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Report No. 8239

PROJECT COMPLETION REPORT

VIET NAM

DAU TIENG IRRIGATION PROJECT
(CREDIT 845-VN)

DECEMBER 11, 1989

Agriculture Operations Division
Country Department II
Asia Regional Office

CURRENCY EQUIVALENT1/
(Dong/US$)

1978-80	D2.17
1981	D4.35*
1982-84	D9.00
1985	D13.00*
1986	D30.00*
1987	D104.00*
1988	D740.00*

GLOSSARY OF ABBREVIATIONS

DCA	-	Development Credit Agreement
ERR	-	Economic Rate of Return
GON	-	Government of the Netherlands
GOV	-	Government of Viet Nam
HYV	-	High Yielding Variety
ICB	-	International Development Association
IDA	-	International Development Association
IDS	-	Institute of Design and Survey
MUV	-	Manufacturing Unit Value (Index)
MWR	-	Ministry of Water Resources
O&M	-	Operations and Maintenance
OPEC	-	Organization of Petroleum Exporting Countries
PAS	-	Provincial Agricultural Services
PCR	-	Project Completion Report
SAR	-	Staff Appraisal Report
SCR	-	Standard Conversion Factor

*Weighted Average
Source: Bank for Foreign Trade of Viet Nam.

1/ Official commercial exchange rate.

THE WORLD BANK
Washington, D C 20433
U S A

Office of Director-General
Operations Evaluation

December 11, 1989

MEMORANDUM TO THE EXECUTIVE DIRECTORS AND THE PRESIDENT

SUBJECT: Project Completion Report on Viet Nam Dau Tieng Irrigation Project (Credit 845-VN)

Attached, for information, is a copy of a report entitled "Project Completion Report on Viet Nam - Dau Tieng Irrigation Project (Credit 845-VN)" prepared by the Asia Regional Office. No audit of this project has been made by the Operations Evaluation Department at this time.

Attachment

PROJECT COMPLETION REPORT

VIET NAM
DAU TIENG IRRIGATION PROJECT
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PROJECT COMPLETION REPORT

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PREFACE

This is the Project Completion Report (PCR) for the Viet Nam Dau Tieng Irrigation Project, for which IDA Credit 845-VN of US$60 million was signed on August 24, 1978. The project was co-financed by an additional US$10 million equivalent each from the Kuwait Fund, OPEC and the Government of the Netherlands. Subsequently, in April 1984 the Kuwait Fund approved a supplemental US$20.4 million credit for the project. The IDA Credit Closing Date was extended twice from December 31, 1984 to December 31, 1986. The final disbursement was made on July 10, 1987, at which time a balance of US$303,008.53 equivalent was cancelled from the Credit account.

The PCR was prepared by FAO-CP on behalf of the Government of Viet Nam, on the basis of the Staff Appraisal Report and other project and credit documentation available in IDA files, as well as data received and discussions with the Government during an FAO-CP mission to Ho Chi Minh City and the project area in November/December 1988. The Evaluation Summary was prepared by IDA on the basis of an FAO-CP draft.

This PCR was read by the Operations Evaluation Department (OED). The draft PCR was sent to the Borrower and Cofinanciers for comments and they are attached to the Report.

PROJECT COMPLETION REPORT

VIET NAM
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(CREDIT 845-VN)

BASIC DATA SHEET

KEY PROJECT DATA

Item	Appraisal1/ Expectation	Actual or Current Estimate	Actual as % of Appraisal Estimate
Total Project Costs (US$ million)	110.0	124.1	113
Credit Amount (US$ million)	60.0	59.7	100
Co-financing-Total (US$ million)			
Kuwait Fund	10.02/	29.93/	299
OPEC	10.0	9.8	98
Kingdom of Netherlands	10.44/	8.05/	77
Date Physical Components Completed	December 1984	1990	
Economic Rate of Return			
Stage I	17%	4%	
Stage II & III	20%	7%	

CUMULATIVE ESTIMATED AND ACTUAL DISBURSEMENTS

	FY79	FY80	FY81	FY82	FY83	FY84	FY85	FY86	FY87	FY88
Appraisal Estimate (US$ million)	34.0	44.5	51.0	56.0	59.0	60.0				
Actual (US$ million)	0	24.5	31.1	34.9	38.6	44.4	50.7	57.4	59.6	59.7
Actual as % of Appraisal (%)	0	55	61	62	65	74	84	96	99	99.5
Date of Final Disbursement:	July 10, 1987									

PROJECT DATES

	Original Plan	Actual
First Mention in Files	6/77	
Negotiations	6/78	6/78
Board Approval	8/78	8/78
Signing (Credit Agreement Date)	8/78	8/78
Effectiveness	11/78	2/79
Closing Date	12/84	12/86

STAFF INPUTS
(staff weeks)

	FY78	FY79	FY80	FY81	FY82	FY83	FY84	FY85	FY86	FY87	FY88	TOTAL
Preappraisal	27.6											27.6
Appraisal	42.9											42.9
Negotiations	13.3	4.0										17.2
Supervision		15.0	36.5	21.9	12.8	28.4	32.8	20.8	7.1	6.2	7.9	189.3
Other	.6			.5								1.1
Subtotal	84.4	18.9	36.5	22.4	12.8	28.4	32.8	20.8	7.1	6.2	7.9	278.2

MISSION DATA

	Date (mo./yr.)	No. of Persons	Specializations6/ Represented	Performance Rating	Trend7/	Types of Problems8
Preparation	8-9/77	3	II			
Appraisal	1/78	6	EEIIAP			
Post-Appraisal						
Supervision 1	11/78	2	IP	2	2	F
Supervision 2	7/79	1	I	2	2	M
Supervision 3	11/79	1	I	2	1	M
Supervision 4	03-04/80	3	III	2	2	TM
Supervision 5	01-02/81	2+59/	II	2	2	MT
Supervision 6	05-06/81	1	I	3	3	MT
Supervision 7	01/82	1	I	3	2	MFT
Supervision 8	6-7/82	1+3	I	2	2	MT
Supervision 9	01/83	2+310/	IL	2	2	FMT
Supervision 10	06/83	3	IIA	2	2	FMT
Supervision 11	11/83	2	II	11/		
Supervision 12	01/84	3	IAP	2	1	FMT
Supervision 13	06/84	3	IAE	2	1	FMT
Supervision 14	11/84	3	IAI	2	1	T
Supervision 15	04/85	3	IAI	2	1	T
Supervision 16	11/85	2	AI	10/		
Supervision 17	06/86	1	A	10/		
Supervision 18	11/86	2	AI	10/		
Supervision 19	01/88	2				

1/ Includes physical contingencies and expected price increases.

2/ KD2.9 million.

3/ An additional agreement for KD6.0 million (approximately US$20.4 million) was signed on April 25, 1984. The total disbursed was KD8,756,000.

4/ DFI 22,357,500.

5/ DFI 17,946,149.

6/ I = Engineer; E = Economist; A = Agriculturalist; P = Procurement.

7/ 1 = improving; 2 = stationary; 3 = deteriorating.

8/ F = financial; M = managerial; T = technical.

9/ From Kuwait Arab Development Fund (KADF).

10/ From KADF (2) and Netherlands (1).

11/ Not reported.

PROJECT COMPLETION REPORT

VIET NAM
DAU TIENG IRRIGATION PROJECT
(CREDIT 845-VN)

EVALUATION SUMMARY

Introduction

1. The Project Completion Report (PCR) was prepared by the FAO/World Bank Cooperative Program (FAO-CP) on behalf of the Government of Viet Nam (GOV). It is based on data from the Borrower's Ministry of Water Resources (MWR), examination of the Staff Appraisal Report (SAR), Development Credit Agreement No. 845-VN, IDA supervision reports, and information obtained and discussions held during a mission to Ho Chi Minh City and the project area in November/December 1988.

2. Available data were provided freely to the mission, although these were not always complete. Agricultural data were particularly difficult to acquire. Records of local construction costs were presented by MWR in constant 1981 dong, but the mission was unable to analyze the original figures from which these were derived. Supervision missions had expressed frequent concerns that the quantity of fuel used was exceeding appraisal estimates; however, no means were found to verify the actual fuel used by the project. Finally, rapid inflation in Viet Nam and large disparities between official and unofficial exchange rates required some fairly fundamental assumptions to be made in order to re-estimate the ERR, as explained in the PCR.

3. The PCR mission was asked by IDA to pay particular attention to reservoir safety, and the Annex is therefore devoted to this topic.

Project Background

4. Dau Tieng Irrigation Project was conceived by GOV as part of its plan to achieve foodgrain self-sufficiency and to improve the lives of the working population. The project, which was to be the first stage of a proposed development of 172,000 ha of irrigation, comprised the construction of a dam to form a reservoir on the Saigon river and irrigation development of 42,000 ha, mainly for cultivation of rice and groundnuts.

5. The project was to be implemented over five years, at an estimated total cost of US$110 million. It was financed by IDA Credit 845-VN of US$60 million, which became effective on February 22, 1979. The Kuwait Fund, OPEC and Government of the Netherlands each provided US$10 million equivalent, bringing the total of external financing to US$90 million, for the purchase of construction equipment, fuel and materials. Subsequently, in April 1984 the Kuwait Fund approved a supplemental credit of US$20.4 million equivalent.

Implementation Experience and Project Results

6. Although construction of some project works will not be finished before end-1990, about seven years late, the major construction was substantially completed when the Credit was closed at the end of 1986. The main reasons for the delay and the associated cost overruns are:

(a) The survey data and maps available at appraisal proved to be inaccurate and new surveys had to be conducted. The primary irrigation canals had to be realigned, a second intake structure added, and the dike which forms the right bank of the reservoir extended from 22 to 29 km.

(b) Procurement delays occurred at the start of the project, primarily because GOV was inexperienced with international competitive bidding (ICB). IDA staff and consultants assisted in preparing the first three procurement documents under which most of the early construction equipment was obtained; however, after bids were received, there were very lengthy contract negotiations and the first deliveries did not take place until more than one year after receipt of bids.

(c) Government was unable to operate the heavy construction equipment procured for the project as intensively or efficiently as assumed at appraisal. For example, the SAR assumed the equipment would be operated for two shifts daily, whereas there was only one shift. Also, the work force was not familiar with the operation and maintenance (O&M) of such equipment, partially because local technicians with relevant experience were not available to work on the project in the numbers originally anticipated.

7. As a result of the inaccurate survey, the project area had to be altered to omit some 14,000 ha which could not be supplied with water in the absence of pumping. Although pumping would have been economically feasible, IDA did not agree to finance this because of the unreliability of the supply of both electricity and diesel. Instead, to compensate, 14,000 ha served by the east canal (originally proposed to form part of Stage II of the development) was included in the project.

8. During implementation Viet Nam experienced very high inflation and official exchange rates were overvalued. At appraisal, local cost estimates were based on the prevailing official exchange rate, and were therefore high in US dollar terms. If actual local costs are converted into US dollars at the official rates throughout the project period, cost overruns appear to be very high. However, if estimated unofficial rates are used (as has been done in the PCR), local costs are less than the appraisal estimates. Overall, the PCR estimates that project costs increased by about 6% in constant US dollars, or 18% in current US dollars, above the appraisal estimate of US$110 million (i.e., to about US$129.5 million). Incremental foreign costs were met through the supplemental financing from the Kuwait Fund.

9. The comparatively high unit cost of over US$3,000 per ha irrigated is due mainly to the dam, which contributed about 48% of total costs. However, the dam could supply a much greater area. For instance, if the reservoir cost were apportioned over 120,000 ha, the cost of Stage I would reduce to about US$2,100 per ha.

10. The design and construction of the dam, dike and their structures appear satisfactory from the point of view of safety, but there has not been full compliance with the Credit Agreement concerning the preparation of a spillway operations manual or periodic inspections after completion. The PCR mission considered the lack of adequate spillway operation procedures to be a source of potential danger to the dam and recommended that, until such procedures are established, the reservoir water level be kept sufficiently low to permit the rservoir to absorb the design flood without having the water level exceed the designed maximum level. This would not restrict irrigation in 1989. Sound engineering practice also suggests that the reservoir be inspected annually for the first few years after completion and then at five-year intervals by independent, qualified engineers, assisted by other specialists, as necessary.

Sustainability

11. Although the project has achieved most of its physical objectives, it has not yet produced the level of agricultural benefits assumed at appraisal. The PCR mission estimates that, at full development in 1994, paddy production will be about 73% of SAR estimates and groundnut production 53%; these lower estimates are due mainly to lower crop yields. Crop yields are constrained by low use of fertilizer and insecticide, both of which are expensive and scarce in Viet Nam. Also, poor drainage in some areas discourages the use of dwarf HYV rice.

12. The economic rate of return (ERR) has been re-estimated at 4% for Stage I (cf. SAR 17%) and 7% for Stages I and II (SAR 20%). These reduced ERRs are partly due to the fact that the current forecast price of rice is much lower than that used at appraisal. Other factors include lower incremental production, and delays in reaching this, as well as slightly higher costs.

Recommendations

13. Completion of secondary and tertiary canals is proceeding slowly, but might be accelerated by increased budget. The works that have been completed have not yet been handed over to the newly appointed O&M organization. This O&M organization needs to be fully established and formal inspection, acceptance and handing over effected as quickly as possible. Adequate spillway operational procedures do not yet exist, and these are urgently required. Also, the reservoir is not being periodically inspected in accordance with sound engineering practice, and this should be done. Finally, agricultural production is constrained by lack of fertilizers and insecticides, apparently because of shortage of foreign exchange. Dau Tieng irrigation project could benefit from additional financial assistance for: (a) completion of Stage II, (b) supply of fertilizer and insecticides, (c) accumulated maintenance needs, and (d) technical assistance to establish an effective O&M organization.

Lessons Learned

14. The project was prepared and appraised under great time pressure. Project implementation would have proceeded more smoothly if adequate surveys had been carried out and the design of the dam and major works completed before appraisal. A feasibility study would probably have led to a reduction in the height of the dam, thereby saving considerable expense.

15. A first-time Borrower from IDA, having little experience with international procedures, could have benefitted from stronger external technical assistance in planning, design, specification, procurement and construction.

PROJECT COMPLETION REPORT

VIET NAM
DAU TIENG IRRIGATION PROJECT
(CREDIT 845-VN)

I. INTRODUCTION

1.1 Agriculture is the predominant economic sector in Vietnam. It is estimated that about 70% of the population earn their income from agriculture even though agriculture appears to contribute less than half of the national income. Rice is the basic food. Over 70% of the area sown with annual crops is for wetland rice. Largely due to limited availability of fertilizers and other inputs, crop yields are low in comparison with other southeast Asian countries and Chinese provinces bordering Vietnam, which are amongst the poorest in China.

