

**THE SOCIALIST REPUBLIC OF VIET NAM
MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT**

**ENVIRONMENTAL IMPACT ASSESSMENT FOR VIET NAM WATER
RESOURCES ASSISTANCE PROJECT**

**VOLUME 1:
MAIN REPORT**

**PREPARED BY
CENTRAL PROJECT OFFICE**

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TABLE OF CONTENTS

1: INTRODUCTION	1
1.1 Background and Objectives.....	1
1.2 Overview of VWRAP	3
1.2.1 Overview of Yen Lap Sub-Project.....	3
1.2.2 Overview of Cam Son-Cau Son Sub-Project.....	3
1.2.3 Overview of Ke Go Sub-Project.....	5
1.2.4 Overview of Quang Hue-Vu Gia Sub-River Control Works.....	6
1.2.5 Overview of Phu Ninh Sub-Project	7
1.2.6 Overview of Da Ban Sub-Project.....	7
1.2.7 Overview of the Dau Tieng Sub-Project	8
1.3 Legal and Planning Context for this EIA.....	8
1.4 Approach to VWRAP Implementation Plan	9
1.5 General Approach to EIA Preparation.....	10
1.5.1 Sources of Information Used in the Preparation of this EIA.....	10
1.5.2 EIA Methodology	10
1.5.3 Area of Influence of Sub-Projects	11
1.5.4 Scope of Environmental Management Plan for VWRAP	11
1.6 Outline of this EIA.....	11
2: VWRAP PROJECT DESCRIPTION	12
2.1 Summary of Current Situation	12
2.1.1 Dam Safety.....	12
2.1.2 Yen Lap Sub-Project.....	12
2.1.3 Cam Son-Cau Son Sub-Project.....	14
2.1.4 Ke Go Sub-Project.....	15
2.1.5 Quang Hue-Vu Gia River Control Works.....	17
2.1.6 Phu Ninh Sub-Project	18
2.1.7 Da Ban Sub-Project.....	19
2.1.8 Dau Tieng Sub-Project.....	21
2.2 Description of VWRAP Project.....	22
2.2.1 Overall Objectives.....	22
2.2.2 Changes in Water Use and Allocation with Modernization	23
2.2.3 Engineering Required for Quang Hue-Vu Gia River Control Works.....	23
2.2.4 Summary of Engineering Required for Upgrading Irrigation Schemes.....	23
2.2.5 Modernization of Irrigation Management System	29
2.2.6 Requirements for Resettlement and Compensation for Land Acquisition	29
2.2.7 Expected Changes in Agricultural Land Use.....	29
2.3 Description of Dam Safety Fund	31
2.4 Description of EVN Hoa Binh Dam Safety Instrumentation and Da and Red River Reservoir Operations Infrastructure	31
3: DESCRIPTION OF EXISTING ENVIRONMENT'	33
3.1 Overview of Project Area	33
3.2 Physical Resources.....	33
3.2.1 Climate.....	33
3.2.2 Soils.....	33
3.2.3 Surface Water Quality	39
3.2.4 Groundwater Resources.....	39
3.2.5 Air Quality.....	40
3.2.6 Mineral Resources.....	41
3.3 Biological Resources.....	42
3.3.1 Terrestrial Ecosystems.....	42
3.3.2 Aquatic Ecosystems and Biodiversity	42
3.3.3 Biodiversity Resources.....	42
3.3.4 Nature Reserves and Protected Areas.....	44

3.3.5	Forest Resources	49
3.4	Socioeconomic Resources	49
3.4.1	Population, Demography, and Ethnic Composition	49
3.4.2	Land Use	49
3.4.3	Agriculture Production	50
3.4.4	Aquaculture.....	51
3.4.5	Forestry.....	51
3.4.6	Household Income and Incidence of Poverty.....	51
3.4.7	Domestic and Drinking Water Supply and Quality	51
3.4.8	Disease and Public Health.....	52
3.4.9	Tourism Resources.....	52
3.4.10	Cultural and Historic Resources	52
3.4.11	Navigation and Transportation.....	53

4: IMPACT ASSESSMENT 54

4.1	Environmental Impact Assessment Methodology	54
4.2	Application of IDA Operational Policies	55
4.3	Activities with Consistent Impacts on all Environmental Resources.....	55
4.3.1	Effects of Design Flood Occurrence.....	55
4.3.2	Repairing and Upgrading Existing Civil Works and Facilities	55
4.3.3	Modernization of Irrigation Management System	58
4.3.4	Construction Activities Associated with Project Implementation	58
4.3.5	Environmental Impacts of Resettlement and Land Acquisition	59
4.3.6	Water Supply for Domestic, Municipal, and Industrial Use	59
4.3.7	Provision of Increased Water Supply to Aquaculture	60
4.3.8	Impacts on Population and Communities	61
4.4	Environmental, Social Resources Receiving Consistent Environmental Impact	61
4.4.1	Impacts on Environmental Resources in VWRAP Project Reservoir Catchments	62
4.4.2	Project Impacts on Rare and Endangered Species.....	62
4.4.3	Project Impacts of the Project on Employment.....	62
4.4.4	Impact on Economic Activities, Income, and Incidence of Poverty	62
4.4.5	Project Impacts on Mineral Resources	63
4.4.6	Project Impacts on Air Quality.....	63
4.4.7	Project Impacts on Noise	63
4.4.8	Project Impacts on Production Forests	64
4.4.9	Project Impacts on Human Health.....	64
4.4.10	Project Impacts on Nature Reserves, Protected Areas, or Protection Forests.....	64
4.5	Project Impacts of Pre-Construction.....	65
4.5.1	Impacts of the Legacy of Conflict.....	65
4.5.2	Requirements for Resettlement and Land Acquisition	65
4.6	Project Impacts of Construction.....	67
4.6.1	Impacts on Physical Resources.....	67
4.6.2	Impacts on Biological Resources.....	71
4.6.3	Impacts on Socioeconomic Resources	72
4.7	Project Impacts During Operational Phase.....	74
4.7.1	Impacts on Physical Resources.....	74
4.7.2	Impacts on Biological Resources.....	75
4.7.3	Impacts on Socioeconomic Resources	77
4.8	Main Conclusions of Impact Assessment.....	77
4.8.1	Summary of Bank Operational Policies in Regards to VWRAP	77

5: ENVIRONMENTAL MANAGEMENT PLAN 80

5.1	Vietnamese Legal and Administrative Framework.....	80
5.1.1	The Legal Framework for Environmental Management.....	80
5.1.2	The Administrative Framework for Environmental Management.....	82
5.1.3	Vietnamese Environmental Requirements	82
5.2	IDA Environmental Requirements	82
5.3	Overall Approach to Implementation.....	82
5.4	Institutions Responsible for Implementing the VWRAP EMP	83
5.5	VWRAP Environmental Mitigation Program	84
5.6	VWRAP Environmental Mitigation Compliance Monitoring Program.....	84
5.7	VWRAP Environmental Effects Monitoring Program.....	85

5.8 Reporting Requirements for VWRAP EMP	85
5.9 Action Plan for Implementing the VWRAP EMP.....	87
5.9.1 Key Features of Action Plan.....	87
5.9.2 Action Plan for EMP Implementation during Pre-Construction Phases.....	87
5.9.3 Action Plan for EMP Implementation during Construction Phases.....	90
5.9.4 Action Plan for EMP Implementation during Operational Phases	91
5.10 Policy Framework and Guidelines for Environmental Assessment and Impact Mitigation for the Follow-On Investments	93
5.11 Indicative Requirements for Construction Bidding Documents	94
5.12 Training and Capacity Upgrading Requirements for EMP Implementation	94
5.12.1 Evaluation of Environmental Management Capabilities	94
5.12.2 Recommended Training and Capacity Building.....	95
5.13 Requirements for Flexibility and Adaptability in EMP Implementation	95
5.14 Costs of VWRAP EMP.....	97
ANNEXES	112
ANNEX 1: TERMS OF REFERENCE FOR EIA	113
ANNEX 2: SUMMARY OF PUBLIC CONSULTATIONS IN SUPPORT OF EIA PREPARATION	118
ANNEX 3: MAPS OF SUB-PROJECTS	122
ANNEX 4: POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK FOR EIA	130
ANNEX 5: SOURCES OF INFORMATION USED IN THE PREPARATION OF THIS EIA	134
ANNEX 6: EIA CONSULTANT SOCIOECONOMIC SURVEY QUESTIONNAIRE	140
ANNEX 7: SUMMARY OF WATER QUALITY INFORMATION FOR VWRAP PROJECT	149
ANNEX 8: COMPILATION OF INFORMATION ON RARE AND ENDANGERED SPECIES IN VWRAP AREA	172
ANNEX 9: DESCRIPTION OF PROTECTED AREAS IN VWRAP AREA	181

LIST OF TABLES

Table 1: Basic information on current situation of VWRAP Sub-Projects.....	4
Table 2: Parameters for existing and required flood design for dams in VWRAP Irrigation Schemes.....	13
Table 3: Changes in water use with VWRAP.....	24
Table 4: Civil works and facilities upgrading for VWRAP Sub-Projects.....	25
Table 5: Quantities of engineering required for upgrading headworks and associated structures.....	29
Table 6: Quantities of material required for upgrading canal systems.....	30
Table 7: Resettlement and compensation requirements for VWRAP.....	31
Table 8: Expected changes in agricultural land use within the command area with Sub-Project implementation.....	32
Table 9: Synoptic population and land use information for the VWRAP Project Area.....	34
Table 10: Synoptic socioeconomic information for VWRAP Project.....	35
Table 11: Summary of climate regime for Irrigation Sub-Projects.....	37
Table 12: Overview of soils in VWRAP Area.....	38
Table 13: Overview of groundwater resources in VWRAP Area.....	40
Table 14: Overview of terrestrial ecosystems in VWRAP Area.....	43
Table 15: Summary of rare and endangered species found in the provinces in which VWRAP will be implemented.....	44
Table 16: Overview of recent land use changes in VWRAP Area.....	50
Table 17: Cultural and historic sites in districts that form the VWRAP Area and in areas in close proximity to the VWRAP Area.....	53
Table 18: Civil works and facilities upgrading assessed to have no impacts on environmental resources.....	56
Table 19: Summary of assessment of Project impacts on nature reserves and protected areas.....	66
Table 20: Estimated incremental inputs of fertilizer required for VWRAP.....	76
Table 21: Estimated incremental inputs of pesticides required for VWRAP.....	76
Table 22: Results of organochlorine pesticide sampling in the O Mon Xa No Sub-Project in 2001 dry season. These data were gathered as part of Crd-3198: Mekong Delta Water Resources Project. The agriculture area of O Mon Xa No Sub-Project is about 36,000 ha, the cropping intensity is 260%, and triple cropping is practiced on 78% of the agriculture land.....	76
Table 23: Application of IDA Environmental and Social Safeguard Policies to VWRAP.....	78
Table 24: Reporting requirements for VWRAP Environmental Management Plan.....	86
Table 25: Reporting requirements for VWRAP Environmental Management Plan. continued.....	87
Table 26: Detailed costs and schedule for VWRAP Environmental Mitigation Program.....	98
Table 27: Detailed costs and schedule for VWRAP Environmental Monitoring Programs.....	99
Table 28: Summary costs and schedule for VWRAP Environmental Management Plan.....	101
Table 29: VWRAP Environmental Management Plan costs by Sub-Project and EMP component.....	101
Table 30: VWRAP environmental mitigation program.....	103
Table 31: Environmental Mitigation Compliance Monitoring Program.....	109
Table 32: Environmental Effects Monitoring Sub-Program for VWRAP.....	110
Table 33: Summary of EIA consultations to date.....	119
Table 34: Water quality in Yen Lap Sub-Project, Quang Ninh Province, 29 December, 2002.....	150
Table 35: Water quality in Uong Bi, Quang Ninh Province.....	151
Table 36: Groundwater quality data from Uong Bi, Quang Ninh Province.....	151
Table 37: Groundwater quality in bore wells in towns, Cam Son-Cau Son Sub-Project.....	158

LIST OF FIGURES

FIGURE 1: LOCATION OF COMPONENTS AND SUB-PROJECTS OF VWRAP.....	2
FIGURE 2: INCIDENCE OF POVERTY IN VWRAP PILOT AREAS.....	53
FIGURE 3: PREDICTED CHANGE IN INCIDENCE OF POVERTY IN VWRAP PILOT AREAS WITH PROJECT.....	64
FIGURE 4: MAP OF YEN LAP SUB-PROJECT.....	123
FIGURE 5: MAP OF CAM SON-CAU SON SUB-PROJECT.....	124
FIGURE 6: MAP OF KE GO SUB-PROJECT.....	125
FIGURE 7: MAP OF QUANG HUE-VU GIA RIVER CONTROL WORKS.....	126
FIGURE 8: MAP OF PHU NINH SUB-PROJECT.....	127
FIGURE 9: MAP OF DA BAN SUB-PROJECT.....	128
FIGURE 10: MAP OF DAU TIENG SUB-PROJECT.....	129

CURRENCY EQUIVALENTS

(as of August 2003)

Current Unit	-	Viet Nam Dong (VND)
US \$1.00	-	VND 15,400
VND 1,000	-	US \$0.065

ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
BP	Bank Procedure
CIDA	Canadian International Development Agency
CPC	Commune People's Committee
CPO	Central Project Office (of MARD)
DANIDA	Danish International Development Assistance
DARD	Department of Agricultural and Rural Development
DoCI	Department of Culture and Information
DoFi	Department of Fisheries
DoI	Department of Industry
DoSTE	Department of Science, Technology and Environment
DSA	Daily Subsistence Allowance
DWT	Dead-Weight Tons
EIA	Environmental impact assessment
EIRR	Economic Internal Rate of Return
EMD	Environmental Management Department (DoSTE)
EMDP	Ethnic Minority Development Plan
EMP	Environmental Management Plan
EPP	Emergency Preparedness Plan
FPD	Forest Protection Department
FS	Feasibility Study
GoVN	Government of Viet Nam
HEC	Hydraulic Engineering Company
HH	Household
IDA	International Development Association
IMC	Irrigation Management Company
IPM	Integrated Pest Management
IUCN	International Union for the Conservation of Nature
MARD	Ministry of Agriculture and Rural Development
MoNRE	Ministry of Natural Resources and Environment
NEA	National Environment Agency
NGO	Non-governmental organization
NLEP	National Law on Environmental Protection
NPV	Net Present Value
O/M	Operations and Maintenance
OP	Operation Policy
PAH	Project Affected Households
PFS	Pre-Feasibility Study
PMF	Probable Maximum Flood
PMU	Project Management Unit
PPC	Provincial People's Committee
RAP	Resettlement Action Plan
Sida	Swedish International Development Agency
SIO	Sub-Project Implementation Office
SIU	Sub-Project Implementation Unit
ToR	Terms of Reference
UXO	Unexploded Ordnance
VND	Viet Nam Dong
VWRAP	Viet Nam Water Resources Assistance Project
WB	World Bank

1: INTRODUCTION

1.1 Background and Objectives

The Government of Viet Nam (GoVN) has requested assistance from the International Development Association (IDA) to support the Water Resources Assistance Project (VWRAP)¹. VWRAP has the following objectives:

- Support the modernization of Vietnamese agriculture and enhance water resources management by improving irrigation services through the introduction of modern hydraulic infrastructure and management;
- Reduce flood and disaster risk by improving dam safety and management; and
- Promote the environmentally sustainable development of Thu Bon Basin through integrated development and management of water resources.

VWRAP is comprised of four separate but integrated elements (please see Figure 1 for the location of the following components and Sub-Projects):

Component 1: Irrigation Modernization in six irrigation schemes:

- Dau Tieng (Tay Ninh Province and Ho Chi Minh City)
- Da Ban (Khanh Hoa Province)
- Phu Ninh (Quang Nam Province)
- Ke Go (Ha Tinh Province)
- Yen Lap (Quang Ninh Province)
- Cam Son - Cau Son (Bac Giang Province)

Component 2: Dam Safety Management:

- MARD Dam Repair Fund
- EVN Hoa Binh Dam Safety
- National Dam Safety Unit

Component 3: Thu Bon River Basin Development (Quang Nam Province):

- Quang Hue-Vu Gia River Flow;
- Thu Bon Investment Preparation

Component 4: Project Management and Capacity Building:

- Technical Assistance for VWRAP
- Provincial and MARD Incremental Costs
- Training and Capacity Building

A separate EIA has been constructed for each of the seven Sub-Projects comprising the six irrigation schemes listed under Component 1 and the Quang Hue-Vu Gia River Control Works listed under Component 3.

This report is the final Environmental Impact Assessment (EIA) for the seven Sub-Projects identified under the overall VWRAP. The report was prepared and submitted in accordance with the Terms of Reference for Consulting Services for the VWRAP EIA Consultant (Annex 1). There are 3 volumes of the EIA related report for these seven Sub-Projects: i.e Volume 1 – Main Report –summarizing the key findings of the seven Sub-Project; Volume 2 – Combined Sub-Project EIA Reports, one for each of the seven Sub-Projects; and Volume 3 – Public Consultation Report

Specific public consultation and disclosure activities conducted in support of this EIA report are summarized in Annex 2. A Public Consultation Report is also presented separately.

Given that VWRAP will also provide financing to other subcomponents in which the investment could not be identified at present, IDA requested that a screening process be prepared and applied to all the activities to be identified and executed during the follow-on phases, especially the MARD Dam Repair Fund and the ENV dam safety subcomponents. This is to ensure that implementation of VWRAP will not cause any adverse impacts on the local communities and environment. A policy framework and guidelines for the environmental assessment and impacts mitigation plan for the follow-on investment (80% of the command areas) of the six irrigation subprojects has been provided in this EIA report. It is anticipated that specific requirements of the EMP for each subproject and the action plans and the safeguard screening process and policy framework, namely the Environmental and Social Safeguard Framework (ESSF), will be prepared separately and they will be submitted to IDA as an addendum to this EIA report.

¹ The Ministry of Agriculture and Rural Development (MARD) obtained a grant from the Government of Japan to procure consultancy services to help prepare VWRAP; the Central Project Office (CPO) of MARD is the coordinating agency of VWRAP preparation.

1.2 Overview of VWRAP

Basic information on the existing condition of the Sub-Projects within VWRAP is provided in Table 1 and Annex 3 contains a set of maps of the Sub-Project areas themselves.

1.2.1 *Overview of Yen Lap Sub-Project*

The Yen Lap Reservoir and Irrigation Scheme is located in Quang Ninh Province in northeast Viet Nam. Irrigation is restricted to Yen Hung District and Uong Bi Town. The irrigated area is on the coastal fringe of the Red River Delta, which is a strongly tidal influenced delta environment. The Yen Lap reservoir is located to the east of the irrigation area in Hoanh Bo District.

The Yen Lap Reservoir is sited north and northwest of Uong Bi and National Highway No. 18. The reservoir is constructed in the Dong Trieu mountain range. The Yen Lap reservoir headwork is comprised of an earthen dam, radial gate spillway and intake sluice. The reservoir spillway discharges to the Mit River (Yen Hung District). Two supplementary dams are located at Nghia Lo and Dan Chu communes (Hoanh Bo District).

Construction of the Yen Lap Reservoir and associated irrigation scheme commenced in 1978 and was completed in 1982. The system was originally designed to gravity irrigate an area of 10,067 ha and supply water at a rate of 9.5×10^6 m³/year for domestic and industrial purposes in Yen Hung district and Cat Hai Island (Cat Hai district, Hai Phong).

The advent of Yen Lap scheme provided significant socioeconomic improvements to what was a seriously water-deficient area of parts of Yen Hung, Uong Bi and Hoang Bo Districts². Rice production has doubled in comparison to conditions prior to the Irrigation Scheme and local people have been supplied with sufficient water for domestic activities.

Nevertheless, insufficient attention to O&M over the years has meant that the original design and system objectives have yet to be achieved. Recent assessments of the Yen Hung Irrigation Scheme indicate that the water supply system services only 4,000 ha, which translates into a rate of ISE of only 40%. Bulk water supply for industrial and domestic use is only a rate of 2.1 million m³/yr and the provision of bulk water supply to Cat Hai Island has not yet been achieved. The poor delivery of irrigation water onto farms has been attributed in large part to the general state of disrepair of the canal system and on-canal regulating structures. Furthermore the dilapidated condition and antiquated operation of the head works exacerbates the problem of low irrigation system effectiveness. In addition, there has been some structural deterioration of the dam and the dam no longer meets new design flood safety standards.

1.2.2 *Overview of Cam Son-Cau Son Sub-Project*

The Cam Son - Cau Son irrigation and drainage scheme is located at the edge of the Red River Delta in Bac Giang Province in northwest Viet Nam - 21°00' - 21°27' N, 106°10' - 106°25' E. Construction of the scheme started in 1966 and began to supplement water to Cau Son Weir in 1973. The scheme was designed to irrigate a total area of 24,100 ha and to provide adequate drainage for some 69,920 ha of cropping area. The designed pump drainage area is approximately 10,090 ha.

The primary source of irrigation water is the Cam Son reservoir, which has an effective capacity of 227.5×10^6 m³. Most of the reservoir area is sited in Luc Ngan District (Bac Giang Province) immediately south of the provincial border with Lang Son. The headworks are positioned at the eastern edge of the reservoir above the Hoa River in Huu Lung District (Lang Son Province).

The total catchment area for the Cam Son reservoir is 378.4 km². The main catchment areas are: (a) relatively narrow, southward draining catchments (including the Vung Nguon River) that originate in Lang Son Province; (b) broader catchments draining northward and westward, located wholly within Luc Ngan.

Cau Son Weir, which is located 41 km south of the Cam Son headworks in Lang Giang district (Bac Giang province), is located on the Thuong River, approximately 8 km south of the confluence of the Thuong and Trung rivers. To improve flow between the Cam Son reservoir and Cau Son Weir it is proposed to dredge sections of the Thuong River. The Cau Son Weir has been operational since 1906. The Cau Son Weir was originally designed to provide irrigation water to some 7,500 ha of cultivated land. After more than 90 years of operation the dam is now in a seriously degraded condition and in need of repair.

² Prior to the Yen Lap Irrigation Scheme, freshwater was supplied to support the local people through tanks and barges.

Table 1: Basic information on current situation of VWRAP Sub-Projects.

Parameter	Units	Yen Lap	Cam Son-Cau Son	Ke Go	Phu Ninh	Da Ban	Dau Tieng
Year Constructed		1982	1909,1973 ³	1983	1986	1989	1989
Province(s)		Quang Ninh	Bac Giang	Ha Tinh	Quang Nam	Khanh Hoa	Tay Ninh, Ho Chi Minh City
Current Flood Design Standard	p (%)	2.0	1.0	1.0	0.5	2.0	0.1
Main Dam, Material		Earth	Earth	Earth	Earth	Earth	Earth
Main Dam, length of crest	m	270	230	988.5	620	348	1,100
Main Dam, Existing Crest Elevation	m asl	32.57	70.5 – 70.8	35.6	37.4	68.7	28.0
No. Auxiliary Dams	No.	2	1	3	5	0	1
Reservoir Catchment Area	km ²	18,260	378	223	235	126	2,700
Reservoir, Full Level	m asl	31.5	68.5	35.0	35.4	66.78	25.1
Reservoir Dead Level	m asl	11.5	51.0	14.7	20.44	45.2	17.0
Reservoir Full Storage	million m ³	127.5	248	345.5	343	75	1,580
Reservoir Effective Storage	million m ³	120.12	227.5	320.6	273.7	69.76	1,110
Reservoir Dead Storage	million m ³	9.38	20.5	24.9	70.3	5.24	470
No. Spillways		1	2	3	4	1	1
Main Spillway, maximum design discharge	m ³ /s	830	560	1,040	1,072 ⁴	538	2,800
Main Spillway, maximum level	m asl	23.5	62.0	26.5	26.0	57.0	14.0
No. Intake Sluices	No.	1	1	1	3	1	3
No. Main Canals	No.	2	1	1	2	1	3
Length of Main Canals	m	29,287	10,000	17,038	55,000	1000	83,805
No. Primary Canals	No.	50	3	9	20	2	252
Length of Primary Canals	m	68,889	75,600	96,388	135,240	20,595	126,885
No. Secondary Canals	No.	Not available	97	Not available	Not available	24	405
Length of Secondary Canals	m	118,980	258,700	77,531	227,844	62,298	303,756
Design Irrigated Area	ha	10,067	17,000	17,000	23,000	7,800	172,000 ⁵
Current Irrigated Area	ha	4,028	12,800	12,800	14,500	6,300	63,000
Management Company(ies)		Yen Lap IMC	Cau Son IMC	Ke Go IMC	Phu Ninh IMC	North Khanh Hoa IMC	Dau Tieng IMC, Tay Ninh IMC, Cu Chi IMC

³ Cau Son Weir was completed in 1909, Cam Son Dam and Reservoir were completed in 1973.

⁴ Spillway 2 (gated spillway) in Final Pre- FS Report, March 2003

⁵ original designed data based on the Prime Minister Decision No 190/TTg, 18 May 1979

Another major regulating structure at the head of the Cam Son – Cau Son irrigation scheme is the Quang Hien Intake. Water from Cau Son Weir arrives at the Quang Hien Intake via the Chua main canal (a former channel of the Thuong River). From Quang Hien intake the system is designed to gravity irrigate an area of 17,640 ha via the Giua, Tay and Yen Lai primary canals.

There are more than 200 small irrigation and drainage pumping stations located along the Thuong and Luc Nam rivers. They deliver irrigation water to an area of approximately 2,500 hectares. The single largest pumping station is Bao Son, which is located on the Chua main canal. Bao Son pumping station services a 742 ha irrigation area via the Bao Son primary canal. Many of the pumping stations are over 40 years old and are generally in a state of disrepair and are in many instances hazardous to operate. To improve irrigation water delivery there will need to be comprehensive refurbishment of many of the pumping stations.

Drainage canals and drainage pumping systems were always intended to play a major role in the operation of the Cam Son – Cau Son irrigation scheme. The design drainage area is approximately 70,000 ha. Poor design and ongoing maintenance of the drainage system has meant that the drainage is often inadequate and at the southern end of scheme has resulted in major problems with soil water logging. Replacement of drainage pumps and reconfiguration of the surface drainage canal network have been suggested as major physical works to improve the effectiveness of the drainage system.

Now the capacity of the system is well below the original design. During the period 1999 to 2000, irrigation water was delivered to approximately 10,300 ha, which translates into a rate of irrigation system effectiveness (ISE) of only 43%. The decline in irrigation delivery has been attributed to a long history of inadequate maintenance practices (due to limited budget). Low-income amenity and ineffectiveness of water fee collection systems are ongoing causes of IMC debt, which result in the IMC not having sufficient funds for maintenance activities.

1.2.3 Overview of Ke Go Sub-Project

The Ke Go Sub-Project is located in Cam Xuyen and Thach Ha Districts of Ha Tinh Province in north central Viet Nam. The Ke Go Reservoir is located in Cam Xuyen District approximately 20 km south of Ha Tinh Town and serves an area north and east of the Reservoir. Approximately 10 km downstream of the reservoir, two rivers – the Gia Hoi and Nghien Rivers - diverge draining north and east to the Sot and Nhuong Inlets respectively. The irrigation area corresponds to the low-lying coastal plain between the Sot and Nhuong Inlets.

The scheme was constructed over the period 1976 to 1983. The original function of the reservoir was to supply water to a design irrigation area of 21,140 ha. Currently the irrigated area is only 17,000 ha (about 80% of the design area).

The Ke Go Sub-Project comprises:

- A main dam and three auxiliary dams, all homogeneous earth-filled embankments and all with a crest elevation of 35.6 m asl;
- The Ke Go Reservoir with a catchment area of 226 km², and a maximum water level of 35.0 m asl;
- A main spillway (at Doc Mieu) with a design discharge of 1,065 m³/sec and a crest elevation of 26.5 m;
- A conduit flood discharge spillway (under the main dam) with a design discharge of 320 m³/sec and a crest elevation 26.5 m;
- An intake sluice, designed for 320 m³/sec, under the main dam, and intended to be used for providing water to the hydropower station (see below) and for irrigation;
- An emergency flood spillway, located in a saddle between the main dam and the Doc Mieu spillway;
- A 17 km long main canal designed to irrigate 21,136 ha and with a design discharge of 28.2 m³/sec; and
- A total of nine primary canals, designated N1 to N9, running more or less parallel to the coastline, and equipped with various water control structures.

Because of insufficient maintenance, engineering works have degraded rapidly and seriously in recent years. Seepage through the body and foundation of the dams has been an ongoing problem. Dam toe seepage may reduce dam strength as well as create an artificial wetland environment immediately downstream of the dam. In addition, the conduit spillway experiences significant leakage through the conduit joints, resulting in approximately 200 l/s inundating the inspection barrel. The problem of conduit leakage was addressed in 1991 and 1993 and involved grouting and covering the joints with steel plates but these remedial measures had no positive effect. The canal system has experienced ongoing problems of erosion, siltation, and canal seepage, and the canal regulating structures have been poorly maintained and are now in poor condition.

A 2,100 kW hydropower station was constructed and operational from 1986 to mid-1988. A number of problems were incurred during the operation of the station, which unacceptably impacted upon the end use of the water for irrigation (e.g. contamination of irrigation with hydraulic oils and unacceptable leakage through conduit joints).

Inadequate maintenance of the hydraulic, electrical and mechanical equipment led to the scheme being abandoned in less than three years of operation. The equipment is still at the site but in a dilapidated condition.

1.2.4 Overview of Quang Hue-Vu Gia Sub-River Control Works

The Quang Hue-Vu Gia River Control Project is located at about 15°51'-15° 53' N, 108°07'-108°08' E and is administratively located in Dai Cuong Commune, Dai Loc District, Quang Nam Province. The Vu Gia-Thu Bon River Basin covers practically all of Quang Nam Province and has a total drainage area of 11,510 km². Of this total, the Vu Gia River drains 5,410 km², or slightly less than half the total, while the Thu Bon River drains 3,590 km², or about 30% of the total. The drainage basins of the two rivers remain separate until only a few kilometers upstream of the Project area when the mountain range separating the two systems disappears, leaving a large plain and estuary through which both rivers flow.

The two rivers are linked via two watercourses in the Project area: the Old Quang Hue River and the New Quang Hue River, formed in 2000. These rivers allow water from the Vu Gia River to transfer to the Thu Bon River. A large, combined estuary begins just below the Project location, with most of the flow of the Vu Gia River remaining after the Quang Hue Rivers traveling to Da Nang City, where it is renamed as the Han River. Flow from the Vu Gia River is an important source of freshwater for Da Nang City. Flow through the estuary via the Thu Bon River reaches the ocean in Hoi An District, providing salinity intrusion to Hoi An District during the dry season. The large estuary is linked also to the Truong Giang River, which flows along the coast of Quang Nam Province down to Ben Van Bay in Nui Thanh District at the extreme southeastern part of Quang Nam Province.

Prior to 2000, about 15% of the flow of the Vu Gia River in the dry season was transferred to the Thu Bon River. The large flood event of 2000 created the New Quang Hue River. The high flows of the Vu Gia River and the general inundation created by the high flows cut a channel beginning slightly downstream of the southernmost portion of the SSE to NE bend in the River, basically cutting through the finger of land between the Vu Gia and Thu Bon Rivers that is formed by the reverse S-shape of the Old Quang Hue River⁶. Property and land belonging to Hamlet No. 9 of Dai Cuong Commune, inhabited by about 200 households (1,000 persons) was washed away by the newly-formed river or isolated on the other side of the new river⁷.

There were a number of consequences of the new river channel:

- The allocation of Vu Gia River water in the dry season reversed from its normal conditions:
 - 85% of the flow in the 2001 dry season, much higher flow than normal, made its way into the Thu Bon River system via the New Quang Hue River. This decreased salinity intrusion and was a benefit to those households cultivating freshwater agriculture, but negatively affected those households cultivating brackish water aquaculture in Hoi An District; and
 - the remaining 15% of the flow, much lower than normal, continued its way through the Vu Gia River system. The lower flows continuing into the Vu Gia River system increased salinity intrusion in and decreased freshwater supply to Da Nang City; and
- the lower flows in the Vu Gia downstream of the New Quang Hue River resulted in lower river velocities which greatly increased sedimentation rates in this section as well as in the Old Quang Hue River. The result of this was that the Old Quang Hue River became unable to convey water in the dry season.

A temporary dam was constructed across the mouth of the New Quang Hue River during the 2001 dry season, consisting mostly of sand bags. Much of the temporary dam was washed away during the 2001 rainy season because of the overwhelming velocity of Vu Gia River water flowing to the Thu Bon River via the New Quang Hue River. There was additional erosion in the 2001 rainy season of about 80 m of the right riverbank of the Vu Gia-New Quang Hue River confluence, causing further loss of property to Hamlet No. 9 in Dai Cuong Commune. The downstream effects in the 2002 dry season were the same as in the 2001 dry season, but there was better documentation of some of the effects of the reversal of normal Vu Gia River water allocation during the dry season:

- water supply to many irrigation systems, pumping stations of all districts in northern Quang Nam including four newly rehabilitated dams of the An Trach system ran extremely low;
- for much of the 2002 dry season there was no water for over 40 electric pumping stations with more than 150 pumping machines, which provides irrigation water to nearly 10,000 ha of agricultural production land (8,000 ha in Quang Nam and 2,000 ha in Da Nang City); and
- residential and industrial areas of Da Nang City had insufficient water supplies for parts of the 2002 dry season. Water supply to the Cau Do Water Supply Plant for Da Nang City experienced salinity intrusion.

⁶ A similar event occurred during the same rainy season on the Thu Bon River some 15 km downstream of the Project area.

⁷ No lives were lost.

1.2.5 Overview of Phu Ninh Sub-Project

The Phu Ninh Irrigation Scheme in southern Quang Nam Province is situated in the Tam Ky Catchment⁸ and is the one large irrigation scheme in the Thu Bon-Vu Gia River Basin. The Irrigation Scheme had its reservoir built in 1997; the scheme was designed to irrigate 23,000 ha and provide 1.6 m³/s of domestic water supply. The main canal system has a total length 53 km and is mainly an earth embankment cross-section. Currently some 6 km is concrete-lined; partially as upgrading to reduce water seepage losses and serious erosion that in turn creates subsequent slippage of canal banks. The spillage facility at the dam has been recently modified and provided with an increased capacity. Currently irrigated areas cover about 14,500 ha and the scheme provides 3,000 m³/day of water supply to Tam Ky Town.

The original design functions of the Phu Ninh scheme were:

- Supply irrigation water for the designed irrigated area of 23,000 ha;
- Supply water for domestic use and industrial use: $Q = 1.6 \text{ m}^3/\text{s}$; and
- Combined with electricity generation : $N_{\text{assembled}} = 1890 \text{ KW}$

Upgrading of the Phu Ninh Irrigation Scheme is required to increase irrigation water to the original planned area together as well as to expanding aquaculture and industrial sectors in Quang Nam Province. The first and now urgent works required is completion of the rehabilitation of the main canals, to ensure security of the irrigation scheme, and the associated off-take works. The repair of north and south main canals downstream of the dam stands out as an essential and urgently needed rehabilitation project. The need and benefit of concrete lining to main canals should be reviewed length-by-length of the canal taking into account cost, seepage mitigation, erosion potential, longer term hazard of canal side-wall collapse, and future maintenance planning and financing.

Upgrading of the Phu Ninh Sub-Project is a key component to the development of Quang Nam Province. In addition to its major role as the one large irrigation scheme in the Thu Bon-Vu Gia basin, it plays a part in flood mitigation and the supply of water to the fast-growing urban and industrial areas situated around Tam Ky Town, the provincial capital.

1.2.6 Overview of Da Ban Sub-Project

The Da Ban Sub-Project is located in Ninh Hoa District of Khanh Hoa Province on the south central coast of Viet Nam. The reservoir is located approximately 35 km north of Nha Trang, the provincial capital. The Da Ban River catchment is defined to the north by the Vong Phu Mountain Range (with peak elevations of 1,730 m), to the east by the Thong Nhat Railway line, and to the west by the Tan Lam River. The Da Ban River is 37 km long and has a catchment area of 358 km². The Reservoir and headworks are located in Ninh Hoa District of Khanh Hoa Province, about 500 km north of Ho Chi Minh City. The Da Ban River converges with the Song Lot River and the combined river drains southward through Ninh Hoa District Town and discharges into Nha Phu Bay.

Before the Da Ban Reservoir was constructed, the area of Ninh Hoa and part of Van Ninh Districts was very dry and very few people lived there because of a lack of water. The main objective of the Da Ban Reservoir was to supply water for a State cotton farm, and for rice cultivation. Many people settled in the area after the reservoir commenced operation because of the increased water availability. After some years, the cotton farm was converted to rice cultivation.

The irrigation system includes two districts of Khanh Hoa Province: Ninh Hoa and Van Ninh. Additional beneficiaries include water supply for 60,000 people, some industrial plants, and water supply for aquaculture development of approximately 350 ha at present.

Construction of the Da Ban Sub-Project commenced in 1981 and the scheme became operational in 1986. The Scheme consists of:

- An earth-fill dam with a crest elevation of 68.7 m;
- A bottom discharge, reinforced concrete spillway with a design discharge of 538 m³/s;
- Reinforced concrete outlet works with a design discharge of 12.0 m³/s; and
- An irrigation scheme comprised of two primary canals - Tay and Dong - which diverge and traverse the land to the west and east of the Da Ban River. The secondary canal network consists of: Doi 5, Nb, Nd, Ne, Nf, NA to NF canals, three major off-takes - N1T, N2T and N4T - at the southern end of the Tay

⁸ Although actually situated in the Tam Ky Basin, it is hydraulically and economically linked to the Thu Bon-Vu Gia Basin.

primary canal, and N1 to N4 canals being the off-takes from the Dong primary canal.

The scheme was designed to irrigate an area of 7,800 ha and to supply water for industrial and domestic uses. In reality, service is only being delivered to 4,327 ha corresponding to an irrigation effectiveness of 55%.

Most of earth works do not meet current design standards. There are cracks in the dam and seepage. In particular, the quality of joints of the inlet and the spillway are causing serious seepage. In addition, because of insufficient maintenance, engineering works have degraded rapidly and seriously in recent years, resulting in potential breakdowns of the Da Ban Dam, one of the highest dams in Viet Nam. Because of cracks that appeared in the body of the dam, MARD decreed that the water level in the reservoir should be lowered by 3 m to an elevation of 60 m instead of the normal water level at elevation of 63.00 m as per design. This reduced the capacity of the reservoir by 15 million m³, equivalent to 20% of the total capacity, a significant reduction in water storage in this water-scarce area. If the water level of the reservoir had not been lowered in the 2001/2002 dry season, the Da Ban Reservoir could have supplied sufficient irrigation water for the 2002 summer-autumn crop to prevent the serious drought of that crop. Degradation, damage, and incomplete canal systems are causing a reduction in irrigation area, but also wasting of water at the head of canals, shortage, as well as unreliable delivery of irrigation water at the end of canals.

The role of the Da Ban scheme within the economy of the Khanh Hoa Province is rather small. It is estimated that the agricultural production of this scheme corresponds to some 10-15% of the provincial GDP. However, the scheme includes about 50% of the provincial paddy area and is therefore essential for provincial food production.

1.2.7 Overview of the Dau Tieng Sub-Project

Dau Tieng Reservoir is located in Tan Chau and Duong Minh Chau districts, Tay Ninh province and Dau Tieng district (Binh Duong province). The Dau Tieng irrigation canal network is spread across 7 districts of Tay Ninh Province – Tan Bien, Tan Chau, Duong Minh Chau, Chau Thanh, Go Dau and Trang Bang, as well as Cu Chi District (Ho Chi Minh City). The beneficiary area extends into Long An and two other districts in Ho Chi Minh City. The reservoir is sited on the Sai Gon River, 20 km kilometers east of Tay Ninh town and 120 km north of HCMC. The reservoir has been operational since 1985. The original functions of the Dau Tieng Reservoir were:

- Water supply to Dau Tieng Irrigation Scheme (65,000 ha gravity-irrigated and 105,000 ha pump-irrigated);
- Water supply for Tay Ninh province urban and industrial users (100x10⁶ m³/year); and
- Salinity protection for the Sai Gon River.

Recommended functions for Dau Tieng Reservoir were revised in 1993 to include:

- Irrigation water supply in Tay Ninh Province equal to 78,830 ha;
- Irrigation water supply in Cu Chi District equal to 14,500 ha;
- Bulk water supply for irrigation in Long An province equal to 21,500 ha; and
- Irrigation water supply in Binh Duong Province equal to 2,000 ha.

The Dau Tieng Reservoir and associated irrigation scheme was the first water resources project in Viet Nam financed by the IDA. Unfortunately the history of scheme implementation has been problematic and the system currently functions inefficiently due to design and operating practices. Major criticisms of the Dau Tieng irrigation area relate to the lack of detailed and reliable survey information used in the design of the canal network and regulating structures.

1.3 Legal and Planning Context for this EIA

This EIA has been prepared according to Viet Nam's legal, policy, and regulatory framework for environmental impact assessment⁹. The key legal instruments defining this national framework are:

- National Law on Environmental Protection (29L/CTN, 1994);
- Decree 175/CP/1994 on Implementation of the NLEP; and
- Circular 490/1998/TT-BKHCHNMT on Setting Up and Appraising Environmental Impact Assessment Reports

This EIA has also been prepared according to the following World Bank directives and guidelines for environmental impact assessment and natural resource management:

⁹ Annex 4 contains a detailed description of the legal, policy, and regulatory framework within which this EIA has been prepared.

- Operational Policy 4.01 (and accompanying annexes) - Environmental Assessment;
- Operational Policy 4.04 - Natural Habitats;
- Operational Policy 4.36 - Forestry;
- Operational Policy 11.03 – Cultural Property;
- Operational Policy 4.12 – Involuntary Resettlement;
- Operational Policy 4.20 – Indigenous Peoples;
- Operational Policy 4.37 – Safety of Dams;
- Operational Policy 4.03 – Pesticide Management;
- Operational Policy 7.60 – Projects in Disputed Areas;
- Operational Policy 7.50 – International Waterways;
- Bank Policy 17.50 – Public Disclosure;
- General Policy 14.70: Involving Nongovernmental Organizations in Bank-Supported Activities;
- where required, the Pollution Prevention and Abatement Handbook; and
- The Environmental Assessment Sourcebook¹⁰.

In addition, this EIA considers other key legal instruments in Viet Nam for environmental protection and natural resource management:

- TCVN 5592 National Surface Water Quality Standards
- TCVN 5944 National Groundwater Quality Standards
- TCVN 6980 (2001) Standards for Industrial Effluents Discharged Into Rivers Used for Domestic Water Supply
- Decree 18/1986, the Ordinance on Conservation and Management of Living Aquatic Resources
- 1991 Forestry Resource Protection and Development Act
- Decision 1171, 1986, on Special Forest Management for Protected Areas

This EIA has also been prepared in the context of a number of international environmental conventions to which Viet Nam is a signatory:

- 1972 Convention Concerning the Protection of the World Natural and Cultural Heritage (the World Heritage Convention).
- 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES Convention)
- 1992 United Nations Framework Convention on Climate Change; and
- 1992 Convention on Biological Diversity. In this context, the 2002 IUCN Red List of Threatened Species¹¹ was a main sourcebook for considering biodiversity resources within the Sub-Project's area of influence.

Finally, a number of national environmental and natural resources programs and plans were considered in the preparation of this EIA:

- National Strategy for Environmental Protection for 2001 to 2010
- National Biodiversity Action Plan (1995);
- Forest Protection Department 1998 Protected Areas Plan of Vietnam to 2010; and
- National Aquaculture Development Program (1999-2010).

1.4 Approach to VWRAP Implementation Plan

IDA and MARD have agreed that VWRAP will have a phased approach to modernization in each of the Sub-Projects and VWRAP preparation adopted a similar approach through detailed investigations of:

- headworks, main and primary canals for each of the Sub-Projects; and
- a small number of pilot areas that consist of secondary and tertiary canal systems off the main and primary canals and which contain a total of about 20% of the total command area.

This approach was adopted so that the options (and combination of options) in terms of investments in physical infrastructure and management improvements that work best can be developed before full VWRAP implementation. The June 2002 IDA Aide Memoire noted that this approach will help reduce the risk associated with new infrastructure and water management techniques while still providing adequate budget to modernize the

¹⁰ World Bank Technical Paper No. 140

¹¹ found at www.redlist.org

whole scheme. This will also mean that VWRAP works will be executed in phases. The first phase will include the finalized dam safety review, rehabilitation works for the dams, rehabilitation works for main and primary canals and rehabilitation works and modernization for the pilot areas. The follow-on phase will include expanding the experiences gained through pilot testing to the command areas beyond the pilot areas.

It is anticipated that the general nature and design of the follow-on investments (i.e., types of civil works, equipment, and facilities) of the six irrigation Sub-Projects will be similar to nature and design of the pilot area component of the first phase, the precise siting and location of the components of the second phase will not be known. Therefore, the VWRAP Project Implementation Plan (PIP) will contain as follows:

- Project and Sub-Project implementation arrangements for the entire VWRAP;
- detailed specification of the technical/engineering implementation of the first phase, including first year works detailed design and bid packages; and
- a programmatic framework specifying the arrangements and procedures for technical/engineering implementation of the follow-on phases.

1.5 General Approach to EIA Preparation

1.5.1 Sources of Information Used in the Preparation of this EIA

Annex 5 contains a list of all the documents, maps, and other materials used in the preparation of this EIA. Information used in preparing this EIA was obtained from a number of sources:

- The public consultations conducted throughout EIA preparation (Annex 2);
- A set of Sub-Project feasibility study reports prepared by (under contract to the Consultant):
 - Hong Ha Construction Consulting Company (HHCCC, Yen Lap)
 - Hydraulic Engineering Company No. 1 (HEC-1, Cam Son-Cau Son, Ke Go, Da Ban)
 - Hydraulic Engineering Company No. 2 (HEC-2, Dau Tieng)
 - Consultant and Technology Transfer Company of the Ha Noi Water Resources University (CTC) (Phu Ninh)
- Information provided by the Consultant during preparation of the overall FS that updates information contained in the engineering feasibility study reports described above;
- A detailed socioeconomic survey conducted by the EIA Consultants of pilot area households in the Cam Son-Cau Son, Da Ban, and Dau Tieng Sub-Projects (Annex 6 contains the survey instrument);
- A socioeconomic assessment survey conducted by the Consultant in the pilot areas of the Sub-Project;
- The gathering of secondary data and information from various sources in government departments at the provincial, district, and commune level in the provinces in which the Sub-Projects are located; and
- A small set of primary data on water quality that was obtained in order to initiate the establishment of a water quality baseline for each of the Sub-Projects.

1.5.2 EIA Methodology

VWRAP is classified as a Category A project and therefore requires the completion of a full EIA, and the overall approach and methodology for this EIA is based on the World Bank's Environmental Assessment Sourcebook. The Consultant has primary responsibility for meeting World Bank and GoVN policies on Involuntary Resettlement, Indigenous People and Dam Safety, and the contents, conclusions, and recommendations of this EIA are intended to support the Consultant in the preparation of Resettlement Action Plan and Ethnic Minority Development Plans for the Sub-Projects if they are required.

The engineering works recommended in the Sub-Project feasibility study reports prepared by the HHCCC, HEC-1, HEC-2, and CTC represent the high end of investments contemplated for the VWRAP, in large part because of the extensive canal lining that these reports recommend. Financial constraints will limit the actual amount of canal lining that can be done in the VWRAP Project under VWRAP. However, because the preparation of the VWRAP FS occurred after the preparation of this EIA, not all the final information relating to the scope, scale, and location of the canal lining engineering works for the VWRAP could be included. Therefore, the assessments contained in this EIA relating to canal lining can be considered as conservative. The actual environmental impacts from canal lining will be less than those described in this EIA because less length of canals will actually be lined under VWRAP.

1.5.3 Area of Influence of Sub-Projects

For this EIA, the area of influence of the Sub-Projects is defined as:

- The Reservoir catchment area (see Table 1);
- The total command area of the Irrigation Scheme; and
- Those locations that are outside of the watershed catchment areas or the total command areas of the Irrigation Schemes but which may be affected by the activities of the Sub-Project. This includes, for example, surface water and groundwater resources downstream of the command areas, air quality outside of the command areas, and natural habitats and ecosystems that may be located downstream of the command areas. These are considered on a case-by-case basis in the Impact Assessment as possible cumulative effects of the Sub-Projects on environmental resources (Chapter 4).

For the purposes of this EIA, the term "Sub-Project Area" is defined as the Reservoir catchment area and the total command area of a particular Irrigation Scheme.

1.5.4 Scope of Environmental Management Plan for VWRAP

The Environmental Management Plan for the seven Sub-Projects (Chapter 5) contains the following components:

- mitigation and monitoring requirements for the first phase of investments (i.e., headworks, main and primary canals, pilot areas, and other non-agricultural uses of the water resources provided by the various schemes), including cost estimates;
- mitigation and monitoring requirements for the second phase of investments (i.e., the remainder of the command area, exclusive of the pilot areas) including cost estimates. This second phase is based on an assessment of the similarity of the current environmental conditions in the pilot areas to the current environmental conditions in the remainder of the Sub-Project's command area (found at the end of Chapter 3: Description of Existing Environment);
- implementation arrangements, implementation schedule, and action plan for the overall Environmental Management Plan, including a specification of the requirements for construction bidding documents;
- requirements for technical assistance to support implementation of the Environmental Management Plan including supervision and training; and
- a detailed workplan for each phase of VWRAP implementation.

For the new investment, the Safeguards screening and policy framework (ESSFs) which specifies how the specific mitigation and monitoring activities associated with the follow-on phases of the six irrigation Sub-Projects, the MARD Dam Repair Fund subcomponent, and the EVN subcomponent, will be designed in detail and implemented during overall VWRAP implementation.

1.6 Outline of this EIA

Including this Introduction, this EIA contains five sections:

Chapter 2: Description of VWRAP Project -- A presentation, using the best available information of what engineering works are to be constructed, quantities of materials required, and land use changes in the command area that will be supported by the implementation of the Project

Chapter 3: Description of Existing Environment -- A presentation of the current status of the physical, biological, and socioeconomic resources of the Project Area

Chapter 4: Impact Assessment -- An evaluation of the environmental impacts of the Project

Chapter 5: Environmental Management Plan -- Mitigation and monitoring requirements, including implementation arrangements, costs, and schedule.

This EIA is supported by a set of technical annexes contained at the end of this volume.

2: VWRAP PROJECT DESCRIPTION

2.1 Summary of Current Situation

2.1.1 *Dam Safety*

The Dam in the Irrigation Schemes under VWRAP do not meet new required design flood probability standards. The Dam were constructed according to national dam safety stands (TCVN 5060-90) with varying flood frequencies (Table 2). However, new national safety standards (TCVN 5060-2002) require that these dams have more stringent design flood probabilities, and a new set of flood design standards prepared by Viet Nam and the World Bank recommends even more stringent standards (Table 2). The dams in the VWRAP Irrigation Schemes are designed far below either of the two new standards and VWRAP will upgrade the dams to meet these new standards.

2.1.2 *Yen Lap Sub-Project*

YEN LAP DAM, RESERVOIR, AND SUPPLEMENTARY EARTH DAMS

Construction of the main earth-dam started in 1978 and was completed in 1980. Since a major flood event in 1982, some deterioration of the dam structure was observed:

- Fractures have appeared on the dam crest, at a point 100 m from the right side;
- Fractures at the dam berm (elevation = +15 m), 100 – 120 m from the right side; and
- Landslides have occurred on the dam roof and dam face.

A number of measures to repair the dam were undertaken in response to the structural deterioration of Yen Lap Dam. Below a dam elevation of +15 m a stone layer was constructed across the roof of the dam and the dam berm was widened (16 m). From +15 m to +22 m elevation, stone-work was undertaken on the roof and the dam berm was widened (7 m). Since its repair, the deterioration of the dam structure is thought to have ceased (VIWRR, 2002). Based on a recent field survey of the dam (VIWRR, 2002), the following observations about the condition of the dam were made:

- The dam cross section maintains the original design and construction dimensions;
- The upstream roof is covered with a layer of stone but due to the effect of flood season storm events the stone jetty is damaged and requires ongoing maintenance; and
- The dam face (on the seaward side) is cracked and inclined.

The supplementary earth-dams of Yen Lap water supply system comprise the Nghia Lo and Dan Chu Dams. Through the monitoring by the IMC, the situation is still good and no additional works will be required.

SPILLWAY

The spillway consists of 3 spans each with B x H= 3 x 8 m with a regulated segment gate system. Due to insufficient investment in O&M, parts of the hoisting system are twisted and difficult to operate. In addition, sluice lifting must be done manually as the system is not electrified, and the stop-log hoisting equipment is in bad need of repair.

INTAKE SLUICE

The operation of the intake sluice has been problematic for much of the operating life of the Yen Lap Irrigation Scheme. Poor water control at the headwork has been identified as a factor contributing to the low irrigation system effectiveness (VIWRR, 2001). As with the flood spillway, attempts have been made previously to improve the operation and safety of the intake sluice.

MAIN CANAL DISTRIBUTION SYSTEM AND ASSOCIATED WATER CONTROL STRUCTURES

The 26 km long Yen Lap Main Canal is comprised of the Ha Bac Primary Canal (14 km) and the Ha Nam Primary

Table 2: Parameters for existing and required flood design for dams in VWRAP Irrigation Schemes.

Parameter	Yen Lap	Cam Son-Cau Son	Ke Go	Phu Ninh	Da Ban	Dau Tieng
Catchment Area (km ²)	183	378	223	235	126	2,700
Existing Flood Design Parameters						
Design Flood Frequency (years)	200	100	1000	200	50	10000
Discharge at Design Flood Frequency (m ³ /s)	2,470	2,560	3,650	4,490	1,540	4,910
New Flood Design Parameters						
Required Design Flood Frequency (years)	10,000	10,000	10,000	PMF	10,000	PMF
One-Day Rainfall (mm)	na	660	1,044	Na	862	510
Flood Peak(m ³ /s)	4,560	3,460	4,360	7,050	2,790	8,120
Flood Volume(million m ³)	129	223.2	236	761	109.85	1,495
Runoff Depth (mm)	896	772	1,058	Na	1,358	553

Canal (12 km). The Chanh River Siphon connects the Ha Bac and Ha Nam Canals. At the time of construction, most of the main canal system was earthen. Concrete lining of the main canal was initially limited to canal sections immediately downstream of the intake sluice and immediately upstream and downstream of the Chanh Siphon.

The topography of Yen Lap irrigation area is semi-mountainous and the canal route crosses many surface water features. Consequently there are numerous diversionary structures in place for controlling the flow of water in the canal system.

Since being commissioned, the canal system has never achieved the designed rate of discharge. Water has ever reached the end of the main canal. Failure of the system has been attributed to the fact that the water conveyance and control capacity of the system is poor.

Almost all of the original canal system was earthen. Earthen main and primary canals at Yen Lap have suffered a range of problems commonly experienced in the irrigation schemes of Viet Nam. As well, due to a lack of capital for ongoing maintenance many of the regulating structures have fallen into disrepair and the operation of such structures has in many instances been altogether abandoned.

Ha Bac Main Canal --The Ha Bac Canal has not been upgraded significantly since its construction. Ha Bac on-canal structures are in a generally poor condition. Most of the irrigation off takes have been eroded, broken or without valve gate. Some siphons have no defense net to prevent rubbish accumulation. Repairs to on-canal structures have been largely limited to the sluices at the head of primary canals N1, N2 and N17.

Ha Nam Main Canal -- Before 1997, Ha Nam canal only ensured a capacity of 40-50% design discharge. Near the downstream end (i.e. Section K21 – K25) canal sedimentation caused the canal bottom to rise by as much as 0.6 – 0.7m relative to the original design. Canal sedimentation has meant that the last 3 km of the Ha Nam canal does not receive water.

In 1997, the province began a program of concretization of the Ha Nam Main Canal and all primary canals serviced by the Ha Nam Main Canal. This program included widening of the main canal. The program of concretization is now largely completed and only 2 km at the canal tail still needs to be lined.

During the program of concretization of the Ha Nam Canal system many of the on-canal structures were repaired. However there remain some important on-canal structures that are still in a seriously dilapidated condition. Additional items on the Ha Nam canal route that should be repaired and upgraded still need to be identified and are supposed to be provided in a supplementary report to the (VIWRR 2001) main report.

Cam La Elevated Flume -- Along the path of the Ha Nam canal system is the Cam La elevated flume. The Cam La elevated flume starts at K16 +430 and has a length of 1,036 m. Prior to 1998, the elevated flume was cracked and leaking. The crossbars of the flume and associated concrete pieces were damaged and it was no longer safe to operate. In 1998, Yen Lap IMC undertook repairs to the Cam La elevated flume. However, the repair program was only half-completed and 500 m of the elevated flume is still in poor condition. VIWRR (2002) singles out the Cam La elevated flume as requiring urgent attention under VWRAP.

CHANH RIVER SIPHON

The Chanh River Siphon, conveying water from the Ha Bac Canal to the Ha Nam Canal across the Chang River, is more than 20 years old. The siphon structure is now quite deteriorated and seepage has become a major problem. Yen Lap IMC attempted to treat the problem of seepage by applying a tar steel belt covering over the major seepage zones, but the remedial measures have only been partly effective and so the safety and stability

of the siphon is not currently assured. Due to the poor condition of the siphon there are very high rates of water loss into the surrounding earth. VIWRR (2002) estimates that loss from the siphon is occurring at a rate of approximately 22,900 m³/day; this is equivalent to slightly more than 14% of all water that enters the siphon each day.

PRIMARY, SECONDARY, TERTIARY, AND ON-FARM IRRIGATION AND DRAINAGE SYSTEM

The lower level canal system is in very poor condition:

- Not all the canal system has been constructed;
- In general the situation is that the canal banks have been eroded and the canal bottoms are silted. This has negatively impacted upon the delivery of water along these canals.
- Due to inadequate investment in operation and maintenance, the condition of civil works is degraded throughout the system. Many civil works are seriously damaged;
- Generally, sluice gates throughout the lower canal system are in very poor condition. Gates in the associated water control structures have not been replaced since installation. Many gates are rusted, some of them are curved;
- Regulators are generally manually operated with screw-type equipment. Hoisting equipment and outlet gates are also in extremely poor condition. None have been replaced since installation. Operation without proper maintenance has meant that the gates and hoisting equipment function poorly and consequently provide inadequate control of water levels. In general, the lower rank a canal belongs to, the worse condition of sluice gates and hoisting equipment

2.1.3 Cam Son-Cau Son Sub-Project

CAM SON DAM

The Cam Son Reservoir is formed by the main dam and one saddle dam. Both dams are homogenous earth-fill embankment dams. Key issues regarding the Cam Son Dam are:

- Both the main and saddle dams are in normal condition and no signs of significant settlement, instability or seepage have so far been observed on either of the dams;
- The existing spillway is presently in poor condition with reduced quality of reinforced concrete and a degraded spillway gate; and
- The 5 km access road to the main Cam Son dam is in very poor condition.

CAU SON WEIR

The Cau Son weir is a stone masonry wall structure with a concrete dissipation basin. Overall, the weir is assessed as being in poor condition and is not considered structurally sound:

- While concrete mortar grouting works were conducted between 1966 and 1989 to repair leaks, the weir continues to leak due to the poor quality of concrete used.
- The riverbank adjacent to the weir has been subject to considerable erosion.
- The silt excluding sluice on the weir is made of rock masonry but it leaks due to deterioration of the mortar and is assessed as being in poor condition;
- The original weir intake sluice is made from rock masonry and includes five gates. It is in normal condition but its entrance canal is silted up and the inlet and outlet strengthening is heavily worn.
- A more recent concrete intake which includes three gates and constructed in 1970 is in normal condition, however the outlet and inlet canals are now silted up.

CAU SON MAIN AND PRIMARY CANAL DISTRIBUTION SYSTEM

Main Canals – Natural waterways play a major role in the conveyance of water from the Cam Son Dam to the Cau Son Weir and associated intakes. Water released from Cam Son Reservoir arrives at the Cau Son Weir via the Thuong River. Water from Cau Son Weir is released to the Quang Hien Intake via the Chua Main canal which was constructed from a former channel of the Thuong River; the Chua Main Canal has a length of 7.1 km and 10 main structures. Key issues regarding the main canals are:

- Prolonged siltation in the Chua Canal has resulted in a general narrowing of the canal and has also caused the floor of the canal to be raised;
- Water conveyance in the main canals during low flow periods is retarded due to sediment build-up; and
- There is limited access to the main canals for management purposes.

Primary Canals -- There are four primary canals. From Quang Hien Intake the system is designed to gravity irrigate an area of 17,640 ha via the Giua, Tay and Yen Lai primary canals. A fourth primary canal is Bao Son, which is pump-fed from a pumping station sited on the Chua main canal. Key issues regarding the primary canals are:

- In general the primary canals are earthen; only limited concrete lining of primary canals has occurred;
- Due to the age of the canals and the low level of maintenance work historically performed, the primary canals are now seriously deteriorated. Canal slope and bank have been subject to considerable erosion and canal embankments suffer subsidence and instability;
- Hoisting equipment is in poor condition;
- Similarly, the civil works structures are deteriorated and damaged;
- Erosion of the earthen primary canal network has resulted in considerable siltation and deformation of the canals and the primary canals now have a decreased water conveyance capacity than originally designed;
- There is limited access to the primary canals for management purposes;
- Discharge regulation at the bifurcation between the Giua and Yen Lai Canals is poor; and
- Proper water level and discharge control in the primary system is difficult to achieve with existing management systems.

SECONDARY, TERTIARY, AND ON-FARM IRRIGATION AND DRAINAGE SYSTEM AND ASSOCIATED REGULATING STRUCTURES

The main issues regarding the irrigation and drainage works at the secondary and tertiary level are:

- The canal system that was originally designed was never fully completed;
- Many of the secondary lower level earthen canals are in a poor condition due to a lack of ongoing maintenance;
- While lining of some canals has occurred in the Cam Son-Cau Son Irrigation Scheme through the National Program on Canal Lining (Decision No. 66/2000/QD-TTg; June 2000), the rate of canal lining has been slower than in other irrigation schemes nation-wide;
- The regulating structures on secondary canal and on-farm canals are in even poorer condition than the regulating structures on the primary canals. The operation of many regulating structures has either been abandoned or such structures were never even established;
- The intake sluices on secondary and lower level canals are generally equipped with steel slide valve gates but many of the gates are now rusted out and/or deformed, slides are rotten, and washers are damaged and not watertight. Manually operated crankshaft hoisting equipment has been poorly maintained and is now difficult to operate. Physical deterioration has included loose positioning bolts and bent crankshafts. Some sluices do not have gates or hoisting equipment.

IRRIGATION AND DRAINAGE PUMPING STATIONS

There are 205 irrigation and drainage pumping stations along the Thuong and Luc Nam Rivers service the Cam Son – Cau Son irrigation scheme, delivering irrigation water to approximately 2,200 ha. Key issues regarding these stations are:

- Many of the pumping stations are more than 40 years old and are in a degraded condition due to a lack of ongoing investment in maintenance; and
- the arrangement of the drainage channel network is poorly suited to the pumping system and consequently the efficiency of pumping stations tends to be very low.

2.1.4 Ke Go Sub-Project

KE GO DAMS AND RESERVOIR

The Ke Go Reservoir comprises a main dam and three auxiliary dams. All of the dams are homogenous earth-fill embankments. In general, the body of the main dam is assessed as being in a normal condition. Generally, subsidence of the dam hasn't occurred. The problems that do exist are summarized as follows:

- During construction 13 piezometers were installed in the downstream slope. Water levels were recorded up to 1988. At present none of the piezometers is operational.
- The upstream revetment of the main dam has been eroded by wave action. To treat the problem of upstream deterioration concrete slabs have been laid between elevations +26 m and +32.5 m. The initial protection was with concrete slabs of 1 m x 1 m x 0.1 m thickness. When this initial protection was seriously damaged in 1990, heavier slabs of 5 m x 10 m x 0.2 m. The remaining slope sections are still protected with small slabs. Slab protection on the right hand abutment has been damaged; and

- The downstream face of the main dam is protected by a surface drainage system. However, the drainage network is now dilapidated and erosion of the downstream face is becoming increasingly problematic. At the normal water level of the reservoir (+32.5 m) more than twenty leakage zones have been detected in the downstream slope and are causing water-logging at the toe of the dam. Thirteen piezometers have been installed in the dam body for groundwater level monitoring but these are now clogged and therefore do not function correctly. The broken down join of intake sluice could be the main reason.

The condition of the three saddle dams is assessed as follows:

Auxiliary Dam No. 1 – This dam is generally in good condition, although the berm on the upstream side is partly eroded.

Auxiliary Dam No. 2 – The upstream slope is partly eroded. In addition, at high reservoir levels, water leaks through the right shoulder of the dam at about .004 m³/s.

Auxiliary Dam No. 3 – There may be some seepage on the left shoulder of the dam.

The management road (from Provincial Road No. 17 to the headworks area) is in poor condition and often submerged in the rainy season.

DOC MIEU CHUTE SPILLWAY

In general, the Doc Mieu Spillway is in good condition. The problems that do exist are summarized below:

- Part of the inlet channel remains blocked by a natural rock barrier;
- The equipment for operating the spillway is not protected; and
- While the gates are in generally good condition, water leaks under the gates.

CONDUIT FLOOD SPILLWAY

The Conduit Flood Spillway outlet is located on two sides of intake sluice/electric generator and the radial gate is manually operated. The existing flood spillway outlet is in good condition. It has not been operated recently.

INTAKE SLUICE

The intake sluice is controlled by two flat gates, a guard gate and the discharge control gate. The guard gate is reported to be difficult to handle, while the control gate is reported to work satisfactorily. Near the end of the conduit the irrigation barrel is diverted towards the powerhouse and bifurcates into six pipes: three pipes 1.6 m to the hydropower station and three pipes to the irrigation outlet valves.

A major problem with the operation of the conduit spillway is the significant leakage through the conduit joints resulting in approximately 0.4 to 0.5 m³/s inundating the inspection barrel. The problem of conduit leakage was addressed in 1991 and 1993 and involved grouting and covering the joints with steel plates but these measures had no positive effect. The hoisting equipment on the intake sluice is now worn out and does not ensure safe operation. Another problem with this component of the system has been persistent slope percolation on the downstream face adjacent to the intake sluice.

EMERGENCY FLOOD SPILLWAY

Additional spill capacity was created by the completion of a rock cum earth emergency spillway in August 2001 and includes some holes for placing dynamite in the case of emergency flood. The spillway is 65 m wide. It is in good condition.

PRIMARY CANALS AND ASSOCIATED WATER CONTROL STRUCTURES

The Ke Go Irrigation Scheme has nine primary canals with a total length of about 92 km. The N1 Primary Canal is the most of these, serving about 50% of the designed command area. Upgrading of this canal was recently initiated with the assistance from an ADB loan. Under the assistance embankment slopes over a length of 23 km of canal were upgraded.

Due to the topography of the terrain where the primary canals are located, some canal sections have a rather high earth filled embankment. This, combined with insufficient maintenance, has deteriorated the primary canals resulting in the reduction of water conveyance capacity.

Existing canal regulating structures are in poor condition and many of the gates and sluices do not operate properly. Some twenty years of operation without ongoing maintenance has resulted deterioration of structural concrete and corrosion of steel frames and gates, thereby contributing to the shortfalls in irrigation supply.

SECONDARY, TERTIARY, AND ON-FARM CANALS AND ASSOCIATED WATER CONTROL STRUCTURES

Existing secondary, tertiary and on-farm canals are of a worse quality than the primary canals. In general, the lower level canals are in very poor condition at present and some areas have no canals at all. There is a clear difference in quality between the secondary canals managed by the IMC and canals that were maintained and operated by the communes. The latter are supported by the local authorities and have had canal slopes lined at many locations. Secondary and lower level canals have virtually no intake sluices.

2.1.5 Quang Hue-Vu Gia River Control Works

The Quang Hue- Vu Gia River Control Works consists of two phases¹²:

- Phase 1: River Revetment and Spillway; and
- Phase 2: Permanent Spillway, Dai An Revetment, Old Quang Hue Control Works, Land Reclamation, and River Dredging.

Phase 1 of the Quang Hue-Vu Gia River Control Works was completed in the 2002 Dry Season over a three-month period ending in September 2002¹³. It consists of:

- Strengthening and stabilizing 3,000 m of riverbank with a rock and concrete revetment (termed the Dai Cuong Revetment). Most of this was built on the right side of the Vu Gia River upstream of the beginning of the New Quang Hue River but this rock and concrete revetment also continued along the right bank of the New Quang Hue River. The left bank of the New Quang Hue River was also strengthened with this revetment, which runs back to the right bank of the Vu Gia River and downstream for some distance;
- Strengthening the right bank along the first bend of the New Quang Hue River in order to protect another hamlet living along the shore of the new river; and
- Construction of a 120 m long spillway and low weir at the head of the New Quang Hue River.

EXPECTED HYDROLOGICAL EFFECTS

The extremely shallow river slopes of the Project area make it difficult to construct a spillway and weir that will restore the water allocation of the system to conditions prior to the 2000 rainy season. MARD and provincial authorities accepted that the design height of the weir would prevent water from traveling down the New Quang Hue River during the dry season. The inability of the Old Quang Hue River to convey water to the Thu Bon River system because of the large increases in sedimentation due to the lower flow and associated velocities of the Vu Gia River downstream of the New Quang Hue River meant that:

- the flow in the Thu Bon River was expected to be lower than normal (i.e., prior to 2000) in the 2003 dry season, creating greater salinity intrusion in Hoi An District; and
- water supply to Da Nang City via the Vu Gia River in the 2003 dry season would be assured and would in fact be higher than normal due to receiving 100% of the Vu Gia River flow in the 2003 dry season.

INITIAL RESULTS OF PHASE 1 AT BEGINNING OF 2002 RAINY SEASON

Despite construction being completed in September 2002, the velocity and force of the water traveling down the New Quang Hue River system at the beginning of the 2002 rainy season washed away large parts of the weir and some associated parts of the spillway. It is possible that little remains of the spillway in early 2003. Without immediate rehabilitation of the damaged weir, the hydrological situation in the 2003 dry season (until completion of Phase 2 of the River Control Works will be the same as it was in the 2002 dry season:

- insufficient amount of water remaining in the Vu Gia River system for meeting irrigation, domestic, and industrial water to Da Nang City and northern Quang Nam Province; and
- likely negative effects to brackish water aquaculture in Hoi An District because of larger than normal freshwater supply down the Thu Bon River through the New Quang Hue River.

¹² There is actually a third phase which consists of constructing canal embankment along much of the Thu Bon River downstream of the Quang Hue River but IDA financing is being sought for this through the Thu Bon Water Resources Investment Fund. This third phase is not central for providing Vu Gia River control in the Quang Hue Rivers.

