REPUBLIC OF THE PHILLIPPINES

DETAIL DESIGN REPORT

ON

TRIAL FARM

FOR

DIVERSIFIED CROPS IRRIGATION ENGINEERING PROJECT

(D. C. I. E. P)

AUGUST 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

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Preface

The Government of the Philippines, since nearly achieved its target in rice self-sufficiency, has been taking a policy positively to enable the farmers to increase their income by crop diversification with upland crops introduced as the second crops to paddy cropping.

In accordance with said policy, the Government of the Philippines, requested the Government of Japan to extend the technical cooperation in the development project of upland irrigation technology.

In response to the request, both the governments confirmed the project in signing the Record of Discussion on the matter on May 28, 1987 to start the five-year long technical cooperation.

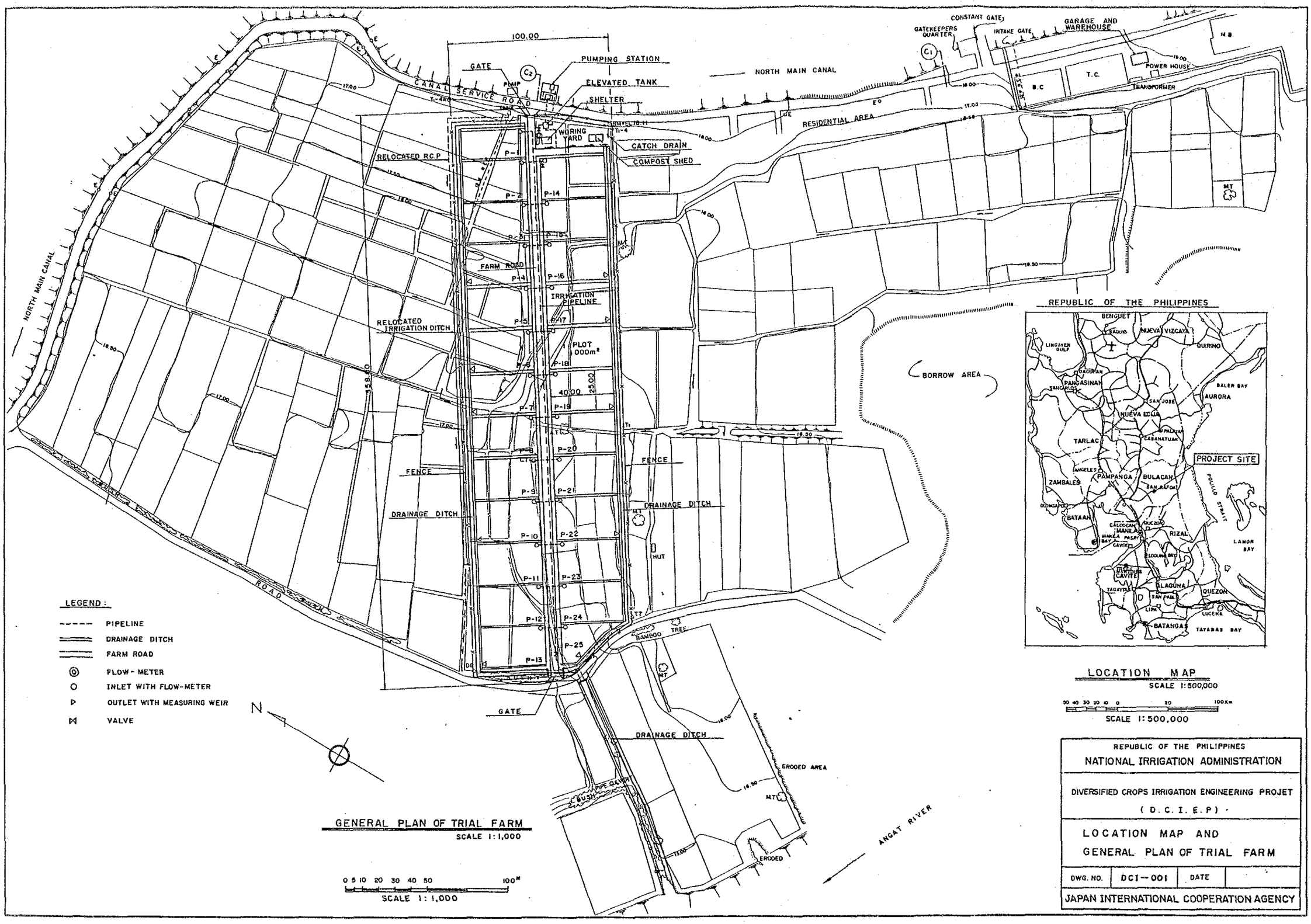
Since some trial farms for technical development are required indispensably for successful implementation of the Project, the Government of Japan dispatched a detail design survey team, headed by Mr. Yuji Sakamoto, Deputy Manager of the Design Division, Agricultural Structue Improvement Bureau, the Ministry of Agriculture, Forestry and Fisheries, in order to carry out the detail design of the land consolidation of the trial farms.

The Report presented herein covers the results of the field survey and home office studies to be utilized desirably as guideline for effective execution of the farm land consolidation works of the future model infrastructure program.

Finally, we wish to express our most sincere thanks to those officials and personnel concerned in extending the closest cooperation to the study team.

August 1987

Kazumi Miyamoto
Manager of Agricultural
Development Cooperation Department
Japan International Cooperation Agency (JICA)



GENERAL PLAN OF TRIAL FARM

REPUBLIC OF THE PHILIPPINES	
NATIONAL IRRIGATION ADMINISTRATION	
DIVERSIFIED CROPS IRRIGATION ENGINEERING PROJET (D.C.I.E.P.)	
LOCATION MAP AND GENERAL PLAN OF TRIAL FARM	
DWG. NO.	DCI-001
DATE	
JAPAN INTERNATIONAL COOPERATION AGENCY	

TRIAL FARM SITE VIEW

TRIAL FARM SITE (PADDY)

PUMPING STATION SITE

FIELD SURVEY OF TRIAL FARM

INTAKE RATE SURVEY

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CHAPTER I. DISPATCH OF STUDY TEAM

1-1. Background and Purpose

In 1970s, rice self-sufficiency came to be almost realized in the Philippines, and the Government has been trying to raise the farmers' income, since then, through diversified upland farming for fodder self-sufficiency, export-oriented cash crop increase, and introducing vegetables. With such background in agriculture, the National Irrigation Administration (NIA) of the Philippines has positively promoted the upland farming as the second cropping to paddy cropping so as to diversify crops and carry out highly effective irrigation systems for improvement of the irrigation project management, and the Philippine Government requested the Japanese Government to render the technical cooperation necessary for development of upland irrigation technology to meet the local requirements.

In answering to the request, the Japanese Government dispatched the contact mission to the field in September, 1985 and long-term assignment experts in August, 1986 so as to confirm the details of the request and forecast the result of the cooperation. According to such studies and analyses, the draft basic plan of the project was prepared.

And in a period between May 19 and May 30, 1987, a mission was sent to the Philippines to have consultative discussion of the details of the cooperation based on the aforesaid basic plan and to sign the Records of Discussion for confirmation.

The successful execution of the proposed Project requires to urgently provide the well-consolidated trial farm lands for conducting a variety of experiments and studies from the very beginning of the Project for development of upland irrigation technology suitable to local conditions.

Under such circumstances, a detailed design study team was dispatched to the field together with the aforesaid mission for detailed discussion so that the team could carry out the detailed design of the trial farms.

1-2. Organization of Survey Team

The survey team is composed of five members as followings.

Name	Assignment	Present Position
Mr. Y. Sakamoto	Team Leader	Assistant Director, Design Div., Construction Dept., Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries (MAFF)
Mr. J. Yamada	Field Planning	Staff, Toyokawa Irrigation Project, Toukai Regional Agricultural Administration, MAFF
Mr. T. Sasaki	Coordination	Staff, Agricultural Development Cooperation Dept., JICA
Mr. H. Hiratsuka	Field Design	Sanyu Consultants Inc.
Mr. Y. Tominaga	Water Facilities Design	Sanyu Consultants Inc.

1-3. Schedule of Team in the Philippines

Date	Schedule
May 25	Meeting with JICA office and R/D Mission Team
26	Courtesy call to NIA, preparation of field trip
27, 28)	Field trip in San Rafael site
29, 31	Internal meeting and data analysis
Jun. 1, 2)	Meeting with NIA
3	Meeting with NIA, supplementary field trip
4	Report preparation, internal meeting
5	Final meeting with NIA and submission of the letter, report to JICA office
6	Leaving for Japan (Sakamoto, Yamada and Sasaki), preparation of field survey (Hiratsuka, Tominaga)
7	Preparation of field survey
8 ∫ 12	Field survey, data collection
13, 14)	Data analysis of field survey
15 ∫ 19	Field Survey, data collection
20, 21)	Data analysis of field survey
22	Field survey, data collection
23	Guidance JICA staff to San Rafael site
24	Data collection

Date	Schedule
Jun. 25, 26)	Supplementary field survey, data collection
27, 28)	Arrangement of data
29, 30)	Data collection, arrangement of data
July 1	Report preparation
2	Meeting with NIA, report to JICA office
3	Leaving for Japan

1-4. Meeting Members

1) Central Office

Atty Federico N Alday, Jr.	:	Administrator
Mr. Sebastian I. Julian	:	Assistant Administrator for Systems Operation and Equipment Management (SOEM)
Mr. Eduardo G. Fernandez	:	Assistant Administrator for Project Development and Implementation (PDI)
Atty. David T. Rojas	:	Assistant Administrate for Services (AS)
Mr. Zenaida C. Sebastian	:	Assistant Administrator for Finance and Management (FM)
Mr. Edilberto B Payawal	:	Manager, Systems Management Department (SMD)
Mr. Lino P. Aldovino	:	Manager, Design & Specification Department (ACD)
Mr. Avelino S. Rivera	:	Manager, Project Development Department (PAA)
Mr. Avelino M. Mejia	:	Manager, Institutional Development Department (IDD)
Mr. Sarafin A. Palteng	:	Manager, Program Development Staff (PDS)
Mr. Abelando Y. Armentia	:	Section Head, PDD
Mr. Salvador Salandanan	:	Manager Research & Development DN
Mr. Dominador D. Pascua	:	Section Head, PDD
Mr. Liberato L. Piczon	:	Chief Researcher, PDS
Ms. A. C. Felizardo	:	Manager, Management Services Department
Mr. Victon C. Cruz	:	Regional Engineer
Mr. Ernesto S. Ventura	:	Design Engineer

2) JICA Expert

Mr. Y. Mishima	:	Irrigation & Drainage
Mr. O. Umekawa	:	Water Management

3) Embassy of Japan

Mr. Y. Nakajo	:	First Secretary

4) JICA Philippine Office

Mr. M. Miyamoto	:	Director
Mr. K. Oshima	:	Deputy Director
Mr. T. Iwata	:	Staff

5) Counterpart Staff

Mr. Serafin A. Palteng	:	Project Manager, Project Mgr. PDS
Mr. Reinerio Irinco	:	Irrigation Engineer, Engineer PDD
Mr. Jaime M. Borlaza	:	Irrigation Engineer, Supervising Engineer DSD
Mr. Liberato Piczon	:	Irrigation Engineer, Chief Researcher PDS/SMD
Mr. Leonardo Costa	:	Agronomist, Sr. Agronomist PDD
Mr. Alexander Cartor	:	Pedologist, Sr. Soil Technologist PDD
Mr. Renato de Lara	:	Irrigation Engineer, Training Specialist SMD
Mr. Ariston Nolasco	:	Farm Manager, Division Manager PDS

CHAPTER II. OUTLINE OF FIELD DESIGN

2-1. Site Selection of Proposed Field

The proposed San Rafael site was selected under the agreement concluded between the Philippine Government and the Japanese Government in July 1987 on the basis of several sites roughly screened through long term investigation made until August, 1986.

2-2. Key Points of Field Consolidation

The field consolidation works shall be executed in paying particular attention to the following points.

- to secure the water intake site and the stable amount of water to be taken
- to form every plot with same shape and acreage
- to provide the facilities with exclusive use for the systematic irrigation and drainage as well as those for individual plots
- to carefully form field plots and treat the surface soils

2-3. Layout and Plotting of Fields

The proposed field with about 3.0 ha shall be laid out in the first candidate Site of 15 ha in San Rafael. In the 15 ha candidate land, consisting mainly of paddy and upland fields, there are some used as paddy fields in the wet season and upland field in the dry season. The existing paddy field can be taken into the Project Lay-out by only 1.5 ha, about 35 percent of the total designed area, although the plan has been so prepared to involve existing paddy fields as wide as possible. That is because there are two large mango trees growing which will be obstacles in the future trial farming if holding these two trees into the proposed field, and the proposed paddy field have unavoidable to be relocated about 50 m toward upland field side.

In other respect, there extends a paddy field area of about five hectares in the western part of the candidate land, and the main stream of the Angat River flows down through the adjacent land where there are some sand-and-gravel borrow pits. And such borrow area might be extended closely toward the afore-mentioned paddy field.

Besides the above, when the trial farm are developed in this area, there will be such problems arisen as construction of new O and M roads and difficulty in successful water control.

The lay-out of the 3.6 hectares proposed field is prepared as shown in the relevant drawing in taking into account the aforesaid various conditions.

Plotting for 3.0 ha of the trial farm is made on the basis of the area with width of 100 m x length of 360 m. And one unit lot is determined by 1000 m^2 (40 m x 25 m) in taking into consideration the convenience and facilitation in the experimental as well as regular shape and leveling.

2-4. Intake Facilities and Irrigation Plan

The intake points determined on the North Main Canal of Augat River Irrigation System, from which the water is pumped up in the 5.0 m high delivery tank to be stored and distributed to the fields through pipelines laid along the farm roads. In this case, the pumps as water sources shall be of engine pump type in view of the unstable electric power supply. And the pipeline shall be provide with PVC pipes, ϕ125 mm.

A hydrant 65 mm, shall be provided at each farm plot for controlling the irrigation discharge. In addition to the hydrant, a sluice valve 125 mm will be installed at plot No. P-14 for availability of plot to plot irrigation from No. P-14 to No. P-25 for the paddy cropping.

2-5. Drainage Plan

The rectangular fields shall be drained through the drainage ditches provided along both long sides of the plots up to the Angat River. At the terminal part of the fields, however the runoff to flow from the outer areas of the candidates land shall be drained out through the canals. For drainage of runoff from the outer areas, there will be no serious problem on drainage capacity because the outer water shed is narrow with about 10 ha only. The drainage canals shall be designed in earth canal with slope as gentle as 1/750 - 1/1,000. The flow velocity will be about below 0.5 m/s. The trial farm shall be drained by surface drainage only and not by underground drainage (with conduits).

In futures, however, when the study is required for provision of underground drainage facilities, another research and experimental facilities shall be additionally constructed for the purposes.

2-6. Farm Road Plan

The proposed farm roads shall have 4.5 m in width with gravel pavement with 3.5 m width for facilitating the necessary farm works and easy accessibility of farming machinery. The farm roads shall be laid in the very center of the fields so as to secure easy access to the fields on the both sides.

