REPUBLIC OF THE PHILIPPINES

DESIGN REPORT
ON
EXPERIMENTAL FARM
FOR
BOHOL AGRICULTURAL PROMOTION CENTER PROJECT

(B.I.A.D.P.)

MARCH 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

REPUBLIC OF THE PHILIPPINES

DESIGN REPORT
ON
EXPERIMENTAL FARM
FOR
BOHOL AGRICULTURAL PROMOTION CENTER PROJECT

(B.I.A.D.P.)

MARCH 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to the request made by the Government of the Philippines, the Government of Japan sent a Preliminary Survey Team to the Philippines, through Japan International Cooperation Agency (JICA), from March 15 to April 5, 1980. The purpose of the survey was to look into the possibility of the agricultural development plan involved in the Bohol Integrated Area Development Project (BIADP). Throughout the survey period, the Team shared detailed and fruitful discussion with the National Council on Integrated Area Development (NACIAD) and other line agencies in Manila, Cebu, and Bohol directly concerned with the agricultural development of Bohol. The Team submitted a survey report to the Government of Japan to convey the Philippine Authorities' interest in and enthusiasm for the development of Bohol as well as data and information on the status quo of the Project Area.

Through a series of discussions, meetings and elaborate studies based on the data available, the Team has drawn a conclusion that a training program along with necessary research facilities should be provided for the successful implementation of the plan.

According to the said recommendation, the Government of Japan decided to extend technical assistance in the agricultural development of Bohol. The purpose of the development is to reclaim farmlands into experimental farms with the provision of appropriate structures, where the improvement in seeds and planting and cultivation methods are conducted on promising variety of paddy and upland crops. At the same time, the technical assistance in farming will likewise be extended to the local farmers by by Japanese experts.

In due consideration of the above, JICA has decided to prepare a detailed design of the required facilities like experimental farms, irrigation and drainage canals, farm roads, and others in the selected areas at Dao(in Tagbilaran city), Bilar, and Ubay districts in Bohol. A planning engineer and a design engineer were dispatched to the field for 36 days from January 5th to February 9th, 1983, and then engaged in home works until March 11th, 1983, which resulted in the preparation of this Design Report.

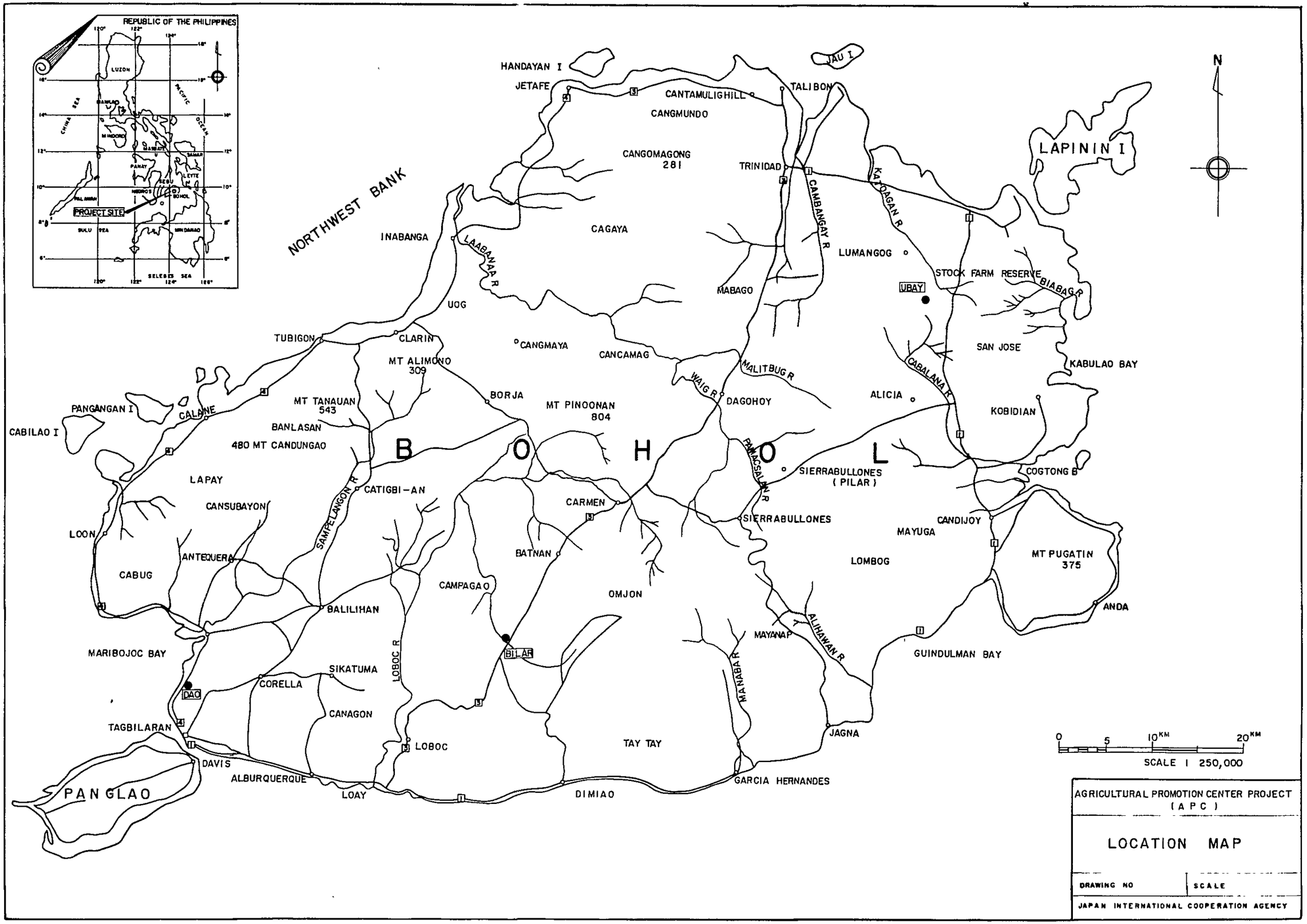

REPUBLIC OF THE PHILIPPINES
PROJECT SITE
LUZON
MINDORO
PANAY
NEGROS
CEBU
LEYTE
BOHOL
SAMAR
MINDANAO
SULU SEA
CELEBES SEA
PACIFIC OCEAN
CHINA SEA
N
NORTHWEST BANK
HANDAYAN I
JETAFE
CANTAMULIGHILL
CANGMUNDO
TALIBON
JAU I
CANGOMAGONG
281
TRINIDAD
CAMBANGAY R
KATIGAGAN R
LAPININ I
INABANGA
LAABANAAN R
CAGAYA
LUMANGOG
STOCK FARM RESERVE
BIABAG R
MABAGO
UBAY
UOG
TUBIGON
CLARIN
CANGMAYA
CANCAMAG
MT ALIMONO
309
MALITBUG R
WAIG R
DAGOHOY
ALICIA
CABALANA R
SAN JOSE
KABULAO BAY
KOBIDIAN
PANGANGAN I
CABILAO I
CALAPE
MT TANAUAN
543
BORJA
MT PINOONAN
804
BANLASAN
480 MT CANDUNGAO
B O H O L
PANACSALEN R
SIERRABULLONES
(PILAR)
COGTONG B
LAPAY
CANSUBAYON
SAMPELANGON R
CATIGBI-AN
CARMEN
SIERRABULLONES
CANDIJOY
MAYUGA
LOON
ANTEQUERA
CABUG
BATNAN
LOMBOG
MT PUGATIN
375
CAMPAGAO
OMJON
BALILIHAN
ANDA
ALIHAWAN R
MAYANAP
MARIBOJOC BAY
BILAR
LOBOC R
MANABA R
GUINDULMAN BAY
SIKATUMA
CORELLA
DAO
CANAGON
TAGBILARAN
LOBOC
TAY TAY
JAGNA
DAVIS
ALBURQUERQUE
LOAY
DIMIAO
GARCIA HERNANDES
PANGLAO
0 5 10KM 20KM
SCALE 1 250,000
AGRICULTURAL PROMOTION CENTER PROJECT
(A P C)
LOCATION MAP
DRAWING NO
SCALE
JAPAN INTERNATIONAL COOPERATION AGENCY

TABLE OF CONTENTS

LIST OF TABLES

ATTACHED DOCUMENTS

TENDER DOCUMENTS and DRAWINGS

APPENDIX(Separate Volume)

1. Construction Costs of Buildings, Bilar
2. Survey Report on Groundwater

ABBREVIATIONS AND GLOSSARY

1. Agencies

NACIAD	:	National Council on Integrated Area Development
NEDA	:	National Economic and Development Authority
MFA	:	Ministry of Foreign Affairs
MOA	:	Ministry of Agriculture
MPWH	:	Ministry of Public Works and Highway
NIA	:	National Irrigation Administration
BAI	:	Bureau of Animal Industry
BAEx	:	Bureau of Agricultural Extension
BAEcon	:	Bureau of Agricultural Economics
BS	:	Bureau of Soil
PDS	:	Provincial Development Staff
APC	:	Agricultural Promotion Center

2. Units of Measurement

Length

mm	:	Millimeter
cm	:	Centimeter
m	:	Meter
km	:	Kilometer

Area

sq.cm, cm^2	:	Square centimeter
sq.m, m^2	:	Square meter
sq.km, km^2	:	Square kilometer
ha	:	Hectares

Volume

l, lit	:	liter
cu.m., m^3	:	cubic meter
lit/sec	:	liter per second
m^3/s	:	Cubic meter per second

Weight

g	:	gram
kg	:	kilogram
ton	:	metric ton

Others

EL	:	Elevation
F.W.L	:	Full Water Level
H.W.L	:	High Water Level
sec	:	second
min	:	minute
hr	:	hour
%	:	percent
H.P.	:	horse power
m/s	:	meter per second
max	:	maximum
min	:	minimum
°C	:	degree centigrade
No.	:	number
Et	:	Evapotranspiration
₱	:	Peso
¥	:	Yen

CHAPTER I. OUTLINE OF EXPERIMENTAL FARM

1-1. General

Experimental farms where seed improvement and experiments on crop production are to be conducted as part of APC's activities will be established at Dao, Bilar, and Ubay. The selection of sites for the experimental farms was made taking into account the topographical conditions, water sources and costs required for development. The area selected covers 1.0, 2.5, and 2.0 ha, respectively, and the farm at Dao is used for the experiment on upland crops, and those at Bilar and Ubay for paddy production. The location of each farm is shown in Location map.