¹³ The EIA Consultant was informed by Quang Nam provincial authorities that funding for Phase 1 would be provided by the IDA under VWRAP even though it has already been constructed.

2.1.6 Phu Ninh Sub-Project

The current situation with respect to the civil works of the Phu Ninh Sub-Project is as follows:

- the headworks are in good structural condition due to extensive upgrading under WB1;
- the system does not meet new dam safety standards; and
- the irrigation system is degraded and requires significant upgrading.

PHU NINH MAIN DAM AND RESERVOIR

There are no structural problems with the main dam as it was extensively upgraded in 2001 - 2002 under WB1.

SADDLE DAMS

The Phu Ninh Dam Complex contains five saddle dams in addition to the main dam. There are no structural problems with the saddle dams as they were all extensively upgraded in 2001 - 2002 under WB1.

SPILLWAYS

The Phu Ninh headworks includes four spillways. There are no structural problems with the existing spillways as three of the four spillways were upgraded in 2001 - 2002 under WB1 and the new emergency spillway has just been completed and is therefore in good working condition.

IRRIGATION INTAKES

There are three irrigation intakes, corresponding to the three main canals in the Irrigation Scheme. There are no structural problems with the irrigation intakes as all were upgraded in 2001 - 2002 under WB1.

IRRIGATION CANAL SYSTEM

The main canals are severely degraded:

- because of the stony terrain, constructed cross sections were often not according to the design requirements. At present, average cross sections are about 60% of design cross section;
- In some sections, severe erosion at canal side slopes has occurred due to high groundwater levels in the rainy season and because water spills over embankment during flood season;
- many canal sections in clay soils are severely eroded;
- canals have also experienced blooms of aquatic plants, coming in to the irrigation system from the reservoir, that has clogged many of the irrigation channels; and
- large part of the main canals are seriously silted up.

The deterioration of the canal system increases in the lower levels of the canal system, with each succeeding level of canal being in worse condition than higher levels. In addition, the system of secondary and lower canals is incomplete.

Some of the canal system has been lined.

WATER CONTROL STRUCTURES ON THE IRRIGATION CANAL SYSTEM

The system of water control structures on the irrigation canal system is also very degraded:

Main Canals

- Almost all structures on North Main Canal are stone masonry; initial construction quality was very poor and maintenance over the years has been insufficient;
- Aqueducts and siphons: there are cracks on inlet and outlet gates, mortar has disintegrated and been washed out, water has percolated through cracks, causing water loss.
- Drainage sluices: inlets and outlets have been eroded, mortar has disintegrated, sluice bodies have settled and are in danger of breaking.

Lower Level Canals

- Structures on the primary and lower level canals are in a more deteriorated condition, experiencing the

same problems as on the main canal system. The deterioration of the water control structures increases at the lower level canal system, with each succeeding level of canal being in worse condition than higher levels.

2.1.7 Da Ban Sub-Project

THE DA BAN DAM AND RESERVOIR

The Da Ban Reservoir is formed by is a homogenous earth-fill embankment with a normal water level of +63 m and a corresponding storage volume of $75 \times 10^6 \text{ m}^3$. Since construction was completed the earthen dam has been affected by significant subsidence (up to 1 m), resulting in an undulating dam form. The dam has been in poor condition since it was first put into operation in 1986:

- During the first impounding of water in the Reservoir in 1986, a number of cracks appeared in the upstream slope and have been repaired using a total of 30,000 m^3 earth. In the 1993 and 1994 rainy seasons, narrow cracks appeared on the downstream slope. Subsequently, 6 cm wide and 3 m deep cracks were found on the downstream slope. These cracks were treated by excavation and backfill;
- An investigation of the dam body carried out by HEC-1 in August 2000 indicated that the quality of the soil for filling the dam is very poor (in term of soil dry density, only 39% samples of soil taken from the upstream inclined wall met the design requirements);
- The dam crest is completely covered by grass. Earth fill has been done at the centre of dam, along a half of the dam crest to compensate for settlements where the subsidence has occurred;
- The parapet is in a poor condition and mortar has fallen down the upstream slope. The dam crest has been filled up by the North Khanh Hoa IMC and currently the parapet's crest is equivalent to the dam crest in height;
- The upstream slope of the main dam is protected by stones of 20x20x30 cm placed on a sand-gravel filter. In general the upstream slope is in a poor condition.
- lining plates on the upstream slope are damaged:
 - Section 1: from elevation 61.00 to 68.00 m, lining plates have been pushed and moved by 5-15cm;
 - Section 2: from elevation 59.00 to 61.00m, lining plates have been pushed and moved by 15-30cm;
 - The sand-gravel filter on the slope as a whole has been washed, and grass grows between slits of stones.
- The downstream slope is mainly protected by grass and gravel on the slope surface. The dam toe near the bottom was lined with riprap over a height of 6m. In this area, besides reeds, shrubs grow rather high and are widespread over the dam slope.
- On the downstream slope, various signs of seepage were noticed. In particular when the downstream gate of the irrigation outlet is closed and pressure builds up in the conduit, leakage starts to appear at the ground surface of the above-mentioned conduit.
- During construction, 13 piezometers were installed in the downstream slope. However, no data were recorded. At present none of the piezometers is in an operational condition.
- Seepage and leakage will be reduced if the conduit is controlled at the upstream side while the downstream radial gate was opened. For that reason, IMC has shifted downstream control of the inlet to upstream control; and
- In 1995, grouting has been carried out to repair leakages, but without result. Repair of the leaking irrigation conduit had no effect.

MAIN SPILLWAY

The main spillway is located on top of the intake conduit; the entire structure was built on rock foundation. The spillway consists of 3 gates of 3 x 6m each with a total design capacity of $538 \text{ m}^3/\text{s}$. The threshold of the spillway is at an elevation of 57 m. The gates are presently operated by manual winch. Problems identified with the main spillway are as follows:

- Joints on the spillway body have been damaged, protection plates have peeled off and water seeps through the joints. In many places water jets out when the gates are closed;
- In general the concrete of the spillway body is in a good condition with partial damage only in some places and stalactites existing on some seepage points;
- Two cracks of 1-5 cm wide, 2-6 m long and 20 cm deep were found in the spillway tower at an elevation of 58.10 m-58.35 m;
- The section of the discharge canal behind the spillway, from the spillway downstream to the conduit on the main canal, has silted up.
- While the three radial spillway gates are in a good condition, the gates are operated manually and it takes eight hours to fully open them.

IRRIGATION INTAKE

The intake sluice is equipped with one flat upstream gate (2.2 m by 3 m, gate was originally designed for maintenance purposes) and a downstream radial gate of 1.75 m by 1.75 m. The design capacity of the irrigation intake is 12 m³/s. The intake is provided with a flat gate of 2.2 x 3.0 m for maintenance purposes. At the downstream end of the conduit, there is an operational radial gate of 1.75 x 1.75m, manually operated. The intake was designed as a penstock and the downstream control was adopted because of the original intention to install a hydropower station at the dam. There are a number of problems with the irrigation intake:

- The joints between the intake sections are seriously damaged, water has leaked back over the downstream slope of the dam and a large area in front of the downstream part of the dam has been affected. Downstream control was cancelled in order to reduce leakage from the joints on the intake body, and the upstream maintenance gate was converted to a manually operated operational gate; and
- The maintenance gate is leaking, about 1 m³/s, depending on the reservoir level. The situation is considered serious, because at present upstream there is only one gate operational; the downstream radial gate can only be used for very short periods in order not to endanger the safety of the dam. This means that in this way water is lost during periods that no irrigation releases are required.

MAIN AND PRIMARY CANALS AND ASSOCIATED WATER CONTROL STRUCTURES

Main Canal -- The main canal is 1 km in length from the spillway to the confluence of the Tay and Dong Primary Canals. The Main Canal was excavated in a rock layer, the earth slopes were lined by stones, and cracks were filled with mortar. The canal is still in good condition; its design capacity is 13m³/s. Embankment sliding and siltation are not considerable. The minor problems of the Main Canal are:

- There have been some landslides into the canal (total length of 20 m);
- Some of the mortar used for filling slits has been washed away;
- some of the masonry of the side spillway is damaged; and
- the sections of the canal in the rock layer have not been excavated to the desired design cross section.

Dong Primary Canal -- The Dong (East) Canal, with a length of 10,246 m commands an area of 4,300 ha and also supplies water for aquaculture, domestic, and industrial zones. There are a number of serious problems with the Dong Primary Canal:

- The Dong Canal runs through an area of soil that is loamy clay with much sand and, in some places, with gravel. Soil excavated from the canal was utilized for filling embankments and thus the quality of the embankments is poor. Both canal embankments show serious sliding, with some sections eroded away up to 3-4 m into the canal embankment over lengths of 40-100 m;
- The canal is heavily silted and the canal embankments have been cut away in some places by farmers wanting to take irrigation water;
- The cumulative effect of geology and soils and insufficient maintenance is a seriously deteriorated primary canal, with severely decreased water conveyance; and
- Only part of the canal has been provided with a service road on its embankment.

A section of the canal embankment, from the national highway to the end of the canal, has been lined with concrete using local funds.

Tay Primary Canal -- The Tay (West) canal is 10,666 m long, and commands an area of 3,500 ha. It is as degraded as the Dong Canal due to the same causes (above). None of it has yet been lined.

SECONDARY, TERTIARY, AND ON-FARM CANAL SYSTEM

There is a distinction between the secondary canals under operation of the North Khanh Hoa IMC and canals maintained and operated by communes. The canals operated by the communes are supported by the local authorities and some of these have been lined. In general, the lower canal system is in relatively poor condition; some of secondary and lower canals have completely disappeared.

ASSOCIATED WATER CONTROL STRUCTURES

Because of the uneven topography of the Da Ban command area, a substantial number of cross regulators and drain-culverts were built in the primary and secondary canal system. The operation of the regulation structures and the outlets is currently based on downstream control. The regulators are generally manually operated with screw-type equipment. Since installation, the equipment has not been replaced. Repair and maintenance has

been poor and many of the structures on these canals are damaged. There are no regulators on the tertiary or on-farm canals.

DRAINAGE SYSTEM

The Da Ban Sub-Project command area is exclusively drained through natural drainages systems that make their way eventually into the Da Ban, Da Han, and Cai Ninh Hoa Rivers, which converge into the Da Ban River, when then converges with the Song Lot River, the combined river draining southward through Ninh Hoa District Town into Nha Phu Bay. No man-made drainage infrastructure is in place except for the drainage culverts crossing the primary and secondary canal system. Due to the topography and the cropping pattern, drainage is not considered a problem in the Da Ban Sub-Project.

2.1.8 Dau Tieng Sub-Project

DAU TIENG DAM COMPLEX

Dau Tieng Reservoir is the largest in Viet Nam and has a live storage of 1,110 m³. The Dau Tieng Reservoir comprises: the Main Dam the Suoi Da Saddle Dam, and a 27.2 km long embankment dike around the western edge of Dau Tieng Reservoir. Key issues regarding the Dau Tieng Dam Complex are:

- Seepage through the body and foundation of all three dams has been an ongoing problem. Dam toe seepage may reduce dam strength as well as create an artificial wetland environment immediately downstream of the dam; and
- In 2000 the GoVN attempted to resolve the problem of dam seepage; physical measures applied included: bentonite - cement mortar grouting to form impermeable diaphragm (not yet to the bedrock layer); and rehabilitation and/or replacement piezometer tubes – used for monitoring groundwater levels.

These measures were only quite superficial and have delivered only short-term improvement in dam safety.

There had been a problem with seepage through the foundation of the main spillway. During the program of dam safety conducted in 2000 the following physical measures were applied:

- Cement mortar grouting was done unto spillway foundation, two dam abutments, and spillway body;
- All spillway gates and piers were strengthened;
- A hydraulic piston from Germany was installed; and
- Stoplogs hoisting equipment was replaced.

The Dau Tieng Reservoir includes three intake sluices 1, 2 and 3, with design discharges of 93.0, 93.0 and 12.8 m³/s respectively. Prior to 2000 there were some ongoing problems with the operation of the intake sluice (or outlet works) system:

- Contact seepage downstream of diversion conduits was causing localized water-logging of the dam toe - potentially compromising the structural integrity of the dam foundation; and
- Dilapidated gate and hoisting equipment resulting in poor control of water releases.

During the rehabilitation program for Dau Tieng Dam (2000) the following physical measures were successfully implemented:

- Cement - bentonite diaphragms installed around leaking conduits;
- Stainless steel outlet gates installed; and
- Electric winch replaced with hydraulic piston hoisting equipment.

MAIN CANAL DISTRIBUTION SYSTEM

Main Canals In Cu Chi District – All the main canals inside Cu Chi District are now lined with concrete. Due to concrete lining the canals have improved slope stability and are no longer subject to erosion. The improved stability of the canal slope associated with concrete lining has delivered a number of positive outcomes to the water supply system. In addition, regulating gates have been replaced and are well maintained and the hoisting equipment has been electrified already.

Main Canals in Tay Ninh – The main canals outside Cu Chi District are earth-filled and are characterized by unstable banks that are prone to erosion along many sections. Along some sections the canal bottom is furrowed and/or silted. There is a common trend that the bank is under erosion and the bottom is under siltation. In general the main canals are now wider but shallower than the original design meaning that the hydraulic cross section is now worse than the designed one, resulting in reduced water conveyance capacity.

Presently, Dau Tieng IMC undertakes dredging in some silted sections of the main canal outside the Cu Chi area. Sections of the East Main Canal (outside the Cu Chi area) have been broken on numerous occasions. This is a serious problem as it results in undesirable flooding and inundation of adjacent irrigation areas.

In general the irrigation outlet gates have not been renewed since first installed. The original gates were of a poor quality and the general level of maintenance and preservation has not been good. Consequently many of the gates are now rusted out and / or bent.

The on-canal hoisting units are all crankshaft operated. The hoisting units are the originally installed ones. Now after nearly 20 years of operation with minimal maintenance the hoisting units are in a poor condition. Dilapidation observed by the Consultant included cogwheels with broken cogs, bent cogwheels, and broken positioning bolts. Due to run-down condition of the hoisting equipment the opening and closing of gates must now be performed manually.

PRIMARY, SECONDARY AND TERTIARY CANALS

The Canals -- Primary, secondary and tertiary canals in the Dau Tieng Irrigation Scheme are generally earthen and are half excavated / half filled. In general the situation is that the canal banks have been eroded and the canal bottoms are silted. This has negatively impacted upon the delivery of water along these canals.

The GoVN issued a Decision No. 66/2000/QD-TTg on June 13, 2000, regarding "Some Policies and Financial Mechanism for the Implementation of the Canal Strengthening Program". Ministry of Finance also issued a Circulation No. 72/2000/TT-BTC on July 19, 2000 giving guidance to recognize the said Decision.

Tay Ninh Province is investing VND 850 billion into a 5-year program of irrigation canal strengthening. By the end of 2001, many of the important canals that were previously in a seriously damaged condition had been strengthened and brought into operation. The Tay Ninh Province investments to date are: (i) Primary - 43,316m with investment budget of VND 47,334 million; and (ii) Secondary and tertiary - 36,946m with investment budget of VND 25,583 million.

Gates and Hoisting Equipment -- Head canal intake sluices are generally equipped with steel slide valve gates, which must be manually operated using a crankshaft system. Many of the gates are now either rusted out and / or bent. Wooden slides are rotten and the washers are variably damaged. In some of the hoisting equipment the positioning bolts are loose and the crankshaft can be bent and / or rusted out. Some sluices lack entirely any operative gates or hoisting equipment.

20 years of operation without proper maintenance has meant that the gates and hoisting equipment function poorly and consequently provide inadequate control of water levels. In general, the lower rank a canal belongs to, the worse condition of sluice gates and hoisting equipment.

2.2 Description of VWRAP Project

2.2.1 Overall Objectives

The overall objectives of the VWRAP Project are to:

- Preserve the available water in the Reservoirs of the existing schemes;
- Upgrade the existing irrigation scheme;
- Improve reliability, flexibility, and effectiveness of the irrigation system;
- Reduce the cost of operation and maintenance;
- Enable the scheme to satisfy all reasonable water needs by supplying a sufficient quantity of water at the required times of the year; and
- Create the conditions for sustainable socioeconomic development using the application of modern design, engineering, and irrigation system management technologies.

This will be achieved by modernization of technical infrastructure from the headworks to the farm fields and by modernization of the management system for the entire Irrigation Scheme.

2.2.2 *Changes in Water Use and Allocation with Modernization*

Table 3 contains the changes expected in water use and allocation with the VWRAP Project. Modernization of the Irrigation Schemes are intended to support the shift in the use of the reservoirs from that of simply supplying water for agricultural purposes to an integrated water use scheme, supplying water to support:

- Increased agriculture production through a more efficient use of water resources (minimum decrease of 46 m³/s);
- expanding aquaculture activities within and outside the command area (minimum increase of 7.9 m³/s); and
- increase supply of domestic water to rural and urban residents and for industrial uses (increase of 169 m³/s).

2.2.3 *Engineering Required for Quang Hue-Vu Gia River Control Works*

The following engineering works are required for the Quang Hue-Vu Gia River Control Works¹⁴:

- Construction of a permanent spillway across the New Quang Hue River at the site of the spillway that was constructed in the 2002 dry season;
- Filling in the New Quang Hue River with material to be dredged from the left bank of the Vu Gia River to both reduced flow velocities in the Vu Gia River bend at the point that the New Quang Hue River was formed and to reclaim land lost when the New Quang Hue River was formed;
- Construction of a gate at the beginning of the Old Quang Hue River to control flow from the Vu Gia River into the Old Quang Hue River; and
- Construction of the Dai An Revetment along the left bank of the Old Quang Hue River to provide stabilization and erosion control in case of high flows into the Old Quang Hue River.

Construction is expected to take six months to complete.

2.2.4 *Summary of Engineering Required for Upgrading Irrigation Schemes*

Table 4 contains a summary of proposed upgrading of the civil works and facilities for the various VWRAP Sub-Projects. Essentially, the engineering that is proposed will consist of:

Headworks (main dam, associated saddle dams, spillways, intake sluices)

- Where required, upgrading the dams and associated saddle dams to deal with deteriorated dam bodies, spillway structures, and intake sluices;
- Preparation of Emergency Preparedness Plans (EPPs) for each of the irrigation schemes;
- Upgrading the headworks to meet the more stringent flood design standards;
- Repair and, if necessary, replacement of dilapidated civil works include spillway and sluice gates and associated structures; and
- Rehabilitating the headworks management roads.

Canal System

- Necessary engineering to ensure that the actual cross section meets present or future water conveyance demands, whichever is the highest;
- Lining canals where poor geological conditions exist;
- Dredging sediment from silted sections and backfilling at eroded areas;
- Overhauling existing civil works structures and associated equipment that can be reused and replace those structures and equipment that can not be reused. This will include:
 - Overhauling and replacing seriously damaged gates
 - Overhauling and replacing other seriously damaged equipment
 - Installing electrification systems for hoisting of larger sluices to facilitate local control (smaller sluices will be manually operated); and
- Rehabilitating roadway and paths along the entire length of the higher level canals.

¹⁴ Staff of the Water Resources Office in the Department of Agriculture and Rural Development of Quang Nam Province indicated that the Old Quang Hue River should be dredged so that it can once again serve as a water conveyance from the Vu Gia River to the Thu Bon River. It is not part of the engineering feasibility study document on which this EIA is based and is therefore not considered in the environmental analysis.

Table 5 contains a summary of the quantities of materials required for upgrading the dams, spillways, intake sluices, and headworks management roads for the VWRAP Project, while Table 6 contains a summary of the quantities of materials required for upgrading the canal system.

Table 3: Changes in water use with VWRAP¹⁵.

Sub-Project	Current	With Project	Difference
Yen Lap	66.0	145.6	79.6
Agriculture	63.0	104.0	41
Aquaculture	0.6	8.1	7.5
Domestic (Municipal) and Industrial	2.4	33.5	31.1
Cam Son-Cau Son	na ¹⁶	9.7	na
Agriculture	na	9.3	na
Aquaculture	0	0	na
Domestic (Municipal) and Industrial	na	0.4	na
Ke Go	7.2	10.2	3.0
Agriculture	7.2	8.53	1.33
Aquaculture	na	na	na
Domestic (Municipal) and Industrial	na	na	na
Industrial	0	1.67	1.67
Phu Ninh	400.5	422.39	21.89
Agriculture	394.2	304.8	-89.4
Aquaculture	0	0.27	0.27
Domestic (Municipal) and Industrial	6.3	117.32	111.12
Da Ban	1.93	3.75	1.82
Agriculture	1.68	2.88	1.2
Aquaculture	0.2	0.37	0.17
Domestic (Municipal) and Industrial	0.05 ¹⁷	0.5	0.45
Dau Tieng	na	na	na
Agriculture	na	na	na
Aquaculture	0	0	0
Domestic (Municipal) and Industrial	2.64	21.56	18.92
Total¹⁸	475.63	591.64	106.31
Agriculture	466.08	429.51	-45.87
Aquaculture	0.8	8.74	7.94
Domestic (Municipal) and Industrial	11.39	173.28	161.49

¹⁵ Data from Engineering Sub-Consultant Reports on Water Balance Calculations and VWRAP Final PFS submitted to MARD in March, 2003.

¹⁶ na – not available from Engineering Sub-consultant feasibility study reports

¹⁷ This is all for domestic (municipal use); none is to be allocated for industrial uses.

¹⁸ Totals are underestimates as estimates are not available from the Engineering Sub-consultant feasibility study reports for all Irrigation Sub-Projects.

Table 4: Civil works and facilities upgrading for VWRAP Sub-Projects.

Yen Lap Sub-Project			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals and Drainage
<ul style="list-style-type: none"> • Upstream slope reinforcement; <ul style="list-style-type: none"> – From elevation 15.0 to 25.0: Masonry inside a reinforced concrete grid. – From elevation 25.0 to 32.5: Concrete slab, 20 cm thick. • Repairing at the damaged sections of the wave wall • Providing a concrete and asphalt layer on the dam crest surface; and • Provision and operation supplementary dam monitoring equipment • Upgrading the entire length of the 600 m management road to the headworks 	<ul style="list-style-type: none"> • Overhauling spillway gates; • Overhauling electric hoists; • Maintenance and upgrading of stop-log lifting system • Upgrading the spillway operational controlling system by: <ul style="list-style-type: none"> – Installing monitoring cabinet locally and at the center. – Installing lighting system. – Installing measuring equipment at the spillway gate aperture. • Constructing new emergency spillway at Thuy San Isthmus between the main dam and the Nghia Lo Saddle Dam to meet new dam safety standards. Water flowing through the spillway will be conveyed to the upper part of the Cai Ca River which very quickly enters the Bai Be Estuary 	<ul style="list-style-type: none"> • Intake Tower <ul style="list-style-type: none"> – Construction an external steel reinforced-concrete armor – Filling cracks with cement grouting • Intake conduit <ul style="list-style-type: none"> – Pressurizing the entire internal part of the conduit with a steel pipe inserted of 2,500 mm diameter. Grouting and reinforcement at watertight joints and at seepage areas • Isolating gates <ul style="list-style-type: none"> – Replacing existing working gates with an isolating gate – The gate slides and gate-opening positions will be overhauled • Working gate <ul style="list-style-type: none"> – conical gates and a control-operating house for this gate will be installed • Sluice control system <ul style="list-style-type: none"> – Various control structures and equipment will be installed, including: (i) installing control cabinets; lighting system; and measuring devices for aperture of opening of each sluice gate. 	<ul style="list-style-type: none"> • Necessary engineering to ensure that the actual cross section meets present or future water conveyance demands, whichever is the highest; • Lining canals where poor geological conditions exist; • Dredging sediment from silted sections and backfilling at eroded areas; • Overhauling existing civil works structures and associated equipment that can be reused and replace those structures and equipment that can not be reused. This will include: <ul style="list-style-type: none"> – Overhauling and replacing seriously damaged gates – Overhauling and replacing other seriously damaged equipment – Installing electrification systems for hoisting of sluices with B ≥ 80 cm to facilitate local control (smaller sluices will be manually operated); and • As with the road along the main canal, rehabilitating the roadway along the entire length of the main canals.
Cam Son-Cau Son Sub-Project			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals and Drainage
<p style="text-align: center;">Cam Son Dam</p> <ul style="list-style-type: none"> • Improving the upstream slope reinforcement by using reinforced concrete slab instead of placed rock; • Reconstruction of the wave wall; • Repair and upgrading of the dam surface; and • Installation of dam monitoring system. • Upgrading 5 km access road to main dam <p style="text-align: center;">Cau Son Weir</p> <ul style="list-style-type: none"> • Maintaining the existing 70 m width; • Overall upgrading from the current ogee design to an Ophixerop design by lowering the crest of the weir and provide reinforced concrete covering, increasing the weir threshold height by 20 -30 cm; • Upgrading the body of the weir itself, possibly with cement mortar grouting and steel armored concrete covering; • Upgrading the weir dissipation yard; • Upgrading the bank protection both upstream and downstream of the weir; • Bridge construction over the sand; • Upgrading the silt-exclusion sluice with concrete and cement mortar grouting; • Upgrading the original and more recent weir intake sluices by dredging the inlet and outlet canal entrances and general upgrading of the engineering works; • Constructing an access - bridge across the weir 	<p style="text-align: center;">Main Flood Spillway</p> <ul style="list-style-type: none"> • Overhauling spillway surface, spillway chute slope, and discharge tunnel; • Heightening working bridge; • Reconstructing stop-log-lifting system; and • Reinforcing gates to enhance flood discharge capacity more than previous. <p style="text-align: center;">Supplementary Spillway</p> <ul style="list-style-type: none"> • widening the spillway width from the current 50m to 70m; all other spillway parameters will remain unchanged 	<ul style="list-style-type: none"> • none 	<p style="text-align: center;">Main and Primary Canals</p> <ul style="list-style-type: none"> • Dredging main and primary canals where required and raising the level of the canals at eroded areas; • Upgrading and enhancing the embankments for management road construction • Overhaul the civil works structures that can be reused and replace those structures that can not be reused; • Completely replace inlet sluice gates; • Replacing hoisting equipment; and • Improve water level and discharge regulation. <p style="text-align: center;">Secondary and Lower Canals</p> <ul style="list-style-type: none"> • Restoring primary canal cross sections to original design by dredging where required and raising the level of the primary canals at badly eroded locations; • Reinforcing primary canals where geological conditions have contributed to embankment breaching and canal erosion; • Upgrading and enhancing the embankments for access road construction; • overhaul the existing civil works structures and associated equipment that can be reused and replace those structures and equipment that can not be reused. <p style="text-align: center;">Drainage</p> <ul style="list-style-type: none"> • upgrading Van Son Pumping Station will be upgraded to increase conveyance of drainage water to the Thuong River

Table 4: Civil works and facilities upgrading for VWRAP Sub-Projects. continued.

Ke Go Sub-Project			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals and Drainage
<p style="text-align: center;">Main Ke Go Dam</p> <ul style="list-style-type: none"> Replace the damaged lining slabs of upstream slope located at elevation 13m to 26m by new concrete slab of bigger and thicker dimension; Repairing the damaged parts of the wave prevention wall and increasing height of the wall crest to 36.60 m; Lining the dam surfaces with a 30 cm rock layer and covering with a 30 cm pebble layer; and Install lighting system on dam surface; Overhaul piezometers system; and On the downstream slopes, repairing the drainage trench system and seepage zones, and constructing new grass frames. <p style="text-align: center;">Saddle Dams</p> <ul style="list-style-type: none"> Replace the damaged lining slab of upstream slope by new concrete slab of bigger and thicker dimension; Overhaul wave wall and heighten to elevation of 36.6 m; upgrading dam surface; and Repairing upstream slope. <p style="text-align: center;">Management Road</p> <ul style="list-style-type: none"> Upgrading management road to Grade No. 3 standard by widening to width of 5 m of which 3.5 meters will be paved with asphalt as well as provision of water drainage trenches 	<p style="text-align: center;">Doc Mieu Chute Spillway</p> <ul style="list-style-type: none"> Destroy the upstream rock barrier located in the inlet canal; Reinforce the spillway surface; Replace the damaged lining slabs by new reinforced concrete slabs of larger dimensions; Replace the old winch by a new hydraulic piston in view to obtain a more reliable gate operation; Reinforce radial gates; Install local and central electrical control; Upgrade the protection covering for the spillway equipment in purpose of creating good conditions for spillway operation in case of unfavorable weather; Upgrade the spillway management station to ensure a favorable condition for working and living condition for the staff and workers who reside their to manage the spillway, especially in rainy season; and Install lighting system. <p style="text-align: center;">Main Flood Spillway</p> <ul style="list-style-type: none"> Widening to 200 m from current width of 65 m to meet the more stringent design flood standards Reinforce the spillway surface to increase flood discharge compared with initial design; Reinforce dissipation basin; Repair damages in whole; Reinforcing spillway gate; Electrification of spillway operation; Protection covering installed at sluice tower and spillway in purpose of becoming the headwork management station. <p style="text-align: center;">Conduit Flood Spillway</p> <ul style="list-style-type: none"> Repair of the broken joints that are causing high seepage; replacing old radial gates as required replacing gate operation machinery. 	<ul style="list-style-type: none"> repairing the broken joints that are causing high seepage and upgrading and replacing as required the associated mechanical and electrical systems. 	<p style="text-align: center;">Main Canal</p> <ul style="list-style-type: none"> no need to upgrade or to overhaul the 5 km length head section of the canal. remaining 12 km must be rehabilitated and the cross section brought back to the original designed section by means of back filling the eroded section and dredging silted places. Canal lining will be carried out at sections where adverse geological features caused frequent sliding of the embankments. introduction of downstream control of the water-levels, combined with a local automatic control of the Cross Regulators in the canal (main canal) installation of Automatic water-level/discharge measurement devices (SCADA) Replacement all seriously damaged hoisting equipment. <p style="text-align: center;">Primary Canals</p> <ul style="list-style-type: none"> Restore the current cross section into to the initial designed cross section by means of dredging silted sections and backfilling eroded canal embankments. Canal lining will be carried out at sections where adverse geological features caused frequent sliding of the embankments. Heighten and upgrade the embankment road to become the main access road <p style="text-align: center;">Secondary and Lower Canals</p> <ul style="list-style-type: none"> Complete the canal infrastructure up to the level of the farm fields Restore the current cross section to the initial designed section. Carry out canal strengthening in accordance with the GoVN Decision No. 66/2000/QĐ-TTg of June 13, 2000.
Quang Hue-Vu Gia River Control Works			
<ul style="list-style-type: none"> provide revetment works to the right bank of the Vu Gia river River bank is to be protected by the proposed embankment faced with masonry and sod facing Gabion mattresses are to be placed to protect the foundation The sediments silted on the left bank opposite to that to be protected are to be utilized for the embankment material. 			
Phu Ninh Sub-Project			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals
<ul style="list-style-type: none"> Increase the height of saddle dam crests up to 37.40 m; and construct wave walls on three of the four saddle dams. 	<ul style="list-style-type: none"> A gate on the main spillway with height 1 m will be added. This will essentially be a rubber dam on top of the present spillway sill; and On the gated supplemental spillways, either 1 m high clapper gates will be added on top of the crest of the present spillway gates or reinforced wave walls will be constructed. 	<ul style="list-style-type: none"> None 	<p style="text-align: center;">Main and Primary Canals</p> <ul style="list-style-type: none"> Widening canal sections located on stony ground to the designed cross-section. With regards to earth canals in which the cross section is smaller than the design requirements, canal lining is preferred for increasing conveyance capability; Strengthen severely eroded canal sections as follows: <ul style="list-style-type: none"> For canal sections not crossing clay soils, use welded concrete slabs on geo-textile For canal sections crossing clay soils use pre-cast canal sections with fasteners.

Table 4: Civil works and facilities upgrading for VWRAP Sub-Projects. continued.

Phu Ninh Sub-Project, continued			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals and Drainage
<ul style="list-style-type: none"> • See above 	<ul style="list-style-type: none"> • See above 	<ul style="list-style-type: none"> • See above 	<p>Main and Primary Canals, continued</p> <ul style="list-style-type: none"> • Add new and strengthen existing inflow and outflow spillways and flood discharge drainage sluices at the canal sections that cross flood courses • Upgrade the canal embankments into proper management access roads; • Remedy and upgrade water control structures as follows: <ul style="list-style-type: none"> – Overhaul, upgrade or replace broken gates; – Supplement gates as required; – Completely rebuild seriously damaged structures; – Overhaul and upgrade or replace damaged hoisting equipment, and supply additional hoisting equipment as required. • Secondary and Lower Canals • Dredging and backfill side slope to restore present canal cross section to the original design; • Lining canals where poor geological conditions exist; • Add additional canals where required • Repair damaged on-canal structures and supplement on-canal structures as required; • Overhaul, upgrade, replace broken gates • Supplement gates as required; and • Overhaul, upgrade, replace damaged hoisting equipment, supply additional equipment as required.
Da Ban Sub-Project			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals
<ul style="list-style-type: none"> • Upgrading the body of the dam to ensure dam safety and safely allow the current allowed water level of 60 m to be increased to the designed normal water level elevation of 63 m. The following actions are suggested: <ul style="list-style-type: none"> – Earthfilling at the dam upstream and downstream; – Earthfilling at the dam downstream; and – Partly grouting into areas of heavy strong seepage. • Repair of lining slabs to strengthen the upstream slope by: <ul style="list-style-type: none"> – Treating seriously damaged sections with masonry on top of reinforced concrete blocks or concrete slabs; – Upgrading less damaged sections by repairing the sand-gravel filter in combination with re-lining slabs; – Reconstruction of the parapet, and improving and upgrade the dam surface. • Complete cleaning of vegetation on the upstream and downstream slopes; • Rehabilitation of the piezometers and implementing program of monitoring; • Installing water-level gauges every 20-100 m along the dam for measuring the upstream water level 	<ul style="list-style-type: none"> • Repairing spillway joints by grouting around the joints and repairing protection plates; • Repairing damaged concrete and two major cracks in the spillway; • Installation of electrical motors for electrification of the operation of the spillway gates and the overhead crane; and • Repair of the shed of the spillway tower to facilitate operation of the spillway in bad weather conditions. 	<ul style="list-style-type: none"> • Repairing the damaged joints by re-installation of the protection plates and grouting around the joints to prevent the present serious leakage through the joints; • Electrification of the operation of upstream and downstream gates of the intake; and • Rehabilitation and upgrading the covering of the operational equipment at the downstream of the intake. 	<p style="text-align: center;">Main Canal</p> <ul style="list-style-type: none"> • Enlargement as necessary and required to ensure canal width meets the design cross section; • Repairing the cracks where mortar has been washed out on the slopes; • Rehabilitating the roadway along the entire length of the main canal, increasing the width from 4 m to 6 m, and providing a laterite topping; and • Repairing the side spillway. <p style="text-align: center;">Primary Canals</p> <ul style="list-style-type: none"> • Necessary engineering to ensure that the actual cross section meets present or future water conveyance demands, whichever is the highest; • Dredging and rehabilitating the entire length of the canals; • Increasing the height of the canal banks where required to ensure no overtopping of floodwaters; • Provision of open drains for surface drainage to minimize bank erosion; • Overhaul the existing civil works structures and associated equipment that can be reused and replace those structures and equipment that can not be reused; and • As with the road along the main canal, rehabilitating the roadway along the entire length of the primary canals, providing a consistent road width of 6 m from the current 4 m width, and providing laterite topping

Table 4: Civil works and facilities upgrading for VWRAP Sub-Projects. continued.

Da Ban Sub-Project, continued			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals and Drainage
<ul style="list-style-type: none"> Upgrading the access road to the headworks to improve access. Increase dam crest height from current 68.7 m asl to 69.50 m asl to meet new design flood standards 	<ul style="list-style-type: none"> See above 	<ul style="list-style-type: none"> See above 	<p>Secondary and Lower Canals</p> <ul style="list-style-type: none"> Completion of the canal system to the field level; Restoring primary canal cross sections to original design by dredging where required and raising the level of the primary canals at badly eroded locations; Implementation of the canal strengthening program; Overhaul the existing civil works structures and associated equipment that can be reused and replace those structures and equipment that can not be reused.
Dau Tieng Sub-Project			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals
<p>Main Dam</p> <ul style="list-style-type: none"> Construction of bentonite core wall and absolutely drilling and grouting until it reaches the rock layer. Continue these works on the remaining sections Install water level meters upstream of the dam <p>Suoi Da Saddle Dam</p> <ul style="list-style-type: none"> Completion of the bentonite cement core wall Strengthening the upstream slope of the dam with better slope (maybe with pre-cast concrete slab) over the length of the dam section. The dam surface of this section should also be upgraded (asphalt or concrete paved) Construct wave wall from locations k11 to kf to meet new design flood standards <p>Dike Embankment</p> <ul style="list-style-type: none"> Development of a better solution to suppress the seepage in some segments. The solution of constructing a Bentonite diaphragm could be used. Strengthening some of the dam segments, which have an open gap, to allow traffic to pass the wave wall. It is recommended to construct a wall and to install slots for stoplogs. Complete the reinforcement of the upstream slope. 	<ul style="list-style-type: none"> Measures to dry up the stoplogs storage sheds; Improve stoplogs hoisting equipment. The presently used type is not appropriate Architecturally redecorate the spillway 	<ul style="list-style-type: none"> None 	<p>East Main Canal</p> <ul style="list-style-type: none"> Dredge and reshape the canal embankment to satisfy design cross section requirements Undertake the concrete lining of the canal over the total length of the East Main Canal Upgrade the road surface on the canal embankment using technical solutions most applicable to individual sections <p>West Main Canal</p> <ul style="list-style-type: none"> Dredge and reshape the canal embankment to satisfy design cross section requirements Where geological conditions are not favorable for canal integrity, the canal structure will be reinforced. It is not recommended to concrete the West Main Canal over its total length. Upgrade the road surface on the canal embankment using technical solutions most applicable to individual sections. <p>Primary and Lower Level Canals</p> <ul style="list-style-type: none"> Completing the canal system to the farm field level; Full implementation of the canal strengthening program; Restoring primary canal cross sections to original design by dredging where required and raising the level of the primary canals at badly eroded locations; Overhaul the existing civil works structures and associated equipment that can be reused and replace those structures and equipment that can not be reused.

Table 5: Quantities of engineering required for upgrading headworks and associated structures.

Sub-Project	Quantities (m ³)						
	Yen Lap	Cam Son-Cau Son	Ke Go	Phu Ninh	Da Ban	Dau Tieng	Total
Dams	4,512	140,542	46,869	150	346,340	662,503	1,200,916
Earth, Rock to be Removed	0	34,401	17,552	0	76,000	304,662	432,615
Other Material to be Removed	0	6,898	0	0	11,780	0	18,678
Earthfill to be Provided	0	50,932	24,911	0	212,400	95,700	383,943
Rock, Sand, Gravel, Masonry, Concrete, Cement	4,512	48,311	4,406	150	46,160	262,141	365,680
Spillways	315,345	39,186	64,917	0	19,850	14,297	453,595
Earth, Rock to be Removed	260,000	30,100	50,893	0	12,800	5,628	359,421
Other Material to be Removed	43,100	1,456	0	0	20	1,075	45,651
Earthfill to be Provided	5,500	2,960	10,520	0	2,700	6,097	27,777
Rock, Sand, Gravel, Masonry, Concrete, Cement	6,745	4,670	3,504	0	4,330	1,497	20,746
Intake Sluices	5,882	32	19,088	0	99	15,570	40,671
Earth, Rock to be Removed	4,800	15	3,306	0	0	7,475	15,596
Other Material to be Removed	30	0	0	0	15	0	45
Earthfill to be Provided	0	7	14,775	0	0	7,475	22,257
Rock, Sand, Gravel, Masonry, Concrete, Cement	1,052	10	1,007	0	84	620	2,773
Headworks Road	3,419	23,886	31,609	0	26,000	49,371	134,285
Earth, Rock to be Removed	2,027	12,086	13,850	0	6,000	0	33,963
Other Material to be Removed	0	0	0	0	0	0	0
Earthfill to be Provided	300	11,179	16,590	0	12,000	48,750	88,819
Rock, Sand, Gravel, Masonry, Concrete, Cement	1,092	621	1,169	0	8,000	621	11,503
Total	329,158	203,646	162,483	150	392,289	741,741	1,829,467
Earth, Rock to be Removed	266,827	76,602	85,601	0	94,800	317,765	841,595
Other Material to be Removed	43,130	8,354	0	0	11,815	1,075	64,374
Earthfill to be Provided	5,800	65,078	66,796	0	227,100	158,022	522,796
Rock, Sand, Gravel, Masonry, Concrete, Cement	13,401	53,612	10,086	150	58,574	264,879	400,702

2.2.5 Modernization of Irrigation Management System

The Sub-Project activities for modernization of the irrigation management system will consist of:

- Electrification of the operation of water control structures down and including the structures controlling water into the secondary canals;
- Upgrading the technical capacity of irrigation management personnel;
- Upgrading the equipment and management facilities of the IMC offices including the IMC Management Stations; and
- Improvement of the water user fee policies and the application and implementation of those policies.

2.2.6 Requirements for Resettlement and Compensation for Land Acquisition

As currently configured, VWRAP will require the resettlement of 10 households for the purposes of constructing the emergency spillway (Table 7). There are also some very modest requirements for compensation as a result of land acquisition (Table 7). It must be recognized, also, that the resettlement and compensation estimates contained in Table 7 do not include requirements that might occur when implementing the completion of the canal system at lower (tertiary and on-farm) levels. Quang Ninh PPC has decided that households requiring resettlement as a result of the Yen Lap Sub-Project will be resettled in Dai Yen Commune in Hoanh Bo District, some five km to the east of the location of the new spillway required to meet the new flood design standards.

2.2.7 Expected Changes in Agricultural Land Use

Table 8 provides the expected changes in agricultural land use within the command area as a result of VWRAP. VWRAP is expected to provide an additional 51,450 ha of cultivated agriculture per year.

Table 6: Quantities of material required for upgrading canal systems¹⁹.

Sub-Project	Total Length (m)		Lined (m)		Management Road Length (km)		Management Road Width (m)		Excavation (m ³)	Earth Fill (m ³)	Concrete, Masonry (m ³)
	Current	With Project	Current	With Project	Current	With Project	Current	With Project			
Yen Lap	104,309	104,309	71,900	103,636	103.85	103.85			305,367	225,307	241,750
Main and Primary	104,309	104,309	71,900	103,636	26.65	26.65	4-6	11.5	206,420*	183,715 *	204,960*
Secondary	na ²⁰	na	na	na	77.2	77.2	0.5-1.5	0.5-1.5	2,327	1,092	na
Other	na	na	na	na	na	na	na	na	96,620*	40,500 *	36,790 *
Cam Son-Cau Son	359,707	359,707	0	94,798	312,797	312,797	3-6	3-6	566,841	569,421	105,805
Main and Primary	359,707	359,707	0	94,798	312,577	312,577	3-6	3-6	566,841**	569,421**	105,805
Secondary	na	na	na	na	220	220	na	na	na	na	na
Other	na	na	na	na	na	na	na	na	na	na	na
Ke Go	206.6	206.6	7	111.4	137.2	137.2			628,163	476,256	215,573
Main and Primary	116.6	116.6	7	111.4	137.2	137.2	1-8	6	463,344	351,981	136,514
Secondary	90.0	90.0	na	na	na	na	0.8	na	164,819	124,275	79,059
Other	na	na	na	na	na	na	na	na	na	na	na
Phu Ninh	1,517,879	1,517,879	59,041	na	169.8	169.8	0.5-5	3-4	2,271,615	2,101,857	1,060,436
Main and Primary	239,714	239,714	30,584	na	169.8	169.8	0.5-5	3-4	2,271,615	2,101,857	1,060,436
Secondary	1,278,165	1,278,165	28,457	na	na	na	na	na	na	na	na
Other	na	na	na	na	na	na	na	na	na	na	na
Da Ban	153,815	153,815	23,085	153,865	205.54	205.54			349,380	314,642	84,091
Main and Primary	51,187	51,187	10,335	51,187	102.84	102.84	4-10	6-11	254,575	248,222	61,815
Secondary	102,628	102,628	12,750	102,678	102.7	102.7	1.5	1.5	80,305	62,120	21,836
Other							0.5		14,500	4,300	440
Dau Tieng	1,244,126	1,244,126	68,874	64.8	398,369.57	398,369.57			4,522,241**	3,293,393**	749,491**
Main and Primary	398,583	398,583	52,151	64.8	398,055	398,055	1.5-10	4-10	4,522,241**	3,293,393**	749,491**
Secondary	466,075	466,075	6,953	na	240	240	na	na	na	na	na
Other	379,468	379,468	9.77		74.57	74.57	na	na	na	na	na
Total	3,380,043	3,380,043	154,102	352,475	711,783	711,783	na	na	8,643,607	6,980,876	2,457,146
Main and Primary	755,432	755,432	112,878	249,797	1,147	1,147	na	na	8,285,036	6,748,589	2,319,021
Secondary***	1,381,349	1,38	1,349	102,678	640	640	na	na	247,451	187,487	100,895
Other***	379	379	10	0	75	75	1	0	111,120	44,800	37,230

* includes all primary, secondary, and tertiary canals

** included secondary canals

*** insufficient data available

¹⁹ Does not include on-farm canal system.

²⁰ na – not available from Engineering Sub-consultant feasibility study reports

Table 7: Resettlement and compensation requirements for VWRAP.

Project	Component	Households to be Resettled	Land Acquisition	
			Permanent (ha)	Temporary (ha)
Yen Lap	Headworks	10	7.8	5.6
	Canals	0	2.12	11.2
	Total	10	9.92	16.8
Cam Son-Cau Son	Headworks	0	0.8	5.0
	Canals	0	9.5	71
	Total	0	10.3	76
Ke Go	Headworks	0	0.6	0
	Canals	0	103.17	60
	Total	0	103.17	60
Quang Hue-Vu Gia	Total	0	0	100.5
Phu Ninh	Headworks	0	0	0
	Canals	0	147.5	163
	Total	0	147.5	163
Da Ban	Headworks	0	0	0
	Canals	0	47.8	204
	Total	0	47.8	204
Dau Tieng	Headworks	0	5	0
	Canals	0	911	150
	Total	0	916	150
Total	Headworks	10	14.2	10.6
	Canals	0	1221.09	659.2
	Total	10	1234.69	770.3

Taken from final VWRAP PFS, submitted to MARD in March 2003 and from Engineering Sub-consultant feasibility study reports.

2.3 Description of Dam Safety Fund

The MARD Dam Safety Fund will be used to upgrade 3 to 5 medium-sized dams owned by MARD in much the same way as the dams in six of the VWRAP Sub-Projects, described above, will be upgraded. This upgrading will include:

- Improving the upstream and downstream slopes of main dams and saddle dams;
- Repairing and upgrading the dam surfaces, and seepage treatment for dam bodies;
- Repair and upgrading the flood spillways, intake sluices; and
- Construction of new emergency spillway if required to meet new dam safety standards.

2.4 Description of EVN Hoa Binh Dam Safety Instrumentation and Da and Red River Reservoir Operations Infrastructure

This VWRAP component will consist of improving Hoa Binh Dam Safety through improving the existing monitoring system and providing new monitoring infrastructure. Da and Red River Reservoir operations infrastructure would be strengthened by:

- Upgrading of the necessary existing stations and development and implementation of the software components of a decision support system that will be used in managing Hoa Binh reservoir; and
- Addition of new stations and modifications to the software components of a decision support system necessary to improve the reliability of the decisions made in managing all dams on the Da River and the water resources throughout the Red River Basin.

Table 8: Expected changes in agricultural land use within the command area with Sub-Project implementation²¹.

Crop	Yen Lap			Cam Son-Cau Son			Ke Go			Phu Ninh			Da Ban			Dau Tieng			Total		
	Current	With Project	Increment	Current	With Project	Increment	Current	With Project	Increment	Current	With Project	Increment	Current	With Project	Increment	Current	With Project	Increment	Current	With Project	Increment
WS Rice	5,550	7,072	1,522	9,763	22,606	12,844	7,061	13,780	6,719	7,966	13,635	5,669	3,221	4,672	1,315	13,691	19,583	5,892	47,252	81,348	33,961
SA Rice	4,662	6,906	2,244	18,870	17,742	- 1,128	8,097	12,747	4,650	7,200	13,788	6,588	3,357	4,672	1,451	18,371	25,223	6,853	60,557	81,078	20,658
Monsoon Rice							0	3,273	3,273							32,892	8,267	-24,626	32,892	11,540	- 21,353
Peanut							2,063	1,550	- 513	1,838	1,072	- 777	44	173	129	17,132	18,322	1,191	21,077	21,117	30
Maize	0	1,248	1,248	1,051	3,424	2,372				460	612	152	71	303	232	6,128	10,575	4,447	7,710	16,162	8,451
Vegetables	2,319	1,248	- 1,071	517	2,094	1,577										1,895	3,626	1,730	4,731	6,968	2,236
Sugarcane													1,166	703	- 463	5,370	8,447	3,076	6,536	9,150	2,613
Soybean				813	5,395	4,582													813	5,395	4,582
Sweet Potato	1,540	1,248	- 292				2,067	1,378	- 689	1,379	1,072	- 302	44	136	91				5,030	3,834	- 1,192
Tobacco																3,660	5,122	1,463	3,660	5,122	1,463
Total	14,071	17,722	3,651	31,990	65,031	33,041	19,288	32,728	13,440	18,843	30,179	11,330	7,903	10,659	2,755	99,139	99,165	26	190,258	241,714	51,449

Derived from information provided in the financial/economic analysis sections of the final VRWAP PFS, submitted to MARD in March 2003.

3: DESCRIPTION OF EXISTING ENVIRONMENT^{22,23}

3.1 Overview of Project Area

Almost 3.8 million persons reside in the districts that form the VWRAP Project (catchment and command areas). Residents of the districts that form the command areas are 98.9% Kinh, while 35% of the residents of the districts communes that make up the catchment areas above the dams of the irrigation schemes are members of a recognized ethnic minority group. Most of the land in the Sub-Project is used for agriculture, and there remains only small amount of unused land.

Synoptic information for the Irrigation Scheme Sub-Projects is presented in Table 9 and Table 10.

3.2 Physical Resources

3.2.1 *Climate*

The entire VWRAP Area lies in the tropical monsoonal climatic region. All Sub-Projects experience two distinct seasons: a rainy season; and a dry season. The exact times of the years in which these two seasons occur varies among Sub-Projects. Table 11 contains a summary of the climate in each of the six Irrigation Scheme Sub-Projects:

Temperature -- The maximum average annual temperature is 27⁰C (Da Ban, Dau Tieng) and the lowest average annual temperature is about 23⁰C (Yen Lap).

Rainfall -- The maximum average annual rainfall is 2,700 mm (Ke Go, Phu Ninh) and the lowest average annual rainfall is 1,350 mm (Da Ban). Ke Go has the highest average monthly precipitation, at 831 mm (October).

Relative Humidity -- The relative humidity in the VWRAP Area is high and with little variation. The maximum average annual relative humidity is 85% (Cam Son-Cau Son, Ke Go) and the lowest average relative humidity is 80% (Da Ban, Dau Tieng).

Sunshine Hours -- The maximum average sunshine is 2,884 hours (Dau Tieng) and the lowest average annual sunshine is 1,570 hours (Ke Go).

Evaporation -- The maximum average annual evapotranspiration is 1,443 mm (Dau Tieng) and the lowest average annual evapotranspiration is 807 mm (Ke Go).

3.2.2 *Soils*

There are a wide variety of soils in the VWRAP area (); acid-sulphate soils are the only soils in the VWRAP area that pose an environmental risk. These soils, when dried out in the dry season, generate large amount of hydrogen ion through oxidation with the atmosphere which are then released into the aquatic environment at the beginning of the rainy season, causing a lowering of pH in surface waters. While none of the Irrigation Scheme Sub-Project areas have a problem with acid-sulfate soils like that found in the Mekong Delta, but a number of them do have some percentage of these soils, with the Dau Tieng Sub-Project containing the highest percentage of the command area.

²² This chapter refers primarily to the six Irrigation Sub-Projects that will receive most of the investment under VWRAP. Key features of the environmental resources of the Quang Hue-Vu Gia River Control Works area are noted.

²³ This chapter is a synthesis of more detailed descriptions of the existing environment in the Irrigation Scheme Sub-Projects and the Quang Hue-Vu Gia River Control Works. Readers are encouraged to read the individual Sub-Project EIAs to obtain more detailed environmental information.

Table 9: Synoptic population and land use information for the VWRAP Project Area²⁴.

Sub-Project	Basic Information			Agricultural Land Use (ha)					Forest Land Use (ha)			Natural Reserve (ha)			
	Area (ha)	Population	Population Density /km ²	Total	Rice, Vegetables, Beans	Fish Cultivation	Perennial Crop	Other	Production/Artificial	Special use forest	Protection forest	National	Provincial		
Pilot Areas															
Yen Lap	8,960	34,293	383	4,232	1,961	2020	46		313		446				
Cam Son-Cau Son	5,030	48,994	974	3,148	2,936		197	0	442	0	0	0	0		
Ke Go	7,271	45,985	648	3,432	5,777				7	0	0				
Phu Ninh	13,821	71,559	518	6,064	2,060		4,004		29	0	0	0	0		
Da Ban	7,530	25,016	332	4,459	1,683	228	742		2389	0	0	0	0		
Dau Tieng	41,474	196,131	473	33,665	22,001	129	2,488	9,047	1,756	0	348	0	0		
Summary, Pilot Areas	84,086	421,978	555	55,000	36,418	2,377	7,477	9,047	4,936	0	794	0	0		
Complete Command Areas															
Yen Lap	26,866	137,034	510	11,912	4,211	6,373	729		4,744		3,127	0	0		
Cam Son-Cau Son	108,830	642,493	590	48,463	30,718		5,324		13,976	0	1,672	0	0		
Ke Go	58,194	355,468	1,080	25,807	31,103	2,098	4,475		1,095	4,372	7,998	0	0		
Phu Ninh	81,792	411,550	503	34,382	24,774		2,435		8,653	0	0	0	0		
Da Ban	25,426	80,709	317	9,703	4,026	321	336		3,081		0	0	3,661		
Dau Tieng	506,725	1,891,301	373	307,066	223,120	4,226	42,757	36,963	4,067		83,799	0	0		
Summary, Complete Command Areas	807,833	3,209,072	562	437,333	317,952	13,018	56,056	36,963	35,616	4,372	96,596	0	3,661		
Sub-Project Areas Upstream of Command Areas															
Yen Lap	26,214	15,097	46	1,851	618	937	204		2,820		11,198	0	0		
Cam Son-Cau Son	181,686	297,226	164	34,030	19,794		2,704		21,327		33,039	0	0		
Ke Go	26,758	18,465	110	1,446	1,997					5,415	11,338*	11,338	0		
Phu Ninh	27,324	21,241	78	2,502	651		956		3,260	0	9,082	0	11,526		
Da Ban	17,175	5,720	33	1,478	643		123		2,148			0	8,709		
Dau Tieng	132,600	207,439	156	34,632	25,332	125	6,855	2,320	1,172	434	4,026				
Summary, Upstream of Command Areas	411,757	565,228	100	75,939	49,035	1,062	10,842	2,320	30,727	5,849	68,683	11,338	20,235		

²⁴ Information is provided only for administrative units that are within particular parts of the Sub-Project; the boundaries of these administrative units do not correspond to the boundaries of the pilot areas, command areas, or areas of influence of the major headworks. The data give a qualitative understanding of the socioeconomic status of the Sub-Project area. Blank entries mean no data were available at the time this EIA was prepared.

Table 10: Synoptic socioeconomic information for VWRAP Project²⁵.

Sub-Project	Basic Information			Household Size			Poverty			Ethnic Minorities								
	Area (ha)	Population	Population Density /km ²	Total No. HH	Average HH Size	No. Agr HH	Ha Ag land/Ag HH	% Below Minimum Poverty	No. Communes on 135 List	% Kinh	% Other	No. Ethnic Minorities	Name	% Pop'n	Name	% Pop'n	Name	% Pop'n
Pilot Areas																		
Yen Lap	8,960	34,293	383	7,354	4.7	3,444	0.59	3.1	0	100	0	0		0				
Cam Son-Cau Son	5,030	48,994	974	11,036	4.4	10,712	0.28	7.9	0	97.4	2.6	3	Nung	1.79	San diu	0.46	tay	0.24
Ke Go	7,271	45,985	648	11,183	4.12	9,015	0.43	Na	0	100	0	0		0		0		0
Phu Ninh	13,821	71,559	518	16,859	4.24	14,150	0.43	23.9	0	99.94	0.06	7	Tay Muong	0.05, 0.11	Cotu, Giarai	0.23, 0.04	Thai, Ede, Hmong	0.12, 0.01, 0.02
Da Ban	7,530	25,016	332	4,427	4.27	3,845	1.16	8.67	0	99.67	0.33	1						
Dau Tieng	41,471	196,131	473	40,709	4.56	27,838	1.23	4.70		99.9	0.1	2	Hoa	0.09	Tamun	0.01		
Summary, Pilot Areas	84,086	421,978	555	91,568	4.4	69,004	0.62	7.6	0	99.5	0.38	13						
Complete Command Areas																		
Yen Lap	26,865	137,034	510	32,904	4.05	26,350	0.452	11	0	98.7	1.3	1	Hoa	0.4				
Cam Son-Cau Son	108,830	642,493	590	141,672	4.5	121,451	0.37	17.5	7	95.5	4.5	8	Nung	0.14	San diu	0.18	Tay, Hoa	1.3, 0.7
Ke Go	7,271	45,985	1,080	73,950	4.2	51,861	0.46	22.4	0	100	0	0		0		0		0
Phu Ninh	81,972	411,550	503	80,023	4.39	66,809	0.51	16.6		99.87	0.13	16	Tay, Hoa	0.03, 0.21	Muong, Cotu, Thai	0.01, 0.03, 0.01	Taoi, Ngai	0.03, 0.01
Da Ban	25,426	80,709	317	14,906	5.41	13,056	0.74	9.88	0	100	0	0		0		0		0
Dau Tieng	506,725	1,891,301	373	414,763	4.59	273,944	1.26	Na		99.44	0.56	8	Kho me	0.25	Hoa	0.14	Cham	0.11
Summary, Complete Command Areas	807,833	3,209,072	562	758,218	4.5	553,471	0.63	16.2	7	98.9	1.30	33						
Sub-Project Area Upstream of Command Areas																		
Yen Lap	26,214	15,097	58	3,271	4.75	3,115	0.54	Na	3	86	14	4	Nung, Tay	6.5, 38.9	Dao	18.7	Muong	0.5
Cam Son-Cau Son	181,686	297,266	164	61,715	4.8	60,185	0.57	Na	19	34.5	65.5	11	Nung	27.3	San diu, Tay	6.6, 13.5	Hoa, Dao	3.99, 1.32
Ke Go	26,758	18,465	110	3,831	4.82	2,298	0.62	Na	0	100	0	0	0	0	0	0	0	0

²⁵ Information is provided only for administrative units that are within particular parts of the Sub-Project; the boundaries of these administrative units do not necessarily correspond to the boundaries of the pilot areas, command areas, or areas of influence of the major headworks. The data give a qualitative understanding of the socioeconomic status of the Sub-Project area.

Phu Ninh	27,342	21,241	78	5,399	3.93	5,341	0.47	31.53	2	96.06	3.94	1	Cotu	29.59				
Da Ban	17,175	5,720	33	1,030	5.55	1,030	1.44	13.21	0	98.54	1.46	1	Muong	1.46				
Dau Tieng	132,600	207,439	156	43,756	4.75	38,126	1.78	5.54	0	99.46	0.54	7	Tamu	0.002	Hoa	0.0004	Tay	0.0002
Summary, Upstream of Command Areas	411,757	565,228	100	119,002	4.8	110,095	0.90	8.1	24	65.0	35.0							

Table 11: Summary of climate regime for Irrigation Sub-Projects.

Climate Parameter	Units	Yen Lap	Cam Son-Cau Son	Ke Go	Phu Ninh	Da Ban	Dau Tieng
Temperature							
Average Annual	°C	23	24	24	26	27	27
Average Monthly High	°C	29	29	30	29	28	29
	Month	Jul	Jul	Jun	Jul	May to Jul	Apr
Average Monthly Low	°C	17	17	18	21	24	26
	month	Jan	Jan	Jan	Dec	Jan	Dec to Feb
Precipitation							
Average Annual	Mm	1,630	1,611	2,700	2,700	1,350	1,940
Average Monthly High	Mm	300	305	831	700	800	300
	Month	Aug	Jun	Oct	Oct and Nov	Oct	Sep and Oct
Average Monthly Low	Mm	17	25	55	51	21	10
	month	Feb	Feb	Mar	Dec	Feb	Feb
Sunshine Hours							
Average Annual	Hours	1,600	1,618	1,570	1,980	2,500	2,884
Average Monthly High	Hours	185	185	212.9	185	266	265
	Month	Jul, Sep	Sep	Jul	Jul	Mar	Mar
Average Monthly Low	Hours	44	47.5	59.1	44	138	171
	month	Mar	Feb	Dec	Mar	Dec	Sep
Evapotranspiration							
Average Annual		860	993	807	1,080	1,400	1,443
Average Monthly High	Mm	93	103	135	145	135	195
	Month	Oct	Jul	Jul	Jul	Dec	Mar
Average Monthly Low	Mm	40	61	26	51	89	74
	month	Mar	Mar	Jan	Dec	Oct	Oct
% Humidity							
Average Annual	%	81	85	85	82	80	80
Average Monthly High	%	86	87	93	88	83	87
	Month	Mar	Mar	Feb	Nov	Oct	Sep
Average Monthly Low	%	75	79	74	77	77	73
	Month	Nov	Nov	Jul	Jul	Jul and Aug	Jan to Mar

Table 12: Overview of soils in VWRAP Area.

Yen Lap Sub-Project
<ul style="list-style-type: none"> • Mountain and Hilly Soils These are weathered soils. The characteristics of these soils range from soft to heavy and are often mixed with parent stone and small gravel. These soils are suitable for forests and fruit trees. Forests are found in areas where this soil layer is thick, while areas where this soil is thin tend to be not treed. • Feralitic Soils These soils are found on the terraced plain for rice cultivation along Highway No.10 Highway from Pha Rung to Bieu Nghi and No.18 from Dong Mai to Minh Thanh. These soils originate from hills with gentle slope and exploited by using to terraced fields where the thickness of cultivated soil layer is 10 - 12 cm. Agricultural production on these soils is mainly rainfed in nature and so only one rice crop is cultivated per year. Yield on these soils are generally and unstable. • Infertile Soils These soils are from 10 -12 cm in depth, largely comprised of is sandy clays. Crop yields are poor. • Sandy Soils These soils are located in Tien An, Tan An, Hoang Tan and Minh Thanh Commune, estuary areas and outside dike system areas. These soils are used for cultivating upland crops (i.e., not rice). • Saline Soils These soils are found in lagoon areas such as Nha Mac, Cai Trap, Ha An, Hoang Tan, Dien Cong Lagoons. This land is suitable for aquatic production.
Cam Son-Cau Son Sub-Project
<ul style="list-style-type: none"> • No soil maps exist for the Cam Son-Cau Son Sub-Project area and so it is not possible to quantitatively describe the soils of the Sub-Project area and the conditions of those soils. Most of the agricultural land is comprised of clayey soils that are alluvial in origin, while the semi-mountainous and mountainous areas contain mostly weathered laterite soils.
Ke Go Sub-Project
<ul style="list-style-type: none"> • Coastal Plain and Valley Soils (93%) consist of four sub-groups: <ul style="list-style-type: none"> – Sandy Soils (22%) These soils are characterized by low amounts of humus (from 0.2 to 0.7%), low total nitrogen, low phosphate, and low acidity. These soils are found along the coast in Cam Xuyen and Thach Ha Districts. Land containing these soils contains bare or artificial forest; some parts grow dryland crops or short period industrial plants. – Saline Soils (3%) are found along the coast. On the low saline soils rice and dryland crops can be grown, but crop yields are low in drought years. On the heavy saline soils, there are some aquaculture ponds, or white salt production fields, and some parts are still unused (likely coastal wetlands). – Saline acid soils (10%) are found in lowlands. These soils are clayey and contain medium amounts of humus. Rice is cultivated on these soils. – Alluvial Soils (58%) are classified by annual upgraded alluvium soil, rare upgraded alluvium soil, low clay alluvium soil, medium or high clay alluvium soil, old alluvium soil and river alluvium soil in the mountain areas. These soils are high in nutrients and are used to grow rice, dryland crops, and short duration industrial crops. Most of the command area is comprised of these soils. • Terrace Soils (7%) These soils have good nutrient content and are used to cultivate fruit trees.
Phu Ninh Sub-Project
<ul style="list-style-type: none"> • Yellow-Red Feralitic Soils These soils comprise 61% of the total Phu Ninh Reservoir catchment area. These soils are thin, with little topsoil, and often stony. These soils are found in almost the communes of this area. These soils contain iron oxide and Aluminum oxide which cause the soils to be acid (pH from 4.5 to 5)²⁶. These soils are easy eroded even on gradual slopes. Agricultural crop yield is low in these soils, but forest trees can be grown. • Red-Yellow Feralitic Soils These soils comprise 20% of the total Sub-Project Area and are covered by forests. • Sloping Alluvial Soils These soils are formed by erosion processes from hillsides to valleys near the streams. These soils are thick and have high humus content. They comprise about 15-17% of total area, and are found mostly in the command area of the Sub-Project.
Da Ban Sub-Project
<ul style="list-style-type: none"> • Alluvial Soils: These soils have a significant role in agricultural production and contain six different soil types. These soils are characterized as being clayey, light acidity, and poor nutrition. Rice agriculture is mostly practiced on these soils. • Terrace Soils: These soils are grey soils and are characterized by some acidity, low humus levels, and light structure. These soils are used to plant annual agricultural crops other than rice and industrial crops.
Dau Tieng Sub-Project
<ul style="list-style-type: none"> • Terrace Soils These soils are Grey Soils and are characterized by low amounts of clay, high concentrations of silt and heavy leaching. These soils can be found in Tan Chau (Tay Ninh), Dau Tieng (Binh Duong), Duc Hoa (Long An) and the upper and middle Vam Co Dong (Chau Thanh in Tay Ninh to Long An); and soil characteristics are mainly clay-sandy and mixed clay particles, and soil thickness 50-100cm. Rice, dry-footed crops, sugarcane can be grown in this soil and have a high yield if enough water for irrigation and good cultivation. • Recent Alluviums These are characterized by clays (and often heavy clays) and are located in Trang Bang (Tay Ninh) and Duc Hue (Long An). This clay thickness is more than 100cm. It is nutrient soil and good keeping water (percolation rate $k \approx 1\text{mm/day}$), suitable for rice growing and dry-footed crops. A problem with these soils is their predisposition to acid sulphate conditions under dry conditions. While waterlogged and anaerobic the iron pyrites (FeS_2) will remain in a reduced condition and acidification will not occur. If allowed to dry out, the sulphides will oxidize to sulphates and produce the acidity when flushed from the soils at the beginning of the rainy season.

²⁶ This acidity is not the same as the acid sulphate soils that are commonly found in the major river deltas Viet Nam. These soils do not generate a pulse of acidity at the start of the rainy season.

3.2.3 Surface Water Quality

There is no regular surface water quality monitoring of any kind within any of the Irrigation Sub-Project Areas or in the Quang Hue-Vu Gia River Control Works area and it is therefore not possible to make any comprehensive quantitative assessment of current water quality conditions within the VWRAP Area. There have been a number of water quality surveys conducted in the six Irrigation Schemes, including surveys conducted in all six Irrigation Schemes as part of the preparation of this EIA; the main results of these surveys are found in Annex 7. The main features of surface water quality in the VWRAP Area are as follows.

Reservoirs -- Irrigation Scheme reservoirs generally have good quality water with most water quality parameters within national surface water quality standards. Most of the reservoirs have a tendency towards eutrophication, as evidenced by high phosphate levels²⁷. In addition, parameters such as COD and dissolved oxygen in a number of the reservoirs recent years have become above national surface water quality standards. Heavy metals have not been found yet in the reservoirs.

Command Areas -- The limited water quality surveys that have been conducted in the command area to date indicate that surface water quality is generally acceptable, save for coliform levels and bacterial contamination. Residents of the command area are surrounded by irrigation canals that are essentially open sewers, particularly in densely populated command areas such as Cam Son-Cau Son and Ke Go. Other water quality parameters such as dissolved oxygen, iron content, and COD, only periodically exceed surface water quality standards (Annex 7). In the Dau Tieng Sub-Project, pH at some locations was measured to be near 5, which may be a result of acidity being released from acid sulphate soils. These levels are not sufficiently low to make aluminum, a metal common associated with high acidity in surface waters, become labile and therefore toxic to aquatic biota. In a number of Irrigation Scheme Sub-Projects (Yen Lap Bac Giang, Dau Tieng), industrial facilities discharge large amounts of waste water either into the command areas or downstream of the command areas. Many of these industrial facilities are old state-owned enterprises with limited waste

treatment facilities and likely limited ability to comply with national industrial waste water standards. Pesticide levels in surface waters of the command areas are unknown.

3.2.4 Groundwater Resources

Groundwater resources in the VWRAP area variable in quantity and quality (Table 13). In general:

- Groundwater quantity, particularly the shallow aquifers, has improved in the Irrigation Sub-Projects as a result of construction and operation of the Irrigation Schemes;
- Pesticide levels in groundwater are unknown;
- There are salinity intrusion problems in a number of the Irrigation Sub-Projects at the lower end of the command areas that are near or in coastal areas; and
- The quality of shallow groundwater resources is generally poorer than that of deeper groundwater resources.

²⁷ Value of PO₄-P < .01 mg/l, Low eutrophication risk; .01 to .04 mg/l, Medium risk; > .04 mg/l, High risk. Source: ANZECC/ARMCANZ (2000)

Table 13: Overview of groundwater resources in VWRAP Area.

