CLASSIFICATION

PROJECT EVALUATION SUMMARY (PES) – PART I

Report Symbol U-447

1. PROJECT TITLE	2. PROJECT NUMBER	3. MISSION/AID/W OFFICE
Mandara Mountains Water Resources	631-2012	USAID/Cameroon

4. EVALUATION NUMBER (Enter the number assigned by the Reporting Unit, e.g., Country or AID/W Administrative Code, Fiscal Year, Serial No. beginning with No. 1 for FY) 631-82-7

☐ REGULAR EVALUATION ☒ SPECIAL EVALUATION

5. KEY PROJECT IMPLEMENTATION DATES			6. ESTIMATED PROJECT FUNDING	7. PERIOD COVERED BY EVALUATION
A. First PRO AG or Equivalent	B. Final Obligation Expected	C. Final Input Delivery	A. Total $	From (month/yr.) September, 1980
FY 9/79	FY 10/82	FY 10/82	B. U.S. $ 4,950,000	To (month/yr.) May, 1982
				Date of Evaluation Review June, 1982

8. ACTION DECISIONS APPROVED BY MISSION OR AID/W OFFICE DIRECTOR

A. List decisions and/or unresolved issues, cite those items needing further study. (NOTE: Mission decisions which anticipate AID/W or regional office action should specify type of document, e.g., airgram, SPAR, PIO, which will present detailed request.)	B. NAME OF OFFICER RESPONSIBLE FOR ACTION	C. DATE ACTION TO BE COMPLETED
USAID/Cameroon must issue final PIL advising CURC that no additional financing will be available as of October 1982 and that project is terminated	Director	October 1982

INVENTORY OF DOCUMENTS TO BE REVISED PER ABOVE DECISIONS

- ☐ Project Paper
- ☐ Financial Plan
- ☐ Logical Framework
- ☐ Project Agreement
- ☐ Implementation Plan e.g., CPI Network
- ☐ PIO/T
- ☐ PIO/C
- ☐ PIO/P
- ☐ Other (Specify)
- ☐ Other (Specify)

9. ALTERNATIVE DECISIONS ON FUTURE OF PROJECT

A. ☐ Continue Project Without Change

B. ☐ Change Project Design and/or ☐ Change Implementation Plan

C. ☒ Discontinue Project

10. MISSION/AID/W OFFICE DIRECTOR APPROVAL

Signature

Typed Name Donald P. Levin

Date Oct 14, 1982

11. NAMES AND AGENCIES OF COUNTRY OR OTHER DONOR PARTICIPANTS (Indicate Host Country Participants)

Claudio Formanto, FDE
Randal Thompson, FDE
Gen Wickham, FSM
Janet Schulman, PDM
Robert Bartolo, Louis Berger International

Victor [illegible], Lamie Rural
Laurent [illegible], Lamie Rural

SUMMARY

The Mandara Mountains Water Resources Project (631-0012) proposed to construct 35 water catchment dams in the Mandara Mountains region of North Cameroon. The water collected in the reservoirs will be used to provide drinking water for the people of the region and their livestock. Women currently must walk distances of seven to ten kilometers one way to collect water. The project also proposed to transfer improved health practices through a health education component. Through a complementary project, the World Bank had proposed to construct 10 additional dams in the area.

The Project Agreement was signed on August 31, 1979 and the Project Assistance Completion Date established for December 31, 1982.

The Government of Cameroon contracted with Louis Berger International to complete technical studies for the dams and to supervise their construction. The technical studies were to include site reconnaissance, topographic survey, drawings/construction plans, hydraulic study, geotechnical study, dam design, bill of quantities, specifications and bid documents, and sanitation aspects. Construction supervision was to consist of quality and quantity control.

The World Bank succeeded in constructing four simple dams, but had inadequate funds to complete the remaining six, due to the fact that the dams were far more expensive to build than anticipated.

The Government of Cameroon appointed a Coordinating Committee to work with the GURC project coordinator in Mokolo, North Cameroon to oversee the project implementation.

In addition, a CARE health specialist working on the AID-funded CARE Margui-Wandala Water Supply Project (631-0025) was to direct the health education activities of the project in conjunction with those of the CARE project.

USAID/Cameroon began receiving feedback from Louis Berger International that the projected costs for the dams had been seriously underestimated by USAID. The original cost estimate for the 35 dams was $9,052,600. By early 1982, the revised cost estimate for just 12 of those dams had skyrocketed to $18,333,000. The drastic increase in costs prompted USAID/Cameroon to re-examine the project's economic viability.

This analysis, which follows as the body of this Project Evaluation Summary, shows that even under the most favorable assumption, the project would not produce any positive internal rate of return or efficiency. As a consequence, USAID/Cameroon has decided not to continue with the project.

MANDARA MOUNTAINS WATER RESOURCES PROJECT

631-0012

REVISED ECONOMIC ANALYSIS

MAY 28, 1982

EXECUTIVE SUMMARY

There have been major alterations in the project since it was approved in 1979. They have had the effect of increasing costs while simultaneously reducing benefits. As originally designed the cost of 35 dams was an estimated $9,052,600. The revised cost estimate for just 12 of those dams is now placed at $18,933,000. As noted below, the amount of water stored, together with the number of potential beneficiaries, has diminished more or less in proportion.