For experiment on the production of upland crops at Dao farm, a minimum irrigation water must be secured. Since Dao district lacks in the surface water such as river flow or reservoir water, the groundwater has to be made use of for the irrigation of the district. For this purpose, a pumping-out test was conducted at a tubewell nearby the proposed experimental farm in June, 1982. Based on the results of this, the water requirement was estimated for the irrigation of upland field.

The Bilar river running 100 m south of National Highway No.3 will be proposed as the water source of the Bilar farm. On the other hand, the water source of the paddy farm at Ubay will be sought in the reservoir which is artificially made by damming the creek flowing nearby the existing reservoir.

The dimensions of the proposed farms and related facilities are as follows:

Total Area		6.06 ha
(1)	Dao	1.12 ha
	Farm	1.00 ha
	Road	0.12 ha
(2)	Bilar	2.94 ha
	Farm	2.50 ha
	Canal	0.10 ha
	Road	0.34 ha
(3)	Ubay	2.00 ha
	Farm	2.00 ha

The construction cost of these experimental farms inclusive of related facilities is estimated on the basis of the prevailing prices as of January, 1983. The estimated labor cost covers, in addition to the basic wage rate, the wage in kind and transportation fee from Tagbilaran to the proposed sites.

1-2. Outline of Farm

1-2-1. Irrigation Facilities

a) Dao

Irrigation water required for upland crops at Dao experimental farm will be supplied from a tubewell. The water will be pumped up with a tubewell pump and delivered to the farm through the pipeline installed along the road. The farm will be brought under irrigation with the use of sprinkler.

b) Bilar

For the supply of irrigation water from the Bilar river to its experimental farm, the existing diversion weir will be so modified that the permanent intake of water is secured. Irrigation of the experimental farm of 2.5 ha as well as the farms of irrigation community of 58.5 ha will require the maximum water intake of 0.119 cu.m/sec from the said river. The main irrigation canal made of concrete blocks will be constructed on the existing one. The farm ditches will be constructed with embankment along with other facilities.

c) Ubay

Ubay experimental farm will make use of the paddy field currently utilized by Bohol Experimental Station. At present, the field is inadequately irrigated with the use of reservoir and pump (including distribution pipe) installed in the Station. In order to augment the supply of irrigation water, the existing reservoir will be linked with a new one to be made by damming the creek running nearby the Station. So the existing irrigation facilities will be put to use at Ubay farm except for the reservoir. The required maximum reservoir capacity is estimated at 30,000 cu.m.

1-2-2. Drainage Facilities

a) Dao

No special consideration is given to drainage at this farm except the drainage ditches to be constructed along the farm roads for the rain water.

b) Bilar

For draining the runoff of 0.66 cu.m/sec from outside the district, a drainage earth canal is planned to the east of the

experimental farm. No consideration is given to subsurface drainage from the viewpoint of topography and depth of underground water.

c) Ubay

No consideration is given to drainage at this farm including subsurface drainage from the viewpoint of topography and soil mechanics.

1-2-3. Farm

The experimental farm proposed is 1.0 ha of dry field at Dao and 2.5 ha(100m x 100m per plot) of paddy field at Bilar. A standard size of farming plot will be 0.2 ha. As for the farm at Ubay, existing experimental paddy fields are utilized.

1-2-4. Road

a) Dao

The three-meter wide farm road, paved two-meter wide with gravel, will surround the north, south, and east side of the farm and will be linked with a city road.

b) Bilar

The five-meter wide main road, paved four-meter wide with gravel, will be extended from National Highway No.3 up to the end of farm. In addition, the three-meter wide farm road, paved two-meter wide with gravel, is planned along the three sides of farm plot excepting for the side facing the National Highway.

c) Ubay

No consideration is given to the farm road at this farm because the existing roads are readily accessible.

1-3. List of Works and Facilities

Following is the list of works and facilities to be provided at the experimental farms at Dao, Bilar, and Ubay:

1-3-1. Dao

1)	Reclamation of farm	1.0 ha
2)	Farm road (W = 3.0 m)	270 m
3)	Pavement with gravel (W = 2.0 m, Thickness = 0.15 m)	270 m
4)	Deep well, pump, and distribution pipeline	1 set

1-3-2. Bilar

1)	Diversion weir:	Length of weir = 13.9 m Flash gate (1.5 m W x 1.6 m H x 2 gates) Intake gate 0.5 m (0.6 m W x 0.6 m H x 1 gate)	1 site
2)	Canal		
	Main irrigation canal (concrete block)		450 m
	Farm ditch (earth)		250 m
	Drainage canal (earth)		280 m
	Drainage ditch(earth)		210 m
3)	Road		
	Main road (W = 5.0 m)		210 m
	Farm road (W = 3.0 m)		550 m
	Pavement with gravel	(W = 4.0 m, T = 0.15 m)	210 m
	- do -	(W = 2.0 m, T = 0.15 m)	550 m
4)	Land Reclamation		
	Land leveling		2.5 ha
	Rock excavation (depth 0.3 m)		

5) Concrete structures

Pipe culvert crossing National Highway(ϕ 800 mm)	1 site
Turnout	2 sites
Pipe culvert crossing farm road	3 sites

1-3-3. Ubay .

1) Dam body (crest length = 47.0 m, crest height =5.5 m)

2)	Spillway (concrete)	1 site
3)	Connecting pipe culvert(concrete pipe ϕ 600 mm)	20 m

CHAPTER II. PRESENT CONDITIONS

2-1. Dao

2-1-1. Topographical Conditions

The proposed farm is located 2.0 km north of Tagbilaran, capital city of Bohol island and along a city road. An area of about 7.45 ha including the farm is presently owned by the government as the main center of Agricultural Promotion Center involved in the Bohol Integrated Area Development Project (BIADP).

The ground elevation ranges from 34 m to 43 m and the surface has a little irregularity. The lowest portion of the area is identified at the northern corner and the highest portion at the central part adjoining a city road. The ground surface is covered with weeds, and bushes grow at the central and east parts.

2-1-2. Geological Conditions

Surface soils of the area consist of the silty clay formed of weathered limestone and these soils are identified at approximately 50 to 150 cm deep from the ground surface. Lumps of slightly weathered limestones are found under the arable soil or partly outcrop on the surface. However, these lumps are not bedrocks and could be grubbed up by a bulldozer with ripper.

2-1-3. Water Source

There is no surface water source in this area and domestic living water is supplied by a tubewell. Pumping-out test was conducted at the proposed experimental farm area by Japanese experts in June, 1982. The test results confirmed that water necessary for the irrigation of upland field of 1.0 ha will be secured throughout a year.

2-2. Bilar

2-2-1. Topographical Conditions

Bilar town where the experimental farm is proposed is located 45 km northeast of Tagbilaran city. Agricultural College of Bohol (including training farmland) is also in the town. Bilar area is a basin surrounded by hills and the National Highway No.3 crosses the central part from east to west. The basin has more than 200 ha of paddy field which is irrigated by the Bilar river in the rainy season.

The experimental farm is proposed in the farmland of the Agricultural College, and the ground elevation of the proposed area ranges from 197.50 to 198.10 m and the area inclines gently toward north. There are two canals running across the area: one flows throughout the lowest portion and the other along the boundary of the area from east to west and the two join on the way.

The farmlands of the College have not been consolidated before and farm plots of 50 to 1,000 m^2 scatter in a disorderly manner with varied topographical conditions. The ground elevation of the paddy field ranges from 197.50 to 198.10m and both sides of the area are slightly higher than the central part.

2-2-2. Geological Conditions

Surface soils of the area consist of the silty loam and appear to have an impervious nature with low percolation rate of less than 1.0 mm. The thickness of surface soils was measured at each paddy lot of the area and was confirmed to be all more than 30 cm. However, limestones of 10 to 50 sq.m outcrop at four to five places on the unreclaimed field. It seems that these rocks would be removed by using jackhammers or equivalent construction equipment.

2-2-3. Water Source

The Bilar river flows from south to north in the area and has watershed area of 80 sq.km at the proposed intake site. The elevation of watershed area is mostly less than 200 m. The river irrigates more than 200 ha of paddy field in Bilar district during the rainy season. In the dry season, however, the rate of irrigation is reduced to about 40 percent of the field due to the shortage of irrigation water.

No data on the river discharge were available, hence an observation was made with current meter at 150 m downstream the proposed intake site from 15th to 24th January, 1983 and the average discharge was found to be 0.09 cu.m/sec. A concrete intake structure constructed in 1934 exists at the proposed intake site but has deteriorated over the years. At present, the irrigation water diverted from the river is supplied by a brush dam located 100 m downstream the existing intake structure. However, the water intake is inadequate due to the topographical condition.

2-2-4. Hydrological Data

Precipitation has been observed since 1978 at the rain gauge station of Agricultural College. The average annual rainfall from 1979 to 1982 is 2,007 mm. On the other hand, no evaporation data are available not only in the College but also in the whole island.

2-3. Ubay

2-3-1. Topographical Conditions

Bohol Experimental Station proposed as the sub-center of Agricultural Promotion Center is located 15 km south of Ubay town and 110 km north of Tagbilaran city. The Station has paddy fields of 4.0 ha which are irrigated with water pumped up from the reservoir in the Station. The paddy fields have been developed in terraces and incline toward north with a gradient of about 1/50.

2-3-2. Soil Conditions

The surface soil of paddy field consists of Ubay sandy loam with PH ranging from 5.4 to 6.5.

2-3-3. Water Source

The above-mentioned reservoir with a watershed of 15 ha will be the water source for the area. However, the small reservoir capacity of 15,000 cu.m falls short of the irrigation requirement for the present paddy fields. Increasing the height of dam body will enhance the reservoir capacity but will be difficult due to the limited budget allocated for the Station.

2-3-4. Hydrological Data

Precipitation has been continuously observed since 1979 till 1982 at the rain gauge station of Bohol Experimental Station. The average annual rainfall in the four years is 1,724 mm.
No evaporation data are available either in the Station or in the whole island.

CHAPTER III. DESIGN OF FARM

3.1. Selection of Farm

Through the field reconnaissance and studies on the data collected by Study Team, a total area of 5.50 ha for experimental farms was finally selected in Dao, Bilar, and Ubay. Of this, 1.0 ha will be used for upland crops and the remaining for paddy.

Following consideration was given to the selection of farm areas:

- Ground surface is more or less flat
- Water sources are obtainable in the vicinity of the experimental farm
- Farm is expected to achieve the maximum demonstration effects
- Existing facilities are readily available

For Dao area, the Government has in advance allotted about 7.5 ha of field as the proposed site, and therefore, the most suitable area was chosen as the experimental farm.