Yen Lap Sub-Project
<ul style="list-style-type: none"> • In general, groundwater resources in Quang Ninh Province are very limited and this is the case with the Sub-Project Area. <ul style="list-style-type: none"> – Groundwater resources in Yen Hung District are poor. Groundwater in coastal areas in areas east of Highway No.10 Highway are saline, while groundwater resources west of Highway No.10 are very deep and so are not used very much. Groundwater resources of Ha Nam Island district are very poor. Almost all dug wells suffer from salinity intrusion with salinity content double the domestic water quality standard for rural areas. In addition, groundwater is also polluted by ammonia, manganese and iron. Of particular concern is the prevalence of high mercury levels in the groundwater of Ha Nam Island that are well above national standards. • By contrast, shallow groundwater resources in Hoanh Bo District are abundant and can provide for domestic requirements year-round. However, groundwater levels in the dry season are lower than that in the rainy season. • Most of the shallow groundwater resources of the Sub-Project Area have coliform levels that exceed domestic water quality standards.
Cam Son-Cau Son Sub-Project
<ul style="list-style-type: none"> • Groundwater quality Area compares favorably with national groundwater standards except for bacterial pollution (coliform, and E. coli). However, many groundwater parameters, including coliform, E. coli, turbidity, color and iron exceed national standards of the Ministry of Health.
Ke Go Sub-Project
<ul style="list-style-type: none"> • Shallow groundwater resources throughout the Ke Go Irrigation Scheme have become more abundant as a result of development of the Ke Go Reservoir and increasing supply of water for irrigation. The groundwater levels depend on the water levels of Ke Go Reservoir and irrigation canal network, with groundwater levels changing with the amount of irrigation water supplied and used and the amount of precipitation. In rainy season, the groundwater level is from 0.5 – 1.5 m, and the dry season from 2.0-3.0 m. Groundwater resources in the Sub-Project Area are generally adequate and meet national groundwater quality standards except for bacterial pollution (coliform, and E.coli). In addition, a number of other water quality parameters periodically exceed national standards. • The deep groundwater resources are often polluted by salinity intrusion. Groundwater at a depth of greater than 5.0 m generally can not currently be used for any purpose.
Phu Ninh Sub-Project
<ul style="list-style-type: none"> • Most of the wells used in the Sub-Project Area tap into shallow groundwater resources, with wells generally being around 7-8 m in depth. Shallow groundwater resources throughout the Phu Ninh Irrigation Scheme have become more abundant as a result of development of the Phu Ninh Reservoir and increasing supply of water for irrigation. • Groundwater resources in the Sub-Project Area are generally adequate and meet national groundwater quality standards except for bacterial pollution (coliform, and E. coli). Bacterial pollution in groundwater has been recorded in Binh Nam Commune (Thang Binh District), Tam Phu, Tam Xuan, Tam Anh 2 Communes (Nui Thanh district). There are problems with heavy metals in the groundwater in some areas. Manganese and iron (Fe) levels in the groundwater in Binh Nam Commune (Thang Binh District) are very high and exceed national groundwater quality standards. In addition, the groundwater in Tam Ky Town has high Nitrogen (N), organic content, and some groundwater samples are polluted by heavy metals. • One of the major groundwater quality issues is that of salinity intrusion in the dry season, into rivers and also into groundwater in domestic wells. Groundwater resources are affected by salinity intrusion in the lower parts of the command area and in all districts of Que Son, Thang Binh, Duy Xuyen, Nui Thanh, and Tam Ky Town.
Da Ban Sub-Project
<ul style="list-style-type: none"> • There are two sets of groundwater resources in the command area: <ul style="list-style-type: none"> – Groundwater in river sediments which is found in the western and northwestern communes of Ninh Hoa District. Shallow groundwater depth is 5-15 m and is of good quality, with neutral pH; and – Groundwater in the estuarine and nearshore sea sediments which found in the eastern and southeastern communes of Ninh Hoa District. Shallow groundwater in this aquifer is at a depth of 3-5 m. The water is brackish, with neutral pH. This groundwater is contaminated by coliform and has high levels of nitrate and total minerals. Groundwater quality in this aquifer degrades from west to the east. This groundwater is polluted by acidity, salinity intrusion. In the dry season, this groundwater levels rise to the surface in some areas, negatively influencing agricultural commodity production. In addition, groundwater in some parts of Ninh Hoa and Van Ninh Districts are polluted by fluoride, with concentrations of more than 0.2 mg/l.
Dau Tieng Sub-Project
<ul style="list-style-type: none"> • There are deep groundwater levels in the Sub-Project Area, with some wells for domestic water purposes being more than 50 m in depth. Shallow groundwater resources throughout the Dau Tieng Irrigation Scheme have become more abundant as a result of development of the Dau Tieng Reservoir and increasing supply of water for irrigation. • As with surface water, groundwater resources in the Sub-Project Area are generally adequate and meet national groundwater quality standards except for bacterial pollution (coliform, and E. coli). In addition, a number of other water quality parameters periodically exceed national standards.

3.2.5 Air Quality

As is the case with surface water quality, none of the air quality monitoring stations in the national Environmental Monitoring system maintained by the National Environment Agency of Viet Nam are located in the Irrigation Sub-Project area, and there are therefore no long term records of air quality from any of the seven areas that are part of this VWRAP EIA. Notwithstanding this lack of information, air quality is generally good in the Sub-Project Area, particularly in the command areas.

Most Irrigation Scheme Sub-Project Areas contain some industrial plants producing air pollution:

Yen Lap - the Uong Bi coal-fired thermal generating station, the paper factory described above, and numerous brick and tile factories;

Cam Son-Cau Son - Bac Giang Town, the major urban center within the Sub-Project Area with a population of almost 100,000 persons contains a number of large and old industrial enterprises;

Ke Go – industrialization is low;

Quang Hue-Vu Gia River Control Works – There are no industrial facilities whatsoever in this area;

Phu Ninh - Only in Tam Ky Town is the air quality of some concern, with simple parameters such as dust being up to twice as high as national air quality standards;

Da Ban - Ninh Hoa Town suffers from poorer air quality. Suspended dust levels have been measured at from 4.7 to 7.3 times above national standards in the Ninh Xuan Industrial Zone, and 1.3 to 3 times above standard in the Hon Khoi Industrial Zone. Hydrocarbon concentrations in the vicinity of the Hon Khoi Industrial Zone have been measured at 7.5 times above provincial standards; SO₂ has been measured at 1.6 times the provincial standard. High concentrations of metals (As, Cu, and Cd) in air have been measured, largely from the activities of the Hyundai-Vinashin Boat Company. This appears to be rather local, however, and concentrated near the major industrial centers of the Town.

Dau Tieng - industrialization is low in most of the command area but degrades as one moves down the Sai Gon River into the greater Ho Chi Minh City area.

3.2.6 Mineral Resources

There are a number of mineral resources in the Irrigation Scheme Sub-Project Areas:

Yen Lap - Coal resources in the Sub-Project Area are located in:

- The Da Chong area of North Yen Hung District, which contains some coal seams containing several thousand tonnes each. These coal seams have been exploited since French Colonial times and are still being exploited; and
- There is extensive small-scale mining in the watershed of the Yen Lap Reservoir. Access to these areas is by boat running from the Dam. There are reports that these activities are causing environmental degradation of the watershed through deforestation and lack of proper treatment of spoil areas, and increasing the sediment loading into the Reservoir. There is no quantitative information on the amount of coal being mined from the Reservoir watershed, the extent of environmental damage being caused by these activities, or the effect on the Yen Lap Reservoir.
- Limestone is found mainly on Hoang Tan Island, east-southeast of the command area, with total reserves estimated at more than 1 million m³. This limestone is being exploited for use as a construction materials;
- Clay is a main mineral resource of Yen Hung District. Clay is exploited to produce construction materials such as brick and tile. Low quality clay is distributed in Minh Thanh and Dong Mai Communes in the Reservoir catchment area and in Tien An and Cong Hoa Communes found within the command area. Total reserves are estimated at more than 1 million m³.
- Sand resources of very high quality are located in Minh Thanh Commune, upstream of the command area and in the Yen Lap Reservoir catchment area. Reserves are very large and remained largely unexploited.

Cam Son-Cau Son - There are no known mineral resources within the Sub-Project area;

Ke Go

- Iron is found in Thach Khe (the coastal area of Thach Ha district), about 7km north east of Ha Tinh Town. The estimation of this iron ore reserve is about 544 million tonnes, occupying nearly 50% of the total national iron ore reserves.
- Titanium: Inmenhite mineral, containing titanium, is found along the coastal areas of Thach Ha, Cam Xuyen, Ky Anh and Nghi Xuan Districts. The reserves are estimated at 5.4 million t Inmenhite and 322,000 tons Zircon.

Quang Hue-Vu Gia River Control Works – no known mineral resources;

Phu Ninh

- There are relatively few mineral resources in the Sub-Project Area. Gold has been found in Nui Thanh District and Tam Ky Town but the reserves have not been estimated and there are no extraction activities at present. Mineral water exploited from the Phu Ninh Reservoir, and granite stone is quarried Que Son District.

Da Ban

- There are only a few minerals resources in the vicinity of the Sub-Project Area. These resources, exploited in Ninh Hoa District, consisting mostly of granite stone and clay that is supplied to brick and tile production plants.

Dau Tieng

- Limestone: found in Tra Va, Soc Trang and Tong Le Chan (Tay Ninh Province) with capacity of 1.4 million tones in case to the elevation of +0.0 m asl. This limestone quality is variable but it can be used to produce cement

- Laterite: can be used for road construction and is distributed throughout Tay Ninh Province; reserves are estimated at 4 million m³.
- Building Stone: located in the Ba Den Mountain area with reserves of approximately 40 million m³.

3.3 Biological Resources

3.3.1 *Terrestrial Ecosystems*

Table 14 contains a summary of the terrestrial ecosystems in the Irrigation Scheme Sub-Projects. In general, there are essentially four types of terrestrial ecosystems in the VWRAP Area:

- Highly simplified agricultural ecosystems that produce annual crops, interspersed with fruit trees and trees planted for shelter and fuelwood purposes. The command areas of the Irrigation Scheme Sub-Projects consist of almost entirely this type of terrestrial ecosystem (the Quang Hue-Vu Gia River Control Works area contains this type of terrestrial ecosystem);
- Areas with more complex vegetative structure, largely forested, but also rather highly altered and consisting either of secondary natural forest or artificially regenerated forest. This type of terrestrial ecosystem is found in the upper portions of the watershed of the reservoir catchments; and
- Pockets of still intact and natural terrestrial ecosystems (the amount of this type of terrestrial ecosystem varies among Irrigation Scheme Sub-Projects; and
- Coastal ecosystems in the bottom end and/or downstream of the command areas in some of the Irrigation Scheme Sub-Project Areas.

Forest coverage has decreased steadily in the VWRAP Area and is generally limited in the command areas.

3.3.2 *Aquatic Ecosystems and Biodiversity*

There are essentially four types of aquatic ecosystems in the VWRAP Area:

- The reservoirs of the Irrigation Scheme Sub-Projects;
- The highly simplified and modified aquatic ecosystems of the irrigation canals;
- The aquatic ecosystems of the major rivers running through the Sub-Project Area; and
- In some of the Irrigation Scheme Sub-Projects, highly simplified and modified aquatic ecosystems of the brackish water aquaculture farming.

In the initial years of operation of the Irrigation Scheme reservoirs, fishery resources increased dramatically with the flush of nutrients into the newly created aquatic ecosystem. After a number of years of this nutrient flush, increased sedimentation of the reservoir reducing aquatic habitat, and overfishing, aquatic resources have generally degraded, with subsequent declines in both fisheries catch and catch per fisherman (an index of reservoir fisheries population).

3.3.3 *Biodiversity Resources*

Flora and fauna have been severely affected by the loss of habitat and exploitation throughout the VWRAP Area. Biodiversity surveys have not been conducted specifically in the Irrigation Scheme Sub-Project Areas, but more general surveys have been conducted in most of the provinces in which VWRAP will be implemented, as well as in some of the important protected areas of these provinces. These provinces and protected areas do contain a number of rare and endangered species, a number of which are on the 2002 IUCN Redlist of Endangered Species (Table 15, Annex 8). It is likely that most of these rare and endangered species, if they are to be found within the VWRAP Area at all, are to be found in the forested areas of the mountainous ecosystems described above, in the catchment areas of the reservoirs and not in the command areas themselves.

A major threat to biodiversity in the Yen Lap Reservoir catchment is timber extraction which is causing a steady decline in forest quality and extent in the area. Currently, the activities of Hoanh Bo Forest Enterprise are contributing greatly to this decline, both directly, by extracting forest products, and indirectly, by constructing logging roads, which facilitate illegal logging. Much of the Yen Lap Reservoir catchment is the focus of commercial forestry activities. At present, 16,827 ha of forest land in Hoanh Bo district are under the management of Hoanh Bo Forest Enterprise, including 4,516 ha of production forest. The main duty of Hoanh Bo Forest Enterprise is to supply wood to coal mining companies in Quang Ninh province.

Table 14: Overview of terrestrial ecosystems in VWRAP Area.

<p style="text-align: center;">Yen Lap Sub-Project</p> <ul style="list-style-type: none"> • Mountainous Terrestrial Ecosystems - In the high mountains of the upper catchment, terrestrial ecosystems comprising both natural forest and artificial forest are found. There are a number of rare and endangered floral and faunal species found in the remaining natural forests of the upper watershed of the Sub-Project. Artificial forests in the upper watersheds are more simplified ecosystems and were established as part of various national forest development programs, including Project 327, Project PAM 4303, Project 661, as well as through annual provincial forest development programs. • Hill Area Terrestrial Ecosystems - In the hill area of the Sub-Project, vegetation cover is poor and soils are strongly affected by erosion. Terrestrial ecosystems in this area are largely simplified agricultural systems, consisting of gardens with a mix trees planted for agricultural production. • Irrigated Ecosystems – This area contains high simplified agricultural ecosystems that produce annual crops such as rice, vegetables, tobacco, groundnut, beans, and maize. These annual crop areas are interspersed with fruit trees and trees planted for shelter and fuelwood purposes. The command area consists almost entirely of this type of terrestrial ecosystem. • Coastal Wetlands Coastal wetlands in Quang Ninh Province have decreased in area (the province as a whole historically had more than 35,000 ha of mangrove). At present, there are about 10,000 ha of wetland in the province, concentrated in Yen Hung District. The historical loss of coastal wetlands in Yen Hung District is due to a number of factors: (i) conversion to coastal aquaculture; (ii) fuelwood exploitation; (iii) land conversion to freshwater agriculture; and (iv) alteration of tidal and salinity regimes caused by dike construction. • Despite the loss of coastal wetlands in Yen Hung District, the District's tidal marshes contain the highest number of aquatic species of any tidal marsh in northern Viet Nam.
<p style="text-align: center;">Cam Son-Cau Son Sub-Project</p> <ul style="list-style-type: none"> • There are no intact, original terrestrial ecosystems remaining within the Sub-Project save for small portions of the watershed of the Cam Son Reservoir. Most of the terrestrial ecosystems in the Sub-Project Area have come under human influence of some sort, particularly for the production of agricultural commodities, but also for natural resources for household use such as fuelwood and food resources, as well as for human settlements.
<p style="text-align: center;">Ke Go Sub-Project</p> <ul style="list-style-type: none"> • The area in which the Sub-Project is located is a transition from the Truong Son Mountains to hilly areas along the coast and Ha Tinh flat plain. There are essentially two types of terrestrial ecosystems in the Sub-Project Area: <ul style="list-style-type: none"> – The catchment of the Ke Go Reservoir with mixed vegetative structure, largely forested consisting either natural forest and regenerated forest or artificial regenerated forest. The Ke Go Nature Reserve is found in this catchment area (see below); and – A highly simplified agricultural ecosystem that produces annual crops, interspersed with fruit trees and trees planted for shelter and fuelwood purposes. The command area consists of almost entirely this type of terrestrial ecosystem.
<p style="text-align: center;">Phu Ninh Sub-Project</p> <ul style="list-style-type: none"> • The Phu Ninh Irrigation Scheme traverses three of Viet Nam's sixteen ecological regions: (i) Kon Tum Mountain Forests Ecoregion; (ii) Northern Viet Nam Coastal Moist Forest Ecoregion; and (iii) Southern Viet Nam Coastal Forests Ecoregion. • There are essentially four types of terrestrial ecosystems in the Sub-Project Area: <ul style="list-style-type: none"> – Mountainous Terrestrial Ecosystems - In the high mountains of the upper catchment, terrestrial ecosystems comprising both natural forest and artificial forest are found. There are a number of rare and endangered floral and faunal species found in the remaining natural forests of the upper watershed of the Sub-Project. Artificial forests in the upper watersheds are more simplified ecosystems and were established as part of various national forest development programs, including Project 327, Project PAM 4303, Project 661, as well as through annual provincial forest development programs. – Hill Area Terrestrial Ecosystems - In the hilly parts of the command area, vegetation cover is poor and soils are strongly affected by erosion. Terrestrial ecosystems in this area are largely simplified agricultural systems, consisting of gardens with a mix of trees planted for agricultural production. – Irrigated Ecosystems – This area contains high simplified agricultural ecosystems that produce annual crops such as rice, vegetables, tobacco, groundnut, beans, and maize. These annual crop areas are interspersed with fruit trees and trees planted for shelter and fuelwood purposes. The command area consists almost entirely of this type of terrestrial ecosystem. – Coastal Wetlands The Quang Nam coastline is dominated by sand and sand dunes and so coastal forests and wetlands have never been very abundant. Coastal wetlands in Quang Nam Province have decreased in area (the province as a whole historically had more than 1,000 ha of mangrove; at present only about 100 ha remain). At present, there are about 19,000 ha of wetland in the province; a large proportion of these are found in the coastal district of Nui Thanh.
<p style="text-align: center;">Da Ban Sub-Project</p> <ul style="list-style-type: none"> • Mountainous Terrestrial Ecosystems - In the high mountains of the upper catchment, terrestrial ecosystems comprising both natural forest and artificial forest are found. There are a number of rare and endangered floral and faunal species found in the remaining natural forests of the upper watershed of the Sub-Project. Artificial forests in the upper watersheds are more simplified ecosystems and were established as part of various national forest development programs, including Project 327, Project PAM 4303, Project 661, as well as through annual provincial forest development programs. • Hill Area Terrestrial Ecosystems - In the hill area of the Sub-Project, vegetation cover is poor and soils are strongly affected by erosion. Terrestrial ecosystems in this area are largely simplified agricultural systems, consisting of gardens with mix trees, mango, jackfruit, coconut, and pomelo. • Plains Ecosystems – This area contains high simplified agricultural ecosystems that produce annual crops such as rice, vegetables, tobacco, groundnut, beans, and maize. These annual crop areas are interspersed with fruit trees and trees planted for shelter and fuelwood purposes. The command area consists almost entirely of this type of terrestrial ecosystem.
<p style="text-align: center;">Dau Tieng Sub-Project</p> <ul style="list-style-type: none"> • The Dau Tieng Irrigation Scheme traverses four of Viet Nam's sixteen ecological regions: (i) Tay Ninh and the upper part of HCMC are in the Eastern Indochina Moist Forest ecological region; (iv) the coastal part of Ho Chi Minh City is in the Gulf of Thailand Mangrove ecological region; (iii) Binh Duong Province is divided between the Eastern Indochina Moist Forest area (adjacent to Tay Ninh) and the Southern Viet Nam Coastal Forest ecological region; and (iv) Long An Province is in the Tonle Sap Mekong Peat Swamp ecological region.

Table 15: Summary of rare and endangered species found in the provinces in which VWRAP will be implemented.

Province and Sub-Project	Biodiversity Group	No Species on IUCN 2002 Redlist	No. Species in Viet Nam Red Book
Quang Ninh (Yen Lap)	Plant	5	5
	Mammals	2	2
	Reptiles	0	0
	Fish	0	0
	Birds	2	2
Bac Giang (Cam Son-Cau Son)	Plant	4	23
	Mammals	9	14
	Reptiles	2	14
	Fish	0	5
	Birds	1	4
Ha Tinh (Ke Go)	Plant	10	10
	Mammals	18	16
	Reptiles	8	0
	Fish	0	0
	Birds	16	9
Quang Nam (Phu Ninh, Quang Hue-Vu Gia)	Plant	8	8
	Mammals	7	7
	Reptiles	10	10
	Fish	0	0
	Birds	4	4
Khanh Hoa (Da Ban)	Plant	0	5
	Mammals	2	2
	Reptiles	0	0
	Fish	0	0
	Birds	2	2
Tay Ninh (Dau Tieng)	Plant	5	1
	Mammals	7	10
	Reptiles	2	8
	Fish	0	0
	Birds	0	7
Total	Plant	32	52
	Mammals	45	51
	Reptiles	22	32
	Fish	0	5
	Birds	25	28

3.3.4 Nature Reserves and Protected Areas

There are no nature reserves or protected areas within the VWRAP command areas, a number of protected areas with some within the Irrigation Scheme reservoir catchments, and a few nature reserves and protected areas in the vicinity of the Irrigation Scheme Sub-Project Areas that need to be assessed for possible downstream impacts. Annex 9 contains a description of these nature reserves and protected areas; summary descriptions are presented below.

YEN LAP SUB-PROJECT: BAI CHAY CULTURAL AND HISTORIC SITE

Bai Chay was included on Decision No. 194/CT of the Chairman of the Council of Ministers, dated 9 August 1986, which decreed the establishment of a 562 ha cultural and historical site (MARD 1997). To date, an investment plan has not been prepared for the site and a management board has not been established (FPD 1998). Bai Chay is not included on the 2010 list of national protected areas (FPD 1998), and can be considered to have been recommended for removal from the national system of Special-use Forests.

Bai Chay Cultural and Historical Site is located in Ha Long City, about 50 km due east of Sub-Project Area. The site is hydrologically disconnected from the Sub-Project Area, save for the municipal and industrial water supply that is to be provided to Ha Long City with the Sub-Project. The site lies on the western side of the Cua Loc

channel, which divides Bai Chay and Hong Gai towns. The site covers a peninsula, which is bordered to the north by a lagoon, and to the south by the waters of Ha Long bay. The site ranges in elevation from sea level to 185 m.

The vegetation within the reserve has little or no biodiversity value. Urban expansion of Bai Chay Town, particularly that related to tourism development, can be expected to have negative impacts on the landscape of the cultural and historical site.

YEN LAP SUB-PROJECT: KY THUONG NATURE RESERVE

Ky Thuong proposed nature reserve is located in Dong Son, Dong Lam and Ky Thuong Communes of Hoanh Bo District. Part of the reserve is contained within far upper reaches of the Yen Lap Reservoir catchment area. The FPD 2010 list includes a proposal to establish a 17,640 ha nature reserve at Ky Thuong. An investment plan for Ky Thuong proposed nature reserve was prepared by North-eastern Sub-FIPI in 1993 (Anon. 1993). The head of the forest protection section of Quang Ninh Provincial FPD reported that the investment plan had been approved by MARD but a management board had not yet been established. Currently, the site is managed by Hoanh Bo District FPD.

Ky Thuong proposed nature reserve is situated on a mountain ridge, which runs from west to east. Streams in the north of the proposed nature reserve flow north into the Ba Che river, while streams in the south of the nature reserve flow south, eventually draining into the Gulf of Tonkin. Although Ky Thuong proposed nature reserve supports viable populations of few mammal and bird species of conservation importance and although in places, the forest has been cleared or degraded, Ky Thuong supports one of the largest remaining areas of evergreen forest in north-eastern Viet Nam.

YEN LAP SUB-PROJECT: CAT BA NATIONAL PARK

The Cat Ba Islands lie to the northeast of Hai Phong City, in the northern part of Viet Nam, about 60 km south of the command area and is in fact in the southern part of Cat Hai District.

The Cat Ba region is composed of one large island called Cat Ba and 366 smaller islands. It has a total area of 15,200 ha, of which 9,800 ha are island forest and presently 5,400 ha are marine. The site falls within the management authority of Cat Hai District, Hai Phong City.

The Cat Ba Protected Area was established in 1983 by the Ministry of Forestry (now a part of MARD). In 1986, MARD proposed that the Cat Ba Protected Area become a national park in status and this was subsequently approved by the President of the Minister's Council of Viet Nam in Decree 79/CT (31 March, 1986). According to the decree, the Cat Ba National Park encompassed 9,800 ha of island forest and 5,400 ha of sea.

In 1991, the economic and technical proposal of the Cat Ba National Park proposed by MARD was approved by the President of the Minister's Council of Viet Nam in Decree 237/CT (1 August 1991). While 9,800 ha of land in the park is currently managed by the National Park Board under the Forestry Department of MARD, the Fisheries Department of Cat Hai District holds the rights on the utilization of the 5,400 ha of marine area inside the park. The relationship between the National Park Board and the local authority is a sensitive one.

An expansion of the Cat Ba Marine Protected Area to 10,900 ha is under discussion (of which 5,400 ha is the existing Marine Protected Area and 5,500 ha is being proposed). According to IUCN criteria, the Cat Ba Marine Protected Area falls under Category II - National Park. The present Viet Nam Management Category under which it falls is also that of National Park.

The Cat Ba region is an important site for nature conservation. It comprises islands and mountains alternating with sea depressions, expanses of salt flats, mangroves, and abrupt limestone islands of very interesting relief. This area contains a variety of habitats including coral reefs, seagrass beds, mangroves, and island forest. In some sites, coral reefs are still in pristine condition. Several sandy beaches provide a nesting habitat for marine turtles. Findings from recent surveys revealed its high biodiversity value relative to the rest of North Viet Nam.

In addition, bordering the Ha Long Bay World Heritage Site, Cat Ba National Park is an attractive site for tourism with growing numbers of visitors each year. Tourism is increasing rapidly and needs careful management attention.

The Cat Ba region and its waters provide fishing grounds for local peoples as well as for fishers that come from other maritime provinces.

The major problems and threats to Cat Ba National Park can be summarized as follows:

- Degradation of coral reefs by dynamite fishing and excavating reefs for collecting other organisms
- Illegal fishing methods including the use of poisons and electric shock
- Over-exploitation of fishery stocks by irrational fishery practices
- 500 sets of fine square fishing nets which specialize on catching fish fries, juvenile shrimp, and squid, which are common in the region
- The lack of a boundary marker system
- Awareness of natural resources and environmental protection among local people is low
- Pollution by marine traffic
- Siltation of corals
- Land derived pollution from ports and other activities in the Hai Phong area

YEN LAP SUB-PROJECT: HA LONG BAY CULTURAL AND HISTORIC SITE

Ha Long Bay Cultural and Historic Site lies to the south and east of Ha Long City, a minimum of about 60 km from the eastern portion of the Yen Lap Sub-Project command area.

Some 1,969 islands of Ha Long Bay lie to the east of Quang Ninh Province, some 164 km north-east of Ha Noi, and rise to a maximum relief of some 200 m in the Tonkin Gulf. They are under the administration of Ha Long City. As intended by MoCI, the national reserve includes all these islands which fall within the coordinates 106°58'-107°22'E and 20°45'-20°56'N, while the accepted Natural World Heritage Site includes islands falling within some 43,400 ha including islands and the surrounding marine environment. The area is managed by the Quang Ninh Provincial Government through the Ha Long Bay Management Board.

On 28 April 1962, the islands of Ha Long Bay were established as a historical and cultural relict and national scenic spot under Decision No. 313/VH VP issued by the Minister of Culture and Information. The islands were proposed by the Vietnamese Government in 1993 to the UNESCO World Heritage Committee, and in 1994, some 43,400 ha portion of the national reserve was recognized as a Natural World Heritage Site. Thorough resource assessments of the islands are being proposed to select specific islands and marine sites to be managed for their biodiversity values. These sites are presently unknown. The Vietnamese management category is a Protected Landscape/Seascape, and it is equivalent to an IUCN Category III - Natural Monument. The selection of specific island and marine components to be managed as nature reserves will change management objectives of part of the sites, but prescription of further management categories is postponed pending further information.

Ha Long is a large bay with a multitude of limestone islets and islands emerging from the Hon Gai sea, and schistic islands from the Cam Pha Sea, and a limited number of lateritic islands. Renown for their beauty and attractive landscapes, the islands vary in elevation from a few meters to 200 m with some featuring almost vertical slopes. Numerous caves and grottos occur in the islands with stalactites and stalagmites, but only few of the islands are inhabited, notably Ba Mun and Cat Ba. The flora is diverse with primary tropical forest found mostly on the islands of Ba Mun and Cat Ba. Results from preliminary surveys indicate the presence of about 1,000 fish species. Mammals, reptiles and birds are also found on the islands.

Numerous archaeological sites have been found and at Giap Khau (Hon Gai) there is evidence to suggest occupation by the Hoa Binh Culture, some 10,000 years ago. Archaeological sites at Tuan Chau, Ngoc Vung, Cai Dam, Dong Naim, and Cat Ba have revealed so many artifacts that they have been grouped under the term 'Ha Long Culture,' typical of the northeastern coast of Viet Nam in the Neolithic Age. During prehistoric times, Ha Long was a significant port, located on the trade routes between China, Japan, and other countries in South East Asia.

The principal conservation values appear to be scenic and include landscape values, geological interest, biological diversity (especially in marine species), and archaeological remains. An unspecified population makes its living in and around Ha Long Bay, which is a major center for fishing, agriculture, and maritime transport. Steps have been taken to open new ports, factories, and housing on the shore in line with a long-term economic development program. Despite development in the region, it appears that Ha Long itself will be protected as a major tourist and cultural center. Ha Long Bay is extremely popular with both Vietnamese and international tourists. The area is a high priority in the National Tourism Master Plan.

YEN LAP SUB-PROJECT: YEN LAP WATERSHED PROTECTION FOREST

The Yen Lap Watershed Protection Forest is a major watershed protection forest in the Yen Lap Sub-Project Area. With a total area of 18,502 ha, the Protection Forest is under the management of Hoanh Bo District FPD. The present coverage of the Protection Forest is as follows:

- Land classified as forest occupies 16,227 ha (87.7%). Of this:

- 10,502 ha is natural forested land (64.7%)
- 2,868 ha is artificial forest land (17.7%)
- 2,857 ha is bare land and grass field (17.6%);
- Other land comprises 2,275 ha (12.3%);

Under the National 327/CT Program from 1991 to 1998, 1,376 ha was planted in the protection forest and from 1999 to 2000, 203 ha of protection forest was planted under Decision No 661/QĐ-TTg (1998).

The coal industry is a threat to the Yen Lap Protection Forest. Various coal mining enterprises belonging to the Dong Bac Coal Factory and the Hoanh Bo Coal Mine Enterprise have been illegally expanding their activities into the protective forests of Yen Lap Reservoir. This includes discharge of sediments and coal mining waste into watercourses that empty into the Yen Lap reservoir.

CAM SON-CAU SON SUB-PROJECT: CAM SON HISTORICAL AND CULTURAL SITE

The only nature reserve either within the Cam Son-Cau Son Sub-Project Area or which could be affected by Sub-Project activities is the Cam Son Cultural and Historic Site (Annex 9 contains a detailed description of this site). Cam Son was included on Decision No. 194/CT of the Chairman of the Council of Ministers, dated 9 August 1986, which decreed the establishment of a 15,000 ha cultural and historical site centered on Cam Son Reservoir. The engineering headworks of the Cam Son Dam area are not part of the protected area. The protected area contains highly degraded terrestrial ecosystems that are being restored through artificial regeneration (i.e., planting instead of natural regeneration), and a highly reservoir fishery highly degraded through overfishing as well as use of very destructive fishing methods such as poisoning and explosives. One of the protection objectives of this protected area seems to be for the waterbirds that frequent the Cam Son Reservoir.

In addition, the status of the Cam Son Cultural and Historical Site is very uncertain. None of its boundaries have been surveyed, it has no formally approved zonation, it has no functioning Protected Area Management Board, it has no Management Plan, and it is absent from the MARD 2010 National List of Protected Areas (indicating MARD has recommended it be removed from the national system of special-use forests). Very likely, Bac Giang DARD supports whatever conservation activities it undertakes for the protected area through the use of funds under National Programs (such as 327/CP historically or National Program 661) rather than through formal annual budget allocations.

KE GO SUB-PROJECT: KE GO NATURE RESERVE

The Ke Go Nature Reserve is located in Huong Khe, Cam Xuyen, and Ky Anh Districts in Ha Tinh Province (Annex 9). It comprises a 24,800 ha area within largest remaining block of broad-leaved evergreen forest in the level lowlands of central Vietnam. The Natural Reserve conserves a representative example of the lowland forest habitat which formerly extended throughout the coastal plain of central Vietnam but which has now largely been cleared for agriculture. These forests of central Vietnam comprises a biodiversity "hotspot", the so-called Annamese Lowlands Endemic Bird Area (ICBP 1992). The richness of the region's biodiversity is reflected in high levels of bird endemism; four species of bird have their global ranges confined to this small region. The Ke Go Nature Reserve aims to conserve populations of the two species which are confined to the northern part of this region - the boundaries of the natural reserve encompass all the recent forested localities in Ha Tinh Province for Vietnamese Pheasant *Lophura hatinhensis* and the locality from which Imperial Pheasant *Lophura imperialis* was collected in 1990.

Much of the Ke Go Nature Reserve lies within the watershed of the Ke Go Reservoir which provides irrigation water to villages in Cam Xuyen District. Watercourses in the south-eastern part of the Natural Reserve drain into the Gianh River watershed which forms the major river system in northern Quang Binh Province. Thus the Natural Reserve has a great economic value maintaining the agricultural viability of the surrounding agricultural areas. The park is divided into two zones, which based the biodiversity value, the current condition of the vegetation and present land-use, comprising a core zone of 20,537 ha and a habitat rehabilitation zone of 4,264 ha. The Nature Reserve offers some potential for environmental education and promoting public awareness. The protected area is considered to have a low potential for tourism.

PHU NINH SUB-PROJECT: PHU NINH WATERSHED PROTECTION FOREST

The 23,409 ha Phu Ninh Watershed Protection Forest is located in the catchment of the Phu Ninh Reservoir is under the management of Quang Nam Provincial FPD (Annex 9). A watershed protection forest management board was established by Quang Nam Provincial People's Committee on 12 March 1997 (Quang Nam Provincial FPD 2000). Remote sensing data, indicate that the site is entirely devoid of natural, original forest resources. A total of 9,289 people live inside the boundaries of the Watershed Protection Forest.

Quang Nam Provincial People's Committee has proposed to use the Phu Ninh Watershed Protection Forest as the basis for establishing a 23,000 ha nature reserve that would be part of Viet Nam's national system of protected areas. This proposed nature reserve is on MARD-FPD's 2010 national list of protected areas.

DA BAN SUB-PROJECT: NHA PHU FISHERIES PROTECTION AREA

On 1 March 1988, Nha Phu Fisheries Protection Area was established by Decision No. 07/UB of Khanh Hoa Provincial People's Committee. Subsequently, the provincial authorities proposed combining Nha Phu bay and Hon Heo peninsula into a single protected area. In 1999, the Asian Development Bank proposed establishing Nha Phu-Hon Heo Marine Protected Area, with a total area of 5,600 ha, comprising a terrestrial component of 1,100 ha and a marine component of 4,500 ha. Nha Phu bay is rich in marine biodiversity, while the Hon Heo peninsula supports primary forest.

Nha Phu-Hon Heo proposed marine protected area is located in Ninh Hoa district, Khanh Hoa province. The proposed marine protected area comprises Nha Phu bay and Hon Heo peninsula. Nha Phu bay is fed by the Dinh, Da Ban and Ca Lam rivers, and is sheltered from the open sea by the Hon Heo peninsula. On the seaward side of the peninsula, there are submerged banks and coral reefs, which are recommended for inclusion within the marine protected area. In 1996, 916 fishermen were operating in the Nha Phu bay. Sometimes, these fishermen employ illegal and destructive fishing techniques, such as use of explosives, which are having severe negative impacts on the coral reefs outside of the bay. The mangrove in the bay has been extensively cleared as a result of aquaculture development. The high human population in the immediate area and a lack of financial incentives to protect the environment are major obstacles to conservation of the site.

Nha Phu Bay is an important breeding and nursery ground for shrimp and fish species. Among the economically valuable species recorded at the site are Mullet *Mugil cephalus*, Giant Seaperch *Lates calcarifer*, Giant Tiger Prawn *Penaeus monodon* and Blue Mussel *Mytilus smaragdinus*. However, some of these species, particularly Mullet and Giant Tiger Prawn, have been over-exploited.

DAU TIENG SUB-PROJECT: LO GO-SA MAT NATIONAL PARK

From a biodiversity perspective, the most important site in Tay Ninh is the Le Go - Sa Mat Nature Reserve established in 1993, and recently designated as a National Park. It is located in the far upper watershed of the Dau Tieng Reservoir on the border with Cambodia. Le Go - Sa Mat was excluded from the protected area network by MARD in 1997 as it was no longer of the requisite standard. However, the review of protected area system carried in 1999 concluded that the site has high biodiversity value and that there was no reason to remove it from the list²⁸. The nature reserve plays an important role in protecting the watershed of the Vam Co River.

DAU TIENG SUB-PROJECT: DUONG MINH CHAU CULTURAL AND HISTORIC SITE

The Duong Minh Chau Reserve is a 5,000 ha diptocarp plantation in the area commanded by the West Canal and is documented as having little or no biodiversity conservation value.

DAU TIENG SUB-PROJECT: NUI BA DEN CULTURAL AND HISTORIC SITE

Nui Ba Den was approved in 1986 as a 2,000 ha cultural and historical site. Nui Ba Den Cultural and Historical Site is currently under the management of Tay Ninh Provincial DARD, although it is not included in the 2010 national list of priority protected areas. The vegetation cover at Nui Ba Den is mainly scrub vegetation dominated by shrubs, climbers and scattered trees. During the Second Indochina War, Nui Ba Den was sprayed with defoliants and heavily bombed. The remaining natural forest at Nui Ba Den is gradually being converted into agricultural land, particularly fruit gardens. Over the centuries, Nui Ba Den, which means Black Lady Mountain, has served as a shrine for various religious sects. There are several cave-temples on the mountain. As well as cultural value, the site also has historical value as it was used as a revolutionary base by Viet Minh and Viet Cong forces during the First and Second Indochina Wars. Each year Nui Ba Den Cultural and Historical Site receives a large number of domestic tourists, especially during religious festivals.

DAU TIENG SUB-PROJECT: BOI LOI CULTURAL AND HISTORIC SITE

Boi Loi Nature Reserve in Trang Bang District with a total of 2,982 ha including 21 ha of natural forest and 1,531

²⁸ Sourcebook of Existing and Proposed Protected Areas in Viet Nam; European Union, Birdlife International & FIPI (February 2001)

ha of grass and scrubland. It is in the area commanded by the East Canal.

DAU TIENG SUB-PROJECT: CAN GIO BIOSPHERE RESERVE

Can Gio Man and the Biosphere Reserve is located in Can Gio District (previously Duyen Hai District), in the coastal zone of Ho Chi Minh City. The area is situated in a recently formed estuary complex of tidal flats, where the Vam Co, Saigon and Dong Nai rivers discharge into the sea. The topography of Can Gio is low-lying and dynamic. The site is divided by a network of canals and rivers. The core and buffer zones of Can Gio Man and the Biosphere Reserve have a human population of 1,500. There are several threats to biodiversity arising from the local population, the most significant of which are cutting mangrove trees for timber and fuelwood (the reserve contains the largest single intact mangrove forest remaining in Viet Nam), and conversion of mangrove forest into aquaculture ponds. ADB (1999) report that, in recent years, pressure to develop aquaculture has increased. ADB (1999) identify several other major human impacts, including destructive fishing techniques, oil spills and sewage discharge from nearby urban areas. The site is currently under the management of Can Gio District People's Committee and the management board for protected forests of Ho Chi Minh City DARD.

3.3.5 Forest Resources

PRODUCTION FORESTS

There are 35,616 ha of land designated as production forest within the districts and communes that form the command areas of the Irrigation Scheme Sub-Projects (Table 9). This land is found on the hills that are scattered in the command areas. Forests on these hills are secondary forests, scrubby, and highly degraded due to long-term exploitation for fuelwood, timber for coal mining, and other purposes. Some of these areas have been artificially regenerated with eucalyptus and other tree species. These hill area production forests lie outside of the actual land that is currently served by the Irrigation Schemes and there is no pumping contemplated in the Irrigation Scheme Sub-Projects to deliver incremental amounts of irrigation water to even the lower slopes of these hills.

3.4 Socioeconomic Resources

3.4.1 Population, Demography, and Ethnic Composition

The VWRAP Area contains a rather young, almost exclusively rural, human population of about 3.8 million persons (Table 10). The average household size is about 4.4.

The predominantly rural population is dispersed, but due to the requirements for communication and transportation, the population is unevenly distributed and is concentrated along the banks of canals and rivers, and beside roads. Most farm families live in small village and commune settlements situated at the intersections or along the banks of the canals and rivers.

The communes with land inside command areas are 99.5% of the Kinh ethnic group, as are all communes with land in the command area (Table 10). The situation upstream of the command areas is different; the communes with land in the Sub-Project Areas upstream of the command areas are comprised of 86% Kinh and 14% ethnic minorities (Table 10).

3.4.2 Land Use

While trends in land use information could not be obtained specifically for the command areas, land use information for the main districts in some of the command areas was obtained (Table 16).

Table 16 reveals that there are no consistent trends in land use across all Irrigation Scheme Sub-Projects save for:

- Increasing crop diversification; and
- Where possible (i.e., Irrigation Schemes that have parts of their command areas in coastal areas) increasing land being used for aquaculture.

Table 16: Overview of recent land use changes in VWRAP Area.

<p style="text-align: center;">Yen Lap Sub-Project</p> <ul style="list-style-type: none"> • Total agricultural land use has been very stable, increasing only 4% between 1995 and 2000; • Most of this increase has been in the cultivation of multi-year crops (150% increase in land use between 1995 and 2000); • Forested land has increased substantially (14% increase between 1995 and 2000. This is due to the mangrove planting in the tidal flats of Yen Hung District; and • Increasing use of available land for various activities (modest decrease in unused land between 1995 and 2000).
<p style="text-align: center;">Cam Son-Cau Son Sub-Project</p> <ul style="list-style-type: none"> • No land time series of land use information could be obtained for the preparation of this EIA
<p style="text-align: center;">Ke Go Sub-Project</p> <ul style="list-style-type: none"> • No land time series of land use information could be obtained for the preparation of this EIA
<p style="text-align: center;">Phu Ninh Sub-Project</p> <ul style="list-style-type: none"> • Total agricultural land use has been very stable, increasing only 3.7% between 1998 and 2001; • Most of the increase in agricultural land has been in the cultivation of multi-year crops (23% increase in land use between 1998 and 2001). The area growing rice has actually increased only 0.9% between 1998 and 2001; • A rapid increase in aquaculture land (30% increase between 1998 and 2001); • Forested land has decreased substantially (16% decrease between 1998 and 2001, mostly due to the loss of natural forest); and • A large increase in the amount of unused land (195 increase between 1998 and 2001).
<p style="text-align: center;">Da Ban Sub-Project</p> <ul style="list-style-type: none"> • Total agricultural land use has increased (20% increase in land use between 1996 and 2000); • Most of this increase has been in the cultivation of annual crops (30% increase in land use between 1996 and 2000); • This increase has not been in rice cultivation, which only increased slightly more than 1% between 1996 and 2000, but in other annual crops, such as maize and groundnuts, and beans (total of 85% increase in land use for other annual crops between 1996 and 2000). This indicates crop diversification is occurring in the Sub-Project Area; and • Increasing use of available land for various activities (17% decrease in unused land - 1996 to 2000).
<p style="text-align: center;">Dau Tieng Sub-Project</p> <ul style="list-style-type: none"> • No land time series of land use information could be obtained for the preparation of this EIA

3.4.3 Agriculture Production

Agriculture is the dominant economic activity of both the command areas and the entire Irrigation Scheme Sub-Project Areas. Approximately 73% of the households in the total of the command areas are engaged in the agricultural sector as their primary occupation. Each family in the command areas cultivates an average of almost 0.63 ha, or about 0.143 ha per capita. The cropping pattern applied by the farmers largely depends on the availability of irrigation water. If sufficient water is available at the proper times of the year, double rice is the common cropping pattern with sustainable production.

Rice is the principal crop and other crops (maize, beans, vegetables, etc.) are grown. There is some shifting of agricultural production away from exclusively rice and towards cash crops and market gardens, which have less demand irrigated water. The low lying areas nearby coastal zone in some of the Irrigation Scheme Sub-Project Areas (Yen Lap, Ke Go, Phu Ninh, Da Ban) also cultivate shrimp. The average income of aquaculture breeding ranges from VND 7 to 10 million per year per household.

All the communes with land in the Irrigation Scheme Sub-Project Areas have received training in IPM methods through the delivery of a number of training courses in each commune. Course delivery was generally to selected representatives from each village in the communes designated for training; these representatives were required to teach and inform other farmers in their villages. However, the ability and success of the "training of trainers" approach is unknown, and it is estimated that 59% of farming households in the VWRAP Area have not yet received training in IPM²⁹.

²⁹ Estimated from results of the socioeconomic survey conducted by the EIA Consultant in Cam Son-Cau Son, Da Ban, and Dau Tieng Sub-Projects.

3.4.4 Aquaculture

Development of brackish water aquaculture is a strong driving force in the coastal areas of four of the Irrigation Scheme Sub-Projects: Yen Lap (Quang Ninh Province), Ke Go (Ha Tinh Province), Phu Ninh (Quang Nam Province), Da Ban (Khanh Hoa Province), mostly due to the ongoing implementation of the National Aquaculture Development Program (1999-2010)³⁰. In the year 2002, the total aquaculture area in the district was 8,013 ha, of which 7,520 ha was brackish water aquaculture. Currently, most of the brackish water aquaculture in these four Sub-Projects is of the extensive variety, requiring relatively low inputs for cultivation. While most of the brackish water aquaculture in these command areas currently consists of coastal wetland, rice cultivation land with historically low yields, part of the provincial aquaculture plans include increasing intensification of aquaculture production.

The water use and allocation for aquaculture with the Sub-Project will increase markedly (Table 3). This represents about 35% of total water supplied to brackish water aquaculture, the remainder coming from marine waters and rainfall³¹. Common tiger prawn, *Penaeus monodon*, is the most common brackish water aquaculture commodity produced and extensive, semi-intensive and intensive cultivation is practiced. The yield under intensive cultivation can be very high, up to 2 t/ha/crop with 2 crops per year. Intensive cultivation is expensive, requiring high capital investments. Average annual yield of extensive shrimp cultivation, with lower inputs, is 0.1 to 0.2 t/ha.

There is little separation of water supply and drainage in the aquaculture areas and there is high water pollution of aquaculture ponds due to poor pond layout. Pond sediment waste which much be disposed of between crops is about 100 wet weight t/ha/crop (with 76% water content). In addition, the higher inputs of feed to the more intense cultivation methods creates higher organic pollution.

3.4.5 Forestry

As indicated above, some 35,616 ha of production forests are scattered throughout the communes and districts that have land within the Irrigation Scheme Sub-Project Areas (Table 9). These are likely scattered throughout the low hills of the Irrigation Scheme Sub-Project Areas. The annual revenues derived from these forests are unknown.

3.4.6 Household Income and Incidence of Poverty

The average annual per capita net income (from all sources and including all costs) in the VWRAP pilot areas is VND 2.77 million (US \$180); about 70% of this is generated from agricultural activities (the rest from other activities such as hired-labor, secondary businesses, and handicrafts), and about 75% of the per capita total net income is generated from rice cultivation.

About 12% of the households in the VWRAP pilot areas do not meet the threshold poverty level of VND 100,000 per person per month (set by the 2001 National Strategy for Poverty Alleviation and Employment) (Figure 2)³².

3.4.7 Domestic and Drinking Water Supply and Quality

Domestic and drinking water supply and quality in the VWRAP Area is in generally good condition. The results of the socioeconomic surveys conducted by the EIA Consultants in the Cam Son-Cau Son, Da Ban, and Dau Tieng Sub-Projects suggests that most pilot area households are satisfied with their domestic and drinking water supply, although groundwater quality surveys of wells in the pilot area suggest that this water does not meet all national drinking water standards, particularly for coliform and bacterial contamination.

³⁰ For example, in the year 2000, the total area of aquaculture in Yen Hung District of the Yen Lap Sub-Project was 6,247 ha, of which 5,810 ha was brackish water aquaculture.

³¹ None will be supplied by groundwater.

³² The figure of 12% is estimated from results of the socioeconomic survey conducted by the EIA Consultant in Cam Son-Cau Son, Da Ban, and Dau Tieng Sub-Projects, supplemented by the results of the socioeconomic survey conducted by the Consultant in the other Irrigation Scheme Sub-Projects. Table 10 indicates that 16% of the households in the communes and districts with land in the VWRAP command areas are below the poverty line.

3.4.8 Disease and Public Health

The residents of the VWRAP Area experience most of the well-known diseases of tropical and sub-tropical areas. Although no specific data were obtained relating to health conditions of VWRAP residents, the presence of bacterial contamination in domestic and drinking water supplies means that risk to water borne diseases of bacterial origin may be high. However, the incidence of waterborne diseases has almost certainly decreased in the VWRAP Area in recent years due to what provincial authorities indicated in the consultations held in support of this EIA were improved sanitary water supply through the provision of drilled wells and improved education on public hygiene.

3.4.9 Tourism Resources

There is a wide variation in the number and quality of the tourism resources in the VWRAP area:

Yen Lap

- There are few significant tourism resources, save for those developed around the major cultural and historic resources of the Sub-Project Area (Table 17). The Yen Lap Sub-Project Area is a transitional area for tourists traveling to Ha Long Bay from Ha Noi and Hai Phong.

Cam Son-Cau Son

- There are few, if any significant tourism resources within the Cam Son-Cau Son Sub-Project Area save for those developed around its major cultural and historic resources (Table 17).

Ke Go

- There are a number of tourism resources in the Ke Go Sub-Project Area. Cam Xuyen, Thach Ha have long beaches that are becoming increasingly attractive to tourists. The Ke Go Reservoir is designated as a priority tourism zone for provincial tourism development, although tourist visits to the reservoir are still rather low. There are no plans to introduce tourism into the Ke Go Nature Reserve

Quang Hue-Vu Gia River Control Works

- Contains no tourism resources

Phu Ninh

- The major tourism resources in Quang Nam Province, the Hoi An Tourism Area, My Son Tourism Area, and Cu Lao Cham Islands Tourism Area. The only tourism resource of and significance in the Sub-Project Area is the Phu Ninh Reservoir Tourism Area which is being developed as an Ecotourism Zone, centering on the degraded secondary vegetation of the reservoir catchment and the mineral water being piped up from a vent at the bottom of the reservoir.

Da Ban

- There are a number of tourism resources in the Sub-Project Area. Ninh Hai, Ninh Thuy, and Ninh Phuoc Communes are located along the coastal zone which have beautiful beaches for tourism. In addition, Da Ban Reservoir is a revolutionary base with beautiful landscape which is attractive to tourists.

Dau Tieng

- There are a number of tourism resources in the Dau Tieng Sub-Project Area. The two most noteworthy are Nui Ba Den Tourism Area, centered on Ba Den Mountain which is within the command area of the West Canal, and the Binh Duong Ecotourism Zone, immediately to the east of the Dau Tieng Dam Complex. Vegetation in this tourism operation zone is comprised mostly of second growth forest. The Cu Chi Tunnel Complex is another major tourism attraction within the Dau Tieng Sub-Project Area.

3.4.10 Cultural and Historic Resources

There are 173 designated cultural and historic sites in the districts which form the Irrigation Scheme Sub-Project Areas and in the vicinity of the Sub-Project Areas, consisting of 56 nationally-designated cultural and historic sites and 117 provincially-designated cultural and historic sites (Table 17).

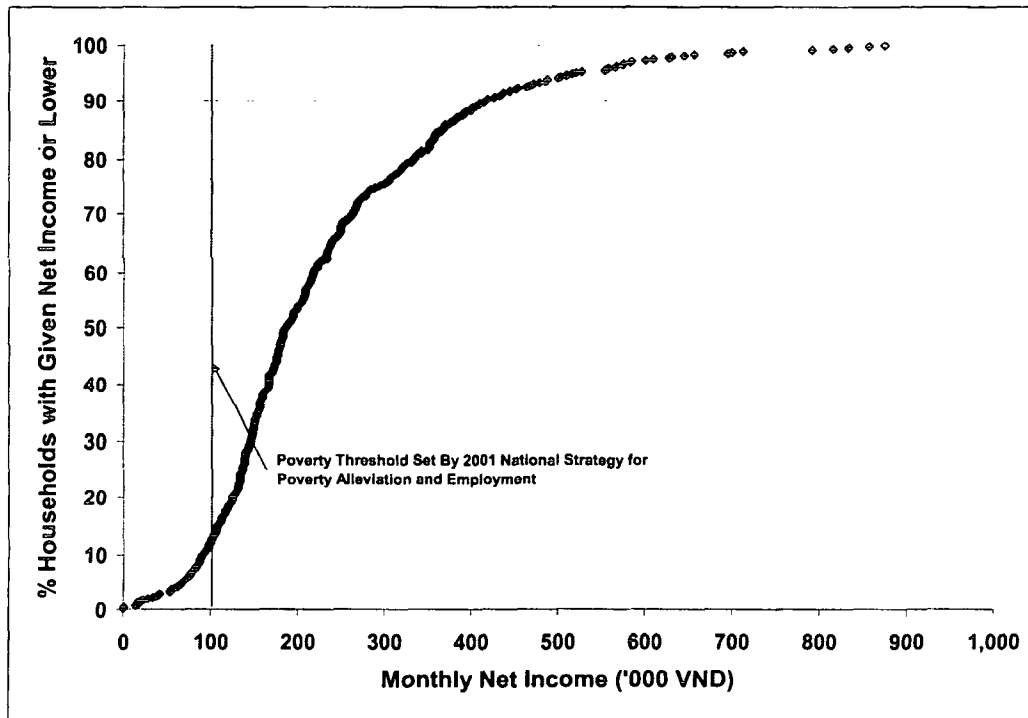


Figure 2: Incidence of poverty in VWRAP pilot areas. Data collected in socioeconomic surveys conducted as part of EIA Consultant activities (Cam Son-Cau Son, Da Ban, Dau Tieng) and Consultant social assessment activities (Yen Lap, Ke Go, Phu Ninh). Each point represents a single household (total of 492 households).

3.4.11 Navigation and Transportation

Transportation -- Transportation along the main roads throughout the VWRAP Area is good. National and provincial roads are paved and in good condition. All communes and most villages are serviced by secondary and tertiary roads, but by contrast, these roads are generally in poor condition. These roads are generally unsurfaced, mostly ungraded, and are difficult to use, especially in the rainy season.

Navigation -- Navigation is a very important means of transportation a number of the Irrigation Scheme Sub-Project Areas (Yen Lap, Cam Son-Cau Son, Dau Tieng), as well as the Quang Hue-Vu Gia River Control Works. Numerous boats ply the waterways of these parts of the VWRAP area; smaller boats also use the narrower rivers to transporting goods such as sand, wood, agricultural inputs (fertilizer) and outputs (rice).

Table 17: Cultural and historic sites in districts that form the VWRAP Area and in areas in close proximity to the VWRAP Area.

Sub-Project	No. Cultural and Historic Sites in Sub-Project Area	
	National	Provincial
Yen Lap	7	0
Cam Son-Cau Son	40	18
Ke Go	5	0
Phu Ninh	3	7
Da Ban	1	14
Dau Tieng	na	78
Total	56	117

4: IMPACT ASSESSMENT

4.1 Environmental Impact Assessment Methodology

The potential impacts of the VWRAP Project on each environmental resource are assessed as being in one of the following seven categories³³:

NO IMPACT -- This assessment is made when there is no impact of the Project on the environmental resource of concern. This assessment is made if the Project activities of concern is to be spatially or temporally removed from the environmental resource.

SIGNIFICANT AND UNMITIGABLE IMPACT -- This assessment is made when there is expected to be an impact of the Project on the environmental resource of concern and:

- the time scale of the impact is equal to or longer than the life span or time scale of the resource of concern **OR**
- the area over which the impact may occur is equal to or larger than the area over which the resource of concern occurs **OR**
- the magnitude of the impact is equal to or larger relative to the abundance or quality of the resource of concern **OR**
- the environmental resource of concern: (i) is important to local human populations; (ii) requires compliance with national, provincial, or district environmental protection laws, standards, and regulations³⁴; (iii) requires compliance with Vietnam's international commitments³⁵, triggers one of the IDA operational policies on environment;

AND any one of the following:

- there are no known mitigations **OR**
- it is uncertain whether the significant impact can be effectively mitigated with available mitigation activities.

MITIGABLE IMPACT -- The impact is Significant, as described above, but it can be effectively mitigated, through one of the following methods:

- **Impact Avoidance** - some aspect of the Project design, construction, or operation is changed such that the impact no longer occurs;
- **Impact Minimization** – measures are taken to reduce impacts to acceptable levels (e.g., ensuring that TCVN emission standards are met or a canal lining program the minimizes disruption to water users);
- **Impact Rectification** – the impact is allowed to occur, but mitigation measures are subsequently taken to rehabilitate the environment to a level whereby the impact is within acceptable limits, such as restoring and re-vegetating borrow sites; or
- **Impact Compensation** – the impact is allowed to occur but non-monetary compensation (first priority) or monetary compensation (second priority) are provided for losses created by the impact, such as in the case of resettlement or reforestation of an equivalent amount of forested land permanently lost through construction of a new spillway.

This Chapter outlines the recommended mitigation and Chapter 5 presents each of the required mitigation measures in greater detail as part of the VWRAP Project Environmental Management Plan.

INSIGNIFICANT IMPACT -- This assessment is made when there is expected to be an impact of the Project on the environmental resource of concern but the impact is assessed to be too negligible to require intervention in the form of either mitigation or monitoring. This type of impact would occur when any one of the criteria for impact significance, above, are not met.

³³ A general comment to the assessment of impacts contained in this EIA is that the actual amounts, scheduling, and location of various types of engineering used in the assessment of impacts are those contained in the final VWRAP PFS prepared by the Consultant dated March 2003 and the associated Engineering Subconsultant Reports.

³⁴ Key Vietnamese documents include: Law on Environmental Protection (1993); CP 175 Providing Guidance on the Implementation of the Law on Environmental Protection (1994); CP 490 Circular letter of Guidance on Setting up and Appraising the Environmental Impact Assessment Report for Investment Projects (1998); and Tieu Chuan Viet Nam (1995, 1998, 2001) – national ambient and industrial air/water quality standards.

³⁵ These include the Convention on Wetlands of International Importance especially as Waterfowl Habitat (RAMSAR), the Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention), and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

UNKNOWN IMPACT – This assessment is made when one of the following apply:

- the presence of the Project activity of potential concern is uncertain;
- the occurrence of the environmental resource within the Project area is uncertain;
- the time scale of the impact is unknown;
- the spatial scale over which the impact may occur is unknown; or
- the magnitude of the impact can not be predicted.

POSITIVE -- This assessment is made when the effect of the given Project activity will be to improve the condition and integrity of the environmental resource of concern.

COMBINATION -- This assessment is made when more than one of the above assessments (i.e., some positive and some negative impacts) apply to the effect of a Project activity on an environmental resource of concern.

4.2 Application of IDA Operational Policies

Most of the IDA Operational Policies identified for possible application to VWRAP apply to the VWRAP Project and are used in the detailed assessment of environmental impacts, below. Some of the IDA Operational Policies, however, are not triggered by the VWRAP Project and are not considered further in this EIA:

Operational Policy 7.60 – Projects in Disputed Areas

- None of the Project Area or the area of influence of the Project is part of a territory whose jurisdiction is disputed by another country

Operational Policy 7.50 – International Waterways

- None of the water bodies associated with the VWRAP Project form a boundary between, or flow through the territory of another country;
- None of the water bodies associated with the VWRAP Project are a any tributary or component of any waterway described above; and
- None of the water bodies associated with the VWRAP Project is recognized as a necessary channel of communication between the open sea and other states countries or of any river flowing into such waters.

4.3 Activities with Consistent Impacts on all Environmental Resources

There are a number of VWRAP Project activities that are assessed to have the same impacts for all environmental resources they will affect, whatever phases of the Project (pre-construction, construction, and operation) they will occur and in whichever phase of investments they will occur - first, second, or both. Rather than present these individually for each environmental resource in this chapter, they are presented synoptically below and not analyzed and presented further in the detailed assessment that begins with Section 4.5³⁶.

4.3.1 Effects of Design Flood Occurrence

In the event of a large flood, residents will be at risk to significant damage to them and their assets. This is assessed as a **SIGNIFICANT AND MITIGABLE IMPACT** through the implementation of the VWRAP Project Dam Safety Emergency Preparedness Plans (EPPs) prepared for each of the six irrigation modernization Sub-Projects as part of the overall VWRAP Project FS. The EPPs will enable residents at risk to be notified and advised on what precautions they should take in order to minimize the risk to them in the event of a design flood occurrence.

4.3.2 Repairing and Upgrading Existing Civil Works and Facilities

A large number of Project activities involve the repairing of existing civil works and facilities; the actual repairing of existing civil works and facilities are assessed as having **NO IMPACT** on any of the environmental resources of the VWRAP Project Area. These are summarized below in Table 18.

The Project activities listed in Table 18, below, will be associated with other Project activities such as the

³⁶ Unless otherwise stated, impact assessments in this section apply to all Irrigation Scheme Sub-Projects and the Quang Hue-Vu Gia River Control Works.

Table 18: Civil works and facilities upgrading assessed to have no impacts on environmental resources.

Yen Lap Sub-Project			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals and Drainage
<ul style="list-style-type: none"> Upstream slope reinforcement; From elevation 15.0 to 25.0: Masonry inside a reinforced concrete grid. From elevation 25.0 to 32.5: Concrete slab, 20 cm thick. Repairing at the damaged sections of the wave wall Providing a concrete and asphalt layer on the dam crest surface; and Provision and operation supplementary dam monitoring equipment 	<ul style="list-style-type: none"> Overhauling spillway gates; Overhauling electric hoists; Maintenance and upgrading of stop-log lifting system Upgrading the spillway operational controlling system by: <ul style="list-style-type: none"> Installing monitoring cabinet locally and at the center. Installing lighting system. Installing measuring equipment at the spillway gate aperture. 	<ul style="list-style-type: none"> Intake Tower <ul style="list-style-type: none"> Construction an external steel reinforced-concrete armor Filling cracks with cement grouting Intake conduit <ul style="list-style-type: none"> Pressurizing the entire internal part of the conduit with a steel pipe inserted of 2,500 mm diameter. Grouting and reinforcement at watertight joints and at seepage areas Isolating gates <ul style="list-style-type: none"> Replacing existing working gates with an isolating gate 	<ul style="list-style-type: none"> Overhauling existing civil works structures and associated equipment that can be reused and replace those structures and equipment that can not be reused. This will include Overhauling and replacing seriously damaged gates Overhauling and replacing other seriously damaged equipment Installing electrification systems for hoisting of sluices with B ≥ 80 cm to facilitate local control (smaller sluices will be manually operated)
Cam Son-Cau Son Sub-Project			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals and Drainage
<p>Cam Son Dam</p> <ul style="list-style-type: none"> Improving the upstream slope reinforcement by using reinforced concrete slab instead of placed rock; Reconstruction of the wave wall; Repair and upgrading of the dam surface; and Installation of dam monitoring system. <p>Cau Son Weir</p> <ul style="list-style-type: none"> Upgrading the body of the weir itself, possibly with cement mortar grouting and steel armored concrete covering; Upgrading the weir dissipation yard; Upgrading the bank protection both upstream and downstream of the weir; Upgrading the silt-exclusion sluice with concrete and cement mortar grouting; Upgrading the original and more recent weir intake sluices by general upgrading of the engineering works; Constructing an access bridge across the weir 	<ul style="list-style-type: none"> Overhauling spillway surface, spillway chute slope, and discharge tunnel; Heightening working bridge; Reconstructing stop-log-lifting system; and Reinforcing gates to enhance flood discharge capacity more than previous. 	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> Overhaul the civil works structures that can be reused and replace those structures that can not be reused; Completely replace inlet sluice gates; Replacing hoisting equipment; and Improve water level and discharge regulation. On secondary and lower canals, overhaul the existing civil works structures and associated equipment that can be reused and replace those structures and equipment that can not be reused.
Ke Go Sub-Project			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals and Drainage
<p>Main Ke Go Dam</p> <ul style="list-style-type: none"> Replace the damaged lining slabs of upstream slope located at elevation 13m to 26m by new concrete slab of bigger and thicker dimension; Repairing the damaged parts of the wave prevention wall and increasing height of the wall crest to 36.60 m; Lining the dam surfaces with a 30 cm rock layer and covering with a 30 cm pebble layer; and Install lighting system on dam surface; Overhaul piezometers system; and On the downstream slopes, repairing the drainage trench system and seepage zones, and constructing new grass frames. <p>Saddle Dams</p> <ul style="list-style-type: none"> Replace the damaged lining slab of upstream slope by new concrete slab of bigger and thicker dimension; Overhaul wave wall and heighten to elevation of 36.6 m; upgrading dam surface; and Repairing upstream slope. 	<p>Doc Mieu Chute Spillway</p> <ul style="list-style-type: none"> Destroy the upstream rock barrier located in the inlet canal; Reinforce the spillway surface; Replace the damaged lining slabs by new reinforced concrete slabs of larger dimensions; Replace the old winch by a new hydraulic piston in view to obtain a more reliable gate operation; Reinforce radial gates; Install local and central electrical control; Upgrade the protection covering for the spillway equipment in purpose of creating good conditions for spillway operation in case of unfavorable weather; Upgrade the spillway management station to ensure a favorable condition for working and living condition for the staff and workers who reside their to manage the spillway, especially in rainy season; and Install lighting system. 	<ul style="list-style-type: none"> repairing the broken joints that are causing high seepage and upgrading and replacing as required the associated mechanical and electrical systems. 	<ul style="list-style-type: none"> introduction of downstream control of the water-levels, combined with a local automatic control of the Cross Regulators in the canal (main canal) installation of Automatic water-level/discharge measurement devices (SCADA) Replacement all seriously damaged hoisting equipment.

Table 18: Civil works and facilities upgrading assessed to have no impacts on environmental resources, continued.

Ke Go Sub-Project, continued			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals and Drainage
	<p>Main Flood Spillway</p> <ul style="list-style-type: none"> Reinforce the spillway surface to increase flood discharge compared with initial design; Reinforce dissipation basin; Repair damages in whole; Reinforcing spillway gate; Electrification of spillway operation; Protection covering installed at sluice tower and spillway in purpose of becoming the headwork management station. <p>Conduit Flood Spillway</p> <ul style="list-style-type: none"> Repair of the broken joints that are causing high seepage; replacing old radial gates as required replacing gate operation machinery. 	<ul style="list-style-type: none"> repairing the broken joints that are causing high seepage and upgrading and replacing as required the associated mechanical and electrical systems. 	<ul style="list-style-type: none"> introduction of downstream control of the water-levels, combined with a local automatic control of the Cross Regulators in the canal (main canal) installation of Automatic water-level/discharge measurement devices (SCADA) Replacement all seriously damaged hoisting equipment.
Phu Ninh Sub-Project			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals and Drainage
<ul style="list-style-type: none"> Increase the height of saddle dam crests up to 37.40 m; and construct wave walls on three of the four saddle dams. 	<ul style="list-style-type: none"> A gate on the main spillway with height 1 m will be added. This will essentially be a rubber dam on top of the present spillway sill; and On the gated supplemental spillways, either 1 m high clapper gates will be added on top of the crest of the present spillway gates or reinforced wave walls will be constructed. 	<ul style="list-style-type: none"> None 	<p>Main Canal</p> <ul style="list-style-type: none"> Remedy and upgrade water control structures as follows: Overhaul, upgrade, replace broken gates; Supplement gates as required; Overhaul and upgrade or replace damaged hoisting equipment, and supply additional hoisting equipment as required. <p>Primary Canals</p> <ul style="list-style-type: none"> Remedy and upgrade water control structures as follows: Overhaul, upgrade, or replace broken structures; Completely rebuild seriously damaged structures; Supplement with additional gates as required; Overhaul and replace all seriously damaged hoisting equipment; and Overhaul and upgrade or replace damaged hoisting equipment, and supply additional hoisting equipment as required. <p>Secondary and Lower Canals</p> <ul style="list-style-type: none"> Repair damaged on-canal structures and supplement on-canal structures as required; Overhaul, upgrade, replace broken gates Supplement gates as required; and Overhaul, upgrade, replace damaged hoisting equipment, supply additional equipment as required.
Da Ban Sub-Project			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals and Drainage
<ul style="list-style-type: none"> Partly grouting into areas of heavy strong seepage; Repair of lining slabs to strengthen the upstream slope; Reconstruction of the parapet, and improving and upgrade dam surface; cleaning of vegetation on the upstream and downstream slopes; Rehabilitation of piezometers, implementing monitoring program; Installing water-level gauges every 20-100 m along the dam for measuring the upstream water level. Increasing dam crest height 	<ul style="list-style-type: none"> Repairing spillway joints by grouting around the joints and repairing protection plates; Repairing damaged concrete and two major cracks in the spillway; Installation of electrical motors for electrification of the operation of the spillway gates and the overhead crane; and Repair of the shed of the spillway tower to facilitate operation of the spillway in bad weather conditions. 	<ul style="list-style-type: none"> Repairing the damaged joints by re-installation of the protection plates and grouting around the joints to prevent the present serious leakage through the joints; Electrification of the operation of upstream and downstream gates of the intake; and Rehabilitation and upgrading the covering of the operational equipment at the downstream of the intake. 	<p>Main and Primary Canals</p> <ul style="list-style-type: none"> Repairing the cracks where mortar has been washed out on the slopes; Repairing the side spillway. <p>Lower Level Canals</p> <ul style="list-style-type: none"> Overhaul the existing civil works structures and associated equipment that can be reused and replace those structures and equipment that can not be reused.

Table 18: Civil works and facilities upgrading assessed to have no impacts on environmental resources., continued.

Dau Tieng Sub-Project			
Dam(s)	Spillway(s)	Intake Sluice(s)	Canals and Drainage
<p>Main Dam</p> <ul style="list-style-type: none"> • Construction of bentonite core wall and absolutely drilling and grouting until it reaches the rock layer. • Continue these works on the remaining sections • Install water level meters upstream of the dam <p>Suoi Da Saddle Dam</p> <ul style="list-style-type: none"> • Completion of the bentonite cement core wall • Strengthening the upstream slope of the dam with better slope (maybe with pre-cast concrete slab) over the length of the dam section. • The dam surface of this section should also be upgraded (asphalt or concrete paved) <p>Dike Embankment</p> <ul style="list-style-type: none"> • Development of a better solution to suppress the seepage in some segments. The solution of constructing a Bentonite diaphragm could be used. • Strengthening some of the dam segments, which have an open gap, to allow traffic to pass the wave wall. It is recommended to construct a wall and to install slots for stoplogs. • Complete the reinforcement of the upstream slope. 	<ul style="list-style-type: none"> • Measures to dry up the stoplogs storage sheds; • Improve stoplogs hoisting equipment. The presently used type is not appropriate • Architecturally redecorate the spillway • Construction of wave wall 	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • none

establishment of construction camps; the assessment of impacts of these associated activities on environmental resources of the VWRAP Project Area is discussed in this Chapter, below. In addition, other Project activities are assessed as having different types of impact on different environmental resources; these assessments are analyzed and presented in greater detail starting with Section 4.5.

