No. 1

MINISTRY OF AGRICULTURE
AND RURAL DEVELOPMENT
THE SOCIALIST REPUBLIC OF VIETNAM

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR IMPROVEMENT OF DRAINAGE SYSTEM IN TAN CHI AGRICULTURAL AREA IN THE SOCIALIST REPUBLIC OF VIETNAM

MARCH, 1998

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JAPAN INTERNATIONAL COOPERATION AGENCY
SANYU CONSULTANTS INC.

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PREFACE

In response to a request from the Government of the Socialist Republic of Vietnam the Government of Japan decided to conduct a basic design study on the Project for Improvement of Drainage System in Tan Chi Agricultural Area and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Vietnam a study team from September 9 to September 23 and from October 8 to November 6, 1997.

The team held discussions with the officials concerned of the Government of Vietnam, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Vietnam in order to discuss a draft basic design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Socialist Republic of Vietnam for their close cooperation extended to the teams.

March, 1998

KIMIO FUJITA
President
Japan International Cooperation Agency

March, 1998

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Improvement of Drainage System in Tan Chi Agricultural Area.

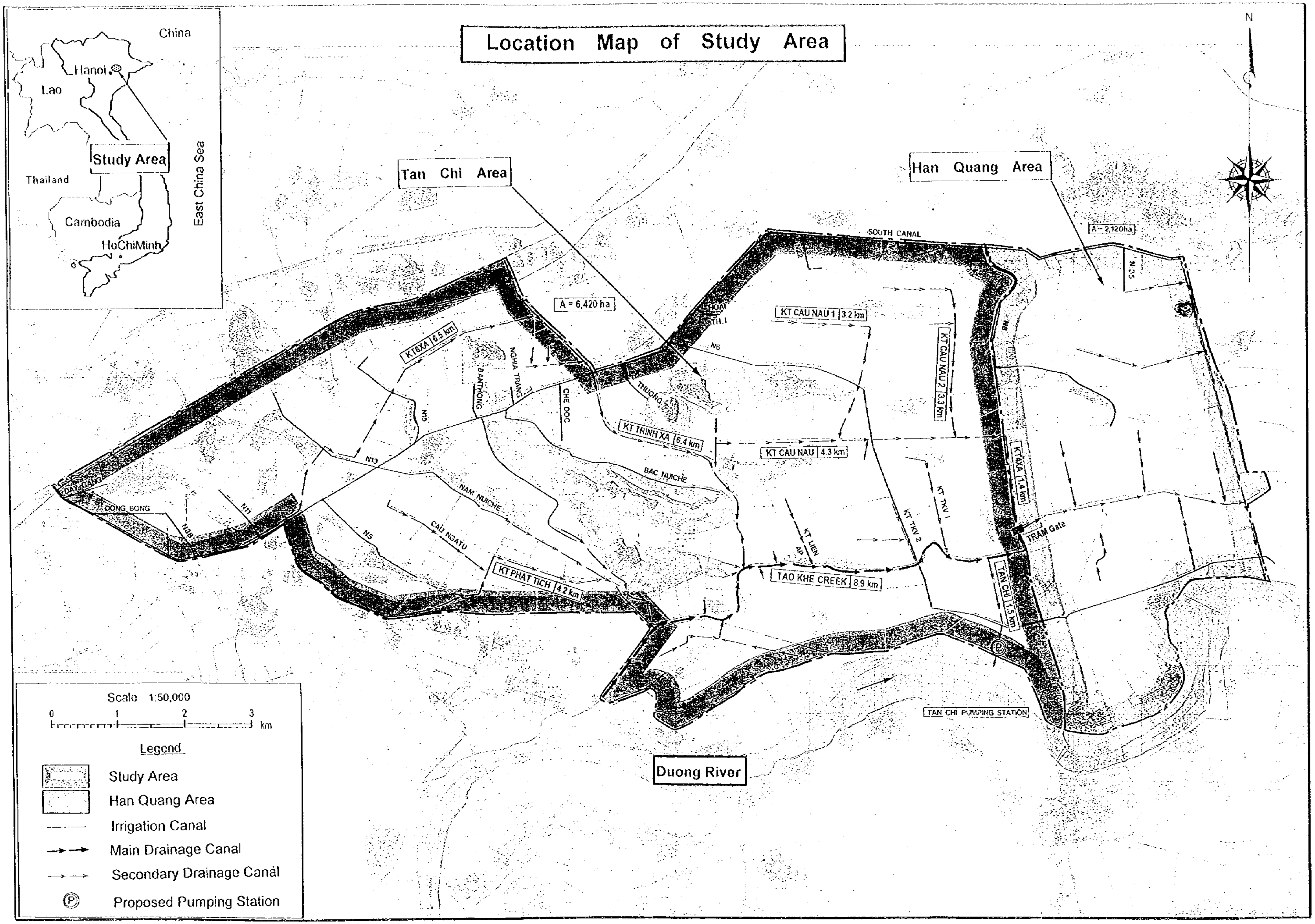
This study was conducted by Sanyu Consultants Inc., under a contract to JICA, during the period from September 4, 1997 to March 31, 1998. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Vietnam and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

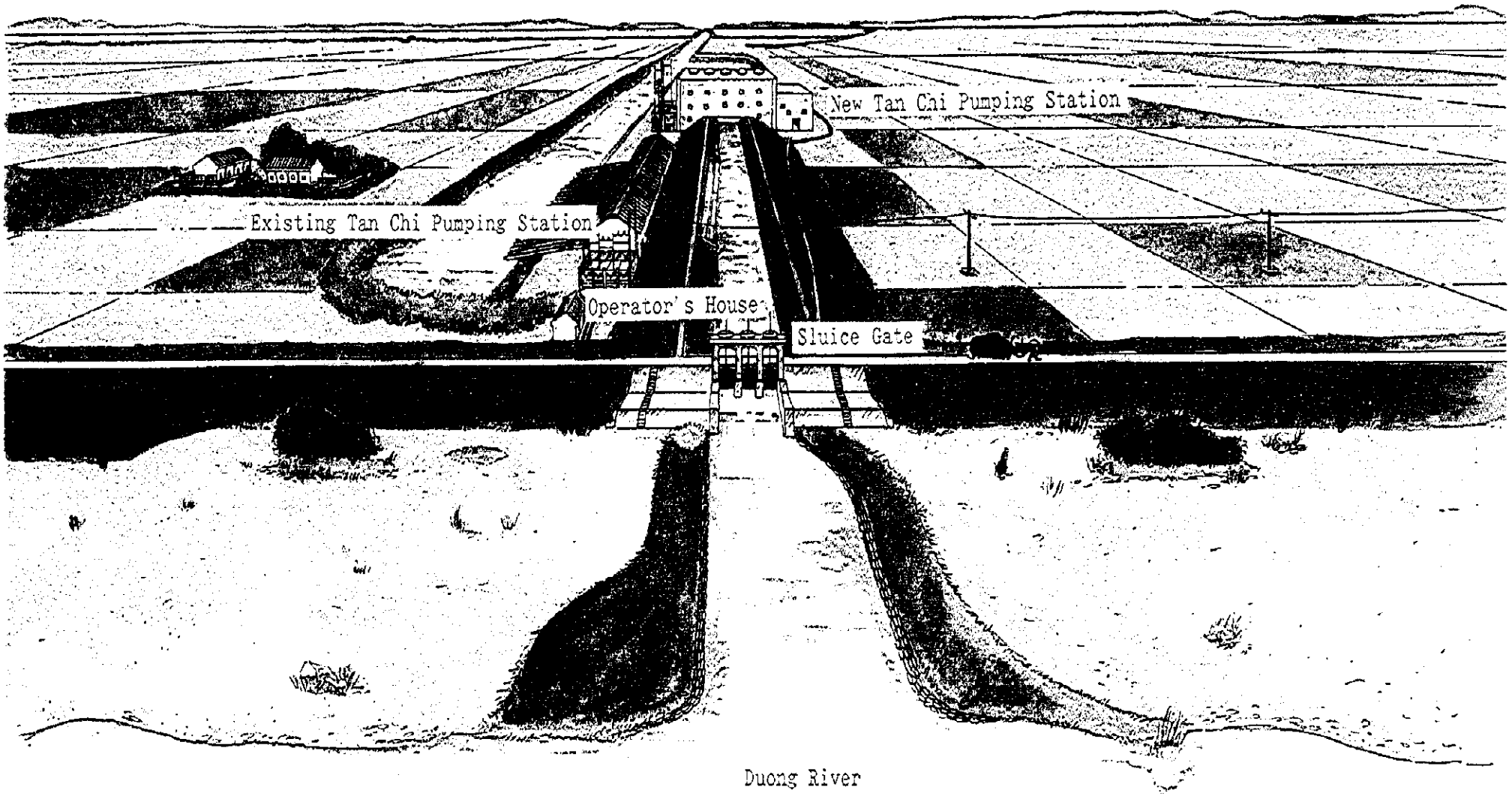
Very truly yours,

大部 史道

FUMIMICHI OBU
Project manager,
Basic design study team on
Improvement of Drainage System
in Tan Chi Agricultural Area
Sanyu Consultants Inc.


Location Map of Study Area
China
Hanoi
Lao
Study Area
Thailand
Cambodia
HoChiMinh
East China Sea
Tan Chi Area
Han Quang Area
A = 6,420 ha
A = 2,120ha
SOUTH CANAL
KT6XA 6.5 km
KT CAU NAU 1 3.2 km
KT CAU NAU 2 3.3 km
KT TRINH XA 6.4 km
KT CAU NAU 4.3 km
KT6XA 1.4 km
TAO KHE CREEK 8.9 km
KT PHAT TICH 4.2 km
TAN CHI 1.5 km
TRAM Gate
TAN CHI PUMPING STATION
Duong River
NGHIA TRANG
BAN THONG
CHE DOC
BAC NUICHE
NAM NUICHE
CAU NGATU
DONG BONG
KT TKV 1
KT TKV 2
KT LIEN AP
N5
N6
N11
N13
N35
Scale 1:50,000
0
1
2
3
km
Legend
Study Area
Han Quang Area
Irrigation Canal
Main Drainage Canal
Secondary Drainage Canal
Proposed Pumping Station

TAN CHI PUMPING STATION
CONCEPTIONAL DRAWING



ABBREVIATIONS

ADB	Asian Development Bank
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMD	Construction Management Department
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization of the United Nation
GDP	Gross Domestic Product
GNP	Gross National Product
IEE	Initial Environment Examination
IWRPM	Institute of Water Resources Planning and Management
JICA	Japan International Cooperation Agency
MARD	Ministry of Agriculture and Rural Development
MPI	Ministry of Planning and Investment
MSTE	Ministry of Science, Technology and Environment
PC	People's Committee
WB	World Bank

GLOSSARY

LENGTH

mm	: millimeter(s)
cm	: centimeter(s)
m	: meter(s)
km	: kilometer(s)
inch	: inch(s)=2.54 cm

ACREAGE

sq.mm	: square millimeter(s)
sq.cm	: square centimeter(s)
sq.m	: square meter(s)
sq.km	: square kilometer(s)
ha	: hectare(s)
Sao	: sao=360 m^2

WEIGHT

mm.gr	: milligram(s)
gr	: gram(s)
kg	: kilo-gram(s)
ton	: ton(s)
ounce	: ounce(s)=28.350 gr

VOLUME

lit	: liter(s)
cu.m	: cubic meter(s)
gallon	: gallon(s)=3.785 lit
MCM	: million cubic meter(s)

DISCHARGE

lps	: liter per second
cu.m/sec	: cubic meter per second
lpd	: liter per day

VELOCITY

mm/sec	: millimeter per second
cm/sec	: centimeter per second
m/sec	: meter per second
knot	: knot(s)=1.86 km/hr

sec	: second(s)
min	: minute(s)
hr	: hour(s)
Max.or.max.	: maximum
Min.or.min	: minimum
%	: percent
C	: degree(s) centigrade
Hp	: horse power(s)
W	: watt(s)
KW	: kilowatt(s)
MW	: megawatt(s)
WH	: watt(s) hour
KWH	: kilowatt(s) hour
EL	: elevation

MSL	: mean sea level
FWL	: full water level
HWL	: high water level
LWL	: low water level
ISWL	: initial water level
LSWL	: lowest suction water level
FY	: fiscal year
Dong	: 1 dong= US$0.0000853US$ (November, 1997)
US$	: 1 US$= 11,710 dong (November, 1997)

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DRAWINGS

APPENDICES

A. MEMBER LIST OF SURVEY TEAM
B. SURVEY SCHEDULE
C. LIST OF ATTENDANCE OF MEETING
D. MINUTES OF DISCUSSION
E. OTHER RELEVANT DATA

CHAPTER 1 Background of the Request

The Socialist Republic of Vietnam (SRV) stretches vertically between latitude 8°N and 23°N, horizontally between longitude 100°E and 102°E. The total area of the country is about 330,000 km² and the population as of 1995 is 74 million, of which 20 % is distributed in the urban area and 80 % in the rural area. Until the year of 2000, the population will increase in 80 million. The population is concentrated in the Red River Delta of the north and in the Mekong River Delta in the south. The two largest cities, Ho Chi Minh City (4.1 million) and Hanoi (2.1 million), account for about 44 % of the urban population.

Vietnam's economy is traditionally founded on agriculture. The agricultural sector, including forestry and fishing stands 35 % of GDP, nearly 75 % of national employment, which plays an important role in the national economy. The total cultivated land is 6.9 million ha and a farm household has 0.2 to 0.3 ha in the north,
1 to 2 ha in the south.

The SRV places the top priority on increasing agricultural production and growing Gross National Product in the Fifth Five Plan (1991-1995) through expansion of and full use of cultivated areas. In order to achieve these objectives, the Ministry of Agriculture and Rural Development (MARD) has prepared the Investment Plan and Development Orientation towards the year 2005. The plan gives a priority to the development of the northern area, particularly leading in the Red River Delta, aiming to control inundation problems, improve irrigation capacity and efficiency.