In case of Bilar area, the Study Team originally proposed the farm northeast of Bohol Agricultural College. However, this area is far from the water source and requires the irrigation canal to be longer than 1.5 km. In addition, halfway to the farm, the water has to be diverted for the irrigation of adjacent areas of 58.5 ha, which makes the water management difficult. Taking these into account, the Detail Design Team had a discussion with the staffs of NACIAD, Provincial Office, NIA, the College, and Japanese experts and finally selected the proposed experimental farm in an area of

2.5 ha along the National Highway, which is closest to the water source and currently used as paddy field.

On the other hand, in case of Ubay farm, following the suggestion of Japanese experts who conducted a field survey from 23rd to 26th January, 1983, the farm was selected, being the closest to the water source, from among the existing paddy fields of 4.0 ha in Bohol Experimental Station.

3-2. Design of Irrigation Facilities

3-2-1. Dao

The irrigation water for upland crops and greenhouses will be lifted from the tubewell bored close to the proposed experimental farm and distributed through a pipeline installed underground along a farm road. The farm will be irrigated with the use of sprinkler. The water will also be used for washing farm equipment.

a) Water Requirements

1) Consumptive use of water by upland crops

The consumptive use of water by upland crops is generally determined by soil conditions and types of crops. However, since no observation data on actual consumptive use by upland crops are available in this area, its value was estimated at 5.0 mm per day based on other existing data and the soil conditions prevailing in the area.

2) Water requirement per day

Irrigation area	1.0 ha
Consumptive use	5 mm/day
Irrigation cycle	once/4 days
Irrigation area/cycle	0.25 ha

Net water requirement

$= 0.25 \times 10^{4} \times 5 \times 10^{-3} \times 4 = 50\ m^3/day$

Gross water requirement

$= 1/0.8 \times 1/0.9 = 70\ m^3/day$

Note: Irrigation efficiency : 0.8

Conveyance efficiency : 0.9

b) Pump

1) Diameter of pump

Diameter of pump is obtained by the following equations:

$D = 90(Q)^{1/2}$

Q = Design discharge (m^3/min)

$(70 \times 1/8 \times 1/60) = 0.146\ m^3/min$

Note: Operation hours per day is 8 hours

$D = 90 \times (0.146)^{1/2} = 35 = 40$ mm

2) Power Requirement of Motor

Power for pump may be generated either by motor or engine. Motor will be mobilized due to the easy access to power line along the city road(lead-in line is less than 100 m) as well as the easy operation.

$$RHP = \frac{0.163 \times Q \times H \times (1 + L)}{nt \times np}$$

where RHP: Power requirement for motor (KW)

Q : Design discharge = 0.146 (m^3/min)

H : Total head = actual head + distribution loss + required water pressure

= 60 + 20 + 20 = 100 (m)

L : Rate of allowance (%) = 25%

nt : Efficiency of Transmissibility (%) = 100%

nP : Efficiency of Pump (%) = 65%

$$RHP = \frac{0.163 \times 0.146 \times 100 \times (1 + 0.25)}{1.0 \times 0.65} = 4.6 \fallingdotseq 5.5 \text{ KW}$$

c) Pump Operation

The automatic operation system will be employed for the pump to be provided in Dao for upland irrigation. In the system, valve operation at the terminal will control pressure in the pressure tank linked directly with the pump, and thus the pump can be operated automatically by valve operation.

d) Specifications of Pump

Pump

Diameter	40 mm
No. of stages	13
Output(design discharge)	0.146 m^3/min
Total head	100 m

Motor

Horsepower	5.5 KW
Voltage	220 V
No. of poles	3

e) Farm roads

Farm roads are proposed on the circumference of farm plots to facilitate the farming works. These will be three-meter wide allowing for the passage of tractors.

3-2-2. Bilar

a) Water Requirement

Irrigation water requirement is expressed in terms of the following equations:

NWR (Net Water Requirement)

= A_1 x (Consumptive use of water by paddy + Percolation - Effective rainfall) + A_2 x (Water required for Land preparation - Effective rainfall)

where

A_1 = paddy fields area

A_2 = land preparation area of paddy fields

GWR (Gross Water Requirement) = NWR/Irrigation efficiency

1) Consumptive use of water by paddy

The consumptive use of water by paddy is determined mainly by the meteorological conditions and the paddy growth.

Since no observation data on actual consumptive use of water are available for the area, the value of evapotranspiration of paddy is estimated at 6.0 mm per day based on the existing data.

Percolation on the paddy fields of silty loam will be 1.0 mm per day and, therefore, the consumptive use will be 7.0 mm per day.

2) Irrigation efficiency

The irrigation canals will be constructed with concrete blocks, the inside being covered by mortar, and the farm ditches branched off from the main canal will be constructed with earth on each plot of the farm.

The irrigation efficiencies are determined taking into account the construction materials of canals, turnout structures, and farm conditions.

Field efficiency	70%
Turnout efficiency	90
Conveyance efficiency	85
Overall	54

3) Peak Irrigation Water Requirement

i) Experimental farm

The peak irrigation water requirement determines the capacity of the irrigation facilities such as canals, ditches, etc. The peak requirement of the experimental farm falls on the last day of land preparation. It is calculated as follows, without any regard to negligible effective rainfall.

NWR = (4/5) x 2.5 ha x 7 mm/day
+ (1/5) x 2.5 ha x 130 mm/day
= 0.0091 m^3/sec

GWR = 0.0091/0.54 = 0.017 m^3/sec

ii) Other irrigable area

Area	•	58.5 ha_3
GWR		0.102 m^3

iii) Intake

The peak irrigation water requirement at the intake of diversion weir of the Bilar river is calculated as follows:

$$Q = 0.017 + 0.102 = 0.119 \ m^3/sec$$

b) Diversion Weir

1) Design intake water level at the Bilar river

Design intake water level (DIWL) is obtained as follows:

$$DIWL = WLR + TL$$

where WLR : water level required at the turnout of experimental farm

TL : total loss such as friction loss and screen loss, etc.

WLR and TL are estimated as follows:

WLR = ground elevation of paddy field + depth of flooding water + turnout loss

= EL.198.10 + 0.10 + 0.03

= EL.198.23 m

TL = intake loss + intake pipe loss + main canal loss + loss of culvert crossing National Highway

= 0.02 + 0.064 + 0.069 + 0.017 = 0.17 m

DIWL, therefore, is determined as:

DIWL = EL.198.23 + 0.17

= EL.198.40 m

2) Design Flood Discharge

In general, the design flood discharge to be applied for the design of diversion weir is estimated, depending on the importance of river(its scale and location relative to catchment area), by the flood discharge occurring with 10 to 50 year probability. Application of this condition to the Bilar river results in the flood discharge of about 330 m^3/sec with the flood discharge of 10 year probability and for a river without any improvement plan, this figure implies the flooding over river banks.

Since the experimental farm will not involve such river improvement plan, the design flood discharge to be used for the design of diversion weir is assumed to be the peak discharge that runs through the cross-sectional flow area of the river. Present dimensions of the river are as follows:

Slope	$\frac{1}{615}$
Cross-sectional flow area	29.1 m^2
Wetter perimeter	19.5 m

Following is the estimation of the design flood discharge made by using Manning's Formula with a coefficient of roughness being 0.04:

$$V = \frac{1}{n} R^{2/3} I^{1/2}$$

where V: Velocity of river(m/sec)
R: Hydraulic radius(m)
I: Slope

$$V = 1/0.04 \times 1.49^{2/3} \times (1/615)^{1/2}$$
$$= 1.315 \text{ m/sec}$$
$$Q = 29.1 \times 1.315 = 38.3 = 40 \text{ } m^3/\text{sec}$$

3) Design Flood Water Level

Design flood water level is estimated at EL199.0 m in consideration of the crest elevation of existing river dikes.

4) Design dimensions of diversion weir

i) Crest elevation of diversion weir

Crest elevation of diversion weir is measured as design intake water level and freeboard:

Crest EL = EL.198.40 + 0.10
= EL.198.50 m

ii) Sill elevation of gate portion

Sill elevation of gate portion is assumed equivalent to the bottom elevation of the river, i.e., EL.197.00 m.

iii) Weir length

The ratio in length of the ogee and the gate must be determined from the economic viewpoint and each portion should be long enough to release flood discharge.

Design flood discharge Q = 40 m^3/sec
Design flood water level EL.199.00 m

5) Length of ogee portion

L = 10 m
$q = C\ B\ H^{3/2}$

where q: Discharge per meter (m^3/sec/m)

C: Coefficient 1.7

B: Width 1.0 m

H: Overflow depth, EL.199.00 m - EL.198.50 m
= 0.50 m

$q = 1.7 \times 1.0 \times 0.5^{3/2} = 0.60\ m^3/sec/m$

$Q_1 = 10 \cdot q = 10 \times 0.6 = 6.0\ m^3/sec$

6) Length and discharge of gate portion

W = 1.5 m x 1 gate = 1.5 m

d: depth = 199.0 - 197.0 = 2.0 m

A: flow area = 1.5 x 2.0 = 300 m^2

P: water perimeter = 2.0 x 2 + 1.5 = 5.50 m

R: hydraulic radius = A/P = 0.545 m

I: slope = 1/60

Manning's Formula

$$V = \frac{1}{n} R^{2/3} I^{1/2}$$

$$= 1/0.015 \times 0.545^{2/3} \times (1/60)^{1/2}$$

$$= 5.75\ m/sec$$

$$Q_2 = 3.00 \times 5.75 = 17.2\ m^3/sec$$

$$2Q_2 = 2 \times 17.20 = 34.40\ m^3/sec$$

Total discharge = $Q_1 + Q_2$

$= 6.0 + 34.4 = 40.4\ m^3/sec > 40\ m^3/sec$

c) Irrigation Canals and Ditches

1) Canal capacity

The capacity of the respective canals and ditches, as

determined by the peak irrigation water requirement estimated in 3) of 3-2-2, is as follows:

Canals/ Ditches	Irrigation Area (ha)	Capacity (m^3/s)
Main Canal	61.0	0.119
Farm Ditch-1	0.6	0.014
Farm Ditch-2	2.0	0.016

The cross-section of farm ditches is determined by the following equation.

$$\text{Capacity } (q) = \left\{ (2.5 \text{ ha}/5 \text{ days} \times 10^4 \times 130 \times 10^{-3} + (2.5 - 0.5) \times 10^4 \times 7 \times 10^{-3} \right\} / (86{,}400 \times 0.54)$$

2) Canal section

i) Hydraulic calculation

The hydraulic calculation for the canals employs Manning Formula as follows:

$$Q = A\,V$$

$$V = \frac{1}{2} R^{2/3} I^{1/2}$$

where Q: Discharge (m^3/sec)
A: Flow area (m^2)
V: Average velocity (m/sec)
n: Roughness coefficient
R: Hydraulic radius (m)
I: Hydraulic gradient

ii) Maximum allowable velocity

The maximum allowable velocity in the canals depends upon the materials and lining method of the canals. Considering the canal materials to be used, the maximum allowable velocity in the canals at Bilar district is determined as follows:

Canal Type	Maximum Allowable Velocity (m/s)
Clay Earth	0.9
Concrete block (Concrete hallow block)	2.0

iii) Roughness coefficient (n)

The roughness coefficient as determined by the canal materials and lining method is estimated as follows:

Canal Type	Roughness Coefficient
Earth canal	0.030
Concrete block	0.015

iv) Freeboard (FB)

The freeboard of canals is determined by the following equation:

$$Fb = 0.05d + hv + 0.10$$

where Fb: Freeboard (m)
d: Water depth at design discharge(m)
hv: Velocity head, $v^2/2g$(m)

v) Standard cross-section

The table below illustrates the general dimensions of the respective canals obtained by the hydraulic calculation. The embankment slope is designed to be 1:1 judging from its height and materials.