2-7. Farm Land Formation and Levelling

The proposed farm land shall be formed in consideration of the fact that the fields must not only satisfy the conditions of the paddy fields but meet the conditions of upland fields. In other words, land levelling shall be carried out by each plot. And for the existing paddy fields, the top soil shall remain possibly undisturbed to be used for the top soils of the new farm plots.

2-8. Planning of Appurtenant Facilities

The other facilities than the above will be planned for warehouses, garage, compost shed, etc.

CHAPTER III. FARM DESIGNING

3-1. Irrigation Planning

3-1-1. Existing and Proposed Irrigation Systems

1) Existing Irrigation System

The proposed farm land with 15 ha in total acreage is located in narrow strip between the existing main canal and the Angat River. And the proposed trial farm fields is irrigates by water directly taken from main canal through two different systems; one is the gravity irrigation by direct water intake from main canal and the other the pumping irrigation. The proposed trial farm is laid just between the areas covered by the above two systems.

2) Proposed Irrigation System

A new irrigation system for trial farm (about 3.0 ha) shall be provided with new intake facilities separately from other intakes so as to appropriately carry out the experiments.

3) Irrigation Facilities Planning

The water supply to the terminal plots shall be made through pumps to distribution pipeline via 5.0 m elevated delivery tank. The water shall be pumped up from the North main canal, and the elevated tank shall be provided at the upstream of the proposed land so as to maintain water at certain level. The elevated tank shall function to facilitates measurement of discharge amount as well as to secure the constant water level for plots.

The PVC pipelines (ϕ125 mm) shall be laid out from tank to terminal plots for water conveyance and valves and flow meters

shall be provided at the terminal points of each pipelines for controlling the irrigation operation.

3-1-2. Unit Water Requirements for Paddy and Upland Cropping

1) Irrigation for Paddy and Upland Cropping in Trial Farm

In the trial farm, the paddy cropping and upland cropping shall be practised alternately, and therefore, the peak water requirements shall satisfy the both of the cropping with paddy and upland crops for successful research and experiment. Generally speaking, the peak water requirements for paddy cropping is larger than those for upland cropping.

Consequently, the larger values have been taken in this planning for facilitates in comparison of both values for paddy cropping and upland cropping.

2) Unit Water Requirement and Consumptive Use for Crops

i) Unit Water Requirement for Paddy

Unit field water requirement in depth is applied to be 11 mm/day ($\fallingdotseq$ 9.16 + 1.90 mm) by evapo-transpiration rate in the area and deep percolation rate observed at the field.

Evapo-transpiration rate is 9.16 mm/day obtained as the maximum monthly mean pan evaporation through the year in the data observed for the period of 1970 to 1979 in Ulingao Research Center.

While, a deep percolation rate of 1.9 mm/day is adopted as observed data in course of the study.

ii) Unit Water Requirement for Paddy Field Soaking

The water requirement for paddy field soaking would be determined by NIA criteria (taken from the AMRIS O & M Improvement Project Report)

	Dry Season	Wet Season
	mm	mm
Soil Saturation	66	95
Standing Water Depth	50	50
Water Req. for Land Soaking	116	145

iii) Consumptive Use for Upland Crops a Day

Seeing that consumptive use for upland crops are assumed as generally ranged from 5 to 10 mm/day, a design consumptive use for upland crops is given 7 mm/day as average of those general requirement.

3-1-3. Peak Water Requirement for Pumping Plan

1) Land Soaking Period, Pump Operations Hours and Irrigations Efficiency

	L/S Period	Operation Hour	Efficiency
For Paddy	10 days	12 hr	0.85
For Upland Crops	-	8 hr	0.85

2) Maximum Water Requirement

For Land Soaking (to be completed by 10 days)

$$Q_1 = \frac{A}{10} \times d_1 \times \frac{1}{F} \times 10 = 512 \ m^3/day$$

where; A : Total Irrigable Area (ha) 3.0

d_1 : Unit Water Requirement (mm/day) 145

F : Irrigation Efficiency 0.85

For Paddy Crop Management

$$Q_2 = (A - \frac{A}{10}) \times d_2 \times \frac{1}{F} \times 10 = 285 \ m^3/day$$

where;

A	: Total Irrigation Area (ha)	3.0
d_2	: Unit Water Requirement (mm/day)	11
F	: Irrigations Efficiency	0.85

Maximum Water Requirement for Paddy

$$512 + 285 = 797 \ m^3/day$$

Maximum Water Requirement for Upland Crops

$$Q_3 = A \times d_3 \times \frac{1}{F} \times 10 = 247 \ m^3/days$$

where;

A	: Total Irrigation Area (ha)	3.0
d_3	: Unit Water Requirement (mm/day)	7.0
F	: Irrigations Efficiency	0.85

Required pumping water discharges are given by the above maximum water requirements and pump operation hours as follows;

For Paddy field $q_1 = (Q_1 + Q_2) \div 12 \text{ hr} \div 60 \text{ min} = 1.11 \ m^3/min$ (18.5 1/sec)

For Upland Crops Field $q_2 = Q_3 \div 12 \text{ hr} \div 60 \text{ min} = 0.52 \ m^3/min$ (8.7 1/sec)

where,

Q_1	: W.R for Land Soaking	(m^3/day)
Q_2	: W.R for Crop Management	(m^3/day)
Q_3	: W.R for Upland Crops	(m^3/day)

3) Design Pumping Water Discharge

As examined above sections, design pumping water discharge is applied to be 1.11 m^3/min (18.5/sec.)

3-1-4. Intake Facilities Works

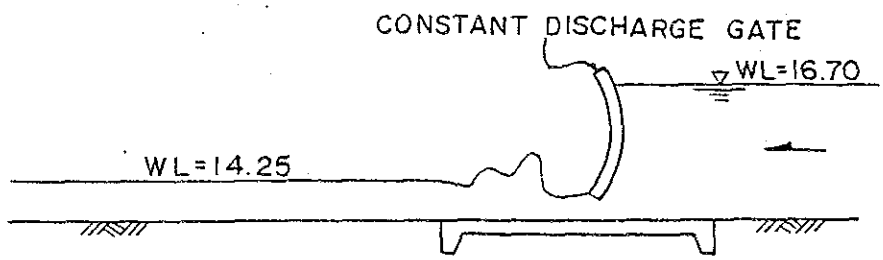
1) Water Source

The water is available through North Main Canal of Angat River Irrigation System passing side along the boundary of planned traial farm. Water discharge of North Main canal is controlled by the constant discharge gate located about 300 m upstream from proposed intake facilities.

2) Intake Facilities

i) Water Level of North Main Canal

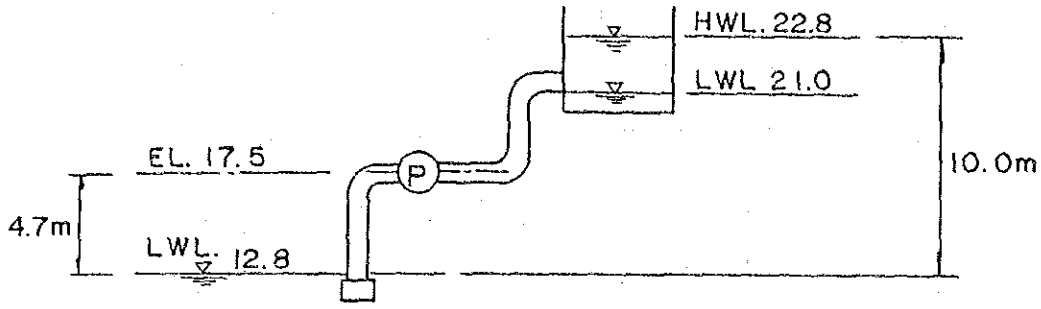
Water level at the existing constant discharge gate and at the proposed intake facilities were observed on June 8, 1987, in the field survey period, as below;



While, water surface elevations at the proposed intake facilities, when the gates were completely closed, was WL = 12.83 m.

ii) Offtake Method

Since ground surface elevation in the proposed traial farm were EL 15.5 to 17.5 m, taking water conveyance losses and



where, P : required Output (ps)

Q : Design Discharge 0.56 (m^3/min)

H : Total pump head

= Actual pump head + water conveyance losses

= 10.0 + 2.5 = 12.5 m

n_p : Pump Operation Efficiency 50 (%)

n_t : Coupling System Efficiency 100 (%)

R : Allowance 25 (%)

$$\text{Then, } P = \frac{0.222 \times 0.56 \times 1.25}{0.50 \times 1.00} \times (1 + 0.25) = 3.9 \text{ (ps)}$$

$$\fallingdotseq 2.9 \text{ (kw)}$$

d) Determination of Pump Type

Type: Horizontal Axis, Single-suctions, Single-stage Centrifugal Pump

Bore: 80 mm

Pumping Water Discharge: 0.56 m^3/min

Total Head = 12.5 m

Output: 3.9 (ps)

Operation: ON-OFF Manual Operation

e) Cavitation

Revolution Number of Centrifugal Pump (N)

$$N = \frac{S\ (Hv + Hs)^{3/4}}{\sqrt{Q}}$$

where, S : Suction Specific Speed 1,000

Hv = (Atmospheric Pressure in water Head) - (Vapor Pressure) - (Suctions Marginal Water Head)

= 10.33 - 0.33 - 0.50 = 9.5 m

Hs = Suction Head = -4.7 - 1.0 = -5.7 m

Q : Design Water Discharge = 0.56 m^3/min

Then;

$$N = \frac{1000\ (9.5 - 5.7)^{3/4}}{\sqrt{0.56}} = 3,637$$

Therefore, Nm = 1,800 r.p.m

Specific Speed

$$N = Nm\ \frac{\sqrt{Q}}{H^{3/4}} = 1800\ \frac{\sqrt{0.56}}{12.5^{3/4}} = 203$$

where H: Total Head 12.5 m

Then, $120 \leq Ns \leq 650$, so that cavitation will not be appeared

3) Suction Sump

a) Dimensions of Suction Sump

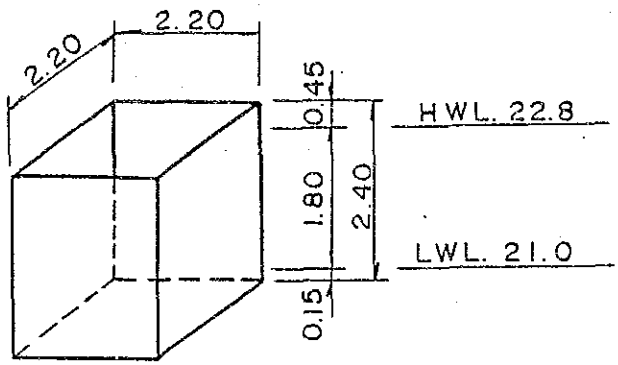
Suction Sump is designed to divert the water smoothly and ensure its required quantity from the North Main Canal,

Table 3.1. Features of Driving Systems

Driving systems	Location/Related Structures	Merit	Demerit	Applrox. Costs
Motor Type (Electric)	Location: Farm site Structure: Elevated Tank (H = 4 m) : Suctions Sump	- Operation, simple - Maintenance, easy - Low operation Costs, in general - Related structures, Simple	- Questionable in the area having power interruptions, frequently.	₱100,000 For 2-pumps ₱120,000 For structures ₱220,000 in Total
Engine Type (Light oils/ Gasoline)	Location: Farm site Structures: Elevated Tank (H = 4 m) : Suction Sump	- Operation, simple - Maintenance, easy - No interruptions of Operation in blowout	- Comparatively high operation costs (About P30,000/300 hr operation a year)	The same in the case of Motor type, P220,000 in Total
Water turbine Type (Water head)	Location: Constant Gate Site Structures: Intake w/gates : Turbine sump : Retaining wall : Elevated Tank (H = 6 m) : Pipe conduit (= 300 m)	- Operation, simple - Maintenance, easy - No operation costs	- Hard to detect machine trouble due to submerged turbine pump - Related structures, complicated/various, comparatively - Installation site, limited, due to use of water head	- ₱350,000 For pump ₱930,000 For structures ₱1,280,000 in Total
Solar System Type (Solar energy)	Location: Farm site Structures: Elevated Tank (H = 4 m) : Suction Sump	- No operation costs - Related structures, Simple	- Stable operation available only w/storage battery - Special high-technology, necessary for O & M	₱100,000 For 2-pumps ₱290,000 For Solar panel ₱120,000 For structures ₱510,000 in Total

$0.52\ m^3/min \times 15\ min = 7.8\ m^3$

While, a design water level (LWL) in the tank is applied to be LWL = 21.0 m, to keep a water head of about 2.0 m at the terminal point.



ii) Spillway

A spill way capacity is applied to flow out the maximum discharge of Q = 18.6 l/s in the land soaking period. Discharge pipe of spill way is provided with bellmouth of 150 mm in a diameter. Overflow depth of water on the bellmouth is within 10 cm.

3-1-5. Irrigation Facilities Works

1) Water Distribution Method

The water distribution is planned by pipeline system in gravity, using available water head in the distribution tank.

2) Type and diameter of pipe

i) Design internal pressure

Maximum hydrostatic pressure	0.8 kg/cm^2
Water hammer pressure	0.8 kg/cm^2

Thereby, internal pressure of pipe is given to be 1.6 kg/cm^2.

ii) Type and diameter of pipe

a) Diameter of pipe

Inner diameter of pipe is worked out to be 125 mm, taking a design discharge of 18.6 l/s in the land soaking period and 8.7 l/s during the dry season period into account.

Design velocities in the above two period are given as follows;

For land soaking period

$$V = \frac{Q}{A} = \frac{0.0185}{1/4 \times 3.14 \times 0.125^2} = 1.51 \text{ m/s}$$

For dry season

$$V = \frac{Q}{A} = \frac{0.0087}{1/4 \times 3.14 \times 0.125^2} = 0.71 \text{ m/s}$$

b) Type of pipe

Considering design internal pressure and diameter of pipe, vinyl chloride pipe (PVC pipe) is selected, which is economical in the cost and facile in the construction.

iii) Pipe installation depth and foundation

The depth of pipe installation are more than 80 cm from the surface of farm road and 50 cm from the ground surface of farms plots respectively. The pipe will be placed directly on the excavated bottom surface. Provided that the excavated foundation is gravelly, the foundations shall be excavated by about 10 cm and replaced with the selected material.

3) Terminal Irrigation Facilities

i) Diameter of pipe is 65 mm, which is planning to be enough to serve 6 plots, simultaneously.
For land soaking period

$$Q = 0.185 \times 1/6 = 0.0031 \ m^3/s$$

$$V = \frac{0.0031}{1/4 \times 3.14 \times 0.065^2} = 0.93 \ m/s$$

For dry season period

$$Q = 0.0087 \times 1/6 = 0.0015 \ m^3/s$$

$$V = \frac{0.0015}{1/4 \times 3.14 \times 0.065^2} = 0.45 \ m/s$$

ii) Flow Meter

At the inlet for each plot irrigations, flow meter devices are installed, in order to observe accumulated discharges. Thereof, straight line of pipe, more than 10 times diameter of the pipe in the upstream from the devices and 2 times diameter of the pipe in the downstream will be provided.

iii) Control Valve

In order to control the velocity and discharge, hydrant ϕ65 mm, will be installed at the end of terminal pipe, which is enable to turn round 360-degree and easy to put hoses in and off.

