2.3.2.3 Design of Dam Structure

(1) Design Concept

The design concept for dam structure is summarized as follows:

(a) The dam, spillway and intake structures are designed in consideration of the sufficient safety/stability against external forces, long-term durability of structure, easy & reliable operation, economic advantages, and so on.

(b) The annual rainfall in the region ranges from 2,900 mm to 3,000 mm of which more than 90% is distributed during the rainy season, from May to October. The spillway is designed with enough capacity to release the flood flow during the rainy season in order to prevent the overtopping from the dam. It is planned to construct the dam within the period of only two dry seasons (the foundation works in the first dry season and embankment in the second dry season).

(c) The geological investigation found that the river deposit is deep ranging from 6 m to 9 m. These deposits will be excavated and replaced by core materials to prevent the seepage through the dam foundation. The excavation line of the dam abutment will be determined, because of deep overburden, in consideration of bearing capacity and seepage rate from the foundation. For the design of foundation, the grouting is necessary due to the results of the geological survey with permeability test. The grouting range is determined in consideration of the distribution of weatherd rock layer with relatively high permeability.

(2) Design Conditions

The design conditions for dam in connection with geology, hydrology, embankment materials, and reservoir water level are as follows:

(2.1) Geology

The drilling survey with the permeability test was carried out at the damsite in 1996 as well as in 1997. The geological conditions are obtained as summarized as follows:

- The abutment slopes on the left and right banks are approximately 20° and 10° respectively. According to the results of the geological investigation at

the dam foundation, the solid rock of gabbro is covered with weathered soil and weathered or clayey rock (D class) of approx. 10m in depth.

- The layer of highly weathered rock of 3 - 5m deep with N value of more than 30 is located from the rock surface.
- The foundation layer under the highly weathered rock is hard rock of CL class.
- The width of the river bed is approxi. 30 m and covered with approx. 9 m depth of deposits composed of sands and gravels.
- The weathered rock zone has the permeability coefficient of a order of 10^{-3} cm/s and the riverbed has a order of 10^{-2} cm/s . However, the solid rock zone under the weathered rock has very low permeability with less than 5 Lugion.

(2.2) Embankment Materials

The material investigation was carried out by boring, test pitting, and laboratory test in 1996 as well as in 1997. As the results of investigation, the main locations of for the embankment materials are selected as follows:

Core materials	:	Blended materials of soil and sand & gravel
		- Upstream right bank abutment (TP-25)
		- Downstream riverbed (TP-16 to 19)
Filter materials	:	River deposits
		- Downstream riverbed (TP-16 to 19)
Random materials	:	River deposits
		- River deposit in the Nayom river (TP-12)

Note : It was decided that silt rock is not be used according to the laboratory test.

(2.3) Reservoir Water Level

According to the required volume of water for irrigation, and the estimated sedimentation volume in the reservoir, the normal high water level and the low water level are determined as follows:

Normal high water level	:	El. 52.00 m
Low water level	:	El. 37.00 m

(2.4) Design Flood

According to the design criteria of NIA, 50 years or 100 years return period of flood is adopted for the design flood of small reservoir. However, it is decided to adopt the probable maximum flood (PMF) for the design inflow in consideration of the reliable safety. PMF is calculated to be a flood with peak inflow of 736 m^3/s at the proposed dam site. The inflow is regulated by the storage function and the design discharge of spillway is obtained at 565 m^3/sec.

(3) Basic Design

(3.1) Dam Axis

The upper dam axis is selected from the three alternatives based on the geological and topographical conditions of the dam site. This axis has an advantages of easier works for river diversion during construction and also less volume of the dam due to the narrow width of the river valley and also comparatively shallow depth of river deposit. (See : Section 2.3.2.2)

(3.2) Dam Type

The type of dam is generally selected based on the syntetic study from the viewpoints of the conditions of topography, geology, spillway capacity, quality of embankment materials, quantity of works, and construction cost. The topography at the damsite is gentle. There are relatively thick weatherd soil layer and weatered rock layer underneath. The riverbed has approx.9 m deep gravel sedimentation.

The fill type dam is selected to be suitable for the geological conditions at dam site and the availability of embankment materials from the nearby areas. And the zoned fill type with center core is adopted to make sure of its safety and also to use the local materials effectively.

(3.3) Design of Dam

(3.3.1) Dam Height

The dam height is determined from the study on some aspects such as reservoir capacity, sedimentation volume, and the design flood. In addition, the wave height and some allowances are added as a surplus height. The wave hight of the reservoir is estimated from the combination of SMB method and Saville method on the following conditions:

- Fetch	:1,400 m
- Slope of dam embankment	:1:3.0
- Slope material of slope	:Rock
- Wind velocity	:30 m/sec
- Height of wave by wind	:0.55 m (< 1.0 m)

The minimum surplus height is decided at 2 m above FWL according to the Japanese standard for a fill-type dam with an ungated type of spillway. The crest elevation is determined at El. 57.00 m by adding the minimum surplus height and some ajustment height above FWL (El. 54.66 m) . The height of dam is thus 34 m from the river bed foundation.

(3.3.2) Foundation Excavation Line

The excavation line for core zone foundation is determined to be a foundation layer of DH - CL class with sufficient bearing capacity and with N value of more than 50 where the use of grouting packer is considered to be effective. On the other hand, it seems to be difficult to improve the highly weathered zone only by cement grouting method and therefore it is decided to use a blanket method together. The excavation depth for foundation is determined at approx. 10 - 12 m on the left abutment, approx. 10 m on the right abutment, and approx. 9 m on the riverbed. On the other hand, the foundation for the randum zone is determined at a layer with a certain level of bearing capacity and shearing strength (A layer with N value over 20, in general).

(3.3.3) Embankment Materials

The embankment materials are composed of soil, gravels and rocks. These materials are obtained from the nearby sites of which locations are tentatively decided as shown in a figure attached in the Appendices. The design criteria of soil materials and random materials are determined in reference to the results of laboratory test. (Refer to the

Appendixes for the deign values)

(3.3.4) Zoning for Dam

The zoning of dam is composed of impervious zone, semi-pervious zone, and pervious zone. These zones are arranged adequately to prevent the movement of embankment materials. The zoned type is adopted for this dam, as it is confirmed from the material survey that there are not sufficient volume of economically acceptable and physically sound rock materials for a rockfill type dam.

(3.3.4.1) Width of Dam Crest

The width of dam crest is generally determined on the basis of synthetical considerations on the safety of the dam from the points of wave and seepage and also the utilization of crest area for construction works and traffic. The crest width of 7 m is decided in reference to the examples of the existing dam of which width is generally 6 - 9 m.

(3.3.4.2) Impervious Zone (Core Zone)

(a) The thickness of core generally corresponds to 30 - 50 % of the water depth of the reservoir. Therefore, 50% of the water depth is adopted for the thickness of the core zone considering the safety side against the seepage. While the top width of the core zone is 4.0 m and the gradient of upstream and downstream slopes are 1: 0.25 respectively.
(b) The permeability coefficient for core materials is decided to be less than 1×10^{-5} cm/sec.
(c) The core materials is decided to be blended by soils and riverbed sands & gravels as the soils/silt materials contain too much fine particles. The blend-ratio may be decided after the laboratory tests during the supplementary survey, however the soil material would be blended with one - two times of sands materials in volume.

(3.3.4.3) Semi-Pervious Zone (Filter Zone)

(a) The filter zone is provided to prevent the runoff of core materials and to safely drain the seepage water.

(b) The materials are selected based on the standard for filter zone.
(c) The thickness of filter zone is 2 m considering the working conditions.
(d) The sand and gravel from river deposit are to be used for the filter zone.

(3.3.4.4) Pervious Zone (Random Materials)

The rock and gravel materials with enough shear strength is used for the random zone to keep the stability against the sliding. The design values are decided according to the results of laboratory tests.

(3.3.4.5) Slope Protection

(a) Riprap is placed on the upstream slope of the dam from the crest to 1 m below LWL. These materials are used to prevent the upstream surface of the embankment from erosion against the wave action.
(b) Gravels from the river deposit are used for riprap.
(c) Downstream slope protection is covered with grasses for the beautification and also to prevent from soil erosion due to rain.

(3.3.5) Foundation Improvement (Foundation Grouting)

(A) Curtain Grouting

The excavation line benieth the core zone is decided by the uppermost boundery of the hardly weathered rock, of which N-value is above 50, because a packer can be set on the drilled wall of grouting hole, and water pass way along the crack can be shut by grouting in this zone.

And solid rock in the deeper zone shows low permeability, thus the curtain and the blanket grouting designed in B/D stage might be enough to improve this section. Grouting plan is shown in Figure 3.3.2.3-1 of which hole pitch is 3.0m both in curtain and in blanket, and the depth is 1~3 stage into CM classs rock in curtain, one stage in blanket.

Moreover, at UBH-1 in the left bank and at UBH-9 in the right bank, the ground water level is higher than the flood water level(EL.54.0m), then rim grouting line is designed towards each bore hole, until the ground water level reach EL.54.0m.

Under the slope of both bank, there is high permeable zone, where the ground water seap in the hardly weathered rock under Darcy's formula. In order to shut small water passway, "Double-piped double packer grouting" or "Underground concrete wall" is efective, but these methods are difficult to accept by the problems of cost and workability. This time, core blanket from the upperstream end of the core-zone toward the reserver is designed in order to reduce the water seapage by elongating passway.

By taking core blanket method, purpose of curtain grouting can be limited to shut the water passway along cracks. Then grouting works are still effective even if injection hole pitch is expanded from 1.5m to 3.0m, in considering few cracks in the deep rock foundation.

By the way, it is necessary to investigate in the next D/D stage the distribution, characteristics, the way of water seapage, and effectiveness of grouting works, of the highly permeable zone showing $k=10^{-3}$ in order.

The bottom of curtain grouting should be half deep as the hight of the dam, because solid rock foundation under weatered rock shows low permeability, under 5Lu.

(B) Blanket Grouting

About blanket grouting, injection holes are designed to place in 4 lines at river bed, in 2 lines at lower part of both bank, in single line at higher part, in every 3m pitch. The injection holes should be 5m deep.

(C) Core Blanket

As above-mentioned, core blanket method is to controll water seapage under Darcy's formula by elongate passway. The requiered length of core blanket to reduce water seapage is decided by the examples of other dam shown in the following table, because the information about under dam foundation is not enough to effective analysis.

Table Earth Blanket , Comparison with the Actual Examples

Name of Dam	Location	Dam height (H)	Geology	Thickness of layor (m)	Seepage coefficient of Foundation	Seepage coefficient after Improvement	Earth balanket	
							Thick-ness	Length
Kanna	Okinawa	37.0m	Gravel*	10**	$1\sim9\times10^{-4}$	10Lu***	1.5m	15m
Kurashiki	Okinawa	33.5m	Sand	15	$1\sim9\times10^{-3}$	10Lu***	1.5m	40m
			Gravel	Max.40	$1\sim9\times10^{-4}$	5Lu***	1.5m	80m
Sanfelipe	Infanta	34.0m	Weathered gabro	5~10	$1\sim2\times10^{-3}$	?	1.5m	- (1H)

* Located in the Maximum section.

** Two satges from the foundation surface.

*** Improvement by using a double packer method.

To be checked by the seepage analyses.

For a verification, permeability analysis on the model that estimated by present information. As shown in Figure 3.3.2.3-5 for a result, appropriateness of a temporary design was confirmed. It is necessary to verify again after geologic distribution, permeability, groutability under damfoundation are studied well.

(D)Sparce Grouting under Core Blanket

In order to prevent pipe flow and piping at the contact of core foundation, and also to shut water passway under core blanket, sparce grouting should be designed at the foundation of core blanket.

The injection holes are set in 10m pitch in every 5m pitch rows.The injection hole sould be 5m deep.

These grouting design is shown in figure 3.3.2.3-6.

(3.3.6) Stability of Dam

The circular arc or slip circle method is applied for the stability analyses of the dam as well as the foundation.

The analyes are carried out for the following cases:

(a) Immediately after completion
(b) Normal high water level

The applied values for the stability analysis are shown in the data of Appendices and the safety factors obtained from the stability analysis are shown below. Seismic coefficient of 0.15 is applied for the case of normal high water level and 0.075 for the case of immediately after the completion respectively.

Slope	Immediately After Completion		Normal High Water Level	
	Normal	Earthquake	Normal	Earthquake
Upstream Slope	2.42	1.93	2.32	1.21
Downstream Slope	2.03	1.66	2.02	1.38

(3.3.7) Seepage Analysis

The following items are studied for the seepage of dam body.

(a) Estimate of seepage discharge through dambody and foundation.
(b) Stability of dam body and foundation affected by seepage (piping).

The grouting & impervious balanket are provided to reduce the seepage from foundation. The results of seepage calculation are as follows:

(a) Seepage through dam body
The seepage through impervious zone is calculated by the flow nets method indicated in the following formula.

$$Q = \Sigma \Delta q = \Sigma \cdot k \cdot H / L \cdot \Delta x$$

Where : Q = seepage quantity (m^3/s)

Δ q = seepage quantity per unit width (m^3/sec)

k = coefficient of permeability (m/s)

H = Total head (m)

L = Flow length (m)

The results of calculation are shown as follows:

Normal High Water Level (m)	Coefficient of Permeability (m)	Seepage Quantity (m^3/day)
52	1×10^{-7}	40

(b) Seepage through Foundation

About water seapage through dam foundation, total quantity and the verocity will be reduced by grouting and core blanket.

	NHWL (m)	Downstream WL (m)	Seepage Width (m)		Seepage quantity (cu.m/day)	Max. Velocity (cm/s)
River bed	52.0	30.0	140	Curtain grouting	66	1.28×10^{-6} *
Abutment	52.0	30.0	100	Earth Blanket	67	2.35×10^{-6}

* : In the case of grouting in the weathered rock.

Quantity: Q=40+66+67=173m3/day

The limitation of quantity is 0.05% of all water storage per day in case of dam for illigation.

The limitation is 4,600,000m3×0.0005=2,300m3/day, which is much more than

the seapage.

In order to make safe against piping, filter zone will be on the both side of core zone, and grout will be injected into foundation.

Thus maximum verocity of seapage is 10-6cm/s which is less enough than the limitation verocity for piping.

(3.4) Design of Spillway

The points of spillway design are summarized below:

- The spillway is a designed as a structure to have enough capacity to outflow the design flood.
- The ungated type of spillway is selected in consideration of the small catchment area of the reservoir
- The spillway is constructed at the right bank of the dam from the topographic and geological viewpoints.
- In consideration of the topographical, geological, and hydrological conditions, a side spillway of ungated type is selected due to the topographic of condition with comparatively steep slope
- The length of side spillway is decide to be 65m with the overflow depth of 2.66 m at the design dischsrge from the study results on the construction cost, past examples, hydraulic stability of flow, topograpgy, foundation geology, etc.
- The spillway is arranged to keep away from the small valley located downstream of the dam axis and to shorten the length of the spillway.
- The whole structure is placed on the foundation with more than 30 of N values to have sufficient bearing capacity.
- The stilling basin is provided at the end of the chute way to control the energy of outflow and to keep the steady flow to the downstream river. The USBR type II is adopted for effective energy dissipation.
- The conrol bridge with the width of 3.0 m is provided at the dam crest over the spillway.

(3.5) Design of Intake Structures

It is decided that the bottom outlet for the irrigation water supply is located on the right bank side from the alternative study based on the geological survey results. An inclined-type conduit is adopted as the intake facility in consideration of the intake volume, purpose of use, management system and also the economic viewpoint. The inclined conduit gate is to be set up on the natural ground for stability. A 1,800 mm dia. steel pipe for the temporary drainage pipe will be used for the bottom outlet. Steel pipes will be held in the bedrock in order to avoid leakage. The inclined conduit gate is designed with three gates of 600 mm dia. each so that the planned maximum intake discharge of 2.5 m^3/sec can be controlled. Two sets of 600 mm dia. sluice valves will be installed as energy dissipating valves after intake.

(3.6) Measurement

The Observation/measurement facilities are to be provided to the dam.

- The measurement for the deflection and seepage is decided to be necessary for the filltype dam
- The deflection is to be checked by providing a concrete pile at three points and the periodical survey of these points.
- The seepage discharege is to be measured by the triangle overflow weir structure to be provided at the downstream side of the dam embankment , but with a certain distance in consideration of the thick river bed sand & gravels.

On the other hand, it is necessarry to check the excess pore water pressure during the construction. The pressure gauges are to be provided at approx. 8 m interval in height and three lones in the maximum dam section.

It is considered that the pore pressure gauges are provided for the reliable quality control although the water content of core materials will be controled sufficiently at the stock yard where the material belending works is carried out in the dry season. In addition, the pore pressure gages are provided at the dam crest and the downstream slope respectively to confirm the seepage line.

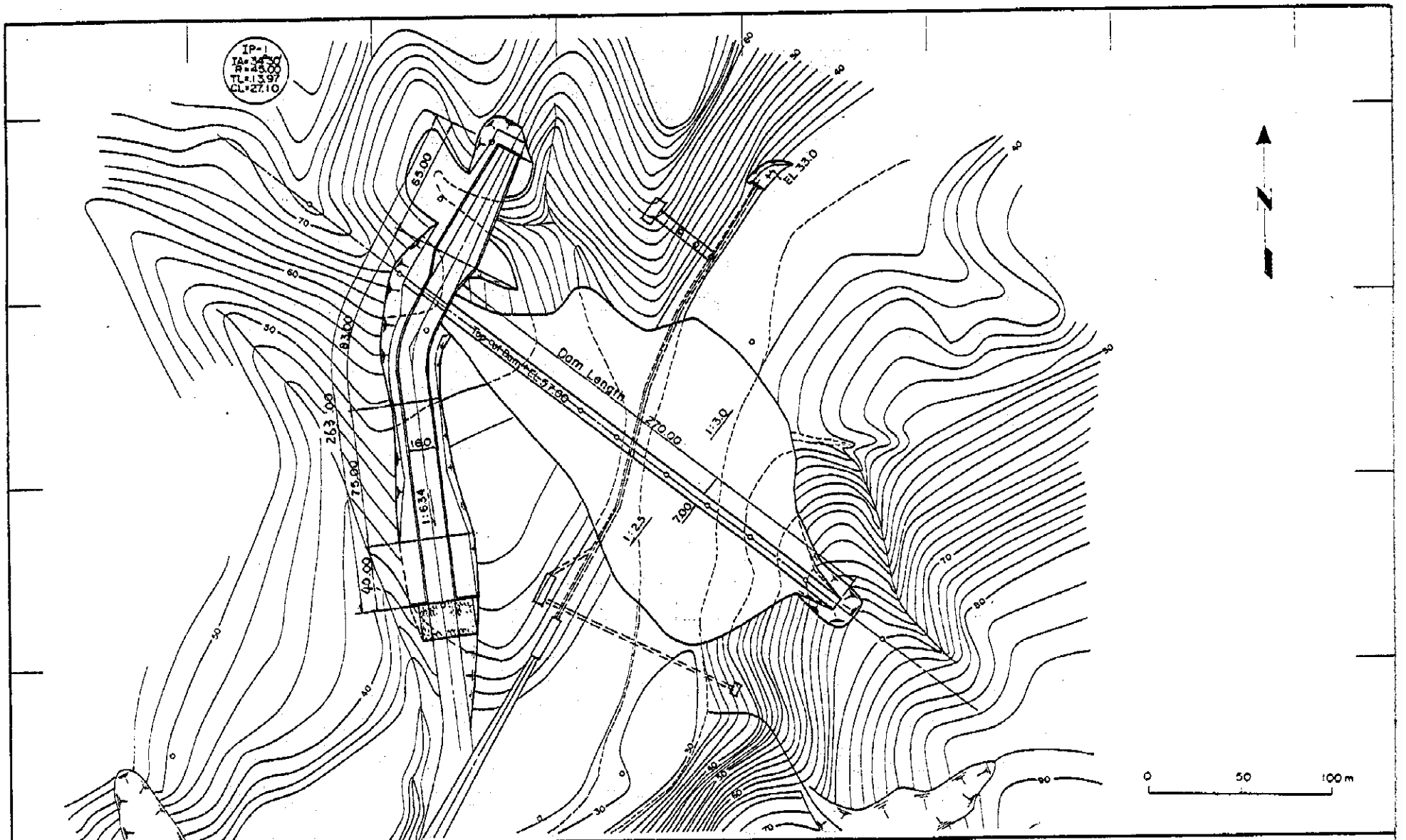
(3.7) Features of Dam and Reservoir

The Salient Features of Dam and Reservoir are as follows:

Type of dam	:	Center core rockfill dam
Height of dam	:	34 m
Crest length	:	270 m
Crest width	:	7 m
Dam volume	:	304,000 m^3
Dam crest elevation	:	Elev. 57.00 m
Type of spillway	:	Ungated side spillway
Design flood	:	565 m^3/sec
Catchment area	:	23.68 km^2
Total capacity of reservoir	:	5.0 MCM
Effective capacity of reservoir	:	4.5 MCM
Design flood elevation	:	Elev. 54.66 m
NHWL	:	Elev. 52.00 m
LWL	:	Elev. 37.00 m

(4) Design Drawings of Dams

The basic design drawings of dam and appartment structures and attached in the following pages.

