(9) The facilities have a role to carry out various technical development tests besides those as a demonstration farm. Many small ponds are necessary. Their size, number and arrangement were planned considering the scale of the total facilities and harmony with other facilities as well as the experimental plan.

(10) The facilities are under the Albion Fisheries Research Centre but their technical operation is managed separately. Accordingly, a technical office building consisting of technical officers' and technicians' room, laboratory and plankton culture room is planned.

(11) Refrigerators for feed, warehouses, machine rooms, a watchroom, and watch facilities are to be provided.

(12) The space lot between the technical office building, the hatchery and the growing-out ponds is to be the site for a would be extension of the hatchery facilities.

3-2-2 Basic Idea on Facilities

Scale of the facilities should be decided based on the present stage of technical development in Mauritius, possibility of expanding technical staff and operational budget.

Considering the various aspects stated above, duration of the development is set to be seven years comprising three phases. Plan is so made that the culture of brackishwater shrimp will be promoted to be commercialized during the period of Phase II and that of seawater shrimp will be in Phase III.

(1) Basic idea on the most suitable facilities from the technical aspect

1) Existing stage of the technical development of shrimp culture in Mauritius.

The existing stage of the technical development of shrimp culture was described in detail in the Chapter 2 and it is shown in Table 8 to help planning of the facilities.

Table 8 Existing State of Shrimp Culture Technical Development

		Brackishwater	Seawater		
		Black Tiger	Speckeled Shrimp	Western King Prawn	White
Seed Produc-tion	Basic Experiment	Done ($2\text{-}4m^3$)	Done	Not started	Not started
	Experimental test	Not started	Not started	Ditto	Ditto
	Pilot test	Ditto	Ditto	Ditto	Ditto
	Technical Level	○	○	◐	◐
Breeder	Domestic	○	○	◐	
	Rearing	◐		◐	◐
	Import				○
	Maturation	○		◐	
Growing-out	Basic Experiment	Done ($40m^3$)	Done ($2m^3$)	Done ($40m^3$)	Not started
	Experimental test	Not started	Not started	Not started	NoDitto
	Pilot test	Ditto	Ditto		Ditto
	Technical Level	○	◐	◐	◐

Note: ○ Development is almost completed.
◐ Basic development is not completed.

2) Basic schedule of technical development and commercialization

First priority of the technical development and commercialization is placed on Black Tiger Prawn and then a species of seawater shrimp which will be the most suitable.

Another species will be selected next for the development in accordance with the overall stage of development. Basic schedule of the technical development of seed production and growing-out by species are shown in Table 9.

Table 9 Basic Schedule of Technical Development and Commercialization

Phase			Phase I			Phase II		Phase III	
		Year	1	2	3	1	2	1	2
Black Tiger	Seed Production	Pilot test	◐	○	○				
		Mass Production				○	○	○	○
	Growing-out	Pilot test	◐	◐	◐	○			
		Commercialization					○	○	○
Seawater Shrimp (A)	Seed Production	Basic Experiment	◐	◐	◐	○			
		Pilot test				◐	◐	○	
	Growing-out	Basic Experiment		◐	◐	◐	○		
		Pilot test					◐	○	
		Commercialization							○
Seawater Shrimp (B)	Seed Production	Basic Experiment				◐	◐	◐	○
		Pilot test							◐
	Growing-out	Basic Experimert						◐	◐

3) Necessary facilities in accordance with the technical development plan

Technical development programme has to be made following detailed study on the selected subject of th development, based on the above mentioned schedule.

There will probably be many subjects of the technical development due to comprehensive elements and their duplicate experiments needed. In this project, as mentioned before, a kind of brackish-water shrimp and a species of seawater shrimp, totally 2 will be selected. Basic principle is to improve the techniques gradually; commercialization will be taking place when the technical development reaches the possible stage for commercialization. Therefore the first priority of the technical development is on basic seed production as well as pilot test of growing-out of Black Tiger Prawn and culture experiments of seawater shrimp. Main subjects of the technical development of growing-out are correlation between growth, productivity of shrimp and salinity, density of shrimp, water exchange rate as well as quality and quantity of feed.