4) Hydraulic Analyses

i) Various Water Head Losses Calculation

a) Friction Head Losses (h_f)

By using Harzen-wiliam's formula;

$$h_f = 10.666C^{-1.85} \cdot D^{-4.87} \cdot Q^{1.85} \cdot L \times 1.05$$

h_f: Friction head loss (m)
C : Velocity coefficient 140
D : Pipe diameter 0.125 m
Q : Design discharge, for land soaking period 0.0185 m^3/s
for dry season 0.0087 m^3/s
L : Pipe length
Including 5% of head losses allowance to be considered.

Given friction head loss per 100m, as below;
1.89 m/100 m for land soaking period
0.46 m/100 m for dry season cropping period

b) Head loss for branch pipe (hb)

By giving 8 m (ϕ65 mm) branch pipe in a length, friction head loss for branch pipe is calculated, as follows;
0.13 m for land soaking period
0.03 m for dry season cropping period

c) Head loss for hydrant
0.30 m for land soaking period
0.15 m for dry season cropping period

ii) Total Head Losses

Total head losses for each period are given as follows;

$$H_f = h_f + hb + hr$$

$$H_f = 1.89 \times \frac{L}{100} + 0.43, \text{ for land soaking period}$$

$$H_f = 0.46 \times \frac{L}{100} + 0.18, \text{ for dry season cropping period}$$

3-1-6. Future Plan of Irrigation Facilities

For making plan of irrigation facilities, as above-stated, the water distribution system is worked out to maintain the maximum water requirement by pump and constant water head by providing elevated tank. Moreover, the system facilitate to convey the water in a desired quantities to each plot controlling by distribution pipes and valves.

As for the future plan of irrigation facilities use, sprinkler spray irrigation, which require high water pressure, may be conceived. In the above-case, it is available to spray the water by providing booster pump near by valves installed for each plot.

3-2. Drainage Plan

3-2-1. Existing and Plan of Drainage System

1) Existing Drainage System

Existing drainage system, in the area of 15 ha where is bounded by North Main Canal and Angat river, is formed to drain in gravity, passing through a depressed land, depending on the present topography, to Angat river. There is no distinguished drainage canals. The area at end of proposed drainage canal situates in the lowest land and becomes existing drainage water way in the topographic condition.

2) Plan of Drainage System

Drainage in the proposed farm land of 3.0 ha is forming as an independent drainage system, separated from drainage in the outside area. However, drainage water at ending point of proposed drainage canal joins with drainage water from the outside area.

3-2-2. Unit Area Drainage Discharge and Peak Discharge

1) Maximum Rainfall (Table-1)

The maximum rainfall observed at the rainfall station, located at SABANG, BALIWAG, BULACAN, are listed below;

Item	Period of Data Available	Rainfall (mm)	Date Occurred
Daily Rainfall	1970 - 1979	205.6	Oct. 15
3 hrs. Rainfall	1969 - 1975	96.5	Aug. 17
1 hr. Rainfall	1972 - 1974	49.5	Aug. 16

2) Design Rainfall

Design rainfall, for determination of drainage canal elements to drain three (3) hour rainfall within three (3) hour, is applied to be 96.5 mm/3 hrs of the maximum rainfall above-listed.

3) Unit area drainage discharge

By using Rational formula;

$$Q = \frac{1}{3.6} f \cdot r \cdot A \frac{1}{3}$$

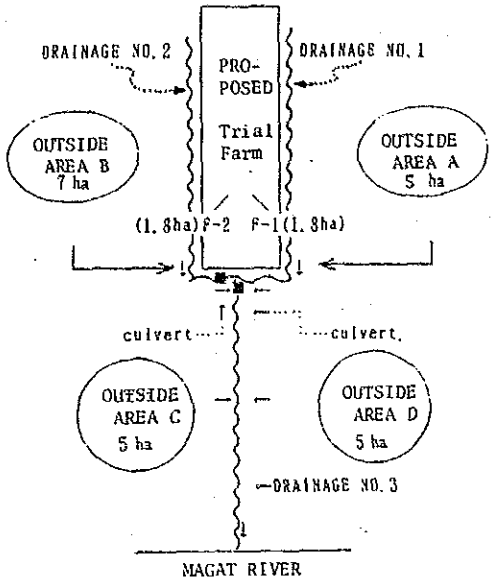
where, Q : Drainage discharge $m^3/sec/ km^2$
f : Runoff coefficient 0.7
r : 3 hrs. Rainfall (mm) 96.5
A : Drainage area (km^2) 1.0

Then; Q = 6.255 $m^3/sec/ km^2$ or 0.063 $m^3/sec/ha$

4) Drainage Discharges for Each sub-drainage Area

Drainage discharges for each sub-drainage area are computed as follows;

Sub-drainage Area	Name of Drainage Canal	Drainage Area (ha)	Drainage Discharge (m^3/sec)
Proposed Trial Farm (F-1)	Drainage No.1	1.8	0.113
Outside Area (A)	At Terminal	5.0	0.315
Sub-total		6.8 1/	0.428 1/
Proposed Trial Farm (F-2)	Drainage No.2	1.8	0.113
Outside Area (B)	At Terminal	7.0	0.445
Sub-total		8.8 2/	0.554 2/
Outside Area (C)		5.0	0.315
- ditto - (D)		5.0	0.315
Sub-total For 1/ & 2/	(6.8 + 8.8)	15.6	0.982
Total		25.6	1.612



3-2-3. Sub-surface Drainage

1) Observation Hole of Groundwater Table

Observation hole shall be provided at each farm plot for survey of groundwater table which will have an effect on the growth of upland crop. Observation hole consists of a perforated vinyl chloride pipe 50 mm, 1.5 m deep, and small size gravel as filter material.

2) Survey of Groundwater Table

Ground water table in the area was confirmed to be low, which was unable to observe at a depth of 1.5 m according to the result of auger boring. Thereof, soils in the area is formed by alluvial deposits of the river, subsoils are sand and/or gravel layer, high in permeability. Those soil layers can be also verified by soil profile of quarry site in the river adjacent the area.

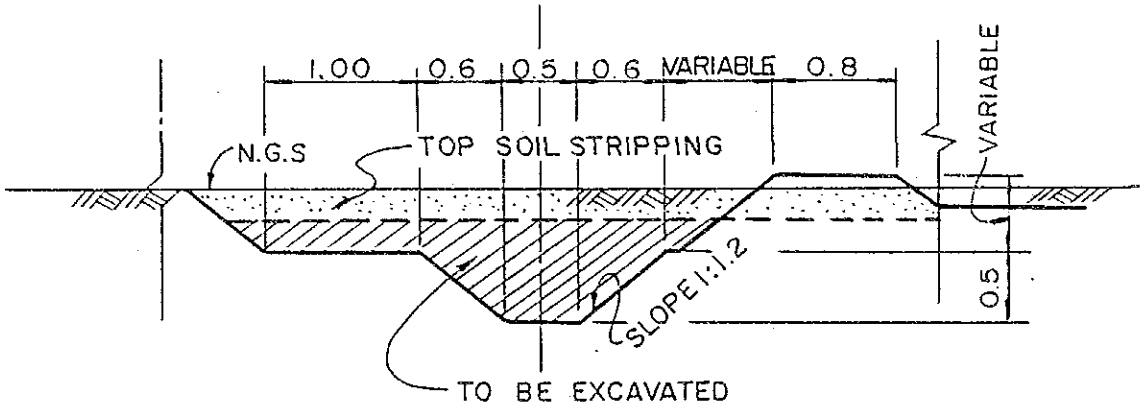
3) Sub-surface Drainage

As a proposed facilities, based on evaluations of ground water table and soil layers above-stated, it is understood that pipe sub-surface drainage is unnecessary.

3-2-4. Drainage Facilities

1) Drainage Canals

Earth canals for surface drainage are provided in the both side, outside the proposed trial farm. The drainage canal is shaped by 0.50 m in the bottom width, 0.5 m in the depth and 1:1.2 (vertical: horizontal) in the side slope, taking into account construction and maintenance after the project.



2) Appurtenant Facilities

Drops, Culverts and Waste-way will be planned on the drainage canal.

3-3. Plan of Farm Road

3-3-1. Farm Road Network and Utilization Plan

1) Farm Road Network

Farm road is planning to traverse the central part of trial farm from Northeast to Southwest in its direction. The existing service road along the North Main Canal will act as an access road to the trial farm. The proposed form road is connected, at its ending point, with the existing farm road.

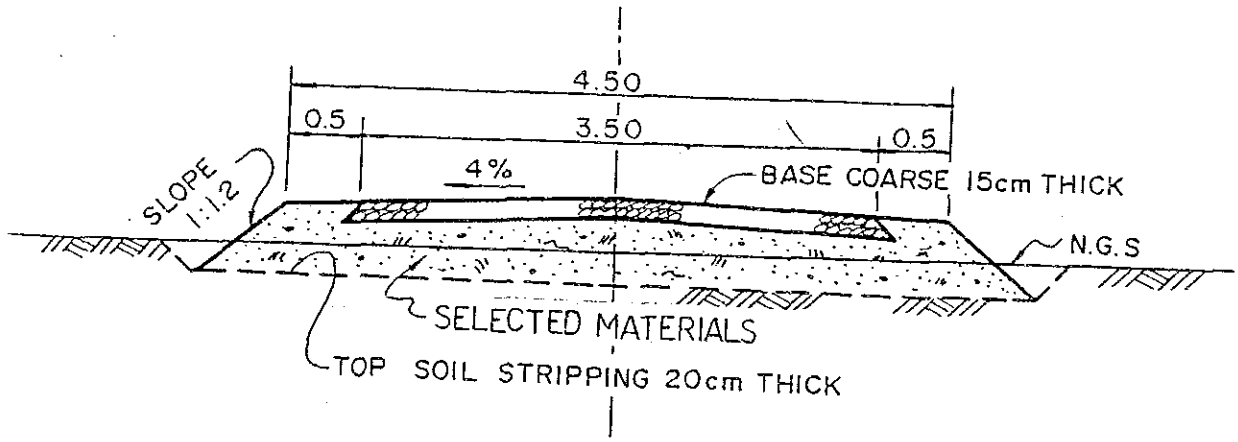
2) Farm Road Utilization Plan

The proposed farm road will serve for all works of trial and research and passing of farm tractors and light trucks. Moreover, the irrigation pipes are laid under the farm road and also the measurement devices for each plot are located alongside the farm road for convenience of irrigation trial.

3-3-2. Farm Road Design and Section

1) Farm Road Section

The road is 4.5 m in the width and 3.5 m in the width of gravel pavement. The across-sectional slope is 4%, with considerations of road surface drainage. Thereof, a depth of pavement is 15 cm.



2) Farm Road Profile

The longitudinal slope of road, depending on the topographical conditions, is 1.6% (1/62) and/or 1.8% (1/55) partly but at a level mostly.

3) Subgrade course

The proposed height of farm road from natural ground surface is 0.75 m in the maximum embankment. For stability of embankment subgrade, materials will be sandy and/or gravelly, and hauled from the quarry site, and well compacted. Before the construction of embankment, national ground surface shall be stripped for clearing and grubbing.

3-3-3. Appurtenant Works of Farm Road

1) Tractor passage works

Tractor passage to each plot is provided, to facilitate the carrying in/out of farming machines and access for farming works, in where a different height between the surface level of farm road and ground level of farm plot is greater (more than 0.5 m in a height). The slope of tractor passage in applied to be 30% (1/3).

3-4. Farm Land Formation and Leveling Plan

3-4-1. Farm Land Utilization and Formation Method

After formation the land, various upland crops irrigation trial will be carried out in the trial farm land. Nonetheless, the farm land will be used for paddy in the rainy season and the trials for upland crop will be carried out in the dry season. Thereby, the farm land shall keep at a level and particularly, surface and sub-surface drainage shall be well moved out for the upland crop cultivations.

In the leveling works, the surface soils shall be removed in the depth of more than 20 cm and backfilled after reclaiming the land, because it is very important for cropping to maintain a fertile soils.

3-4-2. Leveling Works and Problems Confronting

Leveling works shall be performed in a tolerance of ±5cm, in order to undisturb paddy cropping. Furthermore, at the place where original ground was cut and banked, extraordinary increase of seepage was observed sometime after relaining the land. In the above-case, solution will be taken by performing land soaking works carefully and repeatedly by buffaloes and/or tractors.

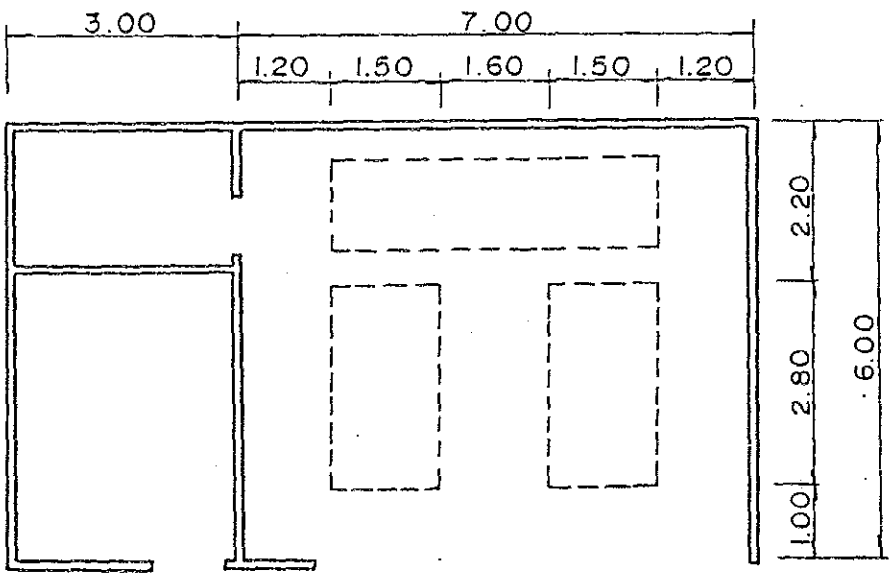
3-5. Appurtenant Facilities

The following facilities are planning to built as appurtenant facilities.

1) Garage and Warehouse
2) Shelter for works
3) Compost Shed
4) Fence

3-5-1. Garage and Warehouse

In the compound of NIA Training Center, garage for farming machines and warehouse for storing of tools and apparatuses are provided in a floor area of 60 m^2 (10 m x 6 m)



3-5-2. Shelter for Works

Shelter for simple works/repair of machines and tools is proposed in a floor area of 24 m^2 (6 m x 4 m), beside the farm lot.

3-5-3. Compost Shed

Compost shed, beside the farm lot, is planned, in order to make paddy straw compost as a source of organic fertilizer for the farming.