A COMPARISON OF THE MANDARA MOUNTAINS WATER RESOURCES PROJECT AS ORIGINALLY DESIGNED WITH PRESENT SITUATION

	A. Original	B. Present	C. B as a % of A
Number of Dams	35	12	34
Total Cost	$ 9,052,600	$18,933,020	209
Average Cost/Dam	$ 258,646	$ 1,577,752	610
Total Storage Capacity	1,546,400m^3	615,000m^3	40
Total Water Produced over 20-year period ..	16,634,000m^3	10,787,642m^3	65
Average Total Cost per m^3 over 20-year period ..	$ 0.65	$ 1.76	270
Number of Beneficiaries	102,000	28,998	28
Cost per Beneficiary ..	$ 107.43	$ 652.91	608

The magnitude of the changes is so great that it has prompted the following reexamination of the project's economic viability. The study has been carried out with the use of cost/benefit analysis. Both costs and benefits have been quantified by item and by year. It was assumed that the dams would last for 20 years. In those cases where the data did not permit quantification, values have been assigned on the basis of results obtained under similar conditions elsewhere. Wherever choice permitted, the values that were chosen were those that permitted the most favorable outcome for the project. The results obtained were then subjected to sensitivity testing to determine the possibility and probability of still more favorable results.

Costs

There are two kinds of costs associated with the project. The first deals with the project inputs. Since some expenditures will not be forthcoming for several more years, assumptions about future price movements had to be made. In order to do so, recent trends in and forecasts for the prices of inputs originating both within and without Cameroon were examined. Based upon the findings, it was assumed that prices for inputs from abroad would increase at an average annual rate of [illegible] percent while those of domestic origin would increase by 15 percent annually.

The other kinds of costs are those associated with the labor required by target area residents to obtain water and bring it back to their households. Since there is no charge for water obtained from present sources, virtually the only cost is the value placed on the time devoted by households to fetching it. Based upon recent surveys, the economic value of such labor is estimated at CFAF 100 per day.

Since the construction of reservoirs will place an estimated 4,940 households, or 29,000 individuals, closer to a permanent source of potable water, the project paper reasoned that a significant amount of the labor devoted to fetching water would be saved. The value of the labor savings can be estimated at $170,645 per year.

This level of labor savings will only exist, however, if target area beneficiaries do not increase the amount of water that they consume. Yet, unless area residents increase the quantity of water consumed by a very substantial margin, the cost of producing each cubic meter of water that is consumed as a result of the project will far exceed the value of the savings in time to labor. At present levels of consumption, approximately 27 per cent of the total volume of water impounded by the 12 reservoirs during their 20-year project life would actually be used by the beneficiaries. The average cost to the people of Cameroon for each cubic meter of water consumed from the reservoirs during this period would be $5.70. By any standard of comparison, this figure appears to be relatively high. The World Bank, for example, estimated the cost per cubic meter for a large Asian city at 22.38 U.S. cents. The uniform charge levied in Cameroon's urban centers is approximately 37 U.S. cents.

To produce a result more favorable to the project, the analysis assumes that the volume of water consumed as a result of the project will double to 53 percent of the reservoirs' capacity. At this level the average cost per cubic meter consumed declines to $2.30. The savings to labor from the closer proximity of the dams no longer exists, however. Instead, as the consumption of water doubles, the former $170,645 savings turns into a net annual deficit of $287,390 as households add more labor to obtain the additional water.

Benefits

There are three benefits that will result from the project. They are (1) a sizeable increase in the supply of water, (2) improved health and labor productivity, and (3) increased agricultural and livestock production.

The first benefit, the increase in the supply of water, presents the most serious methodological difficulties. What is the value of the water produced by the project? Ideally, according to economic theory texts, it is the marginal, or additional cost of producing one additional unit of water. The project, however, consists of dams whose dimensions are determined by technical considerations. They will impound considerably more water than target area beneficiaries are likely to use, even if generous allowances are made for loss through evaporation and seepage. The realities of the project, in other words, do not correspond at all well with the abstract neatness and precision of economic theory.

Under the circumstances, the analysis assumes that the marginal cost, or value of the water is equal to the average total cost per cubic meter of useable water produced by the project. The figure was obtained by assuming that 70 percent of the 12,500,000 m^3 produced by the project, or 8,510,000 m^3, will be useable. The remainder will be lost through evaporation or seepage. By dividing the total amount of the remaining, or useable water into the total cost of the project, an average total cost of $2.20 per cubic meter is obtained.

Another obvious benefit resulting from the project is the improved health and labor productivity of beneficiaries. The incidence of diarrhea is a leading cause of death for the 42 percent of the children five years old or younger who die in the target area. The increased availability of potable water will have positive effects upon health and labor productivity. Those effects cannot be meaningfully quantified, however. There is simply no way of knowing what diseases will be reduced, or by how much. As a consequence, it was arbitrarily assumed that health and labor benefits will equal 20 percent of all other project benefits combined. At this level such benefits amount to approximately seven dollars per person per year in the target area. This the equivalent of 14 percent of the target beneficiaries' annual per capita income of $51.

The remaining category of benefits deals with increases in agricultural and livestock production. Judging from most evaluations of rural water projects in the Third World, these are frequently the most tangible, easily quantified benefits resulting from such projects. Recent research in the area indicates that the present project should be no exception. Given the differences in terrain, soil type, crops grown, patterns of ownership of farm animals and so forth the magnitude of the potential increases cannot be quantified. Instead, it has been assumed that such benefits will directly increase cash incomes by an average of 15 percent annually. The present average annual cash income per household will increase to CFAF 103,500 as a result of the project.

Results

Given the preceding assumptions, the internal rate of return, or efficiency of the project, is zero. Sensitivity testing disclosed that in order to produce a rate of return of 15 percent benefits would have to increase by 330 percent. In view of the results obtained from similar projects elsewhere, it is unlikely that such a high level of benefits will be forthcoming. Indeed, in view of the rather favorable assumptions initially made, the project will probably do well to produce the volume of benefits projected. The project is thus an inefficient use of AID and Government of Cameroon resources.