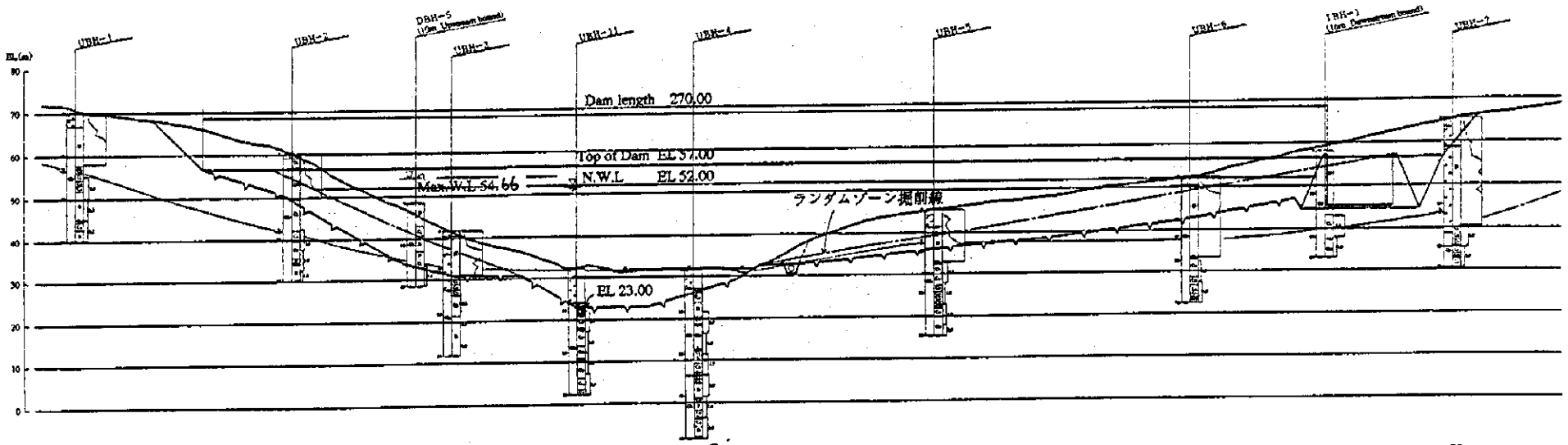


BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT

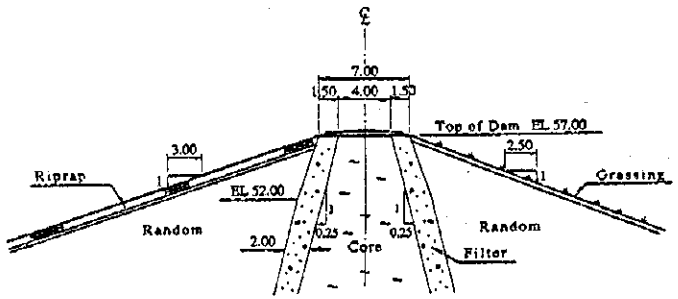
JAPAN INTERNATIONAL CORPORATION AGENCY

Fig. 2.3.2.3 - 1

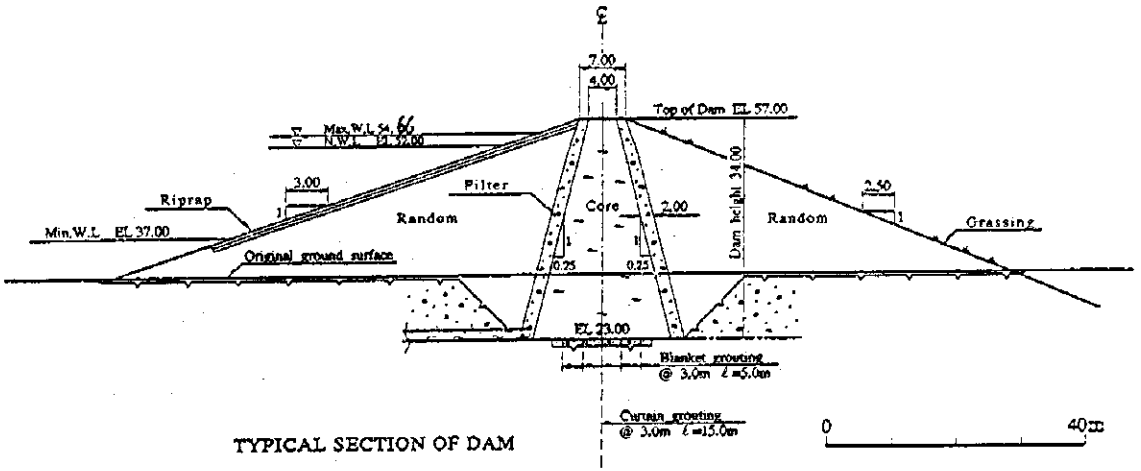
Dam, General Plan



PROFILE ON ℄ OF DAM

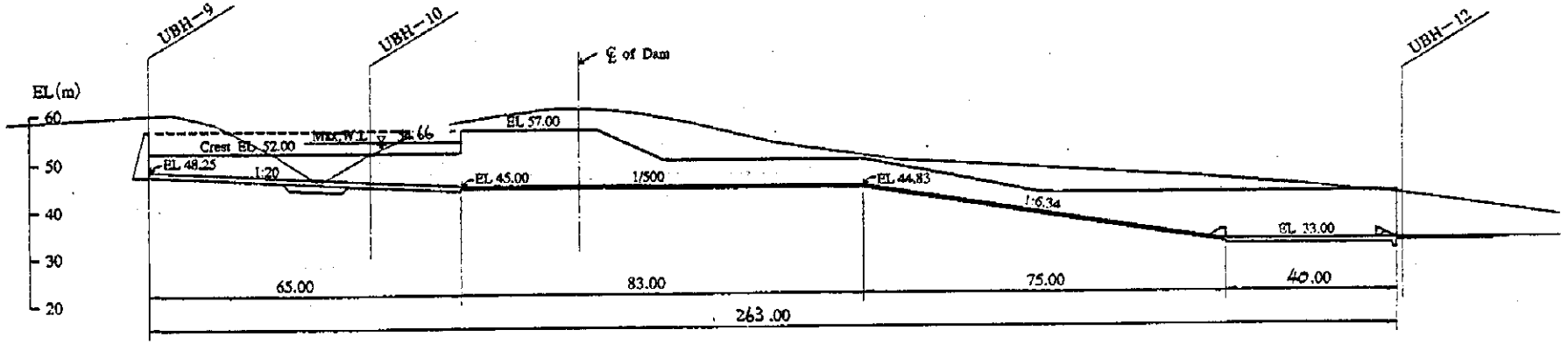


DETAIL OF DAM CREST



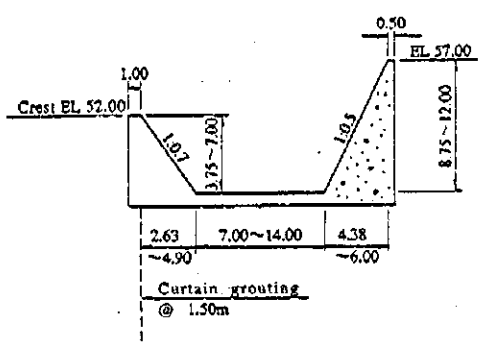
TYPICAL SECTION OF DAM

BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT	Fig. 2.3.2.3 - 2 Dam, Profile and Standard Cross Section
JAPAN INTERNATIONAL CORPORATION AGENCY	

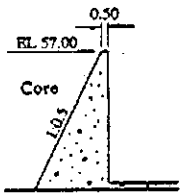


PROFILE ON ℄ OF SPILLWAY

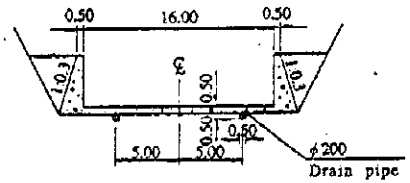
0 50m



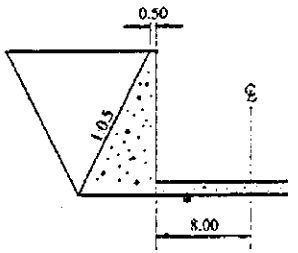
WEIR SECTION



CONTACT OF DAM SECTION



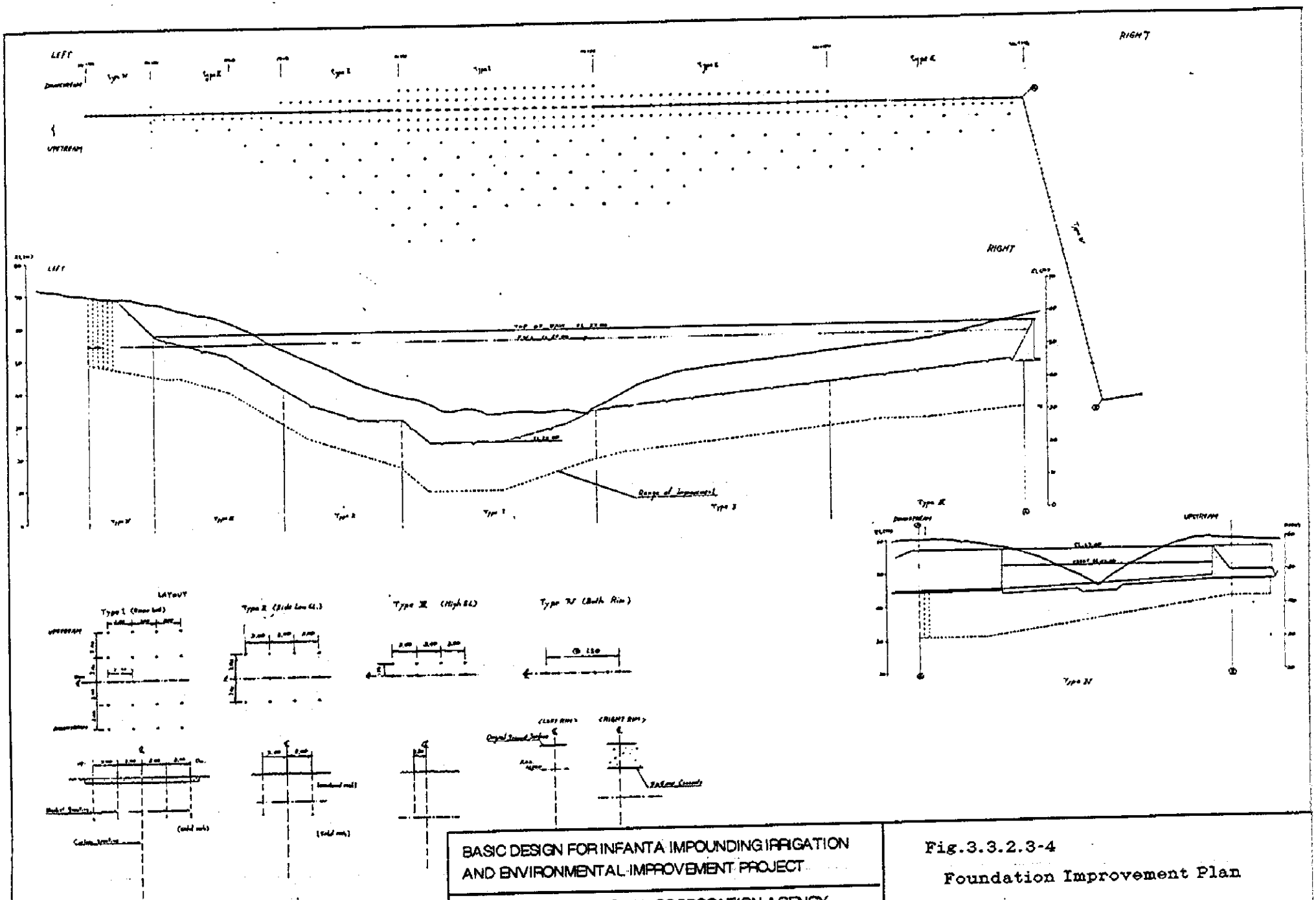
CHUTE SECTION



STILLING BASIN SECTION

0 10 20 m

BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT	Fig. 2.3.2.3 - 3 Spillway, Profile and Cross Sections
JAPAN INTERNATIONAL CORPORATION AGENCY	



BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT

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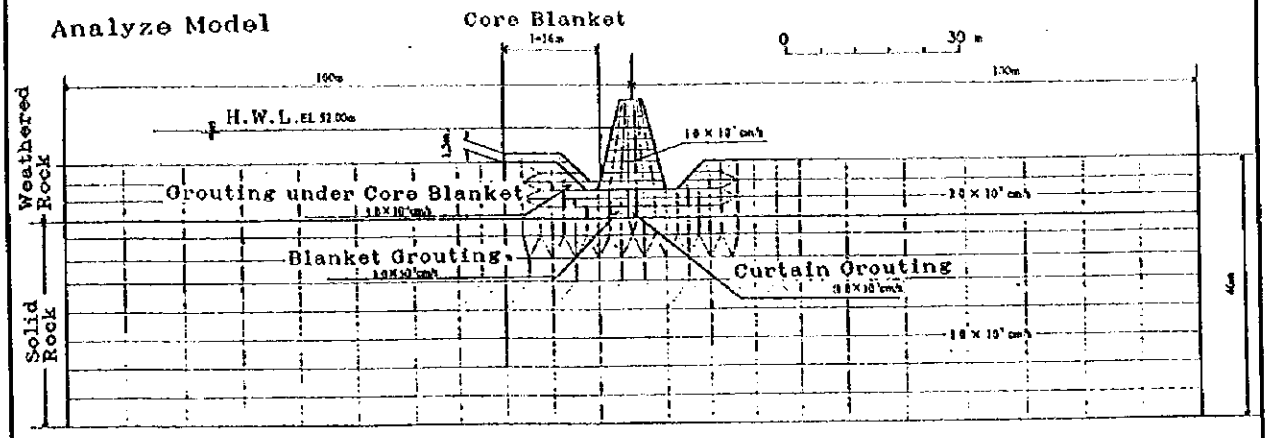
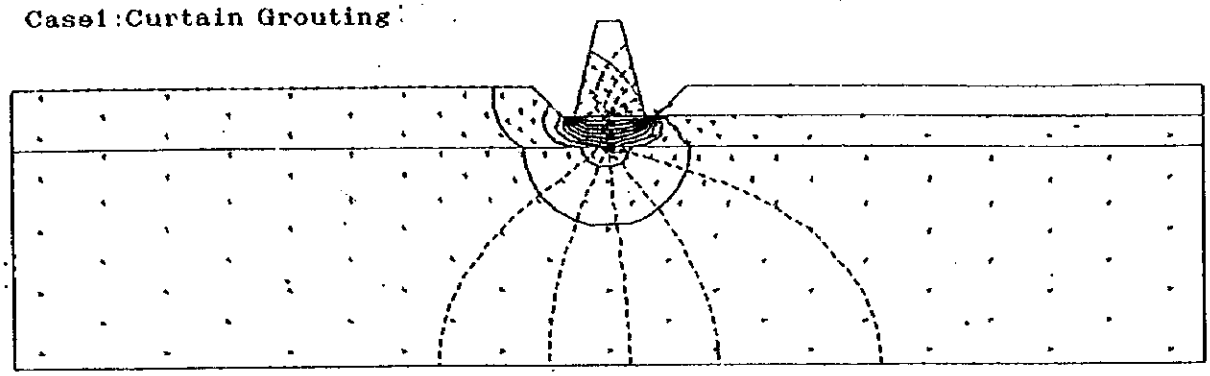
Fig.3.3.2.3-4

Foundation Improvement Plan

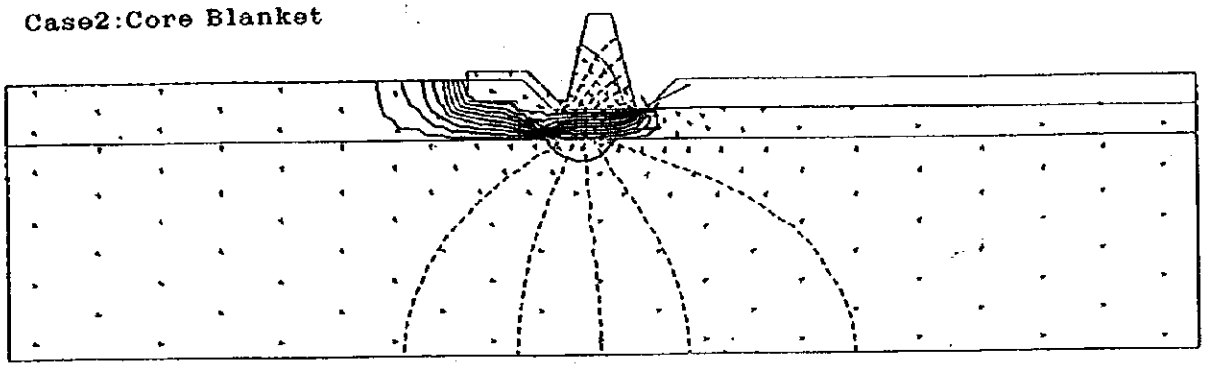


Case1 : Curtain Grouting



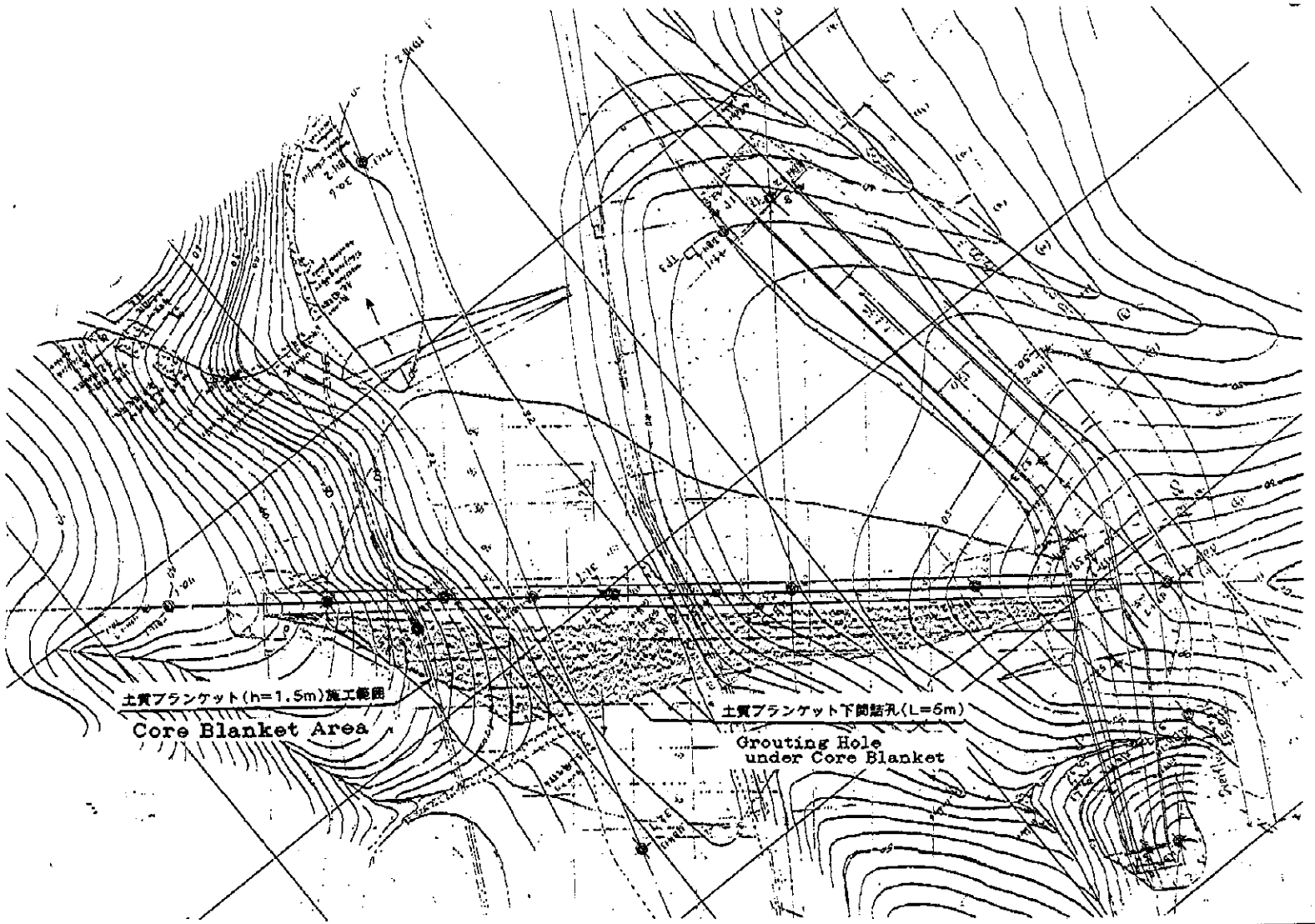
Quantity 0.279ℓ/min : Vmax=1.28×10⁻⁶m/s

Case2 : Core Blanket



Quantity 0.463ℓ/min : Vmax=2.35×10⁻⁶m/s

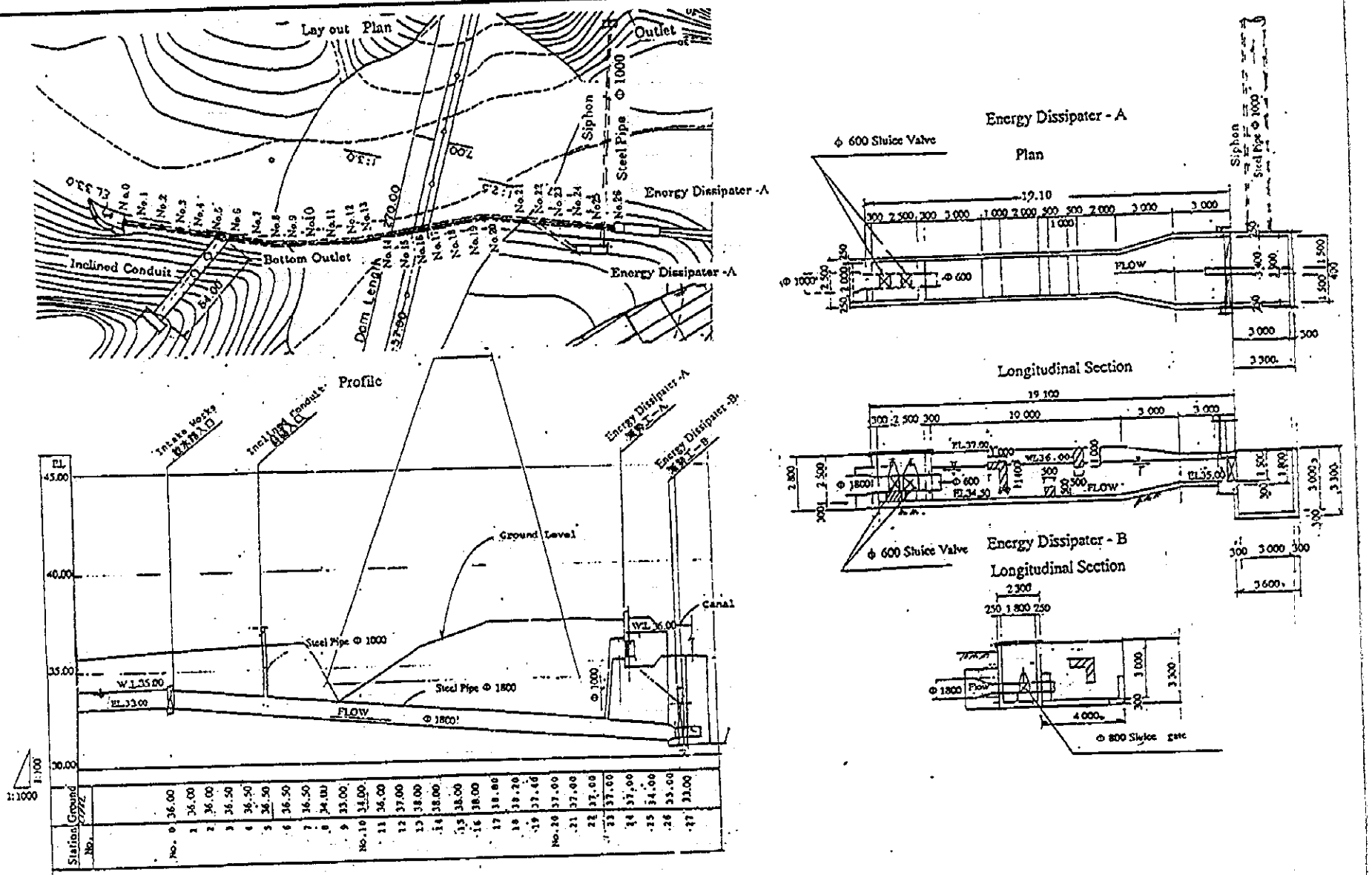
BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT	Fig.3.3.2.3-5 Underseapage Analyze
JAPAN INTERNATIONAL COOPORATION AGENCY	