1) Required Compost Quantity

$W = 2\ t/ha \times 3\ ha = 6\ t$

2) Required Compost Material Volume

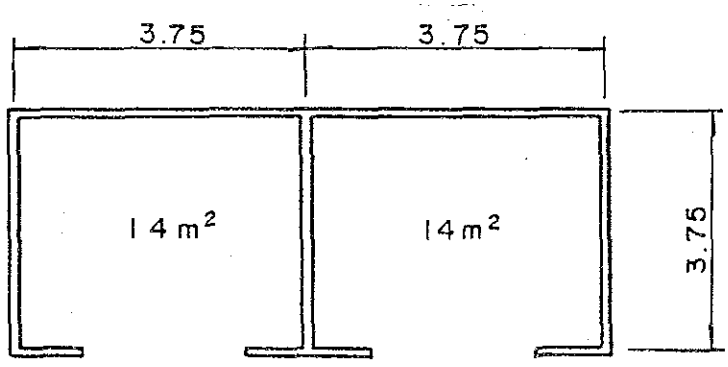
$6\ t \times 8\ m^3/t = 48\ m^3$ in dry condition
$6\ t \times 1.3\ m^3 = 7.8\ m^3$ in pre-matured condition

3) Required Compost Hut Area

$V = 48 \div 2 = 24\ m^2$ in dry condition (2 m piling height)
$V = 7.8 \div 1.5 = 5\ m^2$ in pre-matured condition (1.5 m piling height)

When an area for turning/mixing of compost is considered, the area of shed is required in 10 m^2.

4) Compost Shed



3-5-4. Fence

Fence shall be provided around the trial farm to secure the research independently of outside area.

3-6. Result of Soil Survey

3-6-1. Objectives and Items of Soil Survey

1) Objectives

Soil survey was conducted in order to make soil properties clear, though the surface soils are disturbed by the reclamation works.

2) Survey Items

The following soil surveys were undertaken, based on the above-mentioned objectives.

- Soil texture survey
- Soil permeability test
- Intake-rate test for upland crops irrigation
- Percolation test for paddy irrigation
- Permeability test in the lower subsoil

3-6-2. Result of Survey.

1) Soil Type

Soils in the proposed farm land are classified into three (3) types, namely Sandy clay loam (S.C.L.), Silty clay loam (Si.C.L) and Silty loam (Si.L). These soils are fine loamy to loamy in a texture, well-drained and thick in the layer (See Soil map).

In a series of soil survey, soil profile surveyed upto 1.0 m in a depth by stick soil auger shows that gravels are lying up to 40 to 85 cm in the depth from the ground surface (about 40 cm to be cut/removed in the design), in where is situated at the elevated land with Sandy clay soil. Clay loam and Sandy clay loam are predominant up to 1.0 m in a depth in the remained area.

2) Permeability of Soils

Soil properties are characterized by low permeability in the area of lower paddy field (lower flood plain). On the other hand, subsoils in the middle part of the area, alluvial terrace, are ill-drained.

3) Intake Rate for Upland Crops Irrigation

Basic intake rate is 9.6 to 12.6 mm/hr, which are very low. (refer to Fig.3)

4) Deep Percolation for Paddy Irrigation

Deep percolation rate in a depth were observed as 1.7 to 1.8 mm/day in the lower flood plain (paddy field) and 1.1 mm/day in the alluvial terrace. Those rates are understandable as an average rate in the moderately granulated soils.

5) Permeability of Subsoil

Permeability test was conducted by falling head permeability test using auger hole. The rates are comparatively high 10.91 - 1.0 m/day (1.15×10^{-3}).

CHAPTER IV. CONSTRUCTION METHOD AND PLAN

4-1. Construction Method

The works consists of farm land consolidation work which is earth works predominantly and construction of pumping station to be built adjacent the trial farm.

The major component of construction works is farm land formation which is composed of foundation works, leveling works and other works and small in its quantities of works.

Therefore, from an engineering point of view, considering construction item component and quantities, local contractor will be capable for the construction. Furthermore, construction equipment, which is planned by the quantities of the works and construction period, will be manageable by the local contractors. However, in order to construct the farm land consolidations works in good quality, a well-experienced engineer will be required to oversee the construction works throughout the period.

4-2. Construction Plan

4-2-1. Farm Land Formation Works

The farm land formation works shall be carried out in the ground surface stripping, balanced cut-and-filling works, surface soil backfilling works and ground surface leveling works in order. These series of works will be executed by bulldozer (11 ton class). Embankment works, particularly in the filling works only, shall be carefully undertaken in the compaction and extra-filling, considering settlement after the reclamation. The leveling works shall be carried out by three (3) times, after completion of cut and filling works, backfilled surface soils and in the time of water storage test.

On the other hand, the depth of surface soils stripping shall be more than 20 cm. It shall be understood that soils for cultivation is maintained in a depth of more than 20 cm.

4-2-2. Farm Road Works

The surface soils under the farm road to be constructed are also moved out in a depth of 20 cm before the embankment works for the road, which is used as a surface soils of farm plot.

The materials for road subgrade course shall be sandy/gravelly, which will be brought from the quarry and compacted properly. The works for spreading and compaction of embankment materials will be carried out by bulldozer (11 tons class).

4-2-3. Irrigation Canal Works

Pipe line (Vinyl chloride pipe VP 125 mm) is used as an irrigation canal, which will be placed under the farm road. Therefore, after banking of road materials, the road subgrade will be excavated by backhoe up to the depth required for placing of pipe. The backfilling and compaction works shall be undertaken by manual labors and tampers, respectively.

4-2-4. Drainage Canal Works

Drainage canal is designed to be earth canal, which will be excavated by backhoe and trimmed by manual labors. As the same as case in the farm road constructions, surface soils will be removed and used as soils for cultivation. A part of excavated materials will be used for embankment.

4-2-5. Concrete Works

Concrete works is required for construction of suction sump, foundations and building of pumping station as well as elevated

tank. In addition, other structures, such as culverts, drops, etc., are also constructed by concrete. Those concrete will be mixed and placed by using portable mixer (0.3 cu.m in capacity)

4-2-6. Riprap and Grouted Riprap Works

Stone pitching and masonry works will be constructed by using cobbles (20 to 30 cm in size).

4-2-7. Concrete Block Works

Concrete blocks will be used mainly for construction of wall of buildings. Concrete blocks will be placed on concrete base foundation and constructed by reinforcing with steel bars. An outer facing of wall of garage and warehouse will be finished by cement mortar.

4-2-8. Construction Schedule (Table-4)

Construction works is expected to be completed within about three-and-a-half month (3.5 months), as shown in the table of construction schedule attached herewith, considering mainly quantities of cut-and-filling works and leveling works in the farm land formation works.

CHAPTER V. COST ESTIMATES

5-1. Conditions of Cost Estimates

Construction costs are estimated as stated in the following section.

5-1-1. Estimated Cost Items

The costs are estimated, necessary to complete the proposed works, except costs for land acquisitions and compensation, and construction administration/supervision.

5-1-2. Unit Costs

Unit costs are composed of material costs, labor wages and depreciation costs of equipment.

5-1-3. Scope of the Works

a) Preparatory works involve the following works

- Preparation and finishing works at the site
- Survey for construction

b) Pumping Station Works

- Coffer-damming
- Suction sump works
- Basement and installation of pumps and building works
- Installation of suction and delivery pipes and other apparatus necessary for pump operation

c) Irrigation Canal Works

- Elevated tank (Distribution tank)

- Pipe line and installation of valves and measurement devices

d) Farm Land Formation Works

- Treatment of surface soils (stripping and backfilling)
- Balanced cut-and-filling works for base layer
- Surface soils leveling works
- Farm road works
- Drainage canal works

e) Related Facilities

- Garage and Warehouse
- Shelter for works
- Compost Shed
- Fence

5-2. Construction Costs

5-2-1. Unit Costs (Table-3)

Unit costs, based on prices on June, 1987, are estimated, taking data obtained from NIA, market prices researched and costs prevailing in the recent contract civil works into account.

5-2-2. Contractor's Overhead

The overhead is applied to be 35 % of direct costs, equivalent to 25.93% of contract unit cost, which include the following items.

- Temporary works at the site (dewatering etc.)
- Temporary house for labors
- Transportation fee of construction equipment

- Insurance
- Costs for site engineers
- Overhead of head and branch offices
- Taxes
- Profits

5-2-3. Contingencies

Contingencies is added to compensate for difference, of quantities between in design and after joint survey for construction, uncertain factors in the study stage and other physical changes after the design.

Costs for contingencies is applied to be 10% of direct costs and contractor's over head.

TABLES

Table - 1 RAINFALL RECORD

STATION : SABANG BALIWAG BULACAN

	DAILY (24 HRS)		3 HRS		HOURLY	
	AMOUNT	DATE	AMOUNT	DATE	AMOUNT	DATE
1969			23.0	Dec. 11		
1970	142.5	Sep. 1	74.0	Aug. 31		
1971	132.8	Jun. 15	55.3	May. 18		
1972	182.6	Jul. 18	49.4	Aug. 4	27	Jul. 22
1973	※ 205.6	Oct. 15	84.0	Oct. 15	29.5	Oct. 15
1974	194.6	Aug. 16	※ 96.5	Aug. 17	※ 49.5	Aug. 16
1975	133.3	Oct. 20	44.2	Sep. 25		
1976	145.8	May. 13				
1977	103.8	Jul. 21				
1978	177.3	Oct. 26				
1979	69.3	Aug. 16				

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Table-2. SUMMARY OF BILL OF QUANTITIES

		Pesos
Division 1.	General	116,500
Division 2.	Irrigation Facilities	1,218,729
Division 3.	Drainage Facilities	293,748
Division 4.	Farm Road	145,260
Division 5.	Land Consolidation	243,345
Division 6.	Other Facilities	396,412
	Sub-total	2,413,994
	Over Head (35%)	844,897
	Sum for Contingencies (10% of Sub-total)	325,889
	Total Bid Price	3,584,780
		(¥25,451,938)

Division 1. General

Item	Description	Unit	Quantity	Unit Cost	Amount
1001	Survey works	L.S.	1		6,500
1002	Common temporary works	L.S.	1		110,000
	Total				116,000

Division 2. Irrigation Facilities

Item	Description	Unit	Quantity	Unit Cost	Amount
Section 2.1. Temporary Works					
2101	Temporary works	L.S.	1		10,000
Section 2.2. Civil Works for Pumping Station & Elevated Tank					
2201	Excavation	m^3	42	12	504
2202	Fill & Backfill	m^3	21	27	567
2203	Reinforced concrete (Class - A)	m^3	26	1,365	35,490
2204	Plain concrete (Class - B)	m^2	30	1,329	39,870
2205	Leveling concrete (Class - C)	m^2	0.2	1,329	265
2206	Form work	m^2	255	85	21,675
2207	Reinforing Bar	kg	878	85	7,463
2208	Grouted Riprap	m^3	18	490	8,820
2209	Riprap	m^3	22	250	5,500
2210	Wooden manhole cover	No.	3	250	750
	Total for Section 2.2.				120,904

Item	Description	Unit	Quantity	Unit Cost	Amount
Section 2.3.	Supply & Installation of Pump & Pipes around Elevated Tank				
2301	Single suction volute pump (ϕ80mm, 0.56 m3/min) including suction pipe, foot valve, check valve, sluice valve & outlet pipe around pump	set	2	35,000	70,000
2302	Galvanized steel pipe (ϕ150 mm)	m	13	610	7,930
2303	Galvanized steel pipe (ϕ125 mm)	m	52	500	26,000
2304	Galvanized steel pipe (ϕ 50 mm)	m	19	150	2,850
2305	Galvanized steel pipe (ϕ 25 mm)	m	5	85	425
2306	PVC pipe (ϕ150 mm)	m	22	385	8,470
2307	PVC pipe (ϕ125 mm)	m	4	125	500
2308	Cast iron sluice valve (ϕ125 mm)	No.	1	1,500	1,500
2309	Cast iron sluice valve (ϕ 50 mm)	No.	1	570	570
2310	Bronze valve(ϕ 25 mm)	No.	1	320	320
2311	Strainer (ϕ125 mm)	No.	1	3,850	3,850
2312	Flow meter with measuring function of both moment and accumulated discharge. (ϕ125 mm, one flange)	No.	1	40,000	40,000
2313	Couping (ϕ125 mm)	No.	2	300	600
	Total for Section 2.3.				163,015

Item	Description	Unit	Quantity	Unit Cost	Amount
Section 2.4. Pump House					
2401	Pump house	m^2	13	1,490	19,370
Section 2.5. Supply & Installation					
2501	PVC pipe (ϕ125 mm)	m	366	305	111,630
2502	PVC pipe (ϕ 65 mm)	m	216	105	22,680
2503	Flow meter with measuring function of accumulated discharge (ϕ 65 mm, one flange)	No.	25	24,500	612,500
2504	Hydrant (ϕ 65 mm)	No.	25	2,800	70,000
2505	Cast iron sluice valve (ϕ125 mm)	No.	2	1,500	3,000
2506	Coupling (ϕ 65 mm)	No.	25	250	6,250
2507	Flow meter & hydrant box	No.	25	1,640	41,000
2508	Valve box (ϕ125 mm)	No.	1	810	810
2509	Blow of valve box	No.	1	260	260
	Total for Section 2.5.				868,130
Section 2.6. Miscellaneous Works					
2601	Hand rail	m	12	440	5,280
2602	Ladder (H=3.35 m)	No.	2	2,260	4,520
2603	Ladder (H=4.32 m)	No.	1	2,640	2,640
2604	Screen	No.	3	8,290	24,870
	Total for Section 2.6.				37,310
	Total for Division 2.				1,218,729

Division 3. Drainage Facilities

Item	Description	Unit	Quantity	Unit Cost	Amount
Section 3.1. Civil Works					
3101	Earth works Drainage ditch (No.1)	m	350	55	19,250
3102	Earth works Drainage ditch (No.2)	m	457	70	31,990
3103	Earth works Drainage ditch (No.3)	m	147	75	11,025
	Total for Section 3.1.				62,265
Section 3.2. Structure					
3201	Drops (A) type	No.	3	5,950	17,850
3202	Drops (B) type	No.	1	6,000	6,000
3203	Culvert (A) type	No.	1	9,320	9,320
3204	Culvert (B) type	No.	1	26,280	26,280
3205	Waste way	No.	1	14,500	14,500
3206	Measuring weir (Triangular weir)	No.	10	3,200	32,000
3207	Outlet	No.	25	1,880	47,000
3208	Brick drainage	m	113	88	9,944
3209	Brick drainage with cover	m	14	251	3,514
3210	Drainage lining	m	153	400	61,200
3211	Investigation hole of under groundwater	No.	25	155	3,875
	Total for Section 3.2.				231,483
	Total for Division 3.				293,748

Division 4. Farm Road

Item	Description	Unit	Quantity	Unit Cost	Amount
4101	Farm road	m	417	280	116,760
4102	Gravel paving	m^2	1,425	20	28,500
	Total for Division 4.				145,260

Division 5. Land Consolidation

Item	Description	Unit	Quantity	Unit Cost	Amount
5101	Cut and embankment	m^3	3,369	18.4	61,989
5102	Top-soil stripping	m^3	5,178	11	56,958
5103	Top-soil removing	m^3	5,178	12	61,136
5104	Land leveling (Foundation)	m^2	25,893	0.31	8,026
5105	Land leveling (1st stage)	m^2	25,893	0.46	11,910
5106	Land leveling (2nd stage)	m^2	25,893	0.64	16,571
5107	Plot border	m	2,394	10	23,940
5108	Slope grading	m^2	165	11	1,815
	Total for Division 5.				243,345