These programme may not always progress satisfactorily as shown in Table 9.

Consequently, the facilities, personnel and budget may have to be reconsidered.

Based on the above-mentioned points of view and schedule, necessary facilities are planned as follows (Table 10), referring to the similar development project.

Table 10 Necessary and Effective Facilities from the technical Point of View

	Facility	Scale	Number	Total	Basis of Plan	Scale by original request
Seed Production	Hatching	10 m^3 (2.5m x 2.5m x 2m)	3	30 m^3	1 for brackish water, 2 for seawater shrimp, but water supply system is planned for alternative use available. Scale is medium from technical point of view.	100 (Total)
	Post Larval Tank	20 m^3 (2.5m x 5m x 2m)	3	60 m^3	Correspond to hatching tank	-
	Maturation Tank	20 m^3 (2.5m x 5m x 2m)	3	60 m^3	Correspond to hatching tank	20-50 m^2
Growing-out	Breeder Pond	525 m^2 (17.5m x 30m x 1.5m)	2	1,050m^2	Scale is for common use. Each 1 for brackish and sea water.	-
	Nursery Pond	525 m^2 (17.5m x 30m x 1.5m)	2	1,050m^2	Scale is decided by the scale of hatchery growing-out and experimental pond and Barachois.	7,200 m^2
	Growing-out Pond	3,000 m^2 (40m x 75m x 1.5m)	2	6,000m^2	Pilot project scale applicable for general and small scale of commercial farm in future. To be used both for brackish and sea water. Two ponds are essential for comparative test.	40,000
	Experimental Pond	250 m^2 (10m x 25m x 1.2m)	6	1,500m^2	Both for brackish and sea water. Scale is for common use. Minimum number for the most important tests.	
	Barachois	7,000 m^2	1	7,000m^2	The best scale will be 10,000 m^2 as a model for commercial farm in future but the scale is decided naturally byithe topography.	

(2) *Basic idea on the most suitable facilities from the operational viewpoint*

Based on the result of the consideration on the most suitable plan from th said technical aspect, possibility to make arrangement of technical officer in charge and to make up the operational budget are considered.

1) Consideration from the arrangement of technical officer

Regarding operation checked in 1), details will be described later, but technical officers in charge will be Assistance Director/Chief Technical Officer and two technical officers - one for seed production and the other for growing-out, total three. They can be arranged in the Albion Fisheries Research Centre.

2) Expenses for maintenance and operation

Annual budget of the Ministry of Agriculture, Fisheries and Natural Resources, the Fisheries Division and the related organization for fisheries study are shown as follows, comparing with the operational budget of this project to be described in detail later.

i) Budget of the Ministry (July 1, 1985 - June 30, 1986)
RS. 218,000,000 = US$15,600,000
= ¥3,050,000,000

ii) Budget of Fisheries Division (July 1, 1985 - June 30, 1986)
RS. 13,000,000 = US$930,000
= ¥180,000,000

iii) Comparison of budget for Fisheries Research Organization and rough estimate of operational cost of this project

Table 11 Comparison of Budget

x Rs.1,000 (x US$1,000)

	Expenditure				Revenue	Balance
	Personnel Expenses of Staff	Personnel Expenses at Site	Opera-tional Expenses	Total		
Albion Fisheries Research Center	873 (61.0)	129 (9.0)	518 (36.2)	1,520 (106.3)	0 (0)	1,520 (106.3)
La Ferme Fish Farm	190 (13.3)	75 (5.2)	403 (28.2)	668 (46.7)	100 (7.0)	568 (39.7)
Total	1,063 (74.3)	(14.2)	921 (64.4)	2,188 (153.0)	100 (7.0)	2,088 (146.0)
This Project (Phase III)	530 (37.1)	196 (13.7)	1,037 (72.5)	1,763 (123.3)	935 (65.4)	828 (57.9)
					*1 392 (27.5) *2 543 (38.0)	*3 1,371 (95.9) *4 828 (57.9)

Note: *1 Revenue of harvested shrimp (US$10.00 or Rs.143/kg)
*2 Value of distribution of fry (US$0.02 or Rs.0.286/pc)
*3 Balance of budget and revenue of harvested shrimp only.
*4 Balance of budget and revenue of harvested shrimp plus value of distribution of fry.