1.2 The Dau Tieng Irrigation Project was intended to be the first in a series but has turned out to be the only project so far funded by the World Bank group in Vietnam. The objective of the project was to contribute to making Vietnam self-sufficient in food by developing 42,000 ha of irrigated riceland as the first stage of a project which would ultimately irrigate 172,000 ha.

1.3 This report is based on a review of the World Bank's Staff Appraisal Report (SAR), number 1987a-VN, dated July 17, 1978; the Development Credit Agreement (DCA); IDA supervision reports and data compiled by the Government of Vietnam (GOV). The project area was visited and the project discussed with staff of the Ministry of Water Resources (MWR), Technoimport and Tay Ninh Province People's Committee and other agencies in Ho Chi Minh City and the project area in November and December 1988. As requested by the World Bank, the report pays particular attention to reservoir safety (see Annex A). Although data were made freely available to the PCR mission, these were incomplete and sometimes conflicting. Credible agricultural data were difficult to acquire.

II. PROJECT FORMULATION

Project Preparation

2.1 The Dau Tieng Irrigation Project, as originally proposed by GOV in 1977, would have included three components:

(a) construction of a storage dam on the Saigon River at Dau Tieng village, some 65 km northwest of Ho Chi Minh City;

(b) construction of a gravity irrigation system to serve 72,000 ha of largely rainfed land below the dam; and

(c) development of 100,000 ha of new land under bush and jungle, for irrigated sugarcane cultivation through a series of medium-lift pumps drawing water from the reservoir.

2.2 An IDA mission, which visited Vietnam in September 1977 at the request of GOV, found the investigations for the storage facility and the gravity irrigation scheme to be in an advanced stage, but noted that the sugarcane component was considerably less prepared. Furthermore, a preliminary cost estimate indicated that the irrigation system for the sugarcane component would cost about US$150 million, and that a further investment of some US$300 million for sugar factories, power transmission lines, roads and housing for new settlers would be needed to ensure its success. In view of this huge investment, GOV agreed to postpone the development of the sugarcane component.

2.3 Because of foreign exchange limitations, the scope of the proposed project was further scaled down during appraisal to include only the reservoir and 42,000 ha of the gravity service area (Stage I). The intake and diversion canal of the system would, however, be sized to cover the ultimate 72,000 ha service area. Construction of the remaining 30,000 ha would be carried out as part of Stage II of the project, while the sugarcane component would be developed under Stage III.

2.4 Access to the project area during preparation and appraisal was severely restricted by security considerations and it was difficult for the missions to obtain reliable data.

The Project Area

2.5 The project is located in the southwestern part of Vietnam (Map 1). The 42,000 ha project area includes five of the southern districts of Tay Ninh Province. It is bounded by the Saigon River on the east and by the Kampuchean border on the west. Tay Ninh, the provincial capital, is about 85 km northwest of Ho Chi Minh City. The project areas's climate is tropical and monsoonal.

2.6 The region is characterized by broad plains between gently rolling hills with elevations between 6 and 20 m above mean sea level. All soils in the project area were formed from alluvial sediments. The major part of the project area was rainfed paddy lands (about 75%) and the remainder rainfed upland, used mainly for groundnut cultivation.

The Appraised Project

2.7 Following an appraisal mission in January 1978, the SAR proposed that the project would include:

(a) construction of an earth dam and its appurtenant works on the Saigon River, which would create a usable storage of about 1,000 million m3;

(b) construction of a gravity irrigation system for about 42,000 ha of currently rainfed land, including an adequate drainage network, inspection and access roads and two low-lift pumping stations to serve about 4,000 ha within the 42,000 ha service area;

(c) training of construction engineers, heavy equipment operators and maintenance personnel; and

(d) procurement of vehicles, equipment, construction materials and supplies.

2.8 Dam and Appurtenant Works. The clay fill dam would be 1,100 m long and have a maximum height above the stream bed of 27 m. A dyke, 5 to 7 m high and about 22.0 km long, would be constructed on the right bank of the river to close the southwest rim of the reservoir.

2.9 To protect the dam and dyke against overtopping, a chute spillway would be constructed and be equipped with twelve 8.0 m x 5.0 m radial gates.

2.10 The reservoir created by the dam and dyke would inundate some 500 farm families, who would be relocated in the project area.

2.11 Gravity Irrigation System. The principal features of the irrigation system would be: (a) a gravity intake and an 8.2 km diversion canal to command 72,000 ha (42,000 ha in Stage I plus 30,000 ha in Stage II); (b) a 43 km-long west main canal to command 42,000 ha, about 4,000 ha of which would be served by two low-lift pumping stations that would draw water from the canal; (c) 23 primary canals having a total length of 122 km, and (d) about 2,430 km of secondary and tertiary canals, which would deliver water down to 10-20 ha units. Below these, farmers would construct the farm ditches needed to ensure timely water delivery to their fields with a minimal amount of field-to-field irrigation.

2.12 An extensive system of existing natural drainage channels would be enlarged and improved to minimize flooding of low portions of the project area. In addition, about 430 km of new secondary and tertiary drains would be excavated.

2.13 Inspection and Access Roads. Under the project, about 20 km of new roads would be constructed to provide access to the dam, dyke, spillway and quarry areas. In addition, about 200 km of all-weather, inspection and access roads would be constructed in the irrigation service area.

Negotiations and Effectiveness

2.14 Following a meeting with cofinanciers (Kuwait Fund, Opec Fund, Government of Netherlands) in Paris on 12 and 13 June 1978, negotiations were held in Hanoi between 20 and 28 June 1978, when a draft Development

Credit Agreement was finalized. During negotiations, it was agreed that a Project Manager would be appointed to oversee both design and construction rather than only design, the latter being preferred by GOV. IDA did not agree to specify in the DCA that the panel of dam experts should be Vietnamese; it was agreed that no nationality would be specified.

2.15 GOV strongly opposed cross default and cross effectiveness clauses since these could prejudice their negotiating position with other financiers. After IDA pointed out that the cofinanciers were interdependent in contributing to the total foreign exchange cost of the project and, because IDA were concerned about possible delays, they had excluded the Kuwait Fund from the cross effectiveness clause, agreement was reached.

2.16 The DCA was signed on 24 August 1978 for a credit of US$60 million. Cofinanciers were to provide a further US$30 million. The credit became effective on 22 February 1979 after delays due to slow processing by the Government of the Netherlands of its loan agreement.

III. PROJECT IMPLEMENTATION

Changes to the Project

3.1 During implementation there were several important changes to the project proposed in the SAR.

3.2 At the dam the spillway was changed from 12 gates, 8 m wide by 5 m high, on a concrete crest at level 19.4 m above sea level to 6 submerged gates, 10 m wide x 6 m high, on a cill at level +14 m. This reduced the width of the spillway and the design flood water level while increasing the capacity from 2,500 m3/s to 2,800 m3/s. The parapet on the dam crest was omitted but the fill level was raised to compensate for this. The side slopes of the dam were flattened to increase resistance to earthquakes.

3.3 The design parameters for the irrigation network were changed to increase the frequency of irrigation failure from 1 year in 5 to 1 year in 4 to be consistent with practice in the rest of the country. As a consequence of this and reconsideration of crop water requirements, canal irrigation duties were reduced and drain capacities in riceland were increased.

3.4 Following detailed survey, indicating that SAR was based on inaccurate data, the length of the dyke was increased from 22 to 29 km and the layout of the west canal was completely revised, requiring an additional intake some 11 km from the main dam and omitting about 14,000 ha on the right bank of the Vam Co Dong River. It was now impracticable to irrigate 42,000 ha using the west main canal without substantial areas relying on pumping. IDA was reluctant to agree to this due to doubt concerning availability of electricity and fuel for pumping; it was therefore agreed to include also the area mainly served by gravity from the first 20 km of the east canal as part of the project as shown below:

		Appraisal	Current Proposals
		(ha)	
Project Area (Stage I)			
West Canal -	Gravity	38,000	27,000
	Pumped	4,000	1,000
	Sub-total	42,000	28,000
East Canal -	Gravity	0	13,000
	Pumped	0	1,000
	Sub-total	0	14,000
	Total Project Area	42,000	42,000
Non-Project Area (Stage II)			
West Canal -	Gravity	n.a.	12,000
-	Pumped	n.a.	13,000
	Sub-total	n.a.	25,000
East Canal -	Gravity	n.a.	22,000
	Pumped	n.a.	8,000
	Sub-total	30,000	30,000
	Other (Stage III)	100,000	Not yet designed
	Total Irrigated from Dau Tieng	172,000	97,000 + Stage III

3.5 Two pumping stations referred to in the SAR (but not included in the estimated costs) were omitted from Stage I.

3.6 More hydrological information collected after appraisal reduced the estimate of annual average runoff into the reservoir to 1,830 million m3/year, some 68% of the estimate at the time of appraisal.

Project Start-up

3.7 The project suffered initial delays due to lack of suitable survey equipment, aggravated by delays in finalizing contracts for supply of new equipment, both for survey and construction. Although some early progress was made using locally available equipment, it was found that the early

outline designs, on the basis of which the SAR was prepared, were based on insufficiently accurate survey information. This required a reassessment of the design particularly with regard to the headreach of the canal.

Procurement

3.8 All procurement was handled by Technoimport, a branch of the Ministry of Foreign Trade. Although IDA staff assisted with the preparation of specifications and procurement documents, lack of experience in Vietnam of international contractual procedures and IDA procurement requirements caused delay in award of essential contracts. A delay in finalizing the type of equipment to be financed by the loan from the Government of the Netherlands (mainly trucks) caused loaders that had been delivered to be unused.

3.9 Procurement of construction materials and miscellaneous vehicles and equipment was delayed by communication problems between Washington and Vietnam; for example, documents for contracts for survey instruments were lost in the post.

3.10 Some contract negotiations took unusually long. Scrutinizing delivered equipment in Ho Chi Minh City to ensure compliance with specifications took so long that extensions of contract periods were needed.

Design

3.11 The Institute of Design and Survey (IDS), part of the MWR, was responsible for design. Several changes were made to the feasibility study designs. Significant changes were made to the design of the spillway which required further model tests, thereby delaying completion of design. A disagreement arose between the designers and the foreign experts, appointed to review the dam design, concerning the design of the spillway stilling basin floor. The designers eventually agreed to adopt the recommendation of the experts but maintained that the original design would have been satisfactory. Otherwise, designs appear to have been adequate.

3.12 Design of the irrigation system was delayed by the slow procurement of survey equipment and the need for fundamental changes as a result of the new survey information. A result of this is that the west main canal and intake are designed for greater capacity than is likely to be required.

Construction

3.13 Construction of the dam, dyke, roads, main, primary and secondary canals and drains was entrusted to MWR's Construction Company No.9. In 1980, when it was decided that Stage II work, the construction of the east canal, should proceed simultaneously with Stage I, a number of construction companies were amalgamated into Construction Enterprise No. 4, which completed the work. Tertiary canals and drains were entrusted to the Tay

Ninh provincial authorities. The appraisal and actual implementation schedules are compared in Chart 1.

3.14 The start of construction was delayed by design and procurement difficulties, but by March 1980 work on the dam and dyke with some of the new equipment was starting about a year behind the SAR schedule. Initial progress was slow due to lack of dump trucks, fuel shortages and the need to train equipment operators and maintenance staff. Progress improved but shortages of fuel, lubricants and spares continued, causing some further delay until the supplementary loan from the Kuwait Fund became effective in 1984.

3.15 The Saigon River was closed in December 1983 and work on the dam and dyke was substantially complete by the beginning of 1985, more than two years behind the optimistic SAR implementation schedule. The first irrigation water was diverted in the 1984/85 irrigation season.

3.16 Construction of the main and primary canals was substantially complete by November 1985. By December 1988, about 95% of the secondary canals and 90% of the tertiary canals were complete for Stage I area. It is estimated that all works required to complete the irrigation network to serve 42,000 ha in the project area will be completed by the end of 1990.

Quality and Performance of Project Works

3.17 In general, the quality of earthwork seen by the PCR mission appeared satisfactory. While structures are generally adequate for their purpose, the finish is not always to internationally-accepted standards. Leakage through water-retaining concrete, exposed reinforcing bars and improper electrical cabling was noted.

3.18 The mechanical works at the spillway and intakes to the main canals appeared to work satisfactorily but corrosion protection of structural steelwork and machinery housings could be improved. For minor structures, such as sluice gates at the head of primary and secondary canals, there is often no sign of any painting or lubrication having been done. In many cases spindles, headstocks and/or gate leaves are missing. So long as there is abundant water available and it is feasible to let canals run at all times and frequently spill, the lack of operating gates on minor structures will not be a serious constraint to agricultural development. However, as full development is reached and reservoir water becomes scarce, rehabilitation of many water control structures could be required.

3.19 Canal operation is at present demand driven and in general farmers can have water whenever required. There will be need for an adequate operation and control system when water becomes scarce.

3.20 With regard to safety, the design and construction of the dam, dyke and their structures may be considered adequate, provided due attention is paid to operation of the spillway gates and monitoring of dam settlement,

piezometric levels and percolation. The PCR mission recommends that a clear and simple procedure for spillway operation be established which can be put into effect immediately. Copies of this procedure should be given to all personnel concerned and posted in prominent places at the dam. The mission considers that until this procedure is established the reservoir water level should be drawn down to level +22.5 m above sea level and not allowed to rise above this level. This would permit the reservoir to absorb the design flood without operation of spillway gates being necessary, but would still store sufficient water to meet the irrigation requirement in 1989. Reservoir safety is discussed in Annex A.

Project Costs

3.21 Costs in constant 1978 dollars are summarized below. Foreign costs have been converted to US dollars from the currency in which they were incurred using the average exchange rate in the year in which the expenditure was made. Local costs were given by MWR in constant 1981 dong. These have been divided by the estimated average unofficial exchange rate for 1981 of 43.5 dong/US$ (compared with the official rate of 4.35 dong/US$). For comparision with SAR estimates all dollar costs were then converted to 1978 dollars, using the MUV index. On the basis of these assumptions, actual local costs are about 10% less and foreign costs are about 10% greater than estimated at appraisal as shown below. When expressed in current dollars local costs are 19% greater and foreign costs 19% greater than appraisal estimates.

Project Cost

	In 1978 terms		In Current Terms	
	Appraisal Estimate <1>	Actual	Appraisal Estimate	Actual
	..... (US$ million)			
Local - Project	20.0	16.1	20.0	19.8
East Main Canal	0	2.0	0	2.5
Foreign	79.7	87.7	90.0	107.2 <2>
Total	99.7	105.8	110.0	129.5

<1> Includes physical contingencies.
<2> Based on information provided by Technoimport and assumed price increases.

3.22 The changes in design contributed to increased cost. Also, construction equipment was not operated as efficiently as assumed in SAR and fuel consumption was much greater than assumed. The cost of the east main canal was not included in the SAR.