MANDARA MOUNTAINS WATER RESOURCES PROJECT
631-0012

Economic Analysis

I. Introduction

Major alterations have occurred in the project since it was approved in 1979. Most notable among them, from an economist's perspective, is a very significant increase in costs coupled with an equally significant decrease in benefits. As originally designed the cost of 35 dams was an estimated $9,052,600. The revised cost estimate for just 12 of those dams is now placed at $18,933,020. As noted in Table I, the amount of water stored, together with the number of potential beneficiaries, has diminished more or less in proportion

The magnitude of the changes is so great that it has prompted the following analysis of the project's economic viability. The analysis will demonstrate that there is no reasonable basis for assuming that the project will have an acceptable rate of return.

TABLE I
A COMPARISON OF THE MANDARA MOUNTAINS WATER RESOURCES PROJECT AS ORIGINALLY DESIGNED WITH PRESENT SITUATION

	A. Original	B. Present	C. B as a % of A
Number of Dams	35	12	34
Total Cost	$ 9,052,600	$ 18,933,020	209
Average Cost/Dam	$ 258,645	$ 1,577,752	610
Total Storage Capacity	1,546,400m^3	615,000m^3	40
Total Water Produced over 20-year period ..	16,634,000m^3	10,787,642m^3	65
Average Total Cost per m^3 over 20-year period	$ 0.65	$ 1.76	270
Number of Beneficiaries	102,000	28,998	28
Cost per Beneficiary ..	$ 107.43	$ 652.91	608

TABLE II
A. BASIC ECONOMIC DATA FOR TWELVE DAMS

Dam No.	Construction Costs ($000)	Dam Capacity m^3	No. of Beneficiaries	Cost/ Beneficiary ($000)	Cost/m^3 ($000) *
19	841	36,000	2,055	409	1.15
22	1,026	79,700	5,107	201	.64
48	466	48,000	881	529	.49
55	573	52,800	1,233	424	.80
56	642	44,000	1,761	365	.73
64	822	46,700	2,465	333	.88

* Calculated by multiplying annual capacity for each dam by 20, the number of years of duration and dividing the result by the construction cost of the dam.

107	1,690	58,000	3,992	423	1.46
125	545	54,400	1,378	290	.50
128	1,135	28,400	1,174	967	.72
132	751	36,400	2,289	328	1.03
235	1,248	70,600	4,990	250	.88
141	745	29,400	1,174	653	1.27
Total	10,434	615,000	28,999	429.50	.93

Source: Engineering reports by Louis Berger Company.

B. CONSTRUCTION SCHEDULE

Assuming that construction may start at beginning of 1983, the following implementation schedule may be formulated (note that each "x" represents one month).

Dam No.	(1983) Year 4		(1984) Year 5		(1985) Year 6		(1986) Year 7		(1987) Year 8
19	xxxxxx	xx							
22	xxx	xx	xxxx						
48		xx	xxx						
55			xxxxxx						
56			xxxx	xxx					
64			xxxx	xxx	xxx				
107				xxx	xxxxxx	xxx	xxx		
125					xxxxx				
128					xxx	xxx	xxxxxx	xx	
132					x	xxx	xxxx		
135							xxx	xx	xxxxxxx
141							xx	xx	xxxxxx

II. Methodology

The economic evaluation of the project presented in the project paper made no attempt to quantify prospective benefits for a cost/benefit analysis. Instead, the project was justified on the methodologically less rigorous grounds of its cost effectiveness. The indicator of cost effectiveness that was employed was the average total cost of a cubic meter of water resulting from the project during a twenty-year period. No attempt was made to compare the figures obtained with those resulting from similar water systems undertaken elsewhere. Likewise, there was no examination of cost effectiveness of available alternatives for obtaining water under similar geographical or climitological conditions. The resulting analysis contained, in other words, only what was just marginally acceptable at the time.

In view of the very significant adverse movements in costs and benefits since the project was approved, USAID/Yaounde would be remiss in its implementation responsibilities if the project's economic feasibility were not reexamined.

Moreover, since the decision to proceed or halt implementation of the project may well depend upon the outcome of the analysis, the methodology employed should be as rigorous and as incontrovertible as possible. It is for this reason that a cost/benefit analysis has been undertaken. While there are many serious gaps in the data, the analysis has been facilitated by the detailed engineering surveys of the proposed dam sites that have been undertaken as part of the project. The surveys provide far more accurate estimates of prospective costs and benefits than those that were available to the project committee. The numerous and detailed socio-economic surveys of the target area that were undertaken by Michigan State University's Department of Agricultural Economics between 1979 and 1981 have also provided much useful data.[1]

III. Costs

As in the great majority of cases dealing with cost/benefit analysis, costs proved to be less difficult to estimate than benefits. In the majority of cases the original project inputs have been adjusted for the current and projected rate of inflation - 15 percent. Local currency costs have been converted to U.S. dollars at the prevailing exchange rate, which is much more favorable to the dollar than it was in 1979. Construction costs for each of the 12 dams appear in Table II. One of the reasons why they are substantially higher was the failure to include the cost of sand filters, together with the distribution systems. It was assumed that the prices of local inputs would continue to increase at the economy-wide average for 1981 of 15 percent throughout the four-year construction period. Inasmuch as the high annual rate of growth in the GDP projected through 1986 - between 6 and 7 percent annually - is expected to maintain strong upward pressure on prices, this assumption appears to be realistic. It may well prove to be on the conservative side.

Estimating the value of labor required to get the water and carry it back to the households proved to be somewhat difficult. One of the MSU surveys estimated the annual cash income for women in three target area villages at CFAF 1,500. This income underestimates the value of the women's activities, however. It excludes the labor devoted to the cultivation of crops that are consumed by the the household. If such activities are taken into account, the value of women's labor increases to an estimated CFAF 30,500 per year, or CFAF 100 per day. The latter figure is the equivalent of about 33 U.S. cents at present rates of exchange. It is the estimated value of what the labor devoted to fetching water would be worth if devoted to the highest paying alternative available. It can also be viewed as the opportunity cost of foregoing remunerative economic activities to fetch water.