In the Delta, about 3,400 pumping stations for irrigation and drainage have been constructed and an irrigated area of some 750,000 ha have been developed, but agricultural infrastructures which were damaged by war and nature disasters are not still rehabilitated due to financial difficulties.

Rehabilitation of such deteriorated irrigation and drainage facilities and further development of irrigation and drainage systems are recognized as one of important tasks to be solved in order to improve the productivity of agriculture land. The master plan to guide the development of the Red River Delta was completed by the World Bank with financial assistance of UNDP, involving short term, medium term and long term development plan and proposing some projects for the feasibility study suitable for financing by international agencies concerned.

Under such situations, the SRV requested the Government of Japan (GOJ) to extend the technical assistance for formulation of the Improvement of Drainage System in South Bac Duong Agricultural Area. The GOJ dispatched, through Japan International Cooperation Agency (JICA), a study team to Vietnam from April 1994 to January 1995 to conduct the project study. Based on the study, the SRV requested to the GOJ for grant aid to implement the Project for Tan Chi area to which the high priority was given.

Tan Chi area covering 6,420 ha lies in the low land surrounded by polder dikes, where drainage will be done by pumps. The area is suffering from heavy inundation during the rainy season due to deficiency of drainage capacity by deteriorated pump equipment. The project aims to rehabilitate and improve drainage system in the area by replacing such deteriorated pump equipment and constructing a new Tan Chi pumping station.

CHAPTER 2 Contents of the Project

2-1 Objectives of the Project

In line with the socio-economic development plan during the five years (1996-2000), the Government of Vietnam has placed a high priority on increasing food crop production through effective use of agricultural land as well as improvement of irrigation and drainage facilities from an aspect of national foodstuff security. Although the target is to increase agricultural productivity, agricultural infrastructure damaged by war and natural disasters such as irrigation, drainage, access road and other facilities are not still rehabilitated. Therefore, the Government of Vietnam is promoting the projects to achieve the aim by rehabilitating damaged and deteriorated infrastructures.

Under such situations, Japan International Cooperation Agency carried out the Study on the Improvement of Drainage System in South Bac Duong Agricultural Area in the year of 1994-1995. Based on the study, the project for the Tan Chi area covering 6,420ha is most feasible from a view point of economic evaluation.

The objectives of the Project are to improve the productivity of agricultural land by improving drainage conditions such as replacement of existing pumps and motors, construction of a new pumping station and rehabilitation of drainage canals in the area which is inundated due to deteriorated pumping equipment and deficiency of the capacity.

2-2 Basic Concept of the Project

(1) Contents of the Request

In respect to the request, the contents of the project were confirmed between the Vietnamese side and the Basic Study team as shown in the Table 2-1.

Table 2-1 (1/2) Confirmation of the Contents of the Project

	Quantity	
	Requests by Vietnamese Side	Result of B/D Study
(1) Replacement of Existing Pumps:		
(a) Pump Number	: 20 sets (300mm x 33kw each)	46 sets (350mm x 33kw each)
Type	: Horizontal axis-mixed flow volute pump.	Horizontal axis-mixed flow volute pump.
(b) Motor Number	: 10 sets (33kw x 50Hz each)	46 sets (33kw x 50Hz each)
(2) Construction of New Pumping Station		
(a) Mechanical equipment:		
1. Pump Capacity	: 240m^3/min each	240m^3/min each
Number	: 4 sets	4 sets
Type	: Vertical mixed flow pump	Vertical mixed flow pump
Size	: 1,350mm in diameter	1,350mm in diameter
2. Speed reducing gear	: 4 sets	Cancel
3. Motor Power	: 500kw x 4P x 3kv x 50Hz each	500kw x 20P x 6.6kv x 50Hz each
Number	: 4 sets	4 sets
4. Gates and Valves		
Trash Rack Screen	: 4 sets	4 sets(Screen)
Butterfly valve	: 4 sets (1,350mm each)	4 sets (1,350mm each)
Flap valve	: 4 sets (1,650mm each)	4 sets (1,650mm each)
Movale crane	: 1 set, 15tons	1 set, 20tons
Horizontal conveyor	: 1 set (750mm x 36m)	Cancel
Inclined conveyor	: 1 set (750mm x 15m)	Cancel
Steel pipe	: 4 sets	4 sets
(b) Electrical Equipment:		
1. Electric receiving facilities		
34kv Incoming panel	: 1 set	Vietnamese Side(1 set)
34kv Metering PT & CT panel	: 1 set	Vietnamese Side(1set)
Main transformer Primary panel	: 1 set	Vietnamese Side(2 sets)
4,500KVA main transformer	: 1 set	Vietnamese Side(1800KVA 2 sets)
500KVA auxiliary feeder transformer and Pane	: None	Vietnamese Side(35kv,100KVA Auxiliary feeder transformer and Panel)
2. Distribution and others		
3kv Incoming panel	: 1 set	2 sets(6.6kv Incoming panel)
3kv Reactor & Capacitor panel	: 4 sets	4 sets(6.6kv Reactor & Capacitor panel)
3kv motor starter panel	: 4 sets	4 sets(6.6kv motor starter panel)
Auxiliary transformer panel	: 1 set	Cancel
500KVA auxiliary feeder transformer	: 1 set	Cancel
Low voltage panel	: 2 sets	2 sets(Low voltage panel)
Battery & charger panel	: 2 sets	2 sets(Battery & charger panel)
Local pump control panel	: 4 sets	4 sets(Local pump control panel)
Auxiliary relay panel	: 4 sets	4 sets(Auxiliary relay panel)
Cables	: L.S	L.S(Cables)

Table 2-1 (2/2) Confirm of the Contents of the Project

	Quantity	
	Requests by Vietnamese Side	Result of B/D Study
(c) Pump House	410m²	324m²
(d) Civil Works		
1. Leading Canal	L.S	L.S
Dredging		
Excavation		
Fill		
Spoiled dike		
2. Suction Sump	L.S	L.S
Concrete works		
P.C. pile D450 L=15m		
Excavation		
Fill		
Spoiled dike		
3. Discharge reservoir & sluice way	L.S	L.S
Concrete works		
P.VC pile D450 L=15m		
Excavation		
Fill		
Spoiled dike		
Sluice gate and hoist		4 sets (Operated by electric power)
(3) Rehabilitation of Drainage Canal		
Main Canal Length (km)		
Tao Khe Creek 8.9km	L.S	②N6 Elevated Flume(Japanese Side), Canal Excavation(Vietname
Secondary Canal		
KT Trinh Xa 6.4km	L.S	Vietnamese Side
KT 6 Xa 6.5km	L.S	Vietnamese Side
KT Phat tich 4.2km	L.S	Vietnamese Side
KT 4 Xa 1.4km	L.S	S-①、②、③(Japanese Side) ,Canal Excavation(Vietnamese Side)
KT Kau Nau 4.3km	L.S	S-④(Japanese Side) ,Canal Excavation(Vietnamese Side)
KT Kau Nau-1 3.2km	L.S	Vietnamese Side
KT Kau Nau-2 3.3km	L.S	Vietnamese Side
KT Tan Chi 1.5km	L.S	S-⑤(Japanese Side), Canal Excavation(Japanese Side)
Total 30.8km		
(4) Supply of Construction Machines		
Dredging equipment	(200ps) 1 set	Main chanal --- Dredger(125PS) x 2 sets Secondary canal --- Long armed excavator (135PS) x 3 sets

(2) Contents of the Basic Concept

1) Drainage Plan of Tan Chi Area

Basic concept of the drainage plan the Tan Chi area is to improve a poor drainage area by regulating Tri Phuong sluice gates in the upstream and Tram sluice gates in the downstream. When the flood occurs, rain water in the area should flow out to the Duong river through Tao Khe creek and Tan Chi leading canal while closing both gates according to the Decree, No.406-QD-TN dated on 15, July, 1987 stipulated by the Ministry of Water Resources.

During the ordinary drainage, Tram sluice gates are only opened when Hien Luong pumping station drains water into the Cau river or in case of Hien Luong sluice is opened, drains water by gravity to the Cau river.

Even though the gravity drainage within the Tan Chi area would be possible to the Duong river, sluice gates are not permitted to be installed from a view point of protection for the river dike. Sluice gates installed at the discharge reservoir would be set up at the higher elevation than the bottom elevation of a sluiceway and the discharge reservoir should be enclosed by embankment, functioning a river dike.

In order to improve present situations, Tan Chi pumping station is planned to be replaced with new pumps and motors. Moreover, a new pumping station is requisite to be constructed in order to meet the drainage requirement of $16m^3/s$. Total design discharge of $31.1m^3/s$ summing up the replacement and additional pump's discharge would be flown to the Duong river.

2) Replacement of Existing Equipment

Based on the inspection of 68sets (pump: ¢ 300 mm, motor: 33 kw) of existing equipment being installed at Tan Chi pumping station, 46sets of pumps and motors are judged to be replaced with new ones (pump: ¢ 350 mm, motor: 33 kw) which would be possible to be manufactured and supplied in Vietnam. (See Appendix 5)

At present, new pumps and motors being in accord with the same specification of existing ones are not available in Vietnam, therefore, connection between new and existing equipment should be adjusted by providing reducers. Pumps and motors are installed as

one unit on a common base. Procurement of equipment covering installation and trial run would be born by the Japanese side.

3) Construction of New Pumping Station

The new pumping station would be designed with four sets of vertical mixed flow pump which have a 1,350mm of pump bore as studied in alternatives determining an optimum scale of a pumping station. According to the marketing research in the field of construction materials and equipment, large scaled pumps being manufactured in Vietnam are very limited to experiences on actual results of supply. Considering these situations as well as a lack of quality control for equipment, pumps and motors manufactured in Japan are justified for the Project.

4) Rehabilitation of Drainage Canal

Rehabilitation of main canal and secondary canals have to be carefully considered in order to flow out 31m^3/s of incremental drainage discharge at Tan Chi pumping station. To meet this requirement, canal sections and related structures such as sluice gates, culverts and siphon will be required to be widened and improved, but the land acquisition area shall be minimized in designing canals. As for rehabilitation of related structures, current water right and management shall be considered.

5) Procurement of Dredging Equipment

Small scaled dredging equipment mounted on a boat is suitable for operation and maintenance of a main canal, taking an account of accessibility to the site. In case of secondary canals, excavators with back-hoe type are preferable for dredging and excavating canals.

6) Organization of Project Implementation, Operation and Maintenance

The Department of Investment and Construction, MARD will be a executing agency for the Project. MARD has been implementing many similar projects with well experienced technology in terms of surveying, design and construction.

After construction of the project facilities, operation and maintenance will be undertaken by the Department for Management of Water Resources and Irrigation, MARD and Bac

Duong Irrigation Enterprise under the Bac Ninh People's Committee. Expenses for operation and maintenance will be covered by water fee from farmers and the governmental subsidy.

7) Implementing Schedule

Implementing schedule for the Project is proposed dividing into the following three phases.

Phase 1: Equipment supply consisting of replacement of existing pumps with motors, dredging equipment and electric receiving equipment)
Phase 2: Construction of a new pumping station
Phase 3: Rehabilitation of drainage canal facilities

2-3 Basic Design

2-3-1 Design Concept

(1) Replacement of Existing Pumps and Motors

Existing pumps and motors will be replaced with new pumps (φ350 mm) and motors (33kw) being installed at each common base. Design of this replacement shall be considered for the adjustment of connection between existing pipes and new pumps.

Pumps and motors will be procured in Vietnam, which are currently used or going to be manufactured. Those equipment will be transported to the site through national road No.5 and No.1A or navigation of the Duong river.

(2) New Pumping Station

1) Electric Equipment

① Stability of Power Supply

Based on the site survey conducted in the Basic Design Study, power supply for the existing Tan Chi pumping station is currently stable and being given a high priority among other facilities because of its importance as public facilities protecting floods and

inundation in the area. Considering present situations, the non-utility power generation facility is not necessary to be provided for the operation, management or safety of the main pump facility.

② Incoming Transmission Line and Electric Receiving Facilities

The existing incoming transmission lines shall be renewed with higher capacity to meet the power demand for the existing and new pumping stations. Electric receiving facilities shall be also provided for the new pumping station. Such works shall be executed by the Government of Vietnam.

③ Distribution Voltage

The distribution voltage required by the motor is determined at 6,600v, considering 500kw- motor output power. The distribution voltage for instrumentation and illumination is used to step down with a 3Φ, 400v transformer.

④ Electricity Charge

According to a present system of electricity charge, a basic charge has not been laid for all pumping stations in the project area. Therefore, the generator driven by diesel engine which will be useful for saving basic charge is not necessary to be provided at the drainage pumping station from an economic point of view.

2) Design of Pump

① Hydrological Condition

The drainage discharge and water level required for the design and operation of the pumping station is accorded with the feasibility study conducted by JICA.

For the design rainfall, a consecutive 3 days rainfall of 248.1mm with 1/10 year probability has been adopted. Based on the design criteria applied for this drainage improvement, the inundated period should not exceed one day in a water depth of 0.246m and/or 3 days in a water depth of 0.159m. Under this conditions, the required drainage discharge is obtained at 31.11m^3/s.

Regarding the design water level of the Duong river, the following figures are used for the basic design, basing on the re-computation by additional data.

H.H.W.L	:	EL 9.95m
H.W.L	:	EL 9.65m
H.W.L in the dry season	:	EL 6.30m

② Geological Condition

According to the result of geological survey conducted during the basic design study, the geological profile of the site shows that the foundation is composed of alternated layers between clay soil and silty sand up to EL(-)24.0m in case of the maximum drilling depth of 29m. Clay soil layers have 5 to 18 of N-value and silty sand layers have 10 to 18 of N-value.

The parameters of strength for the each layer is obtained from the triaxial compression test for undisturbed soil samples and the direct shearing test for the disturbed soil samples. The coefficient of compressibility, pre-consolidation press and permeability is obtained from one dimensional consolidation test.

The ground water level is found at 0.30m depth from the ground as a result of observation at the drilling hole. Soil mechanical parameters are shown in Appendix 5.

According to the result of geological survey, the pile foundation, coffer dam and drainage works is studied.