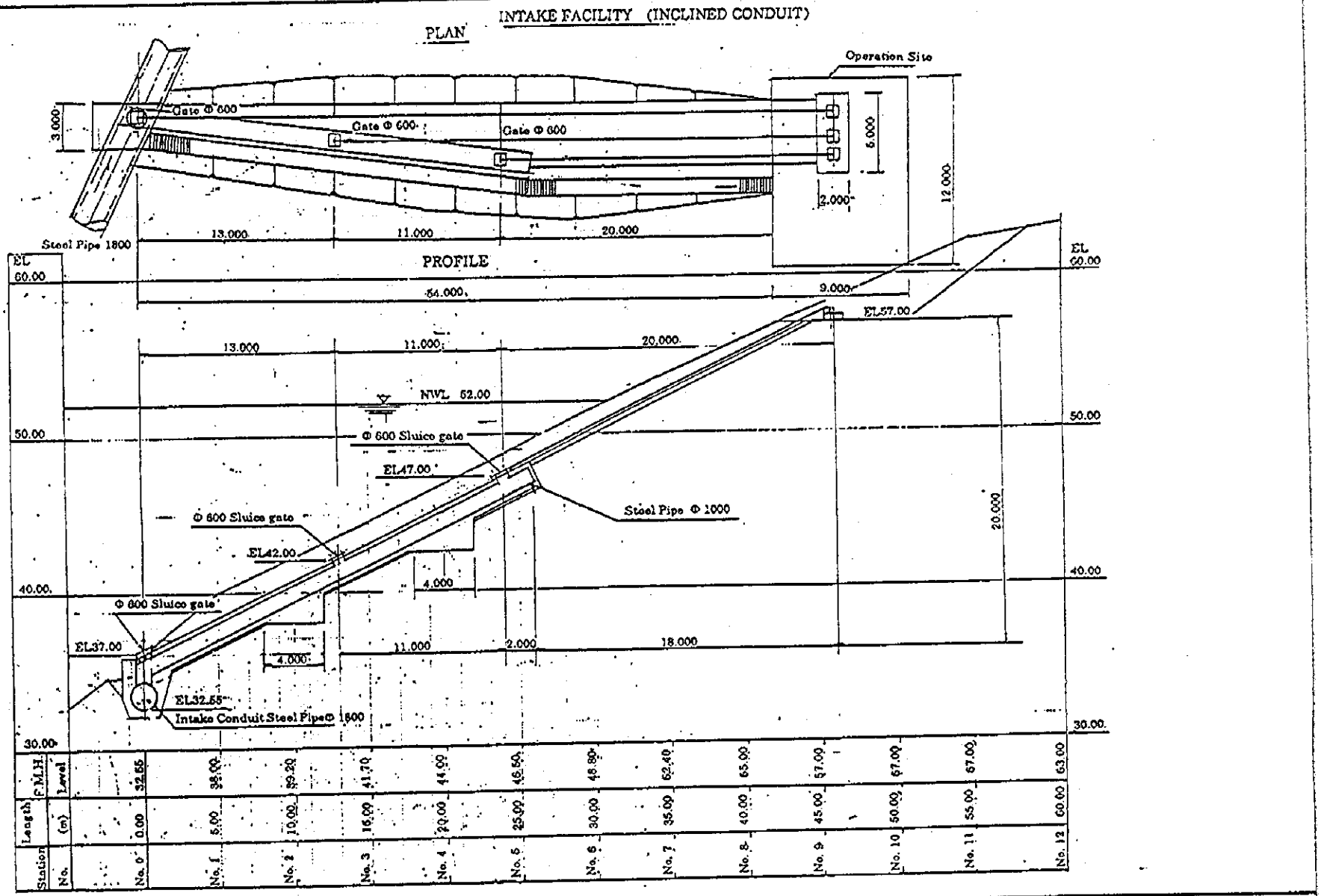
BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT

JAPAN INTERNATIONAL COOPORATION AGENCY

Fig.3.3.2.3-6 Core Blanket Layout



BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT	Fig. 2.3.2.3-1 PLAN OF INTAKE FACILITY AND ENERGY DISSIPATER
JAPAN INTERNATIONAL COOPORATION AGENCY	



BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT	Fig. 2.3.2.3 INTAKE FACILITY (INCLINED CONDUIT)
JAPAN INTERNATIONAL COOPORATION AGENCY	

2.3.2.4 Road and Bridge Plan and Design

(1) Design policy

The design policy of road & bridge are following.

- Two existing village roads in the irrigation area will be improved in the project. New construction of the access road to the proposed resettlement area is also planned. The proposed roads are paved with gravel in principle, however, in the case that longitudinal slope is more than 9%, concrete pavement will be intended, to ensure all-weather traffic.

- The roads around the reservoir will be used for reservoir management, forest management of water source, access for afforestation, and convenience of farmer's daily lives. The location of the route will be selected taking such factors into consideration. Since the roads are to be newly constructed or improved around the reservoir, they are being designed from viewpoint of safety for disaster prevention and protection of the environment.

- For the road design, the detail specifications (width, load, structure, etc.) will be decided based on the expected traffic volume, and the road standards of the Philippines.

(2) Design cross section of road

The design cross section of the proposed road is considered as follows.

Road classification	Width (effective/total)	Design speed	Road surface	Longitudinal slope
Improvement of village road	4.0/5.0 m	30 km/h	Gravel pavement	8.0%
"	"	"	Concrete pavement	more than 9.0%
Roads around reservoir	3.0/4.0	20 km/h	Gravel pavement	10.0%

The standard cross section of the proposed road is shown in the attached cross-section drawing.

(3) Selection of village road improvement route

There are four village roads in the project area. Based on the current conditions of the road network and the survey details, Cato to Bamban access road (3.5 km), which is relatively poor and strongly requested by residents for repair, and the road from PSU Infanta Campus to the San Felipe River (1.2 km) will be selected as major sections for improvement. These roads can be utilized as construction access roads for the project implementation and are considered effective.

There is no existing road to connect Bamban Barangay and the proposed resettlement area. New construction of this road covering 2.5 km (1.9 km newly constructed, 0.6 km improved), which is indispensable for the future, will be planned. Three Village roads are selected as the improvement road.

[Improvement plan]

- Road improvement plan
  - Improvement section : 3 routes, 5.3 km
  - New construction section : 1 route, 1.9 km

- Related structures
  - Road bridge (18 m span) : 2 places
  - Submerged bridge (for crossing San Felipe River): 2 places

The reasons for selection of the roads are as follows.

(A) Cato to Bamban access road (Improvement)

Along this road, there are Cato and Bamban Barangays consisting of approximately 50 farmhouses and 150 ha of paddy fields. Since the Cato Bamban primary school is located along the national road, approximately 30 school children are using this road. The traffic condition is shown in the following table.

Use	Traffic condition	Daily traffic volume
1. Regular bus service	5 to 6 jeepney shuttle services per day	10 cars/day
2. Rice transport (rainy season)	Approximately 450 tons of rice are transported (by 2-ton truck)	24 cars/day
3. Farming traffic	Traffic for 100 ha of agricultural fields (motorcycles, hand tractors etc.)	50 cars/day
4. Use as rural road	Ladies going-out for shopping using tricycles (auto-taxis)	20 cars/day
5. School road	Approximately 30 school children going to school and coming home	60 persons/day
6. Construction access road	Used for construction under the project	

(B) PSU Infanta Campus to San Felipe road (Improvement)

- Rural road to lead to Pita Barangay.
- Bamban intake weir maintenance road.
- Access road to the dam site to be constructed.
- Connecting road to the roads around the reservoir.

Use	Traffic condition	Daily traffic volume
1. Use as rural road	Rural road of Pita Barangay	20 cars/day
2. Agricultural Products transport	Agricultural products are transported from approximately 50 ha	5 cars/day
3. Farming traffic	Traffic for 50 ha of agricultural fields (motorcycles, hand tractors etc.)	25 cars/day
4. O&M road	O&M road for the dam and the intake weir etc.	5 cars/day
5. Access road for the afforestation	Young trees are transported.	5 persons/day
6. Construction access road	Used for construction under the project	

(C) Bamban to Resettlement area road (partially new, partially improvement)

- The road runs in the middle of the project area, and connect the right and left sides of the San Felipe River.
- Connecting road between Bamban Barangay and the proposed resettlement area.
- Access road for future resettlers to go to Infanta.

Use	Traffic condition	Daily traffic volume
1. Regular bus service	5 to 6 jeepney shuttle services per day	10 cars/day
2. Use as rural road	Ladies going-out for shopping using tricycles (auto-taxis)	30 cars/day
3. School road	Approximately 40 school children going to school and coming home	80 persons/day
4. Construction access road	Used for construction under the project	

(4) Design of Bridge

The Cato to Bamban access road, which is planned for the project, has two bridges. Both are 18.0 m long wooden bridges crossing creeks. The wooden girders are partially rotten, and it is very dangerous to go over the bridges.

As for the foundation, there are middle to hard clay layers as main components until the depth of 20 m, and, excepting a certain part, relatively good bearing layers of N-value = 20 to 40 are formed. Since this road is an inter-village connecting road for comparatively light traffic, the bridges will be specified as class 2 (T-15), and the economical box culvert system (the construction cost is 50% of the bridge type) which ground reaction is small will be employed as a bridge.

For crossing the San Felipe River, the submerged bridge system which enables traffic 350 days/year based on the past river data (15 days per common year is more than 5.0 m^3/s), will be employed.

(5) Construction of roads around the reservoir

The crest of the dam is planned to be constructed at an elevation of 52.0 m. The river basin area is approximately 23 km^2. The geographical features of the reservoir area include relatively gentle-sloped hilly land with several ridges of 100 to 300 m elevation. Excepting the forests in valleys, most of the area is covered with grass. Therefore, afforestation is going on in some part. In this project, on the right riverbed side, utilizing the existing mountain woodland paths leading along the ridges, a connecting road along the ridge on the left riverbed side will be planned. Field reconnaissance will be performed based on a 1/5,000 topographical map, and efforts will be made to select a safe and economical route that can protect the natural environment and protect against disaster with the least possible cutting and embankment of soil for construction.

The construction plan are as follows.

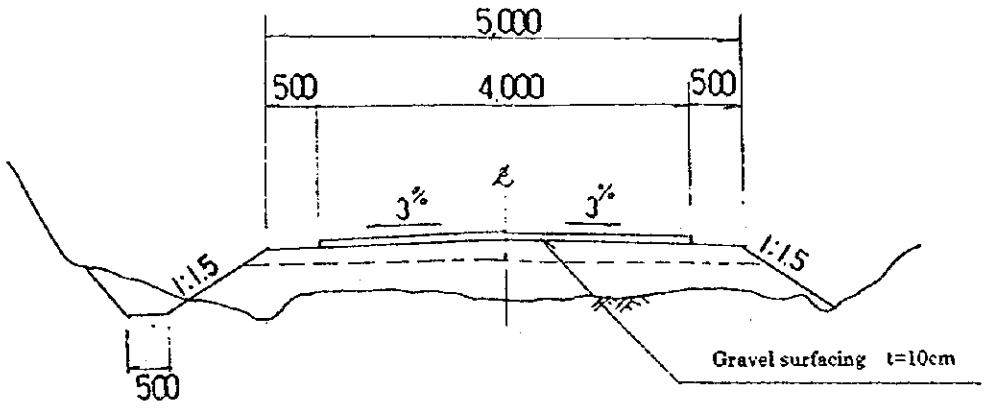
- Road construction plan
  - New construction section : 13.4 km
  - Reconstruction section : 3.4 km
  - Total : 16.8 km

- Related structures
  - Submerged bridge : 3 places (at San Felipe river and its blanch)
  - Crossing conduit : approximately 10 places (at crossing places of mountain stream)

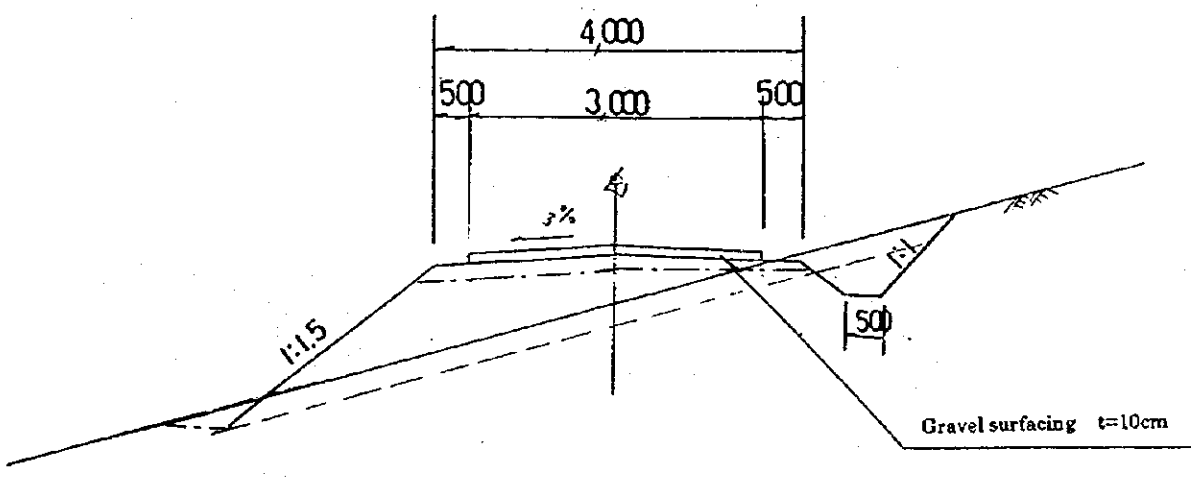
(6) Design Drawings

The drawings for the basic design of road & bridge are shown in the Fig. 2.3.2.4-1 to 2.3.2.4-4.

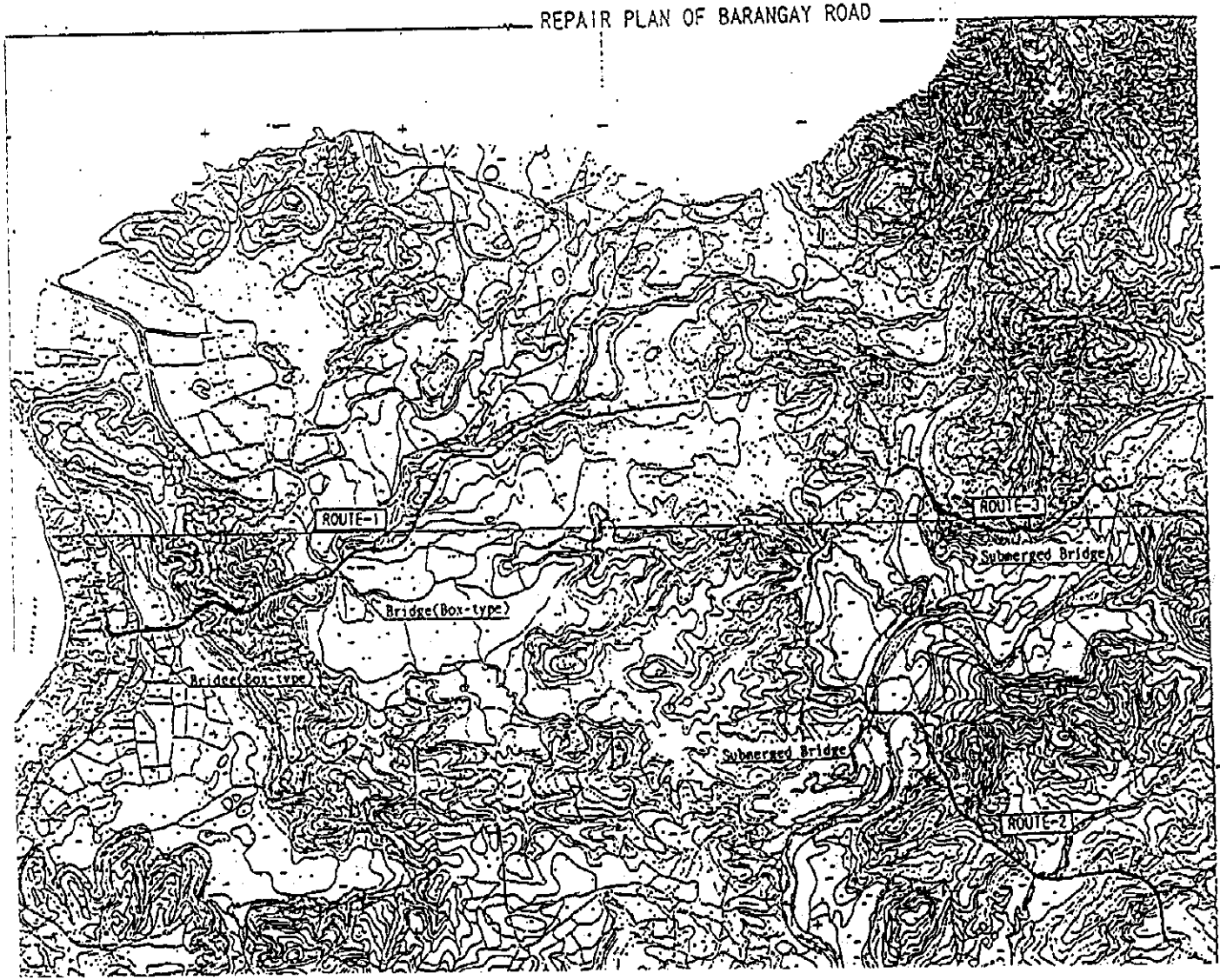
TYPICAL SECTION OF VILLAGE ROAD



TYPICAL SECTION OF ROAD AROUND RESERVOIR

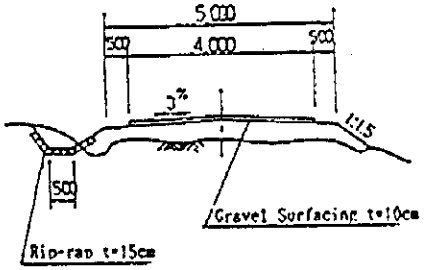


BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT JAPAN INTERNATIONAL COOPORATION AGENCY	Fig. 2.3.2.4-1 TYPICAL SECTION OF ROAD