Project Financing and Disbursement

3.23 Total project cost estimated at appraisal was US$110 million. The foreign exchange component, estimated as US$90 million, was to be financed by US$60 million from IDA and US$10 million each from the Kuwait Fund, OPEC and Government of the Netherlands. The initial arrangement for joint financing (IDA 50 , Kuwait Fund 25%, OPEC 25%) of fuel, materials and supplies was changed to provide parallel financing of different items. Kuwait and OPEC funds financed 100% of the cost of fuel, lubricants and steel. The Dutch Government's loan provided communication equipment, diesel generators, front-end loaders, dump trucks and spare parts for them. IDA financed 100% of the cost of equipment, spares and materials not financed by the cofinanciers. In April 1984, the Kuwait Fund signed a supplementary agreement for a further KD6.0 million (approximately US$20.4 million). IDA did not supplement its credit. The financing is summarized below:

Source of Funds	Appraisal	Actual
	.....(US$ million).....	
IDA	60	59.7
Kuwait Fund	10 <1>	29.7 <2>
OPEC	10	9.8
Government of the Netherlands	10	8.0 <3>
Government of Vietnam	20	22.3
Total	110	129.5

<1> KD 2.9 million.
<2> KD 6.0 million supplementary loan became effective July 1984.
<3> DFL 17.9 million.

3.24 The division of the IDA credit between categories was changed as shown below:

Category	DCA	Actual
	...(US$ million)...	
Vehicles and Equipment	31.0 <1>	35.7 <1>
Materials and Supplies	20.0 <2>	23.8 <1>
Training and Consultants	0.5 <1>	0.2 <1>
Unallocated/Cancelled	8.5	0.3
Total	60.0	60.0

<1> Disbursement based on 100% of foreign expenditure.
<2> Disbursement based on 50% of foreign expenditure.

3.25 Credit closing date was extended in two stages from 31 December 1984 to 31 December 1986. The final disbursements were made on 10 July 1987 and US$303,008.53 was cancelled on 13 July 1987.

Compliance with Covenants of the Credit Agreement

3.26 Status of covenants is summarized in Table 7 of Part III of this report. In general, GOV complied with the covenants of the DCA though often behind schedule. The most important exceptions are described below.

3.27 Section 3.06 of the DCA required the borrower to appoint a panel of experts and require the panel to provide advice on the preparation of a spillway operation manual and recommend a suitable maintenance and safety inspection programme to be carried out after completion of the dam. The PCR mission was not able to establish that the panel of experts had done this nor to find an adequate spillway operation manual. GOV has not yet complied with Section 4.06(b) of DCA, which requires the borrower to cause the dam and appurtenant works to be periodically inspected after completion in accordance with sound engineering practice in order to discover if there are any deficiencies which may endanger their safety and to furnish an inspection programme to IDA.

IV. PROJECT IMPACT

Intended Impact

4.1 The major production impacts intended by the project were increases in annual rice production to about 248,000 tons, from the pre-project 79,000 tons, and annual groundnut production to about 66,000 tons from the pre-project 23,000 tons. These were expected to be achieved through provision of irrigation and drainage systems and strengthening of agricultural support services.

4.2 The project area appraised for irrigation development was 42,000 ha commanded by the West Canal Irrigation Network. It was projected that "full development" production would be attained in 1988, five years after expected completion of the project works in 1983.

Crop Development

4.3 There was a substantial change in the location of the project area as explained in Chapter 3. About 14,000 ha included in the appraised project area were excluded and to make up for this, about 14,000 ha located outside the original project area were added. Total project area therefore remains at 42,000 ha. It should be noted that the impact of the project on crop production is not strictly comparable with appraisal estimates because of the change in location of the project area. However, an attempt has been made, to the extent possible, to compare actual changes on land use, cropping patterns, per ha crop yields and total output, with those projected at the time of appraisal. Re-estimation of the cropping pattern, crop yields and total output at full development with and without project are dealt in Chapter 5 and summarized in Tables 1 and 2.

4.4 Land Use. The table below summarizes appraisal projections and actual changes in land use in the project area:

	Appraisal		Actual <1>	
	Pre-Project (1978)	Completion (1983)	Pre-Project<2> (1984)	Completed (1988)
	..... ('000 ha)			
Rainfed Land				
- Paddy land	28.0	-	33.0	5.0
- Non-paddy land	11.0	-	8.5	4.9
Sub-Total	39.0	-	41.5	9.9
Irrigated Land				
- Paddy land	3.0 <3>	31.0	0.5 <4>	28.5
- Non-paddy land	-	11.0	-	3.6
Sub-Total	3.0	42.0	0.5	32.1 <5>
Total	42.0	42.0	42.0	42.0

<1> Mission estimates based on information obtained from Tay Ninh Provincial Agricultural Services.
<2> First irrigation was in December 1984 for the 1984/85 dry season crop.
<3> Irrigation in dry season only.
<4> Pumping from wells.
<5> The irrigation system has not yet reached full development of 42,000 ha. It is assumed this will be reached in 1990.

4.5 Cropping Pattern. Actual changes in the cropping pattern in the revised project area, compared with the appraisal projections are shown below:

Cropped Area	Appraisal		Actual <1>	
	Pre-Project (1978)	Completion (1983)	Pre-Project<2> (1984)	Completion (1988)
	('000 ha)			
Pre-Monsoon Season:				
- Irrigated Paddy	-	-	-	7.9
- Rainfed Paddy	-	-	2.0 (3)	-
- Irrigated Groundnuts	-	11.0	-	4.0
- Rainfed Groundnuts	-	-	6.0	2.0
Sub-Total	-	11.0	8.0	13.9
Monsoon Season:				
- Irrigated Paddy	-	31.0	-	28.5
- Rainfed Paddy	31.0	-	33.5 <3>	5.0
- Irrigated Groundnuts	-	11.0	-	3.6
- Rainfed Groundnuts	11.0	-	8.5	4.9
Sub-Total	42.0	42.0	42.0	42.0
Dry Season:				
- Irrigated Paddy	3.0	31.0	0.5	24.1
- Irrigated Groundnuts	-	11.0	-	8.5
- Rainfed Groundnuts	12.0	-	10.0	1.5
Sub-Total	15.0	42.0	10.5	34.1
Total	52.0	95.0	60.5	90.0
Net Cultivated Area	42.0	42.0	42.0	42.0
Cropping Intensity	136%	226%	144%	214%

<1> Mission estimates based on information obtained from Tay Ninh Provincial Agricultural Services.
<2> First irrigation was in December 1984 for the 1984/85 dry season crop.
<3> Includes some area receiving supplemental irrigation by pumping from wells.

4.6 Present overall cropping intensity is estimated at about 214% (1988), which is close to the intensity projected at the time of appraisal (226%). Overall irrigation intensity (the ratio of total irrigated crop area to total net cultivated area) is however lower, being about 182%, as the irrigation system in the project area is not yet fully developed.

4.7 It should be noted that the SAR did not consider the irrigated pre-monsoon paddy in projecting the future cropping pattern. Pre-monsoon paddy cultivation has been in practice in the area since the pre-project time, where irrigation water is available. In addition, the SAR overestimated the irrigated groundnuts area under the project. However, this is largely due to difference in land use (proportion of paddy land and upland) between the original project area and the revised area.

4.8 Crop Yields. The table below summarizes actual crop yields, compared with the appraisal projection:

Crops	Appraisal		Actual <1>	
	Pre-Project (1978)	Full Development (1988)	<2> Pre-Project (1984)	Completion (1988)
	(tons/ha) <3>			
Pre-Monsoon Season:				
- Irrigated Paddy	-	-	-	2.2
- Rainfed Paddy <4>	-	-	2.0	-
- Irrigated Groundnuts	-	2.0	-	1.3
- Rainfed Groundnuts	-	-	0.8	0.8
Monsoon Season:				
- Irrigated Paddy	-	3.8	-	2.2
- Rainfed Paddy	2.3	-	2.0	2.0
- Irrigated Groundnuts	-	2.0	-	1.1
- Rainfed Groundnuts	1.0	-	1.0	1.0
Dry Season:				
- Irrigated Paddy	2.5	4.2	3.0	3.4
- Irrigated Groundnuts	-	2.0	-	1.6
- Rainfed Groundnuts	1.0	-	1.2	1.2

<1> Based on data provided by Tay Ninh Provincial Agricultural Services.
<2> First irrigation was in December 1984 for the 1984/85 dry season crop.
<3> Paddy: unhusked yield; groundnuts: unshelled yield.
<4> Includes some area receiving supplemental irrigation.

4.9 The present irrigated crop yields have not reached the full development yields projected by the SAR. The lower yields are reportedly due to insufficient supply of chemical fertilizers and agro-chemicals. According to Tay Ninh Provincial Agricultural Service, the current supply of chemical fertilizers available can meet only 40% of the demand in the area, as estimated by PAS. Available supply of agro-chemicals is estimated to be about 60% of the demand.

4.10 The prevailing unfavourable fertilizer:paddy price ratio could also contribute to lower crop yields. The Provincial Government seeks to maintain the price of 1 kg of urea equal to 2 kg of paddy. However, according to the mission's interviews with a limited group of farmers in the area, the price of 1 kg of urea for the current dry season appears to be 3 kg of paddy. In terms of N:paddy price ratios, this is equivalent to 6.6, which is high among Asian rice producing countries. The interviews also reveal that the lower yield of monsoon paddy is due to difficulty of use of dwarf HYV in the monsoon season because of inadequate drainage in some areas.

4.11 Crop Production. Annual total crop production as estimated at appraisal and as actually achieved in 1988 is summarized below:

Crops	Appraisal		Actual	
	Pre-Project (1978)	Full Development (1988)	Pre-Project (1984)	Completion (1988)
	('000 tons)			
Paddy (unhusked)	78.8	248.0	72.5	172.0
Groundnut (unshelled)	23.0	66.0	25.3	30.2

4.12 Mainly due to lower crop yields, the present production of paddy is about 70% of the appraisal projected production at full development. Lower output of groundnuts (45% of SAR projection) is a reflection of both lower crop yield and cropped area.

Farm Incomes

4.13 Detailed data on size of land holding per farm in the project area were not made available to the mission but the average farm size in the project area was assumed to be 1.0 ha, as it is said to be larger than the provincial average of 0.7 ha. Two representative farm budgets for 1.0 ha holdings have therefore been prepared to show the impact of the project on farm incomes (Tables 4 and 5). These are intended to represent farm incomes of the majority of farmers including independent farmers and farmers who are members of production units. No farm budget for cooperative members was prepared in view of the paucity of information on cooperative farming. Moreover, the extent of cooperative development fell short of the appraisal expectation and the existing numbers in the project area are very limited.

4.14 The two separate budgets reflect the difference in cropping patterns according to land types. One is for a farm entirely on paddy land, generally found in low-lying areas, where only paddy is grown due to fine textured soils and/or poor drainage conditions. The other is representative of well drained paddy land, found above the low-lying area, where paddy as well as upland crops (mostly groundnuts) are grown.

4.15 The re-estimated farm incomes compared with the appraisal projections are summarized below:

	Appraisal			Re-estimated		
	Without	With	% Increase	Without	With	% Increase
	.....(D'000).....			.....(D'000).....		
Paddy Farm	5.0	7.7	+54	421.5	1,042.3	+148
Paddy/Groundnut Farm	2.6	7.7	+196	752.9	1,373.8	+82

4.16 The re-estimated net income "with project" exceeds "without project" net income by about 150% in the case of the farm growing paddy exclusively and by about 80% in the case of the paddy/groundnut farm. These estimates are not strictly comparable with the appraisal farm budgets, which were based on cooperative management, and the cropping patterns and size of holding assumed are different from those used in the re-estimated budgets.

Resettlement

4.17 Families living within the reservoir area were resettled in the area that will be served by pumped irrigation from the east canal. This is some distance from their original homes and the SAR proposal for them to plant an annual dry season crop on their original farms as the reservoir recedes does not seem practicable. However, some 5,500 ha in the reservoir area are presently cultivated.

Other Potential Benefits

4.18 The reservoir has potential for development for fisheries and recreation.

V. ECONOMIC RE-EVALUATION

Assumption

5.1 Economic re-evaluation has been carried out for two separate areas as in the SAR. The first is the 42,000 ha (Stage I) IDA project area and the second includes also Stage II and totals 97,000 ha. It is assumed that no irrigation development could go ahead before completion of the dam; therefore the full cost of construction of the dam has been included in each analysis.

5.2 It is impracticable at this stage to make realistic estimates of the costs of construction and benefits of the additional Stage II works that might be required to make use of the full potential of the reservoir; the SAR gave a preliminary estimate of some US$150 million for irrigation development and an additional US$300 million for sugar factories, power lines, roads and housing for settlers. The economic analysis of Stage III was not attemptd at appraisal and has not been considered in the PCR.

5.3 Costs. Actual foreign expenditure as provided by Technoimport was used for estimating foreign construction costs for the Stage I project. Local costs were as given to the PCR mission by MWR, adjusted as described below. Although not included in the IDA project, the costs of constructing the first 20 km of the east main canal were included in the economic analysis of Stage I on the assumption that the benefits from the area served by this canal could not be achieved without this expenditure. It was assumed that completing the Stage I works still outstanding at December 1988 would require US$250/ha for 10,000 ha and would be completed in 1990. The costs for Stage II works were based on US$300/ha for 28,000 ha commanded by the east main canal between 1983 and 1989 and US$250/ha for 55,000 ha of land to be provided with irrigation between 1986 and 1997.

5.4 O&M costs for 1989 onwards have been assumed to be US$24/year/ha irrigated. The residual value of construction equipment, based on the assumed economic life of 10 years, was assumed to be nil.

5.5 Costs and benefits were expressed in 1988 US$ prices. Local costs were converted into economic values using a standard conversion factor (SCF) of 0.1. The assumed SCF is very low because of heavy price distortion in the Vietnam economy, particularly in relation to the official exchange rate which is far out of line with the real exchange rate. Foreign costs shown in Table 10 were obtained by taking actual expenditures as given by Technoimport and converted to current US$ using the average exchange rate in the year in which the expenditure was incurred. They were then converted to constant 1988 US$ using the MUV index.

5.6 Local costs, including the cost of the first 20 km of east main canal, were provided by MWR in constant 1981 dong. These were multiplied by the SCF and then divided by the 1981 average official exchange rate of 4.35 dong/US$ to obtain local costs in 1981 US$. These were then corrected to 1988 US$ using the MUV index. Local and foreign costs were then summed to obtain total project costs. The effect of uncertain exchange rates was minimized by expressing costs of imported goods as well as benefits in dollars rather than local currency, but this could not, of course, be done for labour. Nevertheless, there are sufficient uncertainties in the figures used that the results should be treated with caution.

5.7 Benefits. Tables 1 and 2 set out assumed future cropping patterns, yields and overall crop production, as re-estimated for the purposes of the analysis.