③ Availability of Construction Materials

The new pumping station is proposed at the paddy area adjacent to the Duong river. The most nearest villages to the site are Tu Le and Ben Ho villages, which are located at 1.5 km upstream and 2 km downstream along the Duong river respectively. The national road No.38 (provincial road 288) branches off the national road No.1 at the Bac Ninh city and reaches to Ben Ho village. After crossing the river, the road No.38 connect to the national road No.5 at Tram Giang town. The aggregate for sand and gravel are transported by using the Duong river navigation and unloaded at Ben Ho village.

Under the above situations, the inland transportation for construction materials and equipment is done by two ways, i.e. one is to use the road No.38 via national road No.1, the second is to use tag boats in the Duong river.

④ Access Road, Electric Power and Water

At present, top of the river dike with 5 m of width is used as a maintenance road to the existing pumping station, but in the rainy season the passage on the dike is restricted due to the dike protection. In the dry season, transportation of construction materials and equipment through the dike is interrupted by harvesting works. Therefore, 600 m of an access road with 6 m- width paved with gravel shall be constructed from Ben Ho village to the site.

The electric power during the construction is supplied from the transformer at the existing pumping station. Water for construction is taken from the deep well, which has to be newly constructed and be checked for water quality.

⑤ Environment

This pumping station is located at the paddy field. In the dry season, the irrigation water is taken from this station. In order to prevent the water pollution from the pumping station, attention shall be paid for the design of pumping facilities such as leakage of oil materials.

Special countermeasures for noise and vibration caused by construction are not necessary because the site is far from villages. In case the deep well method is applied for drainage of the coffer dam works, attention shall be paid for settlement of the existing pumping station.

⑥ Land Acquisition

The area to acquire the land:	paddy field		13,000 m^2
Borrow area for temporary works:			10,000 m^2
Borrow area for removal of surplus soil:			15,000 m^2
		Total	38,000 m^2

The procedure for land acquisition shall be carried out before commencement of the construction works by the Vietnamese Government.

⑦ Workable Days and Construction Period

The number of workable days is 288 days (24 days per month) for civil works, excluding 17 rainy days with more than 30 mm of daily rainfall and 60 holidays. The total construction period for the pumping station require 12 months, of which the sluiceway is constructed within 6 months from November to April. The manufacturing period for mechanical and electrical equipment is 6 months. Ocean transportation, installation and trial run requires 2 months respectively.

⑧ Trash Rake Machine

The trash rake machine is not employed by the following reason.

- The urban area is only 10 % of the project area.
- Weeds floating in the canal such as water hyacinth are cultivated and treated by farmers.

⑨ Facilities for Irrigation Supply

Existing facilities for irrigation supply is rehabilitated with new facilities due to the construction of the new pumping station. The irrigation water taken from the existing station is delivered to the new irrigation facilities through the discharge reservoir.

⑩ Discharge Reservoir

The existing discharge reservoir is also used for the new pumping station. Depending upon the change of the highest delivery water level, the elevation of the reservoir-bed shall be heightened. The left bank of the existing pumping station is heightened by the concrete, on the other hand, the right bank is executed by the embankment.

⑪ Sluiceway

The existing sluiceway shall be removed because the downstream side is now being scoured and not safe for seepage. The sluice gates are operated by manual considering the scale of gates. The size of gates is determined as follows, based on the design discharge of 31.11 m^3/s and maximum allowable velocity 1.5 m/s.

Roller gates : 2.5m x 2.5m 4 sets

The sill elevation of the sluiceway is set up at EL.5.2m which is equivalent to the existing elevation from a view point of dike protection.

⑫ Intake Reservoir

The intake reservoir is so designed as to avoid the sudden drop of water level caused by suctioning at the time of pump operation.

⑬ Pump Type

(a) Power Transmission Devices

In Vietnam, drainage pumps are connected directly to the driver via a coupling. They are unfamiliar with a provision of a gear reducer. Considering operation and maintenance after construction, a gear reducer is not needed.

(b) Floor Type for Installation

The motor with 16 poles or more has been getting smaller in size and become possible to be mounted on a pump. This means pumps and motors can be inspected in the same floor. For this reason, a single floor type is applied for the design.

(c) Check Valves

The flap valve is installed at the end of the discharge line to prevent reverse flow when the pump has a low head (below about 10m) and a relatively short discharge pipe. But it can not assure complete water tightness because of structure, so that it is usually submerged in the discharge chamber. To prevent such reverse flow from the discharge pipe, a check valve is installed at the discharge side of pump.

(d) Ceramic Bearings

According to the result of a site survey on operation and maintenance of existing large scaled pumping stations, water taken from a canal is used as lubricating water for pump bearings and shaft enclosing. This water causes wearing and replacing of pump shaft.

Ceramic bearings, which require no lubricating water and have high wear resistance, eliminate the need for a shaft enclosing tube, piping and lubricating water supply equipment. For this reason, ceramic bearings are selected for the basic design.

(3) Drainage Canal

As the drainage canals are located in low-lying area, these slopes are very gentle as 1/10,000 to 1/20,000. Thus, it is required to improve the existing canal in order to work the new pumping station effectively. The topographical survey of drainage canals are carried out and hydraulic calculation is done by using cross sections with 100m intervals.

The dimensions of new canal and appurtenant facilities are determined based on hydraulic calculation mentioned above. Consequently, 6 appurtenant facilities shall be improved due to shortage of flow capacity and 2 facilities shall be improved due to superannuated structure.

In case of the canal improvement, it is necessary to reduce the land acquisition because the average area of farmland per household is very low with 0.24ha. As to appurtenant facilities improvement, it is necessary to install a regulating gate because the canal is used for the irrigation and drainage purposes.

Due to the bad geological condition, earth lining type is adopted in order to reduce the canal improvement cost. As this method is very common in the vicinity, hiring a contractor would not pose any problem.

The canal maintenance machines are necessary because a large number of manpower is inputted to remove the canal sediment every year. Judging from annual dredging volume, the dredger with capacity of $100m^3$/hour is necessary for main canal and the long-armed excavator with capacity $0.45m^3$ is necessary for sub-canal, and also the excavator is required with wide crawler type in order to reduce the unit weight of machine.

The Bac Duong Irrigation Enterprise is executing the operation and maintenance of existing canal under the People's Committee of Bac Ninh province and Tien Son district. The Enterprise has their own budgetary system based on water fee, the same budgetary system will be applied for the operation and maintenance of the new Tan Chi pumping station. Accordingly, no problems concerning operation and maintenance will occur

after the Project.

In addition, the drainage duty of 4.8l/ha has reasonable value as compared to the standard value of the Ministry of Agriculture and Rural Development.

(4) Equipment and Materials as well as their Firms in Vietnam

1) Replacement of Existing Pump

Replacement of existing pumps consists of repairing of pump, motor and appurtenances. Existing pump, motor, pipes, common base, etc. were manufactured and supplied in Vietnam. Since at present these equipment are manufactured by a few companies in and around Hanoi, it is considered that such equipment for this project may be procured from these companies. However, at present the same equipment are not manufactured because of technology development, such as diameter of inlet and discharge pipes for existing pump is 300mm compared to 350mm for present pump. Moreover, pump set may require the common base because it is necessary to centralize the shafts of pump and motor. It may require a pump test at factory before supplying. It is essential for the rehabilitation of existing pumps to consider the above matters. Considering the above situations and being found that the companies in Vietnam have the experiences as well as pump testing facilities, it is understood that the companies have abilities of manufacture and supply of pump set for this project.

2) Construction of New Pump Station

Construction of a few pump station consists of civil works for intake canals, discharge canals and gates as well as construction works for the pump house. There are may large and small civil companies and construction companies in and around Hanoi. Pipe, cement, reinforcing bar and other materials for civil and construction works are marketed. These company have used these materials and have many experiences. Special construction method will not be applied for this project. Therefore, it is considered that the companies can become the sub-contractor for this project.

3) Equipment and Material for New Pump

Pump manufactures in Vietnam have abilities of producing small or medium scale pumps, but not a large scaled pump such as over 1,000mm diameter nor have any experiences of

supply of such large pumps. One of motor manufacturers has produced maximum 800kw, 16P motor, but has no experience of producing large number of pole such as 18-20 poles. Manufacturers in Vietnam may be able to produce pump's appurtenance such as valves, crane, operation panels which are small and have not sequence system. However, as the large and sequence system's appurtenance of pump should be used in this project, it is appropriate that they will be procured from Japan or newly developed neighbor countries. At present, maintenance and operation of such equipment are not familiar in Vietnam, but it would become popular soon because equipment and its appurtenances as same as this project are under implementation in Vietnam budgeted by the International Agency.

4) Rehabilitation of Drainage Canal

Rehabilitation of drainage canal consists of rehabilitation for main canal, secondary canals and gates. It is considered that civil and construction companies mentioned in above section 2) could perform their works. As gates are manufactured by many large and small factories in Vietnam, it is understood that gates could be procured from Vietnam for this project.

2-3-2 Basic Design

(1) Replacement Plan of Existing Pumps and Motors

1) Number of Pumps to be replaced

① Pump Capacity

Replaced new pump capacity is designed as $900m^3/hr \times 9m \times 33kw$, taking account of the following conditions:

- Pump type and performance curve shall be principally accorded with the existing pump.
- Pump head shall be based on the Figure 2-1.

According to the specification of existing pumps, pump capacity is shown at $1,000m^3/hr \times 9m$, but this output cannot be obtained, judging from the pump performance curve. In this basic design, pump capacity is set up at $900m^3/hr$.

② Head Losses and Total Head

Friction head loss by pipe is calculated as follows:

*The flow velocity in the pipe: V

$$V = \frac{900m^3/hr}{\frac{\pi}{4}(0.3)^2} \times \frac{1}{3,600} = 3.54m/s$$

*Friction head loss by foot valve: H_1

$$H_1 = C_1 \times \frac{V^2}{2 \times 9.8}$$
$$= 1.25 \times \frac{(3.54)^2}{2 \times 9.8}$$
$$= 0.80m$$

*Friction head loss by pipe (20 m in length) H_2

$$H_2 = r \times \frac{V^2}{2 \times 9.8} \times \frac{L}{D}$$
$$= 0.02 \times \frac{(3.54)^2}{2 \times 9.8} \times \frac{20}{0.3}$$
$$= 0.80m$$

*Total head loss H

H= H1 + H2 = 0.8 +0.8 =1.6m

Total pump head is 7.4 +1.6= 9.0m

③ Number of Pumps to be replaced (New)

Design Drainage Discharge: 15.1cu.m/s x 3,600second = 54,360m^3/hr
Number of New Pumps: (900m^3/hr) x
Number of Existing Pumps: (600m^3/hr) y

$$x + y = 68$$
$$900x + 600y = 54,360$$

From the above equation, x = 45.2

Therefore, number of new pumps is decided at 46sets.

④ Size of New Pumps and Common Base

Size of the existing pump and typical size of the new pump to meet the specification for the existing pump are shown in the Figure 2-2. The new pump shall be installed on the renewed common base.

⑤ Motors to be replaced

Size of the existing motor and typical size of the motor being manufactured in the same factory is shown in Figure 2-3.

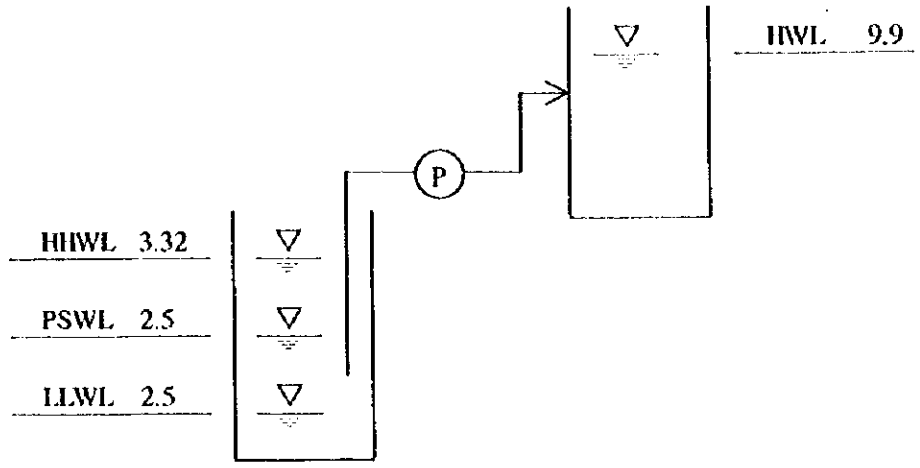
Present motors are becoming small scaled in size and are not accorded with the size of installed motors being deteriorated and not available for reuse. For this reason, replaced pumps will be driven by new motors.

⑥ Pump Performance Test and Spare Parts Supply

All pumps to be replaced shall be supplied after completion of pump performance tests being made in the factory. The result of tests will be used for preparation of the operation and maintenance manual. Concerning spare parts, following materials and equipment will be required and be imported from foreign countries.