Division 6. Other Facilities

Item	Description	Unit	Quantity	Unit Cost	Amount
Section 6.1. Relocation of Existion Pipeline					
6101	Removal of existing pipeline	m	94	28	2,632
6102	Pipeline	m	127	290	36,830
6103	Irrigation ditch	m	210	35	7,350
	Total for Section 6.1.				46,812
Section 6.2. Fence Works					
6201	Fence	m	915	120	109,800
6202	Gate	No.	2	30,000	60,000
	Total for Section 6.2.				169,800
Section 6.3. Building					
6201	Garage and warehouse	m^2	60	1,900	114,000
6202	Compost shed	m^2	28	1,200	33,600
6203	Shelter	m^2	24	1,050	25,200
6204	Septic tank	No.	1	7,000	7,000
	Total for Section 6.3.				179,800
	Total for Division 6.				396,412

Table-3. Labor Wages, Material Prices and Unit Cost

1. Labor Wages

Unskilled Labor	per day	₱55
Skilled Labor		60
Foreman		80
Driver (truck)		65
Operator (heavy equipment)		70
Carpenter		65

2. Material Price

Cement	40 kg/Bag	per ton	₱1,250
Sand		per cu.m	100
Gravel	(size 5 - 30 mm)	- do -	135
Steel Bar	(deform 10-19 mm)	per ton	8,500
Rectangular Timber		per cu.m	10,000
Wooden Board	(t = 1 cm)	per sq.m	80
Concrete Block	(10 x 20 x 40 cm)	per Nos	4.95
	(15 x 20 x 40 cm)	per Nos	5.10
	(20 x 20 x 40 cm)	per Nos	7.75
R.C Pipe	ϕ300	per m	82
	ϕ450	- do -	192
	ϕ600	- do -	260
P.V.C Pipe	ϕ65	- do -	128
	ϕ125	- do -	655

3. Unit Cost

Form works		per sq.m	85
Concrete	(1:2:4)	per sq.m	1,365
Concrete	(1:3:6)	- do -	1,329
Mortar	(1:2)	- do -	1,645
Mortar	(1:3)	- do -	1,342
Road Paving Gravel		per sq.m	20

Table - 4 CONSTRUCTION SCHEDULE

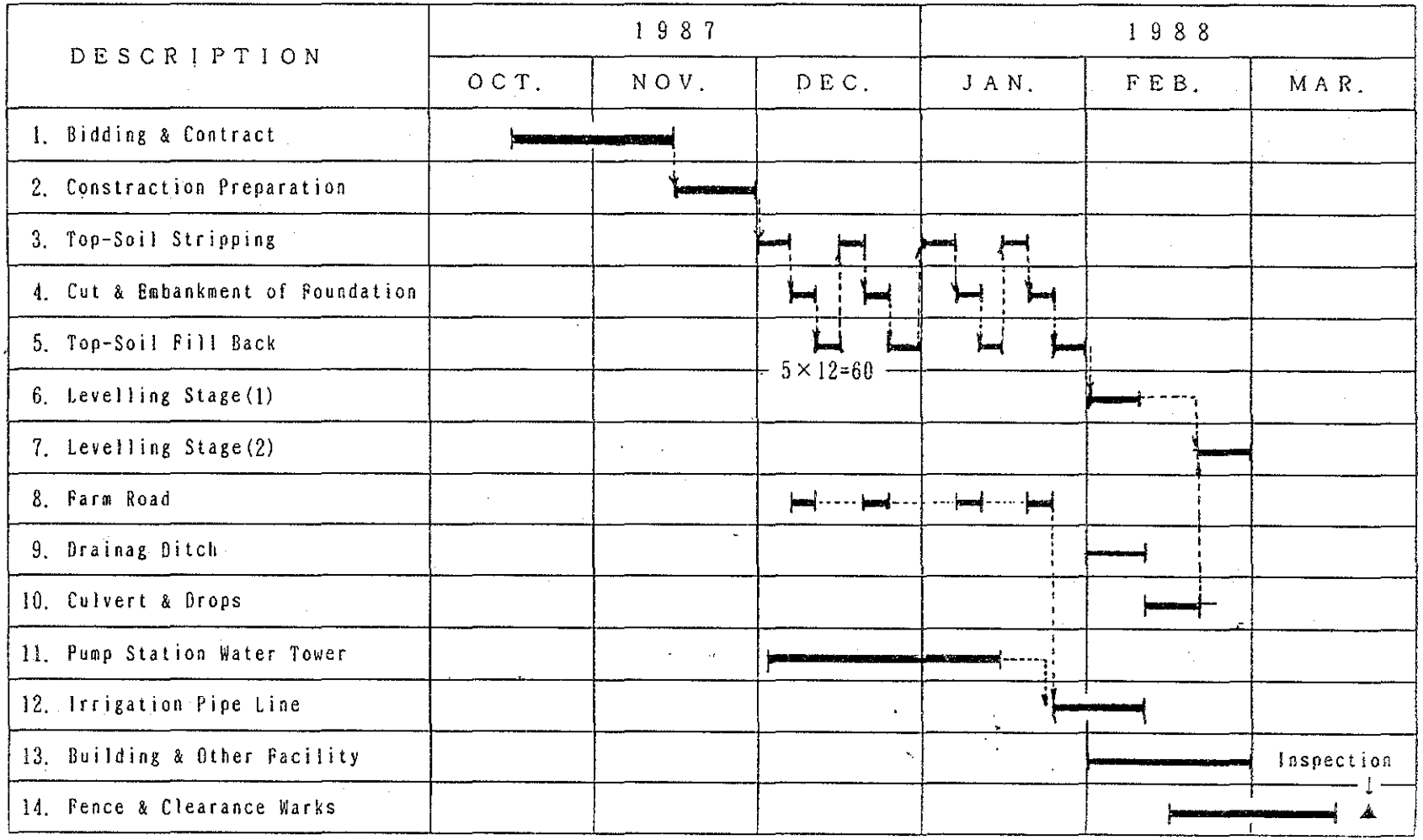


Table - 5 (H-Q) Value of Drainage Ditch

TYPE I-a I-b n=0.03 b=0.5 side slope 1:1.2 Dith slope 1/500

H(m)	0.2	0.3	0.35	0.40	0.45	0.5
Q (m³/s)	0.057	0.122	0.165			
V (m³/s)	0.385	0.474	0.513			

TYPE I-c n=0.03 b=0.5 side slope 1:1.2 Dith slope 1/750(0.00133)

H(m)	0.2	0.3	0.35	0.40		
Q (m³/s)	0.046	0.099	0.134	0.175		
V (m³/s)	0.314	0.387	0.419	0.448		

TYPE II n=0.03 b=0.5 side slope 1:1.2 Dith slope 1/1000(0.001)

H(m)	0.2	0.3	0.35	0.40		
Q (m³/s)	0.040	0.086	0.116	0.152		
V (m³/s)	0.272	0.335	0.362	0.388		

TYPE III n=0.03 b=1.0 side slope 1:1.2 Dith slope 1/500(0.002)

H(m)	0.2	0.3	0.35	0.40	0.45	0.5
Q (m³/s)				0.362	0.450	0.548
V (m³/s)				0.612	0.650	0.686

TYPE IV-a n=0.03 b=0.5 side slope 1:1.2 Dith slope 1/750(0.00133)

H(m)	0.2	0.3	0.35	0.40		
Q (m³/s)	0.046	0.099	0.134	0.175		
V (m³/s)	0.314	0.386	0.419	0.448		

TYPE IV-b n=0.03 b=0.5 side slope 1:1.2 Dith slope 1/125(0.008)

H(m)	0.2	0.25	0.30	0.40		
Q (m³/s)	0.114	0.172	0.244			
V (m³/s)	0.771	0.864	0.948			

TYPE V n=0.03 b=1.8 side slope 1:1.2 Dith slope 1/750(0.00133)

H(m)	0.5	0.6	0.7	0.8	0.9	1.0
Q (m³/s)			1.345	1.723	2.145	2.623
V (m³/s)			0.728	0.780	0.827	0.874

Table - 6

Summary Result of Infiltration (Intake Rate) Test

Project: Diversified Crops Irrigation Engineering Project

Site : DCIEP Trial Farm Soil Moisture: Wet

Date Performed: June 15-17, 1987

Observation No.	Location	Texture		Infiltration Rate (mm/hr)	
		Surface	Subsurface	Cummulative (Ic)	Basic (Ib)
1	Upland	SCL	SL	$0.1851\ T^{1.0325}$	12.63
2	Upland	SiCL	SiCL/CL	$0.1516\ T^{1.0165}$	9.61
3	Paddy Field	SiL	SiCL/ FSL	$0.1000\ T^{1.0000}$	6.00

Table - 7

Result of Percolation Test

Project : Diversified Crops Irrigation Engineering Project

Site : DCIEP Trial Farm Soil Moisture: Wet

Date Performed: June 9-11, 1987 Slope: Level to nearly level

Observation No.	Location	Texture		Passing Time (min.)	Reading (mm)		Rate (mm/day)
		Surface	Subsoil		Initial	Final	
1	Paddy Field	SiL	SCL/SL	10	0.8	2.6	1.8
2	Paddy Field	SiL	SCL/FSL	10	0.6	2.3	1.7
3	Upland Field	SiCL	SCL/CL	10	0.3	1.4	1.1

Table - 8

Result of Hydraulic Conductivity Test

Project: Diversified Crops Irrigation Engineering Project

Site : DCIEP Trial Farm Soil Moisture : Wet

Date Performed: June 18, 1987

Observation No.	Location	Soil		Test Zone (cm)	Passing Time (min.)	Water Level (cm.)	Intake (cm) Reading	Hydraulic Conductivity (m/day)
		Depth	Texture					
1	Paddy Field	0 - 28 28 - 130 130 - 190 190 - 220	SiL SCL LFS VFS	30.7 - 220	- 2 5 10	34.7 46.0 61.9 82.0	- 11.3 27.2 47.3	1.0
2 (A)	Paddy Field	0 - 25 25 - 105 105 - 155 155 - 180	SiL SCL SiL FSL	18.9 - 120	- 2 5 10	22.9 24.9 27.8 31.1	- 2.0 4.9 8.2	0.22
2 (B)				22.6 - 180	- 2 5 10	26.6 36.1 51.7 72.4	- 9.8 25.1 45.8	0.91
3 (A)	Upland	0 - 70 70 - 110 110 - 145 145 - 180	SiCL SCL GL SiC	77.2 - 120	- 2 5 10	81.2 83.7 85.7 90.0	- 2.5 2.0 8.8	0.59
3 (B)				68.9 - 180	- 2 5 10	72.9 80.5 95.2 115.0	- 2.5 22.3 42.1	1.26

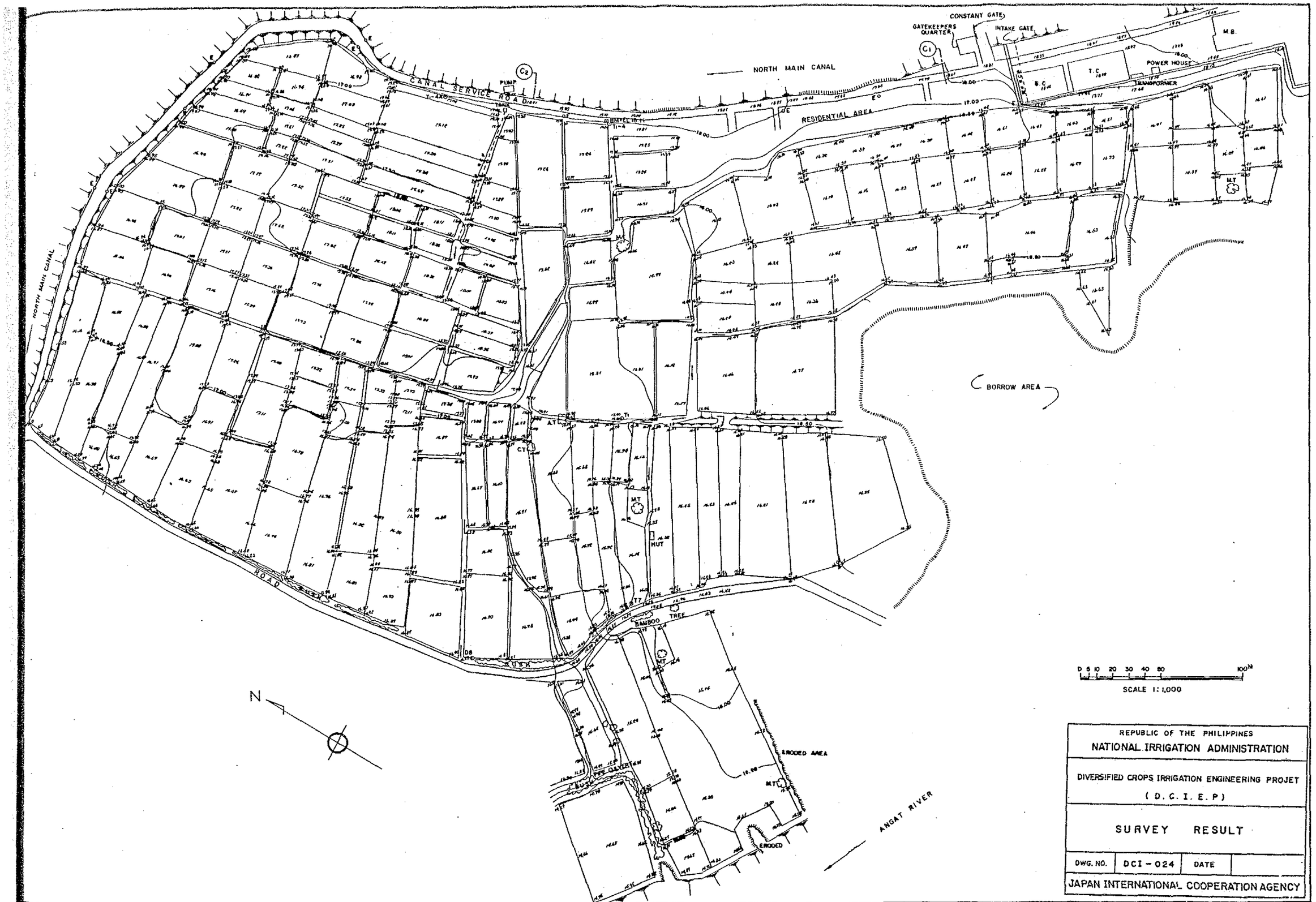
Summary Result of Moisture Ratio Analysis.