The elevation of canal bottom is so determined that the water level of the respective canals and ditches should be kept at least 0.10 m above the ground surface of the field.

Canal Dimensions

Item	Main Canal		Farm Ditch-1	Farm Ditch-2
Lining	Concrete block		Earth	Earth
Peak Discharge (m^3/sec)	0.119		0.014	0.016
Roughness coefficient	0.015		0.030	0.030
Slope	1/3,700	1/200	1/200	1/200
Bottom width(m)	0.80	0.50	0.30	0.30
Water depth (m)	0.40	0.21	0.09	0.10
Freeboard (m)	0.20	0.19	0.21	0.20
Velocity (m/s)	0.37	1.11	0.38	0.40
Embankment height(m)	0.60	0.40	0.30	0.30

d) Drainage Canals and Ditches

1) Drainage capacity

The drainage capacity of the canals and ditches is calculated based on the drainage modulus of 6.6 lit/sec/ha as employed in Report on Detail Design of Bohol Integrated Agricultural Development. The drainage area covers about 100 ha including the experimental farm of 2.5 ha.

Drainage Capacity Q = 0.0066 x 100 = 0.66 m^3/s

2) Canal section

The canal section is derived from Manning's Formula

$$v = \frac{1}{n} R^{2/3} I^{1/2}$$

Allowable maximum velocity(earth canal)	0.9 m^2/s
Roughness coefficient (n)	0.030
Freeboard (Fb) Minimum	0.30 m
Slope	I = 1/2,000
Bottom width	B = 0.70 m
Water depth	d = 0.69 m
Water board	Fb = 0.31 m
Velocity	v = 0.69 m/s

e) Main Road and Farm Roads

i) The main road to be diverted from the National Highway No.3 will lead to the office for Japanese experts, the warehouse, and garage and is designed to be five-meter wide to allow for the transportation of farming equipment and materials by large dump trucks.

ii) Farm roads will be constructed around each farm plot to facilitate farm works and are designed to be three-meter wide to allow for the passage of tractors.

The following are road width and height from the field surface.

	Width (m)			Height	Pavement Width (m)
	Effective	Shoulder	Total	(m)	(thickness 0.15 m)
Main Road	4.0	0.5	5.0	0.4	4.0
Farm Road	2.0	0.5	3.0	0.3	2.0

3-2-3. Ubay

The experimental paddy farm at Ubay is planned to be located in the Bohol Experimental Station. As the water source for the irrigation of the farm, two alternative plans are proposed from the viewpoint of topographical conditions. The first is to heighten the dike of existing reservoir to raise the reservoir capacity and shift a pump station and a pipeline. The second is to make a new reservoir by constructing a dam on the creek running along the border of Experimental Station. The new and the old reservoirs will be connected by culverts and the conveyance facilities are the existing pump and pipeline.

a) Irrigation water requirement at paddy farm

i) Consumptive use

For the estimation of consumptive use of water by paddy, the data in the Feasibility Study on Bohol Integrated Agricultural Development Project will be employed since the district lacks in the relevant observation data. This Study reveals that the peak evapotranspiration takes place in April. However, since no definite cropping pattern for the farm has yet been proposed, an annual average value of 5.5 mm is adopted as daily consumptive use of water by paddy.

3) Percolation rate

Though no observation has been made on the percolation rate of the farm, since the soils of the proposed experimental farm consist of sandy loam, the percolation rate could be assumed to be 1.5 to 2.0 mm/day throughout the growing period of paddy. The design percolation rate is estimated at 2.0 mm/day considering that the farm is experimental.

4) Effective rainfall

Seventy percent of the annual rainfall will be proposed as the effective rainfall,i.e., in case of Ubay, the effective rainfall of 722 mm.

5) Water requirement for 2.0 hectares of farm

Water requirement for 2.0 hectares of a farm was estimated as follows:

Water Requirement $= 2.0 \times 10^4 \times 5.5 \times 10^{-3} \times 30$ days x 5 months x 2 times

$= 33{,}000\ m^3/year$

Effective Rainfall $= 2.0 \times 10^4 \times 722 \times 10^{-3} = 14{,}500\ m^3$

Net Water Requirement = Water Requirement - Effective Rainfall

$= 33{,}000 - 14{,}500 = 18{,}500\ m^3$

Gross Water Requirement = Net Water Requirement/(0.7 x 0.9)*

$= 29{,}000\ m^3$

Note * : The values of 0.7 and 0.9 are coefficients of field irrigation loss and conveyance loss, respectively.

b) Reservoir Capacity

1) First alternative

i) Dimensions of reservoir

Watershed area	A = 15.0 ha
Coefficient of runoff	f = 0.4
Annual Rainfall	R = 1,548 mm *

Evaporation from reservoir	Assumed to be equal to the rainfall on the reservoir
Effective rainfall for the experimental farm	$Re = 1,548 \times \frac{8}{12} \times 0.7$
	= 722 mm
High water level	EL 49.5 m
Effective reservoir capacity	30,000 m^3
Usable depth	1.5 m (EL 48.00 - 49.50 m)

Note *: Rainfall data at Ubay are available for four years from 1979 to 1982. Since the 1980 figure of 2,250 mm is 1.4 to 1.6 times higher than those in other years, this figure is excluded and Annual Rainfall refers to the three-year average(1979, 1981, and 1982)

ii) Inflow

$$Q_1 = \left\{ 15.0 - (3.17 + 1.65)^{1/} \times 1/2 \right\} \times 10^4 \times 1,548$$

$$\times 10^{-3} \times 0.4 \times 0.9^{2/} = 70,000 \ m^3$$

Note: 1/ The values of 3.17 and 1.65 are reservoir areas in hectares at high and low water level, respectively
2/ The leakage from the dam body and reservoir area is assumed to be ten percent of the maximum reservoir capacity

The above estimation reveals that the inflow is more than twice as much as the net water requirement. Therefore, the dike of existing reservoir will be heightened in order to store the net water requirement of 29,000 m^3.

2) Second alternative

i) Dimensions of reservoir

Watershed area	A = 50.0 ha
Coefficient of runoff	f = 0.4

Annual Rainfall	R = 1,548 mm
Evaporation from reservoir	Assumed to be equal to the rainfall on the reservoir(same as First alternative)
Effective rainfall for the experimental farm	$Re = 1,548 \times \frac{8}{12} \times 0.7$ = 722 mm (same as First alternative)
High water level	EL 48.3 m
Effective reservoir capacity	34,300 m^3
Usable depth	1.8 m (EL 46.50 - 48.30 m)

ii) Inflow

$$Q_1 = \left\{ 50 - (3.2 + 0.8) \times 1/2 \right\} \times 10^4 \times 1,548 \times 10^{-3} \times 0.4 \times 0.9 = 267,000\ m^3$$

The above estimation assures that the reservoir capacity is large enough to store the inflow which is more than seven times as much as the net water requirement.

c) Spillway

1) Design flood discharge

There are no long-term data available on the discharge and rainfall in Ubay district that make possible the estimation of design flood discharge. The flood discharge is, therefore, estimated based on the following formulas commonly used in the Philippines. In due consideration of the importance of dam, effects on the downstream area as well as economic aspect, the third formula for occasional discharge is applied for the estimation.

$$Q_p = 235\ A/(A + 22)^{1/2} \quad \text{(Extreme)}$$

$$Q_p = 155\ A/(A + 13)^{1/2} \quad \text{(Rare)}$$

$$Q_p = 85\ A/(A + 11)^{1/2} \quad \text{(Occasional)}$$

$$Q_p = 50\ A/(A + 9)^{1/2} \quad \text{(Frequent)}$$

where Qp : Peak discharge (m^3/sec)
A : Watershed area (km^2)

$$Qp : 85 \times 0.15/ (0.15 + 11)^{1/2} = 3.82\ m^3/sec.$$

For both alternatives, the reservoir area is larger than the watershed area, which implies that the flood discharge is stored temporarily in the reservoir and that the discharge from spillway becomes smaller than the peak flood discharge.

i) First alternative

$$Q_p = 85\ A/(A + 11)^{1/2} = 85 \times 0.15/(0.15 + 11)^{1/2}$$
$$= 3.82\ m^3/sec$$

Overflow depth	0.3 m
Overflow level	EL 49.80 m
Reservoir area at EL 49.80	4.0 ha
Reservoir capacity at EL 49.50 to 49.80 m	10,700 m^3
Total discharge when peak discharge continues for 1 hour	13,800 m^3
Capacity effect	10,700/13,800 = 77 %
Design flood discharge	3.82 x (1 - 0.77) = 1.0 m^3/sec

ii) Second alternative

$$Q_p = 8.97\ m^3/sec$$

Overflow depth	0.5 m
Overflow level	EL 48.80 m
Reservoir area at EL 48.80	4.5 ha
Reservoir capacity at EL 48.30 to 48.80 m	19,200 m^3
Total discharge when peak discharge continues for 1 hour	32,300 m^3
Capacity effect	19,200/32,300 = 59 %
Design flood discharge	8.97 x (1 - 0.59) = 3.68 m^3/sec

2) Overflow depth and width of crest

In general, the open type spillway is designed for the fill type dam for the prevention of overtopping due to unexpected floods. The reservoir at the district will also adopt the overflow type spillway in view of the safety of dam and the limited flood discharge. The dam crest will be used as a maintenance road for the farms in Bohol Experimental Station.

i) First alternative

Overflow depth	0.3 m
Spillway design discharge	$Q = C\ B\ H^{3/2}$

where

C: Coefficient

B: Width of crest(length of weir)

H: Overflow depth 0.3 m

$Q = 1.0 \times 1.7 \times B \times 0.3^{3/2}$ B= 4.0 m

$= 1.0 \times 1.7 \times 4.0 \times 0.3^{3/2} = 1.12$ (m^3/sec)

Crest elevation = high water level + overflow depth + freeboard

= EL 49.5 + 0.3 + 0.5

= EL 50.3 m

ii) Second alternative

Overflow depth 0.5 m

Spillway design discharge 3.68 m^3/sec

$B = 3.68/1.7 \times 0.5^{3/2} = 6.0$ m

Crest elevation = EL 48.3 + 0.5 + 0.5

= EL 49.3 m

d) Construction cost

The following is the comparison in Pesos of the construction costs between the two alternative plans:

Item	First alternative	Second alternative
Dam body	₱ 167,900	₱ 126,700
Spillway	87,000	135,000
Connecting culvert	-	10,000
Pump station	35,000	-
Other expenses	148,000	126,500
Total	₱ 446,700	₱ 398,200

Second alternative will be adopted since its construction cost is 12 percent lower than that of First alternative.