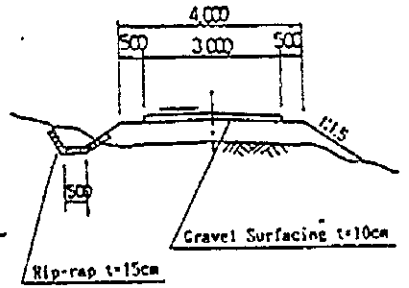


TYPICAL ROAD SECTION

(TYPE 1) ROUTE-1&2

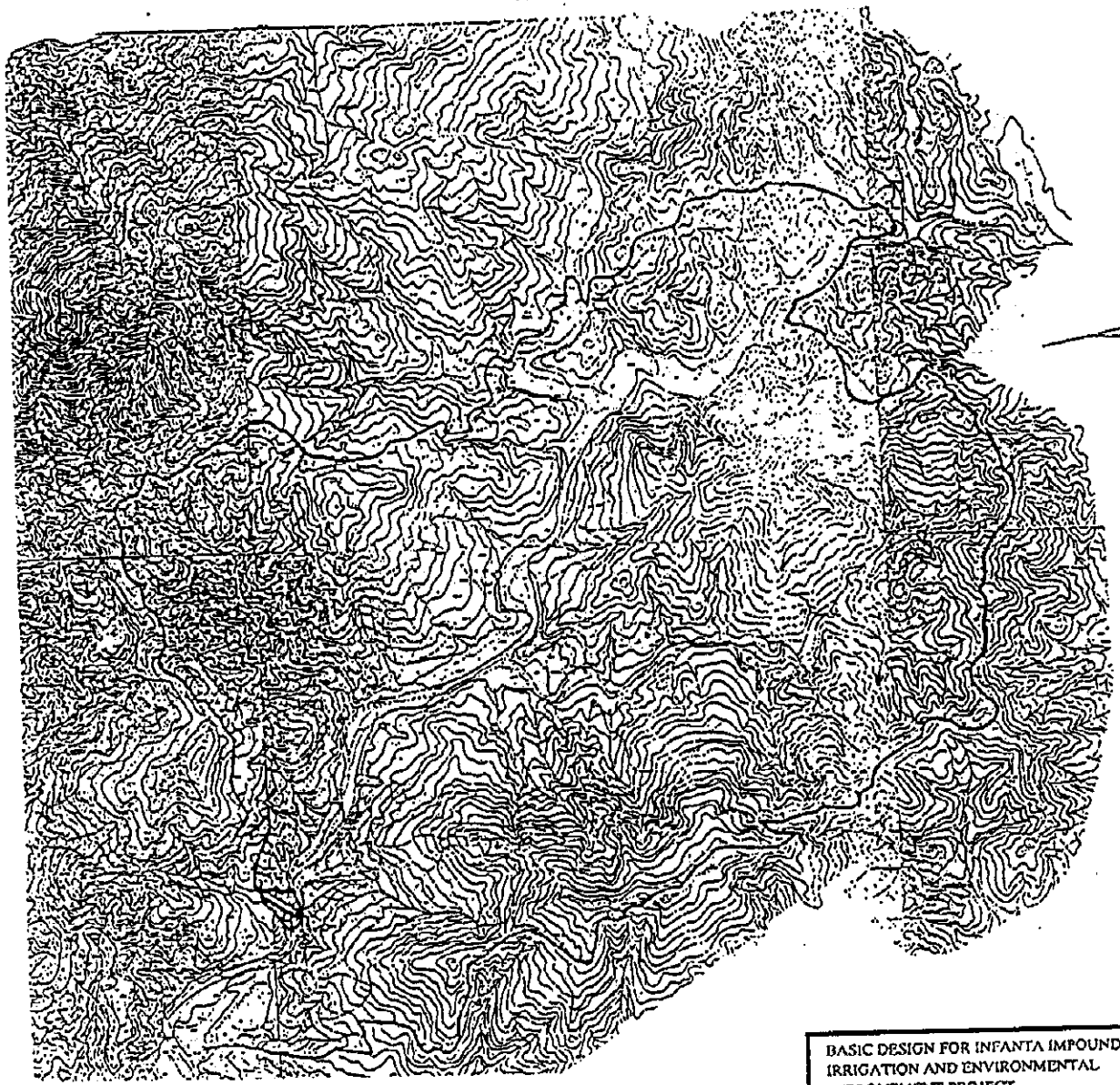


(TYPE 2) ROUTE-3

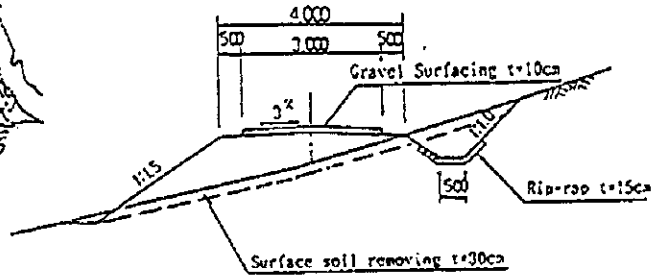


BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT	Fig. 2.3.2.4-2 LOCATION OF REPAIRING ROAD AND TYPICAL SECTION (1)
JAPAN INTERNATIONAL COOPORATION AGENCY	

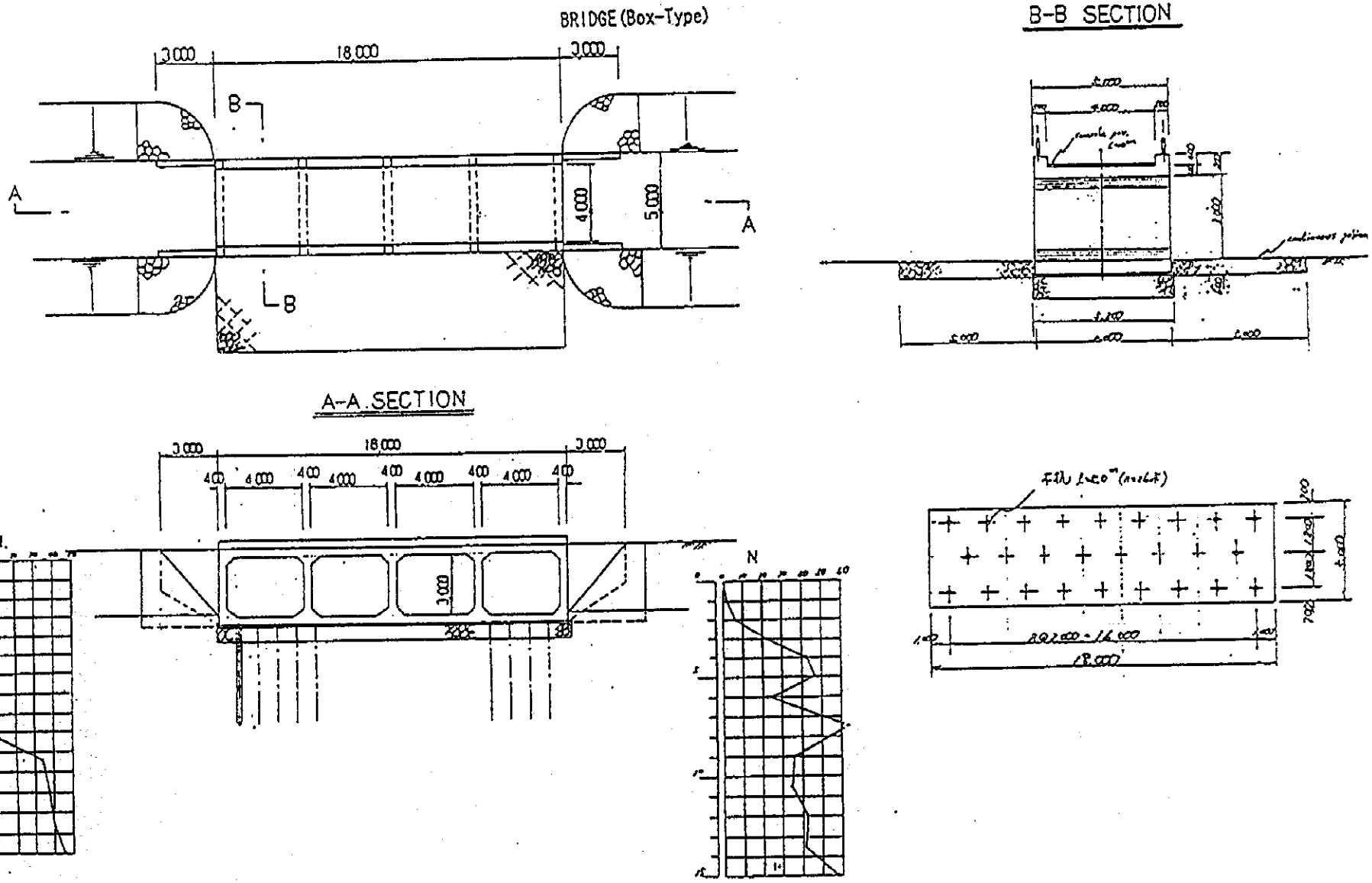
AROUND RESERVOIR ROAD PLAN



TYPICAL ROAD SECTION



BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT	Fig. 2.3.2.4-3 LOCATION OF REPAIRING ROAD AND TYPICAL SECTION (2)
JAPAN INTERNATIONAL COOPORATION AGENCY	



BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT	Fig. 2.3.2.4-4 BRIDGE (CULVERT)
JAPAN INTERNATIONAL COOPORATION AGENCY	

2.3.2.5 Post-harvest Facility Plan and Design

After completion of the project, considerably increased rice production is expected in every Barangay, both in the rainy and the dry seasons. To comply with such increased production, an additional request is applied by the Infanta Municipal Government to prepare a solar dryer (concrete pavement, 25 m wide x 35 m long) in every Barangay.

As the result of survey on the situation of solar dryer, there are some existing solar dryers in the municipality, however the capacity is not enough even at present. Therefore, road surface which is paved, and school yard are used as a solar drier. Utilization of the road make trouble for the traffic as well as so danger. The shortage will be more serious after the project which can remarkably increase the rice production. Because there are approximately 60 to 200 ha of rice fields at each Barangay respectively. Therefore it is considered necessary for providing the additional solar dryers.

This facility is 875 m^2 (25 m x 35 m) per location, or about two times as large as a standard basketball court area. A solar dryer capacity of approximately 200 gavan/day can be expected. Assuming that harvesting period is approximately 20 days, husk collected from paddy fields equivalent to 2.5 ha to 3.0 ha/day x 20 days = 50 to 60 ha, can be dried. Since it starts raining unexpectedly during the rainy season, a simple storage (approximately 5 m x 8 m) will be necessary near the drying facility.

[Facility plan]

Solar dryer: Concrete pavement (approximately 15 cm thick) at 8 locations
875 m^2 (25 m x 35 m)
furnished with a simple storage (approximately 5 m x 8 m)
Location of proposed facilities are shown in Fig. 2.3.2.5-1.

As a secondary benefit, when the solar dryer is not used for its primary purpose, it can be used for recreation and sports activities at each Barangay. The facility is earnestly requested by the farmers.

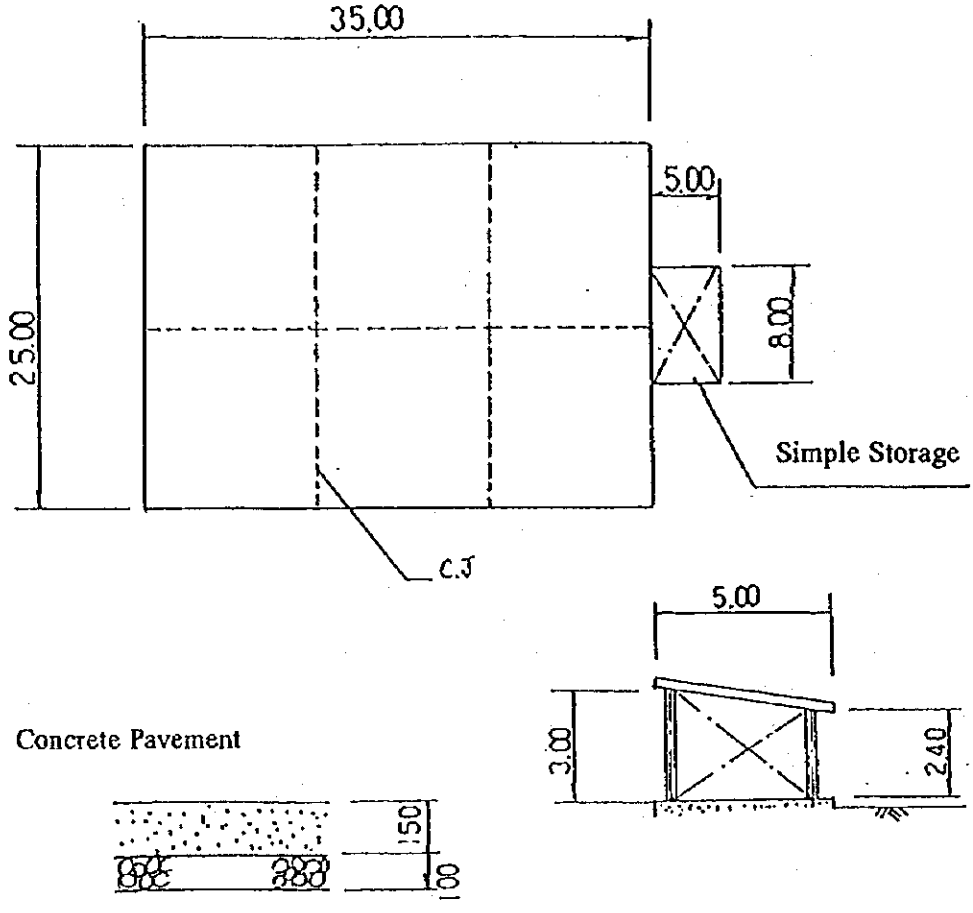
After completion of the project, rice cultivation area will be 1,180 ha during rainy season and 620 ha during dry season respectively. Its harvesting period of each Barangays will be different a little, on the whole, 30 to 40 days from February to March and September to October. Solar dryer facilities are necessary in the period. Assuming that drying capacity per day is 3.0 ha, the annual using day of the each facilities are as following.

Name of Barangay	Cultivation area (ha)		Annual using day of new solar dryer facilities		
	Rainy season	Dry season	Rainy season	Dry season	Total
1. Bamban	417	248	40	30	70
2. Doliman	216	128	40	40	80
3. Potol	140	83	40	28	68
4. Nangalisan	154	91	40	30	70
5. Patima	99	59	33	20	53
6. Cato	62	37	21	13	34
7. Maya	117	70	39	24	63
8. Nayom	180	107	40	36	76

Location of proposed facilities which are constructed at each Barangay, are shown in Fig. 2.3.2.5-1.

■ Location of Postharvest facility

BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT	Fig. 2.3.2.5-1 LOCATION MAP OF POSTHARVEST FACILITY
JAPAN INTERNATIONAL COOPORATION AGENCY	



BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT JAPAN INTERNATIONAL COOPORATION AGENCY	Fig. 2.3.2.5-2 GENERAL PLAN OF POSTHARVEST FACILITY

2.3.2.6 Resettlement Plan and Design

(1) Proposed resettlement area

The proposed resettlement area is located on the left bank of the San Felipe River, east of Infanta. Soil investigations were performed at seven places of the resettlement area. Additionally, BSWM/SRDC (Soil Research and Development Center, Bureau of Soil and Water Management) also performed the soil investigation at the resettlement area and presented the data. The result of investigation shows that there are geologic and topographic constraints to turn into farm land. Therefore, following facility improvement and soil amendment are necessary to perform the stable farming.

a. Land reclamation and canal construction for the leveling of farmland
b. Improvement of surface soil by the removal of gravel
c. Soil amendment by the calcareous fertilizer and the organic fertilizer
d. Farming support such as proper water management and management practices

It is possible to propose the execution of this improvement plan technically. However, since economically and farming technique of the resettler as well as supporting system can not be expected, the development of farmland in the proposed resettlement area is not proposed in the project. Therefore, the object of the resettlement plan is only regidential area of 12 ha for resettlers.

(2) Expected number of resettler and households

The expected resettler in this project are living in neighboring farm area of the project such as Infanta, Dasol and Santa Cruz. Approximately 70 households will move to the resettlement area.

(3) Residential zone of resettler and its area

The residential zone for resettlers will be located in the southern side of the resettlement area in consideration with the obtainment of domestic water (domestic water supplied from the dam should be distributed by gravity after filtration as well as expenses for maintenance should be low), convenience for social life.

Minimum 1,200 square meters (30 m x 40 m) per household is planned for the area of the residential zone in order to save the necessary living space that resettlers can live on the agriculture, in short, including kitchen garden, cattle shed, agricultural machinery storage and granary. The total land area for the residential area and road etc. is approximately 12 ha.

(4) Social infrastructure improvement plan

(A) Electric power supply

Electric power supply to farmers is available at Barangay Sitio Mose located approximately 1.0 km from the proposed resettlement area. The electric power supply to the resettlement area, therefore, will be extended from here. The District I Electric Cooperative supplies electric power to the resettlement area, and expenses will be paid by the Pangasinan Provincial Government. The estimation of this electric power distribution plan is under preparation. Electric power transmission lines will be located along the road to be constructed, and indoor wires to each individual household will be paid by the corresponding household.

(B) Schools

School children in the resettlement area will go to primary school in Barangay Doliman. The junior high school in Barangay Bamban is approximately 3.0 km from the resettlement area. The resettlement will not be executed at once, but executed for a few years according as the progress of construction. Therefore, the municipal government judges that there is no serious impact to receive pupils into existing schools. For future, the Provincial Social Welfare & Development Office of the provincial government is studying an expansion plan.

(C) Health and sanitation

The Health Office in Barangay Bamban is the nearest for health and sanitation of resettlers which distance is approximately 3.0 km. The municipal government recognizes the insufficiency of the current health and sanitation facilities, and has applied to the provincial government for an expansion plan.

(5) Resettlement plan implementation schedule

The Pangasinan Provincial Government is preparing the following construction schedule on the resettlement plan implementation schedule.

Implementation Plan of Resettlement

Items	1999	2000	2001	2002	2003	2004	2005
Land acquisition			PGP				
Construction of road				Japan			
Construction of domestic water					Japan		
Construction of house					PGP		
Conduct of resettlement						PGP	
Electric power					PGP		
Social welfare							
Finance of Pangasinan Province	3,000	3,000	3,000	3,000	3,000	3,000	3,000

Notes: Unit on Finance of Pangasinan Province is Ps. 1,000.

Construction of Japanese Grant Aid

Construction of road							
Construction of domestic water							
Construction of dam							

(6) Attention of movement to resettlement area

As for the implementation of resettlement plan, following matter should be paid attention to.

- To distribute the house for settlers at once after have finished to construct roads
- To station a tap for two households at useful places for inhabitants.
- The provincial government should guide the life of resettler in order to defend the friction between existing inhabitant and resettler.

The social infrastructure improvement will be carried out by the Pangasinan Provincial Government with their budget.

(7) Scope of works in the project

For constructions under the above resettlement plan, Japan will execute the construction of roads to approach the resettlement area, roads in the residential area, reclamation of the housing area and domestic water supply facilities for the resettlers. As for the execution of land reclamation, existing nature such as trees should be kept.

(A) Domestic water supply plan

(a) Water supply volume

The volume of water supply to the resettlement area should cover the total of water for the population of resettlers and miscellaneous use for cattle, etc. Assuming that a hundred immigrant household (including expected future setup of branch families), with seven family members per household on the average, 200 lit./day per person is estimated. Approximately 400 lit./day per household is estimated for miscellaneous use (livestock, cleaning water for machine, garden agricultural)

$$Q\ max. = 100 \times 7 \times 200 + 100 \times 400 = 180{,}000\ (lit./day)$$

The design purified water volume (Qt), with a 10% margin, is calculated as follows.

$$Qt = 180.0 \times 1.1 = 198.0\ (m^3/day)$$
$$= 0.138\ (m^3/min.)$$
$$= 2.3\ (lit./sec)$$

(b) Capacity of facility

(b-1) Intake facility

The dam to be constructed is the source of domestic water supply. Water will be taken in at the division facility that will be constructed at down stream of the inclined conduit. Therefore, the discharge control valve for the intake facility is set up at the division facility.

(b-2) Water supply pipe

The domestic water supply pipe will utilize vinyl chloride pipes. A 150 mm pipe diameter is used in consideration with the elevation of the water distribution area and the pressure of water supply. Hydraulic conditions of conduit for the domestic water supply are as follows.

$$I = 10.66 \times C^{(-1.85)} \times D^{(-4.87)} \times Q^{(1.85)}$$
$$hf = I \times L = 1.8\ m$$

where I: Hydraulic gradient

C: Coefficient of discharge	:	130
D: Pipe inner diameter	:	0.15 (m)
Q: Discharge	:	2.3 (lit./sec)
L: Length of conduit	:	3,600 (m)
hf: Friction loss	:	(m)

(b-3) Purified water facility

The purified water facility consists of an regulation pond, slow filter bed, disinfection facility, and distribution pond. The capacity of each facility is described below.

<Regulation pond>

The capacity of the regulation pond (V_{IT}) can be calculated as follows.

$$V_{IT} = Qt \times Mt \times a \qquad (m^3)$$

where V_{IT}: Regulation pond (m^3)
Qt : Design purified water volume (m^3/min.)
Mt : Residentiary time (1.5 min.)
a : Safety factor (5.0)

$$V_{IT} = 0.18 \times 1.5 \times 5.0 = 10.35 \qquad (m^3)$$

Therefore, the facility is constructed by reinforced concrete as follow.

$$1.0\ m\ (W) \times 1.0\ (L) \times 1.2(H) = 1.2\ (m^3)$$

<Slow filter bed>

The area necessary for filtration is given by the following formula.

$$A = Qt/Vs \qquad (m^2)$$

where A : Necessary area (m^2)
Qt: Design purified water volume (m^3/day)
Vs: Filtration speed (m/day)

Assuming that filtration speed is 6 m/day,

$$A = 198.0/6.0 = 33.0 \qquad (m^2)$$

The structure is as follow.

$$3.0\ m\ (W) \times 6\ m\ (L) = 36\ m^2 > 33\ m^2 \times 2.0\ m\ (H) \times 2\ ponds = 144\ m^3$$

Two ponds are planned, because one is prepared as a spare for cleaning of the filtration pond.