Since labor alone is required to obtain water, once the value of labor together with the quantity of water consumed is determined, the value of a unit of water is also determined. Studies made by the Project Committee resulted in an estimated average annual consumption of water per household in the target area of 33 cubic meters. This figure amounts to about 90 liters per household

---

[1] Michigan State University/USAID. Mandara Mountains Research Reports Nos. 1-17, 1980-1981.

per day, or, at 5.27 persons per household, approximately 15.5 liters per person per day.[2] The amount of labor required to obtain that quantity was estimated in the Project Paper at an average of 1.5 persons per household per day. These figures imply that residents in the target area are implicitly paying a price for their water in terms of foregone economic opportunities for labor ranging from $4.81/m³ during the rainy season to $5.55/m³ during the extended 8-9 months dry season.[3] The figures exclude whatever additional costs are incurred for containers to carry the water in and the wear and tear on clothing and sandals from the long walks to and from present water sources. It is assumed, however, that such costs represent a relatively minor expenditure in comparison to the economic value of the time spent in carrying water.

According to the detailed reports of the 12 dam sites, an estimated 4,940 households will be close enough to them to benefit from their construction. With each household consuming an average of 33 m³ of water per year, the total amount of water presently consumed in the target area can be estimated at 163,020m³ per year. The value of labor required to obtain that amount of water would be equivalent to approximately $872,157 annually.[4]

At present levels of consumption of 163,020m³ per year, target area beneficiaries would be utilizing 27 percent of the estimated total annual storage capacity of the 12 dams, which is 615,000m³. The engineering reports for the dam sites estimate, however, that the demand for water will more or less double as a result of the project, to 66m³ per household. If so, the utilization rate of the stored water would double as well, to 53 percent of total capacity.

The capacity figure is itself somewhat misleading, however. Given the hundred plus degree temperatures that are characteristic of the target area, much of the stored water - the USAID Engineer estimates 20 percent - will evaporate before it can be used. In addition, there is bound to be some seepage

---

[2] About 5 liters per capita per day are necessary to sustain life, according to the WHO. Thus, it is doubtful that the 15.5 liter figure would permit much more than the water necessary for drinking, bathing, cooking and washing household utensils and clothing. cf. Robert J. Saunders and Jeremy J. Warford. Village Water Supply: Economics and Policy in the Developing World. Baltimore: Johns Hopkins University Press, 1976, pp. 43-44.

[3] Estimates derived as follows:
CFAF 150/day. 90 liters = CFAF 1,677 for 1,000 liters = 1m³ = $5.55/m³
CFAF 102/day. 90 liters = CFAF 1,444 for 1,000 liters = 1m³ = $4.81/m³
With labor valued at CFAF 100 per day and an average of 1.5 persons per day per household. The cost per household per day would be CFAF 150. With 3.75 hours per household per day of labor savings during the rainy season the cost per day would decline to CFAF 102.

[4] A weighted average obtained from $5.55 m³ for 245 days per year and $4.81 for the remaining 120. This is the average distribution of days for the dry and rainy seasons. Presumably, there will be no labor savings during the rainy season, as water is more accessible during this period.

of stored water into the ground. The rock bed is so broken in parts of the target area that two out of a total of four dams constructed there by the World Bank literally do not hold water. Despite the best efforts of project engineers to select sites that avoid problems of seepage, some water - at least 10 to 15 percent of the total stored - is found to be lost in this manner. Overall then, it is doubtful that more than 60 or 70 percent, perhaps even less, of the total volume of water stored by the dams could be effectively utilized by beneficiaries under the best of circumstances. Seen from this perspective, the 53 percent utilization rate that would result from a doubling of demand doesn't seem quite so low. Moreover, if, after an initial one hundred percent increase in the demand for water, there were to be an annual increase in demand of 1.5 percent per year thereafter, the utilization rate would stand at 78 percent of total water stored by the time that the dams terminate their useful economic life 20 years hence. As noted previously, the 78 percent figure is well in excess of the estimated 65-70 percent of total useable storage capacity.

How realistic is the project engineer's assumption that the demand for water will double? Let us investigate the project's design to at least make clear the implications of such an assumption. The reservoirs created by the dams will result in a year-round source of potable water where only an occasional, or rainy season, source was available previously. Given the target area's relatively high population density, the reservoirs will unquestionably result in sizeable numbers of people being closer to a year-round source of potable water than previously. Nonetheless, the project will not result in house, or even neighborhood connections. Instead, those who carry water must go to standposts located below the dams. Beneficiaries may be expected to act in any one of three ways. Under the first alternative, or alternative A, they would continue to consume the same amount of water as before. The time saved in fetching water, about 7 hours 45 minutes per day per household on the average, could be divided between work and leisure as the beneficiaries see fit. Under a second alternative, or B, the household would continue to devote the same amount of time as previously to fetching water. Since the source is now closer, however, household members can make more trips than previously in the same amount of time. As a consequence, they can now obtain approximately 111 liters per day as opposed to the former 36. This alternative would raise average household consumption from 37 to 17m³ annually without any additional time devoted to labor. It would increase total annual consumption in the target area to 212,420m³. The third alternative C, would require that households be willing to increase the amount of time devoted to water collection from 1.5 to 2.5 persons per household in order to double the consumption of water.