4.3.3 Modernization of Irrigation Management System

The modernization of the VWRAP Project irrigation management system, consisting of upgrading the technical capacity of irrigation management personnel, improvement of water user fee policies, and upgrading VWRAP Project IMC equipment and management facilities will have **NO IMPACT** directly on the environmental resources of the Project area. There will be indirect **POSITIVE** effects, however, from institutional development and capacity building on improved water management resulting in increased crop production and socioeconomic conditions of beneficiaries.

4.3.4 Construction Activities Associated with Project Implementation

The major engineering civil works of the Project will create the need for temporary construction worker camps. These construction camps will have negative impacts on the environment through land disturbance, generation of waste (solid and liquid), use of heavy vehicles and other machinery (increased noised levels localized air pollution, particularly in areas of human habitation), and requirements for domestic and drinking water supply. Despite the fact that the size and proposed location of the construction camps is unknown at this time, all these impacts are **MITIGABLE** through good construction camp practices.

In addition, there will considerable disturbance of soils in all aspects of headworks and canal system upgrading (Table 5 and Table 6). There will need to be effective handling of soils so that they cause minimal disturbance to the environment, particularly with respect to sedimentation of water courses, and degradation of water quality. These impacts are assessed as **MITIGABLE**.

4.3.5 Environmental Impacts of Resettlement and Land Acquisition

No Environmental Impact of Resettlement:	Cam Son-Cau Son, Ke Go, Phu Ninh, Quang Hue-Vu Gia, Da Ban, Dau Tieng
Insignificant Environmental Impact of Resettlement:	Yen Lap
No Environmental Impact of Permanent Land Acquisition:	All Sub-Projects
Mitigable Impacts of Temporary Land Acquisition:	All Sub-Projects

Large-scale resettlement can cause environmental and social impacts if not implemented carefully implemented such as occurred as a result of resettlement during the construction of the Hoa Binh Dam in northern Viet Nam. Impacts of resettlement on the environment can include forest cutting or wetland encroachment, adoption of unsustainable agricultural practices and livelihood patterns, and land tenure issues. This is not the case with the VWRAP Project in which only ten households will need to be resettled. The environmental impacts from this resettlement will be extremely small and limited and are assessed as **INSIGNIFICANT**. No mitigation or monitoring is required for the environmental impacts of resettlement.

About 1,235 ha of land will be permanently acquired and 670 ha of land will be temporarily acquired (Table 7) as a result of the Project. Compensation will be paid³⁷ and there will be **NO IMPACT** of permanent land acquisition on environmental resources of the Project Area. The effects of temporary land acquisition are assessed as **MITIGABLE** by restoring the landscapes to their original condition after it has been used.

While there may be PAHs as a result of completion of the lower level canal system in the command area, these cases would almost certainly all involve compensation for land acquisition rather than resettlement, given the small size of the canals involved and concomitant land acquisition required.

4.3.6 *Water Supply for Domestic, Municipal, and Industrial Use*

No Impact:	Quang Hue-Vu Gia, Da Ban
Mitigable:	Yen Lap, Cam Son-Cau Son, Ke Go, Phu Ninh, Dau Tieng

The Da Ban Sub-Project and the Quang Hue-Vu Gia River Control Works will not be providing incremental water supply for municipal and industrial uses³⁸ and so the effects of this type of water allocation in these two cases is assessed as **NO IMPACT**.

VWRAP will increase water supply for non-commodity production uses, primarily municipal domestic and drinking water supply and industrial activities, in the other six Sub-Projects from a present total of 11.39 m³/s to 173.28 m³/s with the Project, an increase of more than 1,400%, or 5.5 billion m³/yr (15 million m³/day) (Table 3). About 36% of the estimated NPV generated by the six VWRAP Sub-Projects will come from the net incremental benefits of water sales for municipal and industrial water uses (figures given in the final PFS report indicate EIRR = 20.6% for these combined six Sub-Projects; calculations made on the basis of only agricultural benefits result in an EIRR = 13.2%). The environmental issue concerning incremental environmental impacts of municipal and industrial water use is largely with the industrial sector; increasing the supply of water for domestic use will have substantial human health and other benefits. An expanding industrial sector will also provide many incremental socioeconomic benefits but will create incremental environmental impacts that will be difficult to control and manage.

Viet Nam has new industrial discharge regulations and also requires an approved EIA before licensing is given to an industrial park or individual industrial facility. However, this is no guarantee that there will be no unacceptable environmental pollution as a result of these facilities. Every single facility in an industrial zone can be meeting industrial discharge standards and yet the receiving waters can not meet ambient water quality standards because of cumulative effects. Environmental enforcement also remains extraordinarily weak in Viet Nam and there is little doubt that industrial facilities in even new industrial zones will create incremental environmental pollution within the Sub-Project Areas and associated areas of influence.

The sketchy surface water quality information that is available (Annex 7) suggests that:

- the surface waters of Quang Nam Province (Phu Ninh), Tay Ninh Province (Dau Tieng) and Ha Tinh (Ke Go) are currently rather unpolluted from industrial sources;

³⁷ following the requirements of Decree No.22/1998/ND-CP dated 24 April, 1998

³⁸ The Quang Hue-Vu Gia River Control Works aims to restore water allocation (including allocation to municipal and industrial uses in Da Nang City) to pre-2000 conditions and so no incremental water supply to municipal and industrial uses is assumed.

- the surface waters of the Thuong River in Bac Giang Province downstream of the Cam Son-Cau Son Sub-Project are currently modestly polluted from industrial sources; and
- the surface waters of Yen Hung District in Quang Ninh Province (Yen Lap) and Ho Chi Minh City (Dau Tieng) are currently heavily polluted from industrial sources.

Therefore, the incremental environmental effects of a large increase in water supply to industries whose pollutant emissions are likely to be poorly regulated may be more significant in Quang Nam, Tay Ninh, and Ha Tinh Provinces than in Ho Chi Minh City and the Dau Tieng Sub-Project, where existing levels of industrial pollution in surface waters are already high and the incremental effect may be modest or even insignificant (and where there is already substantial investment from IDA and ADB in industrial pollution control and treatment, as well as an emerging Dong Nai River Basin Organization to assist in dealing with inter-provincial water pollution and water quality issues). Incremental effects in Yen Hung District in Quang Ninh Province (Yen Lap) and the Thuong River in Bac Giang Province downstream of the Cam Son-Cau Son Sub-Project are likely to be intermediate to the two situations described above.

While it is completely impractical for VWRAP to finance the construction and operation of industrial pollution control facilities, because such a high proportion of the Sub-Project benefits accrue from municipal and industrial water supply, it is reasonable to expect VWRAP to provide support to provincial departments (DoSTEs, Dols, etc.) for strengthening their monitoring and enforcement capacity, raising awareness of industrial users, and strengthening the overall environmental governance of the industrial sector³⁹. The first priority provinces would be those that are currently relatively unpolluted from industrial activity (i.e., Quang Nam, Tay Ninh, and Ha Tinh), followed by Bac Giang and finally by Quang Ninh Province and Ho Chi Minh City.

4.3.7 Provision of Increased Water Supply to Aquaculture

No Impact:

Cam Son-Cau Son, Quang Hue-Vu Gia, Dau Tieng

Mitigable:

Yen Lap, Ke Go, Phu Ninh, Da Ban

The Cam Son-Cau Son Sub-Project, the Quang Hue-Vu Gia River Control Works, and the Dau Tieng Sub-Project will not be providing incremental water supply for coastal aquaculture⁴⁰ and so the effects of this type of water allocation in these three cases is assessed as **NO IMPACT**.

VWRAP will increase water supply to brackish water aquaculture both within and downstream of the command areas of four Sub-Projects in order to support expansion of this economic activity in the coastal zone of the provinces in which these Sub-Projects are located and this impact is assessed as **MITIGABLE**.

This aquaculture expansion is part of the National Aquaculture Development Program (1999-2010). This National Program, approved with Decision No. 224/1999/QD-TTg specifies:

- an overall objective of achieving an aquaculture output of 2 million t/yr by 2010 from current levels of about 350,000 t/yr in 1999;
- plans for aquaculture in coordination with investments in water resource infrastructure to increase the efficiency of investment and use of land and water areas; and
- policies of development of aquaculture cultivation oriented towards increasing utilization of land and water areas for cultivating marine products.

Aquaculture is an extremely important economic activity in Viet Nam in general and in the four Sub-Project provinces of concern regarding this impact (Quang Ninh, Ha Tinh, Quang Nam, and Khanh Hoa). It is one of the largest sources of foreign exchange for Viet Nam. However, there are costs of aquaculture expansion:

Loss of Coastal Wetlands - Coastal and marine aquaculture production has increased rapidly in Viet Nam but this increase has largely been accomplished by extensification, rather than intensification of aquaculture production. Average aquaculture yields since 1993 have risen very little. This extensification has occurred at the

³⁹ If the final economic and financial analyses follow recommendations contained in the January 2003 Aide-Memoire ("...municipal and industrial water supply benefit cannot be said to fully accrue from works on the scheme below the hierarchy of primary canals. Therefore costs excluding dam safety and head works must be justified primarily by benefits to agriculture at farm-household level."), the requirement for including this type of mitigation will not be required for VWRAP. At this stage of Sub-Project preparation, it appears that municipal and industrial water benefits may not need to be included to economically justify the Sub-Project.

⁴⁰ The Quang Hue-Vu Gia River Control Works aims to restore water allocation (including allocation to aquaculture in Hoi An District of Quang Nam Province) to pre-2000 conditions and so no incremental water supply to aquaculture uses is assumed.

expense of coastal ecosystems, such as the case of coastal wetlands in the Mekong Delta where IDA is financing a large-scale rehabilitation⁴¹.

Water Pollution – In general, aquaculture in coastal Viet Nam has not been sufficiently carefully planned. The result in some cases is increased water pollution, largely from unregulated flushing of pond sediment wastes into water systems that have not been planned to ensure separation of aquaculture pond intake and effluent⁴².

Freshwater supply to brackish water aquaculture to be provided from the VWRAP Project is needed to achieve the correct salinity levels in the ponds at various stages of prawn development. Without the VWRAP Project, it is doubtful that aquaculture development will be able to proceed at the same rate it will be able to with the Project, and so there may in fact be incremental environmental effects of the VWRAP Project related to expansion of brackish water aquaculture. While Decree 175/CP requires overall strategies for regional and national development to be assessed for their environmental impacts, no EIAs were prepared for the provincial aquaculture plans. It would be prudent as part of the VWRAP Project Environmental Management Plan to:

- conduct an environmental review of those parts of the respective Provincial Aquaculture Programs that will benefit from improved water supply from the VWRAP Project to ensure proper pond arrangements, wastewater management, and pond sediment management are put into place and to determine the additional amount of coastal wetlands that will be lost as a result of the expansion of coastal aquaculture; and
- monitor the increases in aquaculture area and the water quality of waters downstream of the aquaculture areas during VWRAP.

4.3.8 Impacts on Population and Communities

There are four potential impacts on the population and communities of the VWRAP Irrigation Sub-Projects, all of which are assessed elsewhere in this Chapter:

- Mitigable effects of disturbance to households and communities caused by construction activities (Section 4.3.4);
- Mitigable effects of resettlement and compensation for land acquisition (Section 4.3.5);
- Positive effects of increased employment (Section 4.4.3); and
- Positive effects on household income and overall level of economic activity (Section 4.4.4).

There will be a number of very positive effects of the Quang Hue-Vu Gia River Control Works on populations and communities:

- The residents of Village No. 9 will have most of their land that was lost to the formation of the New Quang Hue River restored by backfilling with material dredged from the left bank of the Vu Gia River
- The residents of Village No. 9 and residents living between the New Quang Hue River and the Old Quang Hue River will enjoy lower risk of the events of the 2000 rainy season being repeated; and
- The residents and communities downstream in the Vu Gia and Thu Bon River basins will once again enjoy a secure supply of freshwater during the dry season for their socioeconomic livelihoods.

4.4 Environmental, Social Resources Receiving Consistent Environmental Impact

There are a number of environmental and social resources of the VWRAP Project that are predicted to be affected in the same way from all Project activities (i.e., all positive or all negative impacts) for whatever phases of the Project (pre-construction, construction, and operation) they will occur and in whichever phase of investments they will occur - first, second, or both. Rather than present these individually for each Project activity in this chapter, these environmental resources are presented synoptically below and not analyzed and presented further in the detailed assessment beginning with Section 4.5⁴³.

⁴¹ Coastal Wetlands Protection and Development Project.

⁴² Pollution from aquaculture activities was cited as the second most serious source of land-based pollution in coastal Viet Nam in a survey of the Directors of the provincial Science, Technology, and Environment Departments conducted as part of coastal community surveys under ADB TA 5712-REG: Coastal and Marine Environmental Management in the South China Sea, Phase 2 (GEC Ltd. 1999)

⁴³ Unless otherwise stated, impact assessments in this section apply to all Irrigation Scheme Sub-Projects and the Quang Hue-Vu Gia River Control Works.

4.4.1 Impacts on Environmental Resources in VWRAP Project Reservoir Catchments

The Project will have **NO IMPACT** on the VWRAP Project Reservoir Catchments. There are no Project activities that will affect any environmental resources in the catchments of the VWRAP Project Reservoir:

- The height of the VWRAP Project Dams and the associated saddle dams is not being increased and there will therefore be no land alienation from increased Reservoir height;
- The operation of the VWRAP Project Reservoirs will be basically the same with the Project as under current conditions and the with-Project water level regime in the Reservoirs will essentially be the same as it is at present. The exception to this is the increased water storage at the end of the rainy season for the Phu Ninh Sub-Project, but this will not increase reservoir water levels to greater than design water levels;
- Access to the catchment area above the VWRAP Project Reservoirs will not change. New roads into the catchment will not be built and no existing roads in the catchment area will be enlarged or improved;
- The remoteness of the catchment areas means that no construction materials will be obtained from this part of the Project Areas.

4.4.2 Project Impacts on Rare and Endangered Species

There have generally been no biodiversity surveys conducted in the command areas of VWRAP and so it is not known whether the command areas contain any rare and endangered species. The rare and endangered species contained in the 2002 IUCN Red List (Table 15 and Annex 8) are found in natural forested habitats which in the Project Area are found only in the catchments of the VWRAP Project Reservoirs. It is extremely unlikely that there are any rare and endangered species in the command areas because these areas have long been almost exclusively used for human habitation and associated economic activities. Because of the likely absence of rare and endangered species in the command areas, the effect of the Project on rare and endangered species in the command area is assessed as **NO IMPACT**. In addition, the prediction of no impacts of the Project on environmental resources in the catchment of the VWRAP Project Reservoir (see above) includes no effects of the Project on rare and endangered species in that part of the Project as well.

4.4.3 Project Impacts of the Project on Employment

Practically all Project activities will have a **POSITIVE IMPACT** on local employment. These positive effects will occur in a number of ways:

- short-term increase in employment from construction activities;
- Longer term increase in the requirement for on-farm labor; and
- Substantial indirect and induced employment generated as a result of both the short-term increase in construction employment and the increase in on-farm labor demand.

Direct and indirect benefits of local procurement will boost local economic activity over a period of 3-5 years in each Sub-Project.

The only possible exception will be possible reduced labor requirements under a more automated irrigation management system. However, these are likely to be small and more than compensated for by the overall increase in employment with the Project. To reinforce the positive effects of the Project on local employment, it would be appropriate to give preference and priority to local residents in construction (and operation) of the Project wherever possible, by including a requirement in construction contracts for local hires and specific interest groups (e.g., women and ethnic minorities identified in the VWRAP Project EMDPs as being potentially disadvantaged by the Project), as well as to train local workers before construction begins to increase relevant skills and minimize project delays.

4.4.4 Impact on Economic Activities, Income, and Incidence of Poverty

The Project will have a **POSITIVE IMPACT** on overall economic activity in the Project Area, as well as increasing household income and reducing the incidence of poverty in the Project Area. The increased short-term and long-term employment generated by the Project will increase the general level of economic activity in the Project Area. In addition, net incomes of agricultural households from agriculture activities are predicted to increase by about 11% over and above current levels, from VND 2.77 million to VND 3.07 million (US \$180 to US \$200, **Figure 3**). The predicted increases in household incomes with the Project may be even greater with even higher crop diversification.

This increase in net income will also result in a decrease in overall poverty in the command area. It is predicted that the percentage of households in the two pilot areas not meeting the threshold poverty level of VND 100,000

per person per month (set by the 2001 National Strategy for Poverty Alleviation and Employment) will decline from about 12% at present to about 6% with the Project, a reduction in levels of absolute poverty of some 50% (Figure 3).

However, improvement in water resources is a necessary, but likely not sufficient intervention for achieving this reduction in poverty. For example, numerous pilot area households interviewed as part of the socioeconomic survey conducted by the EIA Consultant in Cam Son-Cau Son, Da Ban, and Dau Tieng indicated they had trouble obtaining sufficient agricultural inputs. This may be limited transportation facilities for getting the agricultural inputs to the fields, but it may also be insufficient credit availability. The Project will remove some, but perhaps not all, the constraints to agricultural production and to increasing farmer incomes.

There may be short-term negative effects to agricultural commodity production as a result of canal lining and other canal reinforcements. This can be mitigated by developing rigid construction timetables for canal reinforcement and lining to minimize disruption to the beneficiaries and at the same time have efficient implementation of this part of the Project. This will require a detailed implementation plan for canal lining developed consultation with Project beneficiaries and is discussed in more detail below in Section 4.6.

The Quang Hue-Vu Gia River Control Works will have **POSITIVE** effects on income and socioeconomic conditions:

- Residents of Village No. 9 who lost their property during the 2000 flood event will have their property restored by the filling of the New Quang Hue River. It is not certain whether the soils will be of sufficient quality for immediate resumption of agricultural activities but the potential will exist for these households, currently without agricultural land, to resume their agricultural livelihoods;
- There will be an improvement in the socioeconomic conditions of Village No. 9 if residents are hired to work on the construction of Phase 2;
- The resumption of the dry season hydrological and salinity regimes to their pre-2000 levels downstream of the Project area will enable the downstream residents to enjoy a stable water supply for their agriculture and aquaculture activities; and
- water will be supplied to the over 40 electric pumping stations that provide irrigation water to nearly 10,000 ha of agricultural production land in the Vu Gia River basin downstream of the River Control Works area.

4.4.5 Project Impacts on Mineral Resources

The effects of removing rock (for road construction or during canal system expansion) from new borrow sites is **MITIGABLE** through the restoration of the borrow sites after construction is completed.

4.4.6 Project Impacts on Air Quality

There will be **NO IMPACT** of the Project on air quality in or outside the Project Area. The exception to this is the operation of construction equipment for various Project activities and these impacts are addressed in detail in Section 4.3.4.

4.4.7 Project Impacts on Noise

There will be **NO IMPACT** of the Project on noise levels in or outside the Project Area. The exception to this is the operation of construction equipment for various Project activities and these impacts are assessed in detail in Section 4.3.4.

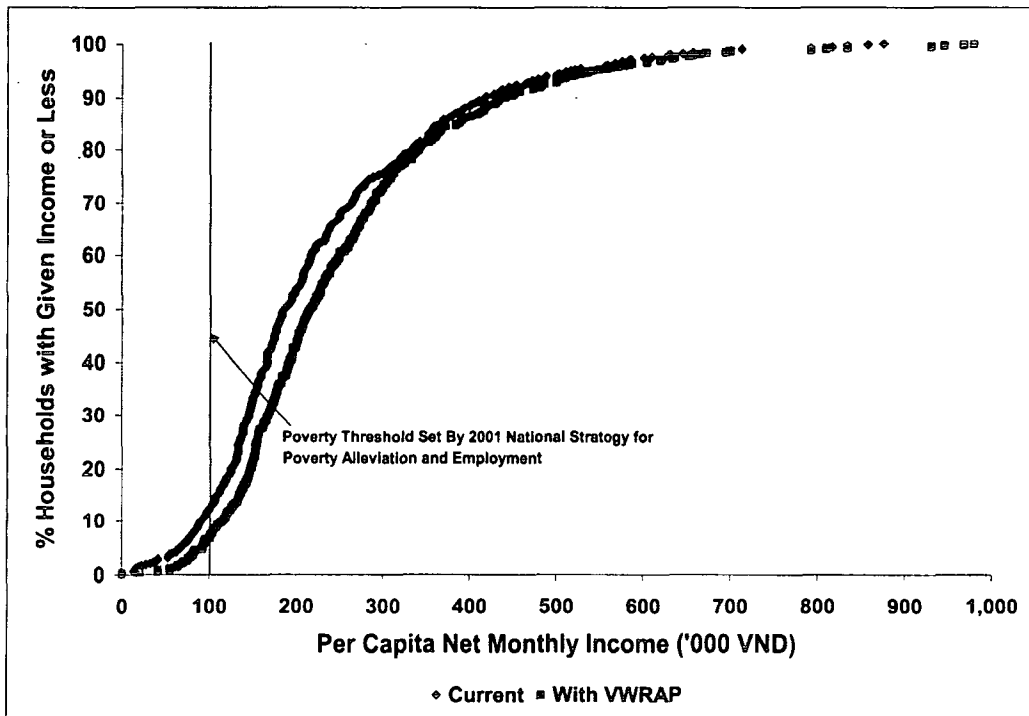


Figure 3: Predicted change in incidence of poverty in VWRAP Pilot Areas with Project⁴⁴.

4.4.8 Project Impacts on Production Forests

There will be **NO IMPACT** of the Project on production forests in or outside the Project Area. The production forest land within the districts and communes that form the Project Area (Table 9) lie outside of the actual land that is currently served by the VWRAP Project Irrigation Scheme and there is no pumping contemplated in the VWRAP Project to deliver irrigation water to even the lower slopes of these hills. Therefore, there will be no impacts on production forests in the command area from Project activities. This, coupled with the assessment of no Project impacts on environmental resources within the VWRAP Project Reservoir catchments (Section 4.4.1), means that there will be no impacts of VWRAP on forest resources.

4.4.9 Project Impacts on Human Health

There will be **NO IMPACT** of the Project on the health of the Project beneficiaries. Expansion of the existing IPM program (Section 4.7.1) should minimize any negative effects of possible increased pesticide use and there may be positive benefits of households having increased disposable income on being able to make increased use of health care services.

4.4.10 Project Impacts on Nature Reserves, Protected Areas, or Protection Forests

No Impact:	Cam Son-Cau Son, Ke Go, Quang Hue-Vu Gia
Insignificant	Da Ban
Migitable:	Yen Lap, Dau Tieng

Table 19 contains a summary of the expected Project impacts on protected areas. With respect to the Cam Son-Cau Son, Ke Go, and Quang Hue-Vu Gia, Sub-Projects, the VWRAP Project will have **NO IMPACT** on any recognized nature reserve. The nearest formal nature reserves (i.e., in the national system of Protected Areas)

⁴⁴ The data in the chart were obtained from the pilot area socioeconomic surveys conducted by the EIA Consultant (Cam Son-Cau Son, Da Ban, and Dau Tieng) and the Consultant (Yen Lap, Ke Go, Phu Ninh). Net income without the Sub-Project is calculated as the sum of all income sources reported less the sum of all costs reported. Net income with the Sub-Project is calculated in the same way but assumes greater income from agricultural production due to the improvements in water supply. Improvements are set to changes in CI (Table 8) and it is assumed that yields of agricultural commodities will increase by the same percentage as CIU. Incremental net income is assumed at 50% total incremental income.

are either in the catchment areas of the Irrigation Schemes (in the case of Ke Go and Cam Son-Cau Son) or completely outside of the Irrigation Schemes and their areas of influence. Because there will be no Project activities taking place in the Reservoir catchments and therefore no effects on environmental resources of the VWRAP Project Reservoir catchment, the Project will have no effects on these protected areas.

With respect to the Da Ban Sub-Project, effects on aquatic ecosystems downstream of the command area would be indirect and mediated through changes in surface water quality. As the effects of the Sub-Project on surface water quality outside of the command areas are assessed to be likely **INSIGNIFICANT**, it is also likely that the impacts of the Da Ban Sub-Project on aquatic ecosystems downstream of the command area is also likely to be significant. The absence of any surface water quality or aquatic resources monitoring information means that these predictions are essentially uncertain. Surface water quality monitoring downstream of the command area will enable these assessments of insignificant cumulative impact to be confirmed

With respect to the Yen Lap and Dau Tieng Sub-Projects, some activities will affect nature reserves and watershed protection forests:

Yen Lap The construction of the new emergency spillway at the Thuy San Isthmus between the main dam and the Nghia Lo Saddle Dam will cause the removal of about 8 ha of production forest. A suitable mitigation to compensate for the loss of ecological services of this production forest will be to plant of the same area of forest elsewhere in the watershed of the Yen Lap Reservoir, within the Yen Lap Watershed Protection Forest

Dau Tieng Extension of the canal system may intrude in the Duong Minh Chau and Boi Loi protected areas. Although the exact location and route of the additional canal works are unknown at this time, the incremental loss of important terrestrial ecosystems (in terms of ecological value) through canal dredging and other similar activities would be small with respect to the Duong Minh Chau and Boi Loi protected areas, both of which are assessed by MARD as being unworthy of inclusion into the national system of protected areas. The planting of an area of forest elsewhere in the watershed of the Dau Tieng Reservoir or in the protected areas themselves that would be equal to the area of natural forest lost through Sub-Project activities would be sufficient mitigation for protected areas with such dubious biodiversity value and such an uncertain future in the National System of Protected Areas.

4.5 Project Impacts of Pre-Construction⁴⁵

4.5.1 *Impacts of the Legacy of Conflict*

One of the ongoing consequences of the American War of the 1960s and 1970s is unexploded ordnance. Unexploded ordnance is uncovered throughout Viet Nam and there are casualties every year from accidents involving these materials. The VWRAP Project involves the movement of a great deal of earth (Table 5 and Table 6) for upgrading of existing civil works and construction of new civil works. Mortar shells, aerial bombs, and other unexploded ordnance may all be found within the Project Area. Some de-mining has occurred at shallow depths, however virtually none has occurred in non-productive land or at depths greater than 2 m. There is a risk that unexploded ordnance will be uncovered during excavation, but this risk is assessed as **MITIGABLE**. As a precautionary measure, it will be necessary to detect and clear unexploded ordnance in the Project Area⁴⁶ for those construction activities that will occur at depths greater than 2 m.

4.5.2 *Requirements for Resettlement and Land Acquisition*

These impacts are assessed as **MITIGABLE**. As indicated in Table 7, 10 households will require resettlement, 1,235 ha of land will be permanently acquired, and 670 ha of land will be temporarily acquired. A detailed resettlement and compensation scheme has been prepared according to both IDA and Vietnamese legal requirements. The total compensation will be US \$442,000⁴⁷.

⁴⁵ Unless otherwise stated, the assessments made in this section apply to all of the irrigation Sub-Projects (i.e., Yen Lap, Cam Son-Cau Son, Ke Go, Phu Ninh, Da Ban, and Dau Tieng). The assessment for the Quang Hue-Vu Gia River Control Works is contained in a separate section at the end of the assessment of the impacts of the Irrigation Sub-Projects and is presented only if there is some type of impact predicted (i.e., predictions of No Impact are not presented).

⁴⁶ This mitigation is part of the ADB/GoVN financed Phuoc Hoa Water Resources Project and is an accepted mitigation measure for linear transportation projects in Viet Nam.

⁴⁷ from final VWRAP PFS, submitted to MARD in March 2003

Table 19: Summary of assessment of Project impacts on nature reserves and protected areas⁴⁸.

Protected Area	Designation	Impact Assessment	Rationale
Yen Lap			
Bai Chay	Cultural and Historic Site	None	<ul style="list-style-type: none"> All protected areas lie outside the Sub-Project Area and associated area of influence
Ky Thuong	National Nature Reserve		
Cat Ba	National Park		
Ha Long Bay	Cultural and Historic Site		
Yen Lap	Watershed Protection Forest	Mitigable	<ul style="list-style-type: none"> 8 ha will be removed as a result of constructing new emergency spillway. Similar area can be planted in other parts of watershed protection forest as compensation
Cam Son-Cau Son			
Cam Son-Cau Son	Cultural and Historic Site	None	<ul style="list-style-type: none"> located exclusively in Cam Son Reservoir catchment where no Sub-Project activities will occur
Ke Go			
Ke Go	National Nature Reserve	None	<ul style="list-style-type: none"> located exclusively in Ke Go Reservoir catchment where no Sub-Project activities will occur
Vu Quang	National Nature Reserve	None	<ul style="list-style-type: none"> All protected areas lie outside the Sub-Project Area and associated area of influence
Khe Net	National Nature Reserve		
Quang Hue-Vu Gia			
<ul style="list-style-type: none"> no protected areas at potential risk from river control works 			
Phu Ninh			
Phu Ninh	Watershed Protection Forest and Provincial Nature Reserve	None	<ul style="list-style-type: none"> located exclusively in Phu Ninh Reservoir catchment where no Sub-Project activities will occur
Nui Thanh	Cultural and Historic Site	None	<ul style="list-style-type: none"> located outside the Sub-Project Area and associated area of influence
Da Ban			
Nha Phu Bay	Fisheries Protection Area	Insignificant	<ul style="list-style-type: none"> located a considerable ways downstream of the command area; any impacts are likely to be related to water quality changes and minor given the dilution of any incremental loading of sediments and pollutants (sedimentation and erosion, fertilizers, pesticides).
Dau Tieng			
Lo Go-Sa Mat	National Park	None	<ul style="list-style-type: none"> located outside the Sub-Project Area and associated area of influence
Boi Loi	Cultural and Historic Site	Mitigable	<ul style="list-style-type: none"> Extension of the canal system may intrude in the Duong Minh Chau and Boi Loi local Nature Reserves. Any losses in forest resources can be compensated for by replanting a similar-sized area in other parts of the protected areas.
Duong Minh Chau	Cultural and Historic Site		
Nui Ba Den	Cultural and Historic Site	None	<ul style="list-style-type: none"> protected area is a steep-sided hill in the middle of the command area, sitting above the irrigated area.
Can Gio	Biosphere Reserve	None	<ul style="list-style-type: none"> protected area lies at the mouth of the Sai Gon River will not be affected by any incremental surface water pollution because of the already high pollution levels in surface waters surrounding the protected area any changes in salinity intrusion as a result of changes in hydrology downstream of the Dau Tieng Dam Complex will not be manifested at the protected area which is influenced more by the East Sea than by Sai Gon River flows.

⁴⁸ as denoted in the Sourcebook of Existing and Proposed Protected Areas in Vietnam, compiled by Birdlife International and the Viet Nam Forest Inventory and Planning Institute (http://www.wing-wbsj.or.jp/~vietnam/source_book/index.htm). Protected areas listed in this publication are either on MARD's 2010 National Priority List for Protected Areas or are not on this list but have been assessed as having some biodiversity value that warrants either protection or further investigation.

4.6 Project Impacts of Construction⁴⁹

4.6.1 *Impacts on Physical Resources*

SOILS

Reduction in Erosion – POSITIVE The reinforcement and strengthening of sections of the canal system throughout the Project's command areas will be a positive effect on soils in the immediate vicinity of the engineering civil works. Erosion will be reduced at those locations and farmers will not have to continually contend with their land eroding along the canals. As well, the additional lining of the canal system will also have a positive effect of reducing soil erosion along those particular lined portions. No direct effects of civil works upgrading on Sub-Project soils are expected.

Alienation of Sub-Project Soils – INSIGNIFICANT Some soils will be permanently alienated as the management roads are upgraded and widened. However, this will be a small proportion of the total Sub-Project Area and the effect is assessed as Insignificant. In addition, construction and/or upgrading of management roads along the main primary and lower-level canals will at worst cause only minor, temporary disturbances to soils from the actual construction activities themselves.

Increased Acidity Generated from Acid Sulphate Soils through Construction Activities – MITIGABLE Although water quality data for the Sub-Project Area suggests the larger-scale effects of disturbing acid sulphate soils is very moderate, there may be localized increased generation of acidity as a result of construction activities, and mitigation measures are recommended to deal with these possible increases in acidity

Earth Excavation, Storage, and Disposal - MITIGABLE Large quantities of soil, rock, and other material will be excavated (total of 9.5 million m³) and provided as fill (total of 7.5 million m³) (Table 5 and Table 6) for the headworks and canal upgrading. Soils to be excavated and/or used as fill are unlikely to be contaminated as the entire Sub-Project Area has had little, if any, economic activities that would generate such contaminants⁵⁰. However, the large quantities of soil likely to be disturbed during construction are such that proper disposal, storage, and management of these soils are recommended as mitigation measures. Part of the mitigation measures will need to be ensuring that contaminated soil does not make it onto the Sub-Project site as earth-fill.

One obvious means of disposal for some of these soils would be as inputs to upgraded management roads and canal tracks, as well as canal banks that need to be raised in order to accommodate possible downstream control of the irrigation system.

Quang Hue-Vu Gia River Control Works – POSITIVE There will be positive effects of the Quang Hue-Vu Gia River Control Works on soils because:

- There will be a loss of soil area on the left bank of the Vu Gia River when it is dredged to provide construction material and to fill in the New Quang Hue River. This type of riverbank is extremely common on the inside of the river bends throughout the lower Vu Gia and Thu Bon River basins;
- This will be compensated for by an increase (from current conditions) in soil area where the New Quang Hue River currently exists as the dredged material on the left bank;
- The soils of the Project area are clays, loam and sand, and have no special characteristics that would cause negative environmental impacts if disturbed (e.g., the soils of the Project area do not contain pyrites or jarosite that could cause acidity problems upon disturbance); and
- Loss of soils along the right side of the Vu Gia River Bank and the left side of the Old Quang Hue River during periods of high flow will be reduced by the construction of the revetment.

SURFACE WATER HYDROLOGY

Improved Efficiency of Water Use - POSITIVE The upgrading of the main and canal distribution system in the Irrigation Schemes through dredging, re-aligning, and raising the main canals where required, replacing main

⁴⁹ Unless otherwise stated, the assessments made in this section apply to all of the irrigation Sub-Projects (i.e., Yen Lap, Cam Son-Cau Son, Ke Go, Phu Ninh, Da Ban, and Dau Tieng). The assessment for the Quang Hue-Vu Gia River Control Works is contained in a separate section at the end of the assessment of the impacts of the Irrigation Sub-Projects and is presented only if there is some type of impact predicted (i.e., predictions of No Impact are not presented).

⁵⁰ Although there may be residual contamination from the application of Agent Orange and other defoliants during the American War.

sluice gates and hoisting equipment, implementation of a program of canal lining, and improving water level and discharge regulation will have positive effects on surface water hydrology by increasing the efficiency of water use, thereby enabling greater water supply to be provided to the lower-level canal systems. This is also the case with the completion and upgrading (through lining) of the lower-level canal systems themselves.

Changes in Basic Hydrological Regime – INSIGNIFICANT The basic hydrological regime of the 1^o, 2^o, and 3^o canals will change only modestly with the Project and the hydrological network will not change, whatever irrigation management alternative for the canals is selected (i.e., upstream or downstream control). It is likely that the spatial and temporal patterns of drainage will not significantly change. Therefore, the hydrological regime downstream of the command areas is predicted to not change much from the current regime.

Interruption of Canal Water Supply to Users During Canal Construction and Canal Lining – MITIGABLE Improper timing of the construction activities associated with main canal reinforcement and lining may negatively affect water supply to farmers downstream. On the one hand, construction of canal reinforcements in the dry season can proceed very quickly, but water supply needs to be turned off during the construction periods; the dry season is the season when water supply via the irrigation scheme is most critical. On the other hand, water supply to the farmers via the irrigation scheme is not as critical in the rainy season and yet construction is much more problematic and expensive given the larger amounts of water in the system at that time. It will be necessary to develop rigid construction timetables for canal lining to minimize disruption to the beneficiaries and at the same time have efficient implementation of this part of the Project. In addition, consultation with all affected parties will be required in order to reach agreement how much impact will be accepted by the affected groups.

Cumulative Effects of Upgrading Irrigation Water Supply Systems – POSITIVE As with the upgrading of the main canal distribution system, the cumulative effects of upgrading the 1^o, 2^o, 3^o, and on-farm canal system in the Irrigation Schemes will have significant positive effects on surface water hydrology by increasing the efficiency of water use, thereby enabling greater water supply to be provided to the farmers, in the appropriate amounts at the appropriate times. This is especially the case at the bottom of many of the command areas during the dry season (with the exception of the Cu Chi District portion of the Dau Tieng command area as its canal system is already lined). With the Project, these beneficiaries, currently facing waterlogged conditions that require IMCs to pump large volumes of water in the rainy season, will no longer receive water seeping in from poorly designed and poorly maintained earthen irrigation canals.

Comprehensive Upgrading of Dike Embankment (Dau Tieng) – POSITIVE There will be a positive effect of comprehensive upgrading of the dike embankment along the western shore of Dau Tieng Reservoir as extensive seepage through the embankment will cease and there will no longer be severely waterlogged conditions along the downstream edge of the embankment.

Quang Hue-Vu Gia River Control Works – POSITIVE There will be positive effects of the Quang Hue-Vu Gia River Control Works on surface water hydrology because:

- The River Control Works will restore the hydrological regime to pre-2000 conditions, with 15% of dry season Vu Gia River flow to be conveyed to the Thu Bon River system and the remainder to remain in the Vu Gia River system.
- There will be no disruption to surface water hydrology during the construction of the remainder of the River Control system. Coffering and dewatering will be required for the construction of the revetment and the spillway across the New Quang Hue River but these activities will have no observable effects on the average Vu Gia River flow during the dry season of more than 30 m³/s.
- The operation of the control gate at the beginning of the Old Quang Hue River system may affect surface water hydrology but the basic allocation of water between the two river systems (Vu Gia and Thu Bon) is not likely to be altered by operation of this control gate.

SEDIMENTATION AND EROSION⁵¹

Improvement of Canal Integrity and Canal Bank Stability – POSITIVE Because incremental lining throughout the entire canal systems of the Irrigation Sub-Projects, as well as re-aligning and strengthening these canals will have a positive effect of reducing soil erosion along the canal systems, sedimentation is likely to be reduced within the canal systems as well. The lining or other reinforcement of sections of the canals will be a positive effect on soils in the immediate vicinity of the engineering civil works. Erosion will be reduced at those locations

⁵¹ All of the effects on erosion and sedimentation described below will be localized. The effects will not be detectable downstream of the command area and almost certainly not detectable in the rivers that drain the command areas.

and farmers will not have to continually contend with their land eroding along the canals. This will reduce sedimentation into canals and surface waters.

Disturbance of Sub-Project Soils During Expansion of Supplementary Emergency Spillway (Ke Go and Dau Tieng) and Construction of New Emergency Spillway (Yen Lap) – MITIGABLE The disturbance to Sub-Project soils as a result of expanding existing spillways in the Ke Go and Dau Tieng Sub-Projects, as well as construction of the new emergency spillway in the Yen Lap Sub-Projects will increase sedimentation into the respective reservoirs and possibly the main canal of these schemes as a result of construction activities, including site preparation and pumping. These effects can be mitigated with properly constructed and maintained sedimentation basins that would be used during the construction phase.

Earth Excavation, Storage, and Disposal – MITIGABLE There will be considerable moving and handling of soils involved with dredging in the main canals as well as raising the canals and strengthening them at locations that have eroded over time. The quantities of soil likely to be involved are such that proper disposal and management of these soils is recommended in order to minimize incremental sedimentation into the canals and other water bodies of the Project.

Disturbance of Sub-Project Soils During Implementation of Canal Engineering Works – MITIGABLE Most of the construction activities associated with upgrading the entire canal distribution systems – completion of the canal distribution systems at the lower levels, canal reinforcement, canal lining, and management road construction and upgrading - could cause local disturbance to soils and thereby increase sediment content of the main canals. Minimization of soil disturbance during the construction activities through the application of standard good practice techniques during construction is recommended in order to minimize additional sedimentation into the canals of the Sub-Project.

Quang Hue-Vu Gia River Control Works – POSITIVE There will be positive effects of the Quang Hue-Vu Gia River Control Works on sedimentation and erosion because:

- The restoration of increased flows (and increased flow velocity) during the dry season in the Vu Gia River and the Old Quang Hue River will decrease the rate of sedimentation in those riverbeds.
- The construction of the Dai An Revetment will decrease erosion rates along the right bank of the Vu Gia River between the New Quang Hue River and the Old Quang Hue River. This will reduce the risk of a new river channel forming during a future flood event such as occurred in the 2000 rainy season.

SURFACE WATER QUALITY^{52,53}

Reduction in Erosion and Sedimentation - POSITIVE Erosion and sedimentation are the major issues with respect to surface water quality in the Project for the above Project activities. The extent to which the Project activities listed above reduce erosion and sedimentation in the surface waters of the Project Area (discussed above) will be the extent to which these Project activities affect surface water quality in the Project Area.

Increased Generation of Acidity from Disturbance of Acid Sulphate Soils (Dau Tieng) – MITIGABLE There is a risk that upgrading of existing canals and construction of new canals in the Dau Tieng Sub-Project in areas of acid sulphate soils will increase the acidity of surface waters and of runoff from any spoils. The following mitigations are recommended in areas containing acid sulphate soils⁵⁴:

- For spoil that is excavated using a grab dredger, it would be the neighboring farmers' responsibility to dig a small ditch between the spoil and their fields to direct sewage and runoff back into the canal;
- For spoil that is excavated using a cutter dredger, containment with surrounding embankments would be built to control the spread of the spoil and to direct runoff back into the canal;
- Where feasible and advantageous, contractors would be required to dredge one side of an existing canal to minimize exposure of and leaching from acid soils;
- The contractors would be responsible for mitigation and compensation for any damage to farmers' land or other assets due to excavation, based on conditions that would be specified in the contractual agreements; and compliance with contract specifications would be monitored during Project implementation.

⁵² The absence of any existing surface water quality monitoring program in the Dau Tieng Sub-Project area makes it difficult to make quantitative predictions of Sub-Project impacts on surface water quality. It will be necessary to implement a water quality effects monitoring program as part of the Environmental Management Plan (Chapter 5) in order to ensure that the predictions and assessments made below are valid and appropriate.

⁵³ Surface water quality may be affected by construction camps and general construction activities in the Irrigation Sub-Projects and the Quang Hue-Vu Gia River Control Works. These impacts are assessed in detail in Section 4.3.4.

⁵⁴ Adapted from the environmental management plan for the IDA-financed Mekong Delta Water Resources Project.

Disturbance of Bottom Sediments (Yen Lap, Cam Son-Cau Son) - INSIGNIFICANT Dredging material from the vicinity of intake sluice channels in order to improve operating efficiency of the Yen Lap and Cam Son-Cau Son intake sluices will increase sedimentation into the surface waters of these Sub-Projects. These effects, however, will be temporary and localized and are therefore assessed as Insignificant. These effects will not be detectable downstream of the command areas.

Cumulative Environmental Effects of Sub-Project Construction on Surface Water Quality – INSIGNIFICANT While there is some risk that surface water quality in the command areas may change significantly as a result of the Project, it is unlikely that this will be the case with water quality downstream of the command areas. Sediment, nutrient, and pesticide concentrations will almost certainly change in the surface waters within the Sub-Project, particularly in the dry season. This, however, is unlikely to significantly affect water quality downstream of the command areas because of the dilution of pollutants that would occur. However, the absence of any surface water quality monitoring information means that these predictions are uncertain. It would be prudent, therefore, to conduct surface water quality monitoring downstream of the command areas to confirm the assessments of cumulative impact made above.

GROUNDWATER RESOURCES⁵⁵

Alteration of Rates and Patterns of Water Exchange Between Canals and Shallow Groundwater Systems – UNKNOWN The issue related to groundwater and canal lining relates to groundwater availability for crop production and likely not to potential changes in the availability of groundwater resources for domestic and drinking water. Based on socioeconomic survey results, most of the households in the Irrigation Sub-Projects use groundwater as a source of domestic water. Lining sections of the main canals and lining the 1^o, 2^o, 3^o and on-farm canals will prevent the exchange of canal water with the shallow groundwater system. This is likely to have different effects in different parts of the command areas in different seasons of the year:

Top End, Rainy Season – little change is expected with the Project as there is already rather good regulation of water supply for cropping in the top end of the command areas in the rainy season. Any shortfalls in shallow groundwater resources that appear as a result of canal lining can be compensated relatively easily by increasing water supply from the canals.

Bottom End, Rainy Season –Because the ground is lower in the bottom end of the command areas and because water in the canals finds its way very quickly into the groundwater through seepage, groundwater levels in the rainy season are very high, often so high in some areas of some Sub-Projects (e.g., Cam Son-Cau Son) that pumping is required to prevent negative effects on crop production. Lining the canals will limit and greatly reduce the infiltration of water from the canals to the groundwater and so the Project will lower groundwater levels in the bottom end of the command areas. This is a positive effect as it should reduce drainage pumping costs in the rainy season.

Throughout Command Area, Dry Season - water levels in the canals at the throughout the command areas are low during the dry season due to system inefficiencies. There is likely a net movement of water from the shallow groundwater to the canal system during the dry season at the present time. This flow will be reduced because of canal lining with the Project. This, plus the expected increased availability of irrigation water throughout the command areas during the dry season (particularly at the bottom end of the system) will increase groundwater levels in the dry season.

It is worth noting that in the Dau Tieng Irrigation Scheme, Cu Chi District IMC indicated that groundwater levels had decreased near canals that were lined but that the decrease was marginal. However, because the magnitude of these effects can not be predicted and because of the importance of groundwater resources to Sub-Project beneficiaries, monitoring of groundwater levels in the vicinity of substantial canal lining activities is recommended.

Quang Hue-Vu Gia River Control Works – INSIGNIFICANT The amounts of material that might be released into the environment from construction activities will be so small that they will almost certainly not make their way into the groundwater resources of the River Control Works area.

⁵⁵ As with surface water quality, the absence of any existing groundwater quality monitoring program in the Sub-Project areas makes it difficult to make quantitative predictions of Sub-Project impacts on groundwater quality. Environmental effects monitoring conducted as part of the Environmental Management Plan (Chapter 5) will need to include groundwater quality monitoring in order to ensure that the predictions and assessments made are valid and appropriate.

4.6.2 Impacts on Biological Resources

TERRESTRIAL ECOSYSTEMS AND TERRESTRIAL BIODIVERSITY

Permanent Loss of Terrestrial Ecosystems – INSIGNIFICANT The upgrading of the management roads along the canals will permanently alienate a small area relative to the total catchment area plus the full command area; these effects are assessed as Insignificant.

The increase in the area of canals will convert land resources into water resources in the command areas of the Project. The land to be converted is already agricultural land and therefore highly modified and extremely simplified terrestrial “ecosystems”. The command area contains no remaining natural terrestrial ecosystem and this effect is therefore assessed as Insignificant. In addition, because the irrigated portion of the command areas contains no natural terrestrial ecosystems but only what can best be considered as highly modified and simple terrestrial “ecosystems” in the form of agricultural land, any changes in land use to more intensive agriculture will be an insignificant effect of the Project on terrestrial ecosystems.

Alteration of Landscapes During Extraction of Construction Materials - MITIGABLE Earth-fill, sand and other materials to be excavated will cause disturbance to landscapes. For example, 50% of the earth-fill and sand to be used in the Yen Lap Sub-Project is to be extracted from the Song Khoai Hill area (about 280,000 m³). This will disturb approximately 10 ha of land^{56,57}. Mitigation will be required to restore vegetation at these sites after construction is completed and to return the landscapes to their original condition.

Disturbance of Terrestrial Ecosystems During Construction - MITIGABLE Construction activities will temporarily disturb terrestrial ecosystems within the Project Area at and downstream of the dams and into the command areas. Also, areas used for earth storage will also disturb landscapes within the Project Area; it is estimated that about 670 ha of land will be temporarily required for construction activities (Table 7). Even though compensation will be paid for the temporary use of this land, mitigation will be required to restore these sites after construction is completed and to return the landscapes to their original condition.

Quang Hue-Vu Gia River Control Works – INSIGNIFICANT There will be insignificant effects of the Quang Hue-Vu Gia River Control Works on terrestrial ecosystems and terrestrial biodiversity because the area to be modified by the River Control Works consists mostly of highly modified and simplified agricultural ecosystems that produce annual crops. The exception to this is the riverbank on the left side of the Vu Gia River that is to be dredged. This type of terrestrial ecosystem is extremely common on the inside of the river bends throughout the lower Vu Gia and Thu Bon River basins and it is likely that, over time, the area lost to dredging will re-form again as sediment continues to be deposited there by the Vu Gia River.

AQUATIC ECOSYSTEMS AND AQUATIC BIODIVERSITY

There are expected to be no impacts of basic upgrading of the Dam Complexes of the Irrigation Schemes, increasing the flood control capacity of the Irrigation Schemes, or comprehensive and upgrading the main canal systems on aquatic ecosystems and aquatic biodiversity in the Project Area. The most significant natural aquatic ecosystems in the Project Area are the reservoirs and the main rivers draining the command areas. The impact of these Project activities on these natural aquatic ecosystems will be negligible at most and completely undetectable.

Creation of New Canals - POSITIVE The completion of the canal system in the command areas will increase the area of open water in the Project Area. While these will be highly simplified and modified aquatic ecosystems, they represent an increase in the total area of aquatic ecosystems in the Project Area.

Reduction in Erosion and Sedimentation - POSITIVE Erosion and sedimentation are the major issues with respect to surface water quality in the Project for the above Project activities and the extent to which the Project activities listed above reduce erosion and sedimentation in the surface waters of the Project (discussed above) will be the extent to which these Project activities affect aquatic ecosystems in the Project Area.

Decrease in Nutrient Inputs from Eroding Soils – INSIGNIFICANT Lining of canal sections as well as re-aligning and strengthening sections of the primary canals will decrease the amount of nutrients entering the primary canals from Project soils and this will be an insignificant, negative effect of the Project on aquatic ecosystems.

⁵⁶ assuming that the average depth of earth removed will be 3 m

⁵⁷ Engineering Sub-consultant feasibility studies (HEC-1 and HEC-2) are not as specific as to the sources of earthfill and sand to be used in the other Sub-Projects.

Increase in Erosion and Sedimentation – INSIGNIFICANT The extent to which erosion and sedimentation are increased as a result of various Project activities will be the extent to which these Project activities affect aquatic ecosystems in the Project Area.

Generation of Acidity from Acid Sulphate Soils (Dau Tieng) – MITIGABLE With respect to acid sulphate soils, the proper implementation of mitigation measures described above for minimizing effects on surface water quality will ameliorate any effects acid generation on aquatic ecosystems.

Earth Excavation, Storage, and Disposal - MITIGABLE There will be considerable moving and handling of soils involved with dredging in the canals as well as raising the canals and strengthening them at locations that have eroded over time (total of 8.6 million m³ of earth to be excavated and almost 7.0 million m³ of earthfill to be provided, Table 6). The quantities of soil involved are such that proper disposal and management of these soils is recommended in order to minimize additional sedimentation into the main canals of the Sub-Project and minimize consequent negative impacts on aquatic ecosystems and biodiversity.

Cumulative Environmental Effects of Sub-Project Construction Activities on Aquatic Ecosystems Effects on aquatic ecosystems downstream of the command areas would be indirect and mediated through changes in surface water quality. As the effects of the Project on surface water quality outside of the Project are assessed to be likely insignificant (Section 4.6.1), it is also likely that the impacts of the Project on aquatic ecosystems downstream of the command areas will also be significant. Again, however, the absence of any surface water quality or aquatic resources monitoring information means that these predictions are essentially uncertain. The recommended surface water quality monitoring downstream of the command areas will enable these assessments of insignificant cumulative impact to be confirmed.

Quang Hue-Vu Gia River Control Works – INSIGNIFICANT There will be insignificant effects of the Quang Hue-Vu Gia River Control Works on aquatic ecosystems and aquatic biodiversity because

- The restoration of the dry season hydrological regime in the Thu Bon and Vu Gia Rivers downstream of the Quang Hue Rivers will restore the aquatic ecosystems to their pre-2000 state through re-attainment of salinity intrusion that existed before the events of the 2000 rainy season.
- The loss of aquatic habitat by the filling up of the New Quang Hue River will be compensated for by the restoration of aquatic habitat in the Old Quang Hue River when it once again conveys water from the Vu Gia to the Thu Bon River.
- There will be an increase in aquatic habitat during the dry season caused by the dredging of the left bank of the Vu Gia River.
- The very localized and temporary effects on surface water quality caused by the construction activities may cause extremely localized and temporary effects on the aquatic ecosystem of the Vu Gia River. Whatever effects that will occur will be temporary, lasting only during the construction phase, and no mitigation measures are required or recommended.

4.6.3 Impacts on Socioeconomic Resources

INFRASTRUCTURE FACILITIES

Cumulative Environmental Effects of Sub-Project Construction Activities on Infrastructure Facilities – MITIGABLE There may be damage caused to existing infrastructure, particularly roads, road signage, and bridges, caused by construction activities associated with implementation of the Project. These impacts are assessed as Mitigable and are presented above in Section 4.3.4.

Quang Hue-Vu Gia River Control Works – POSITIVE The restoration of the dry season hydrological regime to pre-2000 conditions will ensure that:

- water supply to the Cau Do Water Supply Plant for Da Nang City is not affected by salinity intrusion; and
- water will be supplied to the over 40 electric pumping stations that provide irrigation water to nearly 10,000 ha of agricultural production land in the Vu Gia River basin downstream of the Project area.

DOMESTIC AND DRINKING WATER SUPPLY AND QUALITY

The actual construction involved in upgrading the engineering works for the Irrigation Scheme headworks will have no effect on the drinking water supply or quality of the Project.

Change in Water Exchange Between Canals and Shallow Groundwater Systems – INSIGNIFICANT Groundwater is the primary source of domestic and drinking water for most Project beneficiaries (Section 3.4.7). The issue related to groundwater and canal lining relates to changes in groundwater availability for crop

production and possibly also for domestic and drinking water uses. Lining sections of the canal systems will prevent the exchange of canal water with the shallow groundwater systems. This is likely to be most apparent in the dry season. Water levels in the canals throughout the command areas are low during the dry season due to system inefficiencies. There is likely a net movement of water from the shallow groundwater to the canal systems during the dry season at the present time. This flow will be prevented because of canal lining with the Project. This, plus the expected increased availability of irrigation water throughout the command areas during the dry season (particularly at the bottom end of the systems) will increase groundwater levels in the dry season. Little change is expected with the Project in the rainy season. Any shortfalls in shallow groundwater resources in the rainy season that appear as a result of canal lining can be compensated relatively easily by increasing water supply from the canals.

While these Project activities are likely to not have a major effect on domestic and drinking water supply, because the magnitude of these effects can not be predicted and the importance of the groundwater resource to Project beneficiary well-being, monitoring of the ability of beneficiary households to access groundwater for domestic and drinking water purposes is recommended.

Quang Hue-Vu Gia River Control Works – POSITIVE The restoration of the dry season hydrological regime to pre-2000 conditions will ensure that the residents of Da Nang City receive again sufficient quantities of good quality drinking water.

TRANSPORTATION AND NAVIGATION

The roads running along the canals are the main transportation routes for Project beneficiaries, both to getting products to market and to obtain inputs for their economic activities. The upgrading of the canal road systems will make it easier to transport goods and people, increase the quality of products produced by the beneficiaries that are sold at the market and these effects are therefore assessed as Positive.

Improvement of Management Roads Along Main and Primary Canal System – POSITIVE The roads running along the canals are the main transportation routes for Sub-Project beneficiaries, both to getting products to market and to obtain inputs for their economic activities. The upgrading of the canal road system will make it easier to transport goods and people, increase the quality of products produced by the beneficiaries that are sold at the market and these effects are therefore assessed as Positive.

Quang Hue-Vu Gia River Control Works – INSIGNIFICANT The expected effects of the Quang Hue-Vu Gia River Control Works on transportation are:

- The shorter navigation route between the Vu Gia River and Thu Bon River via the New Quang Hue River will disappear with the backfilling of the New Quang Hue River.
- This will be mostly offset by re-opening of the Old Quang Hue River in the dry season, although the navigation distance is greater than it currently is along the New Quang Hue River. However, this will simply be a restoration to pre-2000 conditions; and
- Navigation capacity in the Vu Gia River and Thu Bon River downstream of the Old Quang Hue River will be restored to pre-2000 conditions.

HISTORIC AND CULTURAL RESOURCES

Disturbance from Construction Activities – MITIGABLE While the exact location of each of the cultural and historic sites in the Project Area is known and the locations are maintained in the DoCI offices of each province (Section 3.4.10) the location of many of the Project activities listed in

Table 4 is not yet known in detail. Despite this, it will be possible to mitigate against any possible loss of or damage to the cultural and historical sites listed in Table 17 by adjusting the siting of Project civil works as necessary. It is recommended that this be incorporated into the detailed design of the physical works, in accordance with IDA Operational Policy OP 11.03 – Cultural Property. In addition, it is recommended that terms and conditions be included in the construction contracts to ensure the integrity of these historical and cultural resources.

Quang Hue-Vu Gia River Control Works – MITIGABLE There are no designated historic and cultural resources in the River Control Works area. However, there is a new temple that local residents erected at the beginning of the New Quang Hue River after the events of 2000. This temple is some distance away from the area to be backfilled and so it will not need to be moved. The obvious importance of the temple to the residents of Village No. 9 requires that great care be taken during construction so as to not disturb or damage the temple site.

4.7 Project Impacts During Operational Phase⁵⁸

4.7.1 Impacts on Physical Resources

SURFACE WATER QUALITY

Increase in Application of Fertilizers - MITIGABLE Changes in land use and commodity production (Table 8) will cause more fertilizer to be applied. It is estimated that approximately an additional 150,000 t of fertilizer will be required annually for the entire Project over and above estimates of current fertilizer application without the Project (Table 20), about an increase of about 126%. Without a good database of surface water quality, it is very difficult to even qualitatively predict the environmental impacts of this increased fertilizer use. The very sketchy surface water quality data suggest that the surface water quality of the command areas of most of the Irrigation Sub-Projects is already or close to eutrophic (Section 3.2.3). Therefore this level of incremental inputs may not substantially change the water quality status of the Project Area.

Increase in Application of Pesticides from Changes in Land Use – MITIGABLE Changes in land use and commodity production (Table 8) will cause more pesticides to be applied. It is estimated that an additional 495 tons of pesticides and herbicides will be required annually for the entire Project over and above estimates of current pesticide and herbicide application (Table 21). This is about a 140% increase over estimated current pesticide and herbicide use throughout the Project. This impact is assessed as Unknown but potentially Significant without mitigation or monitoring. Existing baseline information on pesticide concentrations in the Project environment is non-existent and so current conditions can not be estimated, but the expected increase is substantial.

Viet Nam's policy in pest management is stated in its Laws, as the Law on Environment Protection, and the Law on Crime (15/1999/QH10, Article 158). In principle, the legislative framework provides for regulations and guidelines for inspection, production, registration, export/ import, trade in, destruction, and advertisement of pesticides. For dangerous pesticides such as chlorophyll-based substances, special regulations are in place.

Both mitigation and monitoring are recommended for incremental fertilizer and pesticide inputs. With respect to mitigation, IPM extension services should continue to be provided to Project beneficiaries as a part of VWRAP in accordance with the requirements of IDA OP 4.03 – Pest Management Safeguards. Extension services should include the topics of appropriate selection and application of pesticides and herbicides as well as basic techniques of and approaches to IPM. With respect to monitoring, pesticide monitoring in the surface It should be noted that environmental concentrations of pesticides in other agricultural areas of Viet Nam with less crop diversification (and therefore higher risk of pest buildup in mono-crop agricultural systems) and with higher cropping intensity than what is predicted for the command area with the Project are orders of magnitude lower than national or international standards (for example, please see Table 22).

Cumulative Environmental Effects of Sub-Project Operation on Surface Water Quality – MITIGABLE While there is some risk that surface water quality in the command area may change significantly as a result of the operation of the upgraded Irrigation Schemes, this may not be the case with water quality downstream of the command areas. Nutrient and pesticide concentrations will almost certainly change in the surface waters within the Project, particularly in the dry season. This, however, may not significantly affect water quality downstream of

⁵⁸ Unless otherwise stated, the assessments made in this section apply to all of the irrigation Sub-Projects (i.e., Yen Lap, Cam Son-Cau Son, Ke Go, Phu Ninh, Da Ban, and Dau Tieng). The assessment for the Quang Hue-Vu Gia River Control Works is contained in a separate section at the end of the assessment of the impacts of the Irrigation Sub-Projects and is presented only if there is some type of impact predicted (i.e., predictions of No Impact are not presented).

the command areas because of the dilution of pollutants that would occur. However, the absence of surface water quality monitoring information means these predictions are uncertain. It would be prudent to conduct surface water quality monitoring downstream of command areas to confirm assessments of cumulative impact.

GROUNDWATER RESOURCES

Increased Application of Fertilizers – UNKNOWN The shift in land use to more intensive crop production and the increased use of fertilizers may cause shallow groundwater systems to become increasingly eutrophic, but deeper groundwater systems will likely be unaffected. The absence of good groundwater quality baseline information, however, makes assessment of Project impacts on groundwater resources very difficult. Groundwater quality monitoring is recommended within the Project to confirm this assessment.

Increased Application of Pesticides and Herbicides - UNKNOWN As with the increased use of fertilizers, the shift in land use to more intensive crop production and the likely increased use of pesticides and herbicides may cause shallow groundwater systems to become increasingly contaminated; deeper groundwater systems will likely be unaffected. Successful implementation of IPM extension services recommended above will be able to mitigate this potentially negative impact. However, the absence of good groundwater quality baseline information is a severe constraint that makes this impact prediction somewhat uncertain, and periodic pesticide monitoring in shallow groundwater should therefore be a part of the Project monitoring program to confirm this prediction.

4.7.2 Impacts on Biological Resources

TERRESTRIAL ECOSYSTEMS AND TERRESTRIAL BIODIVERSITY

Changes in Land Use - INSIGNIFICANT There will be no conversion of natural terrestrial ecosystems into agricultural land. In addition, because the command area contains no natural terrestrial ecosystems but only what can best be considered as highly modified and simple terrestrial “ecosystems” in the form of agricultural land, any changes in land use to more intensive agriculture will be an insignificant effect of the Project on terrestrial ecosystems.

AQUATIC ECOSYSTEMS AND AQUATIC BIODIVERSITY

Increase in Application of Fertilizers - MITIGABLE Any changes in the eutrophic status of surface waters of the Project Area caused by increases in fertilizer use (Table 20) as a result of changes in land use and commodity production (Table 8) may negatively affect the integrity of the aquatic ecosystems of the Project. Mitigation and monitoring recommendations made above pertaining to provision of extension services for fertilizer pesticide use and IPM apply here as well and would likely mitigate any negative effects on aquatic ecosystems.

Application of Herbicides and Pesticides - MITIGABLE The application of pesticides and herbicides will increase with implementation of the Project (Table 21). There is an extensive world literature on the effects of biocides on aquatic resources. There have been no monitoring programs or even surveys of bioaccumulation of biocides in aquatic resources in the Project Area and so predictions of the magnitude of any impacts of biocides on aquatic resources in the Project are difficult to make given the absence of baseline data, although first effects would likely be seen as bioaccumulation. Mitigation and monitoring recommendations made above pertaining to provision of extension services for pesticide use and IPM apply here as well and would likely mitigate any negative effects on aquatic ecosystems.

Cumulative Environmental Effects of Sub-Project Operation Activities on Aquatic Ecosystems - Effects on aquatic ecosystems downstream of the command area would be indirect and mediated through changes in surface water quality. As the effects of the Project on surface water quality outside of the Project Area are assessed to be likely insignificant (save for perhaps incremental effects of municipal and industrial water use, Section 4.3.6), it is also likely that the impacts of the Project on aquatic ecosystems downstream of the command areas will also be significant. Again, however, the absence of any surface water quality or aquatic resources monitoring information means that these predictions are essentially uncertain. The recommended surface water quality monitoring downstream of the command areas will enable these assessments of insignificant cumulative impact to be confirmed.

NATURE RESERVES AND PROTECTED AREAS

Changes in Salinity Intrusion (Dau Tieng) – NO IMPACT There will be no impact of the Dau Tieng Sub-Project on the Can Gio Biosphere Reserve at the mouth of the Sai Gon River from changes in salinity intrusion. Increased dry season flow will limit the extent of salinity intrusion but the Biosphere Reserve will not be affected by this as it will still be under complete salinity intrusion during the dry season.

Table 20: Estimated incremental inputs of fertilizer required for VWRAP.

Land Use	Fertilizer Required (t/ha) ⁵⁹	Cultivated Area ⁶⁰ (ha)			Predicted Fertilizer Applied (t)		
		Current	With Project	Increment	Current	With Project	Increment
WS Rice	0.65	47,252	81,348	34,096	30,714	105,752	75,039
SA Rice	0.65	60,557	81,078	20,521	39,362	105,401	66,039
Monsoon Rice	0.65	32,892	11,540	-21,352	21,380	15,002	-6,378
Peanut	0.55	21,077	21,117	40	11,592	11,614	22
Maize	0.55	7,710	16,162	8,452	4,241	8,889	4,649
Vegetables	0.65	4,731	6,968	2,237	3,075	9,058	5,983
Sugarcane	0.4	6,536	9,150	2,614	2,614	3,660	1,046
Soybean	0.65	813	5,395	4,582	528	3,507	2,978
Sweet Potato	0.55	5,030	3,834	-1,196	2,767	2,109	-658
Tobacco	0.65	3,660	5,122	1,462	2,379	3,329	950
Total		190,258	241,714	51,456	118,652	268,321	149,670

Table 21: Estimated incremental inputs of pesticides required for VWRAP.

Land Use	Pesticide Required (kg/ha) ⁶¹	Cultivated Area (ha)			Predicted Pesticide Applied (t)		
		Current	With Project	Increment	Current	With Project	Increment
WS Rice	2	47,252	81,348	34,096	95	325	231
SA Rice	2	60,557	81,078	20,521	121	324	203
Monsoon Rice	2	32,892	11,540	-21,352	66	46	-20
Peanut	1.2	21,077	21,117	40	25	51	25
Maize		7,710	16,162	8,452	9	19	10
Vegetables		4,731	6,968	2,237	6	8	3
Sugarcane	1.2	6,536	9,150	2,614	13	37	24
Soybean	2	813	5,395	4,582	1	13	12
Sweet Potato	1.2	5,030	3,834	-1,196	10	15	5
Tobacco	1.2	3,660	5,122	1,462	4	6	2
Total		190,258	241,714	51,456	350	844	495

Table 22: Results of organochlorine pesticide sampling in the O Mon Xa No Sub-Project in 2001 dry season. These data were gathered as part of Crd-3198: Mekong Delta Water Resources Project. The agriculture area of O Mon Xa No Sub-Project is about 36,000 ha, the cropping intensity is 260%, and triple cropping is practiced on 78% of the agriculture land.

Station	Pesticides	Surface Water Concentration (µg/L)	Total (µg/L)	National Standard (µg/L)
OX01	DDE	0.015	0.033	150
	HCHg	0.008		
OX02	HCHd	0.015	0.020	
	HCHg	0.005		
OX03	Parathion	0.024	0.034	
	DDT	0.010		
OX04	DDE	0.020	0.035	
	Quitozen	0.015		
OX05	HCHg	0.080	0.105	
	HCHd	0.025		
OX06	HCHd	0.020	0.020	
OX07	HCHd	0.020	0.035	
	HCHg	0.015		
OX08	DDE	0.008	0.008	

⁵⁹ Unit fertilizer inputs are taken from the economic analyses conducted for the final VWRAP PFS submitted to MARD in March 2003.

⁶⁰ From Table 8,

⁶¹ Increases in pesticide inputs with the Sub-Project are assumed to be proportionately the same as increases in fertilizer inputs with the Sub-Project.

4.7.3 *Impacts on Socioeconomic Resources*

DOMESTIC AND DRINKING WATER SUPPLY AND QUALITY

Increased Supply of Domestic and Drinking Water – POSITIVE The Sub-Project will provide a reliable supply of drinking water to numerous rural and urban residents in all Sub-Projects.

Increased Use of Fertilizer and Pesticide – MITIGABLE Degradation of groundwater resources that may occur as a result of increased application of fertilizer and pesticides may negatively affect domestic and drinking water quality. Project effects on drinking and domestic water quality will depend on the source of water used for drinking and domestic water:

- Those households that rely on deep groundwater aquifers for drinking and domestic water supply will almost certainly be unaffected by any Project activities because the deepness of the wells and their relative disconnectedness of these aquifers from the surface situation; while
- Those households that rely on shallow groundwater aquifers for drinking and domestic water supply may be affected by the Project. Potential impacts are increases in nutrient and pesticide contamination.

Successful application of IPM extension services will ameliorate any negative effects of increased application of chemical inputs to domestic and drinking water quality. The effects monitoring recommended for groundwater resources will enable confirmation of these assessments and of the success of the IPM extension services.

Quang Hue-Vu Gia River Control Works – POSITIVE The restoration of the dry season hydrological regime to pre-2000 conditions will ensure that the water supply to the Cau Do Water Supply Plant for Da Nang City is not affected by salinity intrusion.

4.8 Main Conclusions of Impact Assessment

The following are the main conclusions of the VWRAP impact assessment:

- VWRAP is environmentally feasible. The Sub-Project will have a number of significant positive benefits:
 - Increase in beneficiary income and reduction of poverty throughout the command area through improved and reliable water supply for agricultural production and domestic use; and
 - Increases in employment and labor in a region with very high levels of unemployment and underemployment.
 - With respect to the Quang Hue-Vu Gia River Control Works, restoration of hydrological conditions to pre-2000 conditions enabling a restoration of water supply to Da Nang City and to Hoi An District for agriculture and aquaculture uses;
- All of the potentially significant environmental impacts identified in the impact assessment can be mitigated and they are described below in Chapter 5: Environmental Management Plan.
- These conclusions apply to both phases of investments for the Irrigation Schemes: (i) first phase of investments consisting of headworks, main and primary canals and the two pilot areas that consist of secondary, tertiary and on-farm canal systems off the main and primary canals and which contain a total of about 20% of the total command areas; and (ii) the remaining 80% of the command areas.
- At this stage of VWRAP design, it is expected that no separate environmental assessment will be required for the second phase of investments;
- The programmatic framework for the environmental component of the second phase of investments needs to consist of a detailed design of the Environmental Management Plan (Chapter 5) for the remaining 80% of the command area based on the findings of the environmental management program for the first phase of investments and the actual engineering works in the second phase of investments; and
- The detailed design of the Environmental Management Plan (Chapter 5) for the remaining 80% of the command area should be done concomitant with the detailed technical and engineering design for the second phase of investments.

4.8.1 *Summary of Bank Operational Policies in Regards to VWRAP*

A summary of the IDA operational policies in regards to VWRAP is provided in Table 23.

Table 23: Application of IDA Environmental and Social Safeguard Policies to VWRAP.

