology: Capitalized cost per year =10% of capital cost.
2. Assumes O&M = 5% of initial capital cost.
3. Initial capital cost of temperature modification improvements estimated by PG&E to be $5 million,
4. See Section 1.5 for the definition of the flow and temperature modification alternatives.

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Final Report:

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Pacific Gas & Electric Company
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Submitted by:
Marvin Feldman, Ph.D.

RESOURCE DECISIONS

934 Diamond Street
San Francisco CA 94114

415-282-5330

In Association with:

Prof. John Loomis
&
Water Resource Consultants

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