Existing pump: Gland packing
New pump: Lump, Breaker, Relay, Ceramic Bearing, Sleeve

Figure 2-1 Design Water Level



Actual Head: 9.9m - 2.5m = 7.4m

Figure 2-2 Size of Existing and New Pumps

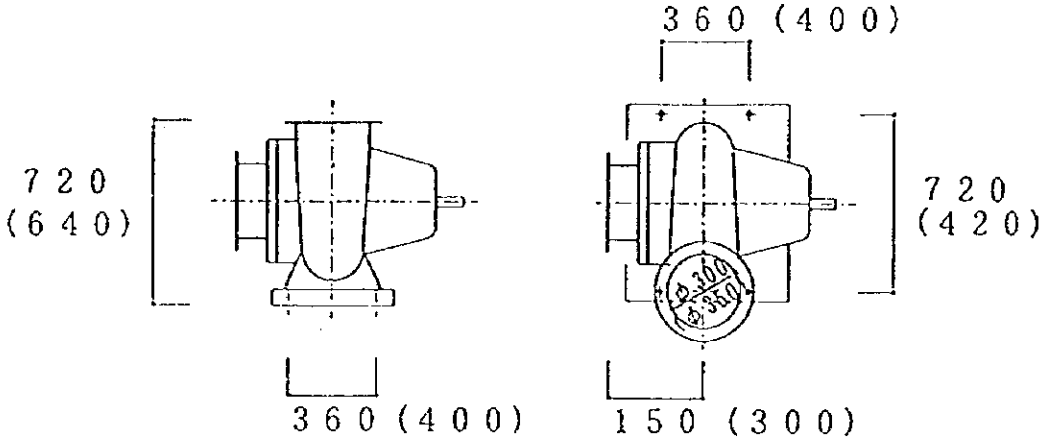
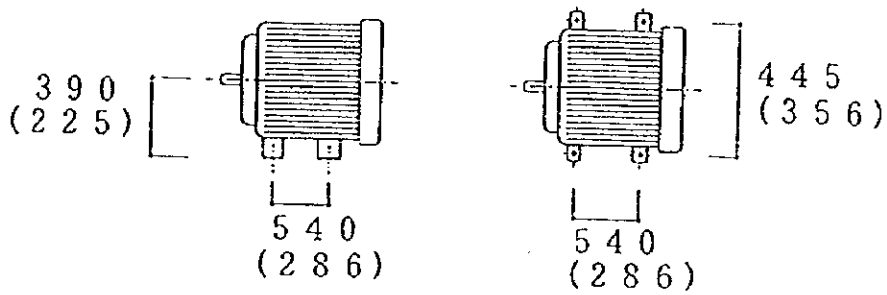


Figure 2-3 Size of Motors



(2) Design of New Pumping Station

1) Design Condition

① Water Level

Design Discharge	:	(Existing) 15.11 + (New) 16.00 = 31.11m^3/s
H.W.L of Duong River	:	9.65m (10year - probability)
H.H.W.L of Duong river	:	9.9 m (20year - probability)
Pump Suction W.L	:	2.0m

② Others

Design Seismic Coefficient : 7th scale in terms of Richer Magnitude shown on the seismic zoning map published by the Global Physics Institute.

Design Strength of Reinforced Concrete : 210kgf/cm^2

Reinforcing Bar : Deformed Bar SD295 (yield strength 295N/mm^2, tensile strength 440k -600N/mm^2

Design Strength of Concrete for PC Pile : 500kgf/cm^2 (49N/mm^2)

③ Design Criteria

The following design criteria are applied for this basic design.

Japanese Design Criteria

* Design Criteria of Land Improvement Project "Pump"
(Ministry of Agriculture, Forestry and Fishery)
* Engineering Manual of Pump Facilities
(Engineering Association of River Pump Facilities)
* Penstock Design Criteria
(-do-)
* Design Criteria of Dam and Diversion Facilities
(Dam and Diversion Facilities Engineering Association)

* Design Criteria of Sluice and Cuvert

(Engineering Institute for Country's Development)

Vietnamese Design Criteria

* Irrigation Canal Systems-Design Standards (TCVN 4118-85)

(Vietnam Standards Institute)

* Concrete and Reinforced Concrete for Hydraulic Structures-Design Standards (TCVN4116-85) (-do-)
* Standards for Classification of Dikes (14-TCN -19-85)

(-do-)

④ Law, Regulation, Decree and Code concerning with the construction of the Pumping Station

* Dike Protection Decree issued by the Vietnamese State President on 16/11/1989
  In accordance with this decree, the construction period in the river dike is limited to six months from October to April.

* Land Law issued by the Vietnamese State president on 24/7/1993.
* Building Standard Act: Decree No.42/cp dated 16/7/1996
  Decree No.43/cp dated 16/7/1996
* Environment Protection Law issued by the Vietnamese State President on 10/1/1994
* Labor Agreement Decree issued by the Vietnamese State President on 10/9/1990
* Labor Protection Decree issued by the Vietnamese State President on 19/9/1991

2) Basic Design

① New Pumping Station

* Site Selection

Site selection of the new pumping station is made at the upstream of the existing pumping station as to find the most advantageous site taking into the following consideration.

- To drain the canal water safely and easily to the Duong River.

- To be easily connected to an existing leading canal and to be able to acquire the land for the pumping station having a sufficient water surface in order to operate pumps.
- To limit entering of sediment and drifting materials, and ensure to take out easily the floating weeds after construction.
- Noise and vibration from the pump operation shall not become a public trouble to the neighboring area.
- To drain smoothly so as not to affect the dike protection during the flood season.
- To operate efficiently with the existing pumping station during the flood time.

* Pump Capacity and Pump Control Method

Pump Capacity	: Existing station	15.1m^3/s
	: New station	16.0m^3/s
	Total	31.1m^3/s

Pump Control Method: Unit control is applied.
For the ordinary drainage, the pumps of new station are operated and for the flood drainage the pumps of new and existing station are operated for 24 hours.

* Suction Water Level and Delivery Water Level

Suction Water Level:	L.W.L	(+)2.00m
Lowest Suction Water Level:	P.S.L.W	(+)1.70m
Pump Stopping Water Level:	P.S.L.L.W	(+)1.40m
Highest Delivery Water Level:	H.W.L	(+)9.90m
Lowest Delivery Water level:	L.W.L	(+)5.80m

* Pump Combination Planning

Pump bore and number of unit are determined, considering the following matters.
To operate efficiently against fluctuation of delivery discharge by pump head and operational duration.

To lower risk of incidental failures
To exchange spare parts among each pump
To have economical advantages

Considering the above items, the number of pumps is determined at 4 sets with 1,350mm of bore size.

* Pump Type

The vertical shaft mixed flow pump is determined in order to prevent cavitation during operation according to the study on suction characteristics.

* Total Pump Head

Total pump head = Actual pump head + various loss heads
= 8.20m + 0.80m
= 9.0m

* Main Pipe and Valves

Connection between pumps and a discharge basin is made by steel pipes. Butterfly valves and reverse flow prevention valves are provided in the pipes. Expansion joints are provided for displacement due to earthquake and unequal subsidence.

Pump bore	Main pipe	Butterfly valve	Reverse flow Prevention valve
ϕ1,350mm	Steel ϕ1,350-1,650 mm	ϕ1,350mm × 4sets	ϕ1,650mm × 4sets

* Crane

The overhead crane is used for installation, inspection and repairing of pump equipment. The type and capacity of the crane is determined depending upon type and scale of pump equipment. In case of this new pumping station, 20tons crane electrically operated is selected.

② Prime Mover

* Selection of Prime Mover

Squirrel cage induction motor with vertical shaft is selected as prime mover from the view point of electrical situation of the project area, examples of other existing pumping stations, operation and maintenance.

* Determination of Prime Mover Output

The output of the pump prime mover is computed as follows:

PH= 500KW x 20P x 6KV x 50HZ

③ Leading Canal and Intake

* Leading Canal

The leading canal is so designed as to have a function of stilling basin for protecting the pump equipment. The total length of the leading canal is 50m. The elevation of inlet of the pumping station is set up at EL.(-)1.50m in order to mitigate the amount of suspended materials flowing into the pumping station.

* Intake

The elevation of canal bed at the intake is set up at EL(-)1.00m. The working space with the 5m-width for removal of trash is provided at the top of intake. The elevation of the space is set up at EL.(+)4.20m, considering the working conditions for removal and hauling of trash.

* Screen

Screen is installed at the intake with the effective clearance of 100mm. The inclined angle of the screen is set up at 75°, taking account of the future provision of trash screen. The flat bar with 9 mm thickness is applied for screen materials being endured against one meter water head at the time of maximum high water level (+)3.29m.

④ Suction Sump

* Water Depth of Suction Sump

Water depth of the suction sump requires 3.45m considering the necessary depth to submerge the suction pipe. The sill elevation of the suction sump is set up at EL(-)2.05m which is 3.45m lower than P.S.L.L.W(+)1.40m.

* Size of Suction Sump

The width of suction sump for each pump	: 3D where, D is pump bore.
The length of deepest part	: from the axis of pump bore 4.5m (upstream) 1.5m (downstream)
The total length of suction sump	: 12.7m
The width	: 19.9m

* Floor Elevation of Pump House

The prime mover is directly installed on the pump in a single floor. The height of installation is obtained as follows:
Floor elevation EL.(+)4.5m + height of pump 3.30m

The height of pump installation shall be set up at not less than H.W.L EL(+)3.29m so as to prevent seepage water flowing into the pump house. In addition, to drain naturally the leakage water through the connection between pipes and pumps, the floor of the pump house is set up at EL(+)4.5m.

⑤ Pump House

* Length of Pump Room

The length of the pump house is decided at 10m, which includes the required length of pump and pipe installation and carrying in and out spare parts for

repairing.

* Width of Pump Room

The width of the pump house is decided at 36.95m, which includes the width of pump, floor space for carrying in equipment and electric room.

* Height of Pump Room

The height of the pump room is decided at 12.80m from the ground floor of the pump house, basing upon the hoist height of the overhead crane.

* Electricity Room

The height of the room is 4.00m, as considered the height of electric power receiving and distribution panels, etc.

* Type of Structure

The beam, pillar and floor of the pump house is constructed by reinforced concrete and the wall by brick.

⑥ Discharge Sump

* Depth

Since the vertical shaft-type pump is adopted for this pumping station, the end of the discharge pipe is fixed by the lowest discharge water level. The required water depth is 2.45m. The sill elevation of the discharge sump is EL.(+)3.35m which is 2.45m lower than Lowest Delivery W.L(+)5.80m.

* Size of Discharge Sump

The width of the discharge sump is 18.30m depending upon the installation interval of main pumps and the length is 33.5m which includes the connecting length to the existing reservoir.

* Gate for Irrigation

The irrigation facilities provided at the existing discharge basin is connected to the new discharge sump. The gate with one meter square is installed to delivery 0.65m^3/s of irrigation water covering 500ha.

⑦ Sluiceway and Sluice Gate

* Operational Water Depth

H.W.L of Duong river:	EL. 9.95m
Sill Elevation of Sluice gate:	EL. 5.20m
Operational Water Depth:	4.75m

* Size of Gate

The size of the sluice gate is 2.5m x 2.5m with the roller type, based on the operational load and electric driving.

* Operation Deck

Top of Wing Wall:	EL.9.7m
Height of Detaching Gate:	3.5m (2.5m + 1.0m)
Thickness of Deck:	0.75m
Elevation of Operation Deck:	EL.13.95m
Width of Deck:	3.5m
Length of Deck:	14.75m

* Sluiceway

Cross Section:	2.65m x 2.5m 2 sets
	8m x 2.5m 2 sets

The impervious walls having each one meter length are provided to protect piping by the seepage through the river dike and the foundation.

* Wing Wall

The wing wall receives different loads from those to the main body and because of this connecting portion becomes a weak point if it is in a unified structure with the main body. It is, therefore, favorable to construct the wing wall separated from the main body.

The connecting portion is protected by water stop and expansion joint. The wing wall is 24.5m in length that is sufficient to protect the foot of the dike.

* Impervious Wall

Impervious walls made by steel sheet pile, type II is installed at more than 2 m depth from the bottom.

* Apron

The apron made by reinforced concrete is installed in the inlet and outlet of the sluice gates. The design of the apron shall be considered in the waterproof, scouring of the bed and connection of the impervious wall.

* Outlet Canal and Dike Protection

The length of outlet canal with riprap works is 20m and dike protection works is executed at each 10m in upstream and downstream side.

⑧ Structural Design of Suction Sump

The suction sump is composed of box culverts with upper slab, bottom slab, member and partition wall. Structural computation is made as rigid frame with quadruple square section.

Load Condition:

Dead load	Unit weight of reinforced concrete	: 2.4t/m^3
	Unit weight of plain concrete	: 2.2t/m^3

Loading

Motor 440kw : 13t × 1.2 =15.6t/unit

Pump and water weight: (28.7t + 3.19t/m × 1.2m)
=32.5t/unit

Crowded load Pump installation floor = 0.5t/m²

Embankment (outside) = 1.00t/m²

House Load

Axial force of house pillar is considered.

Earth Pressure

Internal friction angle : ϕ=12° 44'

Cohesion : C=0.25kg/cm² ≒ 2.5t/m²

Earth pressure :

$$PA=(\gamma Z+q)\tan^2(45^\circ - \phi/2)-2C\tan(45^\circ - \phi/2)$$

Unit weight of earth : γ W=1.86t/m³

Earth coverage depth : Zm

Crowd load : q=1.0t/m²

Water Level

Water Level in the Suction : L.W.L (+)1.40m

Groundwater Level : G.W.L (+)3.20m

⑨ Design of Foundation Works

* Selection of Construction Method

Geological condition

Discharge basin: N-value 11

Internal friction angle ϕ=12° 55'

Cohesion C=0.24kg/cm²

Clay

Suction sump: N-value 6

Internal friction angle ϕ=18° 25

Cohesion C=0.18 kg/cm²

Clayey Sand

The favorable foundation having more than 15 of N-value is existing at not less than 5 meters depth from the ground. Therefore, pile foundation is applied as a construction method of foundation works.

* Length of Pile

The pile tip is necessary to penetrate into the bearing layer which has the sufficient bearing capacity for the important structures with large load. In this pumping station, the depth of pile tip is selected at EL(-)22m for structures such as intake, suction sump, discharge basin and footing of pump house. The pile tip is penetrated up to EL.(-)14m in the transition having small load.