Bank Operational Policy	Summary of Assessment and Rationale	Recommendations
OP 4.01 – Environmental Assessment – Triggered	<ul style="list-style-type: none"> While VWRAP is classified as Category A, requiring a full-scale environmental assessment, the results of this EIA indicate that the scale and magnitude of the expected environmental impacts of VWRAP are more like that of a Category B project. Environmental impacts of VWRAP are site-specific, none are irreversible; very few direct impacts are on environmentally important areas such as wetlands, forests, or other natural habitats, all are preventable, and mitigation measures have been designed for all possible environmental impacts 	<ul style="list-style-type: none"> Implement VWRAP Environmental Management Plan
OP 4.04 – Natural Habitats – Triggered	<ul style="list-style-type: none"> no impacts predicted for catchments of Irrigation Scheme reservoirs, where all of the intact natural terrestrial habitats of the Project Area occur (except Yen Lap, see below) There may be loss of natural habitats from excavation of soil to be used as earth-fill. There will be loss of natural habitats in the Yen Lap Watershed Protection Forest from the construction of the emergency spillway Yen Lap, Ke Go, Phu Ninh, and Da Ban Sub-Projects will provide increased water supply to expanding provincial coastal aquaculture programs which were not assessed for possible environmental impacts. There may be a risk of losing coastal wetland resources. 	<ul style="list-style-type: none"> Mitigation required to rehabilitate and restore all areas of excavation to conditions prior to construction reforestation of 20 ha within Yen Lap Watershed Protection Forest as compensation Environmental review of Quang Ninh, Ha Tinh, Quan Nam, Khanh Hoa provincial aquaculture programs to prepare guidelines for ensuring coastal aquaculture is environmentally sustainable Monitoring of water quality in estuarine areas of Yen Hung (Quang Ninh), Thach Ha (Ha Tinh), Nui Thanh (Quang Nam) and Ninh Hoa (Khanh Hoa) Districts is recommended as part of environmental effects monitoring program
OP 4.36 – Forestry – Triggered	<ul style="list-style-type: none"> 10 ha of Yen Lap Watershed Protection Forest will be lost as a result of construction of the new emergency spillway There may be loss of natural habitats in the Duong Minh Chau and Boi Loi Local Nature Reserves from the completion of the canal system 	<ul style="list-style-type: none"> reforestation of 20 ha within Yen Lap Watershed Protection Forest as compensation Reforestation of Duong Minh Chau and Boi Loi Local Nature Reserves to compensate for losses of natural habitats
OPN 11.03 – Cultural Property - Triggered	<ul style="list-style-type: none"> impacts are assessed as Unknown because, while the exact location of the each of the cultural and historic sites in the Project is known, the specific location of the Project activities is not yet known in detail, particularly for the second phase of investments. 	<ul style="list-style-type: none"> Mitigation recommended against any possible loss of or damage to nationally or locally designated cultural and historical sites by adjusting the siting of Project civil works if necessary; to be incorporated into the detailed design of the physical works terms and conditions be included in construction contracts to ensure integrity of these historical and cultural resources
OP 4.12 – Involuntary Resettlement – Triggered	<ul style="list-style-type: none"> while there is no requirement for resettlement, there is a requirement to pay compensation for permanent and temporary land acquisition 	<ul style="list-style-type: none"> Resettlement and Compensation Action Plan prepared as part of VWRAP Feasibility Study
OP 4.37 – Safety of Dams – triggered	<ul style="list-style-type: none"> Upgrading Dam safety a major component of first investment phase. Specific engineering works are provided for increasing dam safety. Dam Emergency Preparedness Plans also prepared 	
OP 4.20 – Indigenous Peoples – Triggered	<ul style="list-style-type: none"> There are some members of recognized ethnic minority groups living in the command areas of most of the Irrigation Scheme Sub-Projects 	<ul style="list-style-type: none"> Ethnic Minority Development Plans prepared as part of VWRAP Feasibility Study
OP 4.03 – Pesticide Management – Triggered	<ul style="list-style-type: none"> It is estimated that an additional 495 t of pesticides and herbicides will be required annually for the entire Project over and above estimates of current pesticide and herbicide application. This is about a 141% increase over estimated current pesticide and herbicide use throughout the VWRAP Area. This impact is assessed as Unknown but potentially Significant without mitigation or monitoring. Existing baseline information on pesticide concentrations in the Project environment is non-existent and so current conditions can not be estimated, but the expected increase is substantial, particularly as 59% of VWRAP beneficiaries have not yet received training in IPM methods. 	<ul style="list-style-type: none"> Both mitigation and monitoring are recommended. With respect to mitigation, IPM extension services should continue to be provided to Project beneficiaries as a part of the Project in accordance with the requirements of IDA OP 4.03. Extension services should include topics of appropriate selection and application of biocides as well as basic techniques of and approaches to IPM.

Table 23: Application of IDA Environmental and Social Safeguard Policies to VWRAP., continued

BANK OPERATIONAL POLICY	SUMMARY OF ASSESSMENT AND RATIONALE	RECOMMENDATIONS
OP 7.60 – Projects in Disputed Areas – Not Triggered	<ul style="list-style-type: none"> • Not triggered as none of the Project Area or the area of influence of the Project is part of a territory whose jurisdiction is disputed by another country 	
OP 7.50 – International Waterways – Not Triggered	<ul style="list-style-type: none"> • Not triggered as: <ul style="list-style-type: none"> – None of the water bodies associated with any of the VWRAP components assessed in this EIA form a boundary between, or flow through the territory of another country; – None of the water bodies associated with any of the VWRAP components assessed in this EIA are a any tributary or component of any waterway described above; and – None of the water bodies associated with any of the VWRAP components assessed in this EIA are recognized as a necessary channel of communication between the open sea and other states countries or of any river flowing into such waters. 	

5: ENVIRONMENTAL MANAGEMENT PLAN

This Chapter presents the Environmental Management Plan (EMP) for VWRAP. The purpose of the VWRAP EMP is to provide clear guidance on how to ensure the Sub-Project:

- complies with Vietnamese environmental laws, environmental commitments, and IDA environment policies throughout pre-construction, construction, and operation phases;
- employs a suitable organizational framework for environmental protection throughout pre-construction, construction, and operation;
- manages and monitors mitigation measures described in the MoNRE and IDA-approved EIA report;
- can provide emergency response mechanisms to unanticipated environmental issues;
- allocates appropriate financial resources to implement the EMP; and
- undertakes the transition in environmental management and protection from the first to the second phase of investments.

To achieve these objectives, the EMP contains:

- the Vietnamese legal and administrative framework under which the EIA will be approved and the EMP will be implemented;
- IDA's EIA approval requirements;
- significant adverse environment impacts that are anticipated in all phases of the first and second phase of investments – pre-construction; construction; and operation - and a mitigation program for impact avoidance, minimization, rectification, or compensation;
- a program to monitor the performance and effectiveness of the mitigation program;
- a monitoring program to assess the overall environmental effects of the Sub-Project on the environmental resources of the Sub-Project area and the associated area of influence;
- An organizational framework for the effective implementation of the mitigation and monitoring programs, including: collection of environmental information related to the Sub-Project, management, and reporting; project management decisions on the environment; implementation of project management decisions; and external review of EMP activities. This organizational framework contains implementation arrangements, implementation schedule, and responsibilities for the EMP;
- EMP reporting requirements;
- a programmatic framework which specifies how the specific mitigation and monitoring activities associated with the second phase of investments are to be designed in detail and implemented during overall VWRAP implementation;
- cost estimates for each component of the EMP;
- requirements for technical assistance to support implementation of the Environmental Management Plan including supervision of mitigation and monitoring and training.

The EMP is the “master document” from which all other environment-related project documents and actions are guided. This includes construction method statements, tender documents, contractor specifications, general conditions of construction contract, site environmental management plans, ToRs for environmental specialists, and allocation of budgets for environmental protection and monitoring. If an ambiguity exists on how to deal with environmental issues in any project documents or activities, the EMP shall serve as the authoritative reference document.

Any major changes to VWRAP or the legal and administrative frameworks under which it operates may require that MARC provide addenda to the EMP. These addenda should be reviewed and approved by MoNRE.

5.1 Vietnamese Legal and Administrative Framework

5.1.1 *The Legal Framework for Environmental Management*

Viet Nam's framework for environmental management continues to rapidly evolve, with new policies being produced every year. This section introduces the Viet Nam's relevant environmental policies.

Law on Protection of the Environment (LEP) was enacted in 1993. The LEP:

- Identifies the responsibilities of the state centre, provinces, organizations and individuals to prevent and remedy environmental deterioration and pollution and carry out specified environmental protection functions;
- Provides for the development of environmental standards and submission of environmental impact

- assessment reports on new and existing facilities;
- Provides for responsible parties to pay compensation for environmental damage;
- Establishes the right of individuals and organizations to petition for enforcement of environmental regulations;
- Calls for civil and criminal penalties for violations; and
- Encourages international environmental co-operation.

Decree 175/CP was promulgated in 1994 to guide implementation of the LEP and provides broad guidelines for division of responsibility among Ministries; environmental impact assessments; pollution prevention and disaster control; sources of finance; and environmental inspections and standards.

Circular No. 490 was promulgated in 1998 to provide guidance on setting up and appraising environmental impact assessment reports for investment projects. The Circular identifies the legal requirements according to the stages of implementation of a project and its category; defines the content of project subject to the EIA procedures; and specifies management of the EIA report appraisal.

To supplement the above policies a large range of decisions, regulations, and standards may also be considered.

Decree 24/2000/ND-C specifies the implementation on the Law on Foreign Investment in Viet Nam (Article 82) concerning environmental protection as follows: 1) enterprises with foreign investment capital and joint ventures are obligated to observe regulations, satisfy standards in environment protection, and comply with Vietnam legislation on environment protection; 2) if investors apply international advanced environmental standards these standards should be registered with MoNRE.

Resolution No. 5/1997/QH10 identifies projects of national importance to be approved and decided by the National Assembly (Provision 2, Article 2) as "projects which result in major or potentially serious impacts on the environment". For these projects, one of the contents to be submitted to the National Assembly for approval and decision on investment is "fundamental issues that need to be solved in the project implementation: environment protection, population movement/resettlement..."

Decree 52/1999/ND-CP was appended to include environmental considerations for construction management as follows: 1) for PFS, Provision 3 of Article 23 stipulates that requirements for environment study relating to the "selection of construction sites, estimation of land use area needed, in ways which comply to the principle of minimizing land use and environmental and social impacts, and resettlement to the lowest possible level". 2) Provisions 4 and 7 of Article 24 stipulate that FS must propose "specific site options (or regions, routes) which much match with construction plans (including documents on site selection, together with proposed solutions for minimizing environmental and social impacts)," and "architectural alternatives, construction solutions, preliminary designs suggested for selection, environment management and protection solutions". 3) For technical design: Section B, Provision 1, Article 37 and Section A, Provision 2, Article 38, contain regulations on appraisal and approval of "techniques for the protection of environment and ecology; for prevention and combating of explosion and fire and for occupational safety and industrial sanitation."

Decree 26/1996/CP provides regulations on the punishment of administrative violation of Environmental Protection Law. Chapter 1 describes the general provisions for punishment under the Environment Protection Law. Chapter 2, Article 6 details recommended punishments for parties who violate environmental pollution and prevention act. These punishments include financial penalties for not submitting an EIA report.

Tiêu Chuẩn Việt Nam (TCVN) are national standards established by MoNRE and applied to all government agencies. They include engineering, construction, scientific, and environmental standards. The environmental standards include acceptable limits of many air, noise, and water quality parameters. In general, the list of biophysical parameters is broad enough such that most monitoring programs can employ TCVN standards as metrics of evaluation. There are some exceptions — of most importance to VWRAP, sediment, soil, and vibration standards do not yet exist. Most TCVN standards are direct translations of ISO standards.

Pesticide and Herbicide Regulations are numerous but the key legal instruments for regulating use of pesticides and herbicides include

- Decision No.933-NN/BVTV/QD of the old Ministry of Agriculture and Food Industry dated 28 October 1995 - Registration of pesticides which are allowed to use and/ or limited in use in Viet Nam;
- Decision No.229-NN/BVTV/QD of MARD, dated 12 December 1995 and Circular No.724-NN-BVTV/CV of MARD, dated 22 December 1995 - Registration of chlorophyll-based substances allowed for use in agriculture in Viet Nam;
- Regulation No.367-NN-BVTV/CV of the Department of Plant Protection, dated 19 June 1996 - Registration on use of pesticides which are limited to use in Viet Nam; and
- Directive 29/1998/CT-TTg - Measures on management of pesticides.

5.1.2 The Administrative Framework for Environmental Management

The country's administrative framework is undergoing substantial restructuring. The Government of Viet Nam is in the process of creating a new administrative framework for environmental management. For VWRAP, the framework's relevant institutions are as follows:

Ministry of Natural Resources and Environment (MONRE). MONRE was established by a Prime Ministerial Decision on November 11, 2002. This new ministry will include four vice-ministers and 16 departments. The new MoNRE will merge numerous departments from several national agencies. These are outlined in Decree 91/2002/ND-CP: Providing for the functions, duties, powers and organizational structure of the Ministry of Natural Resources and the Environment.

Environmental Impact Assessment and Appraisal Department. This Department is under MoNRE. According to Decree 91/2002/ND-CP, the Department's function includes: To appraise environmental impact assessment reports of projects and of business and production establishments; to issue environmental standards; and to carry out uniform management of the issue and revocation of certificates of eligibility of environmental standards in accordance with the law. It is expected that the Environmental Impact Assessment and Appraisal Department will be guided by the Vietnam's established regulatory framework.

Provincial Departments of Science, Technology and Environment (DOSTE). The Environmental Management Division (EMD) of each provincial DOSTE is responsible for ensuring environmental protection and management of provincial matters in accordance with LEP, Decree 175, and Circular 490. The decision to restructure DoSTEs will likely occur in 2003, after decisions have been made on how to restructure MONRE at the central level. It is expected that regardless as to where EMD is housed, its environmental protection function will remain intact. For this reason, the EMD will likely remain a key partner to the successful monitoring and implementation of the Project.

5.1.3 Vietnamese Environmental Requirements

The largest component of VWRAP is the upgrading of six Irrigation Schemes, many of which irrigate more than 20,000 ha. Due to the Project's large irrigation area, MARD is required to submit a detailed EIA report to MoNRE's Environmental Impact Assessment and Appraisal Department. The format for the detailed EIA report format is found in Appendix II of CP 175. MARD is required to submit this report with CP 490's Annex IV.I: *Application for Appraisal of EIA Report*.

Once the report is received, MoNRE will establish a committee to review and evaluate the Project's potential impacts and mitigation measures. The committee traditionally includes DoSTE and/or PC representatives from the affected provinces, senior technical experts from central-level organizations, and selected MoNRE staff. The committee will review the detailed EIA and provide written comments to MoNRE. According to Section III (5) of CP 490, appraisal of the EIA report is due within 60 days of the date a sufficient and eligible document of the EIA report is received by the relevant Government Management Agencies of Environmental Protection. In case that the EIA report is unsatisfactory, the EIA report appraisal agencies have 5 days of the date the EIA report is received to notify the proponent requirements for adjustment or addition. Within 10 days following the date of the EIA report is approved, the relevant appraisal agencies will issue a decision on the approval of the EIA report of a proposed project. The format for a MoNRE decision on EIA reports is found in Annex V of CP 490. An original copy of this decision is the clearest indication that a project has been subject to a legally-sanctioned environmental assessment process.

5.2 IDA Environmental Requirements

IDA considers VWRAP as "Category A" ("*projects with significant adverse environmental impact*"). The EIA will be submitted to the appropriate IDA department for review and to the IDA Board of Directors at least 120 days prior to loan approval.

5.3 Overall Approach to Implementation

The VWRAP EMP is an amalgamation of seven Environmental Management Plans, one for each Irrigation Scheme Sub-Project as well as one for the Quang Hue-Vu Gia River Control Works. Local institutions (see below) will implement the individual Environmental Management Plans under the direction of the national VWRAP implementing agency. Implementation support will be through by technical assistance provided under the VWRAP Training and Capacity Building and Design and Supervision Technical Assistance Funds to ensure

proper implementation of the individual EMPs and to address overarching environmental issues of VWRAP that transcend individual Sub-Projects.

The implementation of VWRAP EMP will follow the implementation of the overall Project. VWRAP will begin with a Detailed Engineering Design (Pre-Construction) Phase for the first phase of investments (i.e., headworks, main and primary canals, pilot areas, and non-agricultural uses of the water resources provided by the Irrigation Schemes), followed by a Construction Phase and an Operational Phase for the first investment phase. During the Construction Phase for the first investment phase, the Detailed Engineering Design Phase will be implemented for the second phase of investments (i.e, the remainder of the command areas, exclusive of the pilot areas), followed by the Construction and Operational Phases for the second investment phase.

The implementation of VWRAP EMP will follow the same pattern. The final design of VWRAP EMP for the first investment phase will be completed at the same time as the Detailed Engineering Design for the first investment phase. VWRAP EMP for the first investment phase will then be implemented during the Construction and Operational Phases of the first investment phase. Similarly, the final design of VWRAP EMP for the second investment phase will be completed at the same time as the Detailed Engineering Design for the second investment phase based on the overall VWRAP Sub-Project EMP as outlined in this EIA and the lessons learned and results from the first investment phase. VWRAP EMP for the second investment phase will then be implemented during the Construction and Operational Phases of the second investment phase.

5.4 Institutions Responsible for Implementing the VWRAP EMP

The VWRAP EMP will be implemented within a comprehensive organizational framework under the overall VWRAP Project. VWRAP will engage several ministries, departments, and institutes, it will create a project management unit within MARD in Ha Noi (PMU) and Sub-Project Implementation Units (SIUs) in each province, and there will be linkages between these units and other existing institutions at the national, provincial, district, and commune levels. The following institutions will be responsible for the successful implementation of the VWRAP EMP:

VWRAP PMU – responsible for overall VWRAP implementation management and will contain environmental safeguard staff. VWRAP PMU will be responsible for overall quality assurance of EMP implementation.

Sub-Project PMUs –will be responsible for daily implementation activities of VWRAP. At the sub-implementation level, provincial management units (PMUs) will be established and staffed by personnel from provincial DARD offices and the particular IMCs. MARD SIOs will implement inter-provincial works or complicated works beyond the capacity of the PMUs. These institutions will supervise and control the quality of construction and physical implementation of the individual Sub-Project EMPs. The arrangements will be:

- Dau Tieng Headworks and Main Canals: MARD SIO 416
 Canal System: Tay Ninh PMU
- Da Ban Headworks: MARD SIO 414
 Canal System: Khanh Hoa PMU
- Phu Ninh Quang Nam PMU
- Quang Hue-Vu Gia MARD SIO 408
- Ke Go Ha Tinh PMU
- Yen Lap Headworks, Siphon, Cat Hai: MARD SIO 403
 Canal System: Quang Ninh PMU
- Cam Son-Cau Son Bac Giang PMU

For the purposes of this Environmental Management Plan, the term Sub-Project Implementation Unit (SIU) is used as a general term for any one of these organizations.

Vietnamese Environmental Regulators – MoNRE and provincial/city DoSTEs will be responsible for all regulatory reviews and approvals of VWRAP in accordance with the national legal framework for environmental protection and management.

Provincial and City Organizations – Other provincial/city departments will have important responsibilities such as implementing specific components of the mitigation program (IPM), ensuring their particular safeguards are being properly implemented (i.e. DoCIs) and providing supplementary and secondary data to assist in the implementation of the Sub-Project EMPs (e.g., land use and commodity production data).

IDA – IDA will review the implementation of the overall VWRAP EMP. Problems and issues that are identified will be raised to MARD as part of the regular VWRAP review process.

Environmental Safeguard Contractors – An Environmental Safeguard Contractor will be selected from the numerous national environmental consultant organizations in Viet Nam. The Environmental Safeguard Contractor will act as general contractor for primary data collection surveys and for preparation and submission of various compliance and effects monitoring assessment reports. They will also be responsible for undertaking some of the specific mitigation measures for VWRAP.

Consultant Environmental Specialists - some of the resources of the Design and Supervision Technical Assistance under VWRAP will be used to engage two environmental specialists who will take on substantial implementation tasks for the EMP: (i) the Consultant's international environment specialist; and (ii) the Consultant's national environmental specialist seconded from a nationally-recognized environmental management institution. The secondment could be in the form of a fixed-term, renewable contract during pre-construction, construction, and operation phases. It is expected that the services of the Consultant's international environment specialist will be required for VWRAP implementation until the completion of the Detailed Design of the VWRAP EMP for the second phase of investments, at which time sufficient training and capacity building will have been given that remaining institutions and personnel will be able to implement the remainder of VWRAP EMP. In this EMP, it is assumed that the Detailed Engineering Design for the second investment phase will occur in the third year of VWRAP implementation.

5.5 VWRAP Environmental Mitigation Program

Table 30 contains the environmental mitigation program for VWRAP, based on the assessment of environmental impacts contained in Chapter 4: Impact Assessment. Table 30 is organized according to the different phases of the Sub-Project – pre-construction, construction, and operation – for each of the two investment phases.

5.6 VWRAP Environmental Mitigation Compliance Monitoring Program

The Environmental Mitigation Compliance Monitoring Program is designed to determine if the environmental mitigation measures for the Sub-Project (Table 30) are being implemented properly and are having the intended effects of avoiding, limiting, or rectifying negative environmental impacts. If mitigation compliance monitoring indicates that mitigation measures are not being implemented effectively or are not being effective, the appropriate responsible institutions will need to take corrective action.

Table 31 Table 31 describes the Environmental Mitigation Compliance Monitoring Program for VWRAP.

5.7 VWRAP Environmental Effects Monitoring Program

The Environmental Effects Monitoring Program for VWRAP will measure ambient biotic and abiotic indicators of Sub-Project activities on the environmental resources of the Sub-Project Area and the associated area of influence. Chapter 4: Impact Assessment describes a number of instances in which it is necessary to monitoring environmental conditions to determine if the Sub-Project is having any effects on the environment and the magnitude of those effects. The results of the Environmental Effects Monitoring Program will be used, if necessary, to modify the Sub-Project design or implementation to reduce unexpected environmental impacts and to confirm the predictions about Sub-Project environmental impacts made in this EIA. Table 32 describes the Environmental Effects Monitoring Program for VWRAP.

5.8 Reporting Requirements for VWRAP EMP

Table 24 summarizes the reporting requirements for VWRAP and the institutional responsibilities for preparing these reports. All annual reports produced as part of VWRAP EMP will be required to contain:

- An assessment of the success of mitigation activities or an assessment of the actual environmental effects of Sub-Project implementation in comparison to predictions made in the original EIA (in the case of environmental effects monitoring);
- An explicit assessment as to whether the existing EMP framework is sufficient or not; and
- If it is concluded that the existing EMP framework is not sufficient, a description of the reasons why it is not sufficient and a detailed set of recommendations for re-design of the EMP framework, complete with revisions to data and information to be gathered, data analysis to be performed, reporting, and budgets.

Table 24: Reporting requirements for VWRAP Environmental Management Plan.

Report	Responsibility for Preparation	Frequency	Institutions for Review and Approval
Reports Prepared Once During EMP Implementation in Target Provinces			
Environmental Review of Provincial Aquaculture Programs and Associated Environmental Action Plan	Environmental Safeguard Contractor supported by Consultant Environmental Specialists	Prepared during first year of VWRAP implementation	VWRAP PMU, MARD, IDA, DoFIs, DoSTEs, MoNRE
Detailed Design Documents for Sub-Project Environmental Management Plans: First Investment Phase	Consultant Environmental Specialists , supported by Environmental Safeguard Contractors and SIUs	Once, during first year of VWRAP implementation, prior to initiation of construction	SIUs, VWRAP PMU, IDA, MARD, MoNRE, Provincial/City DoSTEs
Detailed Design Documents for Sub-Project Environmental Management Plans: Second Investment Phase	Environmental Safeguard Contractors , supported by Consultant Environmental Specialists and SIUs	Once, in year immediately prior to implementation of investments in remaining 80% of command areas	SIUs, VWRAP PMU, IDA, MARD, MoNRE, Provincial/City DoSTEs
Detailed Design Documents for VWRAP Environmental Management Plan: First Investment Phase	Consultant Environmental Specialists , supported by Environmental Safeguard Contractors and SIUs	Once, during first year of VWRAP implementation, prior to initiation of construction	SIUs, VWRAP PMU, IDA, MARD, MoNRE, Provincial/City DoSTEs
Detailed Design Documents for VWRAP Environmental Management Plan: Second Investment Phase	Environmental Safeguard Contractors , supported by Consultant Environmental Specialists and SIUs	Once, in year immediately prior to implementation of investments in remaining 80% of command areas	SIUs, VWRAP PMU, IDA, MARD, MoNRE, Provincial/City DoSTEs
Canal Lining Schedule and Detailed Implementation Plans: First Investment Phase	SIUs	Once, during first year of VWRAP implementation, prior to initiation of construction	Provincial/City PPC, VWRAP PMU, IDA, MARD, MoNRE, affected communes and villages
Canal Lining Schedule and Detailed Implementation Plans: Second Investment Phase	SIUs	Once, in year immediately prior to implementation of investments in remaining 80% of command areas	Provincial/City PPC, VWRAP PMU, IDA, MARD, MoNRE, affected communes and villages
Program Document for Environmental Governance of Industrial Pollution Control	Consultant Environmental Specialists , supported by Environmental Safeguard Contractors and Provincial/City DoSTEs	Once, prior to first year of operation	VWRAP PMU, IDA, MARD, MoNRE
Regular Reports During EMP Implementation in Target Provinces			
Annual Report on Implementation of Control Program for Aquatic Weeds in Phu Ninh and Dau Tieng Irrigation Schemes	Environmental Safeguard Contractor	Annual for each year that control program for aquatic weeds is implemented	Phu Ninh IMC, Dau Tieng IMC
Annual Reports on Implementation of IPM Program in Command Area Communes	Provincial/City DARDs	Annual for each year that IPM program extension services are provided	SIUs
Sub-Project Mitigation Compliance Progress Reports	Environmental Safeguard Contractors supported by Consultant Environmental Specialists	Monthly	SIUs
Annual Report on Implementation of Environmental Governance of Industrial Pollution Control Program	Provincial/City DoSTEs	Annually for four years	VWRAP PMU, IDA, MARD, MoNRE
Sub-Project Environmental Mitigation Compliance Monitoring Reports	Environmental Safeguard Contractors , supported by Consultant Environmental Specialists for first three years, and supported by SIUs throughout Sub-Project implementation	Annual during construction period	SIUs, VWRAP PMU, IDA, MARD, MoNRE, Provincial/City DoSTEs
Sub-Project Environmental Effects Monitoring Progress Reports	Environmental Safeguard Contractors supported by Consultant Environmental Specialists	Six months into each year	SIUs, VWRAP PMU, IDA, MARD, MoNRE, Provincial/City DoSTEs
Sub-Project Environmental Management Reports, integrating all results from Sub-Project EMP (mitigation, mitigation compliance monitoring, and environmental effects monitoring) into a single annual report	Consultant Environmental Specialists , supported by Environmental Safeguard Contractors for first three years and Environmental Safeguard Contractors supported by Consultant Environmental Specialists for remainder of implementation	Annual, beginning with pre-construction of first phase of investments	SIUs, VWRAP PMU, IDA, MARD, MoNRE, Provincial/City DoSTEs

Table 25: Reporting requirements for VWRAP Environmental Management Plan. continued

Report	Responsibility for Preparation	Frequency	Institutions for Review and Approval
Regular Reports During EMP Implementation in Target Provinces, continued			
VWRAP Environmental Management Reports, integrating all results from Sub-Project EMP reports, (mitigation, mitigation compliance monitoring, and environmental effects monitoring) into a single annual report	Consultant Environmental Specialists, supported by Environmental Safeguard Contractors for first three years and Environmental Safeguard Contractors supported by Consultant Environmental Specialists for remainder of implementation	Annual, beginning with pre-construction of first phase of investments	SIUs, VWRAP PMU, IDA, MARD, MoNRE, Provincial/City DoSTEs
Periodic Reports Required As Needed			
Technical Design of Revised Sub-Project Environmental Management Plan	Consultant Environmental Specialists, supported by Environmental Safeguard Contractors, and SIUs, depending on nature of redesign that is required	Required every time modification of EMP is required	IDA, SIUs, VWRAP PMU, MARD, MoNRE, Provincial/City DoSTEs

The technical and planning reports (Table 24) will be supported by a broad range of administrative policies and contractual agreements. They include but are not restricted to: (i) Inception reports; (ii) terms of reference; (iii) contractor specifications for environmental protection and mitigation; (iv) general Conditions of Contract for protection of the environment; and (v) site Environmental Management Plans produced by construction contractors.

Both the VWRAP PMU Environmental Specialist, on behalf of the VWRAP PMU, and the respective SIUs will keep an electronic and paper library of all EMP planning, technical, and administrative reports produced by the Project. This information will be organized in a way that will be readily available for regulators, donors, government agencies, and other Project stakeholders as required.

5.9 Action Plan for Implementing the VWRAP EMP

5.9.1 *Key Features of Action Plan*

The action plan for implementing the VWRAP EMP that is outlined in detail below:

- works within the Project's overall organizational framework;
- works within the practical human resource constraints of environmental management capacity in Viet Nam;
- explicitly accounts for all aspects of what is required in successfully implementing the Environmental Management Plan: information collection, EMP management, reporting, and revision if necessary, management decisions on the environment, and implementation of EMP management decisions;
- uses existing procedures within the GoVN and between the GoVN and IDA already in place for reviewing and approving modifications to the Environmental Management Plan that are required in the case of Sub-Project design modifications or strengthening of existing mitigation and monitoring programs (see below);
- ensures that the reporting that is done as part of EMP implementation includes information that is needed by MARD, other concerned national agencies, and IDA to make decisions regarding the need for revisions to the Environmental Management Plan as may be required for the second phase of investments.

5.9.2 *Action Plan for EMP Implementation during Pre-Construction Phases*

The Pre-Construction Phase will essentially be the detailed design phase for the first phase of investments. Unless otherwise noted, all responsibilities detailed below apply to both pre-construction phases, i.e., for both the first and second investment phases. In addition, unless otherwise noted, all responsibilities detailed below apply to all Sub-Projects (including the Quang Hue-Vu Gia River Control Works).

VWRAP PMU

VWRAP PMU will have overall responsibility for successful implementation of environmental management activities. VWRAP PMU will make management decisions that support effective implementation of the EMP; this will include:

- approving ToRs, bidding documents, and contracts for the Environmental Safeguard Contractors, including the environmental review of provincial aquaculture programs (Yen Lap, Ke Go, Phu Ninh, Da Ban) (**1st investment phase**);
- efficiently manage the reviews of the following documents and ensure they are approved in a timely manner:
 - Environmental Review of Provincial Aquaculture Programs (Yen Lap, Ke Go, Phu Ninh, Da Ban) (**1st investment phase**);
 - Canal Works and Canal Lining Implementation Plans (not Quang Hue-Vu Gia)
 - Detailed Design Documents for Sub-Project Environmental Management Plans: First Investment Phase
 - Set of terms and conditions for environmental mitigation to be included in construction contracts
 - Pre-Construction Phase Sub-Project Environmental Management Reports (to serve as environmental baselines); and
- Participate in environmental training programs conducted by the Consultant Environmental Specialists (**up to Year 3 of VWRAP implementation**).

SIUs

The responsibilities of the SIUs in the Pre-Construction Phase will be to:

- review and approve the following environmental documents prepared during the pre-construction phases:
 - Detailed Design Documents for Sub-Project Environmental Management Plans: First Investment Phase
 - Pre-Construction Phase Sub-Project Environmental Management Reports (to serve as environmental baselines)
- Implement VWRAP RAPs and EMDPs;
- in consultation with respective DARDs, IMCs, and the districts and communes with jurisdiction in the pilot areas of VWRAP develop a canal works and canal lining program that has the signed agreement of all these stakeholders and prepare Canal Works and Canal Lining Implementation Plans (not Quang Hue-Vu Gia);
- Prepare terms and conditions to include in construction contracts:
 - Ordnance survey and treatment
 - Environmental management of construction camps
 - Canal works and canal lining (to be taken from approved canal lining implementation plans)
 - Minimization of effects of construction activities on local residents
 - Avoidance of cultural and historic sites
 - Minimization of effects of dredged and excavated soils
 - Minimization of effects of acid sulphate soils (Dau Tieng)
- Work with the Environmental Safeguard Contractor to prepare environmental mitigation compliance monitoring report formats and reporting procedures;
- provide physical, biological, and socioeconomic information to the Environmental Safeguard Contractors as required to complete the environmental baseline for Sub-Project Areas and the associated areas of influence; and
- Participate in environmental training programs conducted by the Consultant Environmental Specialists (**up to Year 3 of VWRAP implementation**).

PROVINCIAL/CITY GOVERNMENT ORGANIZATIONS

The responsibilities of the Provincial/City Government Departments in the Pre-Construction Phase will be to:

- review and approve the following environmental documents prepared during the pre-construction phases:
 - Environmental Review of Provincial Aquaculture Programs (Yen Lap, Ke Go, Phu Ninh, Da Ban) (**1st investment phase**);
 - Canal Works and Canal Lining Implementation Plans (Provincial PPCs, DARDs, and IMCs) (not Quang Hue-Vu Gia)
 - Detailed Design Documents for Sub-Project Environmental Management Plans: First Investment Phase (DoSTEs);
 - Pre-Construction Phase Sub-Project Environmental Management Report (to serve as environmental baseline) (DoSTEs)
- participate in VWRAP EIA approval process;
- serve as executing agency (DoSTEs) and implementing agency (DoFIs) for the environmental review of coastal aquaculture (Yen Lap, Ke Go, Phu Ninh, Da Ban) (**1st investment phase**);
- provide physical, biological, and socioeconomic information to the Environmental Safeguard Contractors and Consultant Environmental Specialist as required to complete the environmental baseline for Sub-Project areas and the associated areas of influence (DARDs, DoSTEs, others);
- advise MoNRE on any environmental concerns regarding project design, construction, and operation

(DoSTEs); and

- Participate in environmental training programs conducted by the Consultant Environmental Specialists (**up to Year 3 of VWRAP implementation**).

CONSTRUCTION CONTRACTORS

Construction contractors will commit to all proposed environmental protection and mitigation measures in key construction documents: general conditions of contract, contractor specifications, conditions of contract, etc. They will draft method statements for the Site EMPs and any other relevant environmental protection measures and submit to the SIUs for approval.

ENVIRONMENTAL SAFEGUARD CONTRACTORS

Environmental Safeguard Contractor responsibilities during the Pre-Construction Phase will include:

- conducting the environmental review of the coastal aquaculture programs under the direction of the appropriate DoSTEs (executing agency) and DoFIs (implementing agency) (Yen Lap, Ke Go, Phu Ninh, Da Ban) (**1st investment phase**);
- providing technical support to the Consultant Environmental Specialists in preparing both Detailed Design Documents for Sub-Project Environmental Management Plans: First Investment Phase;
- providing technical support to the Consultant Environmental Specialists in the preparation of the Pre-Construction Sub-Project Environmental Management Reports (to serve as environmental baseline) for review and approval (**1st investment phase**);
- conducting the Pre-Construction Phase information gathering according to the Detailed Design Documents;
- conducting the following activities:
 - designing and establishing environmental monitoring database information and reporting system for VWRAP
 - designing environmental reporting structures and formats, including environmental mitigation compliance monitoring report formats and reporting procedures; and
- Participating in environmental training programs conducted by the Consultant Environmental Specialists (**up to Year 3 of VWRAP implementation**).

CONSULTANT ENVIRONMENTAL SPECIALISTS

The Consultant Environmental Specialists will verify as to whether or not major design changes have occurred since GoVN and IDA approval of the EIA report. If major design changes have occurred, then these changes will need environmental approval from GoVN and IDA. The Consultant Environmental Specialists will also:

- Prepare a detailed Inception Report for all aspects of the consulting assignment, including a detailed training and capacity building program;
- Assist VWRAP PMU to prepare and finalize the following ToRs for the Environmental Safeguard Contractor:
 - Environmental review of coastal aquaculture programs (Yen Lap, Ke Go, Phu Ninh, Da Ban) (**1st investment phase**)
 - Environmental Mitigation Compliance Monitoring of construction contracts
 - Environmental effects monitoring for effects of sedimentation, erosion, fertilizer, and pesticide application on surface and groundwater quality (not Quang Hue-Vu Gia)
- Prepare both Detailed Design Documents for Sub-Project Environmental Management Plans: First Investment Phase for review and approval;
- supervise Pre-Construction Phase information gathering according to the Detailed Design Document (**up to Year 3 of VWRAP implementation**);
- provide assistance to the Environmental Safeguard Contractors (**up to Year 3 of VWRAP implementation**) in:
 - designing and establishing environmental monitoring database information and reporting system for VWRAP;
 - designing environmental reporting structures and formats, including environmental mitigation compliance monitoring report formats and reporting procedures
- Provide technical assistance to SIUs in finalizing environmental terms and conditions for construction contracts:
 - Ordnance survey and treatment
 - Environmental management of construction camps
 - Canal lining (to be taken from approved canal lining implementation plans)
 - Minimization of effects of construction activities on local residents
 - Avoidance of cultural and historic sites
 - Minimization of effects of dredged and excavated soils;

- Minimization of effects of acid sulphate soils (Dau Tieng)
- preparing and submitting the Pre-Construction Phase Sub-Project Environmental Management Reports (to serve as environmental baselines) for review and approval (**1st investment phase**); and
- conducting environmental training programs for VWRAP PMU, Provincial/City SIUs, and Environmental Safeguard Contractors (see Section 5.12) (**up to Year 3 of VWRAP implementation**).

5.9.3 Action Plan for EMP Implementation during Construction Phases

Unless otherwise noted, all responsibilities detailed below apply to both construction phases, i.e., for both the first and second investment phases. In addition, unless otherwise noted, all responsibilities detailed below apply to all Sub-Projects (including the Quang Hue-Vu Gia River Control Works).

VWRAP PMU

The responsibilities of the VWRAP PMU in the Construction Phases will be to:

- efficiently manage the reviews with national environmental regulators, MARD, and GoVN of the following documents and ensure they are approved in a timely manner:
 - Program Document for Strengthening Environmental Governance of Industrial Pollution Control in priority VWRAP provinces
 - Annual VWRAP Environmental Management Report, integrating all results from Sub-Project EMPs (mitigation, mitigation compliance monitoring, and environmental effects monitoring) into a single annual report
 - Annual Sub-Project Environmental Management Reports, integrating all results from each Sub-Project EMP (mitigation, mitigation compliance monitoring, and environmental effects monitoring) into a single annual report for each Sub-Project
- If necessary efficiently manage the review and approval by national environmental regulators, MARD, and GoVN of technical modifications to the Sub-Project EMPs if required (please see Section 5.13); and
- Participate in environmental training programs conducted by the Consultant Environmental Specialists (**up to Year 3 of VWRAP implementation**).

PROVINCIAL/CITY SIUs

The responsibilities of the Provincial/City SIUs in the Construction Phases will be to:

- Assist the Environmental Safeguard Contractor in conducting environmental mitigation monitoring activities;
- provide Sub-Project construction progress information to the Environmental Safeguard Contractors and Consultant Environmental Specialist as required to complete the annual monitoring reports;
- review and approve the following environmental documents prepared during the construction phases:
 - Monthly Sub-Project Mitigation Compliance Progress Reports
 - Annual Sub-Project Environmental Mitigation Compliance Monitoring Reports
 - Annual Sub-Project Environmental Management Reports, integrating all results from Sub-Project EMPs (mitigation, mitigation compliance monitoring, and environmental effects monitoring) into a single annual report for each Sub-Project
- Participate in environmental training programs conducted by the Consultant Environmental Specialists (**up to Year 3 of VWRAP implementation**).

PROVINCIAL/CITY GOVERNMENT ORGANIZATIONS

The responsibilities of Provincial/City Government Departments in the Construction Phases will be to:

- prepare implementation plans for the IPM programs to be conducted under the Sub-Projects and submit to SIUs for approval (DARDs)
- participation in the preparation of the Program Document for Strengthening Environmental Governance of Industrial Pollution Control in priority VWRAP provinces (DoSTEs, Dols)
- provide physical, biological, and socioeconomic information to the Environmental Safeguard Contractors and Consultant Environmental Specialist as required to complete the annual monitoring reports (DARDs, DoSTEs, others);
- review and approve the following environmental documents prepared during the construction phases:
 - Annual Sub-Project Environmental Mitigation Compliance Monitoring Reports (DoSTEs)
 - Annual Sub-Project Environmental Management Reports (DoSTEs)
- Participate in environmental training programs conducted by the Consultant Environmental Specialists (**up to Year 3 of VWRAP implementation**).

CONSTRUCTION CONTRACTORS

The responsibility of the construction contractors will be to properly and effectively implement the environmental mitigation terms and conditions contained in their construction contracts.

ENVIRONMENTAL SAFEGUARD CONTRACTORS

The responsibilities of the Environmental Safeguard Contractors in the Construction Phases will be to:

- Assist in preparing Program Document for Strengthening Environmental Governance of Industrial Pollution Control in priority VWRAP provinces
- Monitor construction contractors during construction activities and report on their compliance with the environmental terms and conditions contained in their contracts;
- Prepare the monthly Sub-Project Mitigation Compliance Progress Reports
- Prepare the annual Sub-Project Environmental Mitigation Compliance Monitoring Report
- Conduct the Construction Phase environmental information gathering according to the Detailed Design Document for the following environmental effects monitoring:
 - Environmental effects of coastal aquaculture (Yen Lap, Ke Go, Phu Ninh, Da Ban);
 - Surface water and groundwater quality effects from erosion, sedimentation, fertilizers, and pesticides (not Quang Hue-Vu Gia)
- providing technical support to the Consultant Environmental Specialists in the preparation of the Construction Phase Sub-Project Environmental Management Reports for review and approval (**1st investment phase**);
- Supervise and provide technical assistance to VWRAP PMU, and SIUs in the implementation of their components of the VWRAP EMP (**after Year 3 of VWRAP implementation**);
- prepare and submit the Construction Phase Sub-Project Environmental Management Reports (annual) for review and approval (**after Year 3 of VWRAP implementation**);
- Participate in environmental training programs conducted by the Consultant Environmental Specialists (**up to Year 3 of VWRAP implementation**).

CONSULTANT ENVIRONMENTAL SPECIALISTS

The responsibilities of the Consultant Environmental Specialists in the Construction Phases up to Year 3 of Sub-Project implementation will be to:

- Supervise and provide technical assistance to VWRAP PMU, SIUs, and Environmental Safeguard Contractors in the implementation of their components of VWRAP EMP;
- Assist in preparing Program Document for Strengthening Environmental Governance of Industrial Pollution Control in priority VWRAP provinces;
- If necessary prepare environmental reviews of technical design modifications and revise the Sub-Project EMPs for approval (please see Section 5.13);
- prepare and submit the Construction Phase Sub-Project Environmental Management Reports (annual) for review and approval; and
- conduct environmental training programs for VWRAP PMU, SIUs, Provincial/City Government Departments, and Environmental Safeguard Contractors (see Section 5.12).

5.9.4 Action Plan for EMP Implementation during Operational Phases

Unless otherwise noted, all responsibilities detailed below apply to both operational phases, i.e., for both the first and second investment phases. In addition, unless otherwise noted, all responsibilities detailed below apply to all Sub-Projects (including the Quang Hue-Vu Gia River Control Works).

VWRAP PMU

The responsibilities of the VWRAP PMU in the Operational Phases will be to:

- efficiently manage the reviews with national environmental regulators, MARD, and GoVN of the following documents and ensure they are approved in a timely manner:
 - Annual VWRAP Environmental Management Report, integrating all results from Sub-Project EMPs (mitigation, mitigation compliance monitoring, and environmental effects monitoring) into a single annual report
 - Annual Sub-Project Environmental Management Reports, integrating all results from each Sub-Project EMP (mitigation, mitigation compliance monitoring, and environmental effects monitoring) into a single annual report for each Sub-Project

- If necessary efficiently manage the review and approval by national environmental regulators, MARD, and GoVN of technical modifications to the EMPs if required (see Section 5.13); and
- Participate in environmental training programs conducted by the Consultant Environmental Specialists (**up to Year 3 of Sub-Project implementation**).

PROVINCIAL/CITY SIUS

The responsibilities of the Provincial/City SIUs in the Operational Phases will be to:

- Assist the Environmental Safeguard Contractor in conducting environmental mitigation monitoring activities;
- provide Sub-Project operational information to the Environmental Safeguard Contractors and Consultant Environmental Specialist as required to complete the annual monitoring reports;
- review and approve the following environmental documents prepared during the operational phases:
 - Annual Report on Implementation of Control Program for Aquatic Weeds (Phu Ninh and Dau Tieng)
 - Annual Sub-Project Environmental Management Reports, integrating all results from Sub-Project EMPs (mitigation, mitigation compliance monitoring, and environmental effects monitoring) into a single annual report
- Participate in environmental training programs conducted by the Consultant Environmental Specialists (**up to Year 3 of Sub-Project implementation**).

PROVINCIAL/CITY GOVERNMENT DEPARTMENTS

The responsibilities of Provincial/City Government Departments in the Operational Phases will be to:

- implement the IPM program to be conducted under the Sub-Project (DARD) (not Quang Hue-Vu Gia)
- participate in the implementation of the program for Strengthening Environmental Governance of Industrial Pollution Control in priority VWRAP provinces (DoSTEs, Dols)
- provide physical, biological, and socioeconomic information to the Environmental Safeguard Contractors and Consultant Environmental Specialist as required to complete the annual monitoring reports (DARD, DoSTE, others);
- review and approve the following environmental documents prepared during the pre-construction phases:
 - Annual Sub-Project Environmental Mitigation Compliance Monitoring Reports (DoSTE)
 - Annual Sub-Project Environmental Management Report (DoSTE)
- Participate in environmental training programs conducted by the Consultant Environmental Specialists (**up to Year 3 of Sub-Project implementation**).

ENVIRONMENTAL SAFEGUARD CONTRACTORS

The responsibilities of the Environmental Safeguard Contractors in the Operational Phases will be to:

- Prepare the monthly Sub-Project Mitigation Compliance Progress Reports
- Prepare the annual Sub-Project Environmental Mitigation Compliance Monitoring Reports
- Conducted the activities for Strengthening Environmental Governance of Industrial Pollution Control in priority VWRAP provinces
- Conduct the Operational Phase environmental information gathering according to the Detailed Design Document for the following environmental effects monitoring:
 - Environmental effects of incremental coastal aquaculture (Yen Lap, Ke Go, Phu Ninh, Da Ban);
 - Environmental effects of aquatic weeds (Phu Ninh and Dau Tieng);
 - Surface water and groundwater quality effects from erosion, sedimentation, fertilizers, and pesticides.
- providing technical support to the Consultant Environmental Specialists in the preparation of the Operational Phase Sub-Project Environmental Management Reports (annual) for review and approval (**up to Year 3 of VWRAP implementation**);
- Supervise and provide technical assistance to VWRAP PMU, SIUs, and provincial/city government departments in the implementation of their components of VWRAP EMP (**after Year 3 of VWRAP implementation**);
- prepare and submit the Operational Phase Sub-Project Environmental Management Reports (annual) for review and approval (**after Year 3 of VWRAP implementation**);
- Participate in environmental training programs conducted by the Consultant Environmental Specialists (**up to Year 3 of VWRAP implementation**).

CONSULTANT ENVIRONMENTAL SPECIALISTS

The responsibilities of the Consultant Environmental Specialists in the Operational Phases up to Year 3 of Sub-Project implementation will be to:

- Supervise and provide technical assistance to VWRAP PMU, SIUs, and Environmental Safeguard Contractors in the implementation of their components of VWRAP EMP;
- If necessary prepare environmental reviews of technical design modifications and revise the appropriate EMPs for approval (please see Section 5.13);
- prepare and submit the Operational Phase Sub-Project Environmental Management Reports (annual) for review and approval; and
- conduct environmental training programs for VWRAP PMU, SIUs, provincial/city government departments, and Environmental Safeguard Contractors (see Section 5.12).

5.10 Policy Framework and Guidelines for Environmental Assessment and Impact Mitigation for the Follow-On Investments

It is anticipated that preparation of the second phase of the VWRAP investments will be the responsibility of the VWRAP PMU. All the new investment package for the remaining 80% of the command area will be screen against the IDS safeguard policies (environment, forestry, natural habitats, cultural property, and pesticide management) and an EMP will be prepared for the package. The details of the EMP will be designed in concomitant with the detailed technical and engineering design for the investments.

During the screening and preparation of the EMP, the following principles should be applied:

Screening --While additional environmental assessment is not anticipated for the follow-on investments of the remaining 80% of command areas, VWRAP PMU will formally confirm this conclusion prior to the detailed design of the engineering works by performing a screening checklist on the IDA safeguards (see below). If the nature and extent of the impacts are similar to those identified during the EIA study of the subproject, the VWRAP EMP will be applied as appropriate. VWRAP PMU will prepare and submit a report on the screening and proposed EMP for the new investment to IDA for no objection. If the quality of the review is satisfactory, prior approval from IDA for the follow-on investment of similar nature of activities may not be required. However, a report will have to be prepared and properly kept for post review by IDA.

Initial Criteria --The approach and criteria used in the EA study of the subproject (see Chapter 4 of the EIA reports) can be used as the initial checklist for the potential impacts to determine whether or not any additional studies would be required to ensure the compliance with the IDA safeguard policies.

Special study or Initial Environmental Examinations (IEEs) --Should the safeguard screening indicate the potentially negative impacts that are significant than those identified in the subproject EIA, VWRAP PMU (assisted by the environmental consultants and in close consultation with IDA) will prepare an IEE or carry out special studies to address the issues.

Consultation and Final EMPs -- Consultation with affected groups and communities in the remaining 80% of command areas will be required for the preparation of all the final EMPs. This consultation will include, but not be limited to,:

- Presenting the results and findings of the EMP of the first phase investments to the affected groups and communities;
- Description of engineering works to be implemented in second investment phase, expected environmental effects, and scope of proposed environmental management plan;
- Receipt of comments and suggestions from the affected groups and communities on the issues associated with the investment activities and scope of the proposed EMP. The consultation records will be documented and considered during the finalization of the EMP;
- Documentation for consultation in simple and understandable language will be provided well in advance, and accessible to consulted people before consultation takes place.

Information Disclosure and IDA Clearance --The final EMP report and consultation report will be disclosed to the public similar to those of the EIA study for the first phase. The reports will be sent to IDA for comments and clearance before commencement of the activities. Failure to meet this requirement may result in IDA objection to the funding for the activities. VWRAP PMU will be responsible for ensuring full compliance with IDA disclosure policy.

Implementation and Monitoring -- VWRAP PMU will be responsible for ensuring effective implementation of the final EMPs and reporting the monitoring results. The lessons learned from the EMP implementation of the first phase investment should be applied during the design of the final EMP for the follow-on investments.

5.11 Indicative Requirements for Construction Bidding Documents

The construction bidding documents will require terms and conditions for the following environmental mitigation measures:

- To detect and clear unexploded ordnance (UXO) in the sub-project Areas;
- To implement mitigation measurements at sites of temporary construction worker camps to minimize the negative impacts on the environment through land disturbance, generation of waste (soil and liquid), use of heavy vehicles and other machinery, and requirements for domestic and drinking water supply;
- To implement the resettlement and compensation for land acquisition in compliance with VWRAP resettlement requirements;
- Soil, rock, and other material will be excavated, dredged and provided as fill for the head works and canal upgrading in compliance with mitigation measures of the proposal disposal and management of these soils;
- Rehabilitate all agricultural and other land affected by construction activities associated with engineering civil works to pre-construction conditions;
- To develop rigid construction time for canal lining to minimize disruption to the beneficiaries and consultation with all affected parties will be required in order to reach agreement on the duration of water disruption between construction contractors and affected households;
- The contractors would be responsible for mitigation and compensation for any damage to farmers' land or other assets due to excavation, based on conditions that would be specified in the contractual agreements;
- To restore the temporarily sites used for construction activities after construction is completed and to return the landscapes to their original condition; and
- Terms and conditions for historical and cultural sites in accordance with IDA Operation Policy OP 11.03 – Cultural Property to ensure the integrity of these historical and cultural resources.

These terms and conditions will be prepared during the design of the final EMPs for these subprojects.

5.12 Training and Capacity Upgrading Requirements for EMP Implementation

5.12.1 Evaluation of Environmental Management Capabilities

SIUs -- Provincial SIUs will be comprised of representatives from provincial DARD and IMC offices. They, along with the MARD SIOs, have received little training in environmental mitigation and project performance monitoring for environmental protection. In particular, the IMCs and the MARD SIOs have no environmental group in their organizations and none of their staff have received any training in environmental mitigation and compliance monitoring. Extensive capacity building will be required.

Environmental Safeguard Contractors -- Environmental Safeguard Contractors will be selected according to IDA procurement requirements (either CQ or QCBS). There are numerous national consultant organizations in Viet Nam that will be able to demonstrate strong capacity sampling and basic environmental information-gathering. Based on experience with national consultant organizations in previous IDA-financed water resources projects, capacities of these organizations are weaker in the area of analysis and interpretation of data that are gathered, drawing conclusions from the results of the analysis, and developing recommendations about environmental impacts of VWRAP for future effects monitoring, as will be required in the reporting for VWRAP EMP.

VWRAP PMU -- This will be a new organization and so its capacity for environmental management is unknown at this time. Using CPO as a guide, it is likely that the environmental staff of VWRAP PMU will be very competent in providing coordination of environmental aspects of water resources investment projects, but will have less capability in the areas of analysis and interpretation of data that are gathered, drawing conclusions from the results of the analysis, and developing recommendations about environmental impacts of VWRAP.

Government Environmental Regulators -- MoNRE has received extensive training and capacity building through multi-year donor projects from CIDA, Sida, and now DANIDA⁶² in EIA, environmental management, environmental protection, and environmental monitoring. Through these very large donor projects, MoNRE has

⁶² For example, CIDA has financed two phases (total of eight years) of the Viet Nam-Canada Environment Project (VCEP), with the National Environmental Agency as the Executing Agency and provincial environmental organizations receiving extensive training in EIA, environmental management, environmental information systems, and urban and industrial pollution control. Total CIDA grants for VCEP have been approximately US \$10 million.

been able to provide extensive environmental training to all provincial DoSTEs. No training or capacity building for these institutions is required and none is recommended.

5.12.2 Recommended Training and Capacity Building

It is expected that the budget for the recommended training and capacity building, below, will be provided by the VWRAP Training and Capacity Building Fund.

SIUs -- SIUs will receive training and capacity building in the following areas:

- preparing and working with terms and conditions to be included in construction contracts. These terms and conditions will include as required responsibility for mitigation and compensation for non-compliance;
- for technical supervision staff training on how to conduct civil works monitoring and supervision to ensure environmental mitigation measures are being properly implemented (frequency of monitoring, type of works to be supervised, assessment and reporting); and
- preparation of compliance monitoring reports in accordance with the reporting requirements outlined in Table 24.

Also, construction contractors may require training on the proper implementation of the environmental mitigation measures in order to meet the terms and conditions included in their contracts and on the preparation of Site Environmental Management Plans. This training will need to be conducted at field locations with demonstrations of mitigation measures as required. The training will be designed so that technical supervision staff from the construction supervision entities will be able to deliver such training to additional contractors as they are engaged for construction works.

Environmental Safeguard Contractors Training and capacity building will be provided in environmental monitoring. This training will focus on detailed design of the environmental monitoring system, including:

- specification of environmental impacts;
- clear set of indicators or criteria, such as water quality standards, or species richness indices, for example, which are used to evaluate changes in environmental conditions;
- preparation of environmental baselines for environmental conditions in VWRAP against which changes in environmental conditions may be assessed;
- spatial and temporal controls for environmental monitoring to make it possible to ascribe changes in environmental conditions to Project effects rather than changes in factors unrelated to the Sub-Project;
- design for the data gathering or data analysis;
- QA/QC;
- analysis and presentation of data and results;
- development of database information systems; and
- reporting structures and formats in accordance with reporting requirements outlined in Table 24

VWRAP PMU Technical assistance will be provided to environment (and other) staff in VWRAP PMU in incorporating the results of environmental management programs (such as VWRAP Environmental Management Plan) into water resources project management decision making. Considerable on the job training will be provided through implementation of the environmental components of the Design and Supervision Technical Assistance.

5.13 Requirements for Flexibility and Adaptability in EMP Implementation

This Environmental Impact Assessment makes predictions about the environmental impacts of VWRAP (Chapter 4) based on existing information and understanding of the environmental and social resources of VWRAP Area (Chapter 3) and the engineering works required for the Project as they are currently defined (Chapter 2). While the assessment concludes that VWRAP is environmentally feasible, as with all predictions of environmental impacts, there is some uncertainty in the reliability of these predictions, certainly not so much uncertainty as to not proceed with the Project, but uncertainty nonetheless. There are a number of sources of this uncertainty:

- the actual impacts that occur as a result of Project implementation may be different than the predictions made in this EIA because of the limited data and information available for a number of the environmental and social resources of the Project area;
- the recommended mitigation measures may not be able to prevent negative environmental impacts;
- during Project implementation, various factors may require Project design modifications whose environmental impacts are beyond the scope of this EIA; or
- the specific engineering works with regards to the second phase of investments are unknown.

The organizational framework for VWRAP is sufficiently flexible and adaptable to be very responsive to these unexpected situations. It is able to accommodate numerous situations during construction and operation of VWRAP as described below. This concept of requiring the organizational framework to be adaptable to changing Project circumstances is in fact supported by IDA OP 4.01 – Environmental Assessment.

Scenario 1: Unexpected Environmental and Socioeconomic Impacts Trigger Project Design Modifications, Environmental Review of Design Modifications, and Possible Revisions to EMP -- There may be a need for modifications to the Project design in order to ameliorate or reduce unexpected environmental and/or socioeconomic impacts that were not predicted in this EIA. There is experience with this type of situation in water resources projects in Viet Nam. In the Mekong Delta Water Resources Project, for example, the South Mang Thit Sub-Project needed re-design as a result of unexpected and negative impacts of using an inappropriate sluice design that had been approved in the Sub-Project FS. If this scenario were to occur at any stage during implementation of VWRAP, the institutional arrangements for implementing VWRAP EMP (Section 5.9) will ensure that:

- The new FS that is required for the Project modifications will include an environmental review of the Project modifications. This environmental review will include a revision of the EMP if necessary, with adjustment of budgets, sampling regimes, and reporting requirements; and
- The new FS for the Project modifications and the associated environmental review and revised EMP will be reviewed and approved using existing review and approval procedures for feasibility studies and environmental assessments in Viet Nam and between the GoVN and IDA. Existing review and approval procedures are sufficient and adequate⁶³.

Scenario 2: Detailed Design of the Follow-on Investments Accompanied by Environmental Review and Possible Revisions to EMP Necessitated by the Investments -- There will be a requirement to review the detailed design of the second phase of investments for VWRAP for environmental effects and, if necessary, modify the Environmental Management Plan. The institutional arrangements for implementing VWRAP EMP (Section 5.9) will ensure that:

- An environmental review will be prepared as part of the detailed design for the second phase of investments for VWRAP. This environmental review will examine the lessons learned from monitoring the environmental effects of the first phase of investments;
- This environmental review will include a detailed design of the Environmental Management Plan for the second phase of investments, including budgets, sampling regimes, and reporting requirements; and
- The detailed design for the second phase of investments and the associated environmental review and revised Environmental Management Plan will be reviewed and approved using existing review and approval procedures in Viet Nam and between the GoVN and IDA. As above, existing review and approval procedures are sufficient and adequate.

Scenario Situation 3: Review and Possible Revisions to EMP to Strengthen Existing Mitigation and Monitoring Programs -- Results from implementing the EMP may suggest that there is a need to modify the EMP for one of the following reasons:

- Additional mitigation measures are required because the Project is having unexpected environmental effects that are not predicted in this EIA and these effects can be mitigated by modifying Project implementation rather than by modifying Project design;
- mitigation measures that were specified in the original EMP are not proving to be effective and need to be strengthened or modified;
- mitigation measures that were specified in the original EMP are proving to be too stringent and can be relaxed to improve cost-effectiveness;
- the effects monitoring sampling regime needs to be adjusted to better detect impacts of the Project.

Again, there is experience with this type of situation in water resources projects in Viet Nam. In the Mekong Delta Water Resources Project, for example, the water quality monitoring program was adjusted two years into Project implementation in order to better detect Project impacts downstream of the Project area. If this scenario were to occur at any stage during implementation of VWRAP, the institutional arrangements for implementing VWRAP EMP (Section 5.9) will ensure that:

- a revised EMP to suit the revised requirements for environmental protection will be prepared, with adjustment of budgets, sampling regimes, and reporting requirements to suit the new requirements; and
- the revised EMP will be reviewed and approved using the existing review and approval procedures in Viet Nam and between the GoVN and IDA.

⁶³ These procedures were followed in the case of the South Mang Thit Sub-Project.

Scenario 4: No Changes Required in EMP -- Results from implementing the EMP may suggest that no changes are required to either the Project design or the EMP itself and the EMP can continue to proceed as designed.

5.14 Costs of VWRAP EMP

The total cost of VWRAP Environmental Management Plan is US \$1,427,096, consisting of:

- A total US \$999,034 for environmental mitigation and monitoring, which includes:
 - US \$221,322 for the environmental mitigation program;
 - US \$628,022 for the environmental mitigation compliance monitoring and environmental effects monitoring programs; and
 - US \$150,000 to implement the program for Strengthening Environmental Governance of Industrial Pollution Control in priority VWRAP provinces; and
- A total of US \$427,752 for training and technical assistance, which includes:
 - US \$90,000 to implement community-based environmental management in key areas of VWRAP implementation; and
 - US \$337,752 from the Design and Supervision Technical Assistance budget under VWRAP for the Consultant Environmental Specialist inputs.

Detailed costs and schedules for the VWRAP EMP are presented as follows:

- Detailed costs are provided in Table 26 and Table 27 for the Environmental Mitigation Programs and the Environmental Monitoring Programs (compliance monitoring and environmental effects monitoring), respectively;
- Table 28 contains a summary of the costs and schedule for the VWRAP Environmental Management Plan;
- Table 29 contains VWRAP Environmental Management Plan costs by Sub-Project and EMP component; and
- Table contains a list of the assumptions made in the preparation of the cost of VWRAP Environmental Management Plan.

Table 26: Detailed costs and schedule for VWRAP Environmental Mitigation Program.

Environmental Mitigation Cost Item	Units	US \$ per Unit	Year of Implementation							Total Costs
			1	2	3	4	5	6	7	
PRE-CONSTRUCTION PHASES			COSTS ARE INCLUDED IN SUB-PROJECT RESETTLEMENT AND DETAILED DESIGN COSTS							
Environmental Review of Coastal Aquaculture										
Fees - National Safeguard Contractor	days	60	240	-	-	-	-	-	-	14,400
DSA - National Safeguard Contractor	days	50	240	-	-	-	-	-	-	12,000
Travel	lump sum	500	4	-	-	-	-	-	-	2,000
Data Acquisition, Reporting, Miscellaneous	20% personnel		2,880	-	-	-	-	-	-	2,880
Subtotal			31,280	-	-	-	-	-	-	31,280
Administration Fee (8% of Subtotal Costs)			2,502	-	-	-	-	-	-	2,502
Total			33,782	-	-	-	-	-	-	33,782
CONSTRUCTION PHASES			Costs are Include In Resettlement Action Plan							
Compensation Afforestation of Protected Areas										
OPERATIONAL PHASES										
Implementation of Action Plan for Controlling Aquatic Weeds in Irrigation Scheme										
Provisional estimation of costs (300% of previous removal programs)		-	-	8,333	8,333	8,333	-	-	-	25,000
Integrated Pest Management Program for Command Area										
IPM Extension in First Investment Package	communes	500	-	-	46	-	-	-	-	23,000
IPM Extension in Second Investment Package	communes	500	-	-	-	128	128	-	-	127,500
Subtotal			-	-	23,000	63,750	63,750	-	-	150,500
Administration Fee (8% of Subtotal Costs)			-	-	1,840	5,100	5,100	-	-	12,040
Total			-	-	24,840	68,850	68,850	-	-	162,540
Total, VWRAP Environmental Mitigation Program			33,782	8,333	33,173	77,183	68,850	-	-	221,322

Table 27: Detailed costs and schedule for VWRAP Environmental Monitoring Programs

Environmental Monitoring Cost Item	Units	US \$ per Unit	Year of Implementation							Total Costs
			1	2	3	4	5	6	7	
MITIGATION COMPLIANCE MONITORING										
Mitigation Compliance Monitoring of Construction Contracts										
Fees - National Safeguard Contractor	days	60	93	185	185	177	177	162	81	63,590
DSA - National Safeguard Contractor	days	50	93	185	185	177	177	162	81	52,981
Travel	lump sum	500	7	7	7	6	6	6	6	22,500
Reporting, Miscellaneous	20% personnel		1,111	2,222	2,222	2,127	2,127	1,938	969	12,718
Subtotal			14,796	26,092	26,092	24,628	24,628	22,708	12,854	151,799
Administration Fee (8% of Subtotal Costs)			1,184	2,087	2,087	1,970	1,970	1,817	1,028	12,144
Total, Mitigation Compliance Monitoring of Construction Contracts			15,980	28,180	28,180	26,598	26,598	24,525	13,882	163,943
ENVIRONMENTAL EFFECTS MONITORING										
Environmental Impacts of Coastal Aquaculture										
1. Coastal Water Quality Monitoring										
<i>Analysis Costs</i>										
pH	sample	2	44	44	44	44	44	44	44	448
Conductivity	sample	1	44	44	44	44	44	44	44	224
TSS	sample	6	44	44	44	44	44	44	44	1,344
BOD5	sample	6	44	44	44	44	44	44	44	1,344
COD	sample	8	44	44	44	44	44	44	44	1,792
Fe	sample	8	44	44	44	44	44	44	44	1,792
Al	sample	6	44	44	44	44	44	44	44	1,344
NO3-2	sample	5	44	44	44	44	44	44	44	1,120
PO4-P	sample	5	44	44	44	44	44	44	44	1,120
DO	sample	5	44	44	44	44	44	44	44	1,120
Total Analysis Costs, Coastal Water Quality			1,664	1,664	1,664	1,664	1,664	1,664	1,664	11,648
Sampling Costs (20% of Analysis Costs)			333	333	333	333	333	333	333	2,246
Personnel, Reporting Costs (20% of Sample and Analysis Costs)			399	399	399	399	399	399	399	2,696
Subtotal Costs			2,396	2,396	2,396	2,396	2,396	2,396	2,396	16,590
Administration Fee (8% of Subtotal Costs)			192	192	192	192	192	192	192	1,327
Total Costs, Coastal Water Quality Monitoring			2,588	2,588	2,588	2,588	2,588	2,588	2,588	17,917
2. Wetland Quality Monitoring										
Personnel Costs, Field Work	day	60	22	22	22	22	22	22	22	7,770
Personnel Costs, DSA and Travel	day	50	22	22	22	22	22	22	22	6,475
Personnel Costs, Reporting	day	60	13	13	13	13	13	13	13	4,620
Total, Personnel Costs			2,695	2,695	2,695	2,695	2,695	2,695	2,695	18,865
Equipment Rental and Supplementary Data Acquisition	% personnel Costs	20	539	539	539	539	539	539	539	3,773
Subtotal Costs			3,234	3,234	3,234	3,234	3,234	3,234	3,234	22,638
Administration Fee (8% of Subtotal Costs)			259	259	259	259	259	259	259	1,811
Total Costs, Coastal Wetland Quality Monitoring			3,493	3,493	3,493	3,493	3,493	3,493	3,493	24,449
Total Costs, Monitoring Environmental Impacts of Aquaculture			6,081	6,081	6,081	6,081	6,081	6,081	6,081	42,564

Table 27: Detailed costs and schedule for VWRAP Environmental Monitoring Programs, continued

Environmental Monitoring Cost Item	Units	US \$ per Unit	Year of Implementation							Total Costs	
			1	2	3	4	5	6	7		
Environmental Monitoring for Effects of Sedimentation, Erosion, Fertilizers and Pesticides											
1. Surface Water Quality Monitoring											
<i>Analysis Costs</i>											
pH	sample	2	118	118	192	192	192	192	192	192	2,392
Conductivity	sample	1	118	118	192	192	192	192	192	192	1,196
TSS	sample	6	118	118	192	192	192	192	192	192	7,176
BOD5	sample	6	118	118	192	192	192	192	192	192	7,176
COD	sample	8	118	118	192	192	192	192	192	192	9,568
Fe	sample	8	118	118	192	192	192	192	192	192	9,568
Al	sample	6	118	118	192	192	192	192	192	192	7,176
NO3-2	sample	5	118	118	192	192	192	192	192	192	5,980
PO4-P	sample	5	118	118	192	192	192	192	192	192	5,980
DO	sample	5	118	118	192	192	192	192	192	192	5,980
Na	sample	5	118	118	192	192	192	192	192	192	5,980
Mg	sample	5	118	118	192	192	192	192	192	192	5,980
Ca	sample	5	118	118	192	192	192	192	192	192	5,980
Biocides	sample	100	60	60	94	94	94	94	94	94	58,892
Fecal Coliform	sample	9	118	118	118	118	118	118	118	118	7,434
Total Analysis Costs, Surface Water			14,968	14,968	23,304	23,304	23,304	23,304	23,304	23,304	146,458
2. Groundwater Quality Monitoring											
<i>Analysis Costs</i>											
pH	sample	2	59	59	88	88	88	88	88	88	1,116
Conductivity	sample	1	59	59	88	88	88	88	88	88	558
TSS	sample	6	59	59	88	88	88	88	88	88	3,348
BOD5	sample	6	59	59	88	88	88	88	88	88	3,348
COD	sample	8	59	59	88	88	88	88	88	88	4,464
Fe	sample	8	59	59	88	88	88	88	88	88	4,464
Al	sample	6	59	59	88	88	88	88	88	88	3,348
NO3-2	sample	5	59	59	88	88	88	88	88	88	2,790
PO4-P	sample	5	59	59	88	88	88	88	88	88	2,790
DO	sample	5	59	59	88	88	88	88	88	88	2,790
Fecal Coliform	sample	9	59	59	88	88	88	88	88	88	5,022
Biocides	sample	100	59	59	88	88	88	88	88	88	55,800
Total Analysis Costs, Groundwater			9,499	9,499	14,168	14,168	14,168	14,168	14,168	14,168	89,838
Total Analysis Costs, Surface Water Plus Groundwater			24,467	24,467	37,472	37,472	37,472	37,472	37,472	37,472	236,296
Sampling Costs (20% of Analysis Costs)			4,893	4,893	7,494	7,494	7,494	7,494	7,494	7,494	48,499
Personnel, Reporting Costs (20% of Sample and Analysis Costs)			5,872	5,872	8,993	8,993	8,993	8,993	8,993	8,993	55,799
Supplementary Data Acquisition			6,000	6,000	9,000	9,000	9,000	9,000	9,000	9,000	55,500
Subtotal Costs			41,232	41,232	62,960	62,960	62,960	62,960	62,960	62,960	390,292
Administration Fee (8% of Subtotal Costs)			3,299	3,299	5,037	5,037	5,037	5,037	5,037	5,037	31,223
Environmental Monitoring for Effects of Sedimentation, Erosion, Fertilizers and Pesticides			44,531	44,531	67,997	67,997	67,997	67,997	67,997	67,997	421,515
Total Costs, Environmental Monitoring Programs			66,592	78,791	102,257	100,676	100,676	98,602	87,960		628,022

Table 287: Summary costs and schedule for VWRAP Environmental Management Plan.