Observation No.	S O i l Layer	Depth (cm)	Apparent Specific Gravity (g/cc)	Real Specific Gravity (g/cc)	Percent Porosity (%)	Moisture Ratio (%)
1	1	5	1.69	2.63	35.74	25.49
	2	15	1.71	2.62	34.65	25.72
	3	25	1.68	2.67	37.14	26.68
2	1	5	1.68	2.66	36.84	30.11
	2	15	1.63	2.68	38.87	29.57
	3	25	1.67	2.66	37.41	28.14
3	1	5	1.76	2.61	32.56	23.58
	22	15	1.64	2.65	38.29	23.25
	3	25	1.59	2.64	39.66	23.59
4	1	5	1.40	2.64	47.16	29.33
	2	15	1.52	2.64	42.62	27.87
	3	25	1.54	2.67	42.22	25.66
5	1	5	1.67	2.60	35.77	29.72
	2	15	1.66	2.64	37.12	28.34
	3	25	1.78	2.65	32.83	25.67
6	1	5	1.93	2.65	26.98	30.47
	2	15	1.93	2.67	32.77	23.47
	3	25	1.95	2.68	27.37	21.32

Table - 10 Summary Result of Moisture Retention Test

Site No./Sample		Percent Moisture Field Capcity	Percent Moisture Wilting Point	Percent Available Moisture	pF
1	A	19.25	5.98	13.26	
	B	18.75	6.33	12.42	
	C	21.16	7.63	13.52	
2	A	19.35	8.08	11.27	
	B	21.54	8.54	13.00	
	C	20.64	8.89	15.09	
3	A	18.20	7.09	11.11	
	B	18.67	6.58	11.63	
	C	17.35	5.93	10.41	
4	A	16.02	4.57	11.45	
	B	16.15	3.21	12.93	
	C	16.21	4.26	11.95	
5	A	16.35	7.77	8.58	
	B	17.86	7.96	9.89	
	C	18.37	7.58	10.78	
6	A	18.89	8.05	10,84	
	B	19.35	7.61	11.74	
	C	18.59	6.81	11.82	

ATTACHED DOCUMENTS



REPUBLIC OF THE PHILIPPINES NATIONAL IRRIGATION ADMINISTRATION			
DIVERSIFIED CROPS IRRIGATION ENGINEERING PROJET (D. C. I. E. P)			
SURVEY RESULT			
DWG. NO.	DCI - 024	DATE	
JAPAN INTERNATIONAL COOPERATION AGENCY			

DATE June 8/97 TRIAL FARM PAGE 1

THE MUTTERING SUN IS YOUR EYES PUSHES YOU A LIGHT YEAR AWAY

STA	BS	HI	FS	RD	ELEV.
BM	.730	19.715			18.985
E-1	1.364	19.079	2.00		17.715
BM	1.108	20.589	0.108		18.971
BMTF	1.197	19.304	2.482		18.107
W-1	0.997	17.288	3.013		16.291
W-1			3.048		14.240
BMTF	2.468	20.575			18.107
E-1	0.058	19.079	1.604		18.971
E-1	1.944	15.659	1.314		17.715
BM			1.67		17.937
W-2			2.93		16.707
	0.718	18.377	2.00		17.659

STA	BS	HI	FS	RD	ELEV.
			0.32		18.055
			0.82		17.555
W-3			4.12		14.255

DATE TRIAL FARM PAGE 1

FLY and FREE

LICO, SAN RAFAEL, BULACAN

(top of retaining wall - constant ref. pt.)

TRIAL FARM

(TP)

(WS) Mid C

(TP)

(17.985) closure

(WS) ← up-station of control pt.

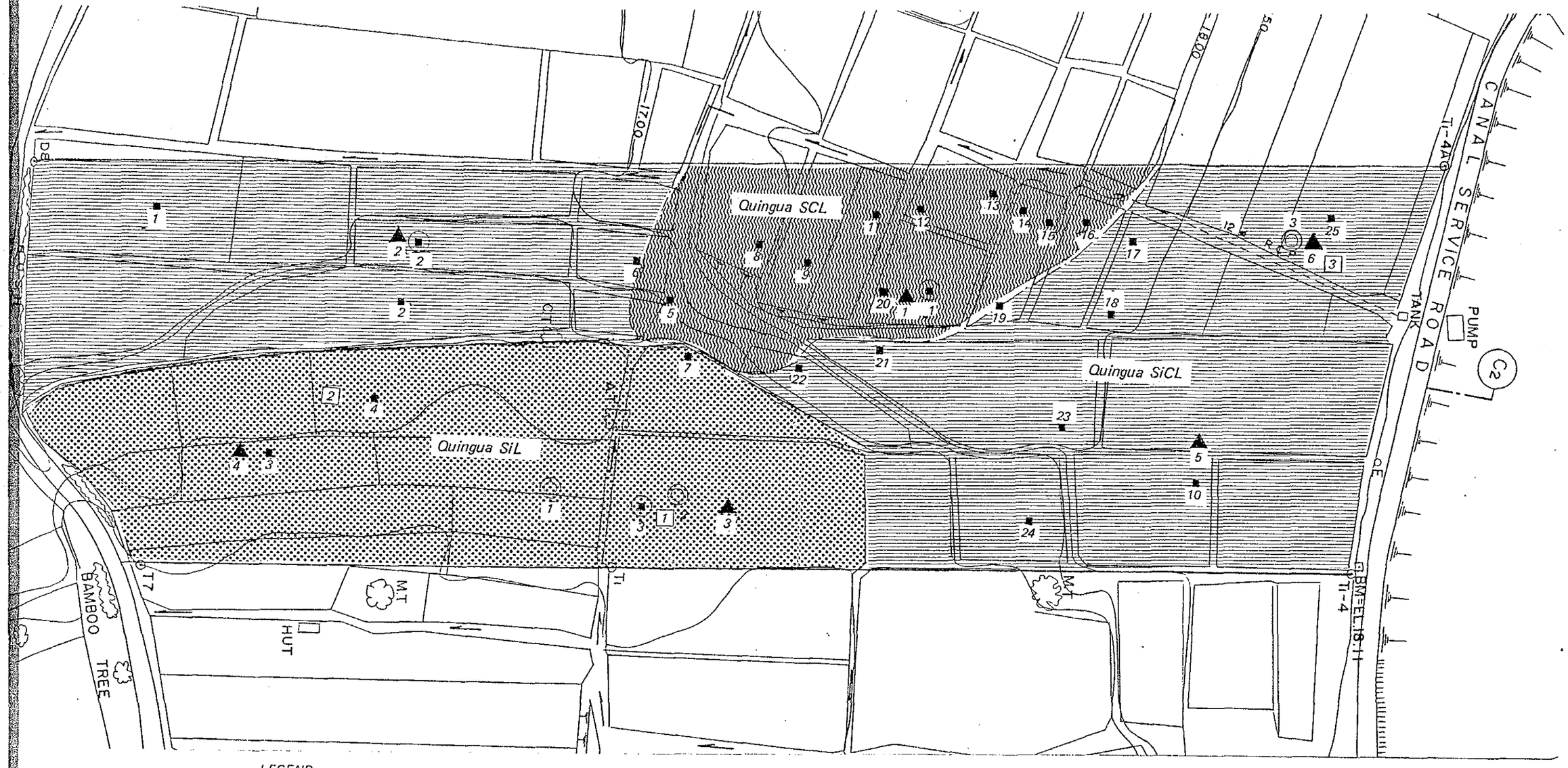
Top of control pt.

Top of TO: (inlet) Turbine pump

Top of outlet Turbine pump

(down-stream of control pt.

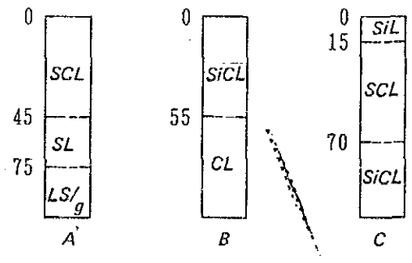
FIGURE 1. SOIL MAP OF THE PROPOSED TRIAL FARM SHOWING THE SAMPLING AND OTHER TEST SITE



LEGEND

- Soil Sampling Site
- Infiltration (Intake Rate) Test
- Percolation Test
- [1] Hydaulc Conductvity Test
- 3 Auger Boring Site

TYPICAL SOIL PROFILE



LEGEND :

- A Quingua SCL
- B Quingua SiCL
- C Quingua SiL

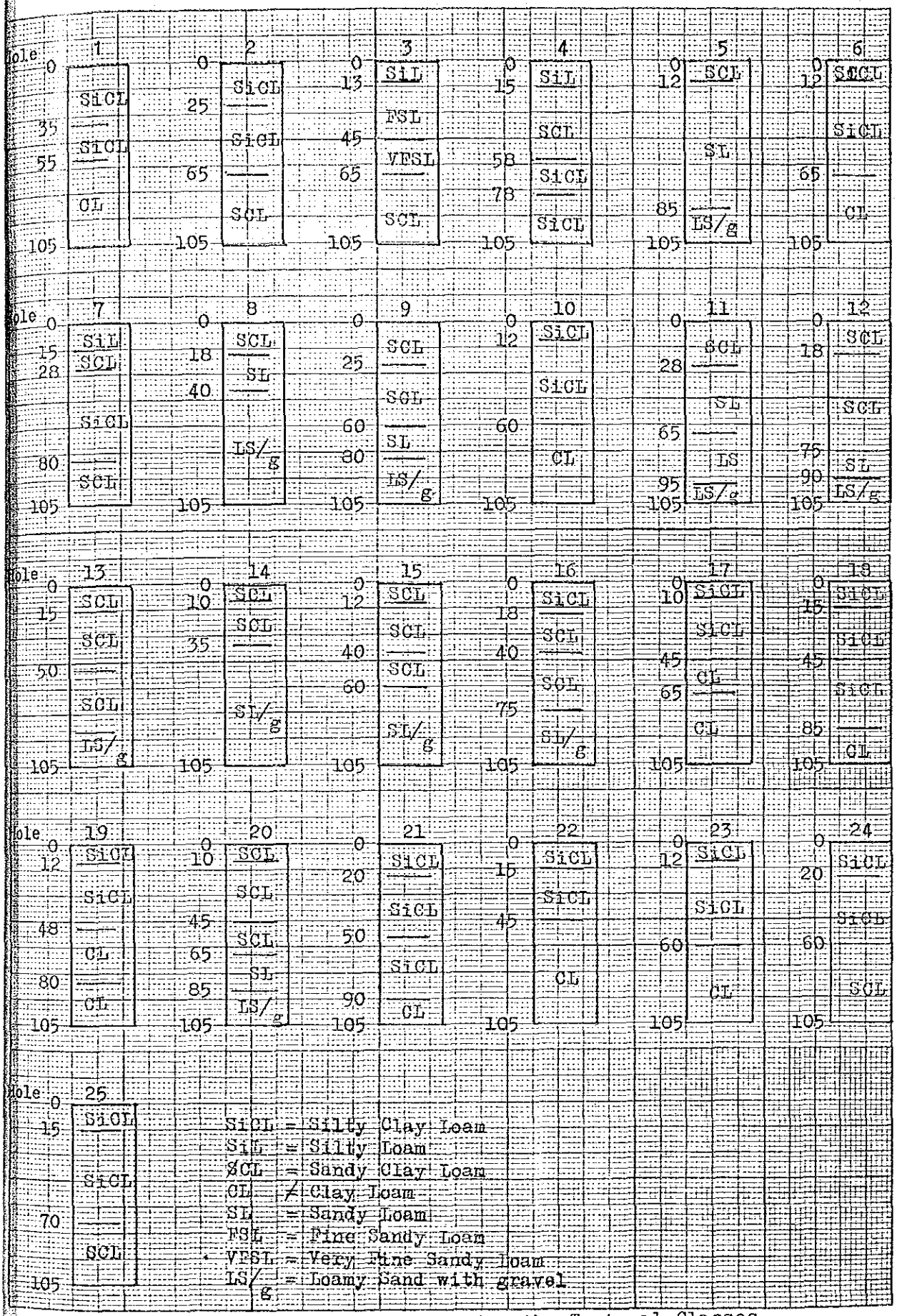
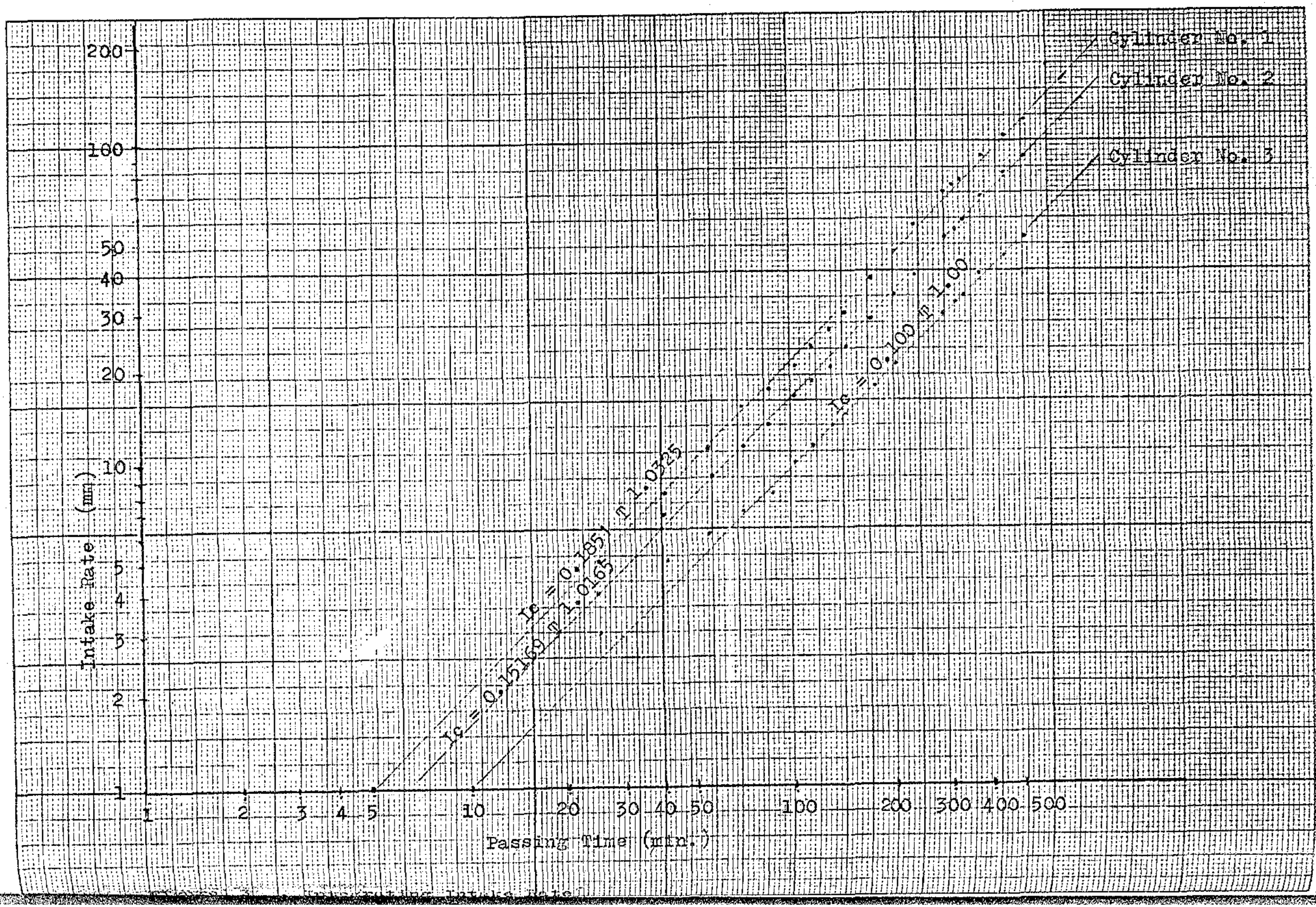


Figure 2 . Columnar Soil Profiles Showing the Textural Classes


Cylinder No. 1
Cylinder No. 2
Cylinder No. 3
Ic = 0.15169 T 1.0165
Ic = 0.185 T 1.0325
Ic = 0.100 T 1.00
Intake Rate (mm)
Passing Time (min.)
200
100
50
40
30
20
10
5
4
3
2
1
1
2
3
4
5
10
20
30
40
50
100
200
300
400
500

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)
DETAIL DESIGN SURVERY TEAM
ON
THE DIVERSIFIED CROPS IRRIGATION ENGINEERING PROJECT
IN
THE REPUBLIC OF THE PHILIPPINES

5th June, 1987

Atty. Federico N. Alday, Jr.
Administrator
National Irrigation Administration

Dear Sir,

Re: The Trial Farm of the Diversified Crops Irrigation Engineering Project in The Republic of the Philippines.