5.8 It is assumed that the "with project cropping pattern" for the Stage I area would remain largely unchanged in the future from that

Stage I area would remain largely unchanged in the future from that prevailing in 1988, except for some increase in cropping intensity due to completion of irrigation development works. The increase is mainly expected in the groundnuts cropped area, as the area remaining to be developed is mostly upland.

5.9 The rather modest increase in the "with project crop yields" reflects an assumption that the current shortage of fertilizer supply in the country would not improve drastically in the future. It should be, however, noted that there is good potential to increase the crop yield to the level projected at appraisal with use of higher rate of fertilizer application.

5.10 The "without project" cropping patterns and crop yields were based on the pre-project cropping patterns discussed in Chapter 4. No change in the cropping pattern was assumed but slight increase in crop yield was considered.

5.11 With regards to the combined Stage I and II area, it was assumed that all the area requiring pump irrigation (23,000 ha) is upland for groundnuts cultivation, and the remaining (74,000 ha) is paddy land, as the land use data for Stage II area are at present not available. On the basis of this, the Stage I cropping pattern assumed above was pro-rated for the combined area. Crop yields identical to those assumed for Stage I were used for the combined area to estimate overall crop production.

5.12 The "full development" production was assumed to be achieved in 1994 for Stage I, and in 2003 for Stage II, both 4 years after completion of each irrigation development. Crop budgets used in the analysis are shown in Table 3.

5.13 Prices of tradeables were based on World Bank projections of 1995 world prices, adjusted for local costs of transport, handling and processing. For unskilled labour, the economic price used was US$0.80.

5.14 The projected 1995 economic farmgate price for paddy was estimated at US$149/t in 1988 US$. Derivations of economic prices of outputs and inputs are shown in Tables 6 and 7 and summarized in Table 8.

5.15 No allowance was made for production foregone on land acquired for project works because families were moved to previously unproductive land. Costs of transferring these families are included in the construction costs. Potential benefits from other possible develpments such as recreation and fisheries development in the reservoir have not been included since these would also require substantial investment.

Economic Rate of Return

5.16 The calculations for economic rates of return (ERR) were carried out for 40 years. Cost and benefit streams are presented in Tables 10 and 11. The results of the re-estimated ERRs are summarized below:

Estimated Economic Rates of Return

	Appraisal	PCR
Stage I	17%	4%
Stage I & II	20%	7%

5.17 Estimated ERRs are lower than expected because of higher costs (about 6%), delays in benefits, lower incremental production and a 54% lower forecast rice price (US$148/t in 1988 US$ compared to US$190/t in 1978 US$ at appraisal).

5.18 At full development, the estimated quantities and equivalent foreign exchange values of incremental annual production would be:

	Full Development Year	Incremental Paddy ('000 t)	Production Groundnuts <1> ('000 t)	Unit Value Paddy ....(US$/t)....	Unit Value Groundnuts <1>	Annual Value (US$ M)
Appraisal Stage I	1988	162.4	38.4	202 <2>	326 <2>	45.3 <2>
PCR Stage I	1994	118.0	20.2	149 <3>	307 <4>	23.8 <3>
PCR Stage I and II	2003	243.9	60.2	149 <3>	307 <4>	54.8 <3>

<1> Unshelled.
<2> 1985 price in 1978 US$.
<3> 1995 CIF price in 1988 US$. See Table 6.
<4> 1995 FOB price in 1988 US$. See Table 6.

VI. INSTITUTIONAL PERFORMANCE

Ministry of Water Resources

6.1 The MWR was responsible for project implementation. This was the largest irrigation project in Vietnam and the first to be constructed making such extensive use of construction equipment. It was the first and so far the only World Bank project in Vietnam. It was therefore not surprising that MWR lacked experience in the planning and implementation of such a project and that decision-making often seemed to be slow. Planning and appraisal went ahead on the basis of inadequate survey data which resulted in extensive changes to the design of the irrigation system. These required

lengthy approval by two deputy ministries of MWR. The Government agencies involved in the project included: the Institute of Design and Survey (IDS) of the MWR, responsible for the design of the irrigation infrastructure; the construction parastatal, Construction Enterprise No. 4 of MWR, carrying out the major civil works; the State procurement compa Technoimport; Tay Ninh Provincial Administration responsible for the construction of the tertiary canal system and on-farm development; the Ministry of Agriculture (Hanoi); and the Tay Ninh Provincial Agricultural Service (PAS), responsible for the provision of agricultural support services.

6.2 The civil works were designed by IDS. Once correct survey data were obtained, design was, in general, carried out competently. However, the IDA supervision mission in 1980 reported that MWR did not prepare technical specifications to control the quality of construction, with technical instructions included only on the construction drawings. More detailed specifications could have facilitated quality control, thereby improving the quality of construction.

6.3 Construction of the main civil works was entrusted to the MWR Hydraulic Works Company No. 9 which was amalgamated into Construction Enterprise No. 4 in 1980, whose performance is described in Chapter 3.

6.4 A project manager assisted by a small project unit was responsible for design and construction but at the outset lacked the necessary authority for coordination and decision making and the experienced staff necessary for supervising construction to achieve internationally acceptable standards of workmanship. In the circumstances, the successful (though late) completion of the project is a considerable achievement of which MWR can be proud. MWR could have received much assistance and valuable training had suitably experienced foreign consultants been employed to assist with planning, design, preparation of specifications and supervision of construction. Although IDA supervision missions proposed the employment of consultants, GOV were reluctant to do this (foreign consultants were employed in 1986 to prepare a water management programme). Technical assistance was provided by IDA supervision missions and in particular by the panel of foreign dam experts (GOV first appointed three Vietnamese experts but IDA and Kuwait Fund considered that more independent experienced engineers should be employed. Kuwait Fund financed a report by three such people, one of whom was employed as a consultant by IDA on 3 supervision missions). Continuity of staff, both by MWR and IDA, ensured that understanding, cooperation and learning developed.

6.5 Supervision missions reported that project management could be improved in a number of areas, including financial management and accounting, and planning and programming. Coordination of the activities of the different agencies, notably the IDS and the PAS, had been poor. Design of the tertiary irrigation system and on-farm development did not start until after secondary canals in some areas were complete; arrangements for

the execution of these works by farmers were not well defined. An implementation schedule of all project activities detailing critical paths, prepared by the project unit and agreed by all agencies, would have facilitated planning and programming.

Ministry of Foreign Trade

6.6 Technoimport, which was responsible for all foreign procurement, had limited experience of such work and none of dealing with World Bank procurement procedures. Consequently, there were some delays in the early contracts. Excessive time taken to scrutinize imports in Ho Chi Minh City to ensure compliance with specification also delayed arrival of plant on site. However, after these initial problems, Technoimport performed satisfactorily.

Training

6.7 A vocational school for training construction equipment operators was established on site in 1979 and the construction company's experienced operators trained new staff. Suppliers' contracts provided for limited training with their equipment. Operators were said to be competent and learning quickly. Although a formal maintenance training programme was considered to be necessary, this was not arranged.

6.8 Short-term expatriate studies on construction management and training requirements were completed in July 1981, but there was little response to the report's recommendations. Two foreign engineers spent 2 weeks in December 1982 providing instruction in construction scheduling and equipment maintenance. MWR found the sessions interesting but did not gain much, possibly due to their short duration.

6.9 IDA organized a four-week visit to Sri Lanka in February 1983 for project staff and irrigation engineers, led by the Vice-Minister of MWR. Several irrigation schemes at various stages of construction and operation were visited. It was one of the first such visits made by Vietnamese engineers for a long time and gave them a unique opportunity to compare technologies. The Ministry requested more visits to such countries as Australia, Indonesia and India to review irrigation design and construction and hydraulic research but this did not happen.

Agricultural Support Services

6.10 Although the appraisal report recognized the need for strengthening agricultural support services in the area, no financing for this was

included in the project. Planning and implementation of the programme were left with GOV as a condition to the credit agreement. Therefore, the appraisal report gave almost no account of the institutional apsects of agricultural support services under the project.

6.11 Tay Ninh Provincial Agricultural Service (PAS) produced a brief report on the 10-year agricultural development programme in 1984 for the original 42,000 ha project area commanded by the West Canal Network. The report does not contain detailed requirements for additional staff, equipment and facilities, nor organization and management aspects of the programme. Since the location of the project area was changed substantially after 1984, the report requires considerable revision. However, no revised version has been prepared so far.

6.12 The PAS falls under the Department of Agriculture Production within the Management Division of the recently reformed Ministry of Agriculture and Food Industry. The PAS is responsible for providing agricultural support services, including research, extension and input supply, to the project area. Each of the six districts involved in the west and east canal command area, has a District Agricultural Office, an Agricultural Production Company and District Veterinary Station. There are presently about 70 senior agricultural staff (university graduate) and about 110 agricultural technicians in the six project districts. It is reported that the above facilities and staff were virtually non-existent at the time of appraisal. The existing support services are constrained, however, by limited financial and material resources and therefore cannot provide adequate support services to the project farmers.

Cooperatives

6.13 The appraisal report envisaged that all the farming activities would be implemented through cooperatives by organizing private farmers in the project area, following the GOV policy at that time. In reality, however, the cooperative development has not been very successful in the project area and elsewhere in the South. Although GOV still encourages farmers to form cooperatives or production units by providing easier access to farm inputs for members, it appears that no significant increase in the formation of new cooperatives is expected. The exact number of cooperatives in the project area is presently not available. In Tay Ninh Province, there are 32 cooperatives with 6,400 farm families in total, 1,627 production units with about 79,000 farm families, and 56,000 private farm families. The production unit in the area is a group of farmers who have organized themselves for work exchange or mutual aid for crop production. There appears to be no strict profit-sharing system. There is practically no difference between private farmers and farmers in production units.

Operation and Maintenance (O&M)

6.14 The main civil engineering works have not yet been formally handed over to the O&M organization. It is now proposed that O&M should be the

responsibility of the Combinat for Operation of Dau Tieng Irrigation; the Project Manager during implementation will become the General Manager of this combinat. Under the General Manager there will be four managers responsible for:

- operation of the west canal irrigation system;
- operation of the spillway and east canal irrigation system;
- operation of the irrigation in Ho Chi Minh district (at the downstream end of the east canal);
- maintenance and repair of all works down to and including secondary canals.

6.15 The managers for operation will be responsible for collecting water charges. Any shortfall between the cost of O&M and the amount collected for water charges will be provided by the provincial governments.

6.16 Water users' groups are responsible for O&M in tertiary and downstream works.

Performance of IDA

6.17 The project was prepared and appraised at a time of rapidly changing social conditions and it was difficult to obtain reliable data. IDA considered that delays in processing the credit would have adverse effects on future relations with Vietnam and raise doubts as to the seriousness of IDA in helping Vietnam's reconstruction and development efforts. Appraisal went ahead on the basis of insufficiently accurate topographical information, which contributed to considerable delay in implementation. Further study of the optimum size of the reservoir might have resulted in the selection of a smaller reservoir, with considerable cost savings and little effect on Stage I and Stage II benefits. The SAR did not foresee that the supply of agricultural inputs would be a constraint.

6.18 Eighteen IDA supervision missions visited the project between 1978 and 1986. IDA supervision staff assisted MWR with design, procurement and other problems. Continuity of staff on IDA missions helped to achieve good understanding and cooperation. IDA concern over weakness in design of the dam was overcome by including dam experts in supervision missions. This averted what one mission considered to be a major weakness in the design of the spillway which could have led to failure of the dam. Additional canal regulator structures were constructed following advice from a supervision mission. However, IDA did not enforce the convenants concerning operating instructions for spillway gates and regular inspections of the completed dam.

Performance of Cofinanciers

6.19 There were several cofinanciers' meetings to discuss the project. The Kuwait Fund was the most active cofinancier, mounting at least one independent supervision mission, joining three IDA supervision missions as well as financing the dam review panel in late 1982. Disbursement by the Kuwait Fund was temporarily suspended in 1982 until a satisfactory review panel was formed. When the overrun in foreign costs became apparent, only the Kuwait Fund provided additional finance; this was on condition that reliable cost estimates were prepared and satisfactory remedial action was taken concerning the spillway floor. The Kuwait Fund also represented OPEC's interests.

6.20 The Government of the Netherlands (GON) financed dump trucks and other equipment from the Netherlands. There were early difficulties in agreeing on specifications. GON declined to finance additional spare parts for their equipment even though only about 80% of their loan was disbursed. A representative of GON joined one IDA supervision mission.

VII. CONCLUSIONS AND LESSONS

Conclusions

7.1 Construction of the project works has been substantially completed and over 75% of the target area can now receive irrigation; it is estimated that the necessary minor irrigation and drainage works to permit irrigation of the full 42,000 ha will be completed by the end of 1990. However, incremental production due to the project is estimated to be substantially less than estimated at appraisal mainly due to lower crop yields.

7.2 Because of the unreliability of energy supplies, the location of the areas attributed to the IDA project has been adjusted to minimize the area served by pumping.

7.3 Although the flow into the reservoir appears to be less than assumed at appraisal, there is ample water for irrigation of the project area of 42,000 ha and for the Stage II area now assumed to be 97,000 ha. Further study of water availability would be needed before substantial development beyond Stage II is undertaken; this could also be constrained by scarcity of energy for pumping.

7.4 To make optimum use of the available water, improvement of the water management and water control would be required.

7.5 Design and construction of the dam, dyke and their structures are considered safe but, until satisfactory operating procedures for the spillway gates have been established, it is recommended that the reservoir level is kept sufficiently low to provide sufficient unused storage capacity to absorb the design flood.

7.6 The GOV has not yet established a satisfactory procedure for periodically inspecting the dam and appurtenant works in accordance with sound engineering practice, in order to determine whether there are any deficiencies in the conditions of the structures or in the quality or the adequacy of the operation or maintenance which may endanger their safety.

7.7 The completed works have not yet been handed over to the newly appointed O&M organization. The O&M organization should be established and formal handing-over effected as soon as practicable.

7.8 Achievement of full agricultural development is constrained by the availability and price of fertilizer, insecticide and quality seed.

7.9 The estimated economic rate of return is much lower than anticipated at appraisal due mainly to lower forecast price of rice, delay in completion and lower crop yields than estimated at appraisal.

Lessons

7.10 Project implementation would have proceeded more quickly and smoothly if adequate survey had been done and if the design of the dam and major works had been completed before appraisal. This is an inevitable risk when projects are prepared under extreme pressure to lend.

7.11 Procurement of equipment and materials using ICB in accordance with Bank guidelines can be a lengthy procedure. It is unrealistic to expect equipment to be in use on site within considerably less than a year of the appraisal report unless the procurement process has started beforehand.

7.12 A first-time borrower from the Bank, with little experience of international procedures and standards, could benefit from strong technical assistance with planning, design, specification, procurement and construction.

7.13 Covenants can be enforced by suspending disbursement as was done by the Kuwait Fund to ensure appointment of a satisfactory dam review panel.