Table 2-2 Length of Pile

Structure	Top of Pile	Tip of Pile	Length
Intake	EL(-)1.70	EL(-)21.70	L=20.0m
Suction sump	EL(-)3.05	EL(-)23.05	L=20.0m
Discharge basin	EL(+)2.35	EL(-)22.65	L=25.0m
Pump house	EL(+)2.50	EL(-)22.50	L=25.0m
Transition	EL(+)5.30	EL(-)14.70	L=20.0m

* Computation of Vertical Allowable Bearing Capacity of Pile

The vertical allowable bearing capacity of pile (Ra) is based on the following formula.

$$Ra=1/3\ (qd \cdot A + U \cdot \Sigma Li \cdot fi)$$

where Ra : vertical allowable bearing capacity (t)
A : area of pile tip (m^2)
U : circumference of pile (m)
Li : thickness of layer for friction force on pile skin (m)
fi : maximum friction force (t/m^2)
: $fi=C+PA \cdot \tan\Phi$
qd : ultimate bearing capacity per unit area of pile (t/m^2)

L/D < 5.0 ··· $qd=(10+4L/D) \cdot N$
L/D >5.0 ···· $qd=30N$

where L : penetration depth into bearing capcity (m)

D : diameter of pile (m)

N : design N-value at the position of pile tip

- Intake

N＝15、 Ln=4.20m、 Ln/D＞5.0

Position of pile top El(-)1.7m, Position of pile tip EL(-)21.7m

3a layer	Li=EL(-)1.7～EL(-)3.5	1.8m	fi=3.7t/m²	Li･fi=6.6t/m
4th layer	Li=EL(-)3.5～EL(-)7.8	4.3m	fi=4.7t/m²	Li･fi=20.2t/m
3b layer	Li=EL(-)7.8～EL(-)12.2	4.4m	f=6.7t/m²	Li･fi=29.4t/m
4th layer	Li=EL(-)12.2～EL(-)17.5	5.3m	fi=7.6t/m²	Li･fi=40.2t/m
				ΣLifi=96.4t/m
3b layer	Li=EL(-)17.5～EL(-)21.7	4.2m	qd･A=30N･A =450t/m2･A	

Length of Pile L=20m

Table 2-3 Allowable Bearing Capacity (Intake)

杭径(mm)	q d	A (m2)	q d･A (t)	U (m)	U･Li･Fi (t)	Ra (t)
φ450	30N	0.159	71.6	1.413	136.2	69.3
φ500	30N	0.196	88.2	1.570	151.3	79.8
φ550	30N	0.237	106.7	1.727	166.5	91.1
φ600	30N	0.283	127.4	1.884	181.6	103.0
φ700	30N	0.385	173.3	2.198	211.9	128.4
φ800	30N	0.502	225.9	2.512	242.2	156.0
φ900	30N	0.636	286.3	2.826	272.4	186.2

N=15 A=(φ/1000)^2/4π U=(φ/1000)π

- Suction Sump

N＝7、 Ln=5.0m、 Ln/D＞5.0

Position of Pile Top El(-)3.05m, Position of Pile Tip El(-)23.05m

3 a layer	Li＝EL(-)3.05～EL(-)3.5	Li=0.45m	Fi＝3.7t/m2	Li･Fi ＝1.6t/m
4 th layer	Li＝EL(-) 3.5～EL(-) 7.8	Li=4.3m	Fi＝4.7t/m²	Li･Fi＝20.2t/m
3 b layer	Li＝EL(-)7.8～EL(-)12.2	Li=4.4m	Fi＝6.7t/m2	Li･Fi ＝29.4t/m
4 th layer	Li＝EL(-)12.2～EL(-)17.5	Li=5.3m	Fi＝7.6t/m²	Li･Fi＝40.2t/m
				ΣLiFi＝91.4t/m
3 b layer	Li=EL(-)17.5～EL(-)23.05	Li=5.55m	q d･A＝30N･A	=450t/m2･A

Lengh of Pile L=20m

Table 2-4 Allowable Bearing Capacity (Suction Sump)

Diameter of Pile(mm)	q d	A (m2)	q d·A (t)	U (m)	U·Li·Fi (t)	Ra (t)
φ450	30N	0.159	71.6	1.413	129.1	66.9
φ500	30N	0.196	88.2	1.570	143.5	77.2
φ550	30N	0.237	106.7	1.727	157.8	88.2
φ600	30N	0.283	127.4	1.884	172.2	99.9
φ700	30N	0.385	173.3	2.198	200.9	124.7
φ800	30N	0.502	225.9	2.512	229.6	151.8
φ900	30N	0.636	286.3	2.826	258.3	181.5

N=15 A=(φ/1000)^2/4π U=(φ/1000)π

-Discharge Sump

N＝15、Ln＝5.0m、Ln/D＞5.0

Position of Pile Top El.(-)2.35m, Position of Pile Tip El.(-) 17.65m

2 th layer	Li＝El.(+)2.35m～El.(-) 1.0m	3.35m	Fi′ =3.9t/m²	Li·Fi＝13.1t/m
3a layer	Li＝El.(-)1.0m～El.(-) 3.5m	2.5m	Fi′ =3.7t/m²	Li·Fi＝12.9t/m
4 th layer	Li＝El.(-)3.5m～El.(-) 7.8m	4.3m	Fi′ =4.7t/m²	Li·Fi＝20.2t/m
3b layer	Li＝El.(-)7.8m～El.(-)12.2m	4.4m	Fi′ =6.7t/m²	Li·Fi＝20.4t/m
4 th layer	Li＝El.(-)12.2m～El.(-)17.5m	5.3m	Fi' =7.6t/m2	Li·Fi＝40.2t/m
				ΣLiFi＝106.8t/m
3b layer	Li＝El.(-)17.5m～El.(-)22.65m	5.15m	q d·A＝30N·A =450t/m2·A	

Lengt of Pile L=25m

Table 2-5 Allowable Bearing Capacity (Discharge Basin)

Diameter of Pile(mm)	q d	A (m2)	q d·A (t)	U (m)	U·Li·Fi (t)	Ra (t)
φ450	30N	0.159	71.6	1.413	150.9	74.2
φ500	30N	0.196	88.2	1.570	167.7	85.3
φ550	30N	0.237	106.7	1.727	184.4	97.0
φ600	30N	0.283	127.4	1.884	201.2	109.5
φ700	30N	0.385	173.3	2.198	234.7	136.0
φ800	30N	0.502	225.9	2.512	268.3	164.7
φ900	30N	0.636	286.3	2.826	301.8	196.0

N=15 A=(φ/1000)^2/4π U=(φ/1000)π

- Transition

N＝15、Ln＝5.0m、Ln/D＞5.0

Position of Pile Top EL.(+)5.30m, Position of Pile Tip EL.(-) 14.70m

1 th layer	Li=EL.(+)5.3m~EL.(+)3.0m	2.3m	Fi' =0.0t/m	Li·Fi=0.0t/m
2 th layer	Li=EL.(+)3.0m~EL.(-) 1.0m	4.0m	Fi' =3.9t/m²	Li·Fi=15.6t/m
3a layer	Li=EL.(-)1.0m~EL.(-) 3.5m	2.5m	Fi' =3.7t/m²	Li·Fi=12.9t/m
4 th layer	Li=EL.(-)3.5m~EL.(-) 7.8m	4.3m	Fi' =4.7t/m²	Li·Fi=20.2t/m
3b layer	Li=EL.(-)7.8m~EL.(-)12.2m	4.4m	Fi' =6.7t/m²	Li·Fi=20.4t/m
				ΣLiFi=69.1t/m
4 th layer	Li=EL.(-)12.2m~EL.(-)14.7m	2.5m	qd·A=30N·A	=450t/m2·A

Length of Pile L=20m

Table 2-6 Allowable Bearing Capacity (Transition)

Diameter of Pile(mm)	qd	A (m2)	Qd·A (t)	U (m)	U·Li·Fi (t)	Ra (t)
φ450	30N	0.159	71.6	1.413	97.6	56.4
φ500	30N	0.196	88.2	1.570	108.5	65.4
φ550	30N	0.237	106.7	1.727	119.3	75.3
φ600	30N	0.283	127.4	1.884	130.2	85.9
φ700	30N	0.385	173.3	2.198	151.9	108.4
φ800	30N	0.502	225.9	2.512	173.6	133.2
φ900	30N	0.636	286.3	2.826	195.3	160.5

N=15 A=(φ/1000)^2/4π U=(φ/1000)π

- Pump House

N=15、Ln=5.0m、Ln/D>5.0

Position of Pile Top EL(+)2.5m, Position of Pile Top EL(-) 22.5m

2 th layer	Li=EL.(+)2.5m~EL.(-) 1.0m	3.5m	Fi' =3.9t/m²	Li·Fi=13.6t/m
3a layer	Li=EL.(-)1.0m~EL.(-) 3.5m	2.5m	Fi' =3.7t/m²	Li·Fi= 9.3t/m
4 th layer	Li=EL.(-)3.5m~EL.(-) 7.8m	4.3m	Fi' =4.7t/m²	Li·Fi=20.2t/m
3b layer	Li=EL.(-)7.8m~EL.(-)12.2m	4.4m	Fi' =6.7t/m²	Li·Fi=20.4t/m
4 th layer	Li=EL.(-)12.2m~EL.(-)17.5m	5.3m	Fi' =7.6t/m2	Li·Fi=40.2t/m
				ΣLiFi=103.7t/m
3b layer	Li=EL.(-)17.5m~EL.(-)22.5m	5.0m	qd·A=30N·A	=450t/m2·A

Length of Pile L=25m

Table 2-7 Allowable Bearing Capacity (Pump House)

Diameter of Pile(mm)	q d	A (m2)	Qd·A (t)	U (m)	U·Li·Fi (t)	Ra (t)
ϕ450	30N	0.159	71.6	1.413	146.5	72.7
ϕ500	30N	0.196	88.2	1.570	162.8	83.7
ϕ550	30N	0.237	106.7	1.727	179.1	95.3
ϕ600	30N	0.283	127.4	1.884	195.4	107.6
ϕ700	30N	0.385	173.3	2.198	227.9	133.7
ϕ800	30N	0.502	225.9	2.512	260.5	162.1
ϕ900	30N	0.636	286.3	2.826	293.1	193.1

N=15 A=(ϕ/1000)^2/4π U=(ϕ/1000)π

Selection of Pile

Specification of pile for each structure of the pumping station is selected according to the economic comparison under design load.

Design Load

Table 2-8 Design Load for Each Structure

Structure		Vertical Force V(t)	Horizontal H(t)	Eccentric Distance e(m)	Moment M(t·m)
Intake	Uplift	1,400	-130	-0.54	-755
	Non-uplift	2.760	-130	-0.55	-1,518
Suction	Uplift	3,600	-510	+0.20	720
	Non -uplift	5,360	-510	+0.15	804
Discharge	Uplift	1,500	—	-1.08	-1,620
	Non-uplift	1,980	—	-1.31	-2,593
Transition 1		850	—	-0.17	-145
Transition 2		600	—	-0.38	-288
Pump house F1		235	—	—	—
Pump house F2		115	—	—	—

Note: horizontal force and eccentric distance is flow direction i.e., downstream direction is plus(+).

* Economic Comparison

  Economic comparison on foundation works for each structure is shown in Table 2-9.

* Diameter of Pile

  Based on economic comparison shown in Table 2-9, diameter of pile is selected as shown in Table 2-10.

* Arrangement of Pile

  The arrangement of pile is shown in Figure 2-4.

Table 2-9 Comparative Study on Foundation Works

Kind of Works	Specification			Bearing Capacity	Required Nember (pcs)	Bearing Capacity	Construction Cost per one pcs (1000yen)	Construction Cost (1000yen)	Ratio
	Pile Type	Diameter	Length						
Intake 2760t	PC	ϕ500mm	20m	64.0	6×6+4×2=44	2816	239	10516	1.01
		ϕ550mm		73.6	6×5+2×2=38	2796	274	10412	1.00
		ϕ600mm		83.9	6×5+2×2=34	2852	309	10506	1.01
Suction Sump 5220t	PC	ϕ600mm	20m	83.9	11×6=66	5537	309	20394	1.02
		ϕ700mm		106.1	9×6=54	5729	404	21816	1.09
		ϕ800mm		130.7	8×5=40	5489	499	19960	1.00
Delivery Sump 1980t	PC	ϕ550mm	20m	54.9	8×5=40	2196	274	10960	1.01
		ϕ600mm		61.6	7×5=35	2156	309	10815	1.00
		ϕ700mm		75.7	6×5=30	2271	404	12120	1.12
Transition 850t + 600t	PC	ϕ550mm	20m	54.9	27	1482	274	7398	1.00
		ϕ600mm		61.6	24	1478	309	7416	1.00
		ϕ700mm		75.7	20	1514	404	8080	1.09
Pump House 235t	PC	ϕ550mm	20m	54.9	4	219.6	NA	NA	
		ϕ700mm		75.7	3	227	NA	NA	
		ϕ800mm		86.5	3	259.5	309	927	

Note: The unit price per one pile is applied from the standard price for civil works in Japan, 1997. such as ϕ450mm 205,000yen ϕ500mm 239,000yen ϕ550mm 274,000yen ϕ600mm 309,000yen ϕ800 499,000yen.