We, the team (Detail Design Survey Team on the Diversified Crop Irrigation Engineering Project) organized by JICA have been dispatched to undertake the detail design and surveys for the construction of the trial farm which is as stipulated in the clause IV of the Attached Document to THE RECORD OF DISCUSSIONS ON THE JAPANESE TECHNICAL COOPERATION FOR THE DIVERSIFIED CROPS IRRIGATION ENGINEERING PROJECT (R/D).

The team has, so far, made a series of site reconnaissances and discussions with your staff concerned in order to fix and determine the scale and size of said farm and its facilities.

We would like to hereby confirm with you the matters which were understood and agreed by you and your staff through discussions and site reconnaissances as per the attached.

In accordane with above confirmed items, we will proceed with your staff to conduct further field and surveys and investigations at the site and make the detail design on the basis of the result of those surveys. After the completion of detail design and assessment of its costs estimated by JICA, you will be informed of its result through the JICA Philippines office.

Furthermore, in order for the construction to get started smoothly we would like to request you to take the necessary formalities in due consultation with our JICA Philippines office.

Lastly, we would like to express our appreciation to you and your staff for a good offices and cooperation during our site reconnaissance and survey.

Sincerely yours,

YUJI SAKAMOTO
Team Leader

cc: President Representative of JICA in the Philippines
Embassy of JAPAN

ATTACHMENT

フィリピン畑地灌漑技術開発計画実施設計調査団

The Detail Design Survey Team
for The Diversified Crops Irrigation Engineering Project
in the Republic of the Philippines

坂元雄次	総括	農林水産省 構造改善局 建設部 設計課 課長補佐
SAKAMOTO Yuji	Team Leader	Assistant Director, Design Div., Construction Dept., Agricultural Structure Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries (MAFF)
山田潤一郎	圃場整備計画	農林水産省 東海農政局 豊川総合用水農業水利事業所
YAMADA Junichirou	Field Planning	Staff, Toyokawa Irrigation Project, Toukai Regional Agricultural Administration, MAFF
佐々木隆宏	業務調整	国際協力事業団 農業開発協力部
SASAKI Takahiro	Coordination	Staff, Agricultural Development Cooperation Dept., JICA
平塚秀夫	圃場整備設計	株式会社 三祐コンサルタンツ 海外技術第2部 参事
HIRATUKA Hideo	Field Design	Manager, 2nd Overseas Engineering Dept., Sanyu Consultants Inc.
富永豊	灌漑排水設計	株式会社 三祐コンサルタンツ 海外技術第2部
TOMINAGA Yutaka	Water Facilities Design	Engineer, 2nd Overseas Engineering Dept., Sanyu Consultants Inc.

1. Schedule of Detail Design Team in the Philippines

1) First half of the schedule.

May 25 Meeting with JICA office and R/D Mission Team

26 Courtesy call to NIA
Preparation of the field trip

27 Field trip in San Rafael site

28 Field trip in San Rafael site

29 Internal meeting

30 Internal meeting

31 Data analysis

June 1 Meeting with NIA

2 Meeting with NIA

3 Meeting with NIA
Field survey in San Rafael site

4 Report preparation

5 Final meeting with NIA and Submission of the letter, Report to JICA Office.

6 Leaving for Japan (Sakamoto, Yamada and Sasaki)
Preparation for the field survey (Hiratsuka and Tominaga)

2) Second half of the schedule - Hiratsuka, Tominaga

June 7 Preparation of field survey

8 – 16 Field survey (Topo-survey and soil-survey)

17 – 21 Analysis of field survey

22 – 23 Supplementary field survey

24 – 27 Collection of cost estimation data

28 – 30 Layout of trial farm

July 1 Meeting with NIA

2 Report to JICA office

3 Leaving for JAPAN

2. Basic Concept for the Detail Design

1) The detail design and surveys of the trial farm is carried out in accordance with the Record of Discussions between the Philippines Authorities concerned and the JICA R/D Team on the Diversified Crops Irrigation Engineering Project.

2) The trial farm is selected as shown in Fig-1 in consideration of the local conditions.

The farm is given the function of the independent irrigation and drainage system as well as farm road.

3) The irrigation water is to be obtained by pumping system from the North Canal of NIA Angat River Irrigation System throughout the year.

4) A warehouse and garage for the farming equipment is planned in the NIA National Training Center.

3. Facility Plan

3-1 Trial Farm

The area of trial farm is planned about 3.3 ha.
The design of trial farm will be carried out in ~~taking into~~ consideration of the following points.

- to design farm plots in the same size for easy operation and easy analysis;
- to design the standard size of farm plot in (25m x 40m);
- to make each farm plot level as paddy field in wet season;
- to be available of plot to plot irrigation method;
- to locate the farm road along the center line of trial farm.
- to locate the drainage canal at the both side of trial farm;

The tentative general plan of trial farm is shown in Fig-2.

3-2 Irrigation Facilities

1) Pumping System

Water turbine pump system and Diesel driven pump system are proposed as alternatives shown in Fig. 3.

After making cost evaluation of the construction, operation and maintenance, the pumping system shall be selected.

The elevated water tank will be located near the pump station to control the water head of irrigation pipeline.

2) Irrigation Pipeline

The design of irrigation pipeline which is aligned along the farm road will be carried out in ~~taking into~~ consideration of the following points.

- to facilitate the inlet with flow-meter at each farm plot;
- to give 0.2kg/cm² water head in minimum at each inlet;
- to facilitate flow-meter at the entrance of trial farm to measure the total water supply;

3-3 Other Facilities

1) Warehouse and Garage

Warehouse and garage is planned at the place between the main building and the tennis court.

2) Compost Shed

Compost Shed will be located at the entrance of trial farm.

4. Working Schedule for Detail Design

Based on the basic concept of detail design as mentioned above, the detail design will be carried out according to the following schedule.

4.1 Field works in the Philippines (Jun. 6 - Jul. 2, 1987)

1) Field survey for design works

The field survey for design works will be carried out at the selected trial farm site. The field survey will cover the following items.

a) data collection

hydraulogical data, water level record at the constant gate, operation record of the constant gate, data for cost estimation

b) topo-survey

travers surveying, leveling, plane table surveying, bench mark surveying

c) soil survey

Intake rate of the field, field capacity, permeability test

d) construction material survey

2) Preliminary design works

Based on the results of the field survey, the preliminary design works will be carried out. The design works will cover the following items.

a) general plan of trial farm

b) typical cross section and typical longitudinal cross section of trial farm

4.2 Home Office Works in Japan (Jul. 4 - Aug. 2)

Based on the results of the works in the Philippines, the detail design report will be prepared in Japan.

5. OUTLINE OF THE SCHEDULE ON INFRASTRUCTURE IMPROVEMENT WORK

	Japanese Side	Philippine Side
1987 May		
	Formulation of Basic Design	Preparation of land
June		
July	Detail Designing	
Aug.		
	Submission of Final Report	Forwarding of Form A1 for Expert
	Consultation with Ministry of Foreign Affairs JAPAN	Request of Construction Work
Sep.		
	Exchange of Verbal Note	
Oct.	Dispatch of supervising Expert	
Nov.	Start of Construction Work	