Between the three alternatives, there is little evidence to indicate which the behaviour of the target area beneficiaries would most likely approximate. There are obviously examples of all three types of response in the literature on village water supply.[5] Some combination of alternatives A and B, in which the household would have both more leisure and more potable water would certainly seem to be plausible. Likewise, alternative B, in which the household maintains a constant level of work for substantially more water,

---

[5] Cf. extensive bibliography in Saunders and Warford Village Water Supply, pp. 241-261.

also seems to be a distinct possibility. Perhaps the last of the three, alternative C, is the least plausible. Why would the household want to devote relatively more of its manpower than before to fetching water precisely at the moment when water becomes more accessible than it ever has? The spread of garden plots and an increase in the number of farm animals, a common result of water projects with house connections, is certainly one possible answer.

While alternative C may not seem quite as plausible as either of the others, or some combination of them, this analysis has nonetheless assumed that project beneficiaries will, in fact, conform to the pattern of behavior suggested in C. The reason that it has done so is that that alternative is the most economically efficient of the three. The additional water requires that the household forgo other productive alternatives available to its members, but the additional effort is worth it. For, by increasing the amount of labor used for obtaining water by 40 percent, i.e., 2.5 persons per day as opposed to 1.5, the quantity of water available for consumption increases by 100 percent - from 53 to [illegible] per year. Moreover, the greater the number of cubic meters of water consumed as a result of the project, the lower is the average cost of each cubic meter produced. To the extent that project beneficiaries' behavior conforms more to alternatives A and B than to alternative C, costs increase relative to benefits and the project's internal rate of return declines.

One important consequence of assuming that project beneficiaries' behavior will conform to alternative C is that in net terms there is no labor savings. The Project Paper made much of such savings. They were estimated at 2 1/2 hours per day for women and children living within 2.5 kilometers of the dams and at 2 hours per day for those living between 2.5 and 5 kilometers away. If each of the 4,940 households in the target area is assumed to have 1 1/2 women and children per day engaged in this activity, the labor savings can be calculated as follows in alternative A:

I. ALTERNATIVE A

	Distance from Dams		
	0 to 2.5 km	2.5 to 5.0 km	Total
1. Number of carriers (4.940 x 1.5)	4,965	2,445	7,410
2. Cost of labor/day	$ 1,653	$ 815	2,468
3. Cost of labor/year (305 days)	$ 534,147	$ 238,394	$ 872,157
4. Hours saved/day	2.5	2.0	-
5. Total hours saved/day	12,413	4,890	17,293
6. Total 8 hours work days saved	1,552	611	2,163
7. Labor savings/day	$ 517	$ 204	$ 721
8. Labor savings/year (245 days)	$ 126,665	$ 49,980	$ 176,645
9. Net cost of labor/day (No. 2-No.7)	$ 1,136	$ 611	$ 1,747
10. Net cost of labor/year (No.3-No.8)	$ 407,482	$ 238,414	$ 695,596

II. ALTERNATIVE C

	Distance from Dams		
	0 to 2.5 km	2.5 to 5.0 km	Total
1. Number of carriers (4,940 x 2.5)	8,275	4,075	12,350
2. Cost of labor/day	$ 2,736	$ 1,358	$ 4,116
3. Cost of labor/year (365 days)	$ 974,539	$ 479,858	$1,454,537
4. Hours saved daily	2.5	2.0	-
5. Total hours saved/day	20,688	8,150	28,838
6. Total 8 hour work days saved	2,586	1,019	3,605
7. Labor savings/day	$ 862	$ 340	$ 1,202
8. Labor savings/year (245 days)	$ 211,190	$ 83,300	$ 294,490
9. Net cost of labor/day (No.2-No.7)	$ 1,876	$ 1,018	$ 2,914
10. Net cost of labor/year (No.3-No.8)	$ 763,449	$ 396,558	$1,160,047

Alternative A accurately reflects the assumptions previously made for it. It calculates the amount and the value of labor savings as a result of the project. The initial situation without the project is set forth in line items 1 through 3. The total value of labor per year presently devoted to the transport of water is $974,539. As a result of the project, on the other hand, only $693,349 worth of labor has to be used for the transport of water. There is thus a total of 2,165 person days of labor saved as a result of the closer proximity of the 12 reservoirs to the target group. The value of the savings is the difference between the two figures, or $176,845 per year.

With alternative C, however, the net savings in labor disappears. Despite the fact that adding one additional laborer from each household increased the number of days of labor saved from 2,162 to 3,605, the net cost of the additional labor required rises to $1,160,047. The net labor savings of $176,845 in alternative A becomes a net deficit of $287,[illegible] under alternative C.[6] This figure is added on as a project cost for each year of the project life between the completion of the 12 dams and their exhaustion 20 years later. The quantity of water available for consumption, however, doubles in the process - from 33 to 66m³.

IV. Benefits

Of the numerous potential benefits resulting from water projects the analysis was able to identify three that are especially applicable to the project in question. These are (1) a sizeable increase in the supply of water, (2) improved health and labor productivity, and (3) increased agricultural and livestock production. In addition, there are several other benefits which may have an impact upon the project, but whose effect is impossible to evaluate. This group includes such factors as the project's potential impact upon the rate of population growth, rural to urban drift, or the target area's long run ability to develop commercially and industrially. Each shall be considered below.

---

[6] That is, $1,160,047 - $872,107 = $287,940.

A. Increase in the Supply of Water

The project's purpose is to increase the supply of water for household use in one of the most arid areas of Cameroon. As noted earlier, consumption in the target area is now estimated at approximately 163,000m³ per year. If properly managed, the water's quality will also be markedly improved. Moreover, it will be more easily accessible for many, especially during the dry season.