<Disinfection facility>

A chlorine agent (sodium hypochlorous acid for tap water) is used for disinfection, and the injection volume (Vc lit./day) is as follows:

$$Vc = Qt \times R \times 100/C \times 1/d \qquad \text{(lit./day)}$$

where Qt: Design purified water volume (m^3/day)
R : Injection volume (ppm)
C : Effective chlorine density (%)
d : Specific weight of chlorine

Assuming that the injection volume is 1.0 ppm, the effective chlorine density is 6%, and the specific weight of chlorine is 1.2, the necessary chlorine quantity is as follows:

$$Vc = 198.0 \times 1.0 \times 100/6 \times 1/1.2 = 2.7 \text{ (lit./day)} = 1.9 \text{ (cc/min.)}$$

A chlorine agent is injected into the pipe directly.

<Distribution pond>

Assuming that the volume of distribution pond is amount for more than eight hour of the maximum daily water supply volume (Qmax) per day and use it twice, the effective distribution pond capacity (Vdr) can be calculated as follows:

$$Vdr = Qmax \text{ } (m^3/day) \times 8/24 \text{ (hr)} / 2 = 198.0 \times 8 / 24 / 2 = 33.0 \text{ } (m^3)$$

Therefore, the distribution pond capacity will be planned as follows.

$$6.0 \text{ m (w)} \times 6.0 \text{ m (L)} \times 1.0 \text{ m (H)} = 36.0 \text{ } (m^3)$$

(b-4) Water supply facility to each household

The water supply to each household are distributed by the conduit from distribution ponds. Pipes of 50 to 150 mm diameter are used so that sufficient water-head is secured at every tap. One outdoor type tap with 25-mm diameter will be planned for every two households.

(c) Summary of the facility

The summary of the principal facilities based on the above mentioned basic policy and design is as follows.

Facility		Size and Construction
Intake facility	:	Intake/irrigation shared valve: 150 mm dia.
Water supply pipe	:	Vinyl chloride pipe, 150 mm dia./L = 3.6 km
Regulation pond	:	V = 1.2 m^3, concrete construction
Slow filter bed	:	V = 36 m^3 x 2, concrete construction
Disinfection facility	:	Chlorine injection
Distribution pond	:	V = 36 m^3, concrete construction
Distribution pipe	:	Vinyl chloride pipe, 50 to 150 mm dia., L = 4.12 km
Tap	:	Outdoor type, 25 mm dia., at 40 locations

(d) Operation and Maintenance of facilities

It is not necessary to operate and maintain from the dam to the tap because of gravity supply. The chlorine disinfection need to add the disinfectant several time per year. It is planed that the operation will be carried out by Infanta Municipality and the cost are paid by inhabitants.

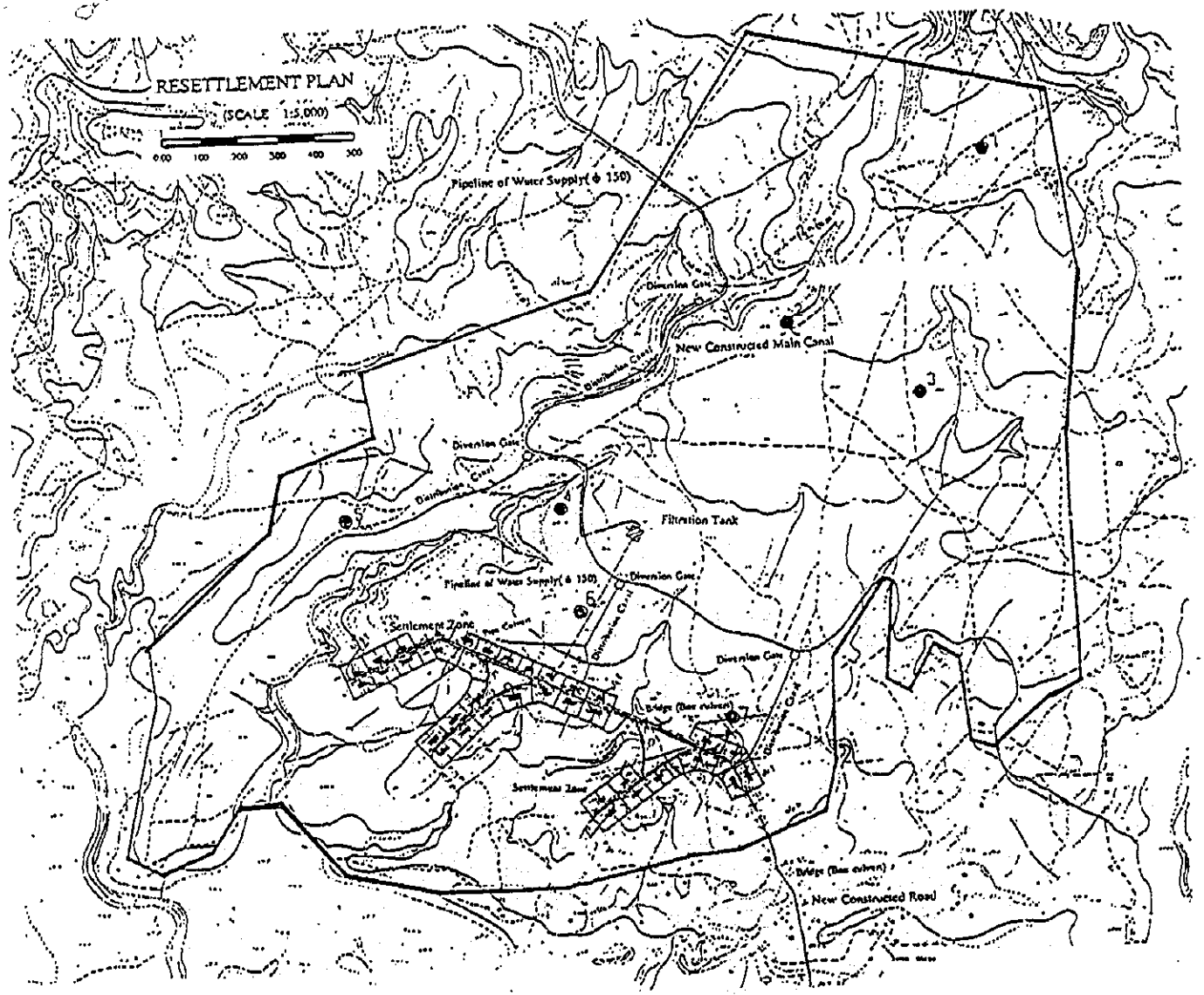
(B) Road improvement plan

The approach road to the resettlement area will extend 400 m from Barangay Sitio Meso. Since the existing road in this zone is extremely poor, it should be repaired. Roads extending 2.09 km in total in the residential zone will be paved.

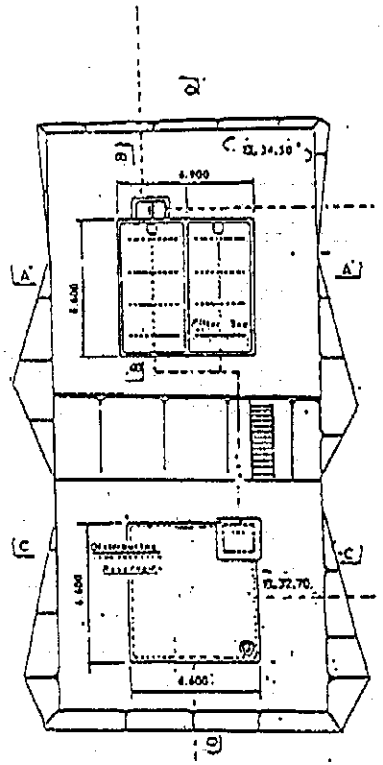
Facility Details of Road

	Item	Road construction	Width (m)	Extension (m)
1	Approach Road	Gravel pavement	5.0	400
2	Residential zone road	Concrete pavement	5.0	2,090
3	Bridges	Concrete box	4.0	3.0
4	Bridges	Concrete box	4.0	1.5
5	Cross structure of concrete pipe	Concrete pipe	500 mm Dia	8.0

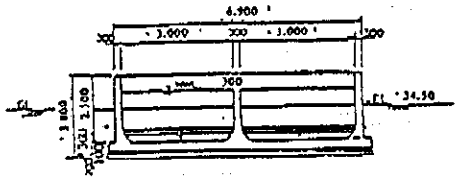
Since utilization rate of the road in the residential area will be so high, MPC has requested the concrete paved road for it in consideration of maintenance.



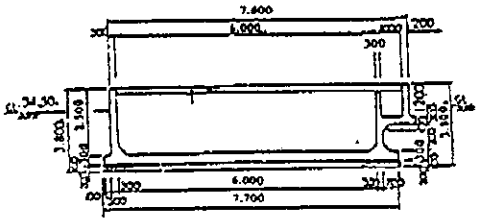
BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT	Fig. 2.3.2.6-1 RESETTLEMENT AREA AND HOUSING AREA
JAPAN INTERNATIONAL COOPORATION AGENCY	



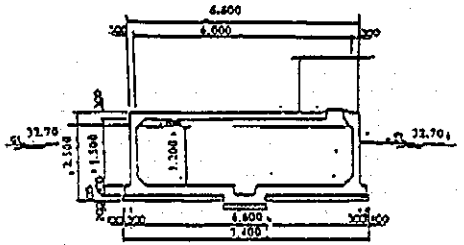
WATER SUPPLY PLANT



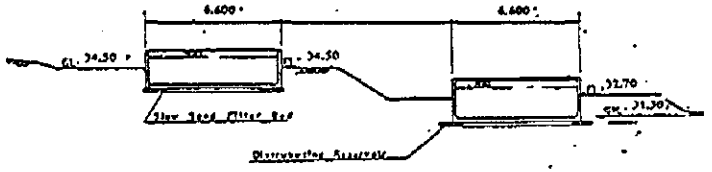
SECTION A – A
(SLOW SAND FILTER BED)



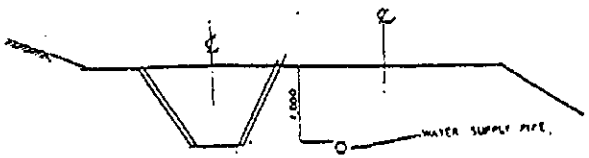
SECTION B – B
(SEDIMENTATION BASIN)



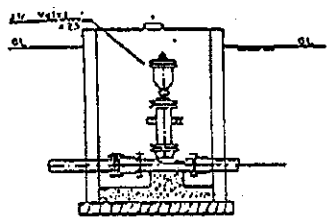
SECTION C – C
(DISTRIBUTING RESERVOIR)



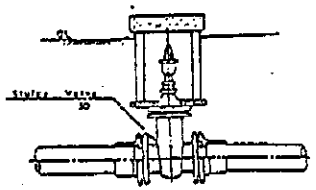
SECTION D – D



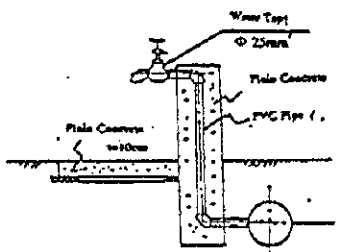
TYPYCAL PIPE LINE CRSS SECTION



AIR VALVE



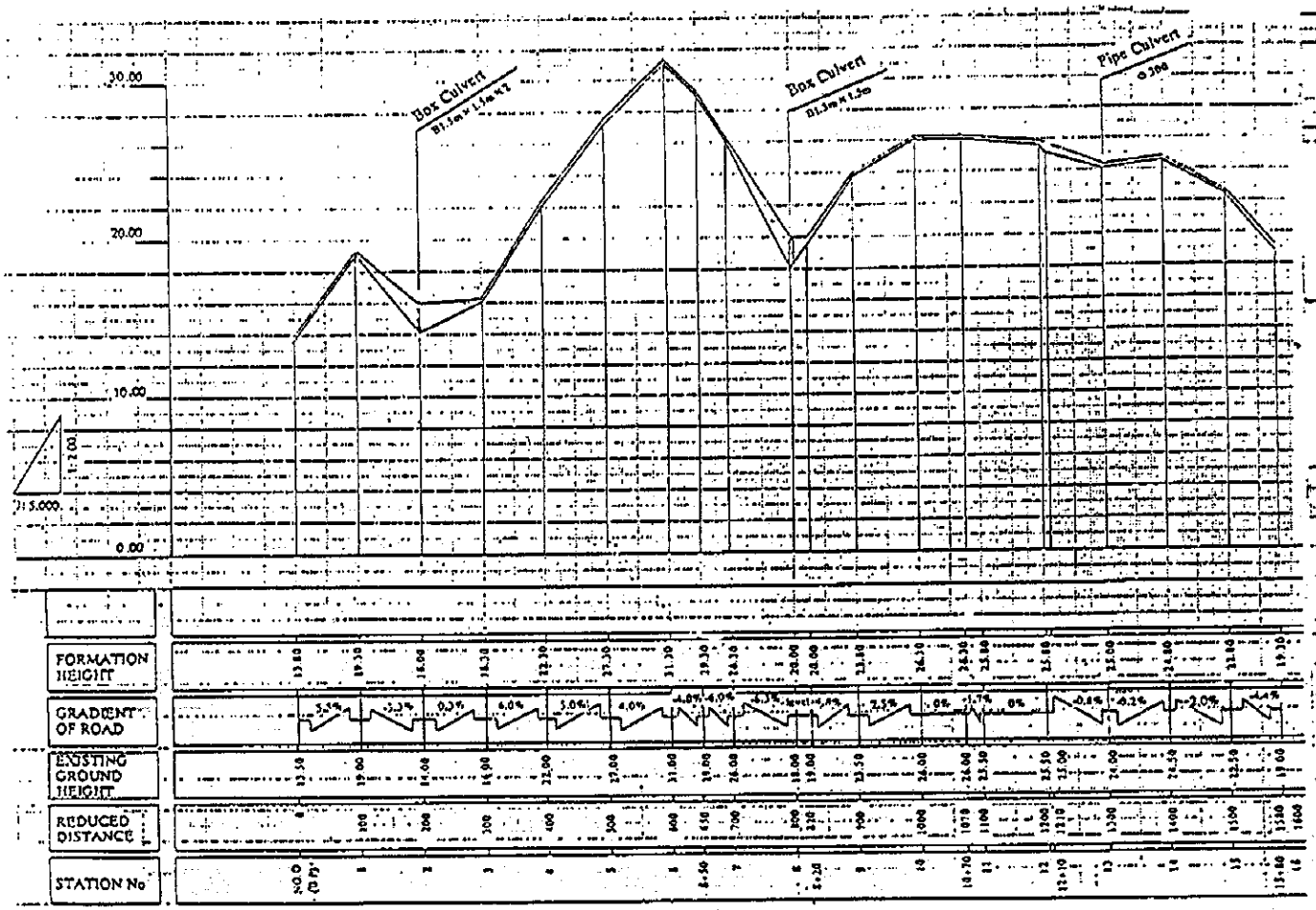
SLUICE VALVE

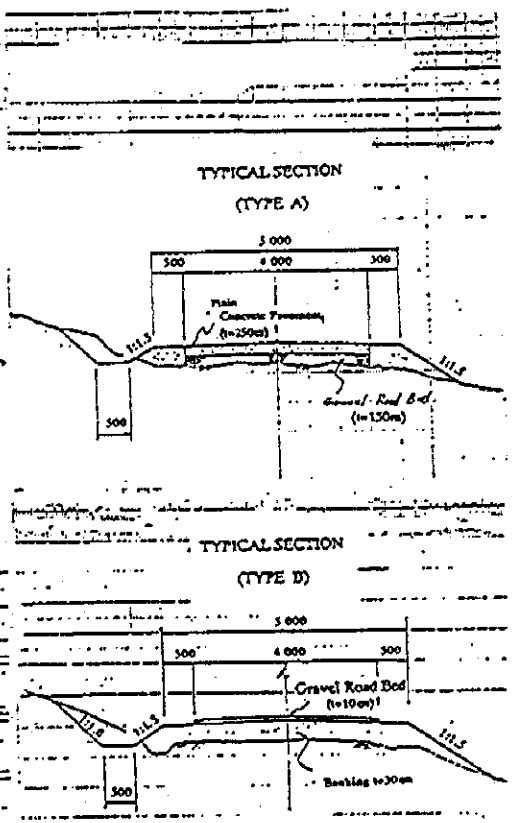


WATER TAP

BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT	Fig. 2.3.2.6-2 DOMESTIC WATER SUPPLY FACILITY
JAPAN INTERNATIONAL COOPORATION AGENCY	

Profile of Proposed Road for Settlement Area





BASIC DESIGN FOR INFANTA IMPOUNDING IRRIGATION AND ENVIRONMENTAL IMPROVEMENT PROJECT	Fig. 2.3.2.6-3 PROFILE OF ROAD FOR RESETTLEMENT AREA
JAPAN INTERNATIONAL COOPORATION AGENCY	

2.3.2.7 Nursery and Afforestation Plan

(1) Afforestation Plan by the Pangasinan Province

The Pangasinan province prepared an afforestation plan in and around the drainage area of the dam site. The main objectives of afforestation plan are briefly explained below:

(a) Environmental conservation and improvement such as water resources cultivation, protection of fauna & flora, forest beautification, and reduction of natural disaster such as soil erosion and flood.
(b) Economic effects by increasing the income of inhabitants from the fruit trees as well as timber trees.
(b) Social effects by becoming conscious of the importance of environment conservation through the beautification by afforestation and improvement of natuarl scenery..

The Province considers that the following trees are suitable for planting in the proposed area.

(A)Forest tree

(a) Gmelina arborea (Yemane)
(b) Mahogany
(c) Acacia auricaleaformes
(d) Acacia mangium
(e) Teak
(f) Eucalytus deglupta
(g) Neem tree
(h) Narra

(B) Orchard tree

(a) Mango
(b) Cahew
(c) Jackfruit
(d) Guyabano
(e) Duhat

(f) Coconut

(C) Others

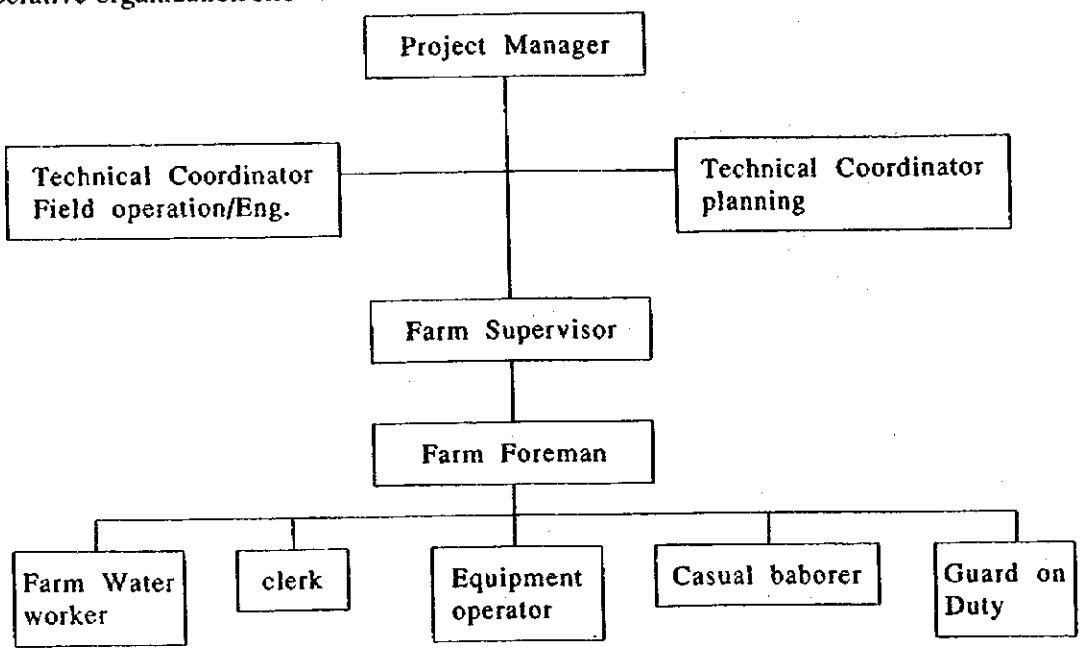
(a) Native bamboo

(b) Grass (Cogon etc.)

These trees are already comfirmed to be suitable for the natural conditions in the objective area as they are already planted in the area and get a good result of growth rate.

The Province prepared the afforestation schedule starting in late 1997 for the first time as they considered that the nursery by Japanese aide could be constructed in 1997. However, the Province takes another look at the schedule now after understanding the present implementation schedule of nursery is in 2000.

After the study and discussion on the matter, the Province entrusted to PENRO to be the responsible agency for O & M of nursery as well as afforestation and both agencies signed on the memorandum for O & M. It is informed that PENRO can prepare more budget for the afforestation and and has more experience for the general trees to be planted in the mountain area. However, the O & M activities will be carried out by the cooperative organization shown below.