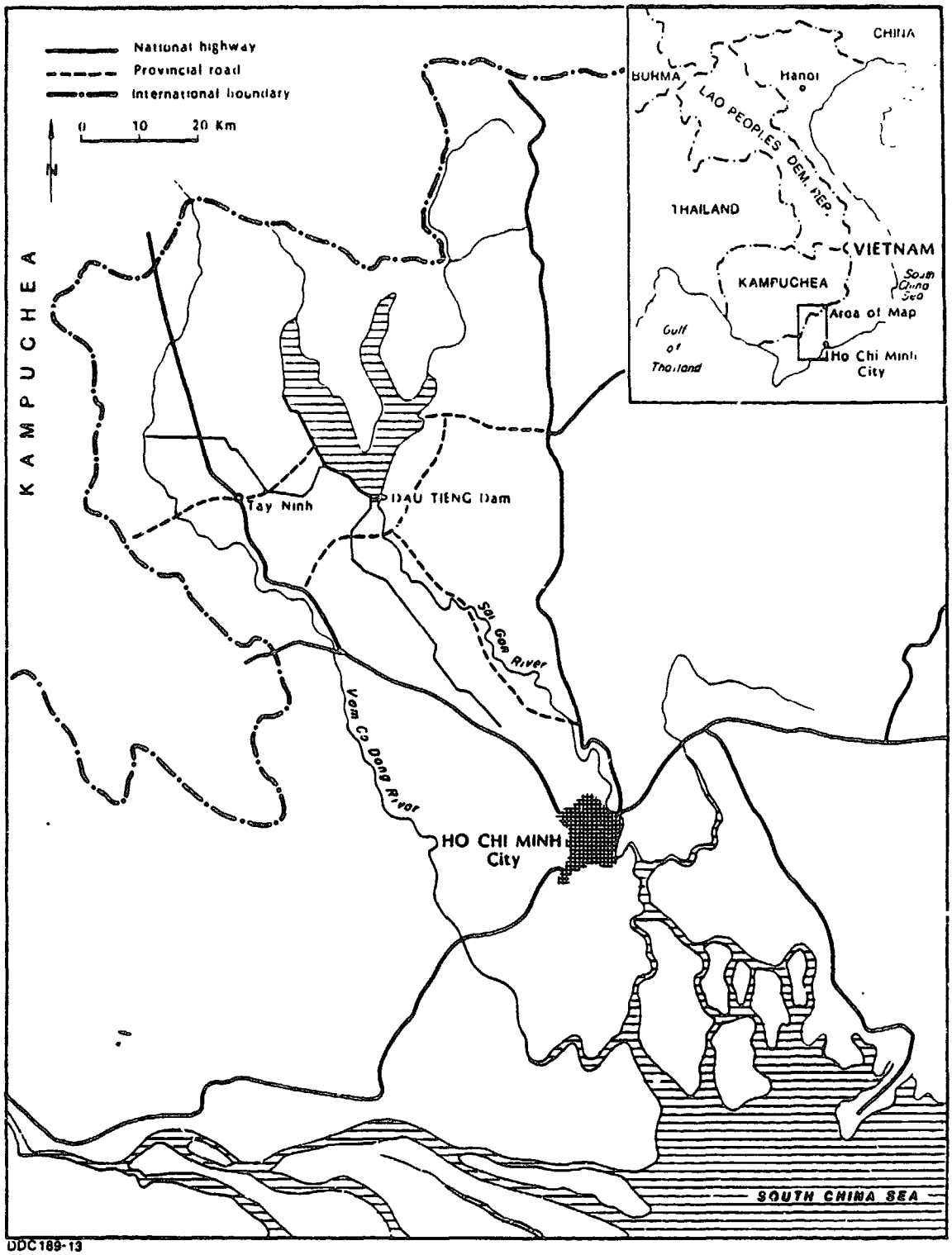
7.14 Provision of agricultural support services was excluded from the project at appraisal; although considerable attention was given to this during supervision, the borrower did not have the incentive to cooperate with the Bank that could have been provided by the inclusion of specific items for agricultural support services.

7.15 When appraising a project in a country which is short of fertilizer and foreign exchange to buy it abroad, the provision of fertilizer under the project should be considered and the pricing of inputs and outputs should be discussed and agreed with the borrower at appraisal.

Map 1

VIETNAM —— DAU TIENG IRRIGATION PROJECT

LOCATION MAP



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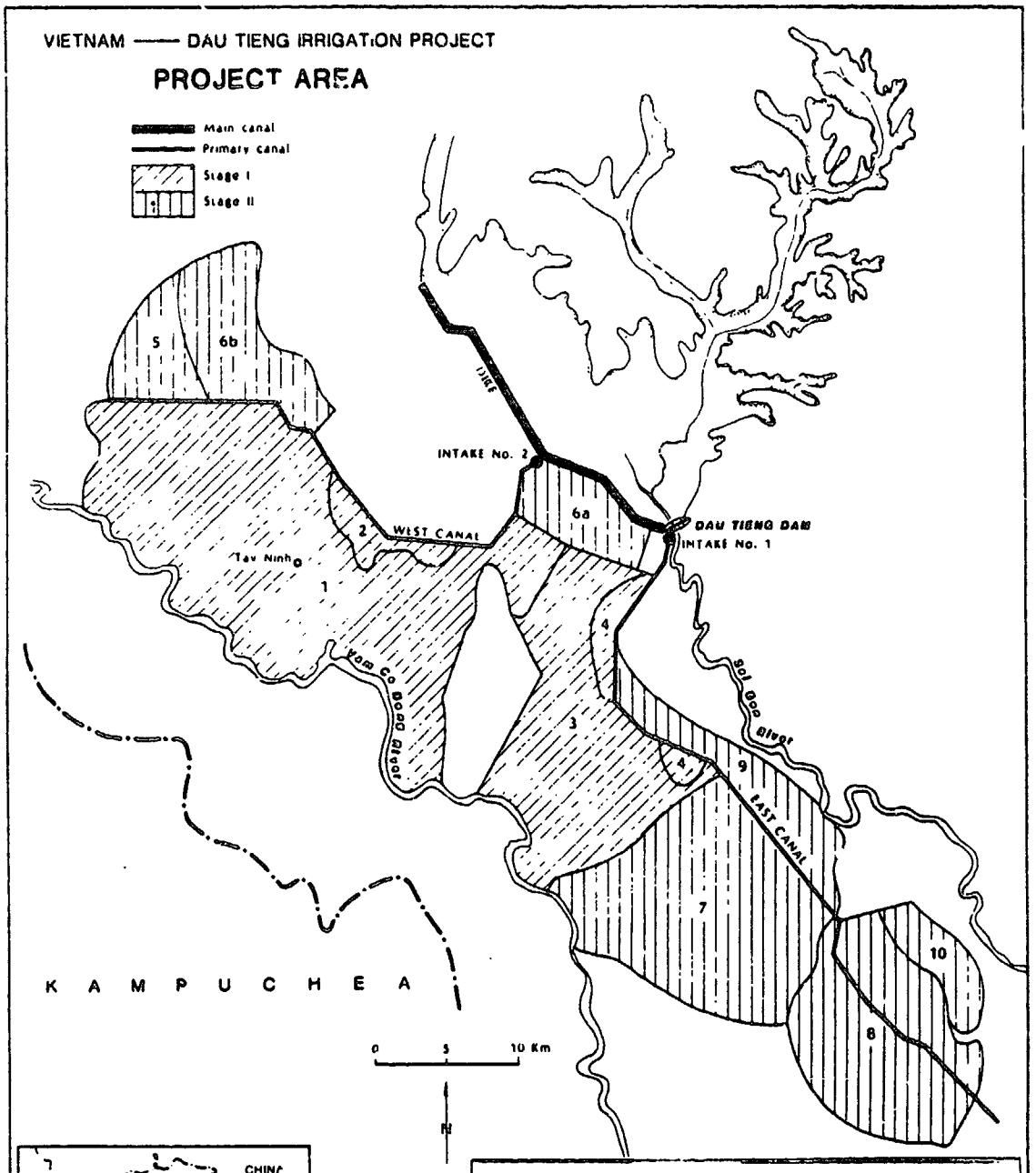
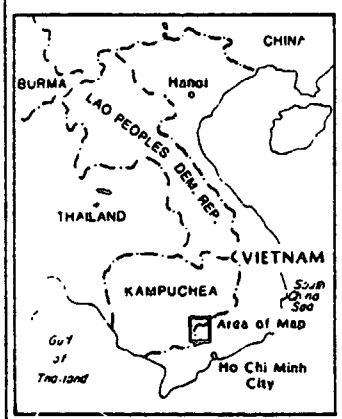
Map 2





	Stage I		Stage II	
	Location (No.)	Area (ha)	Location (No.)	Area (ha)
West Canal				
Gravity	1	27,040	5	12,000
Pumped	2	1,150	6a	5,040
			6b	7,000
Total		28,190		25,040
East Canal				
Gravity	3	13,119	7	12,642
			8	10,000
Pumped	4	977	9	6,042
			10	2,000
Total		14,096		30,684

DDC189-14

VIETNAM

Dau Tieng Irrigation Project

Implementation Schedule

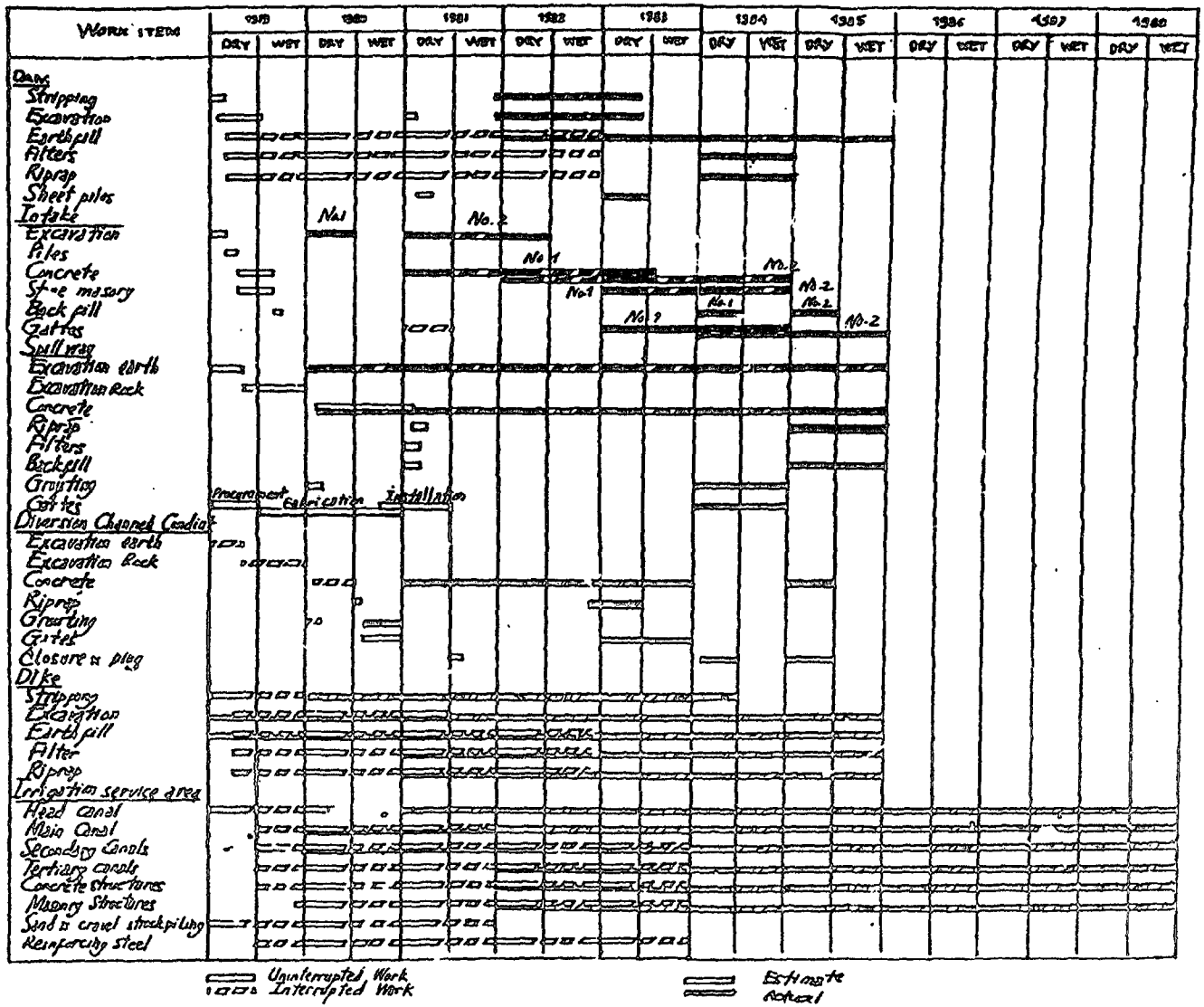


CHART 1

VIETNAM

BAU TIENG IRRIGATION PROJECT (Cr. 845-VN)

Cropped Area, Yield and Production Used for Analysis of Stage I (42,000 ha)

Item	Pre-project			Future Without Project			Future With Project		
	Cropped Area ('000 ha)	Yield (tons/ha)	Production ('000 tons)	Cropped Area ('000 ha)	Yield (tons/ha)	Production ('000 tons)	Cropped Area ('000 ha)	Yield (tons/ha)	Production ('000 tons)
1. Crops									
Pre-monsoon:									
Rainfed - Paddy	2.0	2.0	4.0	2.0	2.1	4.2	-	-	-
- Groundnuts	6.0	0.8	4.8	6.0	0.9	5.4	-	-	-
Irrigated - Paddy	-	-	-	-	-	-	8.5	2.5	21.3
- Groundnuts	-	-	-	-	-	-	4.5 (1)	1.4	6.3
Monsoon:									
Rainfed - Paddy	33.5	2.0	67.0	33.5	2.1	70.4	-	-	-
- Groundnuts	8.5	1.0	8.5	8.5	1.1	9.4	-	-	-
Irrigated - Paddy	-	-	-	-	-	-	33.5	2.4	80.4
- Groundnuts	-	-	-	-	-	-	8.5 (2)	1.3	11.1
Dry Season:									
Rainfed - Groundnuts	10.0	1.2	12.0	10.0	1.3	13.0	-	-	-
Irrigated - Paddy	0.5	3.0	1.5	0.5	3.2	1.6	25.0	3.7	92.5
- Groundnuts	-	-	-	-	-	-	17.0 (3)	1.8	30.6
2. Total Cropped Area	60.5			60.5			97.0		
3. Net Cultivated Area	42.0			42.0			42.0		
4. Cropping Intensity (%)	144%			144%			230%		

---

(1) Includes 1,000 ha of pump irrigated area.
(2) Includes 2,000 ha of pump irrigated area.
(3) Includes 2,000 ha of pump irrigated area.