Under ordinary circumstances, the economic evaluation of a prospective project considers only the marginal increase in output attributable to that particular project. In the present instance, that would entail subtracting the 163,000m³ of water already being consumed in the target area from the total amount that will be produced and consumed as a result of the project. An interesting question arises at this point, however. Namely, is the water that will be produced as a result of the project the same as that which is currently being consumed? As the project is designed, the answer should be no. The project contemplates going to great lengths and extraordinary expense to ensure that the water delivered is of a high standard of purity. In addition, the project includes a health education component designed to ensure that the pure water is handled in such a way by beneficiaries that it does not become contaminated before final use. To the extent that the measures are successful the water resulting from the project will indeed be qualitatively superior to the great majority of that presently being consumed. It should be noted, however, that achievement and maintenance of the desired level of purity will not be an easy task. The sand filters which have been designed for the distribution systems require daily maintenance. Despite barriers of thornbrush and cactus, it may prove difficult to prevent people and livestock from contaminating the reservoirs. Nonetheless, to give the project the benefit of the doubt, the cost benefit calculations do assume that the water resulting from the project is qualitatively different from the water that is being consumed now.

As envisaged in the project paper, the reservoirs were to provide a source of potable water during the dry season. Because of the improved quality of the water in the reservoirs, however, project beneficiaries should use the water stored in them on a year-round basis. This implies that beneficiaries should continue to use the reservoirs as their source of water, even if more convenient sources are available during the rainy season. The water table is relatively high during this period. Water from dug wells effectively does not undergo sufficient filtration to remove pathogens resulting in diarrhea or other more serious water borne diseases.[3] For this reason, it is assumed that

---

[illegible] It should be noted that local officials in target area are of the [illegible] opinion that there are no problems [illegible] water borne diseases. [illegible] they are [illegible] the reservoirs [illegible].

[3] David Pearce et al. [illegible] Water Supply and Health in the Tropics [illegible] Report No. [illegible].

the reservoirs will provide the sole source of water for the inhabitants of the target area affected by the dams.

Placing a monetary value on the water produced presents enormous problems. Theoretically, the value which should be assigned is the marginal, or additional cost of producing the additional unit of water. This changes considerably from one dam to another, however. Some are more isolated than others, some have greater storage potential than others, and some cost more to build. Then too, by their very nature, the dams represent very "lumpy" investments. By this is meant that it is not possible to construct a dam to store one cubic meter of water, then modify it so that it can hold two, then three, and so forth. This is precisely what would be required in order to obtain the marginal cost of each additional cubic meter of water produced, however. Then too, when the construction of a dam results in the storage of a larger quantity of water than can be consumed, as is the case with the present project, the marginal cost of producing one additional cubic meter approaches zero.

Owing to such problems of definition and measurement, the following assumptions were made in assigning a value to the water produced by the project. Since there is no a priori reason to believe that the construction of small dams as a method of obtaining water is subject to significant economies or diseconomies of scale, it was assumed that each additional cubic meter of water can be produced at the same average total cost as the preceding one. If average total costs are constant over the range of output considered by the project, then the marginal cost of producing an additional cubic meter is equal to the average total cost. The average total cost of output of useable water over the economic life of the project - 8,610,000m^3 divided into the total cost of producing it - $18,[illegible],[illegible], results in a value of $2.20 per m^3. This is the value that has been assigned to each m^3 of water resulting from the project.[9] The opportunity cost of labor required to obtain it, other than that resulting directly from the project, is not included. That amount of labor would be forthcoming whether or not the project was undertaken. It thus does not arise as a result of the project and should not be included as a cost of the project.

It should be noted that this figure is the estimated value of water, whether public authorities levy a charge equivalent to that amount or not. Owing to the extreme poverty of the area, the $2.20 per cublic meter price would obviously be prohibitive. Assuming that each household consumes 66m^3 per year, the annual water charge would be $[illegible]. With an average annual cash income of CFAF 90,000, or $[illegible] per year per household, the charge would consume 48 percent of the cash income of the household. Under such circumstances, the Government of Cameroon never intended to levy a charge on beneficiaries. Based upon experience elsewhere, however, a water charge, however low, may in the long run prove necessary. The experience of Kenya is instructive.

> "Kenya provides an interesting example of a case in which water vendors (water kiosk operators) in a number of rural villages

---

[9] The figures were derived as follows:
12,[illegible],000m^3, the total volume of water produced by the project, multiplied [illegible] percent, the amount estimated to be useable after account [illegible] evaporation and seepage, yields 8,[illegible],000m^3.

serve the multiple functions of limiting public tap water wastage, and of protecting the taps from vandalism. In several regions of the country, villagers had not been paying the small monthly tax which was to be used to help operate and maintain their local water supply systems. Furthermore, it was financially very costly and physically almost impossible to maintain many of the public standposts because of frequent acts of vandalism on taps, drainage facilities, protective fences, and so on. As a result, in a few areas the public standposts were converted to water vendor operations in which a licensed vendor is paid a subsidized rate for the metered standpost water and sells it by the container (debe) at a fee slightly higher than he pays. The difference between the kiosk operator's buying and selling price does not have to be large because most of the rural kiosks are operated by the wife or children of the vendor, and their opportunity cost is low. The result of the switch to kiosks is that vandalism has been greatly reduced (the tap and meter are locked up when not in use), a small amount of revenue has been generated, and the rate at which people have applied for house connections has increased. (Some people presumably feel that, if they are going to have to pay for water, it might as well be convenient water). A drawback to the system, however, is the inability of some kiosk operators to retain for any period of time the revenues collected from water sales, thereby forcing the authority to collect its sales revenues daily from the kiosk operators, a rather costly alternative."[10]

B. Improved Health and Labor Productivity

According to the MSU studies, 42 percent of all children in the target area die before reaching the age of five. Impure drinking water is considered to be an important contributing factor to the high infant mortality rate.[11] At any given moment the incidence at diarrhea is estimated at 37 percent. Water is believed to be the source of the diarrhea in "a good percentage of the cases".[12] In addition, the following water-vector-born diseases have been identified as prevalent in the target area: malaria, intestinal and urinary schistosomiasis, onchocerciasis, guinea worm (fracontiasis), bacillary dysentery and amoebic dysentery.