Fig. 1 LOCATION OF TRIAL FARM

S=1:2000

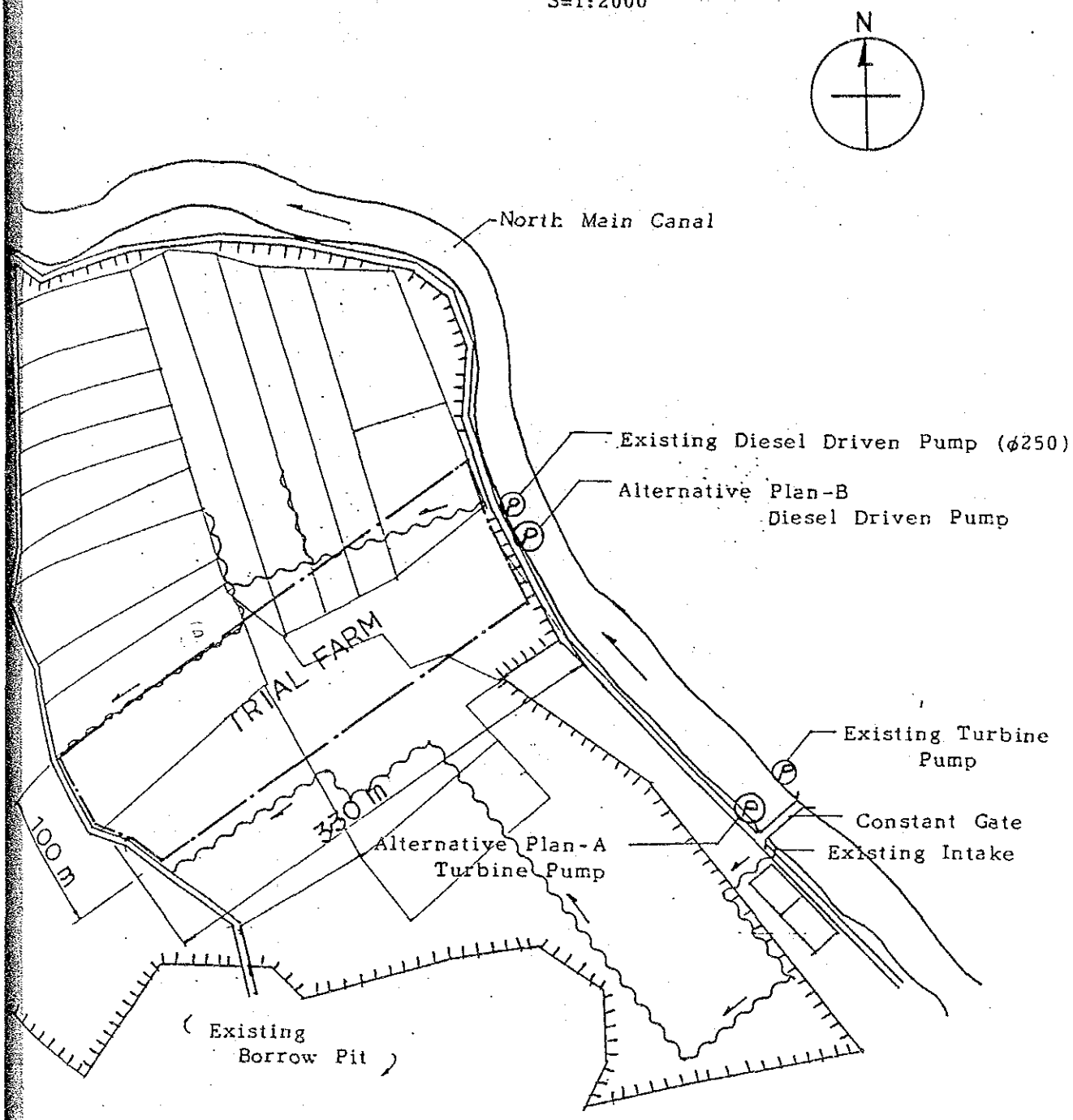


Fig. 2 TENTATIVE GENERAL PLAN OF TRIAL FARM

S = 1:2000

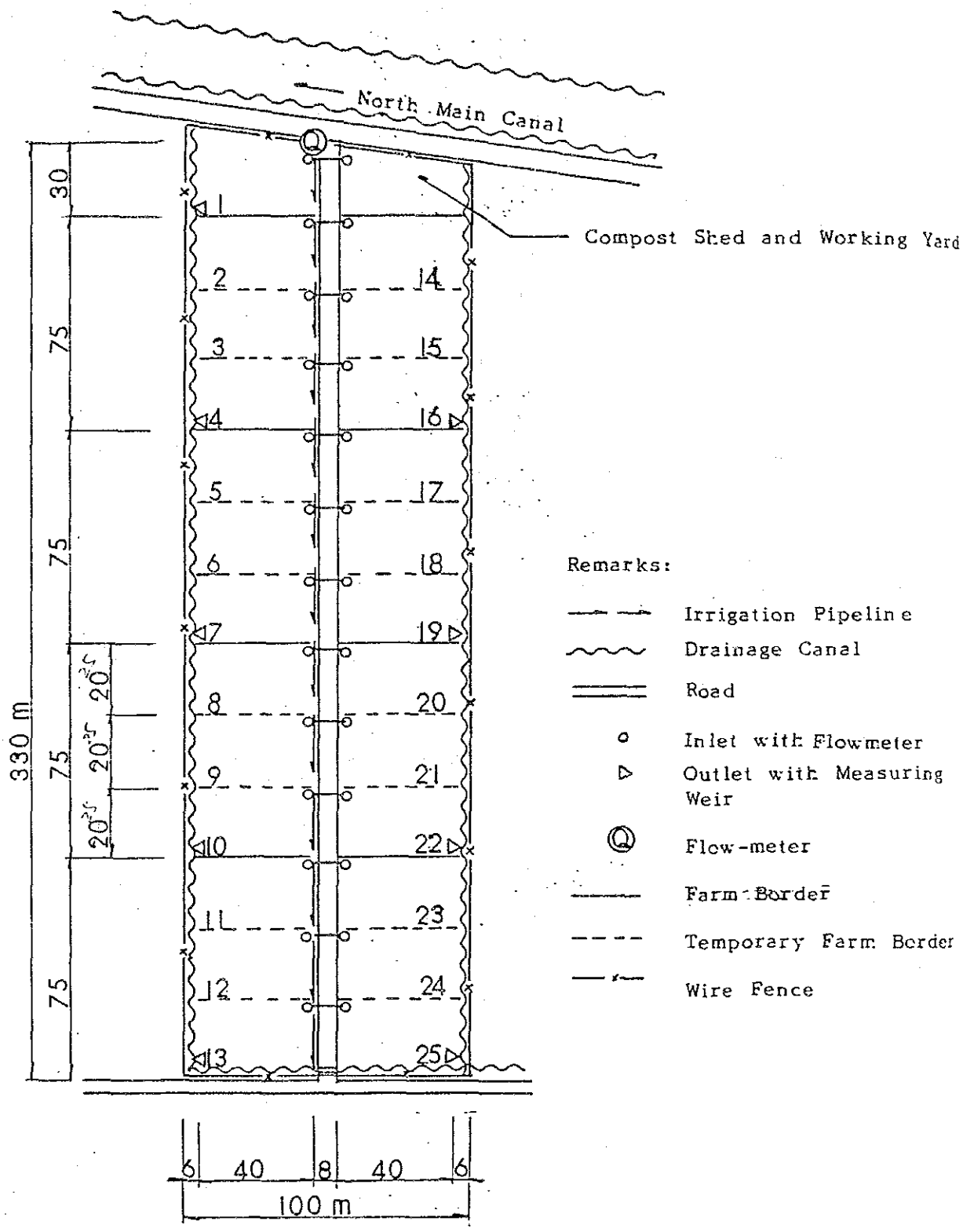
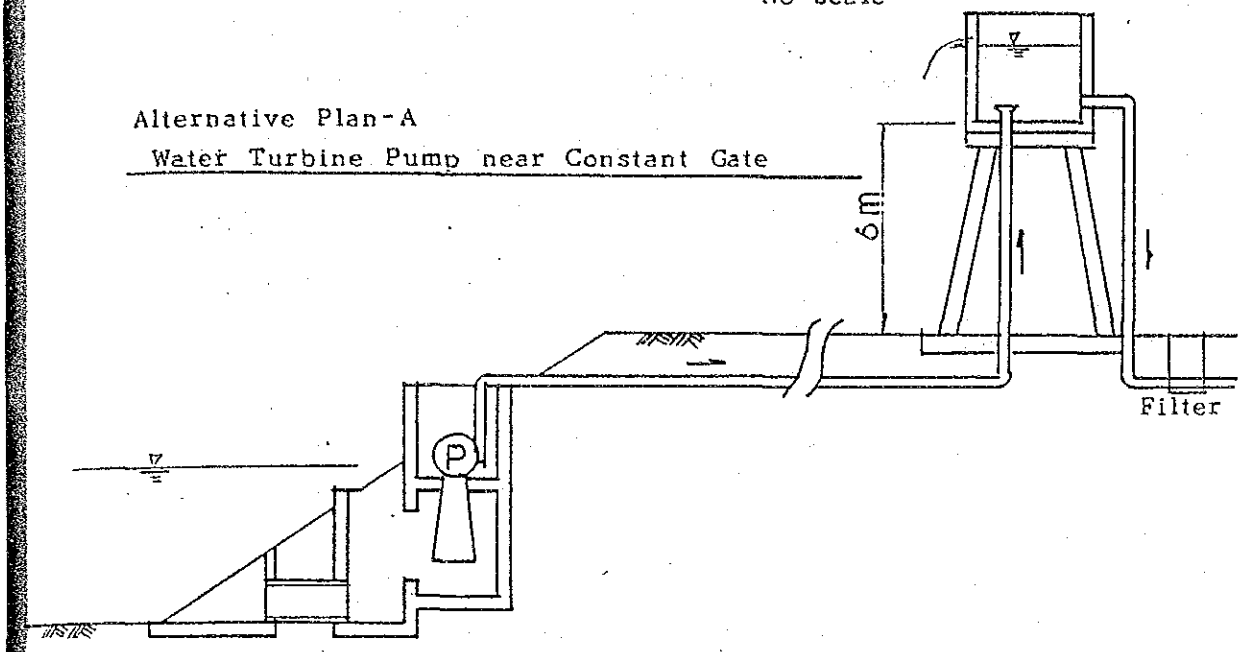


Fig. 3 ALTERNATIVE PLAN OF PUMPING SYSTEM

No scale

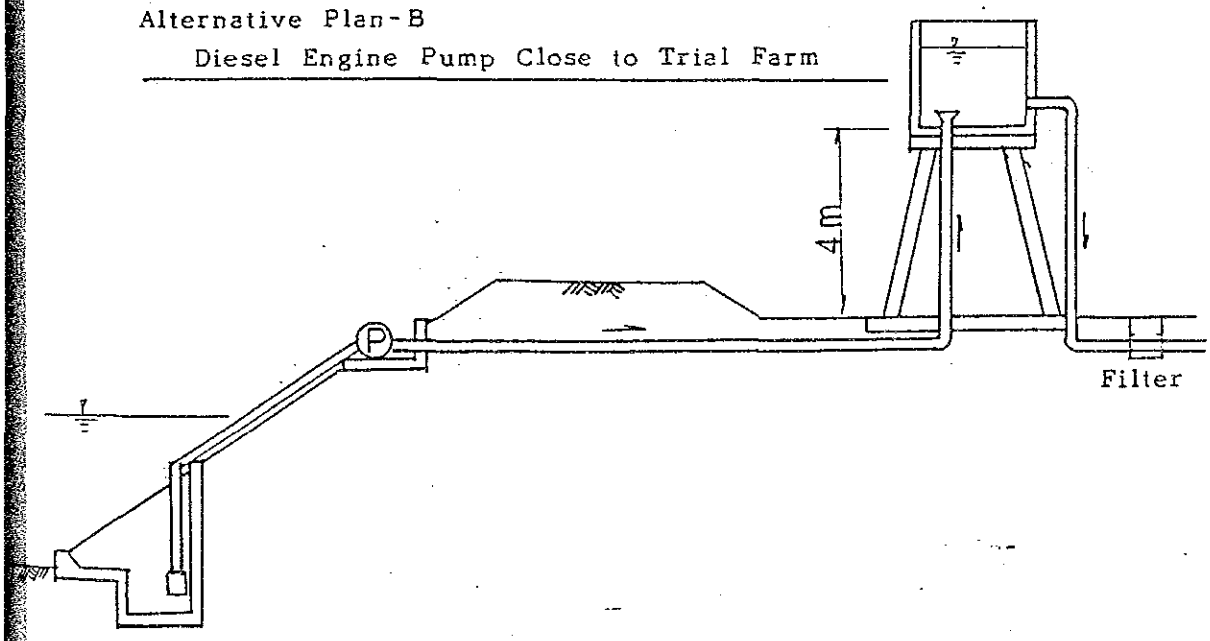
Alternative Plan-A

Water Turbine Pump near Constant Gate



Alternative Plan-B

Diesel Engine Pump Close to Trial Farm



JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)
DETAIL DESIGN SURVEY TEAM
ON
THE DIVERSIFIED CROPS IRRIGATION ENGINEERING PROJECT (DCIEP)
IN
THE REPUBLIC OF THE PHILIPPINES

July 2, 1987

Serafin A. Palteng
Project Manager of DCIEP
National Irrigation Administration

RE: FIELD SURVEY AND PRELIMINARY DESIGN WORKS OF THE TRIAL FARM

Dear Sir,

In accordance with confirmed items concerning the Trial Farm between the National Irrigation Administration (NIA) and Detail Design Survey Team on June 5, 1987, we, Detail Design Survey Team, have completed with your staff the field survey works and the data collection during the period of June 6 to July 1.

In this regard, we would like to submit herewith the completed works as per attached. On the basis of the result of those surveys we will proceed with the detail design work and its cost estimation in Japan.

Lastly, we would like to express our heartfelt appreciation to you and your staff for a good cooperation.

Sincerely yours,

HIDEO HIRATSUKA
Surveying Member

cc: President Representative of JICA
in the Philippine Embassy of Japan

- ATTACHMENT -

1. FIELD SURVEY WORK

a.) Topo-Survey (about 20 ha.)

- traverse surveying
- plane table surveying (7.5 ha.)
- chain surveying (12.5 ha.)
- bench mark surveying (1 Bench Mark)
- leveling (20 ha.)
- cross section of North main canal (2 sections)

The Topo-Survey result (topographical map) is attached to Drawing No. 001.

b.) Soil-Survey (at the proposed trial farm)

- intake rate test (cylinder) 3 sites
- percolation test 3 sites
- soil profile by boring stick 27 sites
- hydraulic conductivity test 5 sites
- permeability test by dry auger-hole
- soil moisture and pF 54 samples

c.) Data Collection

For Design Work Use

- Water elevation at Bustos Dam (1986)
- Discharge of North Main Canal (1985 - 1987.3)
- Table of Discharge (Automatic Constant Discharge Gate) North Main Canal, Sta. 0 + 400
- Operation Schedule of Constant Gate at North Main Canal
- Daily Rainfall Record (1970-1979 , 1984-1986)

- Hourly Rainfall Record (July 1972, October 1973 & Aug. 1974)
- Maximum Rainfall Amount of Various Duration (1969-1975)
- Drawing For Reference
  - Structure of Turbine Pump, Elevated Tank, Fence, R.C.P. Bend

For Cost Estimation Use

- General Construction Cost (By NIA)
- Cost of P.V.C. Pipe, Gate Valve, Strainer, Flow Meter, Steel Pipe (Manila Supplier)

2. PRELIMINARY DESIGN WORKS

- General Plan of Trial Farm (Drawing No. 001)

REPUBLIC OF THE PHILLIPPINES

BID DOCUMENTS

ON

TRIAL FARM

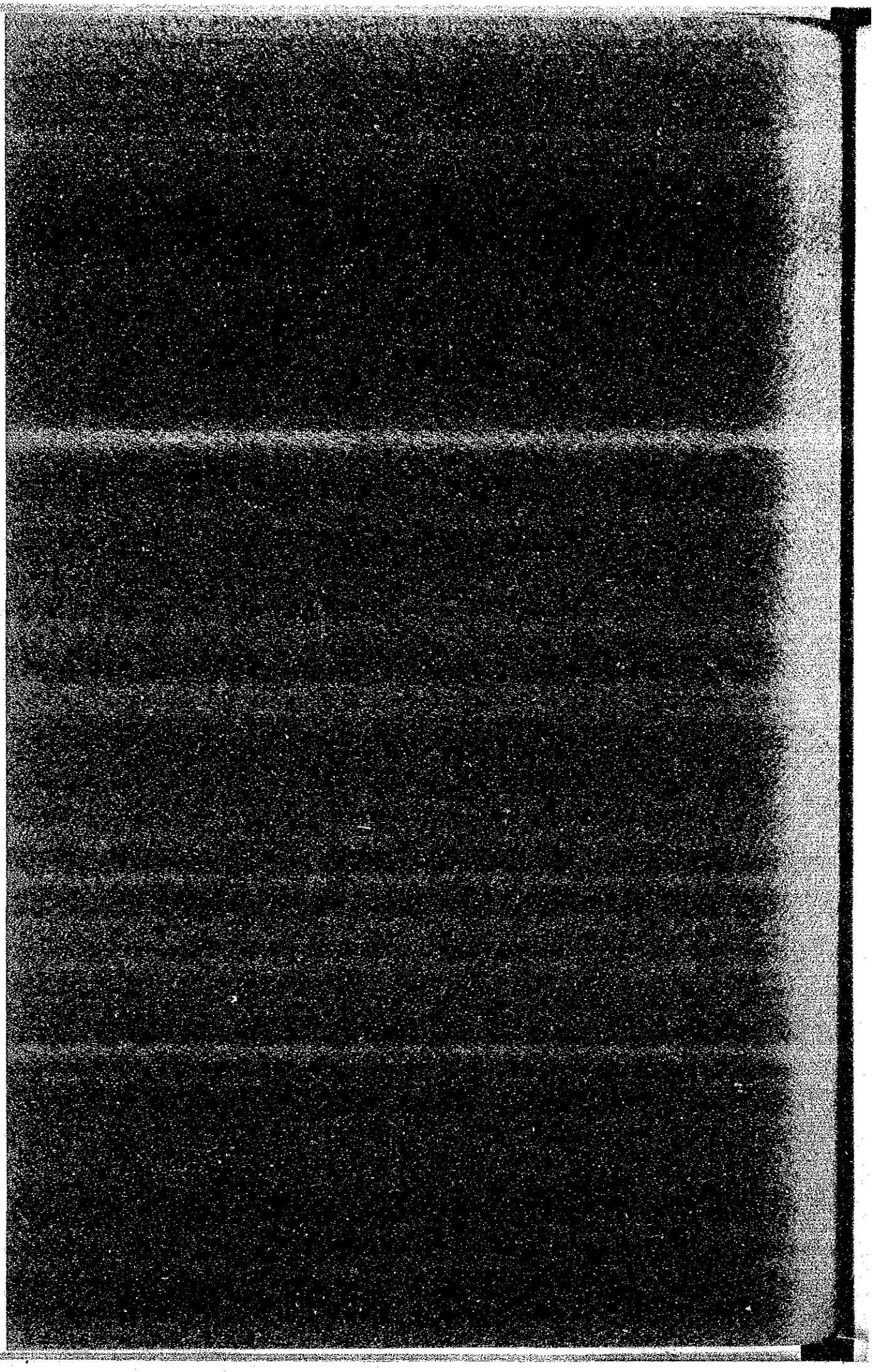
FOR

DIVERSIFIED CROPS IRRIGATION ENGINEERING PROJECT

(D. C. I. E. P)

AUGUST 1987

JAPAN INTERNATIONAL COOPERATION AGENCY



REPUBLIC OF THE PHILIPPINES

BID DOCUMENTS

ON

TRIAL FARM

FOR

DIVERSIFIED CROPS IRRIGATION ENGINEERING PROJECT

(D.C.I.E.P)

AUGUST 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

LIST OF BID DOCUMENTS

ON

TRIAL FARM

FOR

DIVERSIFIED CROPS IRRIGATION ENGINEERING PROJECT

(D.C.I.E.P)

I. INVITATION TO BID

II. INSTRUCTIONS TO BIDDERS

III. GENERAL CONDITIONS

IV. BID FORM

V. CONTRACT FORM

VI. TECHNICAL SPECIFICATIONS

VII. BILL OF QUANTITIES

VIII. DRAWINGS

I. INVITATION TO BID

INVITATION TO BID

THE JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)
MANILA, THE PHILIPPINES

INVITATION TO BID NO.

The Japan International Cooperation Agency (hereinafter designated as the JICA), through its Reprensentative Office in Manila, the Philippines, hereby invites sealed written bids for construction works of Diversified Crops Irrigation Engineering Project.

The project is the construction of trial farm and aims to establish appropriate irrigation methods on diversified crops in the dry season.

The project area is located in San Rafael, Bulacan province, 55 km north far from the Metropolitan Manila.

The Contract will be let for the following works:

1.	Land Reclamation Works	3.5 ha
2.	Road Works	400 m
3.	Drainage Canal Works	1,000 m
4.	Pipe Line Works	350 m
5.	Appurtenant Facilities by Pipeline	
6.	Installation of Volute Pump (ø80 mm Diesel Driven Type)	2 sets
7.	Building Works	
8.	Other works	

General Engineering Construction Contractors who have Contractor's License and experience in the similar construction works to the above are invited to bidding in submitting necessary bid documents to the following address not later than the date ( ) given in the Bid Notice.

Address:

The bid opening will be held at ( ) o'clock (a.m./p.m) (date) at ( ).