Substantial operational cost of this project is about US$100,000 or ¥20,000,000 in case of only sales of harvested shrimp and US$60,000 or ¥12,000,000 in the case including the value of fry distributed.

Considering the related budget shown above, the operational cost of this project will be within the possible range of budget because it is less than the budget of the Albion Fisheries Research Centre.

(3) Consideration from the topographical conditions of the site

Based on the results of the site survey, several plans were made and studied for comparison. the final layout is not restricted topographcially because the most adequate facilities are effectively arranged by the consideration of 1).

(4) Final consideration

In consequence of the above considerations, the operational plan and basic design were made based on the effective facilities necessary from the technical point of view as shown in Table 10.

3-2-3 Selection of Project Site

As the facilities are operated as a section of the Albion Fisheries Research Centre, ground adjacent to the Centre is most preferable for the site of the facilities. The site is 10 km from Port Louis, the Capital, where most of government organizations, including the fisheries administration are concentrated. It has good access and is equipped with infrastructure such as electricity and running water.

One of the most important point for culture facilities is supply of water. The Black Tiger Prawn, the chief objective species does not grow well unless in low salinity environment (15 -20‰). But in the planned site, sea water has high salinity (35‰).So the pond water must be diluted with fresh water, that means fresh water supply is a necessity. Though fresh water supply there is not satisfactory by parting a part of the Belle Eau River running along the site a fresh water reservoir could be built and wells could also be digged.

In this way fresh water supply for pilot growing-out test ponds may be secured. The water thus obtained is considered to be free from contamination by agricultural chemicals. On the other hand, sea water supply will not be so difficult by using present civil engineer technique, though the sea in front of the Centre is very shallow. Another theme in planning industrialization of marine shrimp culture is the study of Barachois. Adjacent parts to the mouth of the Belle Eau River had been used as Barachois, and they are neglected now, but they could be utilized as a test Barachois for shrimp culture, which constitutes a very good condition.

Reviewing the above collectively, the area consisting of the Albion Fisheries Research Centre premises and its adjacent ground along he Belle Eau River are recognized as the most preferable sites for the project.

3-2-4 Organization to Operate the Facilities and Managing System

The organization managing all facilities related to fisheries is the Ministry of Agriculture Fisheries and Natural Resources. So, planned facilities are to be operated under the Director of the Albion Fish Fisheries Research Centre, a governmental institution, as a section of the Centre. The following will be a probable organization diagram of the facilities.

Albion Fisheries Research Centre

Director

- Research Section
  Ass. Director
- Marine Shrimp Culture Section
  Assistant Director (Divisional Scientific Officer)
  - Seed Production
  - Growing-out

In order to run this facilities effectively to obtain good results from the pilot test, the managing system is to be consolidated further.

3-3 Operation Plan

On the assumption that the facilities can be practically used from 1988, operation plan is made to achieve the target of commercial development through three phases as follows:

Phase	I	1988 - 1990
Phase	II	1991 - 1992
Phase	III	in and after 1993

Regarding seed production, emphasis is initially laid on the production of Black Tiger Prawn fry released into the pilot growing-out ponds and experimental Barachois but technical development for seawater shrimp will also be promoted at the same time with securing natured shrimp by catching at the coastal sea or importing. Under the certain circumstances, seed production of Speckled Shrimp (Metapenaeus monoceros) will also be carried out.

Seed production plan is conservatively made with the consideration that the expected productivity may not be obtained in some cases not only for seawater shrimp but also Black Tiger Prawn initially.

Growing-out operation will be carried out for Black Tiger Prawn for the time being but it may be switched to seawater shrimp if the seed production is practically developed.