---

[10] Saundefs & Warford. Village Water Supply, pp. 174-175.

[11] David Trechter. Nutrition and Health during the Hungry Season in the Mandara Mountains [illegible], pp. [illegible].

[12] Trechter. Nutrition and Health in the Mandara Mountains, p. 26.

Assuming for the moment that the measures incorporated in the project design will in fact result in pure drinking water that is handled and stored correctly, it seems reasonable to believe that positive health and labor benefits will in fact occur.[13] It is always difficult to quantify and place a value upon such benefits, however. This is certainly true in the present case. There is no way of knowing which diseases will be reduced, or by how much. For reasons that will soon become clear, however, the analysis wished to bias the potential health and labor benefits which will result as much in favor of the project as possible. As a consequence, it was arbitrarily assumed that the monetary value of health benefits would be equal to 20 percent of all other project benefits combined. At this level, such benefits amount to approximately $200,000 annually, or seven dollars per person per year in the target area.

C. Increased Agricultural and Livestock Production

The increased production of agricultural commodities and livestock is a consistent finding of rural water project evaluations. Indeed, it is frequently the most tangible, easibly quantified benefit of such projects. There is every reason to believe that the present project will be no exception. Evidence from the MSU surveys indicates that sweet potatoes and Irish potatoes, for example, grow well in the few relatively well-watered places in the target area. These crops provide cultivators with cash incomes that are far in access of those derived from most other available alternatives.[14] Inasmuch as they are already part of the household economy, an expansion of small vegetable plots and the watering of stall fed livestock, especially cattle, also appear to be potential benefits of the increased availability of water.[15] Unfortunately, it is not possible to quantify the potential increase in agricultural and livestock production. There are simply too many differences in terrain, soil type, crops grown, patterns of ownership of farm animals, and so forth, to estimate with any degree of precision the changes that will be forthcoming as a result of the project. Instead, it has been assumed that benefits of this nature will directly increase the cash income of each household by an average of 15 percent. The MSU surveys estimated the present average annual cash income per household in the target area at CFAF 90,000. As a direct result of the project it would increase to CFAF 103,500.

Evaluations of rural water projects elsewhere have frequently noted superior increase in agricultural and livestock production. It must be kept in mind that in the project at hand beneficiaries will still have to walk to the standposts located downstream from the dams in order to obtain their water.

---

[13] It should be noted that this is something of a heroic assumption, given the prevalence of water-born diseases in the area, the impossibility of preventing the reservoirs from becoming contaminated and the necessity of keeping the sand filters impeccably maintained.

[14] Tom Zalla, et al. Agricultural Production Potential in the Mandara Mountains in Northern Cameroon. Michigan State University, 1981, p. 44.

[15] Zalla. Agricultural Production Potential, p. 44.

Under such circumstances, the 15 percent increase in cash incomes appears to be not only generous, but perhaps a bit ambitious. This is especially true when one considers that the majority of the increase in household production may well be consumed on the farm rather than sold.

D. Other Potential Benefits

There are a number of other benefits which have been identified as having positive effects upon other rural water projects elsewhere. As noted previously, these include such factors as reducing the rate of population growth, slowing down rural to urban drift and enhancing the area's long run ability to develop commercially and industrially. It is impossible to predict with any degree of certainty whether or not the present project will produce such benefits. It would also be extremely difficult to try to quantify them if they were found to exist. For these reasons, the analysis has assumed that the project will not result in any such benefits.

V. Results

Based upon the assumptions made for costs and benefits in the preceding sections, it is now possible to calculate the project's internal rate or return, or IRR. The IRR is the measure of economic efficiency preferred by AID and most other donor agencies. It has the distinct advantage of being the only measure of the rate of return that does not require the selection of a discount rate that is not in some sense arbitrary. Calculation of the internal rate of return involves nothing more than substracting annual costs from annual benefits for each year of the project's life. The resulting net benefit stream is then discounted. The discount rate which results in a net present worth of the benefit stream that is equal to zero is the internal rate of return.

Table IV contains the costs, benefits and calculations based upon the assumptions outlined previously. To recapitulate, they are outlined below:

Costs

- The annual increase in the price level will average 15 percent.
- The CFA franc exchange rate vis-à-vis the U.S. dollar will remain at its current level, i.e. $1 = CFAF 300. If it returns to customary level, costs in U.S. dollars will increase.
- All construction activities will be completed on time and within budget estimates.

Benefits

- Sand filters will be maintained on a daily basis.
- Reservoirs will not be contaminated and no seepage will occur that would have adverse health consequences.
- Water obtained from the project will be handled, stored and used correctly. That is, it will not become contaminated between standposts and final use.
- Water from project makes it a qualitatively different product than the water presently consumed.

- Evaporation and underground seepage will not exceed 35 percent of total annual storage capacity.
- The marginal cost of producing a cubic meter of water under the project equals the average total cost per meter of $2.20.
- Health benefits are equivalent to 20 percent of all other benefits combined.
- Increased agricultural and livestock production will raise the average annual cash income per household by 15 percent, or CFAF 13,500.
- Dams will have a useful economic life of 20 years with no scrap value thereafter.

Under this set of assumptions the internal rate of return cannot be calculated. The reason is that the stream of net benefits is negative for all possible discount rates. Hence, there is no IRR that can equate the present value of the prospective benefits with the additional costs for water resulting from the project. It should be kept in mind that every effort was made to assign the most realistic possible values to the various costs and benefits that the data permitted. When data did not permit a precise value to be assigned, a value was assumed that appeared to be both reasonable, and, at the same time, favorable to the project.