Units	Units	US \$ per Unit	Year of Implementation							Total Costs	
			1	2	3	4	5	6	7		
Summary of Sub-Project Environmental Management Plans											
Environmental Mitigation			33,782	8,333	33,173	77,183	68,850	-	-	-	221,322
Environmental Monitoring			66,592	78,791	102,257	100,676	100,676	98,602	87,960	-	628,022
Total, Sub-Project Environmental Management Plans			100,374	87,125	135,431	177,859	169,526	98,602	87,960	-	849,344
Implementation of Community-Based Environmental Management											
Fund to Strengthen Environmental Governance of Industrial Pollution Control			-	25,000	62,500	62,500	-	-	-	-	150,000
Provision of Consultant Environmental Specialists											
Fees - International Specialist	person-months	15,000	6	4	3	-	-	-	-	-	195,000
Fees - National Specialist	person-months	1,320	12	8	6	-	-	-	-	-	34,320
International Airfares - International Specialist	airfare	2,500	1	1	1	-	-	-	-	-	7,500
Domestic Airfares - International and National Specialists	airfare	500	9	6	5	-	-	-	-	-	9,750
DSA - International Specialist	person-days	75	180	120	90	-	-	-	-	-	29,250
DSA - National Specialist	person-days	50	360	240	180	-	-	-	-	-	39,000
Miscellaneous Expenses (Communications, Reporting, etc. 10% of Fees)			10,584	7,056	5,292	-	-	-	-	-	22,932
Total, Consultant Environmental Specialists			154,924	104,116	78,712	-	-	-	-	-	337,752
Total, VWRAP Environmental Management Plan			255,298	216,241	276,643	240,359	169,526	98,602	87,960	-	1,427,096

Table 29: VWRAP Environmental Management Plan costs by Sub-Project and EMP component.

VWRAP EMP Component	Sub-Project							Total Costs
	Yen Lap	Cam Son-Cau Son	Ke Go	Quang Hue-Vu Gia	Phu Ninh	Da Ban	Dau Tieng	
Environmental Mitigation Program								
PRE-CONSTRUCTION PHASES								
Environmental Review of Coastal Aquaculture	8,446	-	8,446	-	8,446	8,446	-	33,782
Compensation Afforestation of Protected Areas	-	-	-	-	-	-	-	-
OPERATIONAL PHASES								
Implementation of Action Plan for Controlling Aquatic Weeds in Irrigation S	-	-	-	-	12,500	-	12,500	25,000
Integrated Pest Management Program for Command Area	12,420	26,460	32,400	-	23,220	5,940	62,100	162,540
Total, Sub-Project Environmental Mitigation Program	20,866	26,460	40,846	-	44,166	14,386	74,600	221,322
Environmental Monitoring Program								
Mitigation Compliance Monitoring of Construction Contracts	10,075	32,041	21,373	4,224	17,615	11,716	66,898	163,943
Environmental Impacts of Coastal Aquaculture	9,276	-	8,944	-	15,234	9,110	-	42,564
Environmental Monitoring for Effects of Sedimentation, Erosion, Fertilizers	48,771	73,632	92,331	-	67,507	41,239	98,035	421,515
Total, Sub-Project Environmental Monitoring Program	68,123	105,673	122,648	4,224	100,355	62,066	164,933	628,022
Total Costs, Sub-Project EMPs	88,988	132,133	163,494	4,224	144,521	76,451	239,533	849,344
Overarching Components of VWRAP EMP								
Implementation of Community-Based Environmental Management								90,000
Fund to Strengthen Environmental Governance of Industrial Pollution Control								150,000
Provision of Consultant Environmental Specialists								337,752
Total Cost, VWRAP EMP								1,427,096

Table 29: List of assumptions made in cost estimation of VWRAP Environmental Management Plan.

Parameter for Estimation of EMP Costs	Units	Sub-Project						
		Yen Lap	Cam Son-Cau Son	Ke Go	Quang Hue-Vu Gia	Phu Ninh	Da Ban	Dau Tieng
Final Command Area	ha	8,320	22,942	21,136		18,000	7,800	136,000
Total Construction Costs	million VND	100,738	452,236	281,528	100,000	253,013	145,143	1,010,026
Total Area of Reforestation Required as Compensation for Loss of Forest Resources	ha	20	-				-	20
No. Communes in Pilot Areas	No.	4	8	9	1	7	3	15
No. Communes in Rest of Command Area	No.	19	41	51		36	8	100
No. Surface Water Sampling Locations in Pilot Areas in First Investment Package	No.	3	5	8		4	2	8
No. Surface Water Sampling Locations Upstream and Downstream of Command Area in First Investment Package	No.	4	6	4		6	4	6
No. Surface Water Sampling Locations in Command Area in Second Investment Package	No.	6	10	20		8	4	20
No. Surface Water Sampling Locations Upstream and Downstream of Command Area in Second Investment Package	No.	4	6	4		6	4	6
No. Surface Water Samples per Year at Each Location	No.	2	2	2		2	2	2
No. Groundwater Sampling Locations in Pilot Areas in First Investment Package	No.	3	5	8		4	2	8
No. Groundwater Sampling Locations Upstream and Downstream of Command Area in First Investment Package	No.	4	6	4		6	4	6
No. Groundwater Sampling Locations in Command Area in Second Investment Package	No.	6	10	16		8	4	16
No. Groundwater Sampling Locations Upstream and Downstream of Command Area in Second Investment Package	No.	4	6	4		6	4	6
No. Groundwater Samples per Year at Each Location	No.	1	1	1		1	1	1
No. Surface Water Samples for Coastal Aquaculture Monitoring	No.	4	-	4		4	4	-
US \$ per day for national consultant								60
DSA for national consultant								50
US \$ to implement IPM in a commune								500

Table 30: VWRAP environmental mitigation program.

Pre-Construction Phases

MITIGATION OF RESETTLEMENT AND LAND ACQUISITION	
RESOURCES TO BE PROTECTED	<ul style="list-style-type: none"> • Populations and Communities – Section 4.3.8, • Infrastructure, Local Facilities – Section 4.6.3, Local Employment Levels – Section 4.4.3, Economic Activities and Income – Section 4.4.4.
APPLICABLE SUB-PROJECTS	<ul style="list-style-type: none"> • All
MITIGATION DESCRIPTION	<ul style="list-style-type: none"> • detailed design, approval, and implementation of Resettlement Action Plan for Project affected households in accordance with IDA Operational Policy 4.12 – Involuntary Resettlement • implementation of approved procedures for compensation for loss of land or other assets in accordance with IDA Operational Policy 4.12 – Involuntary Resettlement
PHASE OF PROJECT	<ul style="list-style-type: none"> • Pre-Construction: First Investment Phase • Pre-Construction: Second Investment Phase
MITIGATION TARGETS	<ul style="list-style-type: none"> • All Project-affected persons are fairly compensated.
MONITORING REQUIRED	<ul style="list-style-type: none"> • Monitoring of RAP implementation required
RESPONSIBILITIES FOR IMPLEMENTATION	<ul style="list-style-type: none"> • Implementation responsibility rests with SIUs
REPORTING REQUIREMENTS	<ul style="list-style-type: none"> • VWRAP RAP and Sub-Project RAPs contain complete details on implementation responsibilities, costs, and reporting requirements
MITIGATION COSTS (US \$)	
MITIGATION OF DISRUPTION TO WATER USERS FROM CANAL WORKS, INCLUDING CANAL LINING, PRE-CONSTRUCTION PHASES	
RESOURCES TO BE PROTECTED	<ul style="list-style-type: none"> • Surface Water Hydrology – Section 4.6.1 • Aquatic Ecosystems and Aquatic Biodiversity - Section 4.6.2 • Domestic and Drinking Water Supply and Quality – Section 4.6.372 • Populations and Communities – Section 4.3.8, • Economic Activities and Income – Section 4.4.4
APPLICABLE SUB-PROJECTS	<ul style="list-style-type: none"> • All Irrigation Sub-Projects
MITIGATION DESCRIPTION	<ul style="list-style-type: none"> • ensure lining occurs with minimal disruption to economic activities of water beneficiaries by developing a canal lining schedule that is a combination of construction efficiency and minimal water user disruption • develop a canal lining schedule using a thorough and well-documented consultation process that obtains approval for water disruption to water users and provincial government (responsible for implementing provincial economic development plans and responsible for meeting provincial economic output targets)
PHASE OF PROJECT	<ul style="list-style-type: none"> • Pre-Construction: First Investment Phase • Pre-Construction: Second Investment Phase
MITIGATION TARGETS	<ul style="list-style-type: none"> • Two canal lining plans, each complete with detailed implementation schedule and terms and conditions for construction contractors, one for each investment phase, that have the approval of Sub-Project Provinces, affected districts and communes, and with villages in the affected communes having been consulted and informed.
MONITORING REQUIRED	<ul style="list-style-type: none"> • Monitoring required to ensure canal lining program proceeds as approved and affected households are satisfied with the disruption they endure. Monitoring results from first investment phase will be used to modify the design of the canal lining program for the second investment phase if required.
RESPONSIBILITIES FOR IMPLEMENTATION	<ul style="list-style-type: none"> • SIUs will have primary responsibility for developing canal lining schedule. SIUs will have the responsibility for preparing the appropriate terms and conditions to include in the construction contracts for canal lining. These terms and conditions should include specification of penalties for non-compliance with agreed lining schedule. • VWRAP PMU, IDA, MARD will have the opportunity to review draft plans as they are prepared • PPCs will give final approval of each of the canal lining plans.
REPORTING REQUIREMENTS	<ul style="list-style-type: none"> • Two reports will be prepared, one for each investment phase. These reports will consist of the detailed implementation schedule for the canal lining of each of the two investment phases
COMMENTS	<ul style="list-style-type: none"> • It will be necessary obtain approval for canal lining for water supply disruption from water users and provincial government (responsible for implementing provincial economic development plans and responsible for meeting provincial economic output targets) through an extensive and documented consultation process
MITIGATION COSTS (US \$)	<ul style="list-style-type: none"> • Part of detailed design costs for VWRAP

Table 30: VWRAP environmental mitigation program., continued.

Pre-Construction Phases, continued

MITIGATION OF EFFECTS THROUGH CONSTRUCTION CONTRACTS:	
SURVEY AND TREATMENT OF UNEXPLODED ORDNANCE, DISRUPTION TO WATER USERS FROM CANAL LINING; EFFECTS OF DREDGED AND EXCAVATED SOILS; AVOIDANCE OF CULTURAL AND HISTORIC SITES; DISRUPTION TO LOCAL COMMUNITIES FROM CONSTRUCTION ACTIVITIES	
RESOURCES TO BE PROTECTED	<ul style="list-style-type: none"> • Surface Water Hydrology – Section 4.6.1. • Aquatic Ecosystems and Aquatic Biodiversity - Section 4.6.2, • Domestic and Drinking Water Supply and Quality – Section 4.6.3, • Populations and Communities – Section 4.3.8, • Economic Activities and Income – Section 4.4.4, • Cultural and Historic Resources – Section 4.6.3,
APPLICABLE SUB-PROJECTS	<ul style="list-style-type: none"> • All
MITIGATION DESCRIPTION	<ul style="list-style-type: none"> • Develop terms and conditions to be included in construction contracts to avoid or minimize the effects of construction activities on important environmental resources in the VWRAP and associated area of influence (see Table 30 below, under Construction Phase for details of terms and conditions to be included)
PHASE OF PROJECT	<ul style="list-style-type: none"> • Pre-Construction: First Investment Phase • Pre-Construction: Second Investment Phase
MITIGATION TARGETS	<ul style="list-style-type: none"> • Approved set of terms and conditions included in all construction contracts
MONITORING REQUIRED	<ul style="list-style-type: none"> • No monitoring required at this time
RESPONSIBILITIES FOR IMPLEMENTATION	<ul style="list-style-type: none"> • SIUs will have primary responsibility for developing canal lining schedule • Consultant Environmental Specialists will provide technical assistance to SIUs in preparing these terms and conditions
REPORTING REQUIREMENTS	<ul style="list-style-type: none"> • None
MITIGATION COSTS (US \$)	<ul style="list-style-type: none"> • Part of detailed design costs for VWRAP
MITIGATION OF EFFECTS OF EXPANDED COASTAL AQUACULTURE, PRE-CONSTRUCTION PHASES	
RESOURCES TO BE PROTECTED	<ul style="list-style-type: none"> • Surface Water Quality – Section 4.6.1, • Aquatic Ecosystems and Aquatic Biodiversity - Section 4.6.2, • Terrestrial Ecosystems and Terrestrial Biodiversity – Section 4.6.2,
APPLICABLE SUB-PROJECTS	<ul style="list-style-type: none"> • Yen Lap, Ke Go, Phu Ninh, Da Ban
MITIGATION DESCRIPTION	<ul style="list-style-type: none"> • Conduct an environmental review of the area of coastal aquaculture in key districts of those provinces that are to benefit from the increased supply of freshwater water from the Project. Key issues to be examined include loss of coastal wetlands and other coastal ecosystems, management of sediment pond wastes and pond wastewaters, and existing provisions for environmental management of this program. Output will be a set of recommendations to provinces for effective environmental management of the coastal aquaculture program
PHASE OF PROJECT	<ul style="list-style-type: none"> • Pre-Construction: First Investment phase
MITIGATION TARGETS	<ul style="list-style-type: none"> • Recommended environmental management program for coastal aquaculture in target VWRAP provinces
MONITORING REQUIRED	<ul style="list-style-type: none"> • No monitoring required at this stage
RESPONSIBILITIES FOR IMPLEMENTATION	<ul style="list-style-type: none"> • Consultant Environmental Specialist to prepare detailed Terms of Reference for study as part of detailed design of EMP: First Investment phase • An appropriate Environmental Safeguard Contractor will be engaged to conduct the environmental review (CQ selection recommended). Inputs will be supervised by the Consultant Environmental Specialists • Provincial DoSTEs will be executing agency for the environmental review • Provincial DoFIs will be the implementing agency for the environmental review
REPORTING REQUIREMENTS	<ul style="list-style-type: none"> • completed and approved Environmental Review of Coastal Aquaculture, one for each target province • Institutions to review coastal aquaculture environmental management plan include: VWRAP PMU, MARD, IDA, provincial DoFIs, provincial DoSTEs, MoNRE
MITIGATION COSTS (US \$)	<p>33,782 - Please see Table 26,, for detailed description of costs and implementation schedule.</p>

Table 30: VWRAP environmental mitigation program., continued.

Construction Phases

MITIGATION OF DISRUPTION TO WATER USERS FROM CANAL LINING AND OTHER CANAL WORKS, CONSTRUCTION PHASES	
RESOURCES TO BE PROTECTED	<ul style="list-style-type: none"> • Surface Water Hydrology – Section 4.6.1, • Aquatic Ecosystems and Aquatic Biodiversity - Section 4.6.2, • Domestic and Drinking Water Supply and Quality – Section 4.6.3, • Populations and Communities – Section 4.3.8, • Economic Activities and Income – Section 4.4.4,
APPLICABLE SUB-PROJECTS	<ul style="list-style-type: none"> • All Irrigation Sub-Projects
MITIGATION DESCRIPTION	<ul style="list-style-type: none"> • Implement canal lining programs according to implementation plan developed during pre-construction (detailed design phases)
PHASE OF PROJECT	<ul style="list-style-type: none"> • Construction: First Investment Phase • Construction: Second Investment Phase
MITIGATION TARGETS	<ul style="list-style-type: none"> • Canal lining implemented according to canal lining plans • All stakeholders consulted and informed during design of canal lining programs, including those who signed the canal lining plans are satisfied with results of implementation
MONITORING REQUIRED	<ul style="list-style-type: none"> • Compliance monitoring required to ensure canal lining program proceeds as approved and affected households and communities are satisfied with the disruption they endure. Monitoring results from first investment phase will be used to modify the design of the canal lining program for the second investment phase if required.
RESPONSIBILITIES FOR IMPLEMENTATION	<ul style="list-style-type: none"> • Mitigation measures to be implemented as terms and conditions of construction contracts. SIUs will be responsible for overseeing the implementation of the canal lining plan • Construction contractors will be responsible for implementing the mitigation measures according to contract terms and conditions
REPORTING REQUIREMENTS	<ul style="list-style-type: none"> • Reporting on compliance with mitigation measures to be part of environmental mitigation compliance monitoring activities
MITIGATION COSTS (US \$)	<ul style="list-style-type: none"> • Costs for mitigation measures are included as part of construction contract costs.
MITIGATION OF EFFECTS OF DREDGED AND EXCAVATED SOILS	
RESOURCES TO BE PROTECTED	<ul style="list-style-type: none"> • Soils – Section 4.6.1, • Sedimentation and Erosion – Section 4.6.1, • Surface Water Quality – Section 4.6.1, • Aquatic Ecosystems and Aquatic Biodiversity Section 4.6.2,
APPLICABLE SUB-PROJECTS	<ul style="list-style-type: none"> • All
MITIGATION DESCRIPTION	<ul style="list-style-type: none"> • Use of the construction area at the headworks site should be strictly delineated and controlled (Irrigation Sub-Projects) • Remove topsoil before starting construction activities. Remove topsoil under the future stockpile. Separate topsoil stockpiles and earth stockpile to avoid mixing both soils. Create small stockpiles with topsoil (less than 2 meters high) in order to conserve its characteristics for future use after the construction works • Where possible, used dredged and excavated soils in engineering works such as road foundations. Identify and clearly delineate stockpiles for storage of excavated soils where required. Ensure stockpiles are a suitable distance from surface water sources. • Remove topsoil under stockpile sites before starting construction activities. Separate topsoil stockpiles and earth stockpiles to avoid mixing. Create small stockpiles with topsoil (less than 2 m high)
MITIGATION DESCRIPTION, CONTINUED	<ul style="list-style-type: none"> • Construct sedimentation basins to capture water coming from pumping activities and runoff from stockpiles. Maintain sedimentation basins in good working condition. • Rehabilitate all agricultural and other land affected by construction activities associated with engineering civil works to pre-construction conditions • Compensate, according to the RAP, farmers living along canals who have been affected by the disposal of spoil (Irrigation Sub-Projects)
PHASE OF PROJECT	<ul style="list-style-type: none"> • Construction: First Investment Phase • Construction: Second Investment Phase
MITIGATION TARGETS	<ul style="list-style-type: none"> • best practices" implemented according to specifications. • No soil dumped outside of approved disposal areas. • Borrow pits in environmentally suitable locations, sites re-vegetated to pre-construction conditions at end of construction • 100% of agricultural land rehabilitated and 100% of damaged roads rehabilitated • Farmers living along canals are adequately compensated for damage caused to their assets during construction (Irrigation Sub-Projects)
MONITORING REQUIRED	<ul style="list-style-type: none"> • Compliance monitoring will be required to ensure mitigation targets are met
RESPONSIBILITIES FOR IMPLEMENTATION	<ul style="list-style-type: none"> • Mitigation measures to be implemented as terms and conditions of construction contracts. SIUs will be responsible for preparing terms and conditions with technical assistance from the Consultant Environmental Specialists. • Construction contractors will be responsible for implementing the mitigation measures according to contract terms and conditions.

Table 30: VWRAP environmental mitigation program., continued.

Construction Phases, continued

MITIGATION OF EFFECTS OF DREDGED AND EXCAVATED SOILS, CONTINUED	
REPORTING REQUIREMENTS	<ul style="list-style-type: none"> Reporting on compliance with mitigation measures to be part of environmental mitigation compliance monitoring activities
MITIGATION COSTS (US \$)	<ul style="list-style-type: none"> Costs for mitigation measures are included as part of construction contract costs.
MITIGATION TO AVOID DISRUPTION TO CULTURAL AND HISTORIC SITES	
RESOURCES TO BE PROTECTED	<ul style="list-style-type: none"> Cultural and Historic Resources – Section 4.6.3,
APPLICABLE SUB-PROJECTS	<ul style="list-style-type: none"> All
MITIGATION DESCRIPTION	<ul style="list-style-type: none"> All mitigation regarding cultural and historic sites to be implemented in accordance with IDA Operational Policy 11.03 – Cultural Property Locate construction facilities (worker camps, etc.) to avoid permanent alienation of important cultural or historic sites Where possible, locate engineering civil works to avoid permanent alienation of important cultural or historic sites Mark and fence off important cultural and historic sites that are adjacent or near to construction facilities and engineering civil works to prevent damage Construction contractors to include plan for avoidance of cultural and historic sites as part of their technical bids
PHASE OF PROJECT	<ul style="list-style-type: none"> Construction: First Investment Phase Construction: Second Investment Phase
MITIGATION TARGETS	<ul style="list-style-type: none"> All cultural and historic sites within Project Area remain intact and in the same condition as prior to construction
MONITORING REQUIRED	<ul style="list-style-type: none"> Compliance monitoring will be required to ensure mitigation targets are met
RESPONSIBILITIES FOR IMPLEMENTATION	<ul style="list-style-type: none"> Mitigation measures to be implemented as terms and conditions of construction contracts. SIUs will be responsible for preparing terms and conditions with technical assistance from the Consultant Environmental Specialists. Construction contractors will be responsible for implementing mitigation measures according to terms and conditions.
REPORTING REQUIREMENTS	<ul style="list-style-type: none"> Reporting on compliance with mitigation measures to be part of environmental mitigation compliance monitoring activities
MITIGATION COSTS (US \$)	<ul style="list-style-type: none"> Costs for mitigation measures are included as part of construction contract costs.
MITIGATION OF POSSIBLE DISRUPTION TO LOCAL COMMUNITIES FROM CONSTRUCTION ACTIVITIES	
RESOURCES TO BE PROTECTED	<ul style="list-style-type: none"> Populations and Communities – Section 4.3.8, Infrastructure, Local Facilities – Section 4.6.3,
APPLICABLE SUB-PROJECTS	<ul style="list-style-type: none"> All
MITIGATION DESCRIPTION	<ul style="list-style-type: none"> All vehicles must meet noise and air emission national standards. Households, outside construction Right-of-Way ROW (inside is included in the RP) which have suffered damage from road construction or road traffic impact should be compensated. Speed limits must be enforced on permanent and temporary roads. Safety signs and guard rails should be installed as needed. Specific security measures should be designed for village and school areas along the temporary and permanent project roads (e.g. speed bumps located at each end of residential areas or near schools). Compensate, according to the Resettlement Plan, households outside the ROW who have suffered damage from road construction or construction-related traffic.
PHASE OF PROJECT	<ul style="list-style-type: none"> Construction: First Investment Phase Construction: Second Investment Phase
MITIGATION TARGETS	<ul style="list-style-type: none"> No injuries or death to Sub-Project caused by construction activities Households outside of ROW are adequately compensated for disturbance caused by road traffic, other construction activities All inquiries and any complaints from local residents are promptly and properly dealt with by construction contractors.
MONITORING REQUIRED	<ul style="list-style-type: none"> Compliance monitoring will be required to ensure mitigation targets are met
RESPONSIBILITIES FOR IMPLEMENTATION	<ul style="list-style-type: none"> Mitigation measures to be implemented as terms and conditions of construction contracts. SIUs will be responsible for preparing terms and conditions with technical assistance from the Consultant Environmental Specialists. Construction contractors responsible for implementing the mitigation measures according to contract terms and conditions.
REPORTING REQUIREMENTS	<ul style="list-style-type: none"> Reporting on compliance with mitigation measures to be part of environmental mitigation compliance monitoring activities
MITIGATION COSTS (US \$)	<ul style="list-style-type: none"> Costs for mitigation measures are included as part of construction contract costs.

Table 30: VWRAP environmental mitigation program., continued.

Construction Phases, continued

MITIGATION OF INCREMENTAL EFFECTS OF PROVISION OF WATER FOR INDUSTRIAL USES, OPERATIONAL PHASE	
MITIGATION DESCRIPTION	<ul style="list-style-type: none"> • Development of program for strengthening environmental governance of industrial pollution control in selected priority provinces
TARGET SUB-PROJECTS	<ul style="list-style-type: none"> • First priority: Ha Tinh (Ke Go), Quang Nam (Phu Ninh), Khanh Hoa (Da Ban) • Second Priority: Cam Son-Cau Son, Quang Ninh • Third Priority: Ho Chi Minh City
PHASE OF PROJECT	<ul style="list-style-type: none"> • Construction: First Investment Phase
MITIGATION TARGETS	<ul style="list-style-type: none"> • development of detailed program for strengthening environmental governance of industrial pollution control, including a detailed schedule and allocation of responsibilities for implementation, prepared in consultation with relevant departments of selected priority provinces
MONITORING REQUIRED	<ul style="list-style-type: none"> • Strengthened enforcement and compliance monitoring of industrial pollution regulations in selected priority provinces
RESPONSIBILITIES FOR IMPLEMENTATION	<ul style="list-style-type: none"> • Provisional allocation of US \$150,000 from VWRAP Capacity Building and Training Fund for development and implementation of detailed program
REPORTING REQUIREMENTS	
MITIGATION COSTS (US \$)	

Operational Phases

MITIGATION OF INCREASED APPLICATION OF PESTICIDES AND FERTILIZERS DUE TO AGRICULTURAL EXTENSIFICATION AND INTENSIFICATION	
RESOURCES TO BE PROTECTED	<ul style="list-style-type: none"> • Surface Water Quality – Section 4.6.1, • Groundwater Resources – Section 4.6.1, • Aquatic Ecosystems and Aquatic Biodiversity - Section 4.6.2, • Domestic and Drinking Water Supply and Quality – Section 4.6.3, • Human Health - Section 4.4.9,
TARGET SUB-PROJECTS	<ul style="list-style-type: none"> • All Irrigation Sub-Projects
MITIGATION DESCRIPTION	<ul style="list-style-type: none"> • strengthening existing IPM practices in the command area through the provision of training in IPM techniques, pesticide and fertilizer selection and use, and encouragement of crop diversification. IPM extension will be conducted in accordance with IDA OP 4.03 – Pesticide Management
PHASE OF PROJECT	<ul style="list-style-type: none"> • Operation: First Investment Phase • Operation: Second Investment Phase
MITIGATION TARGETS	<ul style="list-style-type: none"> • No change in eutrophic status of surface and groundwater resources within and immediately downstream of Sub-Project Areas • No change in pesticide levels in surface and groundwater resources within and immediately downstream of Sub-Project Areas • Decrease or no change in amount of pesticide and fertilizer used in Sub-Project Areas per ha of crop cultivation
MONITORING REQUIRED	<ul style="list-style-type: none"> • Effects monitoring will be required to measure environmental conditions in surface and groundwater resources
RESPONSIBILITIES FOR IMPLEMENTATION	<ul style="list-style-type: none"> • IPM program to be implemented by Agriculture Extension offices under provincial DARDs, and involving comprising village level extension officers, subject matter specialists, agriculture extension centers; provincial extension units; farmer association support organizations
REPORTING REQUIREMENTS	<ul style="list-style-type: none"> • Annual IPM program implementation reports to be provided by provincial DARDs to SIUs.
MITIGATION COSTS (US \$)	<ul style="list-style-type: none"> • \$162,540 - Please see Table 26, for detailed description of costs and implementation schedule.

Table 30: VWRAP environmental mitigation program., continued.

Operational Phases, continued

MITIGATION OF INCREMENTAL EFFECTS OF PROVISION OF WATER FOR INDUSTRIAL USES, OPERATIONAL PHASE	
MITIGATION DESCRIPTION	<ul style="list-style-type: none"> Implementation of program for strengthening environmental governance of industrial pollution control in selected priority provinces
TARGET SUB-PROJECTS	<ul style="list-style-type: none"> First priority: Ha Tinh (Ke Go), Quang Nam (Phu Ninh), Khanh Hoa (Da Ban) Second Priority: Cam Son-Cau Son, Quang Ninh Third Priority: Ho Chi Minh City
PHASE OF PROJECT	<ul style="list-style-type: none"> Operation: First Investment Phase
MITIGATION TARGETS	<ul style="list-style-type: none"> Implementation of detailed program for strengthening environmental governance of industrial pollution control in selected priority provinces
MONITORING REQUIRED	<ul style="list-style-type: none"> Strengthened enforcement and compliance monitoring of industrial pollution regulations in selected priority provinces
IMPLEMENTATION RESPONSIBILITIES	<ul style="list-style-type: none"> Provisional allocation of US \$150,000 from VWRAP Capacity Building and Training Fund for development and implementation of detailed program
REPORTING REQUIREMENTS	
MITIGATION COSTS (US \$)	
MITIGATION OF ONGOING DEGRADATION OF SURFACE WATERS IN IRRIGATION SCHEME BY AQUATIC WEEDS	
RESOURCES TO BE PROTECTED	<ul style="list-style-type: none"> Surface Water Quality – Section 4.6.1, Aquatic Ecosystems and Aquatic Biodiversity - Section 4.6.2,
TARGET SUB-PROJECTS	<ul style="list-style-type: none"> Phu Ninh, Dau Tieng, Yen Lap
MITIGATION DESCRIPTION	<ul style="list-style-type: none"> Implement the aquatic weed control program
PHASE OF SUB-PROJECT	<ul style="list-style-type: none"> Operation: First Investment phase
MITIGATION TARGETS	<ul style="list-style-type: none"> Decline in the distribution and abundance of aquatic weeds in the Phu Ninh Reservoir and in the Phu Ninh command area to levels that are acceptable for operation of the Irrigation Scheme
MONITORING REQUIRED	<ul style="list-style-type: none"> Effects monitoring to measure changes in the spatial distribution and overall abundance of aquatic weeds in the Phu Ninh Irrigation Scheme
IMPLEMENTATION RESPONSIBILITIES	<ul style="list-style-type: none"> An appropriate Environmental Safeguard Contractor will be engaged to implement the action plan for the control of aquatic weeds in the Phu Ninh Irrigation Scheme under the supervision of the Consultant Environmental Specialists Phu Ninh IMC will be executing agency for the implementation of the action plan
REPORTING REQUIREMENTS	<ul style="list-style-type: none"> Annual reports will be prepared on progress of implementation of aquatic weed control measures Annual Phu Ninh Sub-Project Environmental Management Plan report will include summary of implementation progress and documentation of changes in distribution and abundance in aquatic weeds in the Phu Ninh Sub-Project Irrigation Scheme
MITIGATION COSTS (US \$)	<ul style="list-style-type: none"> 75,000 – Please see Table 26, for detailed description of costs and implementation schedule.
MITIGATION OF EFFECTS OF DAM SAFETY RISK	
RESOURCES TO BE PROTECTED	<ul style="list-style-type: none"> Populations and Communities – Section 4.3.8, Infrastructure, Local Facilities – Section 4.6.3,
TARGET SUB-PROJECTS	<ul style="list-style-type: none"> All Irrigation Sub-Projects
MITIGATION DESCRIPTION	<ul style="list-style-type: none"> Implementation of Dam Emergency Preparedness Plans
PHASE OF PROJECT	<ul style="list-style-type: none"> Operation: First Investment Phase Operation: Second Investment Phase
MITIGATION TARGETS	<ul style="list-style-type: none"> Please see VWRAP FS for details regarding Dam EPPs
MONITORING REQUIRED	
IMPLEMENTATION RESPONSIBILITIES	
REPORTING REQUIREMENTS	
MITIGATION COSTS (US \$)	

Table 31: Environmental Mitigation Compliance Monitoring Program.

Pre-Construction Phases

MITIGATION OF RESETTLEMENT AND LAND ACQUISITION	
MITIGATION PERFORMANCE MONITORING ACTIVITIES	<ul style="list-style-type: none"> VWRAP RAP and Sub-Project RAPS contain complete details on implementation responsibilities, monitoring, costs, and reporting requirements
RESPONSIBILITIES FOR MITIGATION PERFORMANCE MONITORING	
TOTAL ESTIMATED COST	
MITIGATION OF DISRUPTION TO WATER USERS FROM CANAL WORKS INCLUDING CANAL LINING	
TARGET SUB-PROJECTS	<ul style="list-style-type: none"> All Irrigation Sub-Projects
MITIGATION PERFORMANCE MONITORING ACTIVITIES	<ul style="list-style-type: none"> Review and approval of Canal Lining Plan prepared by SIUs (one for each investment phase)
RESPONSIBILITIES FOR MITIGATION PERFORMANCE MONITORING	<ul style="list-style-type: none"> provincial/city PPCs and affected districts and communes will review and approve plans. All villages in the affected communes will have been consulted and informed regarding the plans prior to approval
TOTAL ESTIMATED COST	<ul style="list-style-type: none"> Costs included as part of VWRAP implementation
MITIGATION OF EFFECTS OF EXPANDED COASTAL AQUACULTURE IN NUI THANH DISTRICT – PRE-CONSTRUCTION PHASES	
TARGET SUB-PROJECTS	<ul style="list-style-type: none"> Yen Lap, Ke Go, Phu Ninh, Da Ban
MITIGATION PERFORMANCE MONITORING ACTIVITIES	<ul style="list-style-type: none"> Review and approval of Environmental Review of Coastal Aquaculture in coastal districts of target Sub-Projects
RESPONSIBILITIES FOR MITIGATION PERFORMANCE MONITORING	<ul style="list-style-type: none"> Institutions to review and approve environmental reviews include: VWRAP PMU, MARD, IDA, provincial DoFIs, provincial DoSTEs, MoNRE
TOTAL ESTIMATED COST	<ul style="list-style-type: none"> Costs included as part of VWRAP implementation

Construction Phases

MITIGATION OF EFFECTS THROUGH CONSTRUCTION CONTRACTS:	
SURVEY AND TREATMENT OF UNEXPLODED ORDNANCE, DISRUPTION TO WATER USERS FROM CANAL LINING; EFFECTS OF DREDGED AND EXCAVATED SOILS; AVOIDANCE OF CULTURAL AND HISTORIC SITES; DISRUPTION TO LOCAL COMMUNITIES FROM CONSTRUCTION ACTIVITIES	
TARGET SUB-PROJECTS	<ul style="list-style-type: none"> All Irrigation Sub-Projects
MITIGATION PERFORMANCE MONITORING ACTIVITIES	<ul style="list-style-type: none"> supervision of construction contractors during construction activities and reporting on their compliance with the environmental terms and conditions contained in their contracts. synoptic reports will be prepared for each construction contractor visit (approximately 10 inspections per month). These will be integrated into monthly summary reports that will be submitted to SIUs. twice-yearly VWRAP Performance Monitoring Reports, summarizing construction contractor performance in the previous six months, will be prepared and submitted to SIUs. All monthly summary reports and the twice-yearly VWRAP Performance Monitoring Report will also be sent to VWRAP-PMU Annual compliance monitoring results will be integrated into the annual VWRAP Environmental Monitoring Reports Design of the reporting formats and supervision procedures will be completed during the Pre-Construction (Detailed Design) Phase
RESPONSIBILITIES FOR MITIGATION PERFORMANCE MONITORING	<ul style="list-style-type: none"> Appropriate Environmental Safeguard Contractors will be engaged to conduct supervision visits to construction sites, and prepare mitigation performance monitoring reports described above. Supervision visits will be conducted with technical supervision staff of SIUs to provide on-the-job training. Consultant Environmental Specialists will assist in design of the reporting formats and supervision procedures during the Pre-Construction (Detailed Design) Phase.
TOTAL ESTIMATED COST (\$US)	<ul style="list-style-type: none"> 163,943 - Please see Table 27, for detailed description of costs and implementation schedule.
MITIGATION OF INCREASED APPLICATION OF PESTICIDES AND FERTILIZERS DUE TO AGRICULTURAL EXTENSIFICATION AND INTENSIFICATION	
TARGET SUB-PROJECTS	<ul style="list-style-type: none"> All Irrigation Sub-Projects
MITIGATION PERFORMANCE MONITORING ACTIVITIES	<ul style="list-style-type: none"> Annual IPM implementation reports to be provided by provincial/city DARDs
RESPONSIBILITIES FOR MITIGATION PERFORMANCE MONITORING	
TOTAL ESTIMATED COST	<ul style="list-style-type: none"> Costs included as part of VWRAP implementation

Table 32: Environmental Effects Monitoring Sub-Program for VWRAP.

ENVIRONMENTAL EFFECTS MONITORING OF WATER QUALITY FOR EFFECTS OF SEDIMENTATION, EROSION DUE TO PROJECT ACTIVITIES AND APPLICATION OF PESTICIDES AND FERTILIZERS DUE TO AGRICULTURAL EXTENSIFICATION AND INTENSIFICATION	
TARGET SUB-PROJECTS	<ul style="list-style-type: none"> • All Irrigation Sub-Projects
MONITORING OBJECTIVE	<ul style="list-style-type: none"> • Determine what are the effects of extensification and intensification of agricultural land use and commodity production on the ability of surface and groundwater resources in the Project to: <ul style="list-style-type: none"> – meet ambient surface and groundwater quality standards – meet irrigation water standards – meet domestic and drinking water stands
ENVIRONMENTAL INDICATORS TO BE MEASURED	<ul style="list-style-type: none"> • With respect to ambient surface and groundwater quality; the following environmental indicators will be measured: <ul style="list-style-type: none"> – pH, conductivity (EC), total suspended solids (TSS), BOD5, COD, Fe, Al, nitrate-nitrite (NO2-3), phosphate (PO4-P), dissolved oxygen, total pesticide and herbicide • With respect to irrigation water standards, the following environmental indicators will be measured in surface waters: <ul style="list-style-type: none"> – Na, Mg, Ca (enabling calculation of sodium absorption ratio [SAR]), fecal coliform (pH, TSS, Al, and dissolved oxygen will also be used to assess Sub-Project effects on ability of surface waters to meet irrigation water standards) • The following environmental indicators, collected above, will be used to assess Sub-Project impacts on domestic and drinking water quality: <ul style="list-style-type: none"> – pH, conductivity (EC), total suspended solids (TSS), BOD5, COD, Fe, Al, nitrate-nitrite (NO2-3), phosphate (PO4-P), dissolved oxygen, fecal coliform
SAMPLING LOCATIONS, FIRST INVESTMENT PHASE	<ul style="list-style-type: none"> • surface water quality sampling will be conducted in 60 specific locations (all stations should be spatially referenced at establishment to enable mapping and spatial analysis of water quality results): <ul style="list-style-type: none"> – Reservoirs as upstream spatial controls (9); – Designated locations in main and primary canal systems (12) – 30 designated locations in pilot areas – 9 downstream (drainage area) locations outside of the command areas as downstream spatial controls • Groundwater quality sampling (as well as groundwater level monitoring) will be conducted in specific locations: <ul style="list-style-type: none"> – 30 designated locations distributed throughout the pilot areas – Spatial Controls: 30 locations outside the command area to serve as spatial controls (upstream and downstream of irrigated areas)
SAMPLING LOCATIONS, SECOND INVESTMENT PHASE	<ul style="list-style-type: none"> • Surface water quality sampling will be conducted in the following 98 locations (all stations should be spatially referenced at establishment to enable mapping and spatial analysis of water quality results): <ul style="list-style-type: none"> – Reservoirs as upstream controls (9) – Designated locations in main and primary canal systems (12) – Command area: a total of 68 locations in the command area – maintain pilot area sampling locations established in first investment phase; add sampling locations in the remaining 80% of the command area, i.e., half the sampling density of the pilot areas in four times the total area to be sampled; – Downstream (drainage area): 9 locations outside of the command area as downstream spatial controls • Groundwater quality sampling (as well as groundwater level monitoring) will be conducted in the following 90 locations: <ul style="list-style-type: none"> – Command Area: a total of 60 locations in the command area – maintain pilot area sampling locations established in first investment phase; add sampling locations in the remaining 80% of the command area, i.e., ¼ the sampling density of the pilot areas in four times the total area to be sampled; – Spatial Controls: 30 locations outside the command area to serve as spatial controls (upstream and downstream of irrigated areas)
SAMPLING SCHEDULE, FIRST AND SECOND INVESTMENT PHASES	<ul style="list-style-type: none"> • for surface water quality: <ul style="list-style-type: none"> – pre-construction (for each investment phase, to establish pre-Sub-Project baseline): 2 times per year in each survey location (rainy season and dry season) – construction: 2 times per year in each survey location (rainy season and dry season) – operation: 2 times per year in each survey location (rainy season and dry season) • for groundwater quality: <ul style="list-style-type: none"> – pre-construction (for each investment phase, to establish pre-Sub-Project baseline): 1 time per year in each survey location (dry season) – construction: 1 time per year in each survey location (dry season) – operation: 1 time per year in each survey location (dry season) • with respect to total pesticides and herbicides, for both surface and groundwater quality, monitoring to be done once per year, in peak of dry season (April) in each of three phases for each investment phase
ADDITIONAL DATA AND INFORMATION TO BE COLLECTED	<ul style="list-style-type: none"> • Up to date, timely, and accurate information on: <ul style="list-style-type: none"> – construction and operation of the Sub-Project, – annual or seasonal land use and commodity production within the command area; – weather data from Hydrometeorological Stations; – IPM activities from provincial/city DARDs – groundwater information from Hydrogeological Service

Table 32: Environmental Effects Monitoring Sub-Program continued.

ENVIRONMENTAL EFFECTS MONITORING OF WATER QUALITY FOR EFFECTS OF SEDIMENTATION, EROSION DUE TO PROJECT ACTIVITIES AND APPLICATION OF PESTICIDES AND FERTILIZERS DUE TO AGRICULTURAL EXTENSIFICATION AND INTENSIFICATION, CONTINUED	
RESPONSIBILITIES FOR IMPLEMENTATION	<ul style="list-style-type: none"> Environmental Safeguard Contractors will be engaged to implement this component of the Environmental Effects Monitoring Program. Detailed Terms of Reference for the Contractor will be prepared by the Consultant Environmental Specialist during Detailed Design Phase for the VWRAP. The Consultant Environmental Specialist will oversee and guide Environmental Safeguard Contractors during first three years of Sub-Project implementation.
REPORTING REQUIREMENTS	<ul style="list-style-type: none"> for first three years of Sub-Project implementation, Consultant Environmental Specialists, with the assistance of the Environmental Safeguard Contractors, will include results in annual VWRAP Environmental Management Plan Report. After this, reporting responsibility will lie solely with Environmental Safeguard Contractors. The Environmental Safeguards Contractors will also be required to prepare a six-month progress report in each year of the monitoring.
COMMENTS	<ul style="list-style-type: none"> it will be necessary to ensure that the pesticides and herbicides that are monitored are representative of the entire suite of pesticides and herbicides that are used in the Sub-Project the sampling regime for second investment phase will need to be reviewed during the detailed design (pre-construction) phase of the second investment phase 15% of budget should be spent of QA/QC; MoNRE Circular on QA/QC for environmental monitoring should be followed.
TOTAL ESTIMATED COST, TOTAL OF FIRST AND SECOND INVESTMENT PHASES (US \$)	<ul style="list-style-type: none"> 421,515 - Please see Table 27, for detailed description of costs and implementation schedule
ENVIRONMENTAL EFFECTS OF EXPANDED COASTAL AQUACULTURE AND EFFECTS OF COASTAL AQUACULTURE ENVIRONMENTAL MANAGEMENT PLAN	
TARGET SUB-PROJECTS	<ul style="list-style-type: none"> Yen Lap, Ke Go, Phu Ninh, Da Ban
MONITORING OBJECTIVE	<ul style="list-style-type: none"> Determine what are the environmental effects of increasing aquaculture as a result of providing freshwater from the target Sub-Projects to the aquaculture sector in the coastal districts of the target Sub-Projects
ENVIRONMENTAL INDICATORS TO BE MEASURED	<ul style="list-style-type: none"> the exact environmental indicators to be measured will be determined during the environmental review of the coastal aquaculture program conducted during the pre-construction phase of the first investment phase (Table 30), but it is expected that the following environmental indicators will be need to be measured: <ul style="list-style-type: none"> Ambient freshwater and coastal water quality: pH, conductivity (EC), total suspended solids (TSS), BOD5, COD, Fe, Al, nitrate-nitrite (NO2-3), phosphate (PO4-P), dissolved oxygen Integrity of coastal wetlands and condition of any wetlands restored as part of coastal aquaculture environmental management plan: area of wetland by wetland category and condition of these wetlands
SAMPLING LOCATIONS	<ul style="list-style-type: none"> Ambient freshwater and coastal water quality: <ul style="list-style-type: none"> Six sampling locations within and adjacent to the aquaculture areas in each of the target Sub-Projects: one sampling location upstream and four sampling locations within the aquaculture area, as well as one sampling location in the nearshore coastal area of the coastal district of the target Sub-Projects. Integrity of coastal wetlands and condition of restored wetlands: <ul style="list-style-type: none"> All coastal wetlands throughout the coastal districts of the target Sub-Projects will be surveyed
SAMPLING SCHEDULE, FIRST AND SECOND INVESTMENT PHASES	<ul style="list-style-type: none"> Ambient freshwater and coastal water quality: <ul style="list-style-type: none"> Each year; 2 times per year in each survey location (once after main shrimp crop and once during rainy season) Integrity of coastal wetlands: <ul style="list-style-type: none"> Annually: Year 1 to provide a pre-Project baselines
ADDITIONAL DATA AND INFORMATION TO BE COLLECTED	<ul style="list-style-type: none"> Up to date, timely, and accurate information for each year of Project on: <ul style="list-style-type: none"> land use and commodity production construction and operation of the target Sub-Project
RESPONSIBILITIES FOR IMPLEMENTATION	<ul style="list-style-type: none"> Environmental Safeguard Contractors will be engaged to implement this component of the Environmental Effects Monitoring Program under the direction of the Sub-Project SIU. Detailed ToR for the Contractor will be prepared by the Consultant Environmental Specialist during Detailed Design Phase for the VWRAP EMP. Consultant Environmental Specialist will oversee and guide Environmental Safeguard Contractor during first three years of implementation.
REPORTING REQUIREMENTS	<ul style="list-style-type: none"> for first three years of Sub-Project implementation, Consultant Environmental Specialists, with the assistance of the Environmental Safeguard Contractors, will include results in annual Sub-Project Environmental Management Plan Reports. After this, reporting responsibility will lie solely with Environmental Safeguard Contractors. The Environmental Safeguards Contractors will also be required to prepare a six-month progress report in each year of the monitoring.
TOTAL ESTIMATED COST, FIRST AND SECOND INVESTMENT PHASES (US\$)	<ul style="list-style-type: none"> 42,564 - Please see Table 27 for detailed description of costs and implementation schedule

ANNEXES

ANNEX 1: TERMS OF REFERENCE FOR EIA

TERMS OF REFERENCE FOR CONSULTING SERVICES FOR VWRAP EIA CONSULTANT

I. BACKGROUND INFORMATION

1. The Government of Vietnam (GOVN) has requested a Credit from the International Development Association (IDA) to help finance the proposed Vietnam Water Resources Assistance Project (VWRAP). In order to carry out VWRAP preparation, the GOVN through the Ministry of Agriculture and Rural Development (MARD) has obtained a PHRD grant from the Japanese Government to procure the consultancy services. VWRAP is scheduled for IDA appraisal in mid-2003. The Central Project Office (CPO) under MARD will lead the overall coordination for VWRAP preparation and manage the grant. It will enter a contract with the Consultant to undertake the services specified herein.
2. VWRAP has three components: (1) Integrated Development of the Thu Bon Basin; (2) Irrigation Modernization; and (3) Dam Safety Management. VWRAP is classified as a "Category A" environmental project, requiring an independent EIA report per IDA requirements. Preparation of the overall project is being done under another contract. The consultants responsible for overall VWRAP preparation are referred to as the "Consultant". The consultant responsible for executing this TOR is referred to as the "EIA Consultant", which includes an EIA international expert and a local EIA team, to complete the scope of work mentioned hereafter at the section of scope of work for the EIA consultant.
3. Some attached reference documents provide a comprehensive description of the VWRAP physical investments (i.e. subprojects) and should be considered an integral part of this TOR. The EIA Consultant and the Consultant are required to work together to integrate the EIA into the project's technical, economic, financial, social, and institutional analyses. The Consultant will carry the primary burden for collecting and analyzing environmental information, holding consultations, and producing an environmentally sound project. The Consultant will provide the EIA Consultant with technical analyses, reports, and engage in technical discussions with the EIA team on engineering analysis, etc. The role of the EIA Consultant is to work with the Consultant to help manage the EIA process, provide specialized environmental analysis where required, and independently produce an EIA report. The specific scope of work is presented below.
4. **Component 1 of VWRAP** is less well-defined at this time and subprojects in the Thu Bon Basin will be identified/confirmed during the formulation of the Thu Bon Integrated Basin Plan (TIBP). Possible subprojects in the Thu Bon Basin include: flood protection works, modernization of water delivery and drainage systems, small storage facilities for local irrigation, mini-hydropower generation, rural water supply, upper watershed management, improvement of flood preparedness and warning, etc. Total estimated investment cost of these sub-projects is around US\$20 million.
5. Under **Components 2 and 3 of VWRAP**, the subprojects are relatively well defined: i) Dau Tieng—mainly in Tay Ninh province), ii) Ke Go—Ha Tinh province, iii) Cam Son-Cau Son—Bac Giang province, iv) Yen Lap in Khanh Hoa province; and v) Yen Lap in Quang Ninh province. The schemes range in size from 10,000-50,000 ha with investment needs estimated to be on the order of \$5-20 million for each scheme. Infrastructure investments include: remedial dam safety works and possible installation of micro-hydropower plants; canal lining and improved water distribution systems; rehabilitation of pumping stations; etc.

II. OVERALL SCOPE OF WORK FOR THE EIA CONSULTANT

6. The types of environmental issues that could occur are listed below. The EIA Consultant is expected to screen and rank the most pressing environmental impacts.
 - Water availability, basin water balances, and water use rights, water quality due to sedimentation, runoff and the use of agricultural chemicals
 - Dam safety
 - Downstream impacts from reservoirs and irrigation schemes,
 - Effects of water abstraction, flood control and salinity control structures on: aquatic ecology, particularly fish resources, hydrology including groundwater recharge and water quality, plant and animal ecology.
 - Involuntary resettlement and project affected people, including impacts on indigenous people.
 - Impacts of resettlement on the environment eg. forest cutting or wetland encroachment, new agricultural practice and livelihood patterns, land tenure
 - Impacts on cultural property
 - Impacts on natural habitats and nature reserves

- Construction impacts, including: construction camps, disposal of dredged material, road safety, etc.
7. The EIA Consultant will help manage the EIA process and prepare an Environmental Impact Assessment and Environmental Management Plan (EMP) for VWRAP. The EIA will meet IDA requirements for Environmental "Category A" projects (OP 4.01 "Environmental Assessment" and associated annexes) and be in compliance with all Vietnamese laws and regulations.
 8. The scope of work for the EIA Consultant is limited to EIAs for the investment subprojects only, meaning 5 subprojects in the component 2 and priority investment subprojects in Thu Bon river basin, and not the TIBP. (The TIBP can be considered a regional environmental study by itself.) The EIA Consultant will prepare a separate EIA/EMP for each subproject, which will then be merged into one final EIA report. The Consultant shall be the main source of information. The EIA Consultant may also request the Consultant (or request MARD to direct the Consultant if necessary) to collect additional information or, if more expedient and within the budget of the EIA Consultant, collect the information itself. The EIA shall cover the issues below, and other relevant matters.
 9. *Policy, legal and administrative framework.* Review policy, legal, and administrative framework within which the EIA is carried out at the national and provincial levels. This includes, among other topics: environmental quality, water resources, dam safety, health and safety, protection of sensitive areas, protection of endangered species, siting, land use control, resettlement, protection of cultural property etc.
 10. *Define the Project and its Area of Influence:* Define the proposed subproject and its geographic, ecological, social, and temporal context, including any off-site investments that may be required (i.e., access roads, construction camps, product storage facilities, sediment disposal areas, etc.). Ascertain the need for plans for resettlement, project affected people, or indigenous peoples. Develop maps showing the project site and the project's area of influence.
 11. *Collect Baseline Data:* Assess the dimensions of the study area and describe relevant physical, biological, and socio-economic conditions, including any changes expected before the project commences. Also take into account current and proposed development activities within the project area, but not directly connected to the project. Data should be relevant to decisions about project location, design, operation, or mitigatory measures. The accuracy, reliability, and sources of data should also be assessed.
 12. *Assess Environmental Impacts:* Predict and assess the project's likely positive and negative impacts, including possible cumulative impacts, in quantitative terms to the extent possible. Identify mitigation measures and residual impacts that can not be mitigated. Explore opportunities for environmental enhancements. Identify and estimate the extent and quality of available data, key data gaps, and uncertainties associated with predictions, and specific topics which require further attention.
 13. *Analyze Project Alternatives:* Systematically compare feasible alternatives to the proposed project site, technology, design, and operation including the "without project" situation—in terms of their potential environmental and social impacts; the feasibility of mitigating these impacts, their capital and recurrent costs, suitability under local conditions, and their institutional, training, and monitoring requirements. For each of the alternatives, quantify the environmental impacts to the extent possible, and attach economic values where feasible. State the basis for selecting the particular project design proposed.
 14. *Environmental Management Capabilities.* This would include issues relating to assessment of the existence, role and capability of environmental units on-site, or at the agency and ministry level, potential participation of project affected people in project implementation, local mass organisations, NGOs and/or academic institutions, and the role of the local population in maintaining the existing ecosystems. Based on these findings, recommendations should be made concerning the establishment and/or expansion of such units, and the training of staff, to the point that EIA recommendations can be implemented.
 15. *Public Consultation and Disclosure:* The EIA Consultant is expected, in conjunction with the Consultant, to plan, manage, and document the consultation and disclosure process. The Public Consultation and Disclosure Plan will be approved by MARD and should contain information on how stakeholders will be identified, key consultation points, objectives of the consultation, level of consultation, consultation techniques and methodology, and timetable. The Consultant will be requested to prepare necessary material to facilitate the consultations. The World Bank Environmental Assessment Sourcebook (Update 26, May 1999 "Public Consultation in the EIA Process") provides guidelines and techniques for effective consultation. The EIA Consultant, in conjunction with the Consultant, will also consult with affected groups throughout project implementation as necessary to address EIA-related issues. The disclosure of the EIA reports as required by the OP 4.01 and BP 17.50, should be approved by MARD in agreement with MONRE, which is in charge of EIA appraisal.
 16. The Consultant will organize, in conjunction with the EIA Consultant and with the assistance of the IMC and Provincial authorities, at least two stakeholder consultation meetings for each subproject. The Consultant will cover the costs of the consultations. The first consultation should take place to discuss the conceptual approach to scheme improvements and the scope of work for the EIA, and the second consultation should review the Draft Final Feasibility Study/EIA. The Consultant shall cover the costs of

these consultations. The Consultant shall cover the costs of these workshops. Relevant stakeholders should be invited to both workshops including: MARD officials, provincial authorities, IMC officers, local mass organizations, NGOs and/or academic institutions, farmer representatives, etc. per the Public Consultation and Disclosure Plan.

17. *Environmental Management Plan*: An EMP shall be prepared which consists of the set of mitigation, monitoring, and institutional measures to be taken during construction and operation to eliminate environmental and social impacts, off-set them, or reduce them to acceptable levels. The plan also includes the actions necessary to implement these measures. Specifically:
18. *Mitigation*: Identify feasible and cost-effective measures that may reduce potentially significant adverse environmental impacts to acceptable levels. The plan should include compensatory measures if mitigation measures are not feasible, cost-effective, or sufficient. The proposed mitigation measures should include technical details and an implementation plan for each mitigation measure and describe linkages with other mitigation plans (e.g., involuntary resettlement, indigenous peoples, cultural property, etc.) required for the project.
19. *Monitoring*: The monitoring program should provide information about key environmental issues and the effectiveness of mitigation measures during project construction and operation. The objectives and types of monitoring should be identified with clear linkages to the impacts assessed in the EIA and the mitigation measures described in the EMP. The monitoring program should provide a set of monitoring indicators, specify descriptions, technical details, and reporting procedures. Monitoring reports should also be submitted to the local environmental authorities (DoSTEs). Independent environmental monitoring is not necessary in general, but environmental monitoring should be a part of the project monitoring to be carried out by a sub-contractor to the Consultant. Independent environmental monitoring could be undertaken if required by the local authorities under certain circumstances.
20. *Capacity Development and Training*: The EMP draws upon the EIA's assessment of the existence, role, and capability of environmental units on site or at the agency and ministry level. If necessary, recommend the establishment or expansion of such units, and the training of staff, to allow implementation of EIA recommendations. The EMP shall provide a description of the institutional arrangements—who is responsible for carrying out the mitigatory and monitoring measures (e.g., operation, supervision, enforcement, monitoring of implementation, financing, reporting and staff training).
21. *Implementation Schedule and Cost Estimates*: For all three aspects (mitigation, monitoring, and capacity development) the EMP shall provide (a) an implementation schedule for measures that must be carried out as part of the project, showing phasing and coordination with overall project implementation plans; and (c) capital and recurrent cost estimate and sources of fund for implementing the EMP. These figures should be integrated into the total subproject cost tables.

III. SCOPE OF WORK FOR THE INTERNATIONAL EIA EXPERT

22. The international expert is responsible to coordinate with the local EIA consultant team (composing expert/specialist in the Table 1) to complete the General Scope of Work for the EIA Consultant. More particularly, the international expert will have following responsibilities:
 - To take the position of the EIA consultant team leader and will coordinate all activities of the EIA consultant team;
 - To review all data and information that were collected and processed by the local EIA consultant team and reasonably propose to the local team further needed data and information collections;
 - To guide the local EIA consultant team to co-prepare draft EIA reports; and
 - With the close assistance by the local EIA consultant team, the international expert will complete and submit final EIA reports, which have to be acceptable by both MARD and IDA, for all investment subprojects.

IV. SCOPE OF WORK FOR THE LOCAL EIA TEAM

23. The local team is responsible to assist and coordinate with the international EIA expert to complete the General Scope of Work for the EIA Consultant. More particularly, the local team will have following responsibilities:
 - Based on data and information provided by the VWRAP Consultant and requirements for preparation of the EIA reports for investment subprojects, the local EIA consultant team will carry out further data and information collections, surveys, and investigations, if required. To be responsible for data inputs, data analyses and processes. Both primary and processed data will be conveyed to the international expert;
 - With the guidance by the international expert, co-prepare and submit draft EIA reports for investment subprojects. Assist the International EIA consultant to complete final EIA reports, which have to be acceptable by both MARD and IDA, for all investment subprojects; and
 - To be liaison between the international EIA expert and local related agencies.

V. EIA CONSULTANT STAFFING AND SUBMISSION OF REPORTS

24. *EIA Consultant Team Profile*. It is expected that the EIA Consultant team will compose an international expert with experience preparing international-level EIA reports as the team leader and a

local team. Table 1 contains suggested areas of expertise for national/experts, and qualifications of key staff. The EIA Consultant may propose alternative staffing to match the proposed lines of action. Under no circumstance does acceptance of the staffing list in Table 1 release the EIA Consultant from any responsibility under these TOR.

25. **Reports.** Final EIA reports for all investment subprojects are to be submitted to MARD and IDA by February, 2003. The number of EIA reports to be submitted and schedule for report submission are in Table 2. The international EIA expert will bear all the cost for the reproduction of the English version of EIA report, whereas the local EIA team will be responsible for the reproduction of the Vietnamese version of the EIA reports. The local EIA consultant team will have to make sure that the meanings of the Vietnamese version of EIA reports are matched with their English version. Electronic copies of all reports should be provided to both MARD and IDA, to the extent possible.

Note: The EIA Consultant shall reach agreement with the Consultant and MARD during project implementation on how best to package the feasibility studies (FS), resettlement action plans (RAPs), management plans (MPs), and EIAs for each investment subproject. MARD will make extra copies of reports as required for consultation/workshop purposes.

VI. INPUTS FROM THE GOVERNMENT

26. **GoVN Input, Data and Coordination Arrangement.** MARD, through CPO, will be the project coordinating unit. The CPO will coordinate with participating Ministries, agencies, and provincial authorities to provide counterpart inputs, and arrange review and participate in discussions with the EIA Consultant on issues related to the assignment. It will facilitate and assign counterpart staff to assist the EIA Consultant in obtaining necessary visas, authorizations and access to facilities for carrying out the services. It will make available to the EIA Consultant all *existing* aerial photographs, maps, studies, plans, reports, drawings and information relevant to the execution of this assignment within the MARD. IDA will assist the GOVN in (i) supervision of PHRD grant implementation; (ii) VWRAP preparation; and (iii) liaison with other donors.
27. The international EIA expert will receive and inherit the EIA inception/ scoping report which was prepared by the previous international EIA expert in association with the local EIA consultant team.

VII. GUIDANCE TO EIA CONSULTANTS

28. The EIA Consultant will be *based in Hanoi* (unless otherwise agreed-upon with MARD), and will be provided by the Government with an office, preferably shared with the Consultant. The EIA Consultant will pay its costs for local transport, operational costs, office equipment (tel./fax/copying), secretarial support, required office equipment and supplies, translation and printing/copying. The EIA Consultant will submit the following items to the Government: (i) licensed copies of all proprietary computer software used together with manuals; (ii) copies of all software developed under the consultancy assignment in magnetic form, together with source listing and full documentation; (iii) satellite imagery and maps procured and used; (iv) copies of all data used in magnetic form and hard copy; and (v) complete description of all methodologies used and the assumptions made.

Table 1: Suggested Staffing Profile for the EIA Consultant

<i>Expertise</i>	<i>International (mm)</i>	<i>Local (mm)</i>
Environmental Expert	3.5	6
Environmental Specialist		8
Social-Resettlement Expert		3
Total	3.5	17

Environmental Expert: The international environmental expert should have at least 10 years experience preparing EIAs for water resources projects in Asia which meet the requirements of international development agencies, such as the World Bank or the Asian Development Bank. Experience in Vietnam would be a plus. The local expert should have at least 10 years experience preparing EIAs in Vietnam, with significant experience in the preparation of water resources projects for international agencies.

Environmental Specialist: Should have experience in the environmental assessment of water resources projects, including dams, flood control structures, and irrigation works in Vietnam.

Social-Resettlement Expert: Should have practical experience in social assessment techniques and the preparation of resettlement plans.

Table 2: Reporting Obligations

Of the Local EIA Team:

<i>Outputs</i>	<i>Number of copies</i>
Draft EIA Reports for Dau Tieng and Cau Son-Cam Son subprojects	10 Vietnamese, 10 English
Draft EIA Reports for Ke Go, Yen Lap and Yen Lap subprojects and priority investment subprojects in Thu Bon river basin	10 Vietnamese, 10 English

Of the International EIA Expert:

<i>Outputs</i>	<i>Number of copies</i>
Final EIA Reports for Dau Tieng and Cau Son-Cam Son subprojects	10 Vietnamese, 10 English
Final EIA Reports for Ke Go, Yen Lap and Yen Lap subprojects and priority investment subprojects in Thu Bon river basin	10 Vietnamese, 10 English
Final EIA Report (integrating EIA Reports for all subprojects)	10 Vietnamese, 10 English

**ANNEX 2: SUMMARY OF PUBLIC CONSULTATIONS IN SUPPORT OF
EIA PREPARATION**

Table 33: Summary of EIA consultations to date.