General Organizational Chart for the Afforestation Project

The technical coordinator will be assigned from the province and most of the other staff including the project manager will be assigned from PENRO. Although the province and DENR agrees to cooperate each other for the afforestation of the Infanta Project., the other agencies such as the Agricultural Department of PSU and Municipality of Infanta are likely to join in the organization for implementing the project with an administrative and technical support in nursery and afforestation, if required. Also, an participation by a Japanese volunteer (JICA) is considerable for expecting the reliable implementation.

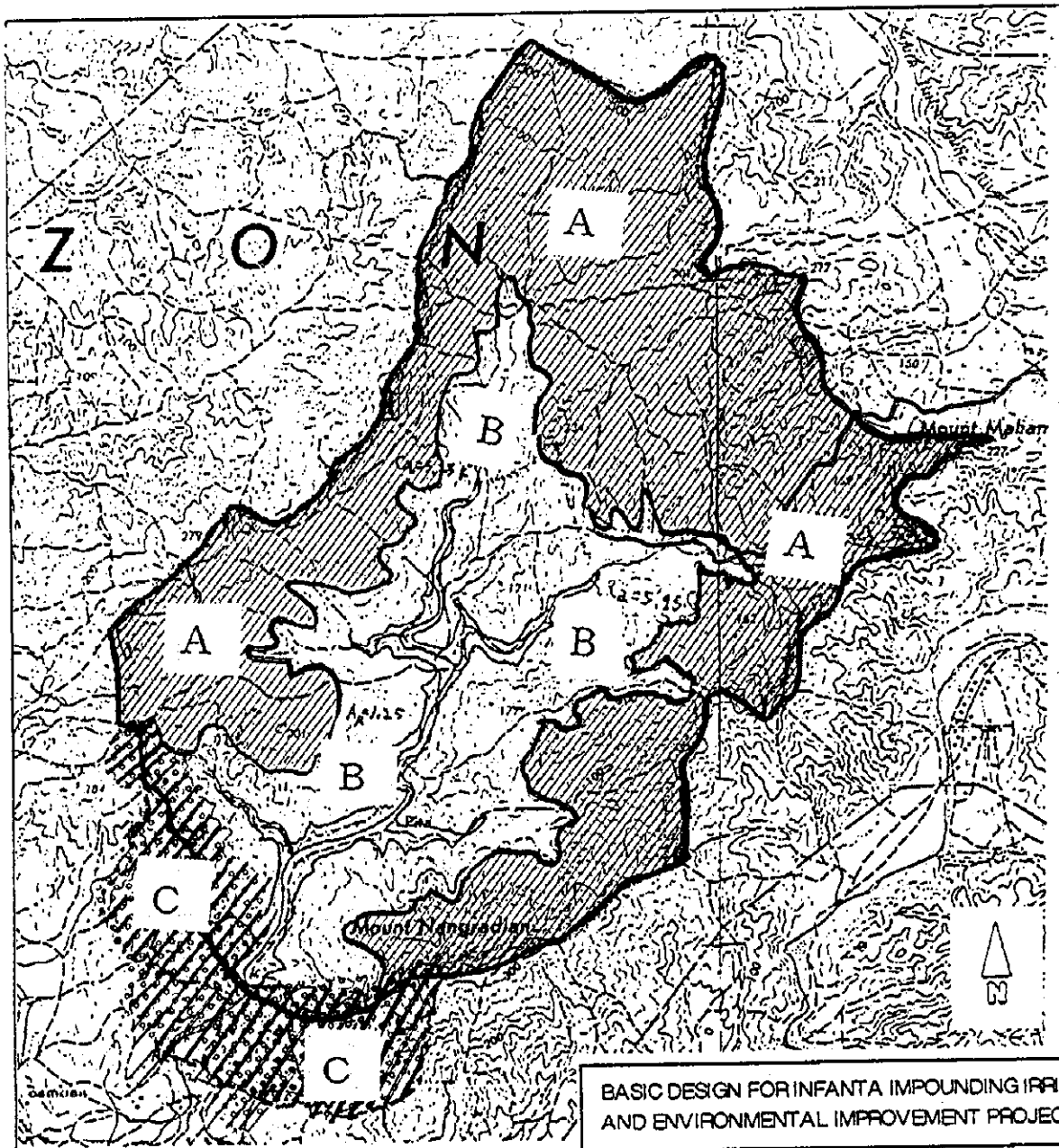
The afforestation plan, which is prepared on the basis of discussion with OPAG & DENR staff, is shown in Fig. 2.3.2.7-1. The area for the plan covers 2,290 ha, which is almost equivalent to the drainage area of the planned dam. The area is divided into the following three categories:

(a) The first one is timber-use forest which covers almost 1,200 ha in total by narra, mahogany teak, and the other useful timber trees.
(b) The second one is nature cultivation forest covering the total area of approximately 600 ha by generally fast growing trees such as acacia, eucalyptus, and gmelina.
(c) The third one is orchard forest covering the area of approxi. 490ha by fruit trees such as oranges, lemons, gayabano, cashew, and coconut.

The afforestation activities will be carried out by labours to be employed periodically and also by volunteers for planting.

(2) Sapling Production Plan

The plan for the nursery and sapling production was prepared based on the afforestation plan of the Pangasinan Province. It has a clear goal of providing good quality saplings necessary for an afforestion project on its own. Paper or ziffee pots used in fixed nursery beds are suited for a low-cost yet efficient production of good saplings. The saplings produced this way are expected to settle well upon planting and grow steady and healthy. The number of saplings to be produced a year based on the plan is shown in Table 2.3.2.7-1.



zone type	tree types
A	Japanese oak, mahogany, teak
B	acacia, eucalyptus, gmelina
C	fruit trees

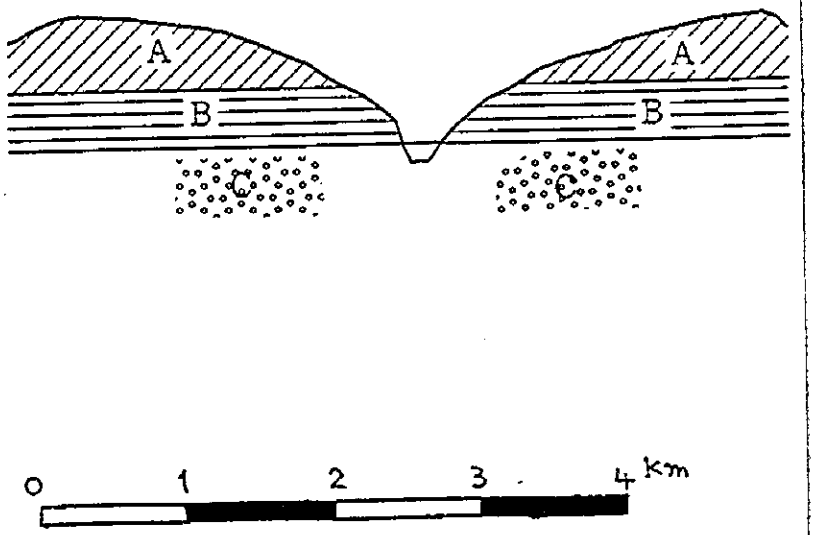


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Fig. 2.3.2.7-1 Two-dimensional Diagram for the Afforestation Plan

Table 2.3.2.7-1 Production Plan for Saplings & Planting

Unit (the number of trees a thousand, the area: ha)

items \ project year / calendar	1	2	3	4	5	6	7	8	total
	1998	1999	2000	2001	2002	2003	2004	2005	
Japanese oak, mahogany, teak									
the area for planting	–	–	80	160	240	240	240	240	1,200
the number to be planted	–	–	88.9	177.8	266.7	266.7	266.7	266.7	1,333.50
the sapling number	–	–	104.6	209.1	313.7	313.7	313.7	313.7	1,568.50
acacia, eucalyptus, gmelina	–	–							
the area for planting	–	–	40	80	120	120	120	120	600
the number to be planted	–	–	44.5	88.9	133.4	133.4	133.4	133.4	667
the sapling number	–	–	52.3	104.6	156.9	156.9	156.9	156.9	784.5
fruit trees	–	–							
the area for planting	–	–	–	90	100	100	100	100	490
the number to be planted	–	–		100	111.1	111.1	111.1	111.1	544.4
the sapling number	–	–	–	125	138.8	138.8	138.8	138.8	680.2
total	–	–							
the area for planting	–	–	120	330	460	460	460	460	2,290
the number to be planted	–	–	133.4	366.7	511.2	511.2	511.2	511.2	2,544.90
the sapling number	–	–	156.9	438.7	609.4	609.4	609.4	609.4	3,033.20

Note: (1) The number to be planted is set as 85% of the total number of saplings.
(2) Planting bamboo and brushwoods shall be implemented only when necessary for protection of the forest soil. The number of saplings after 2000 should be kept sufficiently high enough, even though the number of sapling to be planted is relatively low.
(3) Also bamboos and shrub woods shall be included if necessary for a good forest environment.
(4) The basic condition for estimation is that 1,111 trees per hectare =3 m x 3 m in a total of 2,290 ha are planned with consideration for works and maintenance necessary afterward .

(3) Study on the Nursery Site Selection

The planned site for the nursery is located some 1.6 km south-south-east of the planned dam (in a beeline). It is close not only to a planned settlement site but also to the irrigation canal and water supply pipe to be newly built and service water facilities in the north-east slope. The land is low at some 28 to 36 meters above the sea level facing a slow slope on the south-west direction of the rather high hill. Shrubs are seen sparsely on the top of the northern slope and grasses are dense on the eastern side. The west and

south-west sides are low lands with the cultivated paddies. Those rich grasses are Samon Grass, Tanlar Grass and kaya-kind called Cogon. The adjacent low area is a wet land with water filtered through from the near-by hill sides and seen sufficiently good and suitable for taking nursery soils as it is proven by a healthy growth of farms and rich grasses on it despite a bad water drain system.

The favorable aspects of the site for the nursery establishment are shown below.

(a)The water for the nursery can be diverted from the irrigation canal to be newly built. Thus, a low-cost, gravitational watering system can be made possible.

(b)The east side of the planned site is at a relatively higher altitude to minimize the damages from strong winds.

(c)The lands with sufficient area for nursery plan are available for purchase at a low price due to low level of landuse.

(d)The site is next to the resettlement area and it would be easy for management staff PSU and the center of Barangay Bamban are located in about 1.7 km distance to commute from the village and further there would be sufficient labours available for nursery and planting.

(e)Good soil filling in the nursery pots could be obtained from nearby areas.

(4) The Scale of the Nursery

The plan for the nursery set-up must be made according to the plan to be efficient in a sapling production. Some facilities for this end will include not only a nursery house but also an administrative office.

The pot nursery bed of 4,320 m^2 is necessary for production of 609,400 saplings at maximum, however, with passages for workers to be included, the area for it will be 8,160 m^2. When the areas for passages, buildings and other facilities are included, the total area necessary comes to some 2.35 hectares. The area of each facility/structure is shown in a table below.

items	areas (m^2)	descriptions
pot beds	8,160	yearly turnover is one, 4,320 m for pot nursery bed including passages
passage	4,032	width of 5m with ditch of 0.5 m wide on both sides, total length of 672 meters
peripheral buildings	1,848	buildings and squares
water pools and squares around facilities	5,280	to pool underground water, spring water, rain water soil mixing & preparation
Soil preparation area	4,140	wind breaker, soil fertilizer site
total	23,460	

(5) Planning and Design of the Nursery

The location of various facilities for the nursery shall be allocated in consideration of its geography and topography to nurture healthy saplings in the most efficient way. The allocation plan is shown as Fig. 2.3.2.7-2 and Fig. 2.3.2.7-3. The explanation for major facilities is to be made as follows:

(A) Nursery Facilities

(a) Pot nursery site; (the area of 8,160 m^2 including 4,320 m^2 for pot beds)
The bed will be compacted for preventing weeds and elevated by 10 cm by the mounds for a water drain during the rainy season. Each section of the nursery beds has 2 m x 60 m space with a 10 cm high mound. One block consists of the 1,080 m^2 area with 9 sections. Total of 4 blocks, 36 sections and the area of 4,320 m^2, will be prepared.One section has a capacity of 18,750 sapling pots when 8 cm-diameter pots were used. Thus, total of 675,000 pots (18,750 saplings x 36 sections) should be enough as 609,400 saplings or 511,200 trees are planned for planting at the production peak. The area planned is wide enough even when 10 cm diameter pots are used along with 8 cm diameter pots.

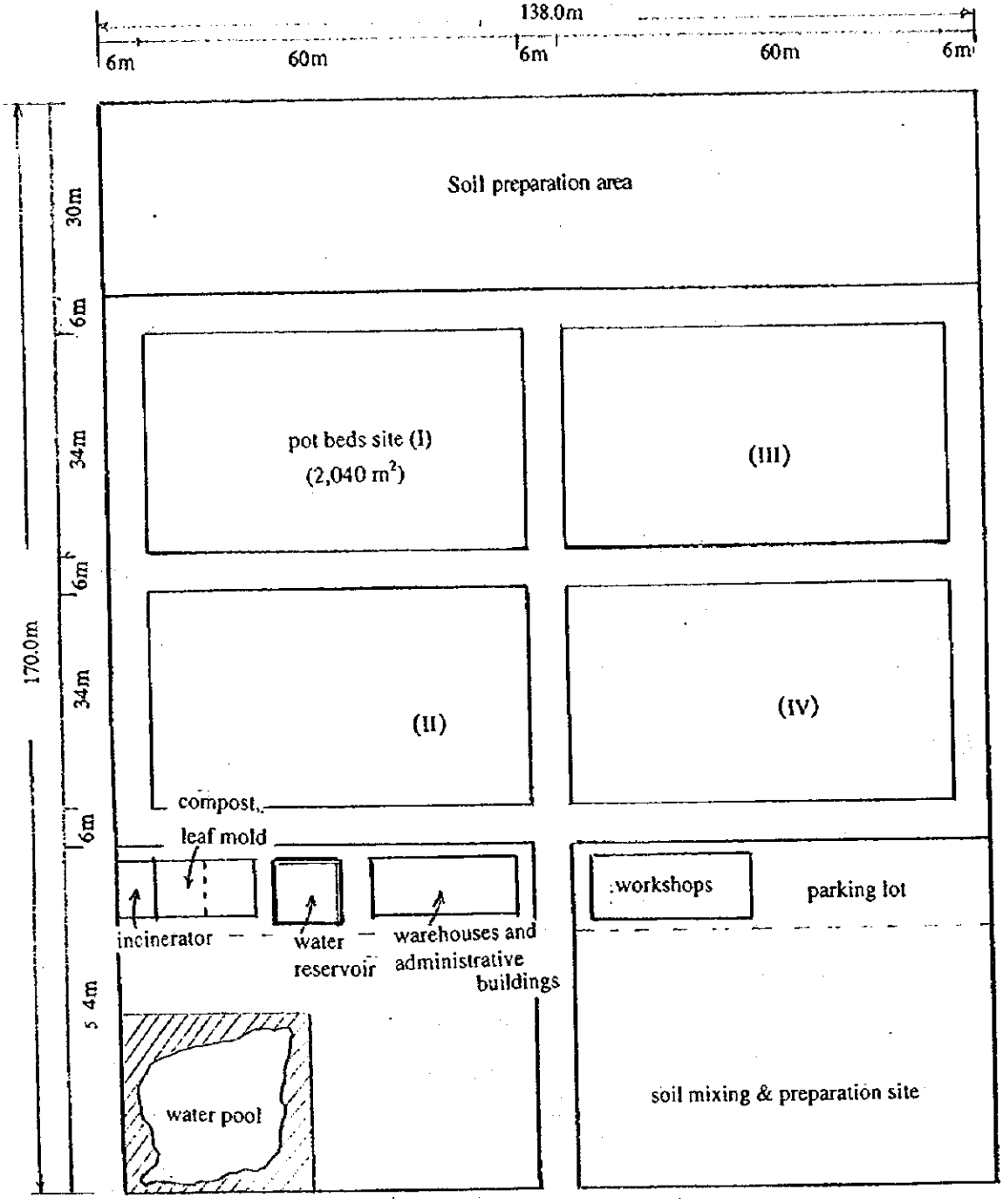

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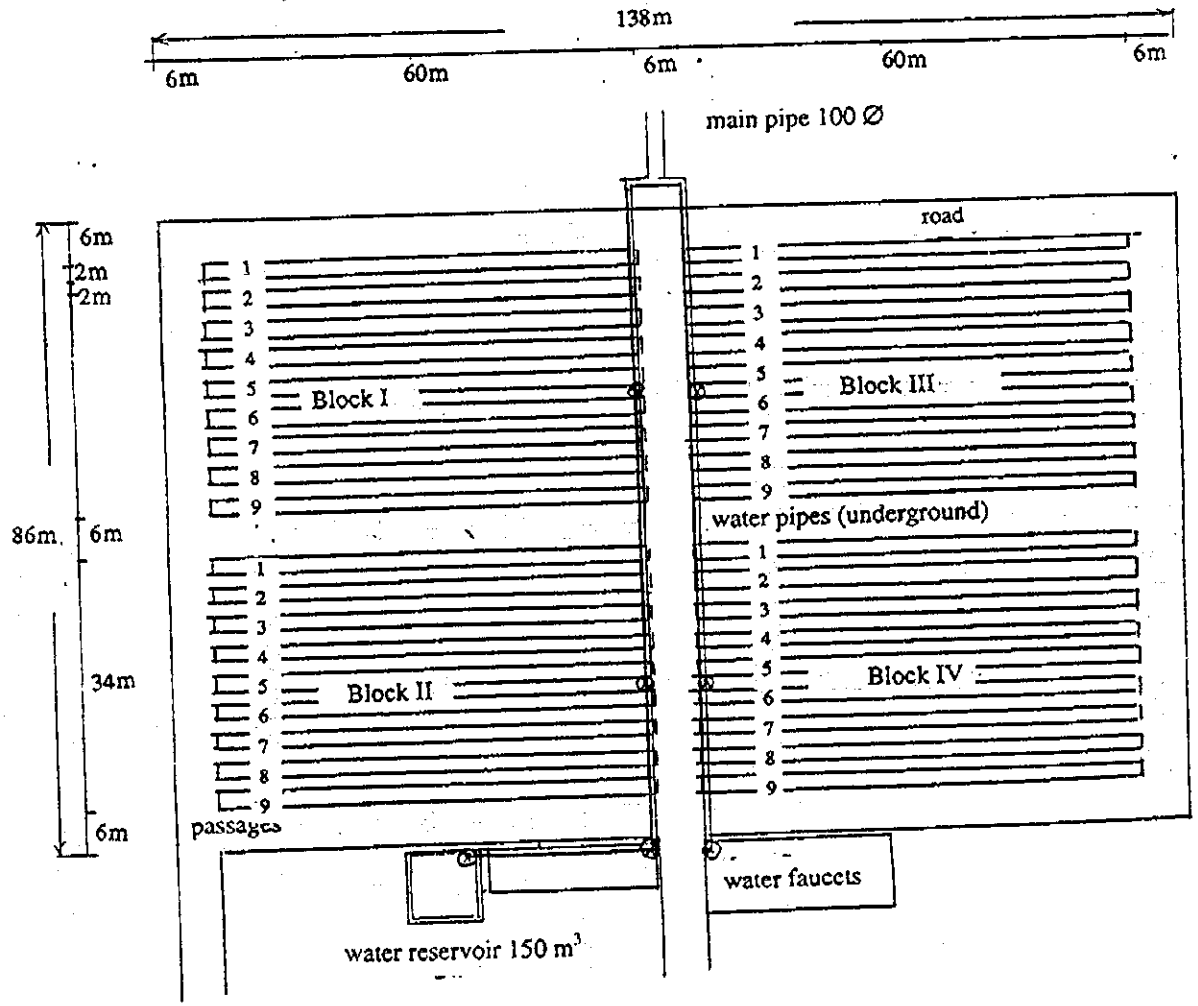
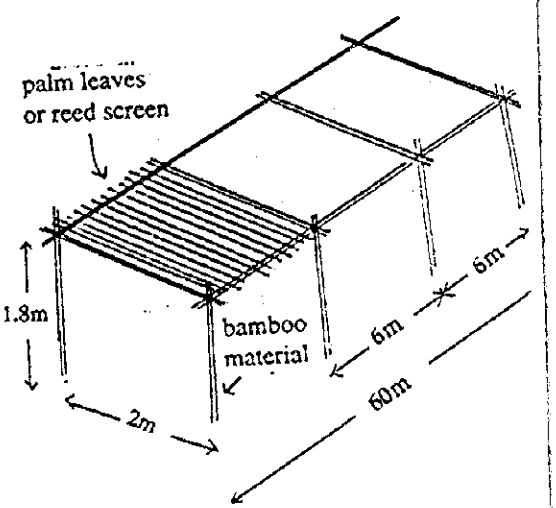
Fig. 2.3.2.7-2 allocation of the Nursery Facilities





Study on Basic Environmental Infrastructure Design for Rain-Water Oriented Agriculture in the Infanta	Fig. 2.3.2.7-3 Pot Nursery Beds Allocation (water supply facility and sun shade facility)
District by Japan International Cooperation Agency	

(b) Sun Shade Facility (the bed area of 4,320 m^2)

The pot nursery bed must have a device to adjust an intensity and amount of sun light and sun light collection after germination so that transplanted saplings in the pots will be protected and nurtured well. Sun screens can be made of locally available bamboos, palm leaves, kaya or reeds. Sun shade screens should have a 40 to 50 % cut-off capacity. Drawing for a sun shade device is shown in Fig. 2.3.2.7-3. See the table below for the necessary materials for it.