CHAPTER IV. CONSTRUCTION METHOD AND PLAN

4-1. Construction Method

The project components involve the construction of the tubewell, pump station, diversion weir, irrigation and drainage canals, roads,land reclamation, and reservoir. However, since the amount of each work is small and the construction sites are scattered, there will not be any private contractors who take interest in the works and the contractor, even if any, will be a small one with insufficient number of engineers, limited construction equipment as well as capital. Problems are likely to be brought about during the course of construction and a satisfactory work is not assured.

On the other hand, most of the construction of small scale irrigation projects in the Philippines are carried out on the force account basis by local offices of NIA and, in case of Bohol, the local NIA office with engineers and sufficient construction equipment directly manage the construction of Communal Irrigation facilities.

Under the circumstance, it is most desired that NIA will execute the construction works using its own engineers and equipment.

4-2. Construction Plan

4-2-1. Excavation

Land reclamation works for the farm will be undertaken by 11-ton class bulldozers class and the earth materials removed by the land levelling and the excavated earth of drainage canals will be used for the embankment of irrigation canals and roads. The excavation works for irrigation and drainage canals will be carried

out by manpower. Excavation of rocks located in the proposed farm at Bilar will be done by equipment or manpower down to 30 cm deep from the designed farm land level.

4-2-2. Embankment and Backfill

As mentioned above, the embankment of irrigation canals and roads will be filled with excavated earth. The embankment materials will be loaded by 1.4-m^3 class tractor shovel and transported by dump trucks of 6 ton class. Spreading and compaction of the materials will be taken care by 11-ton class bulldozers whereas backfilling of the materials for the main irrigation canal and related structures will be carried out by manpower.

On the other hand, the backfill of the downstream area(weathered due to flood discharge) of the existing diversion weir of the Bilar river will be undertaken with earth materials transported from the borrow-pit about 600 m away from the area. In this case, 6 ton dump trucks will be used in combination with 1.4-m^3 class tractor shovels.

4-2-3. Concrete Works

Concrete will be produced using 0.3-m^3 class portable mixer.

4-2-4. Concrete Block Works

In view of the location of borrow-pit where sands and gravels are collected, concrete blocks to be used for the main irrigation canal will be prepared at a place about 100 km east of Bilar farm and carried to the work sites by trucks. Blocks are piled up onto the base concrete and reinforced with steel bars. The inside of blocks are covered by mortar to avoid the leakage and reduce the roughness coefficient.

4-2-5. Construction Schedule

a) Dao

The construction works at Dao cover excavation of tubewell, installation of pump station, land reclamation, and construction of farm roads. The construction period will be determined primarily by the works involved in the installation of pump and is proposed to be about three months.

b) Bilar

The construction works at Bilar involve diversion weir, irrigation and drainage canals, and land levelling and the period will be determined primarily by the diversion weir and is proposed to be about five months.

c) Ubay

The construction works at Ubay consist of dam embankment, spillway works, and connecting culvert, etc, and the period will be determined by the works involved in the first two structures and is proposed to be about five months.

CHAPTER V. ESTIMATION OF CONSTRUCTION COST

5-1. Conditions for Cost Estimation

The cost estimation is made on the following conditions:

5-1-1. Coverage of Cost Estimation

No account is taken of the cost of land acquisition & compensation and construction supervision.

5-1-2. Unit Price

All unit prices comprise those of components such as materials, laborers, construction equipment, and all others required to complete the construction.

5-1-3. Scope of Construction Works

a) The works under the section "Preparatory Work" in the Bill of Quantity mainly include the following:

- Preparation and restoration of work site
- Survey works
- Transportation, assembly, and removal of construction equipment and machinery
- Construction and removal of contractor's workshops and camps for its staffs and laborers
- Construction and removal of access roads
- Installation and removal of equipment necessary for drainage of work site

b) The works under the section "Diversion Weir" in the Bill of Quantity mainly include the following:

- Demolition of existing structures
- Cofferdam of upper and lower stream
- Temporary diversion canal
- Temporary road
- Construction of diversion weir
- Flash gate and intake gate
- Protection of dikes

c) The works under the section "Main Irrigation Canal" in the Bill of Quantity mainly include the following:

- Gravel foundation
- Concrete work
- Concrete block work
- Embankment

d) The works under the section "Land Consolidation" in the Bill of Quantities include the irrigation and drainage canals, roads, land levelling, and rock excavation and removal.

e) The works under the section "Land Reclamation" in the Bill of Quantities include the excavation and removal of rocks and gravels and the construction of roads and related structures.

f) The works under the section "Upland Irrigation" in the Bill of Quantities include the excavation of tubewell and the installation of pump and conveyance pipe.

5-2. Construction Cost

5-2-1. Unit Cost

The construction cost of the experimental farms at Dao, Bilar, and Ubay was estimated on the basis of the prevailing unit costs as of January, 1983. The labor cost is estimated on the basis of the wage rate adopted by NIA of laborers for every type of job.

5-2-2. Overhead Cost

Overhead cost consists of taxes, administration, and profit, and for a contractor this accounts for 28.45 percent of the total cost and 40 percent of the direct cost. In case of NIA, the overhead cost is decreased to 13.45 percent of the total cost and 16 percent of the direct cost. In case of a contractor, the difference in percentages of the total cost, i.e., 15 percent is the profit.

5-2-3. Contingency

Contingency is allocated in the total cost to cover minor differences in estimated and actual quantities, unforeseeable difficulties in construction, possible changes in the plan because of site conditions, or uncertainties regarding foundation conditions. The allocation of contingency is 10 percent of the direct cost plus overhead cost.

5-2-4. Price Escalation

Price escalation is allowed for 15 percent per annum of the total cost which includes the direct cost, overhead cost and contingency.

5-2-5. Total Cost

On the assumption that the works will be undertaken by NIA, the total cost including the price escalation during the construction period is estimated at ₱1,877,460 and is equivalent to ¥46,936,000. Tables 2 and 3 show the breakdown of the total construction cost by major items.

Total Cost

	₱	¥
Dao and Bilar	1,449,900	36,247,000
Ubay	427,560	10,689,000
Total	1,877,460	46,936,000

TABLES

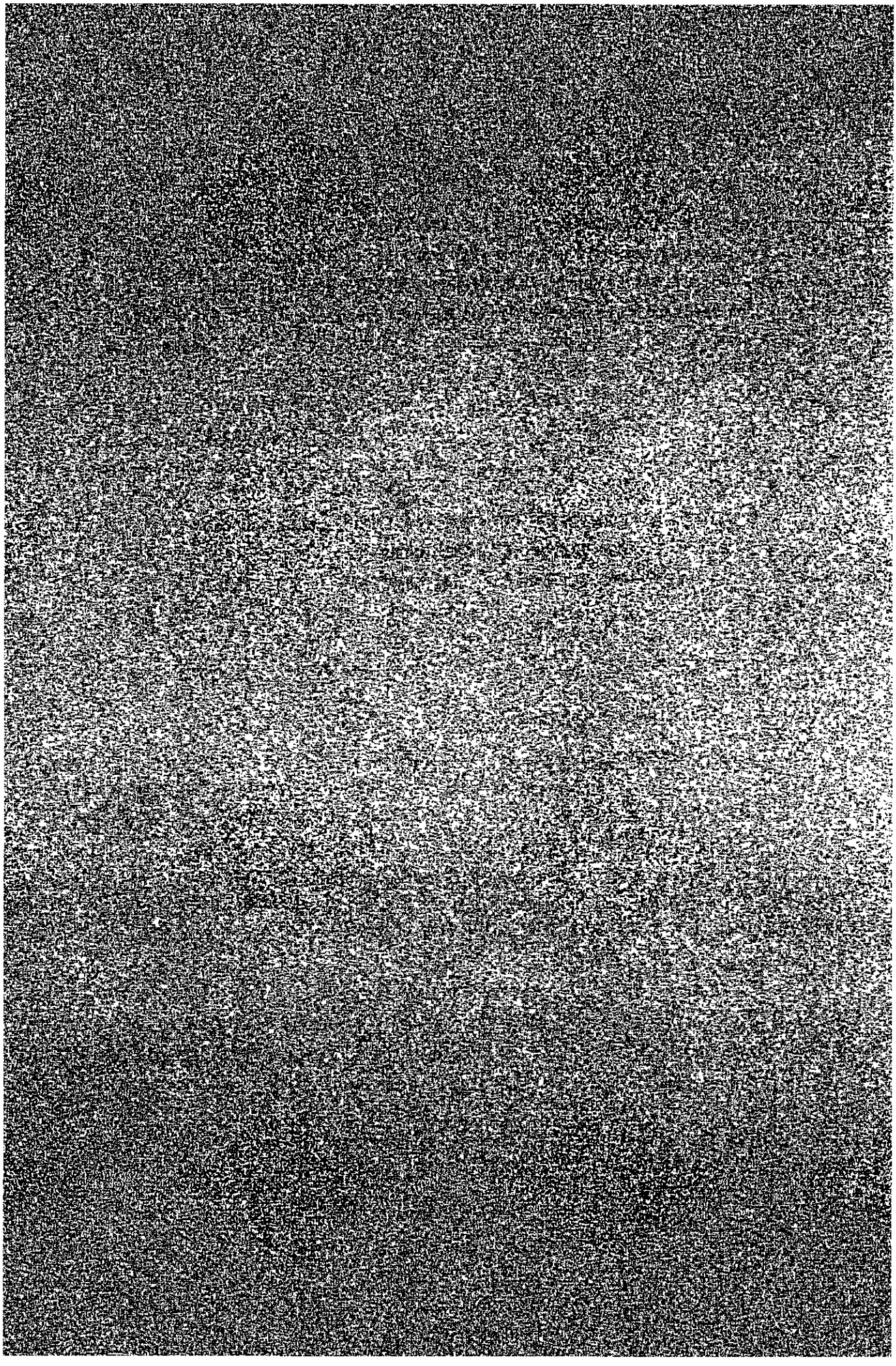


Table-1. Monthly Total Rainfall

Place: Tagbilaran
Unit: mm

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1980	144.5	31.6	12.3	88.3	31.6	217.9	113.7	145.0	53.6	225.3	274.0	98.9	1,436.7
1981	110.1	82.3	7.2	11.1	90.5	64.0	49.2	57.2	188.5	174.7	83.0	184.9	1,102.7
1982	31.0	100.8	103.1	47.0	88.9	132.2	104.1	92.8	92.1	47.2	93.3	109.7	1,042.2
Mean	95.2	71.6	40.9	48.8	70.3	138.0	89.0	98.3	111.4	149.1	150.1	131.2	1,193.9