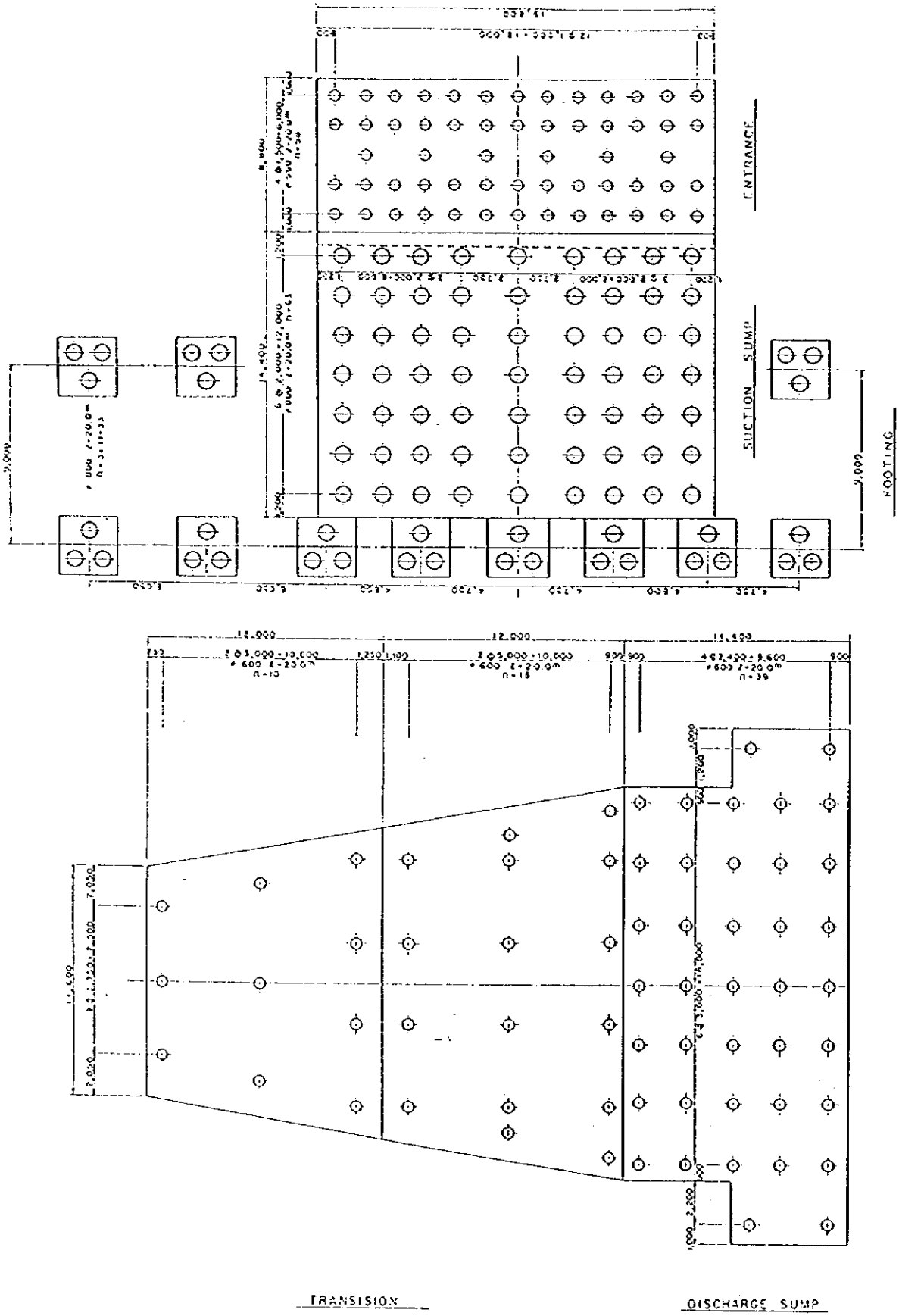
Based on the above table, pile arrangement is made as follows:
intake: ϕ550mm suction sunp & pump house: ϕ800mm delivery sump and transition: ϕ600mm distance: 1.5D (from structure), 2.5D (each pile)

Table 2-10 Computation of Foundation Works

Kind of Works		Diameter of Pile (mm)	Number of Pile (pcs)	Penetrating Strength for Axial Direction (t/pcs)		Strength of Pile (kg/cm²)				Horizontal Displacement (cm)	
						Compressive Strength		Tensile Strength			
				Computed Value	Allowable Value	Computed Value	Allowable Value	Computed Value	Allowable Value	Computed Value	Computed Value
Intake	Uplift	ϕ550	58	47.6	≦73.6	200	≦225	0	0	0.3	≦1.5
Suction Sump	Uplift	ϕ800	63	82.9	≦130.7	182	≦225	0	0	0.3	≦1.5
Delivery Sump	Uplift	ϕ600	35	56.6	≦61.6	166	≦225			-	
Transition	1	ϕ600	16	53.1	≦61.6	93	≦225			-	
	2	ϕ600	10	60.0	≦61.6	93	≦225			-	
Pump House	F1	ϕ800	3	78.3	≦86.5	122	≦225			-	
	F2	ϕ800	3	78.3	≦86.5	122	≦225			-	

Note: The following strength is considered.
Allowable compressive strength: $\sigma c=0.45fc$
Tensile Strength: $\sigma c=40kg/cm^2$ (prestress)

Figure 2-4 Pile Arrangement



(3) Design of Drainage Canal

1) Design Condition

The dimensions of canal section are determined by hydraulic computation based on the cross section with interval 100m. The designed drainage capacity are determined based on the drainage standard as follows established by the Ministry of Agriculture and Rural Development.

- Designed rainfall---------- 10year-probability of continuous rainfall for 3 days
- Allowable depth---------- 0.246m for not over 24 hours
  0.159m for not over 72 hours

Water Level of 2.0m is adopted as the initial water level for the design of drainage canal. In every paddy field, the water level of drainage canal is set up under the elevation of field. But the Project is aimed at the improvement of drainage condition for paddy field, setting up the water level is not considered for the drainage condition for upland crop. In case of designing the drainage canal, the dimensions of canals are determined considering to reduce the land acquisition.

The appurtenant structures that are lack of flow capacity shall be replaced with new structures. The culvert in the main canal is replaced with elevated flume, the culverts in the secondary canal are replaced with widened culvert or bridge. In addition, the regulating gate at the junction between main canal and secondary canal is required in order to control the irrigation water.

2) Basic Plan

① Drainage Duty
The total capacity of Tan Chi pumping station is 31.11m^3/s and drainage area is 6,420ha, accordingly the drainage duty is 4.846l/sec/ha.

② Water Level at Tan Chi Pumping Station
As the elevation of paddy field to be drained at Cau Nau is 2.4m, the designed suction water level of new pumping station is computed as follows.
WL=EL.2.4-8,000m/20,000=2.0m (1/20,000: Slope of canal bed)

③ Cutting slope for canal excavation

The slope of 1 : 1.5 are adopted based on the geological condition.

④ Allowable velocity

The allowable velocity of 0.6m/sec is adopted based on the canal bed conditions.

⑤ Roughness coefficient of Manning Formula

The roughness coefficient of 0.03 is adopted based on the earth canal.

⑥ Appurtenant structures

The 3 structures in the main canal and 5 structures in the sub canal are required to improve. The improvement methods are shown as follows.

• Main Canal

-N6 Elevated Flume

The shortage of flow capacity is occurred at the crossing of N6 irrigation canal. The new elevated flume is constructed after removal of the existing culvert in order to meet the design flow capacity of 23.45m^3/s.

• Secondary Canal

-Tram Culvert (S-①)

The existing culvert is located at the connection of KT 4 XA canal to Tao Khe Creek. As the existing culvert capacity of 4m^3/sec is low compared to design capacity of 7.66m^3/s, new culvert facilitated with dimension of 1.5m × 2.0m × 2 gate shall be constructed after removal of the existing culvert.

-Bridge-1 (S-②)

-Bridge-2 (S-③)

As the flow capacity of existing bridge is low due to the short span of bridge, the inundation along the KT 4 XA canal short is occurred. The new bridge with 8.6m span shall be constructed after removal of the existing bridge.

-N6 Culvert (S-④)

The shortage of flow capacity is occurred at the crossing of N6 irrigation canal. The new culvert facilitated with dimension 2.1m × 1.2m × 2 gate shall be constructed after removal of existing culvert in order to meet the design flow capacity of 4.64m^3/s.

-N6 Elevated Flume (S-⑤)

The shortage of flow capacity is occurred at the crossing of N6 irrigation canal. The new elevated flume is constructed after removal of existing elevated flume in order to meet the design flow capacity of 31.11m³/s.

Drainage network and hydraulic dimensions are shown in Figure 2-5 as follows:

(4) Summary of Facilities and Equipment selected in Basic Design Study

Facilities and equipment selected in the basic design study are summarized as follows;

① Replacement of Existing Pump and Motor

Pump bore : 350 mm
Motor : 33 kw
Number of pump and motor to be replaced : 46 sets

② New Pumping Station

Drainage capacity : 16 m³/s
Pump house : 324 m²
Pump & motor : bore 1,350 mm, motor output 500 kw, number of set 4 sets
Butterfly valve : bore 1,350 mm, number of set 4 sets
Flap valve : bore 1,350 mm, number of set 4 sets
Suction and Delivery Sump: each one place
Electrical Distribution Facilities: Lump sum

③ Rehabilitation of Drainage Canal

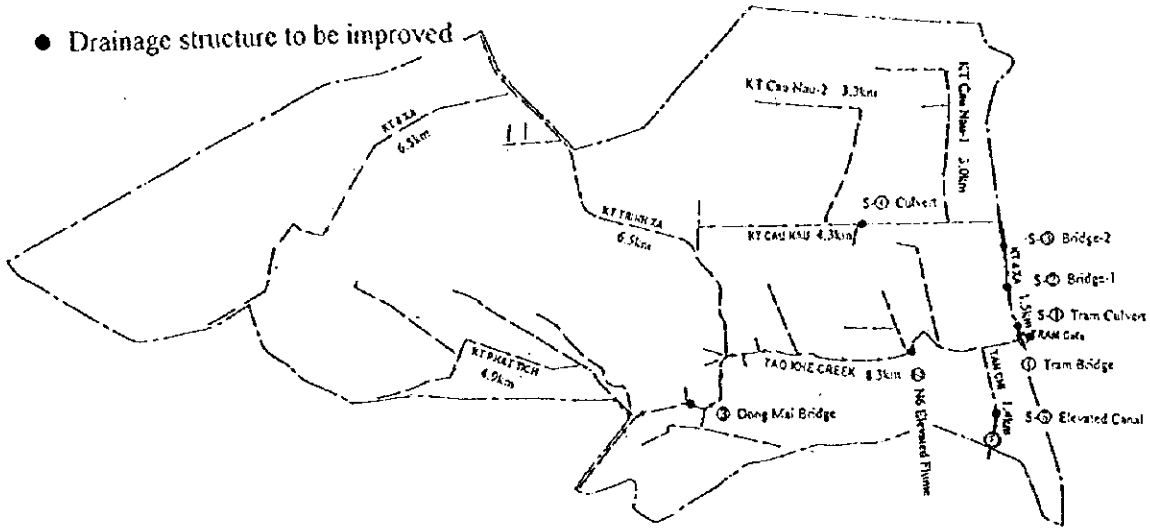
KT Tan Chi canal : L=1.4 km
Appurtenant structure of Tao Khe Creek : One place(N6 elevated flume)
Appurtenant structure of KTXA canal : three places (S-①, S-②, S-③)
Appurtenant structure of KT Cau Nau canal : One place (S-④)
Appurtenant structure of KT Tan Chi : One Place (S-⑤)

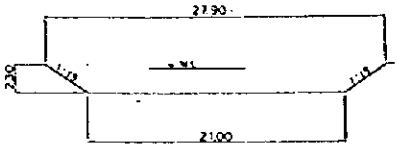
⑤ Construction Machinery

Machinery for maintenance of main canal: Small scale dredger (125 ps×2 sets)
Machinery for maintenance of secondary canal: Excavator
(13 ps×3 sets with long arm and crawler type)

Figure 2-6 shows the location of facilities to be rehabilitated in the project.

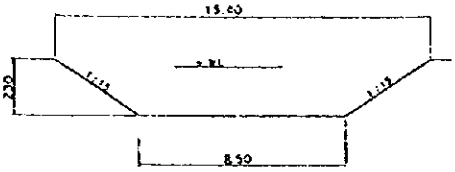
Figure 2-5 Drainage Network and Hydraulic Dimensions