Table 1

VIETNAM

DAU TIENG IRRIGATION PROJECT (Cr. 845-VN)

Cropped Area, Yield and Production Used for Analysis of Stages I and II (97,000 ha)

Item	Pre-project			Future Without Project			Future With Project		
	Cropped Area ('000 ha)	Yield (tons/ha)	Production ('000 tons)	Cropped Area ('000 ha)	Yield (tons/ha)	Production ('000 tons)	Cropped Area ('000 ha)	Yield (tons/ha)	Production ('000 tons)
1. Crops									
Pre-monsoon:									
Rainfed - Paddy	3.5	2.0	7.0	3.5	2.1	7.4	-	-	-
- Groundnuts	14.5	0.8	11.6	14.5	0.9	13.1	-	-	-
Irrigated - Paddy	-	-	-	-	-	-	14.5	2.5	36.3
- Groundnuts	-	-	-	-	-	-	4.5 (1)	1.4	20.3
Monsoon:									
Rainfed - Paddy	67.5	2.0	135.0	67.5	2.1	141.8	-	-	-
- Groundnuts	29.5	1.0	29.5	29.5	1.1	32.5	-	-	-
Irrigated - Paddy	-	-	-	-	-	-	67.5	2.4	162.0
- Groundnuts	-	-	-	-	-	-	29.5 (2)	1.3	38.4
Dry Season:									
Rainfed - Groundnuts	24.0	1.2	28.8	24.0	1.3	31.2	-	-	-
Irrigated - Paddy	1.0	3.0	3.0	1.0	3.2	3.2	53.5	3.7	198.0
- Groundnuts	-	-	-	-	-	-	43.5 (3)	1.8	78.3
2. Total Cropped Area	140.0			140.0			223.0		
3. Net Cultivated Area	97.0			97.0			97.0		
4. Cropping Intensity (%)	144%			144%			230%		

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(1) Includes 11,500 ha of pump irrigated area.
(2) Includes 23,000 ha of pump irrigated area.
(3) Includes 23,000 ha of pump irrigated area.

Table 2

VIETNAM

DAU TIENG IRRIGATION PROJECT (Cr. 845-VN)

Per Hectare Crop Yields, Farm Inputs, and Cost of Production (1)

	Yield (tons)	By-product (tons)	Farm Inputs: Seeds (kg)	Fertilizers N (kg)	Fertilizers P (kg)	Fertilizers K (kg)	Composts (tons)	Agro-Chemicals (1)	Farm Labour (man-days)	Draught Animals (pair-days)	Total Cost Per Ha (2): Financial (3) (D'000)	Total Cost Per Ha (2): Economic (4) (US$)
Pre-Project												
Pre-Monsoon:												
Rainfed - Paddy (6) (broadcast)	2.0	2.0	100	30	15	-	3.0	-	120	4	103.0 (5)	160 5 (5)
- Groundnut	0.8	-	100	10	15	-	1.5	-	90	4	134.5	124.7
Monsoon:												
Rainfed - Paddy (transplanted)	2.0	2.0	80	30	15	-	3.0	-	130	5	101.0	156.8
- Groundnut	1.0	-	100	10	20	-	1.5	1.5	100	4	153.5	143.9
Dry Season												
Rainfed - Groundnut	1.2	-	100	15	25	-	1.5	1.0	105	4	163.5	153.4
Irrigated - Paddy (broadcast)	3.0	1.5	120	60	30	20	3.0	1.0	125	4	173.6 (5)	217.3 (5)
Future Without Project												
Pre-Monsoon:												
Rainfed - Paddy (6) (broadcast)	2.1	2.1	100	30	15	-	3.5	-	120	4	105.5	161.5
- Groundnut	0.9	-	100	10	15	-	2.0	-	95	4	137.0	129.7
Monsoon:												
Rainfed - Paddy (transplanted)	2.1	2.1	80	30	15	-	3.5	-	130	5	103.5	157.8
- Groundnut	1.1	-	100	10	25	-	2.0	1.0	100	4	162.0	147.6
Dry Season												
Rainfed - Groundnut	1.3	-	100	15	30	-	2.0	1.0	110	4	172.0	161.1
Irrigated - Paddy (transplanted)	3.2	1.6	120	60	35	20	3.5	1.0	125	4	179.6 (5)	221.0 (5)
Future With Project												
Pre-Monsoon:												
Irrigated - Paddy (transplanted)	2.5	2.5	50	40	15	-	3.5	1.5	130	5	122.0	170.8
- Groundnut	1.4	-	100	20	35	20	2.5	1.5	110	5	204.6	179.6
Monsoon:												
Irrigated - Paddy (transplanted)	2.4	2.4	50	40	15	-	3.5	1.5	140	6	126.0	180.3
- Groundnut	1.3	-	100	20	35	20	2.5	1.5	110	5	204.6	179.6
Dry Season												
Irrigated - Paddy (broadcast)	3.7	2.0	100	70	40	30	4.0	1.5	130	5	207.9	220.4
- Groundnut	1.8	-	100	25	40	25	3.0	1.5	120	5	199.5	195.7

(1) Mission estimates based on data provided by Tay Ninh Provincial Agricultural Service and data made available to mission from Bank project file. These data are often conflicting and some data such as seed rates and farm labour requirements for transplanted paddy, and draught animal requirements for all crops are either exceptionally high or low for inexplicable reasons. No adjustment on these, however, has been made.

(2) Computed on the basis of prices given in Table 8.

(3) Excludes hired labour. For the purpose of farm budgets given in Tables 4 and 5, hired labour was estimated on the basis of cropping pattern and family labour availability.

(4) Includes economic cost of labour valued at US$0.8.

(5) Includes operating cost of pump irrigation; Dry season paddy = 60 l fuel + 3 l lub. oil + 12 man-days; Pre-monsoon paddy = half of Dry season paddy.

(6) Partially irrigated by low lift pumps.

Table 3

VIETNAM

DAU TIENG IRRIGATION PROJECT (Cr. 845-VN)

Estimated Farm Budget for an Average 1.0 Ha Holding in Lowland

	Pre-Project		Future Without Project		Future With Project	
	Monsoon	Dry Season	Monsoon	Dry Season	Monsoon	Dry Season
Cropping Pattern (ha)						
Rainfed Paddy	1.0	-	1.0	-	-	-
Irrigated Paddy	-	-	-	-	1.0	1.0
Total Cropped Area	1.0		1.0		2.0	
Cropping Intensity (%)	(100)		(100)		(200)	
Crop Production (ton) (1)						
Paddy	2.0		2.1		6.1	
Gross Value of Production (D'000) (2)	555.5		583.3		1,689.6	
Production Costs (D'000) (3)						
Farm Inputs	81.0		83.5		289.9	
Hired Labour	-		-		60.0	
Draught Animals	20.0		20.0		44.0	
Total	101.0		103.5		393.9	
Net Value of Production (D'000)	454.5		479.8		1,295.7	
less Agricultural Tax (10% of GVP)	55.5		58.3		168.9	
Water Charges (5% of GVP)	-		-		84.5	
Net Farm Income (D'000)	399.0		421.5		1,042.3	
Net Per Capita Income (D'000)	66.5		70.3		173.7	

(1) See Table 3 for per ha crop yields.
(2) See Table 8 for financial prices; GVP includes value of by-products.
(3) See Table 3 for per ha crop inputs.

Table 4

VIETNAM

DAU TIENG IRRIGATION PROJECT (Cr. 845-VN)

Estimated Farm Budget for an Average 1.0 Ha Holding in Medium Lowland

	Pre-Project			Future Without Project			Future With Project		
	Pre-Monsoon	Monsoon	Dry Season	Pre-Monsoon	Monsoon	Dry Season	Pre-Monsoon	Monsoon	Dry Season
Cropping Pattern (ha)									
Rainfed - Paddy	-	1.0	-	-	1.0	-	-	-	-
- Groundnuts	0.2	-	0.3	0.2	-	0.3	-	-	-
Irrigated - Paddy	-	-	-	-	-	-	0.5	1.0	0.5
- Groundnuts	-	-	-	-	-	-	-	-	0.5
Total Cropped Area		1.5			1.5			2.5	
Cropping Intensity (%)		(150)			(150)			(250)	
Crop Production (tons) (1)									
Paddy		2.0			2.1			5.5	
Groundnuts		0.5			0.6			0.9	
Gross Value of Production (D'000) (2)		971.5			1,039.3			2,245.3	
Production Costs (D'000) (3)									
Farm Inputs		149.0			154.0			400.7	
Hired Labour		-			-			80.0	
Draught Animals		28.0			28.0			54.0	
Total		177.0			182.0			534.7	
Net Value of Production (D'000)		794.5			856.8			1,710.6	
less Agricultural Tax (10% of GVP)		97.2			103.9			224.5	
Water Charges (5% of GVP)		-			-			112.3	
Net Farm Income (D'000)		697.3			752.9			1,373.8	
Net Per Capita Income (D'000)		116.2			125.5			228.9	

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(1) See Table 3 for per ha crop yields.
(2) See Table 8 for financial prices; GVP includes value of by-products.

Table 5

VIETNAM

DAU TIENG IRRIGATION PROJECT
(CREDIT 845-VN)

Derivation of Economic Farmgate Price for Paddy and Groundnuts

Paddy	US$/ton	Groundnuts	US$/ton
Thai 5% broken f.o.b. Bangkok 1995 price in 1988 US$	243	Shelled nuts, c.i.f. Europe 1995 price in 1988 US$	469
Quality adjustment, 15%	207	Ocean freight and insurance	-30
Ocean freight and insurance	+30	Export price f.o.b. Ho Chi Minh City	439
Import price c.i.f. Ho Chi Minh City	237	Port handling/transport to store	-26
Port handling/transport to store	+26	Processing	-22
Price at store	263	Price ex-mill	391
Paddy equivalent (63%)	166	Farmgate price (unshelled 70%)	274
Drying, cleaning, milling less by-products	-15		
Handling/transport farm to mill	-3		
Farmgate price	149		

Table 6

Table 7

VIETNAM

DAU TIENG IRRIGATION PROJECT
(CREDIT 845-VN)

Derivation of Economic Farmgate Price for Fertilizers

	Urea	TSP	MOP
	..... (US$/ton)		
1995 price in 1988 US$	198	194	101
Ocean freight and insurance	30	30	30
Import price c.i.f. Ho Chi Minh City	228	224	131
Port handling/transport to store	+26	+26	+26
Processing	-	-	-
Transport farm to market	-3	-3	-3
Farmgate price	251	247	154
Farmgate price/kg nutrient	557	537	308

Table 8

VIETNAM

DAU TIENG IRRIGATION PROJECT
(CREDIT 845-VN)

Financial and Economic Farmgate Prices of Outputs and Inputs

	Financial (D/kg)	Economic (US$/kg)
Outputs		
Paddy	275	0.15
Groundnuts	800	0.27
Inputs		
N	800	0.56
P	1,200	0.54
K	480	0.31
Compost	5	0.002
Paddy seed	300	0.18
Groundnut seed	850	0.30
Buffalo traction (pair-days)	4,000	1.5
Unskilled labour (man-days)	2.000	0.8
Lubricant (litre)	2,000	0.8
Fuel (litre)	640	0.12
Agrochemicals (litre)	13,000	8.5

VIETNAM

DAU TIENG IRRIGATION PROJECT (Credit 845-VN)

Economic Analysis for Stage I

Year	Irrigated Area Phasing			Investment Cost (1)			O & M	Agricultural Benefits			Net Incremental
	Pre-monsoon	Monsoon	Dry Season	Foreign	Local (2)	Total	Cost	With	Without	Incremental	Benefits
	('000 ha)			(US$ million)							
1979	-	-	-	39.2	0.3	39.5	-	-	-	-	(39.5)
1980	-	-	-	10.5	1.6	12.1	-	-	-	-	(12.1)
1981	-	-	-	19.9	2.8	22.7	-	-	-	-	(22.7)
1982	-	-	-	17.7	4.1	21.8	-	-	-	-	(21.8)
1983	-	-	-	12.4	6.3	18.7	-	-	-	-	(18.7)
1984	-	-	14.3	19.9	7.7	27.6	-	-	-	-	(27.6)
1985	-	-	20.0	24.8	4.3	29.1	-	11.9	8.8	3.1	(26.0)
1986	5.0	20.0	30.3	2.3	2.1	4.4	-	14.4	8.7	5.7	1.3
1987	10.9	30.3	32.4	-	0.8	0.8	-	18.2	9.1	9.1	8.3
1988	11.9	32.1	38.0	-	0.4	0.4	-	18.7	9.3	9.4	9.0
1989	12.5	37.0	42.0	-	1.2	1.2	0.9	20.3	9.5	10.8	9.6
1990	13.0	42.0	42.0	-	1.3	1.3	1.0	21.3	9.7	11.6	10.3
1991	13.0	42.0	42.0	-	-	-	1.0	22.0	9.7	12.3	12.3
1992	13.0	42.0	42.0	-	-	-	1.0	22.5	9.7	12.8	12.8
1993	13.0	42.0	42.0	-	-	-	1.0	23.2	9.7	13.5	13.5
1994-2018	13.0	42.0	42.0	-	-	-	1.0	23.7	9.7	14.0	14.0

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(1) 48% of construction costs attributed to reservoir construction.

(2) Includes east main canal km 0 to km 20.