Place: Bilar

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1976	171.7	105.2	38.9	15.4	146.4	333.0	168.4	180.3	223.2	129.7	125.2	187.5	1,824.9
1977	49.0	179.2	74.6	4.6	124.6	294.9	387.7	324.5	204.8	191.8	337.3	45.5	2,218.4
1978	269.3	68.2	14.8	44.5	108.0	402.7	134.7	152.9	461.5	259.6	127.1	152.4	2,195.7
1979	138.6	49.6	17.2	90.9	126.1	445.6	214.1	149.7	127.8	221.6	98.9	126.6	1,806.7
1980	208.8	43.6	6.9	63.5	44.0	410.2	232.8	249.1	285.9	473.9	228.4	217.5	2,464.4
1981	141.7	77.7	15.3	20.1	71.1	130.2	124.2	73.8	155.0	268.6	207.2	303.6	1,589.1
1982	160.8	81.2	373.4	46.8	220.6	202.0	182.8	144.0	143.5	203.6	136.3	59.6	1,954.6
Mean	162.8	86.4	77.3	40.8	121.0	316.9	206.4	182.0	228.8	249.8	180.1	156.1	2,007.7

Place: Ubay

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1979	111.5	31.3	19.4	43.5	194.4	270.0	144.7	237.1	238.5	114.3	141.3	121.2	1,567.2
1980	293.4	120.3	11.5	37.8	10.36	246.1	127.9	292.1	199.3	402.4	145.3	270.1	2,249.8
1981	252.4	60.5	71.4	15.9	134.6	74.6	130.4	17.0	141.24	180.0	120.6	220.3	1,418.94
1982	95.4	106.32	263.4	28.0	169.8	136.4	290.7	251.72	84.8	76.4	65.7	89.5	1,658.14
Mean	188.2	79.6	91.4	31.3	150.6	181.8	173.4	174.5	166.0	193.3	118.2	175.3	1,723.5

Table-2. Construction Cost of the Experimental Farm
(Dao and Bilar)

1. Direct Cost

A. Dao

A-1.	Preparatory works	₱ 4,700
A-2.	Land reclamation(1ha)	45,294
A-3.	Irrigation facilities for upland fields	151,200
	Sub-total	201,194

B. Bilar

B-1.	Preparatory works	59,500
B-2.	Diversion works	(340,721)
B-3.	Main Irrigation canal	161,772
B-4.	Land consolidation	224,927
	Sub-total	786,920
	Total	988,114

2.	Overhead Cost	(16%)	158,086	(40%)	395,286
3.	Contingency	(10%)	114,600	(10%)	138,300
4.	Price Escalation	(15%)	189,100	(15%)	228,200
	Sub-total		461,786		761,786
	Grand Total		₱1,449,900		₱1,749,900
	(Conversion rate ₱ = ¥25.0)		¥36,247,000		¥43,747,000

Note: 1) NIA has been requested to undertake Diversion works
2) 16% refers to the case of force account basis by NIA

Table-3. Construction Cost of the Experimental Farm (Ubay)

1. Ubay

1-1. Preparation				₱ 19,950
1-2. Dam				95,710
1-3. Spillway				152,310
1-4. Connecting Culvert				23,400
Sub-total				291,370
2. Overhead Cost	(16%)	46,620	(40%)	116,550
3. Contingency	(10%)	33,800		40,790
4. Price Escalation(15%)		55,770		67,300
Sub-total		136,190		224,640
Total		₱ 427,560		₱ 516,010
₱ = ¥25.0		¥10,689,000		¥12,900,000

Table-4. Labor Wages and Material Prices

1. Labor Wages

Unskilled Labor	per day	₱ 30.00
Skilled Labor		37.00
Driver(truck)		60.00
Operator(heavy equipment)		70.00
Carpenter		42.00
Foreman		55.00

2. Material Prices

Cement(₱40.00/40kg)		per ton	₱ 1,000.00
Sand(good grade)		per cu. m	170.00
Gravel(size 5-30 mm)		- do -	150.00
Steel Bar(deform 10-16 mm)		per ton	7,000.00
Concrete Pipe(reinforced by steel bars)			
	ϕ200 mm	per m	80.00
	ϕ300		120.00
	ϕ400		170.00
	ϕ500		230.00
	ϕ600		270.00
	ϕ800		425.00
	ϕ1,000		670.00
Concrete Block	$10^{cm} \times 20^{cm} \times 40^{cm}$	piece	3.00
	$15^{cm} \times 20^{cm} \times 40^{cm}$		4.50

Table-4. Labor Wages and Material Prices(continued)

3. Unit Cost

Form Works(per concrete one cu.m)		370.00
Concrete with Form Works (1:2:4)		
with steel bar	cu.m	1,400.00
without steel bar		1,100.00
Concrete with Form Works (1:3:6)		
with steel bar	cu.m	1,250.00
without steel bar		1,000.00
Road paving gravel(limestone)	cu.m	100.00
Mortar (1:2.5)		1,240.00

TABLE – 5 CONSTRUCTION SCHEDULE FOR APC

(DAO AND BILAR)