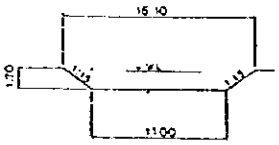
Tao Khe Creek

Q(m3/s)	23.45
V(m/s)	0.480
H(m)	2.034
I	1/10,000



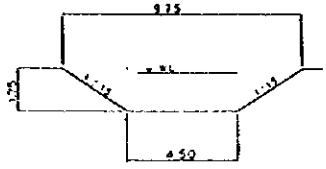
KT Cau Nau-1

Q(m3/s)	2.66
V(m/s)	0.246
H(m)	1.578
I	1/20,000



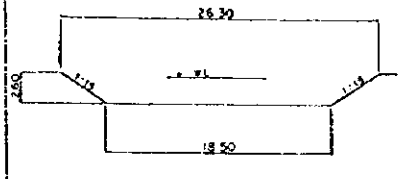
Tao Khe Creek

Q(m3/s)	7.66
V(m/s)	0.381
H(m)	1.516
I	1/10,000



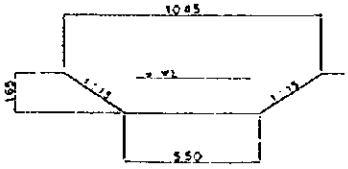
KT Cau Nau-2

Q(m3/s)	2.76
V(m/s)	0.243
H(m)	1.472
I	1/20,000



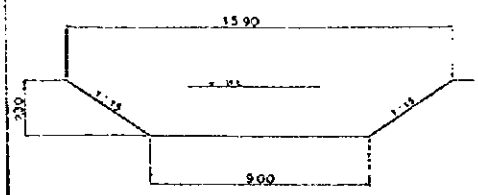
KT Tan Chi

Q(m3/s)	31.11
V(m/s)	0.600
H(m)	2.319
I	1/7,000



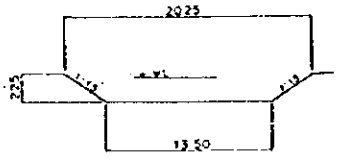
KT Trinh Xa

Q(m3/s)	10.70
V(m/s)	0.322
H(m)	2.010
I	1/20,000



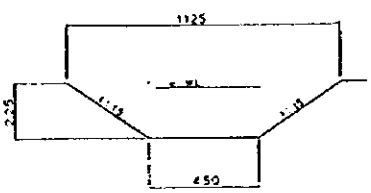
KT 4 Xa

Q(m3/s)	7.66
V(m/s)	0.31
H(m)	2.048
I	1/20,000



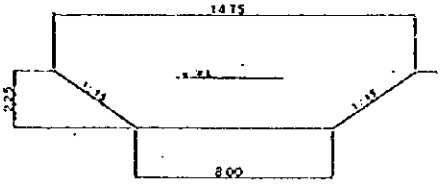
KT 6 Xa

Q(m3/s)	6.67
V(m/s)	0.302
H(m)	2.007
I	1/20,000



KT Cau Nau

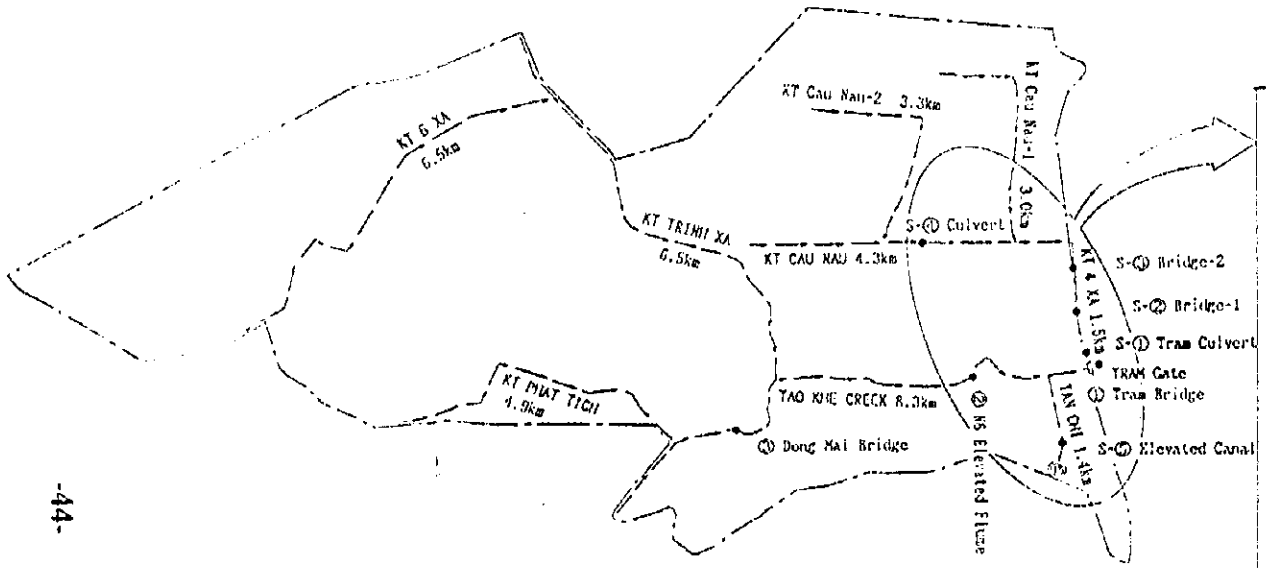
Q(m3/s)	7.30
V(m/s)	0.308
H(m)	2.049
I	1/20,000

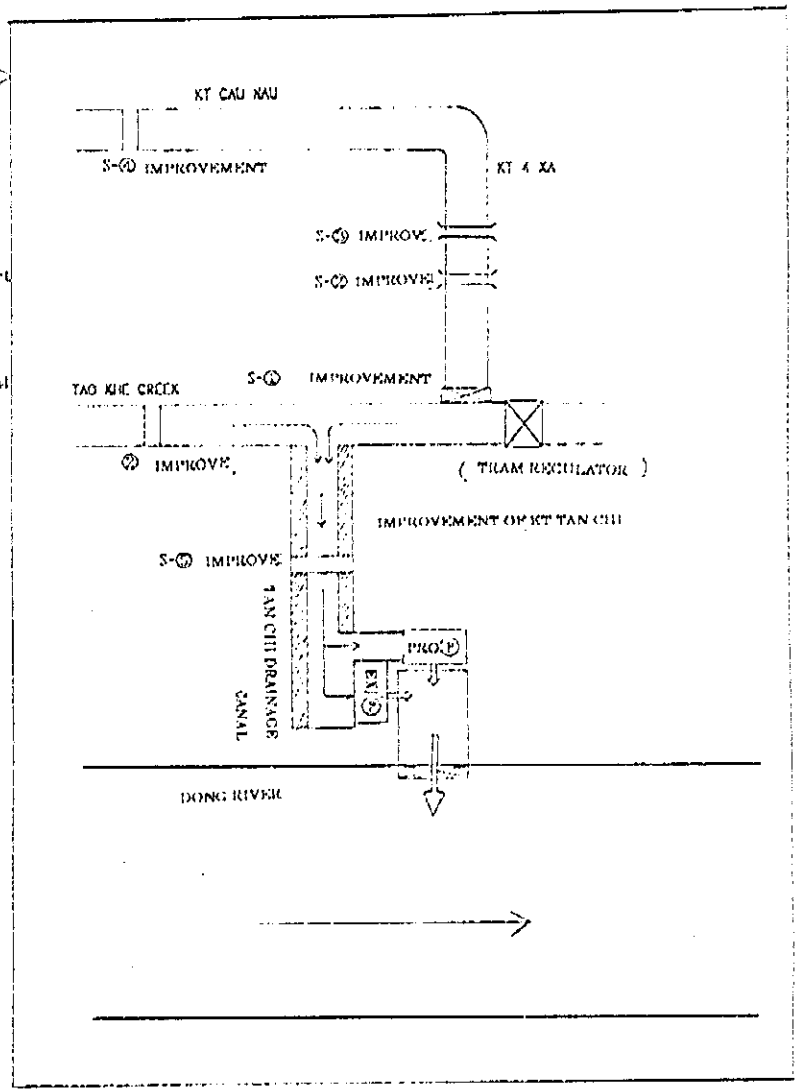


KT Phat Thich

Q(m3/s)	4.31
V(m/s)	0.281
H(m)	2.035
I	1/20,000

Figure 2-6 LOCATION MAP FOR THE IMPROVEMENT OF DRAINAGE STRUCTURES ON THE TAN CHI AGRICULTURAL AREA





DRW. NO. 1

CHAPTER 3 Implementation Plan

3-1 Implementation Plan

3-1-1 Implementation Concept

The implementation plan can be roughly divided into the construction and the procurement of materials and equipment. To allow all the materials and equipment to function as intended, it is requested construction of large-scale temporary works, demolition of the existing structures and reconstruction of these structures. Therefore, the construction works will be carried out under the contract with a general contractor with procurement.

The necessary materials and equipment, including large scaled pumps and motors and related equipment for new Tan Chi pumping station shall be procured in blanket orders including installations and adjustments.

The necessary materials and equipment, including replacement of existing pumps and motors and dredging machines for construction, operation and maintenance shall be procured in blanket orders including installation and adjustments under the contract with a trading corporation.

In case the project will be implemented under the Japanese Grant Aid, a Japanese contractor or trading corporation shall be given the contract in principle. Cooperation with the contractors in Vietnam must be implemented within the grant aid system.

Especially some of the equipment procured from Japan need adjustment at installation. Therefore, engineers shall be dispatched. The type of engineers to be dispatched, the number of engineers, and the period to dispatch are estimated separately.

3-1-2 Implementation Conditions

(1) Background Condition

The climate in this area, influenced by monsoon, is clearly divided into the dry season and the rainy season; the former to last from November to April and the latter to last from May to around October. As construction works for improvement of drainage systems is

to be executed on the low land area which is enclosed by polder dikes, the construction plan shall be studied through sufficient understanding of the different site characteristics in the dry and rainy seasons.

Most of necessary materials for this construction, excluding large scaled pumps and motors which will be procured from Japan, can be obtained in Vietnam. However, attention shall be fully paid to arrangements for obtaining the construction machinery, steel materials for temporary works, pile for foundation, cement, aggregate in order to execute efficient works during the dry season.

(2) Precautions for Implementation

1) Construction Office

The construction office is provided in the Bac Ninh city where is convenient for communicating with the project office of the central implementing agency and related local offices. At the construction site, a site office is provided at Tan Chi pumping station and container-yards are set up at other sites. Communication among offices to cover a wide area will be done by using mobile phones.

2) Tan Chi Pumping Station

① Access Road to the Site

Existing river dikes are not suitable for construction roads, because many construction machines and vehicles going back and forth will affect the security of dikes. Access road to the site will be constructed along a irrigation canal, starting from the crossing point between provincial road No.38 and irrigation canal located 2km far from the Ho ferry bridge.

② Construction of New Pumping Station

Temporary works for construction of the new pumping station shall be so planned as to minimize influence on existing pumping facilities due to the embankment and excavation works. The elevation of pumping yard shall be set up at EL4.50m by embanking the site in order to protect inundation from rain water during the rainy season.

③ Operation of Pump

While constructing related facilities for pump operation, technology transfer shall be done at the same period to personnel of Bac Duong Irrigation Enterprize who will engage in operation and maintenance in terms of the manual on function of facilities and operation, maintenance and repairing.

④ Demolition and Construction of Discharge Sluice

Demolition and construction of discharge sluices shall be executed during dry season. In this case, a coffer dam shall be constructed in the river side, considering the high water level during the dry season. The dam will be also used as a road for passing the river dike. Since the construction period is short, gates and other construction materials shall be procured within this period.

3) Tao Khe Main Drainage Canal

① Rehabilitation of Sluice Gate and Farm Bridge

The farm road is available as a by-pass road, which will be accessible to the river dike at 300m far from the existing road while rehabilitating sluice gates and bridges near Duong Ma village. On the way, small bridges and farm roads shall be reinforced and widened. Construction works will be done by provision of a coffer dam. The farm road is used as an access road to the site from the national road No.1A, but one small bridge shall be improved.

② Dredging Works for Canals

Dredging works for the bottom of Tao Khe canal shall be done in order to improve the drainage capacity. Dredging boats with suction type are used to dredge and delivery sediment materials to farm field along the canal. In this issues, the consent between local authority and land users shall be obtained.

4) Securing Electric Power Supply and Other Power Sources for the Construction

To maintain electric power supply and other power sources required for the construction, auxiliary power supply shall be secured to deal with power failure expected to occur

frequently and not to cause any problems in the progress of the construction.

Besides this issue, since a high tension line is running across the construction site, attention shall be paid to the accident by an electric shock. Concerning water for construction, the water will be secured by exploiting deep wells. The quality of water has been good according to the result of testing done in the basic design.

5) Quality Control of Materials and Equipment

In principle, concrete for the construction works shall be mixed at the site. Here, sufficient guidance and monitoring shall be given to the quality control of this concrete so as to meet the strength specified in the design standard. Additionally, similar efforts shall be made on the quality control of our materials such as reinforcing bars and formworks.

6) Observing Specifications

All the necessary instructions for the implementation of this construction are written in the construction specifications. Therefore, when doing any work related to this project, appropriate work specifications shall be observed.

3-1-3 Scope of Works

1) Acquiring and Compensating for Land

Although the works related to this project are conducted on the farm land, if the whole or part of the construction requires the use of private land, it shall be the responsibility of the Vietnamese side to negotiate with the land owners and acquiring and compensating for the land.

2) Transportation Cost and Trial Run and Adjustment Cost

For the materials and equipment to be procured in Japan, the Japanese side shall bear the costs for transporting to the project site those requiring installation, adjustment and trial runs. Additionally, the Japanese side shall also bear the costs required for adjustments and trial runs.

On the other hand, materials and equipment to be procured in Vietnam shall be turned over on site in principle, all the costs of which shall be borne by the Japanese side.

3) Supplying the Power

For the power required on the construction site, some drop wires branching from the trunk line crossing the site and extending to the locations requiring power shall be installed and the power shall be put through transformers to lower the voltage before being used. The Vietnam shall bear the costs of installing the drop wires from the trunk line to the transformers.

The high tension line on a low tower is proposed to be so transferred by the Vietnam as possible as that working conditions may be improved.

3-1-4 Consultant Supervision

(1) Ministry of Agriculture and Rural Development (MARD)

The Ministry of Agriculture and Rural Development shall select and contract with the consultant for the detailed design and the supervision of this project. The design document and tender documents prepared based on the results of detailed design of this consultant shall be approved by the MARD.

All the facilities completed according to the above design documents, after having been inspected and approved by the MARD, are handed over to the MARD. More specifically, the facilities completed up to the trial runs, as soon as the inspection is completed, are handed over one by one to the Vietnamese side.

(2) Consultant

If this project is implemented under the Japanese Grant Aid, a Japanese consultant recommended by the JICA conduct the following operations related to the detailed design and site supervision based on the contract with the executive organization of the Vietnamese Government.

1) Detailed Design

- Preparation of detailed design and tender documents related to the construction and materials and equipment for it
- Conducting the tendering operation on the Vietnamese behalf and analyzing and appraising the tenders
- Attending negotiations for a contract between the Vietnam and the contractor related to the above tendering and giving advice
- Other necessary consulting services

2) Implementation Supervision

The consultant shall delegate on-site representatives to the Vietnam, who will conduct or assist the following operations:

- Approving the construction drawing
- Supervising the construction progress and the quality control
- Informing and coordinating the activities with the concerned Vietnam organizations
- Supervising and approving the construction records
- Inspecting the construction progress and issuing the construction completion certificate

3-1-5 Procurement Plan

(1) Procurement of Construction Materials and Equipment

The materials and equipment required for the construction shall be procured by Japanese general contractor who has a general contract for it. The materials and equipment mainly required shall be handled as described below. However, sufficient caution must be paid to the procurement because there may be a case where a large amount of materials and equipment are required at one time.

- Construction equipment: In Hanoi, the capital of the Vietnam, there are many lease companies of general-purpose construction machinery which supposedly have sufficient number of devices to meet the needs of each construction site.

- Steel materials for temporary works: Some kinds of steel sheet pile are to be imported, depending upon the type and length. Other steel materials are to be procured in Vietnam.

- Foundation pile: Since Vietnamese manufacturers of foundation piles are confirmed to have well experience, these manufacturers supposedly have sufficient quality and supplying capacity of foundation piles.

- Concrete: Since the suppliers of ready mixed concrete are confirmed not to operate around the site, it takes two hours to transport concrete around Hanoi. The simple batching plant is better to be provided at the site and be produced by the suppliers of ready mixed concrete so as to control the quality.

- Aggregate: The suppliers of aggregate are confirmed to be located along the Doung river and its quality and supplying capacity.

- Reinforcing Bar: Reinforcing bars are produced and supplied in sufficient quality in Vietnam.