Date	Consultation Participants	Objectives of Consultation	Consultation Techniques and Methodologies Used	How Results of Consultation Were Used
Yen Lap Sub-Project				
6 to 7 June 2002	<ul style="list-style-type: none"> Director and staff of Yen Lap IMC, Quang Ninh DoSTE, and Quang Ninh DARD, farmers in proposed pilot areas 	<ul style="list-style-type: none"> introduction of EIA Consultant team to provincial departments and IMC presentation of overview and purpose of EIA scoping and identification of environmental issues 	<ul style="list-style-type: none"> formal meetings and semi-structured interviews some secondary data review site visit to Yen Lap Dam and Reservoir, main and primary canal structures, and pilot areas 	<ul style="list-style-type: none"> inputs to Yen Lap component of Scoping Report and identification of main issues for analysis
10 July 2002	<ul style="list-style-type: none"> Director and staff of Yen Lap IMC, Quang Ninh PPC, Quang Ninh DoSTE, and Quang Ninh DARD, Yen Hung District officials, and representatives from Lien Hoa Agricultural Cooperatives Nos. 1, 2,3 	<ul style="list-style-type: none"> Local EIA consultants participated in larger stakeholder consultation workshop presentation of overview, purpose, and requirements of EIA scoping and identification of environmental issues 	<ul style="list-style-type: none"> formal workshop and secondary data review field visits to Song Khoai Pilot Area (N6 and N12 canals small canals getting water directly from main canal) and Lien Hoa Pilot Area (N26 and N28 canals small canals getting water directly from main canal) semi-structured interviews with farmers during field visits 	<ul style="list-style-type: none"> further identification of environmental issues within pilot areas issue of coal exploitation within watershed of Yen Lap Reservoir destroying reservoir forest cover and changing hydrological regime, as well as degrading water quality
Cam Son-Cau Son Sub-Project				
4 to 6 June 2002	<ul style="list-style-type: none"> Director and staff of Cau Son IMC, Bac Giang DARD, Bac Giang DoSTE, Bac Giang DoLISA 	<ul style="list-style-type: none"> introduction of local EIA Consultant team to provincial departments and IMC scoping and identification of environmental issues 	<ul style="list-style-type: none"> informal meetings and semi-structured interviews in departmental offices and IMC site visit to Cam Son Dam, Cam Son Reservoir, Cau Son Weir, main and primary canal structures, and pilot areas 	<ul style="list-style-type: none"> main inputs to Cam Son-Cau Son component of Scoping Report and identification of main issues for analysis
18 and 19 June 2002	<ul style="list-style-type: none"> Cau Son IMC, Bac Giang DARD, Bac Giang PPC 	<ul style="list-style-type: none"> introduction of international EIA Consultant to provincial departments and IMC scoping and identification of environmental issues 	<ul style="list-style-type: none"> formal meeting and field visit, semi-structured interviews with farmers during field visit 	<ul style="list-style-type: none"> inputs to Cam Son-Cau Son component of Scoping Report and identification of main issues for analysis
28 June 2002	<ul style="list-style-type: none"> Director and staff of Cau Son IMC, Bac Giang DARD, Bac Giang DPI, representatives from Bac Giang Town, Yen Dung District, Lang Giang District 	<ul style="list-style-type: none"> Local EIA consultants participated in larger stakeholder consultation workshop presentation of overview, purpose, and requirements of EIA introduced socioeconomic survey to be done by EIA Consultant additional scoping and identification of environmental issues 	<ul style="list-style-type: none"> formal workshop 	<ul style="list-style-type: none"> improved arrangements for follow-on EIA activities further identification of environmental issues, in particular, use of Bac Giang Fertilizer Factory wastewater as source of irrigation water for Nui Sui command area
6 to 12 August 2002	<ul style="list-style-type: none"> farmer beneficiaries in proposed Y2 and Nui Sui Pilot Areas 	<ul style="list-style-type: none"> inform farming households about purpose of Sub-Project and of EIA obtain socioeconomic information for Cam Son-Cau Son EIA 	<ul style="list-style-type: none"> two consultative meetings to initiate socioeconomic surveys (one in each pilot area). Meetings organized by Bac Giang Town Irrigation Station for Nui Sui and Lang Giang District for Y2 pilot area formal interviews using socioeconomic questionnaire as structure of interview. Total of 120 households surveyed. 	<ul style="list-style-type: none"> socioeconomic information obtained formed the basis for the socioeconomic description of the pilot areas in the preliminary EIA for the Cam Son-Cau Son Sub-Project and for assessment of impacts on socioeconomic resources. survey data augmented by social survey to be conducted in Cam Son-Cau Son Sub-Project by Consultant

Table 333, continued

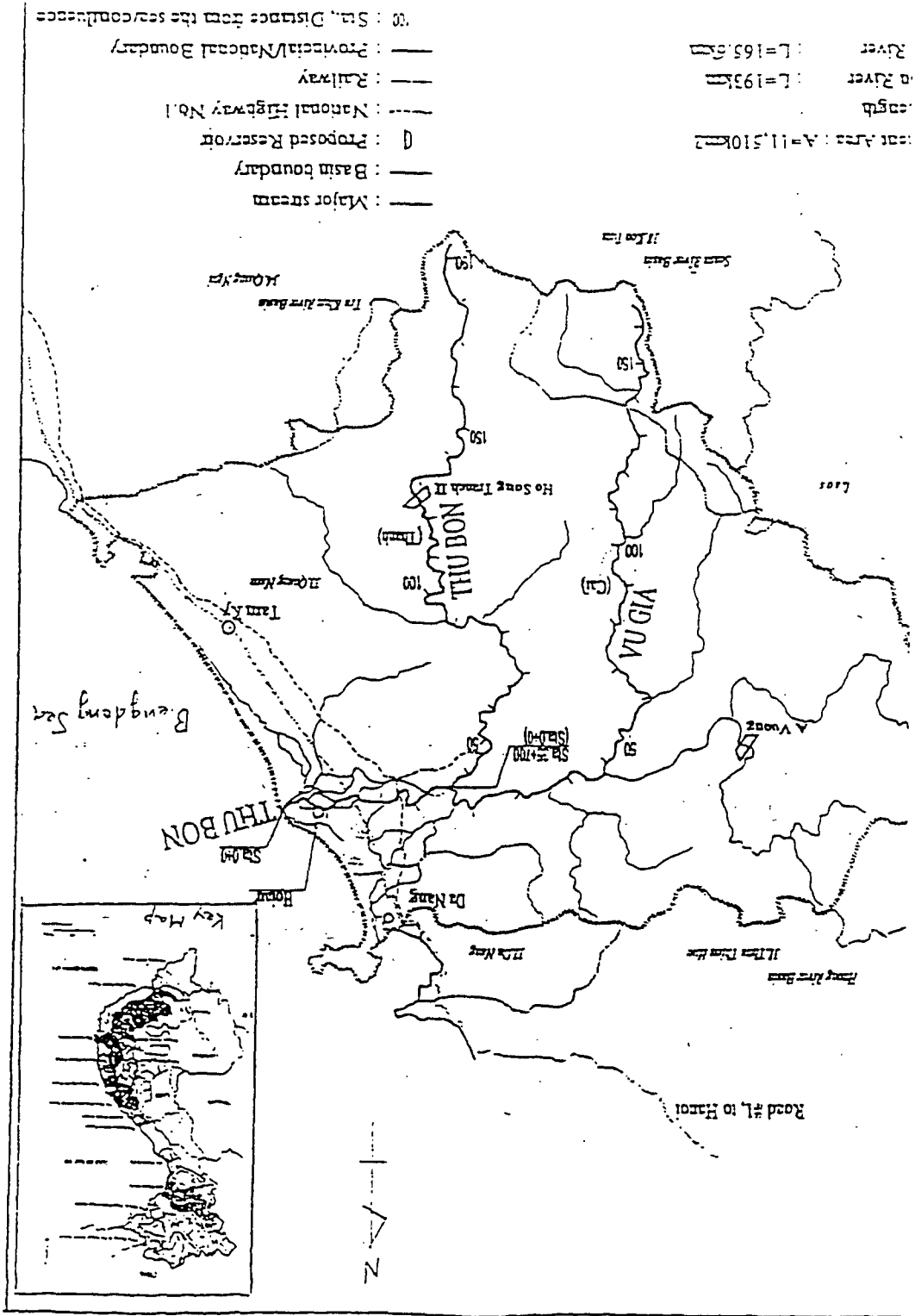
Date	Consultation Participants	Objectives of Consultation	Consultation Techniques and Methodologies Used	How Results of Consultation Were Used
Cam Son-Cau Son Sub-Project, continued				
26 September 2002	<ul style="list-style-type: none"> Cau Son IMC, farmers in proposed Nui Sui Pilot Area 	<ul style="list-style-type: none"> Members of EIA Consultant participated in Consultant visit to discuss modernization issues 	<ul style="list-style-type: none"> Secondary data review and semi-structured interviews with IMC, informal consultations with farmers during field visit 	<ul style="list-style-type: none"> Issues of disturbance to local communities and households from construction activities related to canal widening were identified
Ke Go Sub-Project				
11 July 2002	<ul style="list-style-type: none"> Ha Tinh PPC, Ha Tinh DARD, Ke Go IMC 	<ul style="list-style-type: none"> introduction of EIA Consultant team to provincial departments and IMC presentation of overview and purpose of EIA scoping and identification of environmental issues 	<ul style="list-style-type: none"> formal meetings followed by field visit to Ke Go, semi-structured interviews with farmers during field visit 	<ul style="list-style-type: none"> inputs to Ke Go component of Scoping Report and identification of main issues for analysis
Phu Ninh Sub-Project				
11 November 2002	Phu Ninh IMC, Quang Nam DARD, Quang Nam DoSTE	<ul style="list-style-type: none"> introduction of EIA Consultant team to provincial departments and IMC presentation of overview and purpose of EIA scoping and identification of environmental issues 	<ul style="list-style-type: none"> formal meetings followed by field visit to Phu Ninh, semi-structured interviews with farmers during field visit 	<ul style="list-style-type: none"> identification of main issues for analysis
11 November 2002	Phu Ninh IMC	<ul style="list-style-type: none"> scoping and identification of environmental issues 	<ul style="list-style-type: none"> field visit to lower end of N14 and N16 secondary canals 	<ul style="list-style-type: none"> continued identification of main issues for analysis, particularly with respect to upgrading of canal system
12 November 2002	Quang Nam FPD, Phu Ninh Nature Reserve Management Board, WWF MOSAIC Project staff	<ul style="list-style-type: none"> Preliminary assessment of effects of Sub-Project 	<ul style="list-style-type: none"> formal meetings and interviews 	<ul style="list-style-type: none"> obtained information on status and condition of Phu Ninh Nature Reserve and importance of biodiversity of Nature Reserve
12 November 2002	Phu Ninh IMC	<ul style="list-style-type: none"> Assessment of capacity of Phu Ninh IMC to conduct compliance monitoring 	<ul style="list-style-type: none"> formal meetings and interviews 	<ul style="list-style-type: none"> will be used in development of institutional arrangements for Phu Ninh Sub-Project EMP
Quang Hue-Vu Gia Sub-Project				
11 November 2002	<ul style="list-style-type: none"> Quang Nam IMC, DARD, DoSTE, FPD 	<ul style="list-style-type: none"> introduction of EIA Consultant team to and IMC presentation of overview and purpose of EIA scoping and identification of environmental issues 	<ul style="list-style-type: none"> formal meetings and secondary data review 	<ul style="list-style-type: none"> clearer identification of main issues for environmental analysis
12 November 2002	<ul style="list-style-type: none"> Quang Nam DARD (Water Resources Office) 	<ul style="list-style-type: none"> Obtain detailed description of Quang Hue-Vu Gia River Control works Obtain environmental and social information required for EIA 	<ul style="list-style-type: none"> field visit to Quang Hue-Vu Gia River Control works, semi-structured interviews with farmers during field visit 	<ul style="list-style-type: none"> continued identification of environmental issues
Da Ban Sub-Project				
6 to 9 August 2002	<ul style="list-style-type: none"> Khanh Hoa DoSTE, Khanh Hoa DARD, North Khanh Hoa IMC 	<ul style="list-style-type: none"> introduction of EIA Consultant team to provincial departments and IMC presentation of overview and purpose of EIA scoping and identification of environmental issues 	<ul style="list-style-type: none"> formal meetings and secondary data review site visit to Da Ban Dam and irrigation system 	<ul style="list-style-type: none"> clearer identification of main issues for environmental analysis improved arrangements for follow-on EIA activities

Table 33, continued

Date	Consultation Participants	Objectives of Consultation	Consultation Techniques and Methodologies Used	How Results of Consultation Were Used
Da Ban Sub-Project, continued				
16 August 2002	<ul style="list-style-type: none"> Khanh Hoa PPC, DoSTE, Khanh Hoa DARD, North Khanh Hoa IMC, Ninh Hoa and Van Ninh Districts, representatives from N3 and N4 pilot areas 	<ul style="list-style-type: none"> Local EIA consultants participated in larger stakeholder consultation workshop presentation of overview, purpose, and requirements of EIA additional scoping and identification of environmental issues 	<ul style="list-style-type: none"> formal workshop and field visits, semi-structured interviews with farmers during field visit 	<ul style="list-style-type: none"> continued identification of environmental issues make arrangements for socioeconomic surveys in pilot areas (see below)
19 and 20 August 2002	<ul style="list-style-type: none"> Khanh Hoa DoFi, DARD, DoCI 	<ul style="list-style-type: none"> Obtain information for EIA, and additional scoping of environmental issues 	<ul style="list-style-type: none"> informal meetings 	<ul style="list-style-type: none"> continued identification of environmental issues improved arrangements for follow-on EIA activities
17 to 20 August 2002	<ul style="list-style-type: none"> farmer beneficiaries in proposed N3 and N4 Pilot Areas 	<ul style="list-style-type: none"> inform farming households about purpose of Sub-Project and of EIA obtain socioeconomic information for Da Ban EIA 	<ul style="list-style-type: none"> consultative meeting to initiate socioeconomic surveys (pilot areas were combined). Meeting organized by North Khanh Hoa IMC formal interviews using socioeconomic questionnaire as structure of interview. Total of 90 households surveyed. 	<ul style="list-style-type: none"> socioeconomic information obtained formed the basis for the socioeconomic description of the pilot areas in the preliminary EIA for the Da Ban Sub-Project and for assessment of impacts on socioeconomic resources survey data will be augmented by social survey to be conducted in Da Ban Sub-Project by Consultant
Dau Tieng Sub-Project				
12 to 14 June 2002	<ul style="list-style-type: none"> Tay Ninh, Dau Tieng, and Cu Chi IMCs, CPO, Tay Ninh DoSTE, DoFi, DARD, Chau Thanh and Trang Bang CPCs, 19 WUGs 	<ul style="list-style-type: none"> Local EIA consultants participated in larger stakeholder consultation workshop presentation of overview, purpose, and requirements of EIA additional scoping and identification of environmental issues 	<ul style="list-style-type: none"> formal workshop and secondary data review field visits to TN17, N20, and N31a Pilot Areas and semi-structured interviews with farmers during field visits 	<ul style="list-style-type: none"> inputs to Dau Tieng component of Scoping Report and identification of main issues for analysis
22 August to 1 September 2002	<ul style="list-style-type: none"> farmer beneficiaries in proposed TN17, N20, and N31a Pilot Areas 	<ul style="list-style-type: none"> inform farming households about purpose of Sub-Project and of EIA obtain socioeconomic information for Dau Tieng EIA 	<ul style="list-style-type: none"> two consultative meeting to initiate socioeconomic surveys (in TN17 and N20 pilot areas). Meetings organized by Tay Ninh IMC formal interviews using socioeconomic questionnaire as structure of interview. Total of 180 households surveyed. 	<ul style="list-style-type: none"> socioeconomic information obtained formed the basis for the socioeconomic description of the pilot areas in the preliminary EIA for the Dau Tieng Sub-Project and for assessment of impacts on socioeconomic resources survey data will be augmented by social survey to be conducted in Dau Tieng Sub-Project by Consultant
23 and 24 September 2002	<ul style="list-style-type: none"> Tay Ninh IMC, farmer beneficiaries in proposed TN17 and N20 Areas 	<ul style="list-style-type: none"> Members of EIA Consultant participated in Consultant visit to discuss modernization issues 	<ul style="list-style-type: none"> Secondary data review and semi-structured interviews with IMC, informal consultations with farmers during field visit 	<ul style="list-style-type: none"> continued identification of environmental issues
MoNRE/NEA				
Various, from early June 2002	<ul style="list-style-type: none"> MoNRE and NEA 	<ul style="list-style-type: none"> Inform MoNRE/NEA about VWRAP, EIA requirements, VWRAP preparation schedule 	<ul style="list-style-type: none"> Informal meetings 	<ul style="list-style-type: none"> Developing detailed schedule and procedures for EIA appraisal

ANNEX 3: MAPS OF SUB-PROJECTS

Figure 7: Map of Quang Hue - Vu Gia River Control Works.



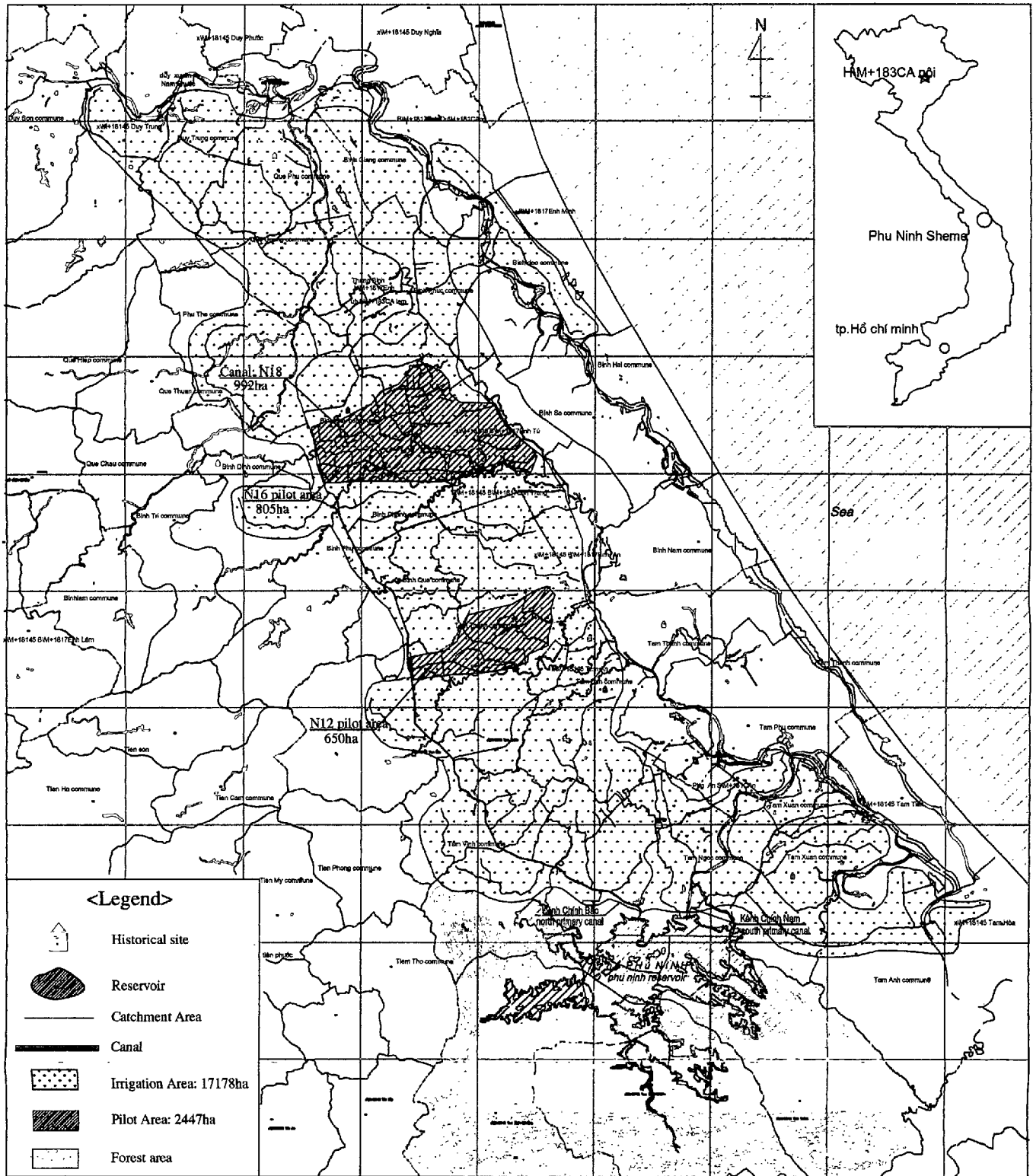


Figure 2 : Overview of PhuNinh Sub- Project

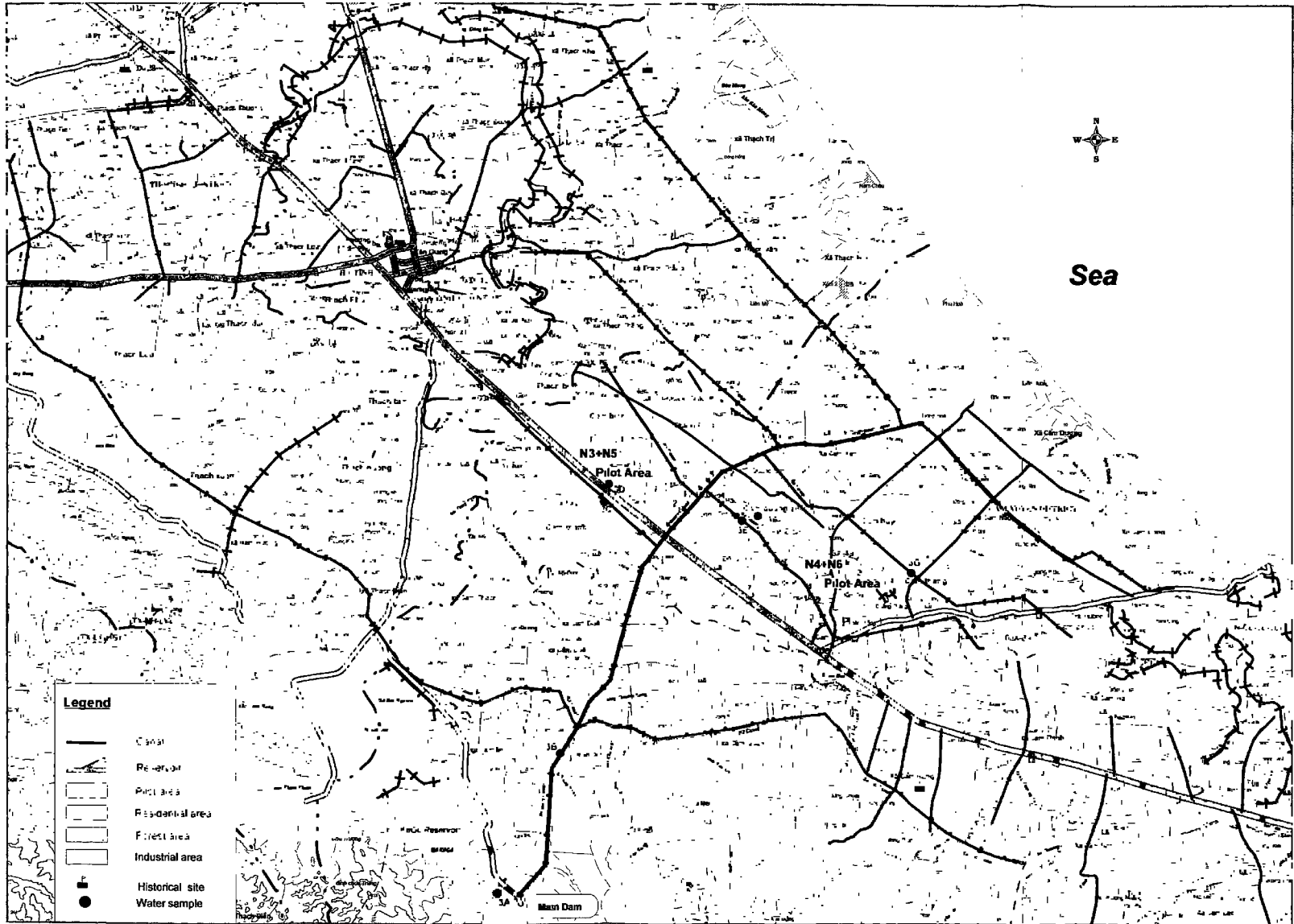


FIGURE 2 : OVERVIEW OF THE KE GO - SUB PROJECT

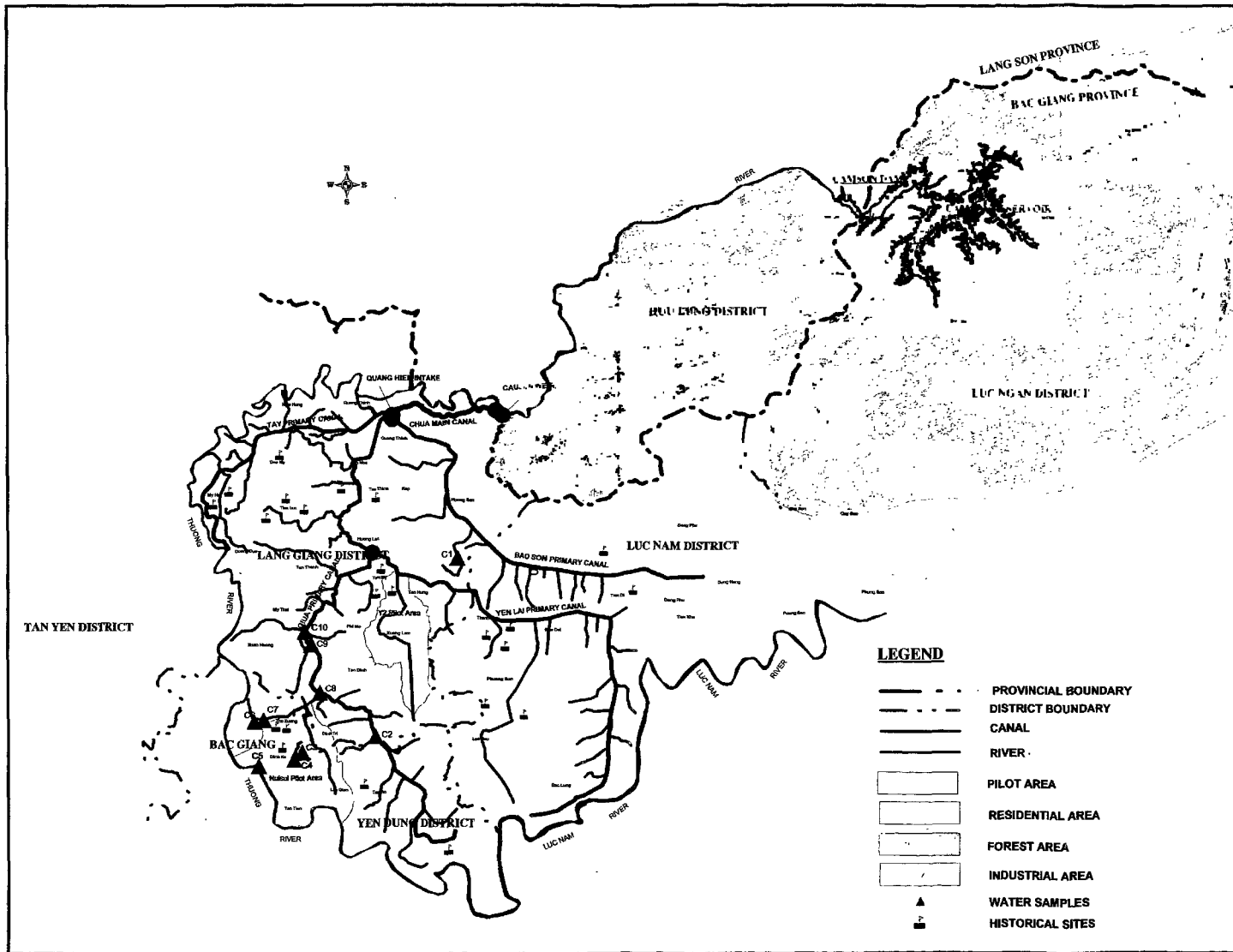


Figure 2 : Overview of CamSon-CauSon Sub-Project

Figure 10: Map of Dau Tieng Sub-Project.

ANNEX 4: POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK FOR EIA

THE LEGAL FRAMEWORK FOR ENVIRONMENTAL MANAGEMENT IN VIET NAM

Environmental Impact Assessment Legislation

The key environmental legislation in Vietnam consists of:

Law on Protection of the Environment (LEP) – enacted in December 1993. The LEP:

- Identifies the responsibilities of the state centre, provinces, organizations and individuals to prevent and remedy environmental deterioration and pollution and carry out specified environmental protection functions;
- Provides for the development of environmental standards and submission of environmental impact assessment reports on new and existing facilities;
- Provides for responsible parties to pay compensation for environmental damage;
- Establishes the right of individuals and organizations to petition for enforcement of environmental regulations;
- Calls for civil and criminal penalties for violations; and
- Encourages international environmental co-operation.

Decree 175/CP – promulgated in October 1994 to guide implementation of the LEP and provides broad guidelines for:

- Division of responsibility among Ministries;
- Environmental Impact Assessments;
- Pollution prevention and disaster control;
- Sources of finance; and
- Environmental inspections and standards.

Circular No. 490 – promulgated in April 1998 to provide 'Guidance on setting up and appraising environmental impact assessment reports for investment projects'. The Circular:

- Identifies the legal requirements according to the stages of implementation of a project and its category. Projects are effectively divided into two categories; No. 1 type projects - all of which require EIA and include projects that have potential to pollute the environment, cause environmental degradation or may have difficulty complying with controls and standards; and No. 2 type projects - including projects which do not require EIA but require registration with the environmental standards registration board'.
- Defines the content of project subject to the EIA procedures; and
- Specifies management of the EIA report appraisal

All projects must follow the process established in the circular:

- *Application for investment license* - for No. 1 type projects this includes the submission of document that sets out the potential impacts of the project (to be appraised by relevant state agencies), and for No. 2 type projects requires the submission of the registration form and technical and economic feasibility report. On approval an investment license is issued;
- *Design stage* - No. 1 type projects prepare and submit the EIA report and technical and economic feasibility report; and
- *Completion stage* - prior to operation relevant agencies coordinated regarding the issuance of construction licenses, inspections and stipulation of environmental standards, and approvals and certifications by the environmental standards registration board. Once all of these processes have been completed the relevant environmental license is issued.

The Circular establishes the timeframes for review and appraisal; examination of the environmental standard registration and issuance of a certificate shall be completed within 20 days of submission, and an EIA report must be reviewed within 30-60 days of submission (or three months for complex or controversial proposals), and the recommendations and decisions of the review must be ratified within 10 days.

Vietnamese EIA Requirements for Yen Lap Sub-Project

According to Vietnamese legislation (Decree 175/CP, Circular 490/1998/TT-BKHCMNT), the Yen Lap Sub-Project requires an Environmental Impact Assessment (EIA) as it consists of the upgrading of an existing irrigation scheme. The project owner must set up and submit an environmental impact assessment report to the Government Management Agencies of Environmental Protection for appraisal.

Other Relevant Legislation

ORDINANCE ON CONSERVATION AND MANAGEMENT OF LIVING AQUATIC RESOURCES

Decree 18/1986, the Ordinance on Conservation and Management of Living Aquatic Resources prohibits all activities that are “detrimental to aquatic resources and cause pollution to the living environment of all aquatic species,” including the use of destructive fishing methods (toxic and harmful substances, explosives, electric currents), the introduction of toxic substances into the marine environment, habitat destruction (mangroves, coral reefs, marine flora, etc.), and emplacement of installations or devices that are harmful to aquatic resources.⁶⁴ For these purposes, the Minister of Fisheries is empowered to regulate habitat protection, total allowable catch, fishing areas, permissible fishing gear, endangered species, introduction of alien species, and so on⁶⁵.

LEGAL INSTRUMENTS FOR PROTECTED AREAS

The legal framework for terrestrial protected areas in Viet Nam dates to the 1980s, but the system of protected areas in Viet Nam is currently guided by the 1991 Forestry Resource Protection and Development Act⁶⁶. This legal instrument authorizes the existence of three categories of forestland: protection forest (critical watersheds and wetlands); special use forests (protected areas); and production forests.

The framework for the designation and management of special use forests is set out in Chapter 4, Part 2 of this Law. Implementation of the Act is done through a set of supplementary ordinances and decrees, such as Decision 1171, 1986, on Special Forest Management for Protected Areas, which defines permissible and prohibited activities in protected areas. A number of decrees to strengthen forest protection (national and provincial) have also been issued. They broadly specify the management principles of each forest category identified in the 1991 Forestry Resource Protection and Development Act; the separation of forest protection from production; and the nature of contractual arrangements with farmers and punishment of illegal use of protected forests.

Vietnamese Environmental Management Administration

The keys agencies and entities with environmental responsibilities in Viet Nam include:

- Ministry of Science, Technology and Environment (MoNRE) – MoNRE is the lead agency for environmental review purposes.
- National Environmental Agency (NEA) – Within MoNRE, the NEA has the responsibility to apply the LEP.
- Provincial Department of Science, Technology and Environment (DoSTE) – Each province has a DoSTE which is in charge of Environmental Management. They also have formal authority to review and comment on environmental aspects of investment applications and to resolve pollution-related disputes.

Requirements for Consultation and Disclosure

Save for certain provisions, there are no specific requirements for consultation in the national legal, policy, and regulatory framework for environmental impact assessment in Viet Nam (i.e., National Law on Environmental Protection [NLEP, 1993]; Decree 175/CP/1994 on Implementation of the NLEP; Circular 490/1998/TT-BKHCMNT on Setting Up and Appraising Environmental Impact Assessment Reports). Most of the provisions requiring consultation are related to the appraisal of environmental impact assessments:

The Ministry of Science, Technology, and Environment (MoNRE) is responsible for appraising reports on the assessment of environmental effects of projects and economic entities for larger projects (identified in Appendix II of Decree 175/CP). The National Environmental Agency (NEA) is assigned the responsibility for assisting MoNRE in performing these environmental management responsibilities⁶⁷, MoNRE/NEA is required to complete appraisals within 60 days of receiving the required EIA reports and associated

⁶⁴ Article 8, Ordinance on Conservation and Management, *supra*.

⁶⁵ Articles 9-13, *ibid*.

⁶⁶ No. 58 LCT/HDNN8

⁶⁷ There may be changes in the responsibilities for environmental management at the national and provincial levels with the recent formation of the new Ministry of Natural Resources and Environment. However, the basic allocation of responsibilities between the central government and the provinces will not change.

documentation;

National government ministries are responsible for the implementation of state management of environmental protection. This means that they participate as required in the appraisal of environmental impact assessments for larger projects.

Provincial (and city) People's Committees are responsible for the implementation of state management of environmental protection. This includes appraising reports on assessment of environmental effects of projects and local economic entities for smaller projects. The provincial Departments of Science, Technology, and Environment (DoSTE) are responsible to the provincial (and city) People's Committees for this task and provincial government departments participate in appraisals as required.

In addition, mass associations (such as Women's Union, Labour Union, etc.) are responsible for assuring the proper implementation and compliance with the legal, policy, and regulatory framework for environmental protection.

Disclosure during the EIA process, as described in Circular 490/1998/TT-BKHCHNMT on Setting Up and Appraising Environmental Impact Assessment Reports, consists of the EIA Appraisal Council to which the EIA documents are provided for review. This Council, acting as a Consultant to MoNRE/NEA, consists of scientists, managers who have appropriate subject-matter knowledge, as well as social organizations and representatives of local people.

Key National Policies and Plans

GENERAL NATIONAL POLICIES

Policies on Decentralization of Planning and Management The GoVN has also been promoting decentralization through a series of laws, decrees and regulations. The major guiding principle has been to give greater power, autonomy and responsibility to districts and communes. The new Budget Law also attempts to bring greater transparency and stability into financing for local development. At provincial level there is also greater awareness of the need to involve local communities in planning and implementation of development activities. The February 1998 Politburo Directive on Grassroots Democracy (30-CT/TW) proposes that people at the community level should participate more actively planning and decision making by (a) being better informed about the law, (b) participating in local decision making before final decisions are made, and, (c) supervising, controlling, and evaluating the operations and activities of their local authorities.

ENVIRONMENTAL POLICIES AND PLANS

National Plan for Environment and Sustainable Development (NPESD) In 1991, the State Committee for Sciences, with the assistance of UNDP, Sida, UNEP and IUCN prepared a National Plan for Environment and Sustainable Development 1991-2000 - Framework for Action (NPESD), which was then adopted by the Government. The NPESD, together with complementary reports submitted by Viet Nam to the United Nations Conference on Environment and Development convened in Rio de Janeiro in 1992, provided a broad, wide ranging framework for environmental action in Viet Nam, including marine environmental protection.

National Strategy for Environmental Protection for 2001 to 2010 This National Strategy replaced the NPESD which expired in 2000. Key strategic directions in the National Strategy are:

- Pollution prevention
- Conserve and sustainably use natural resources and biodiversity
- Environmental improvement in the urban, industrial, and rural areas
- Enhance environmental awareness and forest environmental morality

National Biodiversity Action Plan On December 22, 1995, the National Biodiversity Action Plan (BAP) was approved by the Prime-Minister. The BAP identifies the major causes for loss biodiversity as: over exploitation, leading to deforestation, extinction of species, soil erosion and flooding, overfishing; water and marine pollution; degradation of coastal areas due to human activities; and transition to a market economy and the emphasis on development.

The goals of the National Biodiversity Action Plan include:

- a definition of and approach to biodiversity conservation and action which accommodates the multiple livelihood needs of the Vietnamese people, particularly rural populations residing in areas of high biodiversity;
- reviewing and establishing priorities in provinces, special-use forests, and protected areas (terrestrial and

coastal/marine), using detailed forest status maps, identifying necessary investments in infrastructure, personnel, research, and community extension and economic programs for buffer zones; listing the necessary research, education, and extension activities in the environmental sector for central, provincial and local government agencies; and listing conservation activities required outside protected areas, e.g. integrated watershed management, biologically sound agricultural methods, particularly in hill and mountain areas, restoration of degraded lands, economic activities such as agricultural germplasm and marketing non-timber forest products, preservation of genetic material in zoos and botanical gardens, etc.

The BAP identifies many acts required for the protection of biodiversity. Those relating to the coastal and marine environmental management are as follows:

- establish new laws and regulations for biodiversity protection;
- examine existing laws to identify weakness and propose amendments to promote sustainable development;
- enact laws to protect sensitive terrestrial and aquatic areas;
- identify and protect areas with high biodiversity and establish buffer zones around them;
- identify wetlands in need of protection;
- identify areas which should be designated as new reserves;
- establish a national network of databases and information on biodiversity;
- strengthen the role of local governments in decision-making;
- strengthen the participation of local communities and non-governmental organizations.

Decision No. 224/1999/QĐ-TTg of 8 Dec 1999 by the Prime Minister on the approval of the Aquaculture Program for 1999-2010, which includes:

an overall objective of achieving an aquaculture output of 2 million t/yr by 2010 from current levels of about 350,000 t/yr

plans for aquaculture in coordination with investments in water resource infrastructure to increase the efficiency of investment and use of land and water areas

policies of development of aquaculture cultivation, specifically: increasing utilization of land and water areas for cultivating marine products, favorable credit for poor farmers and fisherman; and preferential conditions for remote areas.

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ANNEX 6: EIA CONSULTANT SOCIOECONOMIC SURVEY QUESTIONNAIRE

HOUSEHOLD SURVEY INTERVIEW

Name of Respondent: _____

Commune: _____

District, Province: _____

Ethnic group _____

Date of Interview: _____

Name of person conducting interview: _____

1. GENERAL INFORMATION

1.1 How many people usually live in this household?

1.2 How many males and females are in each age bracket

Years	Females	Males	M	F
0 - 17		
18 - 60		
Over 60		

1.3 Is the head of the household (1) Male or (2) Female?

1.4 What is level of education the head of household?

- (1) no schooling
- (2) primary education
- (3) junior secondary education
- (4) senior secondary education
- (5) tertiary education

1.5 Is there a business operating out of this house?

- (1) Yes
 - (2) No
- If no, go to Question 1.7

1.6 Labour inputs outside agriculture

Types of off farm labour	No. of days/year

Hired labour (builder or mason coolie)	
Trade	
Handicrafts	
Rice husking	
Transportation services	
Other (specify)	
.....	
.....	

1.7 Household Assets/ Wealth

(Tick the appropriate square where the household has any of the following)

- (1) Connection to electricity supply
- (2) Connection to other electricity sources (or to battery)
- (3) Trucks
- (4) Television
- (5) Radio/cassette recorder
- (6) Refrigerator
- (7) Motor cycle
- (8) Tractor
- (9) Rice husking machine
- (10) Buffaloes, cows, horses

F M

1.8a Source of water for domestic use

- (1) Domestic water
- (2) Digged well
- (3) Drilled well
- (4) Rain water
- (5) river/stream (canal)

1.8b Is that source of water clean or not? (1) Yes (2) No

1.8c. If using well water

Water level in dry season (from the ground to well' surface water) m

Water level in rainy season (from the ground to well' surface water) m

1.8d. Household fuel sources

- (1) Wood
- (2) Charcoal
- (3) Gas
- (4) Electricity
- (5) Other fuels

2. AGRICULTURE

2.1 Data on growing crop

	Area (sao)	Irrigation source ⁶⁸	Irrigation form ²	Shortage of water or waterlogging ³	Low productivity due to ⁴	Total prod. by crop (kg)
Total cultivated area (sao)						
1) Spring crop						
- Rice						
- Subsidiaries						
2) Summer crop						
- Rice						
- Subsidiaries						
3) Winter crop						

2.2. How many plots do you have for your farming?

2.3 How many are un-irrigated ?

Reasons for non-irrigated?

- (1) Far from the source
- (2) High field
- (3) Degraded canals
- (4) Other reasons (specify)

2.2d. Area non-cultivated

2.2e. Reasons for non-cultivated

- (1) Shortage of water
- (2) Waterlogging
- (3) High field
- (4) Other reasons (specify)

2.3 Do you want to change the cropping pattern?

- (1) Yes
- (2) No

if no, because

- (1) Land field not suitable
- (2) Irrigation and drainage not convenient
- (3) Do not like to change the cultivating practices
- (4) Risky (no insurance for the output...)

2.4. 5 If full amount of land not under winter crop, why?

.....

68 Irrigation sources: (1) irrigation and drainage canals; (2) River, pond; (3) Well (4) Rain water ; (5) Industrial waste water

2 Irrigation form: (1) Gravity; (2) partially; (3) Pump of by hand

3 Shortage of water of waterlogging: (1) Shortage of water; (2) waterlogging

4 Low productivity due to: (1) Shortage of irrigation water; (2) waterlogging; (3) Bad land; (4) Pest, rat; (5) shortage of fertilizer; (6) Bad maintenance

2.5 Input for Agriculture production

2.5.1 Rice

Input	Kg/sao	Price (VND) /sao	Note
Seeds			
Fertiliser			
Ure			
Phosphorous			
Kali			
NPK			
Pesticides			
Herbicides			
Others			

2.5.2 Winter crop

Input	Kg/sao	Price (VND) /sao	Note
Seeds			
Fertiliser			
Ure			
Phosphorous			
Kali			
NPK			
Pesticides			
Herbicides			
Others			

2.6 Labour inputs Agriculture

Activity	Men (days)		Women (days)	
	By oneself	Hire	By oneself	Hire
Rice				
Land preparation				
Seedling activities				
Transplanting				
Pesticiding				
Maintenance				
Provision of water and drainage				
Harvesting				
Post-Harvest				
Winter Crop				
Land preparation				
Planting				
Maintenance				
Pesticiding				
Provision of water and drainage				
Harvesting				
Post harvest				

- Labour rate per day

Man: VND

Woman: VND

2.7 Contribution to irrigation system

	Kg	VND
Fees to Irrigation Company		
Fees for on-farm irrigation (O & M)		
Pumping Costs		
Labour contribution To system maintenance		

2.8 Do you hand in full water fee every year? (1) Yes (2) No

If no, why?

2.9 Does conflict often occur when taking water? (1) Yes (2) No

If yes, at what level of canal?

- (1) On-farm canal
- (2) Tertiary canal
- (3) Secondary canal

2.9b. Who deals with the conflict?

- (1) Farmers
- (2) Irrigation team
- (3) Person from Irrigation company
- (4) Commune authorities

A. Annual Income

1. Income from main crop (rice, subsidiaries) in VND

Type	Earning	
	Kg	VND
Rice		
Dry foot crop		
Fruit		
Total		

3.2 Earning from breeding

	Earning	
	Kg	VND
Cattle/buffalo		
Pigs		
Chickens/ducks		
Others		

3. Other incomes

Type		
Hired laborer		
Business		
Salary (clerk, pension...)		
Handicraft		
Other incomes		
Total		

Amount earned per year from other income (VND)

B. Household Expenses

1. Monthly Expenses

2. Annual Expenses

Item	VND
Housing (construction/maintenance)	
Agricultural tools	
Electrical appliances and furniture	
Agricultural inputs (eg seeds, fertiliser)	
Clothing	
Education	
Travelling	
Payment for farm labour	
Repayment of loans	
Other	
Grand Total	

4. CREDIT

4.1 Do you have access to credit? (1) yes (2) No
If no, go to question 3.4

4.2 If yes, what sources do you have and what is the interest rate?

Source	Annual Interest Rate %
1. Bank for Agriculture and Rural development	
2. Poverty reduction fund	
3. Women association	
4. Other associations	
5. Private	

4.3 Have you ever borrowed money for agricultural purposes? (1) Yes (2) No

4.4 Would you consider borrowing money (possibly collectively) to upgrade the condition of tertiary canals directly serving your agricultural land? (1) Yes (2) No

5. AGRICULTURAL EXTENSION AND IPM PROGRAMS

5.1 Do you take part in any IPM training? (1) Yes (2) No
If no, go to the Q 4.3

5.2 From where do you get information of IPM?

- (1) Meeting
- (2) Neighbour
- (3) Radio/TV
- (4) Village speaker
- (5) Other

5.3 Do you take part in any Training of Agricultural Extension? (1) yes (2) No
If no, go to the Q 5

7.3 It is possible that a few people might lose some of their land due to the widening of an irrigation channel or building other structures. If some of your land were to be lost in this way would you expect compensation?

(1) Yes

(2) No

7.4 If yes, what form do you think that compensation should take?

(1) Cash

(2) Land

(3) Other (specify)

If response (2) or (3), interview completed, If (1) go to question 5.3

7.5 If money, how much compensation per sao do you think should be given to the farmer?

**ANNEX 7: SUMMARY OF WATER QUALITY INFORMATION FOR
VWRAP PROJECT**

YEN LAP SUB-PROJECT

Table 34: Water quality in Yen Lap Sub-Project, Quang Ninh Province, 29 December, 2002.

No	Parameter	Unit	4F	4G	4H	4K	4M
1	Temperature	oC	16.2	16.0	16.0	15.5	16
2	pH		7.01	6.20	6.95	7.0	7.20
3	Conductivity	$\mu\text{S/cm}$	237	357	247	342	245
4	Turbidity	NTU	80	67	53	15	56
5	Amoniac (NH_4^+)	mg/l	0.14	0.20	0.32	0.30	0.27
6	NO_2^-	mg/l	0.02	0.07	0.08	0.12	0.03
7	NO_3^-	mg/l	3.2	3.5	3.0	7.9	3.2
8	Phosphate (PO_4^{3-})	mg/l	0.04	0.05	6.06	0.01	0.03
9	Alkalinity	mg/l	122	128	138	130	134
10	Sulphate (SO_4^{2-})	mg/l	7.3	9.7	9.0	10.5	8.0
11	Total Iron	mg/l	0.32	0.73	0.50	0.25	0.38
12	NaCl	mg/l	33.4	37.8	35.5	38.3	55.5
13	Cl^-	mg/l	19.1	21.0	19.7	21.9	31.1
14	HCO_3^-	mg/l	105	124	134	128	130
15	Hardness(CaCO_3)	mg/l	130	223	150	160	180
16	Suspended Load	mg/l	75	32	67	18	35
17	Disolved load	mg/l	217	333	227	302	220
18	COD	mg/l	29.3	6.5	17.1	2.0	18.2
19	BOD_5	mg/l	11.9	4.7	11.2	1.4	10.5
20	DO	mg/l	6.20	5.20	6.32	3.2	6.70
21	Coliform	Col/100ml	2700	170	1200	2	330
22	Fecal- Coliform	F.c/100ml	2100	57	450	0	1507
23	Cl.ferfrigans	No/10ml	35	5	25	0	
24	Mn	mg/l		0.120			
25	Hg	mg/l		0.001			
26	HCB	mg/l	0.005				0.003
27	Lindan	mg/l	0.004				0.001
28	DDT	mg/l	0.001				<0.001

Water sample sites:

- 4F – Surface water in the natural drainage in Hai Phong commune
- 4G - Well water in Lien Hoa commune
- 4H - Surface water in the end of Ha Nam main canal
- 4K - Well water in Quang Yen town (Yen Hung district)
- 4M - Raw water in the tank before going to the treatment plant

Table 35: Water quality in Uong Bi, Quang Ninh Province.

No	Parameters	Unit	M1	M2	M3
1	PH		5.7	7.1	6.6
2	DO	mg/l	4.35	4.34	6.0
3	BOD ₅	mg/l	4.0	10.60	5.0
4	COD	mg/l	6.6	15.60	
5	Cl ⁻	mg/l	8.88	248.50	181.05
6	PO ₄ ³⁻	mg/l	1.50	1.40	1.50
7	SiO ₃	mg/l	12.50	10.5	9.60
8	NH ₄ ⁺	mg/l	2.74	0.435	0.407
9	Na	mg/l	3.36	78.60	18.95
10	K	mg/l	0.58	9.89	4.93
11	Mg	mg/l	8.40	21.60	6.0
12	Ca	mg/l	20.0	30.0	20.0
13	Sunfua	mg/l	0.072	0.05	0.025
14	Pb	10 ⁻³ mg/l	3.85	3.58	25.057
15	Cr	mg/l	0.0022	0.0019	0.0019
16	Cu	10 ⁻³ mg/l	1.701	0.636	0.881
17	Zn	mg/l	0.4968	0.056	0.02724
18	Al	mg/l	0.09	0.095	0.520
19	Mn	mg/l	0.019	0.016	0.532
20	Cd	10 ⁻³ mg/l	0.039	0.184	0.081
21	As	10 ⁻³ mg/l	2.003	2.502	0.952
22	Hg	10 ⁻³ mg/l	0.776	0.489	0.622
23	Coliform	MPN/100ml	18	55	20

Source: Environmental Report, Project for Repairing and Upgrading of Yen Lap Irrigation System

Waste sample sites:

M1 – Tap water

M2 – Surface water in Uong Bi River

M3 – Ground water in bore well

Table 36: Groundwater quality data from Uong Bi, Quang Ninh Province.

No	Parameters	Unit	M4	M5	M6
1	PH		6.9	6.8	7.1
2	DO	mg/l	4.40	4.04	4.38
3	BOD ₅	mg/l	8.85		15.0
4	COD	mg/l	12.80		20.0
5	Cl ⁻	mg/l	42.60	166.85	62.13
6	PO ₄ ³⁻	mg/l	2.20	2.40	2.0
7	SiO ₃	mg/l	15.0	15.3	12.9
8	NH ₄ ⁺	mg/l	0.498	0.335	0.319
9	Na	mg/l	11.36	78.50	58.10
10	K	mg/l	6.71	32.40	12.83
11	Mg	mg/l	9.60	16.80	9.6
12	Ca	mg/l	84.0	136.0	104.0
13	Sunfua	mg/l	0.045	0.065	0.055
14	Pb	10 ⁻³ mg/l	4.61	32.6	4.77
15	Cr	mg/l	0.0022	0.002	0.0022
16	Cu	10 ⁻³ mg/l	1.442	1.129	0.248
17	Zn	mg/l	0.02457	0.1061	0.0354
18	Al	mg/l	0.105	0.030	0.100
19	Mn	mg/l	0.365	0.054	0.139
20	Cd	10 ⁻³ mg/l	0.098	0.205	0.205
21	As	10 ⁻³ mg/l	2.274		4.691
22	Hg	10 ⁻³ mg/l	0.790		0.559
23	Coliform	MPN/100ml	30.5		40.0

Source: Environmental Report, Project for Repairing and Upgrading of Yen Lap Irrigation System

Waste sample sites:

M4, M5, M6 – Ground water in wells

Table 37: Waste water quality in Uong Bi, Quang Ninh Province.

No	Parameters	Unit	M7	M8	M9
1	DO		0.93	4.26	0.33
2	COD	mg/l	87.0	48.0	102.0
3	BOD ₅	mg/l	63.0	35.5	95.80
4	TDS	mg/l	460.0	930.0	386.0
5	SS	mg/l	13.0	14.4	20.7
6	NH ₄ ⁺	mg/l	11.90	0.398	10.30
7	TOT-N	mg/l	12.34	4.20	11.20
8	TOT-P	mg/l	3.30	3.50	0.96
9	Feecal Coliform	MPN/100ml	7400	0	9200

Source: Environmental Report, Project for Repairing and Upgrading of Yen Lap Irrigation System

Waste sample sites:

M7 – Sludge waste water

M8 – Hot water from electricity plant

M9 – Sludge waste water

Table 38: Additional waste water quality data from Uong Bi, Quang Ninh Province.

No	Parameters	Unit	M10	M11	M12
1	DO		3.47	4.13	2.32
2	COD	mg/l	68.0	32.0	62.0
3	BOD ₅	mg/l	45.0	25.0	39.5
4	TDS	mg/l	910.0	415.85	186.0
5	SS	mg/l	15.30	19.70	12.2
6	NH ₄ ⁺	mg/l	0.42	0.31	3.88
7	TOT-N	mg/l	4.48	3.60	4.20
8	TOT-P	mg/l	2.50	2.30	4.10
9	Feecal Coliform	MPN/100ml	0	0	9

Source: Environmental Report, Project for Repairing and Upgrading of Yen Lap Irrigation System

Waste sample sites: M10 – Surface water in Sinh River; M11 – Waste water from The Electricity Plant; M12 – Sludge waste water

Table 39: Water quality in Hoanh Bo District, Quang Ninh province

No	Parameters	Unit	M1	M2	M3
1	PH		7.1	6.4	6.9
2	DO	mg/l	4.22	4.12	4.62
3	BOD ₅	mg/l		8.50	12.5
4	COD	mg/l	12.4	11.50	16.0
5	Cl ⁻	mg/l	47.93	110.05	44.38
6	PO ₄ ³⁻	mg/l	1.86	2.20	1.5
7	SiO ₃	mg/l	12.9	13.6	10.5
8	NH ₄ ⁺	mg/l	0.317	0.426	0.325
9	Na	mg/l	11.77	16.27	12.39
10	K	mg/l	1.96	4.08	1.88
11	Mg	mg/l	6.0	12.0	4.8
12	Ca	mg/l	20.0	12.0	40.0
13	Sunfua	mg/l	0.025	0.035	0.055
14	Pb	10 ⁻³ mg/l	15.401	5.93	4.343
15	Cr	mg/l	0.0021	0.0022	0.0017
16	Cu	10 ⁻³ mg/l	1.336	1.563	0.343
17	Zn	mg/l	0.1408	0.034	0.0247
18	Al	mg/l	0.405	0.125	0.122
19	Mn	mg/l	0.042	0.051	0.026
20	Cd	10 ⁻³ mg/l	0.198	0.268	0.165
21	As	10 ⁻³ mg/l	2.885	1.677	2.727
22	Hg	10 ⁻³ mg/l	0.929	0.786	3.435
23	Coliform	MPN/100ml			

Source: Environmental Report, Project for Repairing and Upgrading of Yen Lap Irrigation System

Waste sample sites:

M1, M2, M3 – Ground water in wells

Table 40: Waste water quality in Hoanh Bo District, Quang Ninh Province.

No	Parameters	Unit	M4	M5	M6
1	DO		2.27	0.45	3.49
2	COD	mg/l	72.0	124.0	60.0
3	BOD ₅	mg/l	48.0	105.50	40.0
4	TDS	mg/l	286.0	310.86	340.60
5	SS	mg/l	14.50	16.6	19.80
6	NH ₄ ⁺	mg/l	4.478	9.65	0.36
7	TOT-N	mg/l	5.60	10.08	5.88
8	TOT-P	mg/l	0.80	4.30	0.90
9	Feecal Coliform	MPN/100ml	0	1720	430

Source: Environmental Report, Project for Repairing and Upgrading of Yen Lap Irrigation System
Waste sample sites: M4 – Surface water in the pond; M5 – Sludge waste water; M6 – Sludge waste water

Table 41: Additional waste water quality in Hoanh Bo District, Quang Ninh Province.

No	Parameters	Unit	M7	M8	M9
1	DO		4.08	4.81	0.22
2	COD	mg/l	36.0	40.0	1300.00
3	BOD ₅	mg/l	25.0	31.0	1020.80
4	TDS	mg/l	6132.60	690.0	2116.0
5	SS	mg/l	38.90	21.80	20.72
6	NH ₄ ⁺	mg/l	0.60	0.28	12.240
7	TOT-N	mg/l	4.25	5.32	14.15
8	TOT-P	mg/l	4.10	0.80	0.90
9	Feecal Coliform	MPN/100ml	0	0	60

Source: Environmental Report, Project for Repairing and Upgrading of Yen Lap Irrigation System
Waste sample sites: M7 – Surface water in Troi River; M8 – Surface water in Khe Da Bang Stream ; M9 – Waste water from The Paper Factory

Table 42: Water quality in Yen Hung District, Quang Ninh Province.

No	Parameters	Unit	M1	M2	M3
1	PH		7.2	6.6	6.8
2	DO	mg/l	4.04	2.90	1.23
3	BOD ₅	mg/l			
4	COD	mg/l			
5	Cl ⁻	mg/l	166.85	408.25	2218.8
6	PO ₄ ³⁻	mg/l	2.40	1.20	1.50
7	SiO ₂	mg/l	15.3	7.80	10.5
8	NH ₄ ⁺	mg/l	0.335		4.612
9	Na	mg/l	78.50		818.0
10	K	mg/l	32.40		55.0
11	Mg	mg/l	16.80		264.0
12	Ca	mg/l	136.0		360.0
13	Sunfua	mg/l	0.065		0.055
14	Pb	10 ⁻³ mg/l	3.26	2.427	3.037
15	Cr	mg/l	0.0021	0.0022	0.0028
16	Cu	10 ⁻³ mg/l	1.129	1.659	1.72
17	Zn	mg/l	0.1061	0.0219	0.0235
18	Al	mg/l	0.030	0.085	0.040
19	Mn	mg/l	0.054	0.204	1.221
20	Cd	10 ⁻³ mg/l	0.205	0.146	0.164
21	As	10 ⁻³ mg/l	1.483	2.339	2.432
22	Hg	10 ⁻³ mg/l	2.687	3.499	0.772
23	Coliform	MPN/100ml		170	110

Source: Environmental Report, Project for Repairing and Upgrading of Yen Lap Irrigation System
Waste sample sites: M1, M2, M3 – Ground water in wells

Table 43: Groundwater quality in Yen Hung District, Quang Ninh Province.

No	Parameters	Unit	M4	M5	M6
1	PH		6.4	7.0	6.6
2	DO	mg/l	3.84	3.47	3.80
3	BOD ₅	mg/l		16.5	
4	COD	mg/l			
5	Cl ⁻	mg/l	248.50	860.88	1251.4
6	PO ₄ ³⁻	mg/l	2.20	2.30	2.48
7	SiO ₃	mg/l	14.2	15.3	15.30
8	NH ₄ ⁺	mg/l	0.42	0.568	2.333
9	Na	mg/l	87.6	260.32	364.00
10	K	mg/l	35.47	92.0	88.00
11	Mg	mg/l	14.4	60.0	240.0
12	Ca	mg/l	212.0	300.0	400.0
13	Sunfua	mg/l	0.075	0.055	0.075
14	Pb	10 ⁻³ mg/l	3.26	4.275	4.59
15	Cr	mg/l	0.0023	0.0021	0.0022
16	Cu	10 ⁻³ mg/l	1.95	3.618	4.63
17	Zn	mg/l	0.0229	0.0223	0.0147
18	Al	mg/l	0.045	0.086	0.060
19	Mn	mg/l	0.054	0.199	0.063
20	Cd	10 ⁻³ mg/l	0.115	0.194	0.267
21	As	10 ⁻³ mg/l	1.953	3.049	2.883
22	Hg	10 ⁻³ mg/l	0.605	1.091	0.866
23	Coliform	MPN/100ml	45	20	1600

Source: Environmental Report, Project for Repairing and Upgrading of Yen Lap Irrigation System
Waste sample sites: M4, M5, M6 – Ground water in wells

Table 44: Additional groundwater quality from Yen Hung District, Quang Ninh Province.

No	Parameters	Unit	M7	M8	M9
1	PH		7.1	6.9	6.7
2	DO	mg/l	2.36	4.55	4.81
3	BOD ₅	mg/l			
4	COD	mg/l	150.0	20.8	28.8
5	Cl ⁻	mg/l	958.50	78.10	56.80
6	PO ₄ ³⁻	mg/l	2.65	3.00	1.50
7	SiO ₃	mg/l	16.0	16.8	10.5
8	NH ₄ ⁺	mg/l	5.093	0.202	0.227
9	Na	mg/l	516.00	44.13	38.60
10	K	mg/l	36.80	20.89	19.86
11	Mg	mg/l	64.8	7.2	6.0
12	Ca	mg/l	164.0	108.0	100.0
13	Sunfua	mg/l	0.077	0.092	0.055
14	Pb	10 ⁻³ mg/l	5.61	6.64	3.537
15	Cr	mg/l	0.0023	0.0018	0.0019
16	Cu	10 ⁻³ mg/l	1.406	2.314	0.282
17	Zn	mg/l	0.0255	0.550	0.0622
18	Al	mg/l	0.088	0.090	0.085
19	Mn	mg/l	0.712	0.712	0.039
20	Cd	10 ⁻³ mg/l	0.174	0.174	0.208
21	As	10 ⁻³ mg/l	2.584	2.584	2.020
22	Hg	10 ⁻³ mg/l	2.736	2.736	1.514
23	Coliform	MPN/100ml	340	340	

Source: Environmental Report, Project for Repairing and Upgrading of Yen Lap Irrigation System
Waste sample sites: M7, M8, M9 – Ground water in wells

Table 45: Waste water quality from Yen Hung District, Quang Ninh Province.

No	Parameters	Unit	M10	M11	M12
1	DO		1.75	2.47	3.78
2	COD	mg/l	96.0	88.0	52.0
3	BOD ₅	mg/l	70.0	60.0	36.6
4	TDS	mg/l	796.60	486.80	578.00
5	SS	mg/l	19.0	19.60	20.00
6	NH ₄ ⁺	mg/l	4.10	1.58	0.30
7	TOT-N	mg/l	7.56	5.36	5.04
8	TOT-P	mg/l	2.30	4.10	0.90
9	Feacal Coliform	MPN/100ml	790	6	0

Source: Environmental Report, Project for Repairing and Upgrading of Yen Lap Irrigation System

Waste sample sites:

M10 – sludge waste water

M11 – surface water in the field

M12 - surface water in the pond

Table 46: Additional waste water quality data from Yen Hung District, Quang Ninh Province.

No	Parameters	Unit	M13	M14	M15
1	DO		2.57	1.68	3.89
2	COD	mg/l	72.0	80.0	56.0
3	BOD ₅	mg/l	50.0	50.8	39.8
4	TDS	mg/l	2875.0	3209.20	298.00
5	SS	mg/l	19.80	26.70	20.10
6	NH ₄ ⁺	mg/l	2.93	9.85	0.33
7	TOT-N	mg/l	5.24	12.32	4.76
8	TOT-P	mg/l	0.85	4.10	0.80
9	Feacal Coliform	MPN/100ml	9200	20	0

Source: Environmental Report, Project for Repairing and Upgrading of Yen Lap Irrigation System

Waste sample sites: M13 – Sludge waste water; M14 – Sludge waste water; M15 - Sludge waste water

CAM SON-CAU SON PROJECT

Table 47: Surface water quality in Cam Son Sub-Project, 6 August 2001

No	Parameter	Unit	M1	M2	M9
1	pH		7.2	7.0	7.0
2	Turbidity	NTU	50.5	55.2	45.5
3	Alkalinity	mg/l	102.5	98.5	95.7
4	Hardness (CaCO ₃)	mg/l	42	47	85
5	Suspended solids	mg/l	30.5	32.7	30.2
6	Ca		8	9	22
7	Mg		5	6	7
8	HCO ₃ ⁻	mg/l	117.5	112.2	102.7
9	Total Clo-Sunphate		3.7	4.2	3.2
10	NO ₂ ⁻	mg/l	1.1	0.72	0.85
11	NO ₃ ⁻	mg/l	11.7	7.32	7.2
12	Ammoniac (NH ₄ ⁺)	mg/l	1.5	1.2	1.2
13	Total Ion (Fe)	mg/l	0.12	0.15	0.2
14	Total Na		4.7	3.2	4.25
15	Total K		3.9	2.8	2.72
16	BOD ₅	mg/l	18.5	17.5	13.7
17	COD	mg/l	30.2	29.2	21.5
18	DO	mg/l	5.5	5.2	5.2
19	Total pesticide	Mg/l	0.12	0.10	
20	DDT	mg/l	0.01	Trace	
21	Coliform	MPN/100ml			750
22	Fecal Coliform	MPN/100ml			230
23	Cl. perfringens	Coli/10ml			22

Note : M1 – Yen Lai irrigation canal, Thanh Liem commune, Luc Nam district

M2 – Giua canal, Tan An commune, Yen Dung district

M9 – Giua canal, Tan Dinh commune, Bac Giang town

Table 48: Ground water quality in Cam Son Sub-Project, 6 August 2001

No	Parameter	Unit	M4	M10
1	pH		6.2	6.5
2	Turbidity	NTU	25	20.2
3	Alkalinity	mg/l	82.5	101.2
4	Hardness (CaCO ₃)	mg/l	92	93
5	Suspended solids	mg/l	17.2	17.5
6	Ca		28	28
7	Mg		5	6
8	HCO ₃ ⁻	mg/l	102.5	105.2
9	Total Clo-Sunphate		3.2	2.75
10	NO ₂ ⁻	mg/l	0.02	0.012
11	NO ₃ ⁻	mg/l	5.7	4.57
12	Ammoniac (NH ₄ ⁺)	mg/l	0.7	0.7
13	Total Ion (Fe)	mg/l	0.21	0.12
14	Total Na		10	1.1
15	Total K		0.1	0.1
16	BOD ₅	mg/l	3.7	3.2
17	COD	mg/l	5.2	5.5
18	DO	mg/l	3.1	2.9
19	Total pesticide	Mg/l		
20	DDT	mg/l		
21	Coliform	MPN/100ml	2100	40
22	Fecal Coliform	MPN/100ml	620	12
23	Cl. perfringens	Coli/10ml	60	2

Note : M4 – Dug well, Dinh Ke commune, Bac Giang town
M10 – Dug well, Tan Dinh commune, Bac Giang town

Table 49: Wastewater quality in Cam Son Sub-Project, 6 August 2001

No	Parameter	Unit	M3	M6	M7	M8
1	PH		6.8	7.2	7.8	6.7
2	Turbidity	NTU	55.5	42.5	57.2	52.7
3	Alkalinity	mg/l	95.7	107.5	292.2	89.9
4	Hardness (CaCO ₃)	mg/l	16	37	46	25
5	Suspended solids	mg/l	55.9	37.8	45.5	57.5
6	Ca		5	8	11	8
7	Mg		1	4	4	1
8	HCO ₃ ⁻	mg/l	89.7	127.5	120.7	72.5
9	Total Clo-Sunphate		2.7		0.1	2.5
10	NO ₂ ⁻	mg/l	1.17	1.2	4.7	1.15
11	NO ₃ ⁻	mg/l	7.8	3.2	67.5	7.92
12	Ammoniac (NH ₄ ⁺)	mg/l	1.7	0.02	5.7	3.78
13	Total Ion (Fe)	mg/l	0.15	0.21	0.1	0.12
14	Total Na		1.72	3.82	2.5	1.25
15	Total K		1.1	3.67	1.2	0.72
16	BOD ₅	mg/l	49.2	10.5	31.5	62.5
17	COD	mg/l	72.7	18.2	56.7	91.7
18	DO	mg/l	2.9	5.7	3.2	2.7
19	Coliform	MPN/100ml		2100		110000
20	Fecal Coliform	MPN/100ml		620		58000
21	Cl. perfringens	poli/10ml		60		430

Note : M3 – wastewater in a pond, Dinh Ke commune, Bac Giang town; M6 – wastewater of the Fertilizer factory discharge to irrigation canal; M7- wastewater of The fertilizer factory at outlet; M8 – wastewater of Bac Giang food processing plant, Tan Dinh commune, Bac Giang town

Table 50: Surface Water quality in HABADA beer factory area. April 1996

No	Parameter	Unit	Thuong river	Pond No 1	Pond No 2	Pond No 3	Dau pond (500m from factory)
1	PH		7.2	8.2	7.8	7.8	8.8
2	Suspended solids	mg/l	78.5	1020	785	620	1790
3	Turbidity	NTU	35	120	80	100	190
4	Colour	PtCo	30	90	50	85	100
5	DO	mg/l	7.80	0.5	0.75	1.2	Und
6	BOD ₅	mg/l	2.5	175.5	130.5	115	272
7	Fe total	mg/l	0.7	0.7	1.0	0.8	1.2
8	NH ₃	mg/l	Und	1.75	1.6	1.5	3.2
9	NO ₃	mg/l	7	5.0	9	9.5	11
10	NO ₂	mg/l	trace	1.2	Und	Und	1.5
11	Coliform	MPN/100ml	7750300	78500000	125000000	15650000	270700500

Source; EIA report of Ha Bac beer factory. Note: Pond No1,2,3 next to the collective quarter of ice plant, 300m from beer factory).
Und : undetectable

Table 51: Wastewater quality of three industrial sites, 30 August 1998

No	Parameter	Unit	TCVN 5945-1995 lo ⁱ B	Bac Giang beer factory	Hung Thinh beer factory	HABADA beer factory
1	PH		5.5-9.0	7.3	7.2	7.1
2	Suspended solids	mg/l	100	125	115	155
3	Solid total	mg/l	-	235	245	235
4	Turbidity	NTU	-	50	60	-
5	DO	mg/l	-	2.3	2.3	2.1
6	BOD ₅	mg/l	50	105.5	82.7	235.5
7	COD	mg/l	100	160	132.5	310
8	H ₂ S	mg/l	1	1.65	1.1	1.35
9	NH ₃	mg/l	1	1.3	0.92	1.1
10	N total	mg/l	60	2.3	3.2	3.2
11	P total	mg/l	6	1.0	1.32	6
12	Coliform	MPN/100ml	10000	18500	21700	16700

Source : Existing environmental report of Bac Giang province for 5 years (1994-1998)
Note: TCVN – Vietnam standard

Table 52: Wastewater quality in Cam Son-Cau Son Sub-Project, March 1998

No	Parameter	Unit	TCVN 5945-1995 Category B	the cardboard paper plant in Bac Giang fertilizer factory	Bac Giang export cardboard paper company	The cardboard paper in Hoa My Company
1	PH		5.5-9.0	9.1	8.7	8.5
2	Suspended solids	mg/l	100	1925	470	275
3	Solid total	mg/l	-	2915	935	505
4	Turbidity	NTU	-	915	155	155
6	BOD ₅	mg/l	50	925.5	152	272.5
7	COD	mg/l	100	1530	323,5	315

Source : Existing environmental report of Bac Giang province for 5 years (1994-1998)

Table 53: Wastewater quality at sluice No 420, discharge to Thuong River, 23 October, 1998.

No	Parameter	Unit	TCVN 5945-1995 Category A	Standard 5945-1995 Category B	Wastewater at sluice 420
1	PH		6.0-9.0	5.5-9.0	7.6
2	NH ₃	mg/l	0.1	1.0	2.25
3	H ₂ S	mg/l	0.2	0.5	1.7
4	CN -	NTU	0.05	0.1	0.57
5	BOD ₅	mg/l	20	50	42.9
6	COD	mg/l	50	100	70.5
7	Phenol	mg/l	0.001	0.05	0.12

Source : Existing environmental report of Bac Giang province for 5 years (1994-1998)
Table 54: Groundwater quality in dug wells, Cam Son-Cau Son Sub-Project.

Parameter	Unit	TCBYT 505/92	TCVN 5944-1995	B% Giang	L'ng Giang	Y'n Dòng	Lộc Nam
PH		6.5-8.5	6.5-8.5	7.0	6.5	6.8	6.8
Hardness	mg/l	500	300-500	255	157	175	169
Colour	PtCo	10	-	30	30	15	35
Turbidity	NTU	<10	-	25	25	15	30
Fe ³⁺	mg/l	0.3	1-5	0.55	0.55	0.2	0.52
NH ₄ ⁺	mg/l	-	-	-	1.2	0.1	0.2
NO ₃ ⁻	mg/l	10	45	9.8	7.5	8.5	7.8
Cu ₂ ⁺	mg/l	-	1.0	-	0.12	0.1	0.1
Pb ₃ ⁺	mg/l	-	0.05	-	Und	Und	Und
COD	mg/l	-	-	7.9	7.2	3.9	7.2
BOD ₅	mg/l	-	-	5.7	4.5	3.2	4.7
Coliform	MPN/100ml	3	3	125	25	70	35
Fecal Coliform	MPN/100ml	0	0	32	5	15	7
Depth	m	-	-	12	5	10	-

Note : TCBYT – Health Ministry standard
 TCVN – Vietnam standard
 Und – Undetectable

Table 375: Groundwater quality in bore wells in towns, Cam Son-Cau Son Sub-Project.

Parameter	Unit	TCBYT 505/92	TCVN 5944-1995	B% Giang	L'ng Giang	Y'n Dòng	Lộc Nam
PH		6.5-8.5	6.5-8.5	6.5	6.5	6.5	6.5
Hardness	mg/l	500	300-500	172	110	125	115
Colour	PtCo	10	-	20	15	10	15
Turbidity	NTU	<10	-	15	20	10	20
Fe ³⁺	mg/l	0.3	1-5	-	0.39	0.22	0.35
NH ₄ ⁺	mg/l	-	-	-	0.17	0.15	0.17
NO ₃ ⁻	mg/l	10	45	7.5	6.7	7.8	7.5
Cu ₂ ⁺	mg/l	-	1.0	--	0.15	0.17	0.15
Pb ₃ ⁺	mg/l	-	0.05	-	Und	Und	Und
COD	mg/l	-	-	8.2	5.7	3.7	5.7
BOD ₅	mg/l	-	-	6.5	3.5	2.5	3.5
Coliform	MPN/100ml	3	3	55	15	55	45
Fecal Coliform	MPN/100ml	0	0	19	3	7	11
Depth	m	-	-	20	25	40	0

Note : TCBYT – Health Ministry standard
 TCVN – Vietnam standard
 Und – Undetectable

Table 56: Groundwater quality at dug wells in Hung Son Commune.

Parameter	Unit	TCBYT 505/92	TCVN 5944-1995	Mr. Duc's dug well	Mr. Ba dug well
PH		6.5-8.5	6.5-8.5	6.8	6.5
Colour	PtCo	10	-	15	10
Turbidity	NTU	<10	-	15	15
Suspended solids	Mg/l	-	-	15	10
NO ₃ ⁻	Mg/l	10	45	12.5	14.2
NO ₂ ⁻	Mg/l	0	-	0.25	0.17
Mn	Mg/l	-	0.1-0.5	Und	Und
Coliform	MPN/100ml	3	3	5	3
Fecal Coliform	MPN/100ml	0	0	1	2
Depth	M	-	-	6	10

Table 57: Water quality in Thuong River at Phu Lang Thuong hydrology station.

No	Parameter	Unit	1/11/1994	15/3/1995	15/12/1995
1	BOD ₅	mg/l	2.4	2.5	2.0
2	COD	mg/l	4.25	3.75	3.15
3	DO	mg/l	6.2	6.5	6.8
4	Coliform	MPN/100	500	500	350
5	Ca ²⁺	mg/l	0.85	1.0	0.9
6	Mg ²⁺	mg/l	1.0	0.1	0.8
7	NO ₂	mg/l	1.0	2.0	0.0
8	NH ⁴⁺	mg/l	0.01	trade	0.01
9	Ptotal	mg/l			0.2
10	HCO ₃	meq/l	2.0	1.9	2.5
11	Hardness	meq/l	1.85	1.1	1.7
12	Alkalinity	meq/l	2.0	1.9	2.5
13	Suspended solids	mg/l	50	55	75

Table 58: Water quality in Thuong River, 500 m upstream of Bac Giang fertilizer factory.

No	Parameter	Unit	1/11/1994	15/3/1995	15/12/1995
1	BOD ₅	mg/l	5.7	3.3	3.5
2	COD	mg/l	7.52	5.7	6.25
3	DO	mg/l	6.5	6.6	5.8
4	Coliform	MPN/100	0	900	930
5	Ca ²⁺	mg/l	1.4	0.65	0.8
6	Mg ²⁺	mg/l	0.8	1.1	0.1
7	NO ₂	mg/l	0.0	0.8	1.5
8	NH ⁴⁺	mg/l	0.01	0.01	0.01
9	Ptotal	mg/l			
10	HCO ₃	meq/l	2.4	2.8	1.5
11	Hardness	meq/l	2.2	1.75	0.9
12	Alkalinity	meq/l	2.4	2.8	1.5
13	Suspended solids	mg/l	21	65	50

Table 59: Water quality in Thuong River, 500 m downstream of Bac Giang fertilizer factory.