Table 9

VIETNAM

DAU TIENG IRRIGATION PROJECT (Credit 845-VN)

Economic Analysis for Stage I and Stage II

Year	Irrigated Area Phasing			Investment Cost			O & M	Agricultural Benefits			Net Incremental
	Pre-monsoon	Monsoon	Dry Season	Foreign	Local	Total	Cost	With	Without	Incremental	Benefits
	('000 ha)			(US$ million)							
1979	-	-	-	39.2	0.3	39.5	-	-	-	-	(39.5)
1980	-	-	-	10.5	1.6	12.1	-	-	-	-	(12.1)
1981	-	-	-	19.9	2.8	22.7	-	-	-	-	(22.7)
1982	-	-	-	17.7	4.1	21.8	-	-	-	-	(21.8)
1983	-	-	-	12.4	6.9	19.3	-	-	-	-	(19.3)
1984	-	-	14.3	19.9	8.5	28.4	-	-	-	-	(28.4)
1985	-	-	20.0	24.8	5.6	30.4	-	23.3	20.2	3.1	(27.3)
1986	5.0	20.0	30.3	2.3	5.2	7.5	-	26.3	20.6	5.7	(1.8)
1987	10.9	30.3	32.4	-	3.8	3.8	-	30.1	21.0	9.1	5.3
1988	11.9	32.1	38.0	-	3.0	3.0	-	30.8	21.4	9.4	6.4
1989	12.5	37.1	42.0	-	3.6	3.6	0.9	32.6	21.8	10.8	6.3
1990	13.0	42.0	42.0	-	2.6	2.6	1.0	33.9	22.2	11.7	8.1
1991	14.5	48.5	48.5	-	1.3	1.3	1.2	35.5	22.2	13.3	10.8
1992	16.5	55.3	55.3	-	1.4	1.4	1.3	37.2	22.2	15.0	12.3
1993	18.6	62.1	62.1	-	1.3	1.3	1.5	38.8	22.2	16.6	13.8
1994	20.6	68.9	68.9	-	1.3	1.3	1.7	40.5	22.2	18.3	15.3
1995	22.6	75.7	75.7	-	1.4	1.4	1.8	42.1	22.2	19.9	16.7
1996	24.6	82.4	82.4	-	1.3	1.3	2.0	43.8	22.2	21.5	18.3
1997	26.7	89.2	89.2	-	1.3	1.3	2.1	45.4	22.2	23.2	19.8
1998	29.0	97.0	97.0	-	-	-	2.3	47.1	22.2	24.9	22.6
1999	29.0	97.0	97.0	-	-	-	2.3	48.4	22.2	26.5	24.2
2000	29.0	97.0	97.0	-	-	-	2.3	50.3	22.2	28.1	25.8
2001	29.0	97.0	97.0	-	-	-	2.3	51.4	22.2	29.2	26.9
2002	29.0	97.0	97.0	-	-	-	2.3	53.0	22.2	30.8	28.5
2003-2018	29.0	97.0	97.0	-	-	-	2.3	54.1	22.2	31.9	29.6

Table 10

ANNEX

VIET NAM

DAU TIENG IRRIGATION PROJECT (CREDIT 845-VN)

DAU TIENG RESERVOIR-SAFETY ASPECTS

A. Introduction

1. This annex has been written to respond to the World Bank's request that reservoir safety be given special attention in the project completion report. Ho Chi Minh City is situated about 65 km downstream of the main dam and a catastrophic failure of this dam could affect the city.

2. This annex is based on a 3-day vist to the reservoir and discussions with staff of the Minisitry of Water Resources (MWR) concerned with design, construction and operation of the dam.

B. Description of Reservoir

3. The reservoir has a total storage capacity of 1,580 Mm3. It is situated in a seismic zone.

4. The dam proper is a homogeneous earthfill structure, 28.0 m high above the river bed and about 1.5 km long. An inclined "chimney" sand filter is incorporated in the downstream section and there is a sheet-piled cutoff to rock level over the deepest part.

5. The spillway is a separate concrete structure adjacent to the northeast end of the dam. It is founded on rock with a downstream channel leading to the river.

6. Along the west side of the reservoir, the dam is continued as a 27 km long dyke varying from 8.0 to 2.0 m high. Some 11 km along the dyke from the main dam there is an auxiliary dam, 20.0 m high.

7. Appendix 1 gives further details of the main characteristics.

C. Physical Inspection of Dam Works

8. The dam, spillway, spillway channel and the dyke including the auxiliary dam were inspected visually. Features noted are grouped under their headings, not geographically according to their locations.

Percolation

9. Three cases of percolation were noted downstream of the dam:

(1) A flow of the order of 3 to 4 l/s on the left bank at the downstream toe, associated apparently with the east side of the river diversion culvert, now the scour culvert. Clear water.

(2) A flow of about 100 l/s along a rough drainage channel following the downstream toe on the right bank between the east intake and the scour culvert. Clear water. This could be from the dam or from the upstream end of the east drainage canal or both.

(3) A significant flow of about 800 l/s discharging below the east canal (in culvert) to the river, about 100 m downstream of the dam. This flow, in an earth-lined channel, was said to come from the downstream seepage of the 11 km of dyke below the saddle dam plus some natural surface drainage downstream of the dam. There had been no rain for at least two weeks, perhaps longer. Clear water. There was insufficient time to follow this drain to its origin.

10. Two cases of percolation were noted along the length of the dyke:

(a) A flow of perhaps 20 l/s from the auxiliary dam, confined in an earth channel and discharging into the west irrigation canal. Clear water.

(b) A small flow of about 2 l/s at km 19 along the dyke. Clear water.

11. In addition, for almost the whole 27 km of the dyke there were stagnant pools of water, up to about 20 cm deep. These lay in a low continuous trench on the downstream side of the dyke, confined by the dyke and the parallel earth road. The trench looked as though it had been formed by stripping the vegetative cover, probably for the dyke construction. Groundwater was noted to be less than 1.0 m below ground surface level in domestic wells immediately downstream of the road.

12. The only other flow seen downstream of the dam, apart from gate leakage, was a flow from a culvert constructed through the dam on the right bank, which had been designed to provide about 200 l/s for a small electric generator. No generator had been installed. The flow represented leakage past the control valve and was discharging into the east irrigation canal, apparently through a hole in the canal lining.

Settlement Monuments

13. The four monuments to read dam crest levels were inspected. They each consist of a small concrete plinth with a 4-inch rail set in it, about 1 cm proud of the surface. The concrete plinths appeared very fresh, perhaps 1-2 weeks old.

Piezometric Tubes

14. There are four tubes on the same cross sections as the settlement monuments. All had wooden plugs fitted and two, which were checked at random, were clear down to water level so satisfactory observation was possible.

Reservoir Water Level

15. There is a vertical graduated staff to provide for visual observations.

Surface Erosion

16. Four areas of erosion due to surface water runoff were noted on the downstream face of the dam. There are probably more. These were typically 20 m2 to 60 m2 in area and just below the downstream berm at the 19.50 m level. These areas had not been made good and there was no evidence of remedial work of any kind. Many examples of similar erosion were noted along the downstream side of the dyke.

Control Gates

17. All control gates are in position and operating. Presently, the west intake gates are operated manually and the east intake and spillway employ temporary cabling. The leakage observed past the radial spillway gates is acceptable. However, the gatehouse structure in the west inlet is still under construction and the gates could not, for example, be hoisted for maintenance. The permanent electrical installation for gate operation remains to be completed. This is scheduled to be done in 1989 before the rains when the transmission line past the dam (now under construction) is completed.

18. It required two days to open a spillway gate selected at random (No. 4). This was mainly because of: (a) the time required to place the stoplogs; and (b) a problem in extracting the locking crane hooks from the stoplog sections. Lifting speed is slow at 2 m/hour so that it takes three hours to open a radial gate fully. All gates may be operated simultaneously so that in an emergency the spillway could be fully opened in three hours, provided no stoplogs are in position.

19. The two-coat paint protection, which was applied four years ago, was flaking off badly and the steelwork of the gate was very rusty. The upstream side was almost bare of paint, there was a continuous film of rust and pitting of the steel surface had commenced.

Spillway Discharge Channel

20. The 1,000 m long spillway channel downstream of the dam conveys the spillway discharge back to the Saigon River using a former river channel.

21. Overburden over a width of about 70.0 to 100.0 m has been cleared down to rock and some of the more obvious rock obstructions removed. However, the bulk of the channel is "as excavated". Just before it joins the Saigon River there is a rock bar in the channel which forms a natural sill to be overtopped by the flood discharge before it gains the river.

Construction Quality

22. In general, the quality of earthworks inspected appeared satisfactory. Concrete structures appeared in general adequate for their purpose, but the finish was poor.

23. Defects of concrete finish included the following:

- insufficient cover to reinforcement for a water retaining structure (in fact uncovered steel bars in some locations);
- poorly constructed joints permitting leakage;
- evidence of honeycombed finish covered over by mortar instead of being cut out and made good;
- shutter ties and other rubbish left cast into the concrete surface.

24. Access ladders and walkways and the temporary electrical cabling seen both fall short of international safety standards.

D. Consideration of Records of Dam Behaviour

25. Appendix 2 lists the data on dam behaviour supplied to the mission. In addition, reservoir water level is recorded daily and these records were shown to the mission. Reservoir water level stood at 23.50 m at the time of the visit. In general, these data are as yet too sparse to permit an informed judgement, particularly in the case of percolation.

Percolation

26. Percolation downstream of the dam has already been described. The two sets of values given, taken at the interval of one year, are clearly insufficient for any judgement of trend. It is important also to remember that these are estimates based on assessment of area of a rough earth channel and of float velocities and in consequence affected by subjective error. They are not readings of absolute values.

27. The most that can be said is that the values seem consistent, which is reassuring, and that the flow which is said to come from the dyke responded to the increase in reservoir level, as would be expected.

28. However, the flow from the dam on the right bank at almost 100 l/s is significant and should be closely monitored. Part of this seepage may be from the east irrigation canal and correlation of a sufficient number of observations with reservoir level and canal level may throw some light on this. The flow from the dyke (which may also be the natural drainage of an area downstream of the dam) seems high and should be monitored. This requires:

- Regular readings at intervals of not more than a month.
- Accurate readings. This means that percolation flows have to be confined in a brick or concrete channel and measured by accurately constructed V notches (for the smaller flows) and weirs or flumes (for the larger).
- Readings of all percolation seepages. Not only relatively large flows but all flows must be monitored. In addition to the two flows just discussed, the following should be read:
    (a) percolation downstream on left bank in area of scour culvert (4 l/s);
    (b) downstream toe of auxiliary dam west of west irrigation canal (20 l/s);
    (c) downstream of the dyke, at km 19 (2 l/s).

29. In the case of the large flows thought to be from the dyke, the channel should be traced back from its outlet to the point where the dyke joins the dam proper and the measuring flume sited at this point. This will eliminate the possibility of reading part of the natural drainage below the dam. In addition, a second measuring point about halfway between the dam and the west intake, say at 6 km, should be established. This will permit an assessment of whether seepage is proportional to distance.

30. In order to do this, it will be necessary to dig a downstream ditch to drain the stagnant pools of water. Above the auxiliary dam at 12 km, this ditch will have to discharge to the natural drainage. This would then permit closer observation of seepage along the dyke.

Settlement

31. The dam settlement readings taken annually indicate a rate of settlement of about 3 to 4 cm/year, still in progress but perhaps decreasing. These values are acceptable. It would be an advantage to take observations at the maximum and minimum reservoir levels (24.00 m and 17.00 m), which would mean about a 6-month frequency and perhaps even mid-point observations whilst settlement is in progress.

32. It is of course most important to continue to take observations after initial settlement has ceased and the levels observed have become steady in order to monitor any subsequent movement.

E. Operation of Reservoir

33. The mode of operation of the reservoir has obviously been considered deeply and the sequence of operations to regulate water level over the year is fully appreciated by the designers. What lacks is a set of clear operating instructions which can be understood and followed by junior technical grades. This has a special importance in the Dau Tieng case where controlled spilling can start only by human intervention.

34. At present, the O&M organization has been designated in the form of an organization chart and by defining who is responsible for what section. The complement to this is the operating manual which would explain the action required and the regular practice of these actions.

35. One of the conditions (Section 3.06) of the Development Credit Agreement is that the expert panel would provide advice for the preparation of a spillway manual and would recommend a maintenance and safety inspection programme. This has not yet been done.

36. Most important in the formulation of these procedures is that the person at the dam site has full responsibility and must initiate the required action without first having to refer to Tay Ninh, Ho Chi Minh or even Hanoi.

37. Another aspect of operation is the regular monitoring of dam behaviour. This requires regular observation of not only reservoir water level but of settlement, percolation and piezometric levels. Monitoring implies a close watch of trends.

F. Flood Warning System

38. The flood warning system at Dau Tieng operates as follows. An operator at a rain gauge in the catchment area makes rainfall readings at 6-hour intervals during the rainy season. He telegraphs this information once per day to the dam. The weak point in the system is that it requires the presence on the dam of a person with the intelligence and initiative to interpret the information and to decide if action (e.g. opening spillway gates) is required.

39. The operation manual already referred to (Section E) for spillway operation would contain explicit instructions for action, based on intensity and duration of the rainfall.

40. The mission visited the Mekong Secretariat in Bangkok and discovered the existence of another early warning system. A diagram of the communication system between the Secretariat and the Regional Meteorological and Hydrological Centre in Ho Chi Minh City and also Hanoi is shown in Appendix 3.

41. Although the information is mainly for flooding in the Mekong River and Delta, the Secretariat has a satellite forecast of cyclone activity in the China Sea and a tracking system which operates during the cyclone season. This is broadcast by radio every morning to the Regional Meteorological Centre in Ho Chi Minh City. Heavy rains in the wake of cyclones are one of the causes of flooding in the region and it would clearly be prudent to establish a formal link between the Regional Meteorological Centre in Ho Chi Minh and the dam.

G. Commentary

General

42. In creating a reservoir in a seismic area which relies on mechanical operation of the spillway, the designers have relied on well-trained operating personnel. Amongst the junior staff at the dam there is the lack of a clear understanding of what physical actions are required for reservoir operation and what signals would cause these actions to be taken. All the information required to compile operating instructions exists already in various reports and calculations; what remains to be done is to codify this material into clear instructions meaningful to junior staff.

43. At present, the project manager is the only person in a position to interpret the data and to decide when to start opening the spillway gates. Even now it is not clear whether he could initiate this action on his own responsibility or whether he would have to refer first to a higher authority in Ho Chi Minh City or in Hanoi. He is not, of course, resident 365 days per year at the dam site.

Hydraulic Design Parameters

44. The original design flood (SAR) was taken as that with a return period of 1,000 years. This was estimated to have a total volume of 820 Mm3 and a maximum reservoir inflow of 5,600 m3/s. It was estimated that this flow would be passed through the reservoir starting from the maximum operating level of 24.40 and rising to a maximum 25.90 with a spillway discharge of 2,500 m3/s.

45. When the dam review panel visited the site in December 1982, these values were revised taking into account rainfall data from 1915 to 1975 and discharge measurements near the dam site from 1976 to 1979. The 1,000 year flood was then estimated to have a total volume of 563 Mm3 and a maximum reservoir inflow of 5,860 m3/s. Starting from the maximum operating level of 24.40, this flood would be passed through the reservoir at maximum level 25.10 and a spillway discharge of 2,800 m3/s.

46. In response to the review panel's concern with the effects of a catastrophic dam-burst on the population downstream and to the continued insistence of the supervision missions, the main embankment level was raised to 28.00. The top level of the long dyke was left at 27.00. Because of the risk to Ho Chi Minh City downstream, the panel considered that the dam should be able to withstand the flood with a retain period of 10,000 years. This is estimated as 700 Mm3 total volume and will pass through the reservoir at about 26.0 m maximum level with the spillway discharge at 2,800 m3/s. On the Creager curve for a catchment area of 2,700 km2, this flood of 7,200 m3/s is 64% of the probable maximum flood and as such may be taken as acceptable.

47. It might be argued that the importance of Ho Chi Minh City merits an even more conservative flood protection than that of 1 in 10,000 years. The reservoir designers have provided this extra protection by leaving the top elevation of the west dyke at level 27.00 when the level of the main dam embankment was raised to the 28.00 level.