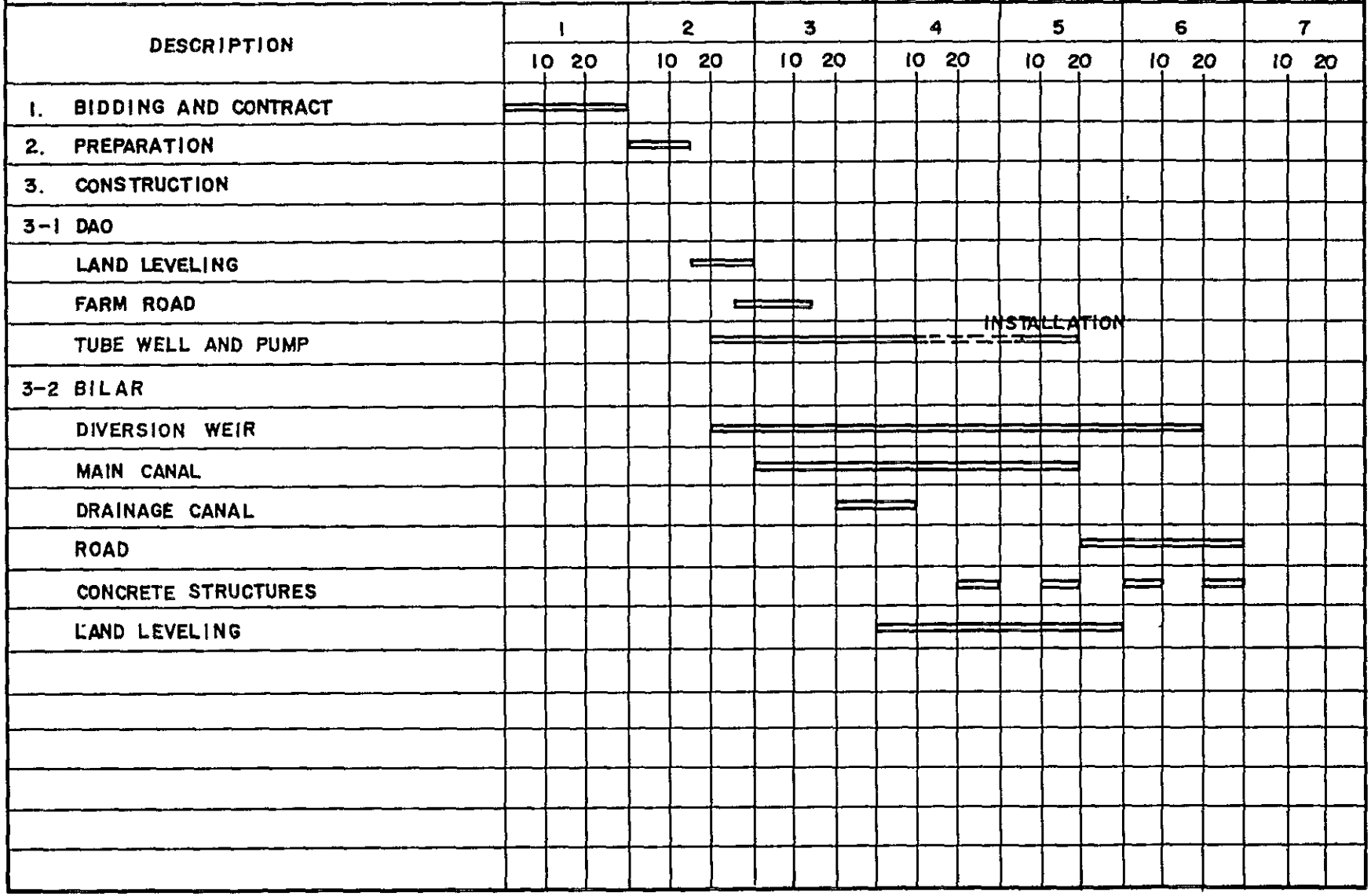


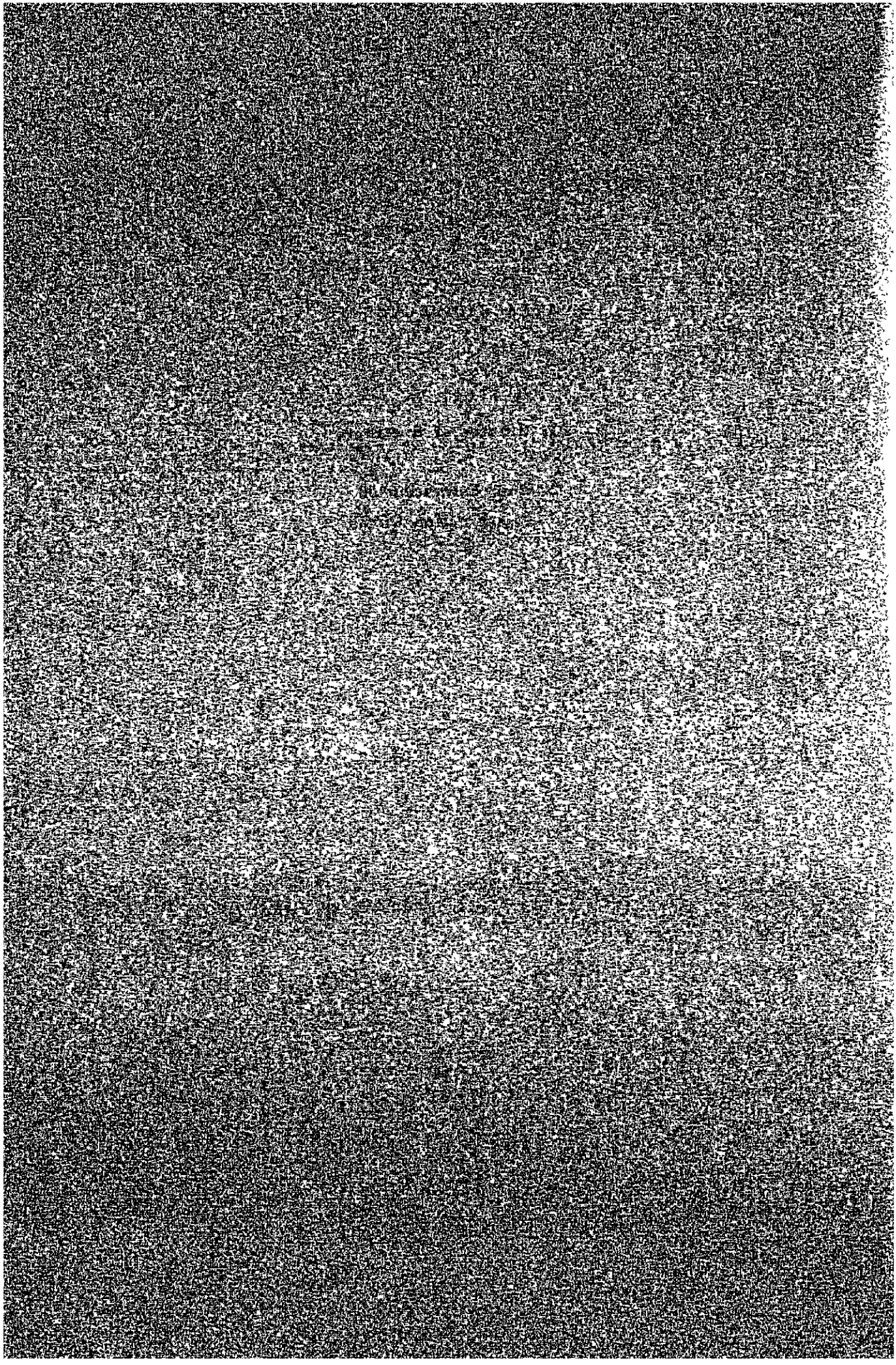
TABLE – 6 CONSTRUCTION SCHEDULE FOR APC (UBAY)

DESCRIPTION	1		2		3		4		5		6		7	
	10	20	10	20	10	20	10	20	10	20	10	20	10	20
1. BIDDING AND CONTRACT														
2. PREPARATION														
3. CONSTRUCTION														
3–1 DIKE EMBANKMENT														
STRIPPING OF FOUNDATION & BORROW														
AREA														
EMBANKMENT														
GRAVEL PAVING OF CREST														
3–2 SPILLWAY														
EXCAVATION														
CONCRETE PLACING														

ATTACHED DOCUMENTS

1. Minutes of Meetings

2. Cost Estimation of
Construction Works



1. Minutes of Meetings

January 6, 1983

1. Location: NACIAD Office
2. Participants:

NACIAD	Reynaldo E. Desagon, Director
	Maurice Feliciano, Deputy Director
	Jonathan Orozco, Agricultural Engineer
	Israel Carlos, Director for Planning
SANYU	Koichi Inoue, Team Leader
	Toshio Yokoi, Design Engineer

3. Minutes:

1) Explanation of Inception Report
2) Explanation of Survey Schedule
3) Requests of Counterparts
4) Schedule of Japanese Survey Mission

January 11, 1983

1. Location: Bohol Agricultural College
2. Participants:

Provincial Development Staff		Domingo
NIA		
Bohol Agricultural College		Mateo Limbgo, Superintendent II
SANYU	Koichi Inoue	
	Toshio Yokoi	

3. Minutes:

Change of the site for the proposed experimental farm: The previous Japanese Survey Team proposed a site for Bilar experimental farm in the northeastern part of experimental farm of Agricultural College, however, the area has much irregularities which leads to high costs of the land consolidation and also is far away from the water source which makes the water management rather difficult. Therefore, a part of areas closest to the water source and currently used as paddy field was proposed and approved by the College. The formal procedures regarding this were to be discussed after the Japanese Survey Mission arrived.

January 23, 1983

1. Location: NIA Office
2. Participants:

NIA	
Japanese Survey Mission	Toyoshima
SANYU	Koichi Inoue
	Toshio Yokoi

3. Minutes:

1) Explanation of design plan for Dao, Bilar, and Ubay farms

a) Dao

No water source development plan will be made for Dao farm where upland crops are to be experimented. The farm of 50 m x 200 m (1.0ha) will be located along a city road and farm roads are designed on all sides of the farm.

b) Bilar

Irrigation water will be supplied through a diversion weir from the Bilar river as the water source. The existing weir will not be utilized due to the deterioration and will be replaced with a new one to be constructed at the same site. The main canal will be constructed on the existing one and the farm ditches will be relocated or newly constructed. The farm covers in principle an area of 2 ha, but due to topographical conditions includes an adjacent area of 0.5 ha. The road leading to the temporary living quarter will be 5 m wide and other farm roads 3 m wide. The temporary quarter, warehouse, and garage will be planned alongside the farm.

c) Ubay

Ubay farm will make use of a part of paddy fields of about 4 ha currently used as Bohol Experimental Station. The irrigation water is pumped up from the reservoir located in the Station. The storage capacity of the reservoir is inadequate and the augmentation of the capacity was proposed.

2) Mr. Toyoshima was of an opinion that further consideration be given to the selection of the proposed site for Dao farm since the living quarter for Japanese experts will be located in the same area.

January 28, 1983

1. Location: NIA Office

2. Participants:

NIA	
Local Contractor	J. Digal Construction (Tagbilaran)
SANYU .	Koichi Inoue

3. Minutes:

Expenses to be incurred by contractor out of the contracted costs of construction

a) In case a contractor undertakes the construction:

tax	3.45% of the contracted amount
preparatory cost	5.0 %
office expenses	10.0 %
profit	15.0 %
total	33.45%

relative to direct cost

50.3 %

b) In case NIA undertakes the construction:

tax	3.45% of the contracted amount
preparatory cost	5.0 %
office expenses	10.0 %
profit	-
total	18.45%

relative to direct cost

22.6 %

February 1, 1983

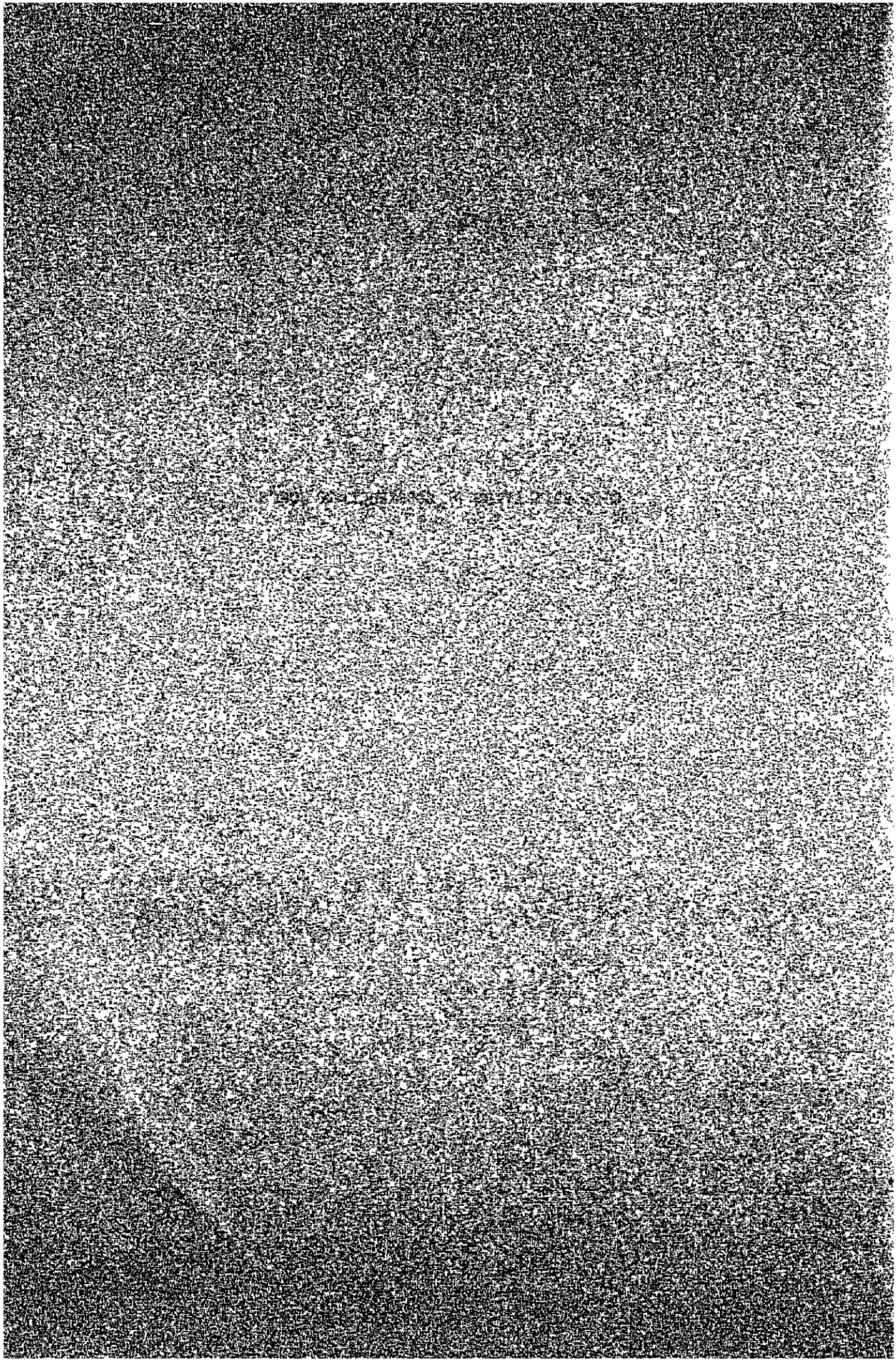
1. Location: NACIAD
2. Participants:

NACIAD	Reynaldo E. Desagon
	Maurice Feliciano
PDS	
NIA	
SANYU	Koichi Inoue
	Toshio Yokoi

3. Minutes:

1) Explanation of design plan for farms and related structures.
2) Japanese Survey Mission pointed out the necessity of constructing irrigation facilities at Dao farm. The irrigation by groundwater was proposed. PDS and NIA participants expected no objection from the local people of Tagbilaran since the groundwater will be pumped up only for upland field irrigation.
3) Team leader mentioned that since the construction cost(estimated)is high, the Japanese financial assistance may not necessarily cover the whole amount and depending on the budget to be allocated, the construction period may be extended over two years. Therefore, the final decision has to be made after the Design Team returns to Japan and holds a discussion with the Ministry of Foreign Affairs.
4) JICA mentioned that details of Final Report would be determined after the Team returns to Japan.