In case of the experimental Barachois, however, depending on its salinity, growing-out operation for Western King Prawn (Penaeus latisulcatus) may be planned by releasing wild fry instead of Black Tiger Prawn, and if the seed production and nursery operation of seawater shrimp is practically developed, juveniles of the seawater shrimp will be released into the experimental Barachois from the nursery pond.

Growing-out operation plan is made by the classification of growing-out pond and experimental Barachois.

3-3-1 Experimental Plan

Basic experiment and investigation will be carried out by the existing Albion Fisheries Research Centre, but the experiment beside the basic study will be carried out in the present project facilities in compliance with the facilities and technicians.

Main experiments will be as follows:

(1) Seed production

1) Complete technical development of breeder production of Black Tiger Prawn.

2) Complete technical development of pure culture of various feed phytoplankton and mass culture of feed zooplankton such as Rotifer.

3) Complete technical development of stable mass production of Black Tiger Prawn fry.

4) Technical development of seed production for Banana Prawn, Indian White Prawn and Western King Prawn.

(2) Growing-out

1) Confirmation of correlation between various environmental conditions such as water temperature, salinity, water exchange rate, density of shrimp and growth as well as survival rate.

2) Research of nutrition requirement, development of suitable feed and its comparative experiment for each kind of shrimp.

3) Experiment of correlation between adoptive environmental conditions density of shrimp and growth as well as survival rate for white shrimp.

Experimental plan by year by using the six experimental ponds are shown in Table 12.

Table 12 Experimental Plan

Phase	Year	Black Tiger Prawn (Blackishwater)	Seawater Shrimp A	Seawater Shrimp B
I	1	Density test in N (2) Density test in G (2)	Breeder production test (2)	
	2	Feed test in N (2) Feed test in G (2)	Salinity test in N (2)	
	3		Density test in N (2) Water exchange rate test in N (2) Salinity test in G (2)	
II	1		Feed test in N (2) Density test in G (2)	Breeder production test (2
	2		Water exchange rate test in G (2) Feed test in G (2)	Salinity test in N (2)
III	1			Density test in N (2) Water exchange rate test in N (2) Feed test in N (2)
	2			Salinity test in G (2) Density & Water exchange rate test in G (2) Feed test in G (2)

Note: 1) N means Nursery pond
2) G means Growing-out pond
3) Figure of ( ) is number of pond used for the said test.

3-3-2 Seed Production Plan

(1) Securing of Breeder

Regarding breeder of Black Tiger Prawn which will be the main species for the pilot test, it is said that about 100 breeders may be caught in the brackishwater area, south of the Grande Riviere Sud-Est River mouth on the east coast of Mauritius Island based on the result of the study carried out by Dr. Yoshimasa Enomoto, an aquaculture expert who was dispatched from JICA for two years from December, 1983. Since that investigation was carried out by small seine net on the very shallow shore at the low tide of spring tide, there will be a further possibility of catching more breeders in quantity and frequently, by using gillnet or boat-seine net on the deeper area.

However, Black Tiger Prawn caught may neither be of adequate size for breeder nor fully matured. Especially, they may not be caught seasonally and they may be too small or immature. Therefore breeder production is to be operated in the culture farm for the future stable and deliberate production

The commercial size of shrimp harvested from the growing-out pond for sale is usually 30 - 40 g, and shrimp bigger than 100 g is scarcely expected in this case. Therefore it should be planned to release harvested shrimp or youngsters thinned out from the nursery or the growing-out pond in the breeder pond with low density under the special conditions using paddle wheel and to rear with special feed such as squid, shellfish meat and/or cattle heart so as to grow fast. It is often said that the number of eggs of breeder reared in pond is not large and quality of eggs is not so good, and the reason for this is now established that they are not reared for breeders with special care.

Two breeder ponds of 525 m^2 and 1.5 m deep each are planned. One of them is for breeder of Black Tiger Prawn and the other is used for breeder of other species which may be reared in the high salinity water. Material shrimp of breeder will be caught in the natural sea initially, but if it is not available in Manitius, they will be imported by air. After second operation year, harvested shrimp or youngster grown in ponds are used in principle, and so the size is planned as 50 g in Phase I, 40 g in Phase II, III.