No	Parameter	Unit	1/11/1994	15/3/1995	15/12/1995
1	BOD ₅	mg/l	11.0	2.4	2.5
2	COD	mg/l	15.5	4.25	3.75
3	DO	mg/l	4.2	6.2	6.5
4	Coliform	MPN/100 ml	1100	500	500
5	Ca ²⁺	mg/l	1.2	0.85	1.0
6	Mg ²⁺	mg/l		1.0	0.1
7	NO ₂	mg/l	0.1	1.0	2.0
8	NH ⁴⁺	mg/l	trace	0.01	trace
9	Ptotal	mg/l			
10	HCO ₃	meq/l	2.4	2.0	1.9
11	Hardness	meq/l		1.85	1.1
12	Alkalinity	meq/l	1.8	2.0	1.9
13	Suspended solids	mg/l	40	65	50

Table 60: Water quality in Thuong River, Bac Giang Bridge.

No	Parameter	Unit	1/11/1994	15/3/1995	15/12/1995	7/9/1996
1	BOD ₅	mg/l	9.7	11.0	5.8	8.5
2	COD	mg/l	11.8	18.5	8.63	11.6
3	DO	mg/l	5.6	5.5	5.9	6.5
4	Coliform	MPN/100 ml	11000	930	1100	700
5	Ca ²⁺	mg/l	0.75	1.0	1.0	1.2
6	Mg ²⁺	mg/l	0.5	0.5	0.1	1.1
7	NO ₂	mg/l	0.0	0.7	2.0	2.1
8	NH ₄ ⁺	mg/l	V	0.02	0.01	2.3
9	Ptotal	mg/l				0.7
10	HCO ₃	meq/l	2.0	1.6	1.5	2.7
11	Hardness	meq/l	1.25	1.5	0.9	2.3
12	Alkalinity	meq/l	2.0	1.6	1.5	2.7
13	Suspended solids	mg/l	20	60	30	70

KE GO SUB-PROJECT

Table 61: Water quality in Ke Go Sub-Project Area, Ha Tinh Province, 20 December, 2002

No	Parameter	Unit	3A	3B	3C	3D
1	Temperature	oC	19	19.1	19.3	18.9
2	PH		7.00	7.05	7.21	7.1
3	Conductivity	μS/cm	217	225	270	257
4	Turbidity	NTU	25	29	47	22
5	Amoniac (NH ₄ ⁺)	mg/l	0.25	0.27	0.40	0.06
6	NO ₂	mg/l	0.04	0.05	0.09	0.01
7	NO ₃	mg/l	3.7	3.9	3.0	4.7
8	Phosphate (PO ₄ ³⁻)	mg/l	0.05	0.06	0.09	0.02
9	Alkalinity	mg/l	98	100	122	134
10	Sulphate (SO ₄ ²⁻)	mg/l	6.7	7.0	7.2	9.0
11	Total Iron	mg/l	0.27	0.30	0.32	0.85
12	NaCl	mg/l	22.2	22.5	23.0	22.9
13	CL ⁻	mg/l	12.0	12.3	12.5	12.1
14	HCO ₃ ⁻	mg/l	96	98	115	128
15	Hardness(CaCO ₃)	mg/l	110	115	120	130
16	Suspended Solid	mg/l	20	23	65	18
17	Disolved load	mg/l	200	207	243	221
18	COD	mg/l	22.9	23.0	29.6	4.2
19	BOD ₅	mg/l	13.7	14.0	19.1	2.5
20	DO	mg/l	7.50	7.30	6.20	4.30
21	Coliform	Col/100ml	230	280	630	70
22	Fecal- Coliform	F.c/100ml	110	150	240	32
23	Cl.ferfrigens	no/10ml	3	4	9	1

Water sample sites

- 3A- Ke Go Reservoir
- 3B- Surface water in the Main canal
- 3C- Surface water in the irrigation canal N3
- 3D- Well water next to the irrigation canal N3

Table 62: Water quality in Ke Go Sub-Project Area, Ha Tinh Province, 20 December, 2002, additional sampling stations.

No	Parameter	Unit	3E	3F	3G
1	Temperature	OC	19.0	19.0	19.2
2	PH		7.20	7.25	7.08
3	Conductivity	µS/cm	270	2.62	279
4	Turbidity	NTU	60	20	49
5	Amoniac (NH ₄ ⁺)	mg/l	0.02	0.03	0.32
6	NO ₂ ⁻	mg/l	0.05	0.02	0.10
7	NO ₃ ⁻	mg/l	4.0	5.4	3.2
8	Phosphat (PO ₄ ³⁻)	mg/l	0.08	0.04	0.16
9	Alkalinity	mg/l	130	128	152
10	Sulphate (SO ₄ ²⁻)	mg/l	8.0	7.9	8.2
11	Total Iron	mg/l	0.32	0.28	0.31
12	NaCl	mg/l	24.0	22.1	37.5
13	CL ⁻	mg/l	12.7	11.9	21.1
14	HCO ₃ ⁻	mg/l	128	124	134
15	Hardness(CaCO ₃)	mg/l	150	160	155
16	Suspended Solid	mg/l	58	17	57
17	Disolved load	mg/l	225	230	240
18	COD	mg/l	27.6	3.7	25.3
19	BOD ₅	mg/l	16.3	2.4	16.0
20	DO	mg/l	6.5	4.5	5.10
21	Coliform	Col/100ml	710	20	830
22	Fecal- Coliform	F.c/100ml	300	5	34.
23	Cl.ferfrigans	no/10ml	13	1	16

Water sample sites

- 3E- Surface water in the irrigation canal N4
- 3F- Well water next to the irrigation canal N4
- 3G- Surface water in the irrigation canal N6

Table 63: Surface water quality in Ke Go Sub-Project Area, Ha Tinh Province, 2001

No	Parameter	Unit	M1	M2	M3
1	PH		7.6	5.9	6.3
2	COD	mg/l	115	227	37
3	BOD ₅	mg/l	58	155	20
4	NO ₂ ⁻	mg/l	0.23		
5	NO ₃ ⁻	mg/l	4.25		
6	Coliform	Col/100ml	60,000	80,000	58,000
7	Cd	mg/l	Und		
8	Pb	mg/l	Und		
9	As	mg/l	0.018		
10	Cu	mg/l	0.037		
11	Zn	mg/l	Trace		
12	Suspended Solid	mg/l	108	57	67
13	DO	mg/l	1.2	1.4	7.6
14	Conductivity	mg/l	0.05		0.02
15	Total solid	mg/l	352		
16	NH ₄ ⁺	mg/l	3.6		
17	Total P	mg/l	2.8	0.35	0.78
18	Total Iron	mg/l	1.2		
19	Detergent	mg/l	0.01		
20	Cr	mg/l	0.03		
21	Turbidity	mg/l		57	78

Water sample sites

- M1- Surface water in Cay River, under the influence of Do Diem Frozen Food Factory Thach Ha District , dated 28 May, 2001
- M2 – wastewater from Beer Factory, dated 29 May, 2001
- M3 – wastewater from Ha Tinh Hospital, dated 27 May, 2001

Table 64: Surface water quality in Ke Go Sub-Project Area, December, 1998

No	Parameter	Unit	Middle Ke Go reservoir (surface) 22/10/1998	Middle Ke Go reservoir (bottom) 22/10/1998	Rao Cai River 23/10/1998	Rao Mon River 23/10/1998
1	PH		7.0	6.9	6.94	7.21
2	Salinity	o/oo	0.0	0.0	0.0	0.0
3	Turbidity	NTU	0.5	0.5	0.3	0.3
4	Suspended solids	mg/l	16.50	19.0	23.0	29.0
5	DO	mg/l	4.25	4.1	4.93	4.9
6	BOD ₅	mg/l	0.3	0.3	0.4	1.07
7	COD	mg/l	0.87	0.82	3.2	3.2
8	Ca	mg/l	12.75	13.5	14.7	14.7
9	Mg	mg/l	9.1	9.2	10.5	10.5
10	Fe	mg/l	0.01	0.01	0.01	0.01
11	Ni	mg/l	0.0		0.0	0.0
12	Cu	mg/l	0.0	0.0	0.0	0.0
13	Zn	mg/l	0.0	0.14	0.16	0.16
14	Mn	mg/l	0.001	0.001	0.002	0.002
15	K	mg/l	0.01	0.01	0.01	0.01
16	Na	mg/l	0.85	0.97	0.95	0.95
17	HCO ₃ ⁻	mg/l	11.35	11.25	9.78	8.97
18	Cl ⁻	mg/l	1.05	1.05	1.5	1.5
19	SO ₄ ²⁻	mg/l	0.09	0.08	0.01	0.01
20	PO ₄ ³⁻	mg/l	15.0	12.0	15.0	14.0
21	NH ₄ ⁺	mg/l	0.083	0.082	0.078	0.068
22	NO ₂ ⁻	mg/l		0.009	0.009	0.009
23	NO ₃ ⁻	mg/l		0.004	0.003	0.003
24	Coliform	vk/100ml				
25	Hg	mg/l				
26	As	mg/l				

Source: Ke Go Reservoir basic survey 1998, Hanoi Water Resources University

Table 65: Additional surface water quality data in Ke Go Sub-Project Area, December, 1998

No	Parameter	Unit	Rao Pheo river 23/10/1998	Cau Phu 25/10/1998	Cau Cua Hoi (Cam xuyen town) 25/10/1998
1	PH		7.0	6.26	6.48
2	Salinity	o/oo	0.0	0.2	0.1
3	Turbidity	NTU	30.0	0.4	0.4
4	Suspended solids	mg/l	0.4	185.0	126.0
5	DO	mg/l	4.5	4.0	4.15
6	BOD ₅	mg/l	1.0	0.1	0.28
7	COD	mg/l	3.0	2.4	3.2
8	Ca	mg/l	15.2	50.0	46.8
9	Mg	mg/l	11.0	27.5	23.2
10	Fe	mg/l	0.01	0.01	0.01
11	Ni	mg/l	0.0	0.0	0.0
12	Cu	mg/l	0.0	0.0	0.0
13	Zn	mg/l	0.14	0.15	0.15
14	Mn	mg/l	0.002	0.002	0.002
15	K	mg/l	0.01	4.24	3.42
16	Na	mg/l	0.83	13.42	8.24
17	HCO ₃ ⁻	mg/l	8.2	18.24	16.0
18	Cl ⁻	mg/l	1.4	24.7	16.2
19	SO ₄ ²⁻	mg/l	0.01	9.2	7.0
20	PO ₄ ³⁻	mg/l	14.0	14.0	14.0
21	NH ₄ ⁺	mg/l	0.06	0.088	0.065
22	NO ₂ ⁻	mg/l	0.008	0.003	0.004
23	NO ₃ ⁻	mg/l	0.002	0.004	0.003
24	Coliform	vk/100ml		200	150
25	Hg	mg/l			0.0
26	As	mg/l			0.0

Source: Ke Go Reservoir basic survey 1998, Hanoi Water Resources University

Table 66: Surface water quality in Ke Go Sub-Project Area, August, 1997

No	Parameter	Unit	Middle Ke Go reservoir (surface) 27/8/1997	Middle Ke Go reservoir (bottom) 27/8/1997	Middle Ke Go reservoir (surface) 28/8/1997	Middle Ke Go reservoir (bottom) 28/8/1997
1	PH		7.15	6.8	6.9	6.63
2	Salinity	o/oo	0.0	0.0	0.0	0.0
3	Turbidity	NTU	0.9	0.999	1.1	1.1
4	Suspended solids	mg/l	18.0	20.0	18.0	19.0
5	DO	mg/l	4.55	4.49	4.49	4.5
6	BOD ₅	mg/l	0.95	1.0	0.48	0.95
7	COD	mg/l	0.8	1.4	1.0	1.1
8	Ca	mg/l	13.2	13.2	13.1	13.2
9	Mg	mg/l	9.0	9.0	9.0	9.0
10	Fe	mg/l	0.01	0.01	0.01	0.02
11	Al	mg/l	-	-	-	-
12	Ni	mg/l	0.0	0.0	0.0	0.0
13	Cu	mg/l	0.0	0.0	0.0	0.0
14	Zn	mg/l	0.15	0.15	0.15	0.15
15	Mn	mg/l	0.002	0.002	0.001	0.001
16	K	mg/l	0.01	0.01	0.01	0.01
17	Na	mg/l	0.92	0.92	0.95	0.99
18	HCO ₃ ⁻	mg/l	9.76	9.76	9.78	9.78
19	Cl ⁻	mg/l	1.2	1.2	1.20	1.20
20	SO ₄ ²⁻	mg/l	0.1	0.2	0.15	0.18
21	PO ₄ ³⁻	mg/l	14.0	14.0	14.1	14.2
22	NH ₄ ⁺	mg/l	0.078	0.078	0.075	0.08
23	NO ₂ ⁻	mg/l	0.033	0.049	0.034	0.037
24	NO ₃ ⁻	mg/l	0.052	0.039	0.05	0.053

Source: Ke Go Reservoir basic survey 1997, Hanoi Water Resources University

Table 67: Additional surface water quality in Ke Go Sub-Project Area, August, 1997

No	Parameter	Unit	Rao Cai River (tide) 27/8/1997	Rao Cai River (tide) 27/8/1997	Cau Phu (tide) 27/8/1997	Cau Phu (tide) 28/8/1997
1	PH		7.0	6.97	6.19	6.1
2	Salinity	o/oo	0.0	0.0	0.01	0.01
3	Turbidity	NTU	1.12	0.14	8.9	9.0
4	Suspended solids	mg/l	41.0	42.0	37.0	37.0
5	DO	mg/l	4.81	4.80	4.27	4.25
6	BOD ₅	mg/l	0.81	0.83	0.8	0.81
7	COD	mg/l	3.2	3.2	4.0	4.0
8	Ca	mg/l	24.4	24.5	10.0	10.0
9	Mg	mg/l	9.5	9.7	9.5	9.4
10	Fe	mg/l	0.09	0.09	0.25	0.2
11	Al	mg/l	-	-	0.0	-
12	Ni	mg/l	0.0	0.0	0.06	0.06
13	Cu	mg/l	0.0	0.0	0.10	0.1
14	Zn	mg/l	0.07	0.07	0.18	0.2
15	Mn	mg/l	0.003	0.003	0.004	0.004
16	K	mg/l	1.1	1.1	2.2	2.1
17	Na	mg/l	1.38	1.4	4.9	5.0
18	HCO ₃ ⁻	mg/l	15.86	19.9	9.76	9.8
19	Cl ⁻	mg/l	2.0	2.0	3.0	3.0
20	SO ₄ ²⁻	mg/l	0.1	0.1	8.0	8.0
21	PO ₄ ³⁻	mg/l	12.0	12.0	16.0	16.5
22	NH ₄ ⁺	mg/l	0.026	0.026	0.036	0.04
23	NO ₂ ⁻	mg/l	0.03	0.03	0.02	0.02
24	NO ₃ ⁻	mg/l	0.316	0.3	0.484	0.48
25	Pb	PPb	0.38		0.29	
26	Hg	PPb	4.00		2.0	
27	As	PPb	<2		<2	

Source: Ke Go Reservoir basic survey 1997, Hanoi Water Resources University

Table 68: Additional surface water quality in Ke Go Sub-Project Area, August, 1997

No	Parameter	Unit	Cau Cua Hoi (Cam xuyen town)	Cau Cua Hoi (Cam xuyen town)
			-tide 27/8/1997	-tide 28/8/1997
1	PH		6.57	6.23
2	Salinity	o/oo	0.01	0.01
3	Turbidity	NTU	9.0	9.1
4	Suspended solids	mg/l	35.0	35.0
5	DO	mg/l	4.7	4.70
6	BOD ₅	mg/l	0.85	0.84
7	COD	mg/l	0.8	0.8
8	Ca	mg/l	8.4	8.4
9	Mg	mg/l	9.5	9.5
10	Fe	mg/l	0.25	0.24
11	Al	mg/l	-	0.0
12	Ni	mg/l	0.06	0.06
13	Cu	mg/l	0.08	0.07
14	Zn	mg/l	0.18	0.19
15	Mn	mg/l	0.003	0.003
16	K	mg/l	2.1	2.1
17	Na	mg/l	4.9	5.0
18	HCO ₃ ⁻	mg/l	9.76	9.8
19	Cl ⁻	mg/l	3.0	3.1
20	SO ₄ ²⁻	mg/l	8.0	8.0
21	PO ₄ ³⁻	mg/l	15.0	16.0
22	NH ₄ ⁺	mg/l	0.039	0.039
23	NO ₂ ⁻	mg/l	0.02	0.03
24	NO ₃ ⁻	mg/l	0.484	0.484

Source: Ke Go Reservoir basic survey 1997, Hanoi Water Resources University

PHU NINH SUB-PROJECT

Table 69: Surface water quality in Phu Ninh Sub-Project Area, 17 December 2002.

Parameter	Units	Sampling Station							
		2A	2B	2C	2D	2E	2F	2G	2H
Temperature	°C	21.2	21.4	21.3	21	21	19.7	19.8	19.5
pH		7.0	7.05	7.10	7.35	7.20	7.20	7.03	7.0
Conductivity	µS/cm	225	229	232	380	230	241	269	250
Turbidity	NTU	22	24	26	57	55	20	18	21
Ammonia (NH ₄ ⁺)	mg/l	0.12	0.13	0.15	0.62	0.21	0.71	0.08	0.07
NO ₂ ⁻	mg/l	0.03	0.04	0.04	0.17	0.10	0.02	0.01	0.01
NO ₃ ⁻	mg/l	4.1	4.0	4.3	3.0	4.0	4.5	5.7	5.5
Phosphate PO ₄ ³⁻	mg/l	0.05	0.05	0.06	0.32	0.09	0.04	0.03	0.02
Alkalinity	mg/l	103	105	109	218	130	122	134	128
Sulphate SO ₄ ²⁻	mg/l	6.2	6.1	6.3	10.9	7.9	7.5	9.70	9.5
Total Iron	mg/l	0.21	0.22	0.22	0.57	0.42	0.25	0.28	0.25
NaCl	mg/l	19.7	20.5	21.0	43.3	25.0	20.3	21.1	20.7
Cl ⁻	mg/l	10.5	10.6	10.7	24.5	14.3	11.1	11.2	11.4
HCO ₃ ⁻	mg/l	98	98	100	120	128	115	128	124
Hardness CaCO ₃	mg/l	150	155	157	170	160	170	180	180
Suspended Load	mg/l	15	19	21	90	80	20	16	18
Dissolved load	mg/l	209	213	215	345	216	218	220	219
COD	mg/l	17.5	18.0	78.3	27.3	20.6	3.7	3.0	3.6
BOD ₅	mg/l	10.5	10.7	10.8	19.8	12.7	2.4	2.9	2.3
DO	mg/l	7.50	7.30	7.10	5.30	5.80	5.0	4.7	5.2
Coliform	col/100 ml	290	300	310	2100	860	100	60	55
Fecal coliform	Fc/100 ml	180	192	195	900	330	42	19	17
Cl.ferfrigens	No/10 ml	4	5	5	19	12	3	1	1

..Water sampling sites: 2A- Phu Ninh Reservoir; 2B- Surface water in the North Main Canal, 100 m downstream of irrigation intake; 2C- Surface water in the North Main Canal, 150 m downstream of irrigation intake; 2D- Surface water in the irrigation canal N16; 2E- Surface water in the irrigation canal N12; 2F- Well water next to the irrigation canal N12; 2G- Well water next to the irrigation canal N16; 2H- Well water next to the irrigation canal N18

Table 70: Surface water quality in the Phu Ninh Reservoir, 1999 and 2000.

Parameter	Unit	2000				1999			
		22 Mar	10 May	10 Sep	24 Oct	10 Mar	30 Mar	22 Sep	6 Jul
pH		7.54	7.67	6.76	6.53	7.35	6.97	7.06	6.93
Dissolved oxygen	mg/l	6.4	4.5	5.95	5.88	6.43	6.7	6.94	6.32
Conductivity	μS/cm	38.3	37	35.1	33.4			44	43.7
Salinity	‰	0	0	0	0			0	0
Turbidity	JTU	6	5	5	5			6	8
COD	mg/l	3	12	Und ⁶⁹	3	Und	15	10	Und
BOD ₅	-	Und	4	Und	1	Und	3	Und	Und
Pb	-	7.1x10 ⁻⁴	2.86x10 ⁻³	5.50x10 ⁻⁴	9.72x10 ⁻⁴	1.12x10 ⁻³	4.97x10 ⁻⁴	9.71x10 ⁻⁴	7.76x10 ⁻⁴
Nitrate (total N)	mg/l	4.08	0.0132	0.093	0.14	0.14	0.076	0.018	0.018
Cianua	-	Und	Und	Und	Und	Und	Und	Und	Und
Active surface matter	-	Und	Und	Und	Und	Und	Und	Und	Und
Mercury	μg/l	Und	0.45	Und	Und			0.13	0.079
Coliform	MDP/100ml	0	0	700	20	26	49	5	0
Suspended solid	mg/l	15.6	13.9	18	18.8	10.8	12.9	20	20.5

DA BAN SUB-PROJECT

Table 71: Water Quality in Da Ban Sub-Project Area.

Parameter	Unit	Station						
		1A	1B	1C	1D	1E	1F	1G
Temperature	°C	20	20,4	20,5	19,7	20	19,5	20
pH		7.21	7.29	7.30	7.25	7.12	7.0	6.2
Conductivity	μS/cm	234	247	252	260	282	250	219
Turbidity	NTU	30	59	50	5	19	15	55
Ammonia (NH ₄ ⁺)	mg/l	0.22	0.28	0.32	0.10	0.52	0.07	0.09
NO ₂ ⁻	mg/l	0.04	0.05	0.08	0.01	0.25	0.03	0.05
NO ₃ ⁻	mg/l	3.0	3.2	2.8	4.0	3.1	4.5	2.9
Phosphate(PO ₄ ³⁻)	mg/l	0.04	0.05	0.08	0.01	0.32	0.01	0.01
Alkalinity	mg/l	128	134	134	122	120	130	120
SO ₄ ²⁻	mg/l	8.3	8.5	8.4	7.4	18.8	7.3	8.9
Total Iron	mg/l	0.41	0.44	0.42	0.72	0.60	0.20	0.40
NaCl	mg/l	60.2	61.0	61.5	57.7	67.3	52.2	60.3
Cl ⁻	mg/l	34.1	34.5	35.2	30.6	38.8	28.8	34.6
HCO ₃ ⁻	mg/l	124	128	130	120	110	128	118
Hardness(CaCO ₃)	mg/l	180	180	182	170	200	180	270
Suspended Load	mg/l	20	90	85	20	100	18	65
Dissolved Load	mg/l	215	225	220	231	250	205	205
COD	mg/l	19.2	22.5	20.4	3.20	25.5	3.0	8.5
BOD ₅	mg/l	12.5	15.6	13.3	2.1	16.7	2.1	5.2
DO	mg/l	6.61	5.42	5.51	4.30	5.27	4.70	6.6
Coliform	Coli/100ml	560	600	900	90	2100	60	810
Fecal- Coliform	F.c/100ml	240	310	430	40	850	35	400
Cl.ferfrigens	no/10ml	12	18	25	5	26	4	20

Sampling on 15 December, 2002. sample sites: 1A-Da Ban Reservoir; 1B-Surface water in the East Main Canal; 1C-Surface water in the N3 irrigation canal; 1D-Well water next to N3 irrigation canal; 1E-Surface water in the N4 irrigation canal; 1F-Well water next to N4 irrigation canal; 1G-Da Ban River

⁶⁹ undetected

Table 72: Water Quality in Cai Ninh Hoa River, 2000.

Parameters	Unit	TCVN5942-1995	Year 2000
PH			6.59-7.05
TSS	mg/l	20	32
DO	mg/l	6	6.5
BOD ₅	mg/l	4	3.1
NO ₃	mg/l	10	0.11
Zn	mg/l	1	0.009
Cu	mg/l	0.1	0.002
As	mg/l	0.05	0.003
HC	mg/l	0	0.3

Source: Khanh Hoa State of the Environment Report, 2000-2001; Underlined values are above water quality standards; Data are averages of four sampling times in 2002.

Table 73: Water Quality in Cai Nha Trang River and Cai Ninh Hoa River, 12 April, 2000.

Parameter	Unit	Station			
		M1	M2	M3	M4
Temperature	°C	29.9	29.8	29.0	29.0
PH		7.88	8.02	7.51	6.90
Conductivity	µS/cm	165	135	136	105
Turbidity	NTU	8	10	20	50
Hardness(CaCO ₃)	mg/l	350	350	270	75
Alkalinity	mg/l	320	310	230	78
DO	mg/l	3.87	3.75	4.23	2.95
COD	mg/l	2.46	3.52	3.68	11.0
BOD ₅	mg/l	1.5	2.2	2.3	8.5
HCO ₃ ⁻	mg/l	320	310	230	0.061
Cl ⁻	mg/l	47.5	41.6	41.3	78
SO ₄ ²⁻	mg/l	38.7	34.6	28.7	71.2
Ammonia (NH ₄ ⁺)	mg/l	0.034	0.069	0.066	45.3
NO ₂ ⁻	mg/l	0.030	0.018	0.029	0.040
NO ₃ ⁻	mg/l	0.263	0.153	0.206	0.298
Phosphate(PO ₄ ³⁻)	mg/l	0.001	0.038	0.002	0.045
Total Iron	mg/l	0.020	0.050	0.190	0.470
Suspended solid	mg/l	23.0	31.0	38.0	50.0
Dissolved solid	mg/l	171	214.2	236.4	152.7
Coliform	Coli/100ml	210	330	350	270
Fecal- Coliform	F.c/100ml	90	85	95	85
Cl.ferfrigens	no/10ml	5	4	6	5

Water sample sites: M1 – Da Ban Reservoir, surface water depth of 0.5m; M2 – West Main canal from Da Ban reservoir, surface water in depth of 0.5m; M3 – East Main canal from Da Ban reservoir, surface water in depth of 0.5m; M4 – Dinh Bridge on the Cai Ninh Hoa with influent wastewater discharged into the river; M5 – Cai Ninh Hoa River at Quang Trach village, Xuan Hoa commune, surface water in depth of 0.5m

Table 74: Water Quality in Nha Phu Lagoon, 2000.

Parameters	Unit	TCVN5942-1995	Year 2000
PH			7.8-8.11
TSS	mg/l	50	150.3
DO	mg/l	5	6.6
BOD ₅	mg/l	10	3.1
Zn	mg/l	-	0.018
Cu	mg/l	0.01	0.002
As	mg/l	0.01	0.005
HC	mg/l	0.01	0.4

Source: Khanh Hoa State of the Environment Report, 2000-2001
Underlined values are above water quality standards at that time
Data are averages of four sampling times in 2002.

Table 75: Air quality in Ninh Xuan Industrial zone – Ninh Hoa District, 2000.

Parameter	Unit	Ninh Hoa Sugar Plant	Ninh Hoa Brick and Tile Plant	TCVN 5937-1995
Suspended dust	mg/m ³	2.2	1.41	0.3
SO ₂	mg/m ³	0.57	0.18	0.5

Source: Khanh Hoa State of the Environment Report, 2000-2001. Underlined values are above air quality standards at that time

Table 76: Air quality in Hon Khoi Industrial Zone – Ninh Hoa District 2000

Parameter	Unit	Hon Khoi Industrial Xone	TCVN 5937-1995
Suspended dust	mg/m ³	0.4 – 0.9	0.3
HC	mg/m ³	37.4	5
SO ₂	mg/m ³	0.8	0.5

Source: Khanh Hoa State of the Environment Report, 2000-2001. Underlined values are above air quality standards at that time

DAU TIENG SUB-PROJECT

Table 77: Water quality of Dau Tieng Reservoir, September 2002⁷⁰.

No	Station	Physical characteristics					Chemical characteristics (mg/l)						
		Depth (m)	Transp.	Temp water 0C	Temp air 0C	pH	COD	NH4+	NO3-	NO2-	PO4-	SS	
1	A1	6	30	29	28	6	36	1.32	0.8	0.025	1.130	2	
2	A2	8	50	28.5	31	6	12	1.1	0.54	0.007	0.115	999	
3	A3	5.5	80	30.5	31	6	14	0.98	0.44	0.004	0.15	290	
4	A3.1	25	65	29.5	30.5	6	14	1.1	0.38	0.002	0.13	230	
5	A4	7.25	125	29.5	30	6	24	1.1	0.38	0.003	0.16	150	
6	A5	13.8	300	30.5	33	6	26	0.66	0.34	0.002	0.05	250	
7	B1	2.2	180	31.5	30	6	28	0.32	0.56	0.008	0.11	130	
8	B1.1	-	-	-	-	-	10	0.66	0.184	0.005	0.15	310	
9	B2	3	185	30.5	33	6	12	0.44	0.13	0.002	0.1	1150	
10	B3	9	300	30.5	32	6	16	0.48	0.26	0.009	0.06	930	
11	B4	6.30	210	29.5	30.5	6	18	0.6	0.3	0.005	0.105	200	
12	B5	2.85	190	28	29	6	36	1.22	0.188	0.004	0.11	920	
13	1a	2.1	145	30	32	5	148	1.2	0.54	0.003	0.15	1250	
14	1b	2.3	150	30	32	5	140	1.28	0.46	0.003	0.125	1170	
15	1c	2.2	165	30	31	5	66	1.08	0.44	0.002	0.12	840	
16	C1	2	130	32	36	5	68	0.66	0.46	0.008	0.15	950	
17	C2	1.8	40	30	32	5	152	1.0	0.48	0.005	0.12	1250	
18	C3	1.9	35	29.5	29	6	176	1.44	0.42	0.04	0.194	1330	
19	C4	2.4	140	29	31	6	60	0.92	0.44	0.004	0.11	940	

A1, A2, A3, A3.1, A4, A5: sampling sites along west profile of Dau Tieng lake

B1, B1.1, B2, B3, B4, B5: sampling sites along east profile of Dau Tieng lake

C1, C2, C3 sampling sites along Eastern flow of Dau Tieng Reservoir (Cu Chi)

C1, C2, C3, C4: sampling sites along Eastern flow of Dau Tieng lake

C1: Canal N31A, Gia Be hamlet, Trung Lap Ha commune, Cu Chi district

C2: Cau Bong Sai Gon River, water access point of East main canal flow into Sai Gon river

C3: Binh Dien bridge next to cement factory and fertilizer, this source is for

C4: K13 West main canal

1a, 1b, 1c: sampling sites along Western flow of Dau Tieng lake

⁷⁰ Data collected as part of the preparation of this EIA.

Table 78: Historical changes in water quality of Dau Tieng Reservoir, September 2002.

No	Parameter	1993	1997	1998	2001	2002
1	PH	6,2 – 7	6,3 – 7,3	6,9 – 7	6,1 – 6,5	6
2	Transparency	30 cm				30-210 cm
3	to of water	30 – 31oC				28,5-30,5 o
4	Dissolved solids	30				200 –1330
5	Do mg/l	4,96 – 6,24	5,8 – 6,6	6,1 – 7	4,8 – 5,4	
6	COD mg/l	5,8 – 8,4	9,8 – 70	14,7 – 30,5	8,1 – 13,1	10 – 148
7	BOD5 mg/l		6,5 – 29	3 – 5	3 – 6	6,08 – 76,8
8	PO4 mg/l	0,17 – 0,3	0,04 – 4,35	0,01 – 0,02	0,06 – 0,08	0,11 – 0,25
9	NH4 mg/l	0,1 – 0,15	1,4 – 3,4	0,01 – 3,4	1,7 – 3,4	0,4 – 1,44
10	NO3 mg/l					0,13 – 0,54
11	Fe+3 mg/l	0,32 – 0,45				0,003-0,23
12	Mg mg/l	1,45 – 2,9				
13	Ca mg/l	2,4 – 3,2				
14	SiO2 mg/l	1,5 – 5				
15	CO2 mg/l	3,52 – 6,16				

Source: Hanoi National University

Table 79: Sample sites for surface water quality.

- M1- Quan bridge, Tay Ninh stream, Tay Ninh town
- M2 - Gio bridge, Tay Ninh stream, Tay Ninh town
- M3a - Suoi Da bridge, Hoa Thanh commune, Tan Bien district
- M4 - Can Dang bridge, Tan Bien district
- M5 - Tha La bridge, Tan Chau district
- M6 - Suoi Ngo bridge, Suoi Ngo commune, Tan Chau district
- M7 - Ben Keo, Vam Co Dong river, Chau thanh district
- M8 - Go Chai ferry station, Thanh Dien commune, Chau Thanh
- M9 - Go Dau bridge, Go Dau district
- M10 - Bau Nau Moi bridge, Cam Glang commune, Go dau district
- M11 - Bung Binh ferry station, Trang Bang district
- M12 - Bridge of Re Giua stream, Hoa Thanh district
- M13 - Weir on the East main canal (near by main dam), Duong Minh Chau district
- M14 -Main dam, at the round house, Duong Minh Chau district
- M15 - Weir on the West main canal, Phuoc Ninh commune, Duong Minh Chau district

Table 80: Surface water quality in Tay Ninh Province, September, 2001, Stations M1 to M8.

No	Parameter	Unit	Tay Ninh Town		Tan Bien		Tan Chau			Chau Thanh
			M1	M2	M3a	M4	M5	M6	M7	M8
1	PH		5.6	5.5	6.3	6.3	6.1	5.9	6.2	6.5
2	Temperature	OC	30.7	31.2	30.9	30.1	32.0	28.2	30.2	32.1
3	Turbidity	NTU	26	9	31	83	30	18	10	12
4	DO	Mg/l	1.3	3.8	4.9	4.5	4.8	4.8	5.6	4.9
5	N-NH4 +	Mg/l	0.46	0.2	0.07	0.14	0.1	0.05	0.12	< 0.01
6	Hardness (CaCO3)	Mg/l	19	13	19	28	16	9	38	31
7	BOD 5	Mg/l	4	3	3	3	4	4	6	5
8	COD	Mg/l	6	4	5	4	6	5	10	9
9	Fecal Coliform	MPN/100ml	240,000	2,300	2,300	9,300	9,300	1,500	15,000	3,900
10	Coliform	MPN/100ml	240,000	4,300	4,300	24,000	9,300	4,300	21,000	9,100

Table 81: Surface water quality in Tay Ninh Province, September, 2001, Stations M9 to M15.

No	Parameter	Unit	Go Dau		Trang Bang	Hoa Thanh	Duong Minh Chau		
			M9	M10	M11	M12	M13	M14	M15
1	PH		6.4	5.7	5.7	5.5	7.0	7.3	7.2
2	Temperature	oC	32.6	32.4	31.7	32.4	29.3	31.1	30.2
3	Turbidity	NTU	7	13	14	22	0	0	3
4	DO	mg/l	3.7	5.1	3.6	4.7	4.4	5.0	4.5
5	N-NH4 +	mg/l	0.14	0.11	0.16	0.23	0.12	0.1	0.1
6	Hardness (CaCO3)	mg/l	31	16	25	16	16	16	13
7	BOD 5	mg/l	6	3	3	5	3	4	4
8	COD	mg/l	10	4	6	9	4	6	6
9	Faecal Coliform	MPN/100ml	110,000	4,300	2,300	110,000	9,300	900	400
10	Coliform	MPN/100ml	110,000	9,300	2,300	110,000	9,300	4,300	900

Table 82: Surface water quality in Tay Ninh Province, January, 2001.

No	Parameter	Unit	Tay Ninh town		Tan Bien		Tan Chau			Chau Thanh
			M1	M2	M3a	M4	M5	M6	M7	M8
1	PH		5.7	5.8	28.6	6.5	6.5	6.0	6.1	6.2
2	Temperature	oC	28.2	29.2	6.1	27.7	30.3	25.4	27.2	29.3
3	Turbidity	NTU	18	12	60	320	28	15	8	33
4	DO	mg/l	4.4	4.8	5.4	5.0	6.2	6.2	5.8	5.4
5	N-NH4 +	mg/l	0.35	0.15	0.15	0.07	0.05	0.03	0.08	0.10
6	Hardness (CaCO3)	mg/l	54	50	50	57	50	44	40	57
7	BOD 5	mg/l	3	3	5	4	3	3	4	4
8	COD	mg/l	7	6	8	6	4	4	7	5
9	Total Fe	mg/l	0.74	0.62	1.71	10.12	1.85	0.80	1.20	1.76
10	Cu	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
11	Pb	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
12	Zn	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
13	Cd	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
14	Fecal Coliform	MPN/100ml	1,500	46,000	24,000	9,300	400	4,300	9,300	11,000
15	Coliform	MPN/100ml	24,000	46,000	24,000	9,300	4,300	9,300	11,000	24,000

Table 83: Additional surface water quality in Tay Ninh Province, January, 2001.

No	Parameter	Unit	Go Dau		Trang Bang	Hoa Thanh	Duong Minh Chau		
			M9	M10	M11	M12	M13	M14	M15
1	PH		6.1	6.0	5.9	5.7	7.5	7.5	7.2
2	Temperature	oC	29.2	28.2	29.3	27.5	28.5	29.5	28.2
3	Turbidity	NTU	40	36	28	56	5	5	4
4	DO	mg/l	4.7	5.3	5.0	5.2	5.5	6.4	6.7
5	N-NH4 +	mg/l	0.14	0.13	0.09	0.17	0.11	0.05	0.03
6	Hardness (CaCO3)	mg/l	57	50	41	47	54	32	57
7	BOD 5	mg/l	4	4	4	5	3	3	3
8	COD	mg/l	5	5	7	7	7	7	5
9	Total Fe	mg/l	1.94	1.04	0.30	1.02	0.09	0.08	0.15
10	Cu	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
11	Pb	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
12	Zn	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
13	Cd	mg/l	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
14	Fecal Coliform	MPN/100ml	240,000	1,500	900	110,000	0	0	0
15	Coliform	MPN/100ml	240,000	24,000	24,000	240,000	1,500	900	700

Table 84: Surface water quality at selected stations in Tay Ninh Province.

No	Parameter	Unit	Hoa Thanh commune, Tay Ninh town, field 20/8/1999	Tan Hung canal 20/8/1999	Middle West main canal 20/8/1999	Saigon bridge 27/9/1998	Saigon bridge 20/8/1999	Tong Le Chan, Sai Gon river 9/8/1999	Thu Dau Mot, Sai Gon River 27/9/1998	Thu Dau Mot, Sai Gon River 9/8/1999
1	Temperature	oC	29	30.3	30	28.8	29.3	30	28	30
2	pH		6.07	6.34	5.34	6	5.0	6.86	5.15	5
3	EC	µS/cm	91.8	30	32.1	16	24.3	60.5	44	75
4	Salinity	o/oo	0	0	0	0	0	0	0	0
5	Suspended solids	mg/l	43	14	15	9.5	10.5	28	23	33
6	Turbidity	NTU	3.7	0.5	0.6	0.6	0.85	0.8	0.42	0.55
7	DO	mg/l	5.1	5.8	5.4	5.4	5.1	5.2	4.2	5.1
8	BOD5	mg/l	2.5	1.9	2	2.7	2.8	2.2	2.3	2.6
9	COD	mg/l	6.7	6.2	6.1	6.5	6.5	6.6	6.2	6.8
10	Coiliform	MPN/100ml	450	230					625	
11	Ca	mg/l	13.1	12	11	8.8	9.4	12.6	12.3	13.3
12	Mg	mg/l	10	11	12	3.5	7.0	7.3	5.6	7.2
13	Fe total	mg/l	0.85	0.04	0.05	0.3	0.28	0.5	0.29	0.11
14	Na	mg/l	6.2	1.8	3.79	0.7	0.8	1.9	0.8	2.1
15	K	mg/l	8.1	0.55	0.75	0	0	0.4	0	0.8
16	Cu	mg/l	0	0	0.0	0	0	0	0	0
17	Zn	mg/l	0.12	0.09	0.1	0.1	0.09	0.11	0.12	0.11
18	NH4-	mg/l	0.07	0.06	0.06	0.08	0.07	0.07	0.05	0.08
19	HCO3-	mg/l	13.1	12	12.6	13.24	13	13	15	10.3
20	Cl-	mg/l	3.7	1.2	1.2	1.1	1.2	1.3	1.4	3.7
21	SO42-	mg/l	0	0	0	0	0	0	0	0
22	NO2-	mg/l	0.006	0.004	0.005	0.005	0.005	0.004	0.005	0.004
23	NO3-	mg/l	1.2	0.98	1.1	0.1	1.293	1.2	1.0	1.08
24	PO43-	mg/l	0.03	0.02	0.02	0.02	0.02	0	0.01	0.02
25	Cn	mg/l	0	0	0	0	0	0	0	0
26	Ni	mg/l	0	0	0	0	0	0.02	0	0
27	Mn	mg/l	0.12	0.20	0.01	0.4	0.02			0.28

Table 85: Sample sites for groundwater quality.

- N1- dug well at Mr. Nguyen Thanh Hai house, near by PC's office of Binh Minh commune, Tay Ninh town
- N2- Bore well at Thai Chanh Kindergarten, commune No2, Tay Ninh town
- N3- Tap water at Tay Ninh DOSTE
- N4- 25m deep Bore well at Ta thanh Suong house, village No1, Tan Bien town, Tan Bien district
- N5- 7m deep dug well at Nguyen Thanh Binh house, village No1, Tan Bien town, Tan Bien district
- N6 – 20 deep bore well at Tran Van Cau, village No1, Tan Chau town, Tan Chau district
- N7- Dug well at Huynh Thi Thanh Xuan, village No1, Tan Chau town, Tan Chau district
- N8- 20 deep bore well in Ba Den mountain area
- N9- 6m deep dug well at Nguyen Quang Kim, Binh Phong village, Thai Binh commune, Chau Thanh district
- N10- 30 m deep bore well at the office of Thai Binh PC commune, Chau Thanh district
- N11- 86m deep bore well at Go Dau water supply plant
- N12- 10 m dug well at Ngo Van Tham, village No 2, Go Dau town, Go Dau district
- N13- 45 m deep bore well at Trung Nguyen Ltd. Company, Trang Bang district
- N14- 10m deep dug well at Nguyen Ngoc Thu, Bung Binh village, Dong Thuan commune, Trang Bang district
- N15- 40m deep bore well at Hoa Thanh market , Hoa Thanh district
- N16- dug well at Ngo Van Ngoc, Tan Lap village, Rung Dau commune, Ben Cau
- N17 – Bore well at Company No 61, Ben Cau district
- N18 – 25m bore well at the police office in Moc bai harbour mouth,
- N19- Dug well at Phan Van Nghiep, village No 2, Duong Minh Chau town, Duong Minh Chau district
- N20- dug well at Do Van Duc, village No1, Duong Minh Chau town, Duong Minh Chau district

Table 86: Groundwater quality in Tay Ninh Province, September, 2001, Stations N1 to N10.

No	Parameter	Unit	Tay Ninh town			Tan Bien		Tan Chau		Chau Thanh		
			N1	N2	N3	N4	N5	N6	N7	N8	N9	N10
1	PH	mg/l	4.7	4.0	5.4	4.8	5.2	4.9	4.2	5.3	4.2	4.4
2	N-NO ₂ ⁻	mg/l	0.02	<0.01	0.0	0.0	0.03	0.0	0.0	0.0	<0.01	<0.01
3	N-NO ₃ ⁻	mg/l	6.0	3.4	0.3	0.07	6.0	0.4	0.45	2.1	13	2.8
4	Hardness (CaCO ₃)	mg/l	13	16	31	25	62	19	19	53	53	38
5	Fe	mg/l	0.26	0.83	0.4	0.87	0.33	0.94	0.74	0.75	0.37	0.39
6	Mn	mg/l	<0.02	0.05	<0.02	0.05	0.88	<0.02	<0.02	<0.02	0.06	0.06
7	Hg	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
8	Fecal Coliform	MPN/100ml	240	0	0	93	2,400	460	460	460	14	460
9	Coliform	MPN/100ml	240	0	0	93	2,400	2,400	2,400	460	150	2,400

Table 87: Groundwater quality in Tay Ninh Province, September, 2002, Stations N11 to N20.

No	Parameter	Unit	Go Dau		Trang Bang		Hoa Thanh	Ben Cau			Duong Minh Chau	
			N11	N12	N13	N14		N15	N16	N17	N18	N19
1	PH	mg/l	6.1	4.3	4.7	4.9	4.9	4.0	4.0	4.7	4.6	4.4
2	N-NO ₂ ⁻	mg/l	0.0	<0.01	0.0	<0.01	0.0	0.0	0.0	0.0	0.0	<0.01
3	N-NO ₃ ⁻	mg/l	0.07	4.6	0.6	0.6	0.07	3.2	3.9	0.07	0.7	1.9
4	Hardness (CaCO ₃)	mg/l	56	75	9	9	19	19	31	25	13	19
5	Fe	mg/l	0.38	0.23	0.26	2.5	0.55	0.27	0.22	0.71	0.22	0.27
6	Mn	mg/l	<0.02	<0.02	<0.02	<0.02	0.05	0.04	0.05	0.05	<0.02	<0.02
7	Hg	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
8	Fecal Coliform	MPN/100ml	460	2,400	460	0	460	460	1,100	1,100	3	460
9	Coliform	MPN/100ml	1,100	2,400	2,400	9	2,400	2,400	1,100	2,400	6	1,100

Table 88: Groundwater quality in Tay Ninh Province, January, 2002, Stations N1 to N10.

No	Parameter	Unit	Tay Ninh town			Tan Bien		Tan Chau		Chau Thanh		
			N1	N2	N3	N4	N5	N6	N7	N8	N9	N10
1	PH	mg/l	5.0	4.2	4.8	5.3	5.3	5.3	5.0	5.4	4.2	5.8
2	N-NO ₂ ⁻	mg/l	<0.01	0.0	0.0	<0.01	0.01	0.0	0.01	0.0	<0.01	0.01
3	N-NO ₃ ⁻	mg/l	5.5	7.0	0.4	0.47	16.0	0.47	3.60	5.1	24.5	9.8
4	Hardness (CaCO ₃)	mg/l	60	63	69	50	69	57	47	85	76	82
5	Fe	mg/l	0.15	0.04	0.25	1.60	0.04	0.05	0.05	0.01	0.02	0.01
6	Mn	mg/l	0.03	0.03	<0.03	0.07	0.19	0.02	0.01	<0.01	0.05	0.04
7	Hg	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
8	Fecal Coliform	MPN/100ml	460	43	93	0	460	4	0	23	9	150
9	Coliform	MPN/100ml	460	150	1,100	0	1,100	9	43	460	43	460

Table 89: Groundwater quality in Tay Ninh Province, January, 2002, Stations N11 to N20.

No	Parameter	Unit	Go Dau		Trang Bang		Hoa Thanh	Ben Cau			Duong Minh Chau	
			N11	N12	N13	N14		N15	N16	N17	N18	N19
1	PH	mg/l	5.8	3.7	5.1	4.5	3.9	4.2	4.6	5.1	4.1	4.6
2	N-NO ₂ ⁻	mg/l	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<0.01
3	N-NO ₃ ⁻	mg/l	0.15	13	0.3	0.7	6.0	2.8	6.1	0.18	0.5	1.6
4	Hardness (CaCO ₃)	mg/l	57	95	95	41	69	22	65	63	76	63
5	Fe	mg/l	0.9	0.22	0.09	0.1	0.03	0.25	0.01	0.26	0.09	0.16
6	Mn	mg/l	0.06	0.06	0.02	0.02	0.06	0.02	0.03	0.02	0.03	0.03
7	Hg	µg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
8	Fecal Coliform	MPN/100ml	9	23	0	23	9	1,100	0	0	460	1,100
9	Coliform	MPN/100ml	43	23	0	460	23	2,400	7	9	2,400	1,100

ANNEX 8: COMPILATION OF INFORMATION ON RARE AND ENDANGERED SPECIES IN VWRAP AREA

Notes for IUCN Redlist of Threatened Species

EX: Extinct
 EW: Extinct in the wild
 CR: Critically and Endangered
 EN: Endangered
 VU: Vulnerable
 LR/cd: Lower Risk /Conservation Dependent
 LR/nt: Lower Risk /Near Threatened
 DD: Data Deficient

Notes for Vietnamese Red Book:

(+) A group can be 5 – 6 individuals
 Level V: Vulnerable
 Level E: Endangered
 Level R: Rare
 Level T: Threatened
 K: Data-deficient

YEN LAP SUB-PROJECT

Table 90: List of rare and endangered mammals found in Quang Ninh Province.

Scientific Name	Vietnamese Name	English Name	IUCN 2002 Redlist	Vietnamese Red Book
<i>Capricornis sumatraensis</i>	SƠN DƯƠNG	Serow (E)	VU A2cd	V
<i>Cervus Nippon</i>	HƯƠNG SAO	South China Sika Tonkin Sika (E)		V
<i>Lepus sinesis</i>	THỎ RỪNG TRUNG HOA			R
<i>Phasianus colchicus</i>	TRÍ ĐỎ			R
<i>Prionodon pardicolor</i>	CÂY GẤM			R
<i>Rhinopithecus</i>	VOọc MŨI HÉCH	Tonkin Snub-Nosed Monkey (E)	CR C1, E	E
<i>Ursus thibetanus</i>	GẤU NGỰA	Asiatic black bear (E)		E

Table 91: List of rare and endangered plants found in Quang Ninh Province.

Scientific name	Vietnamese name	IUCN 2002 Redlist	Vietnam Red Book
<i>Altingia Chinensis</i>	TẮM		R
<i>Madhuca pasquieri</i>	SÉN MẬT	VU A1cd	k
<i>Sindora tonkinensis</i>	GỤ LAU		V
<i>Cycas Micholitzii</i>	TUẾ LÁ XÉ		V
<i>Dacrydium pierrei</i>	HOÀNG ĐÀN GIÁ		K
<i>Podocarpus pilgeri</i>	THÔNG TRE LÁ NGẮN		R
Markhamia	ĐÌNH		T
Pinaceae Lindl	THÔNG		R
<i>Chukrasia tabularis</i>	LÁT HOA		k
<i>Vatica tonkinensis</i>	TÁU MẬT		(K)
<i>Amomum zanthoides</i>	SA NHÂN		(K)

CAM SON-CAU SON SUB-PROJECT

Table 92: List of rare and endangered mammals in Bac Giang Province.

	SCIENTIFIC NAME	VIETNAMESE NAME	ENGLISH NAME	IUCN 2000 REDLIST	VIETNAM RED BOOK
1	<i>CATOPUMA TEMMINEKI</i>	BÁO LỬA	ASIATIC GOLDEN CAT (E) GOLDEN CAT (E)	LR/NT	V (*)
2	<i>CERVUS NIPPON</i>	HƯƠNG SAO	SOUTH CHINA SIKA (E)	CR D	V
3	<i>CUON ALPIMUS</i>	SÓI ĐỎ	ASIATIC WILD DOG (E) RED DOG (E)	VUC2A	E
4	<i>LEPUS SINESIS</i>	THỎ RỪNG TRUNG HOA			E
5	<i>LUTRA LUTRA</i>	RÁI CÁ THƯỜNG	COMMON OTTER (E) OLD WORLD OTTER (E)	VUA2CDE	T
6	<i>LUTROGALE PERSPICILLATA</i>	RÁI CÁ LÔNG MƯỢT	SMOOTH-COATED OTTER (E)	VUA1ACD	V
7	<i>MACACA ARCTOIDES</i>	KHỈ MẶT ĐỎ	BEAR MACAQUE (E) STUMP- TAILED MACAQUE (E) STUMPTAIL MACAQUE(E) MACAQUE BRUN (F) MACACA URSIN (S)	VUA1CD	V (+)
8	<i>MACACA NEMESTRINA</i>	KHỈ ĐUÔI LỚN			V
9	<i>MANIS PENTADACTYLA</i>	TÊ TÊ VÀNG	CHINESE PANGOLIN (E)	LR/NT	E (*)
10	<i>NICTICABUS CAUCANG</i>	CULI LỚN			V
11	<i>PARDOFELIS TIGRIS</i>	BÁO GẤM			V (*)
12	<i>PETAURISTA PETAURISTA</i>	SÓC BAY LỚN			R
13	<i>PRIONAILURUS VIVERRINUS</i>	MÈO CÁ	FISHING CAT (E)	LR/NT	R
14	<i>URRUS THIBETANUS</i>	GẤU NGỰA	ASIATIC BLACK BEAR (E)	VUA1CD	E (*)

Table 93: List of rare and endangered birds found in Bac Giang Province.

	SCIENTIFIC NAME	VIETNAMESE NAME	ENGLISH NAME	IUCN 2000 REDLIST	VIETNAM RED BOOK
1	<i>AERODRAMUS BREVIROSTRIS</i>	YẾN NÚI			R
2	<i>GARRULAX MILLETI</i>	KHƯỚU ĐEN	BLACK-HOODED LAUGHINGTHRUSH (E)	LR/NT	R
3	<i>LOPHURA NYTHEMERA</i>	GÀ LÔI TRẮNG			R
4	<i>MAGACERYLE LUGUBRIS</i>	BÓI CÁ LỚN			T

Table 94: List of rare and endangered reptiles found in Bac Giang Province.

	SCIENTIFIC NAME	VIETNAMESE NAME	ENGLISH NAME	IUCN 2000 REDLIST	VIETNAM RED BOOK
1	<i>ACONTHOSAURA LEPIDOGASTER</i>	Ô RÔ VÂY			T
2	<i>BUNGARUS FASCIATUS</i>	RẮN CÁP NONG			T
3	<i>CISTOCLEMMUS GALBINIFRONS</i>	RỪA HỘP TRÁN VÀNG			V
4	<i>GEKKO GEKKO</i>	TẮC KÈ			T
5	<i>INDOTESTUDO ELONGATA</i>	RỪA NÚI VÀNG	ELONGATED TORTOISE (E) PINEAPPLE TORTOISE (E)	EN A1CD+2CD	V
6	<i>MANOURIA IMPRESSA</i>	RỪA NÚI VIỄN	IMPRESSED TORTOISE (E)	VU A1ACD, B1+2ACD	V
7	<i>NAJA NAJA</i>	RẮN HỔ MANG			T
8	<i>OPHIPHAGUS HANNAH</i>	RẮN HỔ MANG CHÚA			V
9	<i>PALEA STEINDACHNERI</i>	BA BA GAI			V
10	<i>PTYAS KORROS</i>	RẮN RÁO THƯỜNG			T
11	<i>PTYAS MUCOSUS</i>	RẮN RÁO TRÂU			V
12	<i>PHYSIGNATHUS CONCINCINUS</i>	RỒNG ĐẤT			V
13	<i>PYTON MOLUTUS</i>	TRẦN ĐẤT			V
14	<i>VARANUS SALVATOR</i>	KỶ ĐÀ HOA			V

Table 95: List of rare and endangered fish found in Bac Giang Province.

No.	Scientific name	Vietnamese name	English Name	IUCN 2000 Redlist	Vietnamese Red Book
1	<i>SPINIBARBUS CALDWELI</i>	CÁ CHÀY ĐẤT			V
2	<i>SPIRIBARBICHTHYS DENTICULATUS</i>	CÁ BỔNG			V
3	<i>MYLOPHARYNGODON PICEUS</i>	CÁ TRẮM ĐEN			V
4	<i>MEGALOBrama TERMINALIS</i>	CÁ VẼN			V
5	<i>CRANOGLANIS SINENSIS</i>	CÁ NGẠNH			V

Table 96: List of rare and endangered plant species found in Cam Son Reservoir Watershed.

NO.	SCIENTIFIC NAME	VIETNAMESE NAME	ENGLISH NAME	IUCN 2000 REDLIST	VIETNAMESE RED BOOK
1	<i>ARDISIA SILVESTRIS</i>	LÁ KHÔI			V
2	<i>ARISTOLOCHIA INDICA</i>	SƠN ĐỊCH			R
3	<i>ASARUM BALANSAE</i>	BIẾN HOÁ			E
4	<i>BURRETIODENDRON (EXENTRODENDRON) TONKINENSIS</i>	NGHIỄN		ENA1D	V
5	<i>CAESALPINIA SAPPAN</i>	TÔ MỘC			T
6	<i>CALAMUS PLATYACANTHUS</i>	SONG MẬT			V
7	<i>CHUKRASIA TABULARIS</i>	LÁT HOA			K
8	<i>CIBOTIUM BAROMETZ</i>	CÁU TÍCH			K
9	<i>COLONA POILANEI</i>	CHÔNG		LR/NT	R
10	<i>CYCAS BALANSAE</i>	THIÊN TUẾ ĐÁ VÔI			R
11	<i>DENDROBIUM NOBILE</i>	THẠCH HỘC			R
12	<i>DRYNARIA FORTUNEI</i>	BỔ CỐT TOÀI			T
13	<i>MADHUCA PASQUIERI</i>	SẾN MẬT		VU A1CD	K
14	<i>MARKHAMIA STIPULATA</i>	ĐINH			V
15	<i>MELIANTHA SUAVIS</i>	RAU SẼNG			K
16	<i>MONRINDA OFFICINALIS</i>	BA KÍCH			K
17	<i>PARASHOEIA CHINESIS</i>	CHÒ CHỈ		EN A1CD, C2A, D	K
18	<i>PSILOTUM NUDUM</i>	LOẢ TÙNG TRẦN			K
19	<i>RAUVOLFIA VERTICILATA</i>	BA GẠC LÁ VÒNG			V
20	<i>SARGENTODOXA CUNEATA</i>	HUYẾT ĐẰNG			R
21	<i>SMILAX GLABRA</i>	THỎ PHỤC LINH			V
22	<i>STROPHANTHUS DIVARICATUS</i>	SÙNG DÊ			T
23	<i>STRYCHNOS UMBELLATA</i>	MÃ TIỀN DÂY			V

KE GO SUB-PROJECT

Table 97: List of rare mammals in Ke Go Nature Reserve.

	Scientific name	VIETNAMESE NAME	English Name	IUCN 2000 Redlist	Vietnam Red Book
Mammalia		THÚ			
1	<i>Felis temmincki</i>	BEO LỬA	Panther	LR/nt	V
2	<i>Cynocephalus variegatus</i>	CHÓN DỜI	Weasel	R	
3	<i>Pygathrix nemaĐu</i>	VOOC VÁ		E	E
4	<i>Helarctor malayanus</i>	GẤU CHÓ		E	V
5	<i>Lutra lutra</i>	RÁI CÁ THƯỜNG	Common Otter (E) Old World Otter (E)	VUA2cde	T
6	<i>Hylobates gabriellae</i>	VƯỜN MÁ HUNG		E	E
7	<i>Macaca arctoides</i>	KHỈ MẶT ĐỎ	Bear Macaque (E) Stump- Tailed Macaque (E) Stumptail Macaque(E) Macaque Brun (F) Macaca Ursin (S)	VUA1cd	V (+)
8	<i>Macaca nemestrina</i>	KHỈ ĐUÔI LỚN		V	
9	<i>M. assamensis</i>	KHỈ MỐC			V
10	<i>Nicticabius caucang</i>	CULI LỚN	Loris		V
11	<i>Arctictis binturong</i>	CÁY MỤC		V	
12	<i>Manis pentadactyla</i>	TÊ TÊ VÀNG	Chinese Pangolin (E)	LR/nt	E (*)
13	<i>Petaurista petaurista</i>	SÓC BAY LỚN	Flying squirrel		R
14	<i>Panthera tigris</i>	HỔ	Tiger	E	E
15	<i>Urrus thibetanus</i>	GẤU NGƯA	Asiatic Black Bear (E)	VUA1cd	E (*)
16	<i>Bos gaurus</i>	BÒ TÓT		E	V
17	<i>Capricornis sumatraensis</i>	SƠN DƯƠNG	Chamois	V	V
18	<i>Elephas mximus</i>	VOI	Elephant	V	E
aves		CHIM			
1	<i>Cairina scutulata</i>	NGAN CÁNH TRẮNG	Swan	E	E
2	<i>Rheinartia ocellata</i>	TRÍ SAO	Pheinaridia ocellata	T	V
3	<i>Lophura hatinhensis</i>	GÀ LÔI LAM ĐUÔI TRẮNG	pheasant	E	E
4	<i>L. imperialis</i>	GÀ LÔI LAM MÀO ĐEN	pheasant	E	CR
5	<i>L. diardi</i>	GÀ LÔI HỒNG TÍA	Lophura diardi	T	V
6	<i>Arborophila charltonii</i>	GÀ SO CHÂN VÀNG	Hill partridge		V
7	<i>Carpococcyx renauldi</i>	PHƯỜN ĐẤT		T	
8	<i>Ceryle lugubris</i>	BÓI CÁ LỚN	Kingfisher	T	
9	<i>Alcedo hercules</i>	BÔNG CHANH RỪNG		T	V
10	<i>Buceros bicornis</i>	HỔNG HOÀNG	Great hornbill	T	
11	<i>Rhyticeros undulatus</i>	NIỀC MỎ VẦN		T	
12	<i>Picus rabieri</i>	GỖ KIẾN XANH ĐẦU ĐỎ	woodpecker	T	V
13	<i>Psarisomus dalhousiae</i>	MỎ RỘNG XANH		T	
14	<i>Pitta ellioti</i>	ĐUÔI CỤT BỤNG VẦN		T	
15	<i>Temnurus temnurus</i>	KHÁCH ĐUÔI CỜ		T	
16	<i>Jabouilleia danjoui</i>	KHIẾU MỎ DÀI		T	V
17	<i>Paradoxomis davidianus</i>	KHIẾU MỎ DỆT ĐUÔI NGẮN		T	V
Reptilia		BÒ SÁT			
1	<i>Cistoclemmus galbinifrons</i>	RÙA HỘP TRÁN VÀNG			V
2	<i>Gekko gekko</i>	TẮC KÈ			T
3	<i>Indotestudo elongata</i>	RÙA NÚI VÀNG	Elongated Tortoise (E) Pineapple Tortoise (E)	EN A1cd+2cd	V
4	<i>Manouria impressa</i>	RÙA NÚI VIỄN	Impressed Tortoise (E)	VU A1acd, B1+2acd	V
5	<i>Naja naja</i>	RẮN HỔ MANG			T
6	<i>Ophiphagus hannah</i>	RẮN HỔ MANG CHÙA			V
7	<i>Pyton molutus</i>	TRẦN ĐẤT			V
8	<i>Varanus salvator</i>	KỶ ĐÀ HOA			V

Table 98: List of rare plants in Ke Go Nature Reserve.

No	Scientific Name	VIETNAMESE NAME	English Name	IUCN 2000 Redlist	Vietnamese Red Book
1	<i>Aquilaria crassna</i>	TRẮM HƯƠNG		CR A1cd	(E)
2	<i>Churasia tabularis</i>	LÁT HOA			(K)
3	<i>Dalbergia tonkinensis</i>	SUA		VU A1cd	(R)
4	<i>Madhuca pasquieri</i>	SẾN MẬT		VU A1cd	(K)
5	<i>Parashorea chinensis</i>	CHÒ CHỈ		EN A1cd, C2a, D	(K)
7	<i>Podocarpus henryi</i>	KIM GIAO			(T)
8	<i>Manglietia fordiana</i>	VÀNG TÂM			(T)
9	<i>Calamus platyacanthus</i>	SONG MẬT			(T)
10	<i>Sindora tonkinensis</i>	GỤ LAU		DD	(V)

PHU NINH SUB-PROJECT

Table 99: List of rare and endangered mammals in Quang Nam Province.

Scientific Name	Vietnamese Name	English Name	IUCN 2002 Red List Status	Vietnam Red Book
<i>Pygathrix nemaeus</i>	VOOC CHÀ VÀ		V	V
<i>Elephas indicus</i>	VOI	Elephant	V	E
<i>Capricornis sumatraensis</i>	SƠN DƯƠNG	Chamois	V	V
<i>Macaca speciosa</i>	KHỈ MẶT ĐỎ	Red face monkey	VU	V
<i>Cervus unicolor</i>	NAI	Deer		
<i>M. arctoides</i>	KHỈ MẶT ĐỎ	Red face monkey	VU	V
<i>Macaca mulatta</i>	KHỈ VÀNG	Yellow monkey	VU	V
<i>M. fascicularis</i>	KHỈ ĐUÔI DÀI	Long tail monkey	VU	V
<i>Lutra sumatrae</i>	RÁI CÁ	Otter	nt	V
<i>Ceryle lugubris</i>	BÓI CÁ LỚN	Kingfisher	T	
<i>Ceryle rudis</i>	BÓI CÁ NHỎ	Kingfisher	T	
	CHÓ SÓI	Wolf	nt	V

Table 100: List of rare and endangered birds in Quang Nam Province.

Scientific Name	Vietnamese Name	English Name	IUCN 2002 Red List Status	Vietnam Red Book
<i>Egretta garzetta</i>	CÒ TRẮNG	Little Egret	EN	

Table 101: List of rare and endangered reptiles in Quang Nam Province.

Scientific Name	Vietnamese Name	English Name	IUCN 2002 Red List Status	Vietnam Red Book
<i>Geoemyda tcheponensis</i>	RÙA ĐẤT SÉPÔN			V
<i>Gekko gekko</i>	TẮC KÉ			T
<i>Acanthosaura lepidogaster</i>	Ồ RÒ VẤY			V
<i>Physignathus cocincinus</i>	RỒNG ĐẤT			V
<i>Naja naja</i>	RẮN HỔ MANG	Copperhead		T
<i>Python molurus</i>	TRẦN ĐẤT			V
<i>Varanus salvator</i>	KỶ ĐÀ HOA			V

Table 102: List of rare and endangered plants in Quang Nam Province.

Scientific Name	Vietnamese Name	English Name	IUCN 2002 Red List Status	Vietnam Red Book
Markhamia	ĐINH			T
Cassia siamea	MUỐNG ĐEN			R
Pinaceae Lindl	THÔNG KHU 7	Pine sp.		R
<i>Peltophorum</i> sp.	LIM XET			T
<i>Parashorea</i> sp.	CHỒ CHỈ			R
<i>Fagraea</i> sp.	TRẮC NAM BỘ	Rosewood		

DA BAN SUB-PROJECT

Table 103: List of rare and endangered mammals and birds in Khanh Hoa Province.

Scientific name	Vietnamese Name	English Name	IUCN 2002 Redlist	Viet Nam Red Book
Mammals				
<i>Elephas indicus</i>	VOI	Elephant	V	E
<i>Panthera tigris</i>	HỔ	Tiger	EN	E
Birds				
<i>Polyplectron bicalcaratum</i>	CÔNG	Grey Peacock - pheasant	Nt	
<i>Lophura hatinphensis</i>	TRÍ	Vietnamese pheasant	E	E

Table 104: List of rare and endangered plants in Khanh Hoa Province.

Scientific name	Vietnamese Name	English Name	IUCN 2002 Redlist	Viet Nam Red Book
Markhamia	ĐINH	UNKNOWN		T
Cassia siamea	MUỐNG ĐEN	UNKNOWN		R
Pinaceae Lindl	THÔNG KHU 7	PINE		R
<i>Peltophorum</i> sp.	LIM XET	UNKNOWN		T
<i>Parashorea</i> sp.	CHỒ CHỈ	UNKNOWN		R

DAU TIENG SUB-PROJECT

Table 105: List of rare and endangered plants in Tay Ninh Province.

Scientific name	Vietnamese name	English Name	IUCN 2002 Redlist	Vietnam Red Book
<i>Anisoptera costata</i>	Vên vên		EN A1cd+2cd	
<i>Dillenia obovata</i>	Sổ		EN A1cd+2cd; B1+	
<i>Dipterocarpus alatus</i>	Dầu nước			
<i>Dipterocarpus dyerii</i>	dầu Song Nàng		CR A1cd+2cd; B1+	
<i>Dipterocarpus costatus</i>	Dầu mít		EN A1cd+2cd	
<i>Peltophorum pterocarpum</i>	Lim sét			R
<i>Shorea roxburghii</i>	Sến mù		EN A1cd	

Table 106: List of rare and endangered mammals in Tay Ninh Province.

Scientific name	Vietnamese name	English Name	IUCN 2002 Redlist	Vietnam Red Book
<i>Buceros bicornis</i>	Hồng hoàng			T
<i>Cynocephalus variegatus</i>	Chồn bay	Weasel		R
<i>Felis bengalensis</i>	mèo rừng	Leopard Cat	E	
<i>Helarctos malayanus</i>	Gấu chó	Malayan Sun Bear	DD	E
<i>Hystrix hodgsoni</i>	Nhím	Crestless Himalayan porcupine		V
<i>Macaca arctoides</i>	Khỉ mặt đỏ	Monkey	V	V
<i>Macaca nemestrina</i>	Khỉ đuôi lợn	Monkey	V	VU
<i>Macaca fascicularis</i>	Khỉ đuôi dài	Monkey	LR.nt	T
<i>Menetes berdmorei</i>	Sóc vàng lưng	squirrel	R	
<i>Nycticebus pygmaeus</i>	Cu li đỏ	Lesser Slow loris	VU	V
<i>Lutra perspicillata</i>	Rái cá	Otter		V
<i>Tragulur javanicus</i>	Cheo cheo			T

Table 107: List of rare and endangered birds in Tay Ninh Province.

Scientific name	Vietnamese name	English Name	IUCN 2002 Redlist	Vietnam Red Book
<i>Ducula aenea</i>	Gấm ghi lưng xanh	Green imperial pigeon		R
<i>Grus antigone</i>	Sếu cổ đỏ	Crane		V
<i>Lophura diardi</i>	Gà lôi hông tía	Cock of the wood		V
<i>Pavo muticus imperator</i>	Công	Peacock		V
<i>Polyplectron bicalcaratum</i>	Gà tiền mặt đỏ	Cock of the wood		T
<i>Pseudibis papillosa</i>	Quắm lớn			T
<i>Pseudibis davisini</i>	Quắm cái xanh			T

Table 108: List of rare and endangered reptiles in Tay Ninh Province.

Scientific name	Vietnamese name	English Name	IUCN 2002 Redlist	Vietnam Red Book
<i>Cuora amboiensis</i>	Rùa hộp	Reptile		T
<i>Gekko gekko</i>	Tắc kè	Gecko		T
<i>Hieremis annandalei</i>	Rùa rặng	Turtle	V	V
<i>Indotestudo elongata</i>	Rùa núi vàng	Elongated Tortoise (E) Pineapple Tortoise (E)	EN A1cd+2cd	V
<i>Naja naja</i>	Rắn hổ mang	Indian cobra		T
<i>Ptyas korros</i>	Rắn ráo thường	Grass-snake		V
<i>Varanus bengalensis</i>	Kỳ đà vân	Varan		V
<i>Varanus salvator</i>	Kỳ đà hoa	Varan		V

ANNEX 9: DESCRIPTION OF PROTECTED AREAS IN VWRAP AREA