2. COST ESTIMATION OF CONSTRUCTION WORKS



ABSTRACT OF TENDER

No. of B.Q.	Description	Pesos
D-BQ-1	Preparation	6,900
D-BQ-2	Land Reclamation	66,460
D-BQ-3	Tubewell and Related Structures	221,860
	Sub-total	295,220
B-BQ-1	Preparation	87,300
B-BQ-2	Diversion Weir	499,950
B-BQ-3	Main Canal	237,370
B-BQ-4	Land Consolidation	330,060
	Sub-total	1,154,680
	Total	1,449,900
U-BQ-1	Preparation	29,270
U-BQ-2	Dam Body	140,450
U-BQ-3	Spillway	223,500
U-BQ-4	Connecting Pipeline	34,340
	Sub-total	427,560
	Grand-total	1,877,460

D-BQ-1. Preparation

Unit: Peso

Item	Description	Unit	Quantity	Unit Cost	Amount	Remarks
D-01	Survey for land reclamation and roads.	L.S			1,500	
D-02	Contructor's camp and accessories	L.S			3,200	
	Total				4,700	

D-BQ-2. Land Reclamation

Unit: Peso

Item	Description	Unit	Quantity	Unit Cost	Amount	Remarks
D-11	Clearing and land reclamation of farm	ha	1.0	20,000	20,000	
D-12	Embankment of road	cu.m	380	23	8,740	
D-13	Gravel paving (thickness 15 cm, width 2.0 m)	cu.m	120	118	14,160	
D-14	Drainage ditch	cu.m	70	15	1,050	
D-15	Drainage pipe (R.C. pipe ϕ200 m, L=1.0 m)	pcs	16	84	1,344	
	Total				45,294	

D-BQ-3. Tubewell and Related Structures

Unit: Peso

Item	Description	Unit	Quantity	Unit Cost	Amount	Remarks
D-21	Deep well (D=200mm H=70m) including pumping test	Place	1		28,000	
D-22	Casing (Steel pipe D=150mm 19.8kg/m H=60m)	set	1		31,000	
D-23	Screen (Jonson type)	m	10	1,200	12,000	
D-24	Submersible motor pump (ϕ40mm 5.5 KW) & Pressure tank	set	1		52,400	
D-25	Pumping house (reinforced concrete block t=0.15m)	sq.m	7.5	1,000	7,500	
D-26	Irrigation facilities (Galvanized pipe, P.V.C. pipe, Hydrant & etc.)	L.S			17,200	
D-27	Electric facilities	L.S			3,100	
	Total				151,200	
	Grand Total				201,194	

B-BQ-1. Preparation

Unit: Peso

Item	Description	Unit	Quantity	Unit Cost	Amount	Remarks
B-01	Survey for diversion weir, canals, roads and farm land	L.S			3,000	
B-02	Access road	L.S			15,000	
B-03	Coffer dams for Bilar river	L.S			13,500	
B-04	By-pass canal	L.S			22,000	
B-05	Dewatering	L.S			6,000	
	Total				59,500	

B-BQ-2. Diversion Weir

Unit: Peso

Item	Description	Unit	Quantity	Unit Cost	Amount	Remarks
B-11	Earth excavation	cu.m	230	15	3,450	
B-12	A-Concrete	cu.m	75	1,400	105,000	
B-13	B-Concrete	cu.m	125	1,000	125,000	
B-14	Reinforced concrete pipe (ϕ600mm L=1.0m)	pcs	5	342	1,710	
B-15	Stone masonry with concrete (t=300mm, B=2.83m)	m	105	204	21,420	
B-16	Backfill (Structure)	cu.m	140	15	2,100	
B-17	Embankment (Earth)	cu.m	180	31	5,580	
B-18	Backfill (Dike protection)	cu.m	273	31	8,463	
B-19	Hand rail (Steel pipe ϕ1-1/4')	m	9.0	90	810	
B-20	Gate (Scouring sluice) (H=1.5m W=1.6m)	set	2	20,000	40,000	
B-21	Gate (Intake) (H=0.6m W=0.6m)	set	1	12,000	12,000	
B-22	Screen (1.0mx1.26m)	set	1	2,000	2,000	
B-23	Weep hole (PVC pipe ϕ50mm)	pcs	8	10	80	
B-24	Water stop (b=200mm)	m	67	84	5,628	
B-25	Expansion material (t=1cm)	sq.m	20	104	2,080	
B-26	Demolition of existing structure	cu.m	45	120	5,400	
	Total				340,721	

B-BQ-3. Main Canal

Unit: Peso

Item	Description	Unit	Quantity	Unit Cost	Amount	Remarks
B-31	Embankment	cu.m	490	23	11,270	
B-32	Gravel	cu.m	120	118	14,160	
B-33	Type-A Main canal (0.8m x 0.60m)	m	159	268	42,612	
B-34	Type-B Main canal (0.5m x 0.4m)	m	233	311	72,463	
(Appurtenant Structure)						
B-35	Road crossing					
B-35-1	Earth excavation	cu.m	30	15	450	
B-35-2	Gravel	cu.m	3	118	354	
B-35-3	A-Concrete	cu.m	8	1,400	11,200	
B-35-4	Reinforced concrete pipe (ϕ800mm, L=1.0m)	pcs	8	525	4,200	
B-35-5	- ditto - (ϕ600mm, L=1.0m)	pcs	6	342	2,052	
B-35-6	-ditto - (ϕ300mm, L=1.0m)	pcs	10	162	1,620	
B-35-7	Sand bed	cu.m	7	176	1,232	
B-35-8	Wooden stop log	cu.m	0.03	5,300	159	
	Sub-total				21,267	
	Total				161,772	

B-BQ-4. Land Consolidation

Unit: Peso

Item	Description	Unit	Quantity	Unit Cost	Amount	Remarks
B-41	Land reclamation and Leveling of paddy field	ha	2.5	54,000	135,000	
(Appurtenant Structure)						
B-42-1	Gravel	cu.m	7	118	826	
B-42-2	A-Concrete	cu.m	5	1,400	7,000	
B-42-3	B-Concrete	cu.m	5	1,000	5,000	
B-42-4	Reinforced concrete pipe (ϕ100mm, L=1.0m)	pcs	40	76	3,040	
B-42-5	- ditto - (ϕ300mm, L=1.0m)	pcs	30	162	4,860	
B-42-6	- ditto - (ϕ600mm, L=1.0m)	pcs	5	342	1,710	
B-42-7	Wooden stop log	cu.m	0.06	5,300	318	
B-42-8	Embankment by manpower	cu.m	17	15	255	
	Sub-total				23,009	
B-43	Road					
B-43-1	Embankment by machine	cu.m	950	23	21,850	
B-43-2	Gravel paving	cu.m	251	118	29,618	
	Sub-total				51,468	
B-44	Canal					
B-44-1	Excavation (Earth)	cu.m	240	15	3,600	
B-44-2	Excavation (Rock)	cu.m	90	100	9,000	
B-44-3	Embankment by manpower	cu.m	190	15	2,850	
	Sub-total				15,450	
	Total				224,927	
	Grand Total				786,920	

U-BQ-1. Preparation

Unit: Peso

Item	Description	Unit	Quantity	Unit Cost	Amount	Remarks
U-01	Survey for profiles on dam axis and spillway	L.S			450	
U-02	Coffer dam and dewatering	L.S			4,500	
U-03	Contractor's camp and accessories	L.S			15,000	
	Total				19,950	

U-BQ-2. Dam Body

Unit: Peso

Item	Description	Unit	Quantity	Unit Cost	Amount	Remarks
U-11	Clearing of Surface	sq.m	2,500	3	7,500	
U-12	Foundation excavation (Earth)	cu.m	380	23	8,740	
U-13	Dam embankment	cu.m	1,520	33	50,160	
U-14	Filter	cu.m	54	200	10,800	
U-15	Riprap	sq.m	195	56	10,920	
U-16	Toe rocks	cu.m	20	157	3,140	
U-17	Gravel paving on dam crest	cu.m	25	118	2,950	
U-19	Surface leveling	sq.m	300	5	1,500	
	Total				95,710	

U-BQ-3. Spillway

Unit: Peso

Item	Description	Unit	Quantity	Unit Cost	Amount	Remarks
U-21	Stripping	cu.m	30	15	450	
U-22	Excavation (Earth)	cu.m	150	23	3,450	
U-23	A-Concrete	cu.m	85	1,400	119,000	
U-24	B-Concrete	cu.m	20	1,000	20,000	
U-25	Backfill	cu.m	50	15	750	
U-26	Weep hole (PVC pipe ϕ50mm)	pcs	50	10	500	
U-27	Grouted riprap	sq.m	40	204	8,160	
	Total				152,310	

U-BQ-4. Connecting Pipeline

Unit: Peso

Item	Description	Unit	Quantity	Unit Cost	Amount	Remarks
U-31	Excavation (Earth)	cu.m	50	30	1,500	
U-32	Reinforced concrete pipe (ϕ600mm L=1.0m)	pcs	20	342	6,840	
U-33	A-Concrete	cu.m	1	1,400	1,400	Inlet and outlet
U-34	B-Concrete	cu.m	5	1,000	5,000	
U-35	Backfill (Earth)	cu.m	44	15	660	
U-36	Motor (7.5 KW)	No.	1	4,000	4,000	
U-37	Electric facilities	L.S			4,000	
	Total				23,400	
	Grand Total				291,270	