Sun shade facility		
materials	descriptions	volumes
bamboo	bamboo materials length of 6 meters or more, diameter of 5 cm (20 poles) length of 2 meters or more, diameter of 5 cm (11 poles) length of 1.8 meters or more, diameter of 5 cm (22 poles)	36 sets
palm leaves or reed screens	600 kg as one set, total of 21,600 kg	36 sets
others	strings or ropes	

(c) Irrigation Facility (the area for irrigation: 4,320 m^2)

This facility will be built only for the use in the pot nursery beds. The water for this purpose can be diverted from the irrigation canal, which will run the nearby high-land north to the site. A gravitational watering method will be adapted to avoid any influence by seasonal changes such as a rainy or dry season and to be seen as economical, efficient and practical in the area.

The water volume needed for irrigation per day on an average is set as 8 mm. Bases for this figure are a high evaporation rate in the area and eucalyptus trees to be planted. The break-down for the water volume is shown below:

Pot nursery beds : 2m x 60m x 36 sections =4,320m^2

Irrigation water (per day) : 0.008m x 4,320m^2=34.56 tons

The total irrigation water volume for a dry season = 34.56 tons x 180 days= 6,300 tons.

In addition, water needed for administrative offices, a germination room, a season. As for a rainy season, only one fourth of a dry season, that is approximately 12 tons per day, will be needed. The total water use during the rainy season is estimated to be 2,160 m^3 (= 12 m^3 x 180 days)

(d) Storage Water Pond and Water Pool

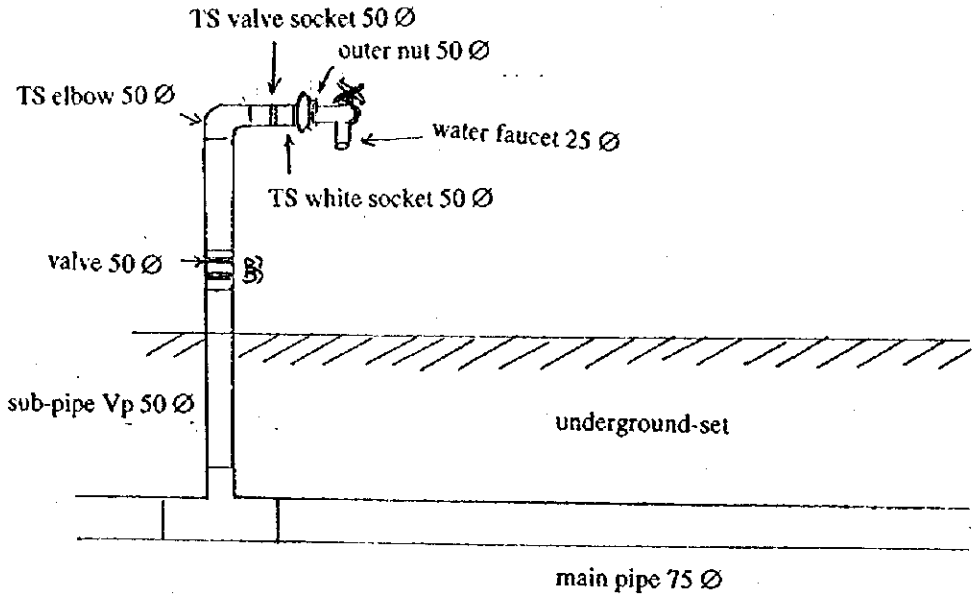
A storage pond will be located in an appropriate low land to gather water from the underground, spring waters and rains. The pond will be useful not only for water use in an emergency case but also nature conservation in the area. The pond has approximately 400 m^2 of area. The water pool is a concrete structure of 10m x 10m x1.5m.

(e) Irrigation System

The drawing for the nursery plumbing with a gravitational irrigation method is shown below.

Vinyl chloride material will be used for plumbing pipes. Motored watering involves synthetic rubber hoses connected to the water faucets. The necessary materials for the system are as follows:

water flow adjustment	water valve one set
main pipe	Vp 100 Φ, 28 m
sub pipe	Vp 75 Φ,210m (70m x 2= 140m set underground)
pipe with a drain faucet	Vp 50 Φ,60cm 7 pipes
water faucet	Vp 25 Φ,7 faucets



(B) Buildings

(a) Warehouse, Administrative office: the area of 90m^2

Wooden flat buildings will be build for a warehouse and an administrative office. The warehouse should be big enough to store all nursery equipment. And some quarter of the administrative office will be partitioned to be used for a clerical work and a room for sleeping and resting. The warehouse structure should allow a door open as wide as possible and has a careful robbery prevention system.

(b) Germination House: the area of 48m^2

The lower half of a germination house of a wooden flat structure will be covered by wood panels and be built next to the warehouse to make an easy access to the each other. The roof top will use a strong semi-transparent plastic material to gather sun light in the room and on the nursery beds. Another consideration is shelves for germination boxes.

(c) Work Shop:the area of 250m^2

The work shop is of a wooden flat building with part of the flooring concrete

mortar. The building will be simple and the lower half of it will be covered by wood panels or concrete blocks. Works such as mixing soil or fertilizer and filling pots will be done here and the soil for nursery pots will also be stored here.

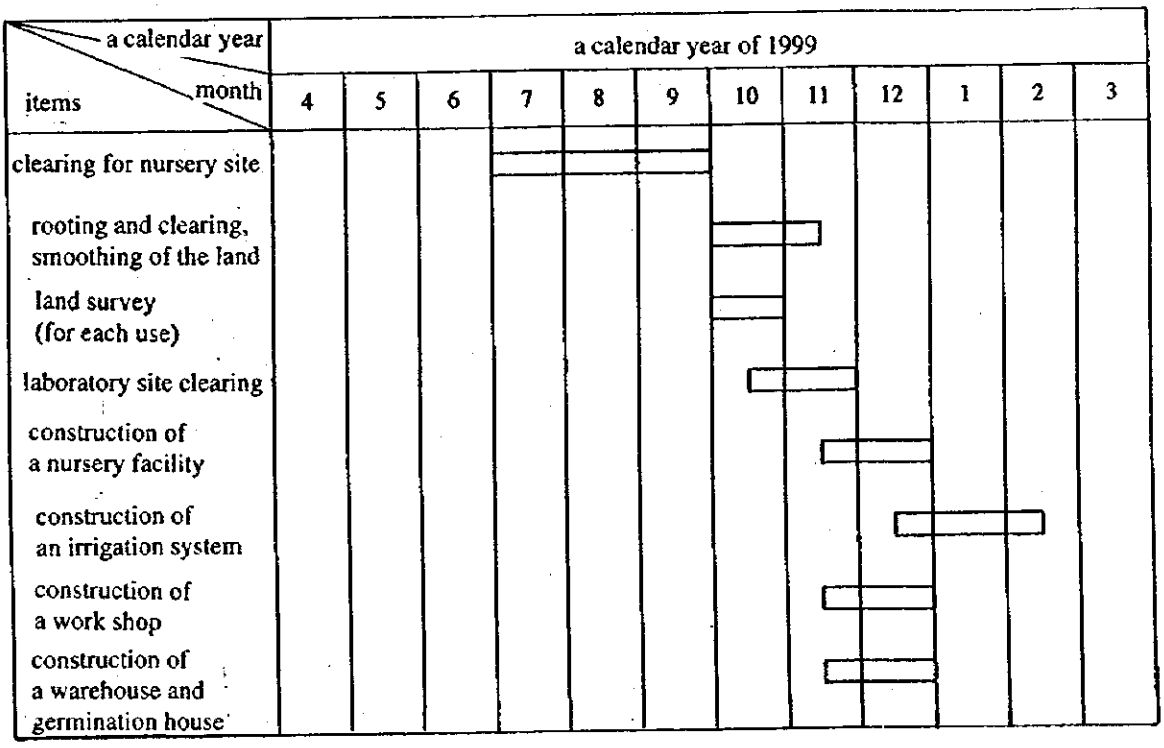
The plan for these building facilities is shown in Fig. 2.3.2.7-4

(C) Passage (Road)

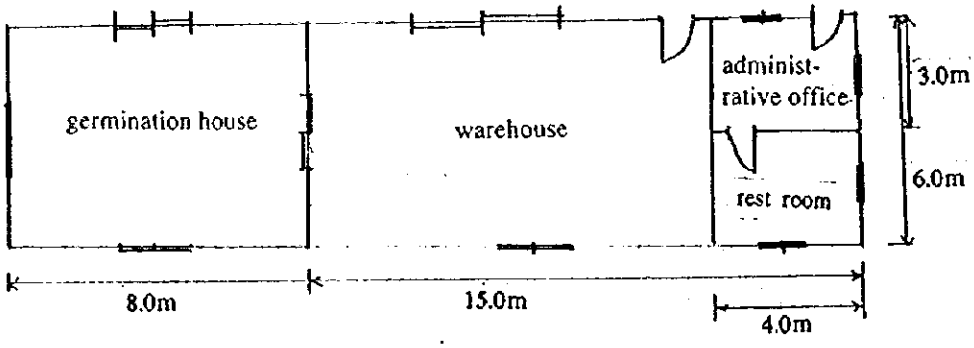
The passages within the nursery area is designed to be a road of 5 m wide and 672 m long with a side ditch of 50 cm wide and 30 cm deep on the both sides and the gravel pavement of 6 cm thick.

(6) Schedule for the Nursery Land Development

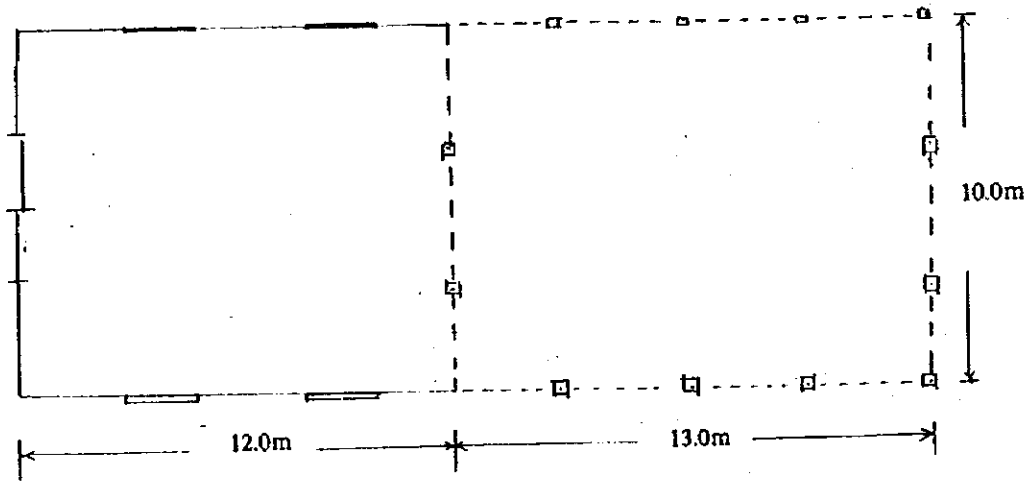
Nursery and afforestation plans for this project should be well integrated into each other. For this reason, works must start with securing a water supply from the new canal. The time schedule for a nursery land development and the nursery was set in such a way that the full-fledged afforestation project is to begin in 1999. Therefore, the start of a actual planting work as a preparatory phrase is planned to be in 2000. The table for the nursery land development schedule is shown as follows:



warehouse, administrative office, germination house



work shop



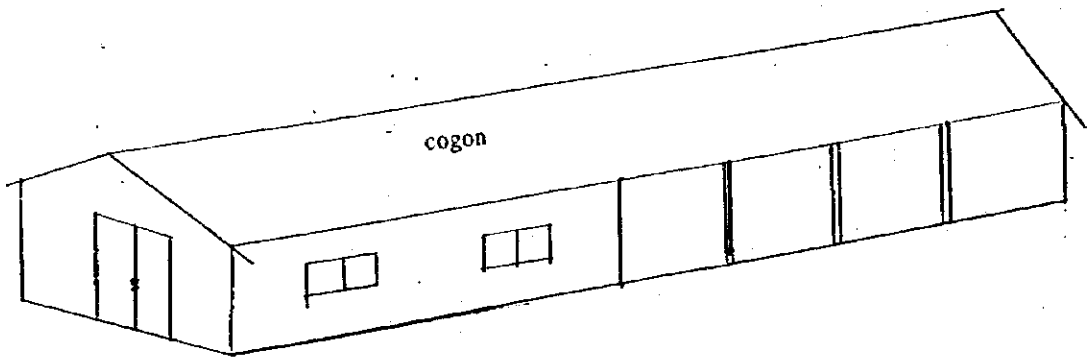


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Fig. 2.3.2.7-4 building facilities

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(7) Planting and Foresting Plan

Some reference explanations for the planting and foresting plan are made as follows:

(A) Work Schedule

The Philippines side will be in charge of planting and forestation. Yet a careful planning should be drawn up because of its importance just as in the nursery planning. Table 2.3.2.7-2 shows a yearly work schedule for planting and forestation plan for reference, although the definite work schedule is not prepared yet by the province.

A normal workload for planting is 100 to 300 trees a day for a person. However, it would be conservation to assume approxi.100 trees/day/person in consideration of the necessity of careful planting as well as planting by many common labours in wide area.

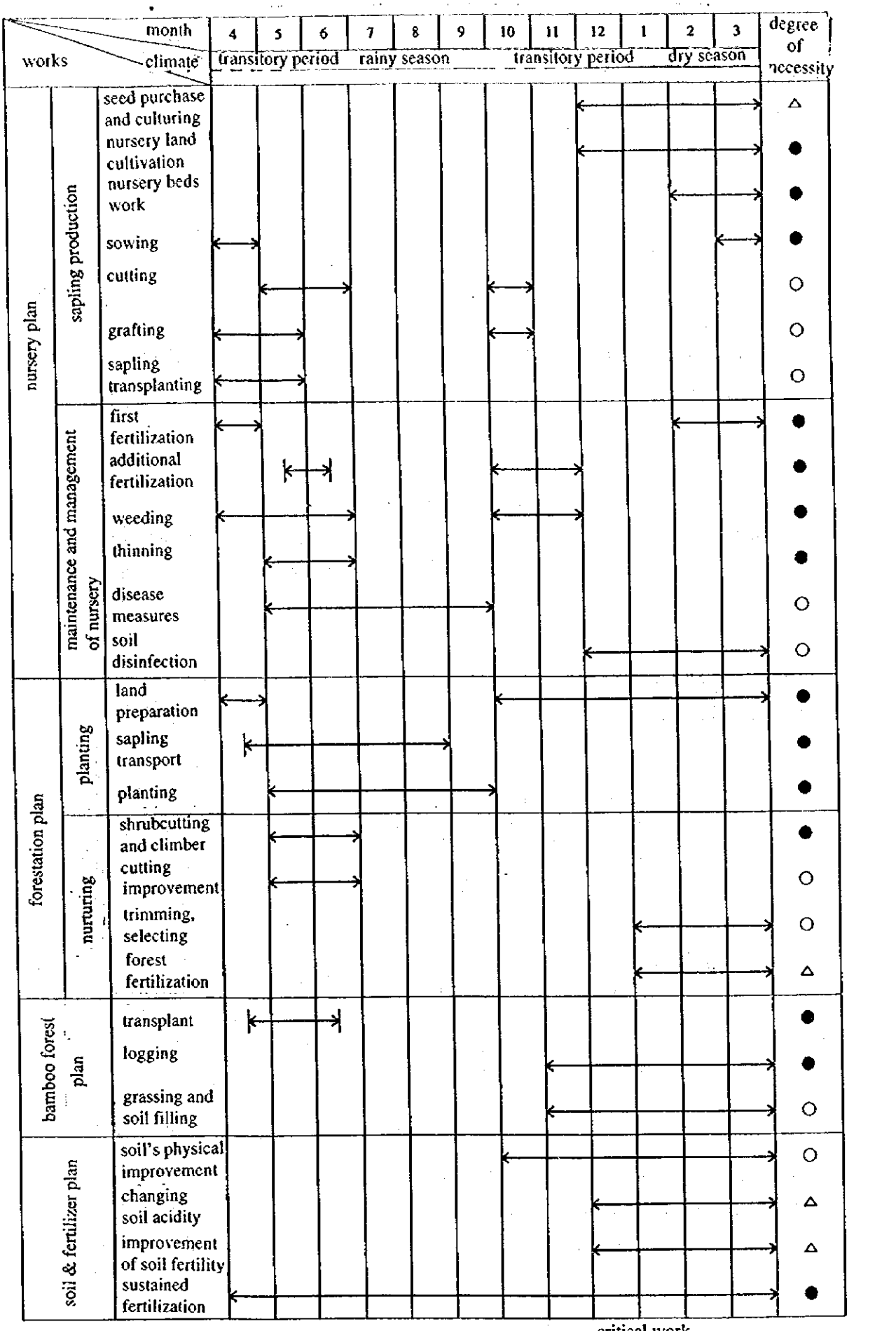
(B) Nurturing Forests

Forest fertilization for the first time will be carried out as shown in the table below.

frequency	method		fertilizer volume used			
first time	timing	1. at the time of planting 2. after settlement or after shrubcutting 3. a year after planting	tree types	volume per tree (gram)		
				N	P	K
	fertilizer placement	1. in a row (3 to 4 spots) 2. underground 3. ground surface 4 combination of above	Trees around the reservoir. Broadleaf trees (including fruit)	6~8 10~20	4~6 8~16	4~6 6~12

From the second time on, the amount can be increased by 20 to 40 percent from that of the first time but only by carefully observing the outcome of the first fertilization and a fertility condition of the forests from the time of planting to the fully matured

Table 2,3.2.7-2 yearly work schedule plan for forestation (draft)



phrase. A use of nitrogen only would be fine once forests have matured. However, fertilizer of phosphorus and potassium together with nitrogen applied over the ground surface twice or three times are good as well. After thinning of young forest, 80 to 100kg per ha of fertilizer with nitrogen ingredient are suggested. Applying fertilizer at the time of planting should be avoided when planting were delayed or carried out in a dry season or saplings were not healthy.

Although many kinds of fertilizer for forest lands are now available in a market, the soil characteristics of a particular forest and a growth of the trees there require a careful choice of fertilizer.

(C) Forest Nurturing & Management

(a) Shrubcutting

Shrubcutting together with climber cutting are recommended once in the year of planting, then four times by the end of the fifth year. A workload for a clear shrub cutting is about 0.05 to 0.1 ha per day for a person in a land populated by sprouts, shrub and grasses.

(b) Pruning

The best timing of pruning is when trees seem to be fully crowned and a few lower branches are dead. Most of the time, it is carried out at the time of thinning or either before or after that. In a warn area like Infanta, a pruning work of two or three times between a fifth and fifteenth ring year are desired.

(c) Thinning

Thinning is to adjust forests' density so that a quality and quantity of the remaining trees' growth will improve. Thus, the number of the remaining trees and their spacing become more important. To implement this process, an attention should be paid to the trees to be left rather than those cut down. Those to be cut are of dying, too weak to grow, poor quality and hampering a growth of the neighboring good, healthy trees. A start of a thinning phrase is from a fifth to fifteenth year after planting. As for an interval of the work, it differs depending on a type of trees, a tree's age, a land altitude and a thinning rate. However, with 20% of logging, once every four or five years would be common.

(8) Share of Works

Although the study is carried out for all the major structures and facilities necessary for the nursery, it is essential to make the share of responsibilities between the Japanese side and the Philippines side for the construction works as well as the preparation of equipment & tools. The Japanese side will construct the major structures & facilities including the roads and water supply facility. However, the Provincial side has to construct comparatively simple or temporary facilities and also prepare the working equipment & tools without delay. The share for the nursery preparation and the share of facilities for the nursery site are respectively shown in Table 2.3.2.7-3 & 4.

Table 2.3.2.7 - 3 Share of the Nursery Preparation (1/2)

List of Facilities for the Nursery Site

(A) Pot nursery site

Items	Descriptions	Share
Pot beds Passage	W.2m x L.60m x 36 line = 4,320 m², 10cm high mound W.2m x L.60m x 32 line = 3,840 m²	Japan
Sun shade facility	bamboo materials, diameter of 5cm, L.6m x 20 poles x 36 sets L.2m x 11 poles x 36 sets L.1.8m x 22 poles x 36 sets palm leaves or reed screens 1 sets x 600 kg x 36 sets = 21,600 kg strings or ropes and others	Philippine
Water pool	Concrete structure, 10m x 10m x 1.5m = 150 m³	Japan
Irrigation facility	1. Vinyl chloride Water flow adjustment Water valve one set Main pipe Vp 100 28m Sub pipe Vp 75 210m Pipe with a admin faucet Vp 50 60cm x 7 Water faucet Vp 25 7 2. Water sprinkler pipe Synthetic rubber hoses 100m x 2	Japan

(B) Buildings

Items	Descriptions	Share
Warehouse administrative office	90m² Wooden flat buildings and roof with cogon (thach) or slate include of warehouse, administrative office and rest room	Philippine
Germination house	48m² wooden flat and roof top will use a strong semi-transparent plastic material	
Work shop	250m² Wooden flat building and roof with cogon (thach) or slate, the flooring concrete mortar.	