(2) Maturation

Not only breeder produced in pond but also natural breeder have to be matured for spawning except in the case of fully matuerd shrimp selected strictly.

The method of maturation is basically by eyestalk ablation but there are various know-hows which have not been disclosed, and so it is necessary to establish the effective and stable techniques by practical application of these know-hows.

Three maturation tanks with shade cover with a size 5 m x 2.5 m and 2.0 m deep each, are planned.

(3) Seed Production

Three lines of seed production plant are planned. Each line includes a hatching tank and a post-larval tank (PL tank), and so there are totally 3 hatching tanks and 3 PL tanks. In Phase I and II one line will be used for Black Tiger Prawn in principle, but if the production is not satisfactory two lines will be used for it. In Phase III two lines will be used for Black Tiger Prawn.

Therefore two lines will be used for the technical development of seawater shrimp seed production in Phase I and II, and one in Phase III in principle.

Regarding feed in the initial larval stage, diatoms and other phytoplankton cultured in the feed tank are used and also natural plankton in the natural seawater taken in is used by propagation in the hatching tank with fertilizer. Zooplankton fed for the stage after Zoea III will be nauplius of brine shrimp (Artemia) as well as cultured Rotifer, etc.

Artemia is used in the former stage of post-larva but it is gradually changed to special compound feed for larva. Ground meat of fresh fish and shellfish could be utilized alternatively or together with. Since the quantity of compound feed is not so large considering with the scale of production, the exclusive compound feed for larva of Black Tiger Prawn commercially sold in Japan and Taiwan could be imported for the time being but peculiar formula of the compound feed for larva in Mauritius should be developed in future.

Seed production plan is shown in Table 13.

The reason for the setting-up of low level of survival rate, etc. is that the hatchery operation may not always be going well and may have to be abondoned on the way particularly during the period of operation in hatching tank under the certain circumstances. Accordingly, the indicated survival rate means the average survival rate of the operations including very poor case, though not including case of disposal.

Table 13 Seed Production Plan

	Phase I	Phase II	Phase III
	1988 - 1990	1991, 1992	after 1993
Breeder production			
Breeder pond	$525m^2$ x 2	$525m^2$ x 2	$525m^2$ x 2
Size of material shrimp	50 g	40 g	40 g
Number of material shrimp	60(360/yr)	70(560/yr)	100(800/yr)
Density	*5.7g $/m^2$	7.1g $/m^2$	7.6g $/m^2$
	*50gr x 360 x 4/12 ÷ ($525m^2$ x 2) = 5.7gr$/m^2$		
Rearing period	4 months	3 months	3 months
Survival rate	80%	80%	80%
Size of breeder(F & M)	100-200g	100-200g	100-200g
Number of breeder	42(288/yr)	56(448/yr)	80(640/yr)
Density in weight	**13.7g $/m^2$	16.0g $/m^2$	22.9g $/m^2$
	** $\frac{100g + 200g}{2}$ x 288 x 4/12 ÷ ($525m^2$ x 2) = 13.7 g $/m^2$		
Maturation			
Maturation tank area	$12.5m^2$ x 3	$12.5m^2$ x 3	$12.5m^2$ x 3
Number of breeder(F & M)	48	56	80
Maturation period	20 - 30 days	10 - 30 days	10 - 20 days
Number of mature female	(50%) 24	(50%) 28	(50%) 40
Number of spawner	(50%) 12	(50%) 14	(60%) 24
Hatchery (per cycle)			
Hatching tank	$10m^3$ x 3	$10m^3$ x 3	$10m^3$ x 3
Number of spawner	12	14	24
Number of egg per spawner	100,000	100,000	100,000
Total number of egg	1,200,000	1,400,000	2,400,000
Rearing period(egg to Pl 1)	12 days	10 days	10 days
Survival rate (egg to Pl 1)	15%	20%	30%
Number of Pl 1	180,000	280,000	720,000
Pl tank	$20m^3$ x 2	$20m^3$ x 2	$20m^3$ x 3
Rearing period	20 days upto Pl 20	20 days upto Pl 20	15 days upto Pl 15
Survival rate	20% upto Pl 20	30% upto Pl 20	40% upto Pl 15
Number of fry	36,000	84,000	288,000
Average productivity	600$/m^3$	1,400$/m^3$	4,800$/m^3$