48. If the rare event of a maximum flood occurred and it were sufficient to overtop the reservoir, the breach would occur in the west dyke. This would draw down the reservoir water level thereby protecting the main dam embankment. The resulting flood would pass down the valley of the west irrigation canal and a newly constructed drain to the valley of the Vam Co Dong River. This river discharges to the sea without passing through Ho Chi Minh City.

49. A consideration of the foregoing discussion leads us to recommend the following:

(1) To check that the 28.00 level of embankment is continued a safe distance past the Saigon River watershed.

(2) To check, as recommended by the 1982 review panel, the shape of the design flood hydrographs by analyzing actual flood hydrographs from the Saigon River or similar catchments.

(3) To route the flood resulting from a catastrophic failure of the dyke and saddle dam down the west irrigation valley using, for example, the empirical approach suggested by Kirkpatrick in the August 1977 issue of "Water Power". This would give some assessment of the potential threat to the downstream population.

(4) If necessary, to prepare a "disaster plan" for the affected area with advance warning as a prominent component.

50. The spillway consists of six submerged radial gates each 10.0 m wide and 6.0 m high with an invert level of 14.00. At maximum reservoir level (25.10) these 6 openings appear adequate to pass the design discharge of 2,800 m3/s. At a reservoir level of 26.50 (which still leaves 1.50 m freeboard at the dam) 5 openings will pass the design discharge. This would allow for the failure of one gate to operate. Spillway capacity may therefore be accepted as adequate. It must never be forgotten, however, that spillway discharge depends on correct functioning of the gates which in turn depend on human action and perfect maintenance of the gates and raising equipment.

51. Maximum jet velocity at just over 13 m/s is below the value of 15 so that cavitation should not pose undue problems. The cut-off wall at the downstream end of the spillway chute which the 1982 review panel recommended has been built to prevent erosion from stilling-pool back eddies. The spillway chute may therefore be considered adequate for its purpose.

52. Under the effect of maximum discharge, the spillway channel will suffer some erosion but the dam and spillway proper are unlikely to be affected. Large floods are sufficiently rare to permit repairs and modifications to be carried out after the event, if necessary. The discharge channel

Seismic Design Parameters

53. The greatest seismic shock recorded in the area (historical epicentre about 100 km distant) is 6 on the Richter scale. The dam cross section is designed for a value of 8 on the Richter scale. This is reasonable. There is no record of induced seismicity during impounding. There are no steep slopes to the sides of the reservoir and the average depth of the full reservoir is 6.0 m. It is reasonable to expect no tidal wave effect from these conditions.

Observance of the 1982 Review Panels' Recommendations

54. A review panel, composed of three foreign engineers, visited the dam in December 1982 and made recommendations. Most but not all of these recommendations were adopted. Amongst those not carried out are:

(1) Construction of a line of relief wells immediately downstream of the dam about 15 m deep and at 15 m centres.

(2) The placing of pore pressure cells at the interface of fill and vertical concrete walls.

(3) The placing of pore pressure cells in sand foundation upstream and downstream of the sheet-piled cut-off.

(4) Tri-axial tests on dam fill material.

(5) Effective corrosion protection of hydraulic control gates by chipping and painting.

55. The construction of relief wells downstream of the dam as suggested in 1 above has no immediate function for the operation of the embankment. It would be advisable to defer any decision to drill such wells until the mode and amount of percolation is understood.

56. It is too late to place pressure cells as suggested in 2 and 3 above. These might have yielded useful information on the percolation now being observed.

57. It would still be possible to do tri-axial tests on samples collected from the embankment.

58. The spillway gates in particular were observed to be badly corroded. Chipping or sandblasting, cleaning and painting now and at regular intervals in the future will be required.

Monitoring and Testing

59. The percolation flows of 100 l/s and 800 l/s are large enough to cause worry. Their origins are not clear. It is therefore most important to start monitoring on the basis of accurate and regular measurements to get to now the behaviour of the embankment and to recognize trends.

60. In addition to percolation there is a need for a programme of monitoring:

- embankment settlement;
- piezometric levels.

61. As before the purpose of the monitoring is to understand the behaviour of the structure and to recognize trends away from normal.

Operation of Reservoir

62. The importance of clearly understood procedures to ensure correct operation of the spillway at all times has already been stressed. The writing of these procedures is the immediate priority for the proprietors of the reservoir. The second priority is to ensure that everyone concerned down to junior staff is fully aware of these procedures and that operating instructions are freely available.

63. Following from this, there should be adequate training which would include testing of gate opening both with electrical supply and hand operation, allied to a regular servicing of mechanical parts.

Quality of Finish

64. The concrete finishes already described under "construction quality" are poor. This requires repair and regular maintenance to keep steel reinforcement covered, to prevent further deterioration of joints and to improve poor or honeycombed surfaces. A regular programme of systematic repair and maintenance could improve the finish.

Maintenance and Repair

65. It was an obligation of the dam review panel to recommend a suitable maintenance and safety inspection programme. This has not so far been produced. It is most important to make this programme as early as possible and to put it into effect. Nothing appears to have been done in the past two years, for example, to make good surface erosion of the embankment due to rain.

66. Such a programme should include systematic attention to:

- embankment erosion: regular replacement and compaction of material washed out by filling and compacting, for example, with small aggregate. Construction of erosion barriers in selected areas.

- concrete finish: repair and making good of surface imperfections, in particular inadequate cover, exposed reinforcement and poorly finished joints.

- regular inspection and repair as necessary of upstream concrete slabs, downstream rip-rap, and stone protection walls.

Periodic Inspection of Completed Reservoir

67. The terms of the DCA (Section 4.02) requires the borrower to arrange for the periodic inspection of the completed reservoir works in accordance with sound engineering practice; this would normally require inspection by independent experts annually for the first few years after construction and every 5 years thereafter. The DCA requires that the Government's proposals for the periodic inspections be submitted to IDA for its consideration not later than December 1981. This has nct yet been done. It is important that these periodic inspections commence as soon as possible.

H. Summary of Recommendations

68. The recommendations for action are summarized below for convenient reference. The order given is the mission's assessment of priority.

(1) Prepare a manual in several bound copies of operating procedures for the reservoir. Promulgate to all concerned. Until this is done, keep reservoir level to maximum 22.50 m. This level ensures that the 10,000 year flood can be absorbed in the reservoir without operation of the spillway gates.

Institute reasonably frequent drills of these procedures including checks on gate operation (see Operation of Reservoirs and Commentary).

(2) As required by clause 4.02(b) of the DCA, make a proposal to IDA for the periodic inspections of the completed reservoir works by suitably qualified independent experts and carry out such inspections.

(3) Start to monitor percolation closely:

- construct measuring devices;
- take weekly observations;
- make a daily visual inspection (see Dam Behaviour).

(4) Clean, prepare and paint all exposed hydraulic steelwork - in particular the spillway radial gates - with at least a 4-coat recommended paint system (see Commentary).

(5) Drain the pools of water downstream of the dyke (see Dam Behaviour).

(6) Prepare a manual of maintenance and safety procedures (see Operation of Reservoir).

(7) Establish a formal and permanently live link with the Mekong early warning system through the Regional Meteorological Centre in Ho Chi Minh City (see Flood Warning).

(8) Increase the frequency of embankment settlement readings from 1 year to 3 months (see Dam Behaviour).

(9) Check shape of the various flood hydrographs used in the design process against a continuously increasing stock of actual flood hydrographs from the Saigon River (see Commentary).

(10) Check that dam crest level of +28.0 m extends a safe distance beyond the boundary of the Saigon River watershed and route the catastrophic dyke-burst flood down the Vam Co Dong valley. If necessary, prepare a "disaster plan" (see Commentary).

ANNEX
Appendix 1

VIETNAM

DAU TIENG IRRIGATION PROJECT
(CREDIT 845-VN)

Characteristics of Dau Tieng Reservoir

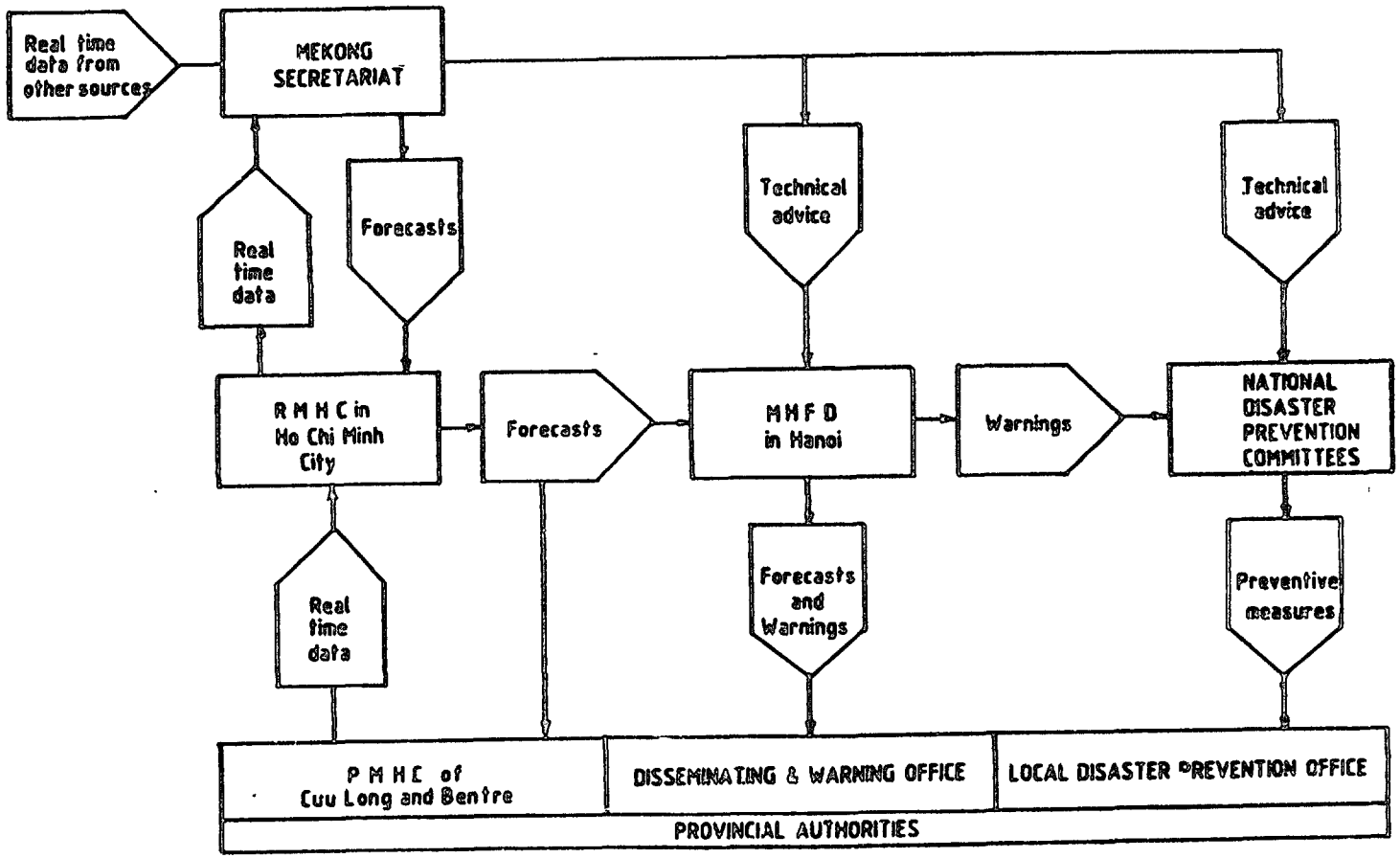
	SAR	Actual
Dam:-		
Crest level	27.0 + 1 m parapet	28.0
Crest length (m)	1,100	2,500 <1>
Crest width (m)	10.0	8.0
U/S slope H:V	3.5:1	3.5, 4.0, 4.5:1
D/S slope H:V	3.5:1	3.5, 4.0, 2.5:1
Reservoir:-		
1,000 year flood level	25.9	25.1
10,000 year flood level	-	26.0 <2>
Maximum storage level	24.4	24.4
Normal drawdown level	17.0	17.5
Live storage (Mm3)	1,050	1,056
Dead storage (Mm3)	400	524
Total storage (Mm3)	1,450	1,580
Mean annual flow (Mm3)	2,700	1,800
Area at 24.4 level (ha)	26,000	26,000
Dyke:-		
Crest level	-	27.0
Top width (m)	-	5.0
Length (km)	22.0	27.0
Spillway:-		
Type	Gated chute	Submerged orifice with radial gates
Size	12 (No.) 8 m x 5 m gates	6 (No.) 10 m x 6 m gates
Invert level (m)	+19.4	+14.0
Capacity (m3/s)	2,500	2,800

<1> Including spillway.
<2> Mission estimate.

VIETNAM

DAU TIENG IRRIGATION PROJECT

COMMUNICATION OF FORECASTS BETWEEN THE MEKONG SECRETARIAT AND VIETNAMESE AUTHORITIES



ANNEX
Appendix 3

ATTACHMENT I

Ministry of Foreign Affairs

The Hague

COMMENTS FROM THE COFINANCIER

World Bank
For the attn of Mr. G. Donaldson
1818 H Street, N.W.
Washington DC 20433
U.S.A.

Date:
November 22, 1989

Our ref:
VN-FI-128.884

Subject:
Vietnam/Dau Tieng Irrigation Project (Credit 845-VN)
Project Completion Report

Region:
DAL/ZO

Dear Mr. Donaldson,

I herewith confirm the receipt of the Project Completion Report on the Dau Tieng Irrigation Project carried out in Vietnam and inform you that there are no comments on the contents of the document.

THE MINISTER FOR DEVELOPMENT COOPERATION
For the Minister
The Deputy Head of the South-East Asian Counties Section
of the Development Cooperation Asia

Mrs. M.A. van Drunen Littel, LLM

ATTACHMENT II

COMMENTS FROM THE COFINANCIER

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197688 WORLDBANK

112153 FUND A
REF.NO. 7812/28
NOV.28.89
FROM:OPECFUND VIENNA
TO:MR. GRAHAM DONALDSON, CHIEF, AGRICULTURE, INFRASTRUCTURE AND HUMAN RESOURCES DIV., OPS EVALUATION DEPT., THE WORLD BANK, WASH. D.C.

RE - OPEC FUND LOAN NO. 93P, DAU TIENG IRRIGATION PROJECT, URLET OCT. 10.
PLSD TO ACKNOWLEDGE WITH THANKS RECEIPT OF ABOVE LET WITH ATTACHED DRAFT PCR ON AFORESAID PROJECT. WE WENT OVER THE REPORT AND APPRECIATE ALL THE EFFORTS U TOOK IN COMPILING INFO THEREIN, AND ARE PLSD TO INFORM U THAT WE HAVE NO COMMENT ON THE DOUCUMENT. WE LOOK FORWARD TO RECEIVING FINAL COPY OF THE REPORT.

BEST REGARDS

SAID AISSI
ASST. DIRECTOR-GENERAL, OPS
OPECFUND

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