- Pipes: PVC and GI pipes that may become necessary in this project have large demand and are produced sufficiently in Vietnam.

- Pumps: Pumps and related equipment will be procured from Japan.

(2) Procurement from Other Countries

1) Equipment for Operation and Maintenance as well as Construction

At present, operation and maintenance of drainage canals in the project area are conducted by the Bac Duong Irrigation Enterprise. It would be necessary to procure dredgers and excavators for operation and maintenance as well as construction works for this project. Dredgers are produced by some shipping companies in Vietnam and may have suitable sizes for drainage canal in the project area. Excavators are not produced in Vietnam, but second hand excavator made in Japan are popularly used, other country's one are few. Considering width of drainage canals and soil hardness around canals, excavators to be used should have long arms and wide crawlers. Therefore, it is understood that excavators from Japan would be most suitable for this project, taking

operation and maintenance after implementation into account.

2) New Pump and Motor

Many small pumps are manufactured in Vietnam, but large pumps such as having diameter 1,350mm of discharge mouth to be used for this project have not been produced and supplied. Pumps made in third countries as same as this project are under implementation budgeted by the international agencies, but it is not said that this is a experience. Since many pumps made in Japan are used in the neighbor countries, it is proper that pumps made in Japan would be used for this project, taking into account quality, performance, supply period, operation and maintenance, etc. On the other hand, large capacity's motors are manufactured in Vietnam, however, pump which has large number of poles has not been manufactured. Therefore, it is considered for motor to be supplied from Japan, taking account of quality, supply period, etc.

3) Transportation Route

Unloading port in Vietnam will be Hai Phong. General cargo can be received customs clearance in Hai Phong. On the other hand, container cargo will be received admission in Hanoi, then its seal will be sent to Hai Phong. Route between Hai Phong and project site is of national road No.5 which is bound for Hanoi. No.5 is under rehabilitation for widening, is fully paved and large trucks can pass through. No.5 intersects before crossing the Red River national road No.1A which is from Hanoi to the east. Route takes the No.1A up to 20km far from the crossing and reaches the People's Committee which is in the project area in Tein Son Province. People's Committee stands on the north center in the project area.

Route for existing pump station and new pump station for this project takes No.1A to east up to 5km and turn to the right at the point of crossing the provincial road No.18. Pump station for this project stands 15km from the crossing point along No.18 and the Duong River. As the project site is blessed with rivers, inland transportation by ship could be used through such as the Tai Bin River, the Cau River, the Duong River, etc. for procurement of equipment and materials around the project area. However, small quay is at the bank of the Duong River near the project site, there is not wide area for unloading of equipment and materials as well as unloading facilities.

3-1-6 Implementation Schedule

If this project is implemented under the Japanese Grant Aid, the consultant contract shall be concluded after the E/N (Exchange of Notes) and appraised by the Japanese Government. Then, it shall take four months to prepare the detailed design and tender documents and have them approved. After the construction contract with the contractor is verified, it shall take another twelve months to carry out the construction. Figure 3-1 shows the project implementation process chart.

3-1-7 Obligation of the Government of Vietnam

If the Japan's grant aid is extended, the following items shall be born by the Government of Vietnam.

(1) After the implementation of this project is determined, necessary materials and information shall be provided to the detailed design study conducted by the Japanese consultant.

(2) The facilities necessary for the operation of the facilities in this project such as land, power , water supply, and access road shall be secured.

Land Acquisition: 2.5 ha
Rehabilitation of Transmission Line: 11.5 km
Installation of Electric Receiving Facilities: Lump Sum
Access Road: 600 m

(3) Based on the bank arrangement, necessary commissions shall be paid to the banks.

(4) Measures shall be provided for the prompt unloading, customs clearance, and the transportation within the Vietnam of the equipment to be delivered for this project.

(5) The taxes, the domestic taxes, and other financial surcharges charged to the preparation of equipment and provision of services by the Japanese nation for this project shall be exempted or born by the Government of Vietnam.

(6) Necessary measures shall be taken for the entry to and the staying in the Vietnam of Japanese nation to supply services for the implementation of this project.

(7) The permit necessary for the implementation of this project and ratification of the said permit shall be obtained in advance according to the laws of the Government of Vietnam.

(8) Appropriate budget and staff members for proper and effective operation and maintenance of the facilities constructed under the project shall be assigned.

(9) The equipment prepared for this project shall be maintained and operated appropriately and effectively. The operating situation of equipment shall be reported to Japan as requested from Japan.

(10) All the other necessary expenses not included in the grant aid shall be born.

Figure 3-1

3-2 Project Cost Estimation

Cost born by the Government of the Vietnam for project implementation is estimated as follows:

Table 3-1 Estimated Cost Born by Vietnam

	Item	Cost (VND)
1)	Land acquisition	390million
2)	Banking commission	120million
3)	Rehabilitation of electric line to new pump station	1,410million
4)	Electric receiving facilities	50million
5)	Access road to new pump station	240million
6)	Customs clearance and inland transportation	50million
	Total:	2,260million

3-3 Operation and Maintenance Cost

(1) Organization

The Bac Duong Irrigation Enterprise is under the administration of Department of Agriculture and Rural Development in Bac Ninh People's Committee. It has a main office in Tu Son, Tien Son district and is well managing the irrigation and drainage facilities. Under the Director, one board, two enterprises and five offices are organized. Those offices are provided in respective district and the staffs together with the provincial governmental staff under the Director who will be appointed by the provincial government.

The productive division of the Enterprise has four sections of Tien Dong, Investigation and Design, Project Management, Preparation. The non productive division has three sections of Personnel and Administrative, Materials and Financial, and Economic Planning.

The Project Management section deal with planning and management of operation and maintenance works in the entire Bac Duong area at present and is expected to continue those works and conduct planning of irrigation water management, drainage water control and facilities' maintenance as well as monitoring and management of pumps and sluices as a day-to-day activity after the project.

The superintendents for each pumping station and gate-keepers for each sluice will be appointed. The communication will be kept up by telephone between the main office and pumping stations and to the gate-keepers through Project Management section in Tien Son district. In order to implement adequate and effective management of irrigation and drainage, inspection/communication team will be organized in the Tien Son office.

The team will serve to monitor the present state of facilities and operation of irrigation/drainage sluices, and check the offtake water discharge from the main and secondary canals, and provide instruction/guidance of proper gate operation to the gate keepers, as a daily works.

After completion of project facilities, the organization will follow the present organization of the Enterprise to operate and manage the Tan Chi pumping stations, main and secondary canals and related structures.

In respect to the method of operation and maintenance for new Tan Chi pumping station, the technology transfer will be required according to technical assistance by the Japanese Government. The Province/Enterprise will take the initiative in very operation and maintenance of the project facilities for the time being.

In future, it is advised that the operation and maintenance of secondary canals and related facilities should be operated and maintained by farmers concerned. For this institutional set-up, the farmers' association will be developed to shoulder a part of the operation and maintenance system, aiming to make the farmers understand necessity of operation and maintenance and common use of the facilities among them.

As spoken in the public hearing held October, 1997 at Tien Son district, all farmers fully understand this situation, therefore, in future the new operation and maintenance system is expected to be easily accepted by farmers.

(2) Method of Operation and Maintenance

The maintenance of Tan Chi pumping stations and Tao Khe main canal consists of daily maintenance and periodical maintenance works. Inspectors should observe the state operation of the facilities, as a day-to-day activity. When required for repairing, he should take prompt action to report the chief and restore those structures with assistance

of staffs concerned.

While, the periodical maintenance works for the facilities should be carried out with advice of supervisor/experts in the months of March to May. In order to implement proper maintenance works, it is integral to provide maintenance manual for the facilities and pumping equipment as well as training/education to the staffs concerned, based on Decree No.405-QD-TN. "Decision of the Minister of Water Resources on Publishing the Operation and Development Rules for Bac Duong Irrigation Management", Decree No.1289 N/TM "Temporary Stipulations, Some Changed Points on the Operation Rules for the Bac Duong Irrigation System".

(3) Water Fee

The Government of Vietnam has been collecting the water fee from the farmers through farmers' cooperatives since 1984. In the project area, Bac Duong Irrigation Enterprise has been collecting the water fee from farmers.

The water fee is collected by cash equivalent to 6 percent of the past three year's average paddy production through farmers' cooperatives. The collected rate of water fee is now high at over 90percent. The price of paddy will be decided by the central and local authorities.

(4) Operation and Maintenance Cost

① Comparison of O&M cost between without Project and with Project

The annual operation and maintenance cost for the Tan Chi area without the project consists of those of the existing Tan Chi pumping station as drainage and Trinh Xa pumping station as irrigation. As for the Trinh Xa pumping station, the cost allocation to the Tan Chi area is estimated by the percentage of the area against the total commanding area by Trinh Xa station.

The operation and maintenance of the Tan Chi area with the project is composed of the existing and new Tan Chi pumping station and a part of Trinh Xa station. The following table shows the comparison between without project and with project.

Table 3-2 Comparison of O & M Cost

(Unit: Million Dong)

Item	Without Project			With Project		
	Drainage	Irrigation	Total	Drainage	Irrigation	Total
Salary	68	31	99	94	31	125
Electricity	556	504	1,060	1,263	504	1,767
Repairing	67	209	276	380	209	589
Others	202	257	2459	202	257	459
Total	894	951	1,894	1,939	951	2,940

Note: Figures without project are average values from 1992 to 1996.

Data are obtained from Bac Duong Irrigation Enterprize.
Drainage ..... O&M cost of Tan Chi pumping station
Irrigation ..... O&M cost of Trinh Xa pumping station x area ratio (0.3)

The above table shows operation and maintenance cost with project is 2.94 billion dongs, comparing with 1.89 billion dongs without project.

② Comparison of Water Fee between without and with Project

The comparison of water fee between without and with project is shown as follows:

Table 3-3 Comparison of Water Fee

Item	Without	With
(a) Paddy Cultivated Area (ha)	6,608	6,253
(b) Paddy Yield (t/ha)	3.5	4.2
(c) Total Production (t)	23,128	26,263
(d) Collected Paddy as Water Fee (t)	2,122	1,576
(e) Price of Paddy (dong/kg)	1,276	2,500
(f) Water Fee(million dong)	2,708	3,940

Note: (a) JICA study report
(b) Data are based on the Bac Duong Irrigation Enterprise. Average value of 1992 to 1996.
(d), (e) Without project is based on the data obtained from the Bac Duong Irrigation Enterprise. Average value of 1992 to 1996.
Price of paddy as water fee with project is estimated in the year of 2002.

From a view point of water fee, the expected water fee with the project will be 3.94 billin dong, which is 1.23 billion dong increase comparing with 2.71 billion dong without project.

③ Direction of Operation and Maintenance

As understood in the above two tables, the operation and maintenance cost for the facilities with the project is 2.94 million dong, on the other hand, the water fee with the project to be collected will be 3.94 million dong. This means operation and maintenance cost for the facilities after implementation of the project will be borne by the water fee, unless natural disasters happens. The water fee with the project is estimated only for the paddy cultivation according to the current decree, but considering the expansion of upland cropped areas by promotion of crop diversification, water fee shall be collected from such land. As a result, more incremental water fee for the operation and maintenance will be secured.

CHAPTER 4 Project Evaluation and Recommendation

4-1 Project Effect

About 180,000 people of the Tan Chi area will receive the direct benefit and about 130,000 people of the neighboring area will receive the indirect benefit through the implementation of the project. The following project effect will be brought to the project area.

The most remarkable effect by the project is expected to mitigate the inundation of the agricultural field by improving drainage conditions, namely the maximum inundation area of 1,937 ha will be reduced to 937 ha and the duration of inundation will be shortened to one day from 4 days.

The reduction of inundation time will give a stable farming in the paddy cultivation and lead the increase of rice production. Furthermore, the decrease of inundated area will induce the enlargement of upland cropping in terms of cultivating area and crop multiplication. As a result, farmers will increase the farm income by diverting the paddy to upland crops which will bear the higher benefits than rice.

With the improvement of drainage facilities, stable farming will be materialized by prevent against flood and waterlogging damages for paddy. Hence, even small-scale farmer is expected to obtain the surplus of about 556,000 VND annually, in the farm household economy side. These circumstances will promote investment, functioning to expand the scale of the local economy in the area and neighboring agricultural areas.

By construction of new Tan Chi pumping station, sluice gates provided at the border between Tan Chi and Han Quang areas will be efficiently operated without any trouble for the reason that flood water will be cut in the upstream, as a result, surplus water will not be flown out to the downstream area.

Considering the above effects, the project will meet basic human needs and extend socio-economic impact on activation of the rural area, assuring poverty eradication, food security by stabilization of farming.

4-2 Recommendation

For the smooth implementation of this project, the following points should be considered.

(1) Before the commencement

① To confirm the completion of land acquisition necessary for the sites of the project facilities by the Bac Ninh People's Committee .
② To check the preparation and procedures undertaken by the MARD for rehabilitation of transmission line and electrical receiving facilities for the new pumping station.
③ To confirm whether the mutual agreement between farmers and Bac Duong Irrigation Enterprise would be made or not in terms of interruption of irrigation water supply during the construction of canal appurtenant structures and change of cropping period.
④ To confirm quick procedures for getting an approval from the related agencies of the Government of Vietnam for the commencement of construction works on removal of the existing drainage sluiceway and the river dike.
⑤ It should be responsible for the Vietnamese side to provide the land to place and manage the spoiled soil which would be produced by excavation and dredging..

(2) During the Construction

① The Japanese side will recommend the Vietnamese side to complete canal works born by the Vietnamese side within the validity of the E/N depending upon the progress of construction works.
② To pay attention to environment.

(3) After Completion

① Operation manuals should be prepared and on-the-site training should be implemented for the establishment of operating techniques.
② Regular inspection and repair works for equipment and facilities of pumping station and drainage canals should be carried out by the Vietnamese side in order to maintain the function of each facility.
③ Dispatch of short-term experts is necessary for transferring the operation method of a new pumping station and sluice gates before and after the trial run of equipment.