As a form of sensitivity testing, the analysis posed the question of by precisely how much benefits would have to be increased in order to arrive at an internal rate of return of 15 percent. Given our preceding assumptions, one can then observe whether or not it is likely that this minimum rate of return established by AID will be forthcoming. These calculations appear in Table IV. They disclose that total project benefits as estimated in the present analysis would have to increase by a factor of 3.3 in order to achieve an IRR of 15 percent. Such an increase would entail an across-the-board increase in the value of water, agriculture production and health benefits as a result of the project of 330 percent.

In view of the results obtained by other rural water projects elsewhere, and in the opinion of the USAID/Yaounde staff, it is highly unlikely that such increases will be forthcoming. Indeed, they will do well to reach the levels projected in our previous assumptions.

Under the circumstances, the probability of the project having a positive rate of return, much less the required 15 percent rate of return, appears to be highly unlikely. As such, it is not a wise use of either Agency or Government of Cameroon resources.

VI. Possible Alternatives

Accepting the fact that the dams represent an unwise use of public resources, both foreign and domestic, what are the alternatives? There are, after all, a great many poor people in the target area who face the prospect of remaining not only poor but thirsty as well if alternative sources of water are not forthcoming.

The present project was based upon the assumption that there were, in effect, virtually no practical alternatives to the dams. The assumption was based upon a UNDP sponsored study which concluded that given the geologic characteristics of the Mandara Mountains, wells alone cannot provide sufficient water for those who live there.

The engineering firm that contracted to do the detailed design of the dam sites cast doubt upon the conclusions reached by the UNDP study. In conversations with the USAID Engineer, the firm has stated that an appropriate analysis of aerial photographs will permit the location of numerous potential well sites. In view of the average cost of a dam of $1,577,752, it goes without saying that a number of deep wells - possibly as many as 20 - with solar powered pumps can be constructed and maintained at less cost. Less sophisticated and less expensive wells with wind or hand pumps may also be possible. Given the disappointing performance of the dams, this alternative merits further investigation.

TABLE III

MANDARA MOUNTAINS WATER RESOURCES
COSTS, BENEFITS AND INTERNAL RATE OF RETURN

	PY[1] 1979	PY[2] 1980	PY[3] 1981	PY[4] 1982	PY[5] 1983	PY[6] 1984	PY[7] 1985	PY[8] 1986	PY[9] 24 1987 2002	PY 25 2003	PY 26 2004	PY 27 2005	PY 28 2006
I. Without Project	PYs 1-28												
A. Costs													
1. Value of labor	872,157												
B. Benefits													
2. None	872,157												
II. With Project													
A. Costs													
1. Design and supervision	250,000	443,000	607,000	380,000	207,500	249,000	207,000	166,000					
2. Construction	40,000	60,000	60,000	1,805,000	2,802,000	2,810,000	2,435,200	1,041,500					
3. Technical assistance	45,000	70,000	97,000	115,000	115,000	115,000	115,000	50,000					
4. Commodities	12,000	93,000	35,000	18,000	100,000	50,000	25,000	10,000					
5. Health and nutrition				52,964	52,964	52,964	52,964	52,964					
6. Evaluation			20,000			20,000		25,000					
7. Recurrent costs					60,000	80,000	140,000	210,000	3,150,000	175,000	105,000	70,000	35,000
8. Incremental labor					74,851	97,883	138,187	210,160	4,318,350	221,675	201,523	166,976	106,519
Total Costs	347,000	666,000	799,000	2,370,964	3,362,315	3,474,847	3,133,351	1,765,624	7,468,350	396,675	306,523	236,976	141,519

	PY[1] 1979	PY[2] 1980	PY[3] 1981	PY[4] 1982	PY[5] 1983	PY[6] 1984	PY[7] 1985	PY[8] 1986	PY[9] 24 1987 2002	PY 25 2003	PY 26 2004	PY 27 2005	PY 28 2006
B. Benefits													
1. Water	-	-	-	-	125,525	210,882	235,987	336,403	7,531,515	436,828	256,072	135,567	90,378
2. Agr. Production	-	-	-	-	61,650	71,100	115,200	148,500	2,470,050	209,610	200,160	186,660	113,700
3. Health	-	-	-	-	37,435	56,396	70,237	96,982	2,000,313	129,288	91,246	64,445	40,828
Total Benefits	-	-	-	-	224,610	338,378	421,424	581,889	12,001,878	775,726	547,478	386,672	244,[illegible]6
Net Benefits	-347,000	-666,000	-799,000	-2,370,964	-3,137,705	-3,136,469	-2,711,927	-1,213,735	4,533,528	379,051	240,955	146,696	103,447

Internal Rate of Return = 0.00

TABLE IV

STREAM OF NET BENEFITS REQUIRED TO PRODUCE AN IRR OF 15 PERCENT

		PY 1979	PY 1980	PY 1981	PY 1982	PY 1983	PY 1984	PY 1985	PY 1986	PY 24 1987-2002	PY 25 2003	PY 26 2004	PY 27 2005	PY 2 2006
I.	Total Costs	347,000	666,000	799,000	2,370,964	3,362,315	3,474,547	3,133,351	1,765,624	7,468,350	396,675	306,523	236,976	141,5
II.	Total Benefits	-	-	-	-	660,618	995,229	1,239,482	1,711,438	35,299,641	2,281,547	1,610,229	1,137,271	720,4
III.	Net Benefits	-347,000	-666,000	-799,000	-2,370,964	-2,701,697	2,479,618	-1,893,869	- 54,186	27,831,291	1,884,872	1,303,706	900,295	578,9

Internal Rate of Return 15.0 Percent