(C) Passage (Road)

Descriptions		Share
Road	W.5m x L.672 m, banks of 30 cm high, gravel of 15 cm thickness.	Japan
Ditch	W.50cm, bottom width 30 cm, D.30cm	

Table 2.3.2.7 - 4 Share of the Nursery Preparation (2/2)

List of Equipment for the Nursery Site

Items	No.	Descriptions	Share
Sprayer	2	half-pressure, automatic 10 lit, spread of agricultural chemicals, and liquid fertilizers	Philippine
Incubator	2	automatic (temperature, humidity, light effect etc.)	Philippine
Tracter	1	with accesories for plow, harrew dozer,diesel fed 8 - 10 HP	Philippine
Kuliglig (Hand tractor) tractor and complete accessories	1	main body (3 - 4 HP) with accessories	Philippine
Grass Cutter	4	main body diamond teeth file	Philippine
Truck (1t, Small Size)	1	4WD, 1 ton transport of soil, saplings materials, machine and parts	Philippine
Pump (Small Size)	1	main body (2 inches, 3 HP) synthetic rubber hoses L = 100 m	Philippine
Soil sampling and tester	1		Philippine
Incinerator	1		Philippine

Note: Some items can be excluded from the list if considered to be not required.

2.3.2.8 Operation, Maintenance & Management Plan

Concerning the operation, maintenance & management by PGP after the completion of the project, there are some anxieties from the Japanese officials concerned on the following points :

(A) PGP does not have an experience as an implementation agency of a Japanese grant aide project.
(B) PGP does not have sufficient experience for O & M of project facilities , especially for the dam.
(C) The PGP's activities for the preparatory works (as a counterpart agency) during the basic design stage are usually delayed.
(D) There are remarkable unsuccessful examples in the Philippines in the past for O & M of dam, irrigation, and forestation projects.

However, the PGP's side considers that the O & M activities could be done properly and sufficiently according to the following reasons :

(A) Dam and Irrigation Facilities

- The existing irrigater's associations have nearly 20 years experience of irrigation. And their management is good enough from the viewpoint that the collection rate of water charge is high. In addition, it is desirable that the O & M activities are carried out by the direct participation of farmers. The newly organized united association composed of the existing three associations and newly added farmers may manage the project facilities efficiently.

- It is true that PGP itself does not have experience of O & M for dam, however PGP or IA has sufficient experience in O & M of intake facilities from a river. It is considered that the dam of this project does not have facilities with complicated operation. So that, it would be possible that the PGP's operater can operate them without trouble if the guidance and training are provided by NIA as well as the Japanese experts. Further, the education level of farmers are comparatively high in the Philippines.

- NIA already signed on the MOA (Memorandum of Agreement) for the

assistance in the implementation and O & M of dam & irrigation facilities. In addition, the provincial office of NIA prepared the plan for the implementation and O & M of dam & irrigation facilities.

- It is proposed that the Japanese consultants will prepare the O & M manual and provide the guidance & training during the construction supervision period. And it is also expected that the periodical inspection & guidance by the consultants will be posssibly continued after the construction period as well.

(B) Road Facilities

- It is already included in the project that four units of maintenance equipment are provided from the Japanese government. Accordingly, the maintenece & repair will be carried out by usung these equipment effectively. The operation & maintenance of equipment itself will be carried out without any difficulty as the province has sufficient number of experienced operators and mechanics.

(C) Nursery and Forestation

- Concerning the nursery and forestation, PGP and PENRO/DENR already signed on MOA. That is , PENRO/DENR agreed to take responsibility to carry out all the necessary activities by their budget. PENRO/DENR has an abundant experience in the past and a model forestation project (243 ha) is on-going in the basin of Infanta project. Further, there is an agricultural department of Pangasinan State University in the Municipality of Infanta and they have actual experience of forestation in and around the campus. In addition, the intention of inhabitants on the participation to forestation is comparatively high due to some forestation events in the past.

- It is already officially proposed from PGP to the Japanese side that an expert/specialist will be dispatched for the technical guidance during the operation & maintenance period of nursery & forestation.

- The planning report on the implementation and O & M for the nursery and forestation is prepared by PENRO/DENR.

(D) Resettlement Plan

- Concerning the resettlement plan, PGP and MPC signed on MOU and MPC already agreed to assist in the execution of resettlement plan by PGP.

- It is decided after the dicussion with MPC that the resettlers are to be selected from the Mt. Pinatubo victims already living in the municipality of Infanta or the neiboring municipalities. The survey of the victims and selection of resettlers are already carried out.

- Concerning the living of the resettlers , 70 families in total, there are some measures for their income, although the Japanese side decided that the farming land would not be provided to them due to poor quality of soil in the proposed area. PGP as well as the Municipality of Infanta will give them special priority for the employment opportunities for some items such as forestation, construction, tenant, fishery, etc. And the follow-up care will also taken to them by the PHUDC of PGP.

- The planning report on the implementation and O & M for the resettlement is prepared by PHUDC of PGP.

In connection with the matters described above, there are the following common points which should be significant for O & M :

(A) Organization for Operation, Maintenance & Management

The basic organization for operation, maintenance & management is already established among the related government agencies in which the province is the responsible one, as seen in Fig. 2.3.2.8 - 1. The related agencies are different by the objective structures. The cooperation from NIA and DENR/PENRO would be the most essential one among all the cooperative agencies.

(B) Share of Responsibility

The cordination for share of responsibility among the cooperative agencies in the organization would be made by PGP. The cooperation from the other agencies is

inevitable as the province itself does not have sufficient experience for O & M of a project with a dam. The municipality of Infanta would have to participate in the activities directly as a part of the provincial government. The staff for O & M will be prepared among the cooperative agencies.

(C) Finance/ Budget

The provincial government is the agency for taking full responsibility of budget preparation for O & M. The province already prepared a certain amount of budget, however it could be increased according to its necessity. On the other hand, the cooperative agencies also share a part of budget for their resposible fields. For example, PENRO/DENR will share most parts of the cost for the nursery and forestation.

It seems that the explanation above is more or less reasonable, although some anxiety is actually argued among the officials concerned about the continuous attention and effort by the PGP side after the project completion in the future. Some supplementary comments and suggestion on the O & M plan for each component of the project are presented as follows:

(1) Road

All the roads to be constructed or improved by the Japanese side will belong to the municipality/barangay. Consequently the municipality/barangay has to take responsibility for the maintenance. There is no construction equipment for the maintenance in the municipality at present. Accordingly, the following cases are considered for the construction equipment at the present conditions :

- Rent a equipment from the mining company (Short hours would be possible depending on the company's convenience)
- Rent a equipment from the district office of DPWH (It would not be easy as DPWH is in charge of national road)
- Rent a equipment from the province, a new team established in 1996 (It would be more or less reliable than the above two cases, however one team has to be used in common among ten municipalities of the district. The municipality of Infanta only could not use them with priority.)

The situation mentioned above shows that it is difficult to expect the good maintenance without the additional countermeasures.

Accordingly, it is proposed by PGP to provide the following equipment for the maintenance.

- Dump truck
- motor garder
- Backhou
- Bulldozer

Note; The equipment is commonly used for the maintenance of the irrigation facilities as well.

The new equipment to be procured by the Japanese side (if agreed officially) could be used efficiently for the maintenance activities. It is essential, however, to establish the organization and system for the proper use of these equipment. The inhabitants will participate in the field works and the materials (sand & gravel) can be obtained from the nearby riverded. It seems difficult for the municipality of Infanta to maintain the equipment by itself due to shortage of budget & expert for keeping them in good condition. Therefore, it is considered better for the province to take responsibility of maintenance & repair of the equipment and for the municipality to bear the direct cost for operation and maintenance. In any case, the province and the municipality have to prepare a definite organization, budget, share system, operation rule, and so on . In addition, it is necessary for the municipality to prepare the garage for these equipment before the arrival of the equipment.

(2) Irrigation Canals and Structures

There are, at present, the farmers who belong to one of the existing three irrigators' associations and also the farmers who do not belong to either of them. All these farmers will be newly organized in the new united IA or the associated body by the three IA , after the project implementation. The fundamental system would be not different, however all the irrigation network including existing one and new one should be managed as a unified system for the efficient and fair use of water. The maintenance works would be carried out as follows:

- Large - Medium scale canal works

  The provincial government is in charge ,but with the cooperation from NIA.
  (However, NIA has to take share the works for the structures constructed by NIA and the farmers have to share the man-power works when necessary.)

- Small scale canal works

  The farmers would have to share the works depending on the locations and individual paddy areas based on the cooperative discussion. However, the province as well as NIA has to assist in the work when required.

The remaining amount of present amortization of existing IA could be paid by the province to NIA on behalf for the farmers. And the new irrigation water fee will be paid from the farmers to the province. That is , the payment system is basically the same for the farmers, although the adjustment of fee amount would be necessary between the present member of IA and the non-members. The amount will be decided in reference to the present fee, so that the 1.5 - 2.0 cavan (75 - 100 kg)/ha/year would be the probable amount. As far as the collection rate is high at present, no anxiety for collecting the water charge would be necessary.

With regard to the construction of secondary & tertiary canals, PGP will execute the construction according to the guidance by NIA. The local farmers will participate in the works. The works will make the most of the experience through the activities for existing irrigation system .

(3) Dam & Reservoir

The dam design is made in consideration of the easier operation and maintenance. It is suggested to assign a permanent staff who belongs exclusively to the dam for the reliable duties. It is suggested to assign the reliable O & M staff from OPAG as well as IA. However, it would be necessary to get technical guidance & assistance from NIA. That is, the O & M system would be made by the cooperative organization among the province (PEO & OPAG), NIA, and IA, although the province should be the responsible agency. However, it would be desirable for the province to entrust the site management to the new IA , with the assistance from the municipality, for the daily operation and maintenance. The budget for O & M has to be prepared by the province, however the water charge

collected from the farmers can be allotted for such expenses. In addition, it is advised to prepare the O & M manual, before the completion of the construction, for the measurement of dam & reservoir, meteorological observation, inspection, maintenance, repair of structures/facilities, and so on.

(4) Tree Nursery and Afforestation

The O & M activities will be in charge of PENRO(DENR) with the cooperation from OPAG of the province. The other cooperative agencies such as BSWM, OMAG, PSU, and the municipality of Infanta will assist in the work, if necessary. The share of budget & management would be decided through the cooperative discussion between the Province and PENRO, although PENRO/DENR will share the most part of the budget. Both agencies have sufficient experience for the nursery and afforestation activities so that the effective progress is expected but depending on the definite plan with sufficient budget. It is necessary to prepare the practical and appropriate implementation plan by the both agencies. In addition , it is considerable to have cooperative participation from the inhabitants and school students for the planting activities.

The Japanese side will construct basically the roads, pot nursery bed (land preparation) and water supply facilities. Then the provincial side has to construct the other necessary facilities such as building/houses, sunshade, storage pond, etc. and also to provide the necessary equipment , tools & materials such as insecticide sprayer, cultivation set, small truck, farm tractor, potting compost, shovels and so on at the earlier stage. It is suggested for the province to prepare the sufficient budget to make sure the implementation and assistance to O & M. It is probable for JICA to dispatch a volunteer for assisting in the O & M activities for a few years.

(5) Resettlement Area

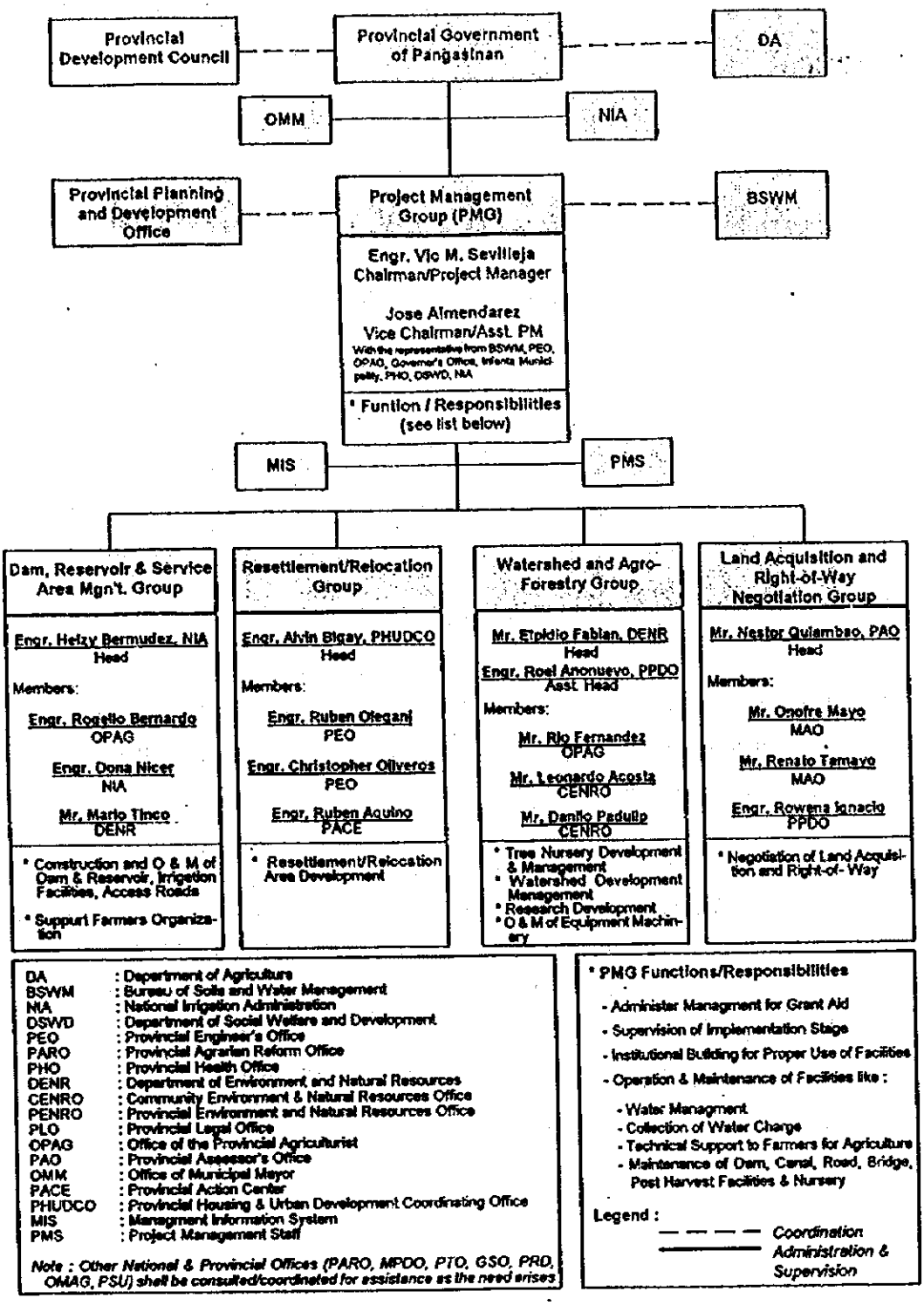
The O & M activities for the resettlement area have to be carried out basically by the resettlers themselves, however the positive backup from the related agencies is necessary at least for several years until they can live independently from the constant agricultural production. The provincial government will support them with the cooperation from the other agencies such as MPC,NIA, BSWM, and so on. The general conditions for the resettlers seem to be comparatively good in regard to the size of agriculture land per family as well as the infrastructure so that it is probable that this resettlement area become

a good model for the other similar schemes.

The Japanese side will construct the housing yards, main access roads, and water supply facilities. Then the provincial side has to construct or provide the other necessary facilities such as houses, canals, power supply and so on at the earlier stage. The tentative budget is already prepared by the province, however it is suggested for the province to prepare the additional/contingency budget to make sure the implementation and assistance to O & M, especially for the care to their living.

ORGANIZATIONAL STRUCTURE

Infanta Impounding Irrigation and Environmental Improvement Project



インファンタ地区天水農業環境整備計画基本設計調査 国際協力事業団	**Fig. 2.3.2.8 - 1** **Organization Structure for the Implementation of the Project by the PGP side**

2.3.2.9 Maintenance Equipment Plan

There are eight Barangays in the project area, and the total length of the roads connecting these Barangays is approximately 30 km. Except a certain paved section, these Barangay roads are unpaved soil roads, and there appear many suspension of traffic sections during the rainy season.

Improvement of these roads is planned as gravel pavement in consideration with the traffic volume and the road size. Therefore, the road surface maintenance will be necessary occasionally. Some equipment is necessary to maintain and improve the road, however, the municipality has no maintenance equipment at present and it seems difficult to rent the equipment from the outside owners, except some cases. For this purpose, it was requested from the province to provide one motor grader and one dump truck as the minimum requirement.

Construction and improvement of main irrigation canal is mostly planned as earth canal as well as secondary and tertiary canals which are connected to main canal, is planned as the earth canal totally. Therefore, the maintenance activity such as dredging work of canal is necessary.

Additionally, since the project include the dam construction and construction work in the river such as submerged bridge, the maintenance work in the river or reservoir are necessary in future. A bulldozer is necessary for the work as the maintenance equipment. The provincial government has provided a bulldozer for ten municipality including Infanta municipality. However, the project can not receive the priority of the bulldorzer.

Under the circumstances, procurement of one motor grader, one dump truck, one back hoe and one bulldozer are planned. The size of equipment is decided in consideration of the efficiency of operation and maintenance. For example, a motor grader with 3.7m blade will be appropriate for the road width of 5 to 6 m. As for the truck, a 10ton dump truck is useful to carry the gravel and sand. A 0.35m^3 back hoe is selected in consideration of width of canals. A 15ton bulldozer which mobility is high, is selected in consideration of works in the river and maintenance works.

The utilization plan of these equipment are following.

Name	Purpose	Annual amount used
Motor grader	Improvement of road and shoulder	2 times per year (the end of dry season, during the rainy season) for 30 km of village road in the area. Totaling 120 days.
Dump truck	Carriage of banking material and gravel or sand	2 times per year according as the working schedule of motor grader
Back hoe	Excavation of canal, Loading of gravel and sand	2 times per year (the end of dry season, during the rainy season) for 40 km of canal
Bulldozer	Excavation and pushing works in the river	Excavation and pushing works in the river if necessary

2.3.3 Evaluation of Basic Design

Although the basic design features of all the project components are shown in the previous sub-section 2.3.2 , it seems that there are some subjects or problems for proceeding, at the present situation , to the detailed design and the construction. That is, the additional survey especially for the dam foundation is considered to be inevitable. The major subjects are described as follows :

(A) Subjects

(a) Design of Dam

According to the results of geological survey in 1997, the highly permeable zone (the permeability coefficient k = 10^{-3}cm/sec in order , or Lu = 10 or more) was found on the both abutments of damsite. It is essential to confirm, by the additional survey, the range of this zone, the more detailed characteristics of geological layer, the seepage conditions, etc. and also the effectiveness of grouting. At present, it is probable that the grouting method only can not sufficiently improve the foundation. So that, the combination method of earth-blanket and grouting is applied for the foundation treatment. However, if the seepage flow according to Darcy's law unexpectedly exists along the cracks, the present method (ordinary method of grouting) would not be reliable enough. That is, a quite expensive method such as a double tube grouting and diaphragm wall may be used.

(b) Livelihood for the Resettlers (the Pinatubo victims)

In the original plan, the resettlers could work as a farmer in the irrigated paddy field located in the proposed resettlement area. However, it was concluded that the irrigable farmland should be abandoned due to difficulty of improving the poor quality of soil conditions. Accordingly, the resettlers can not get their income from farming in their own farmlands and they have to find the other sources for their income.

The PGP side explains on this matter that the care of their livelihood is the matter of the PGP side and it is a basic condition that the resettlers themselves have to make efforts for their own living. The PGP side also explains that PGP can arrange a

priority for their employment for the forestation activities, construction works, maintenance of project facilities, farming assistance to the new irrigated areas and so on. Further, it is informed that SEA (Self-Employment Assistance) Kaunlaran system , which assist in poor people , could be applied and they can get a financial assistance with a special loan condition.

However, it would be necessary to confirm the livelihood of resettlers and the significance of resettlement plan on the condition that the farming lands are not provided them.

(c) Significance of Dam

There were the following major roles for the dam in the original plan.

a) Irrigation water supply to the resettlement area for Pinatubo victims
b) Irrigation water supply to the existing agricultural areas

However, above a) was already canceled. Accordingly, it would be necessary to re-evaluate the significance of dam from the viewpoint of removing the irrigation water supply scheme to the proposed resettlement area for Pinatubo victims

(d) Resettlement Plan for Pinatuvo Victims

In the application from PGP, the original number of resettlers was 750 people (approx. 150 family) , however the number was changed to 70 families according to the result of review and discussion on this matter.

At present, the reliable number is only 25 families who already live in the Municipality of Infanta, even if it is assumed that all of them can actually resettle there. That is, the confirmed number of resettlers (Pinatubo victims) at present is still far below the required number.

The definite number is more or less not confirmed yet, so that it would be necessary to get a reliable confirmation of resettlers and at the same time the memorandum of agreement/understanding from MPC on the resettlement implementation.

Accordingly, it is necessary to reconfirm the justification of the project from the viewpoint of the significance and benefit of the resettlement for Pinatubo victims.

(e) Reforestation Plan

The PGP side(DENR) already prepared the forestation plan according to the request from the JICA side.

It is essential that all the arrangement for the budget, experts, facilities & materials, experienced technology, etc., have to be well prepared on time for the operation and management of forestation activities. It is informed that a successful case in the past forestation projects in the Philippines is quite limited.

Accordingly, it would be necessary to confirm the reliability for execution by the PGP side.

(f) Land acquisition

The agreement from the landowners as well as from the farmers to be relocated in connection with the construction of dam, road, and canals are not completed yet at present. It is probable that the project execution has a serious difficulty and induces a social issue even in case of a family who opposes to the agreement. It is necessary to confirm definitely the present status of the agreement.