	Phase I	Phase II	Phase III
	1988 - 1990	1991, 1992	after 1993
Production cycles per year	6	8	8
Annual production	216,000	672,000	2,304,000
Necessary number of fry			
for Growing-out	176,000	264,000	264,000
(Growing-out Pond)	(96,000)	(144,000)	(144,000)
(Experimental Barachois)	(80,000)	(120,000)	(120,000)
for Experimental pond	40,000	40,000	40,000
for Distribution	-	340,000	1,900,000
for Reserve	-	28,000	100,000

3-3-3 Growing-out Plan

Fry that is Pl 20 (20 days old post larva) produced in the hatchery is not directly released into the growing-out pond and experimental Barachois but is released after rearing upto juvenile in the nursery. Suitable size of juvenile is 0.5 g for the pond and 0.7 g for the Barachois. Duration of rearing in the nursery will be 45 days and 60 days respectively.

Growing-out is planned by feeding type culture. Main feed should be compound feed but raw feed will also be used supplementarily.

Growing-out pond pilot production plan and experimental Barachois pilot production plan are shown in Table 14 and 15:

Table 14 Growing-out Operation Plan 1 (Growing-out Pond)

	Phase I	Phase II	Phase III
	1988 - 1990	1991, 1992	after 1993
Nursery operation for a cycle in summer season			
Nursery pond	$525m^2$ x 1	$525m^2$ x 1	$525m^2$ x 1
Number of fry released	16,000(96,000/yr)	24,000(144,000/yr)	24,000(144,000/yr)
Stocking rate	30 pcs/ m^2	57 pcs/ m^2	57 pcs/m^2
Rearing duration	45 days	45 days	45 days
Growth	Pl 20 - 0.5 g	Pl 20 - 0.5 g	Pl 15 - 0.5 g
Survival rate	30%	40%	45%
*1 Number of juvenile produced	4,800(14,400)	9,600(28,800)	10,800(32,400)
Total weight	2,400 g	4,800 g	5,400 g
Density in weight	4.6 gr/m^2	9.1 gr/m^2	10.3 gr/m^2
Growing-out operation for a cycle in summer season			
Growing-out pond	6,000m^2	6,000m^2	6,000m^2
*2 Number of juvenile released	14,400(28,800)	28,800(57,600)	32,400(64,800)
Stocking rate	2.4 pcs/m^2	4.8 pcs/m^2	5.4 pcs/m^2
Growing-out duration	150 days	150 days	150 days
Growth	0.5g - 30 g	0.5g - 35g	0.5g - 40g
Survival rate	60%	70%	80%
Number of shrimp produced	8,640	20,160	25,920
Total weight of shrimp	257kg	706kg	1,037kg
Density in weight	43g /m^2	118g /m^2	173g /m^2
Harvest efficiency	95%	97%	97%
Effective production	246kg	684kg	1,006kg
*3 Production cycles in a year	2	2	2
*4 Total weight of shrimp in winter season	(60%) 155kg	(70%) 494kg	(80%) 829kg
Effective products in winter season	147kg	479kg	805kg

	Phase I	Phase II	Phase III
	1988 - 1990	1991, 1992	after 1993
Total weight of shrimp in a year	414kg	1,185kg	1,866kg
Total annual production	393kg	1,163kg	1,811kg
Productivity per year	66gr/m^2	194kg/m^2	302kg/m^2

Note: *1 Figure in ( ) - Total number of juveniles produced in summer cycle

*2 Figure in ( ) - Total number of juveniles released in a year

*3 One cycle in summer season and another in winter season

*4 Figure in ( ) - Percentage of production in winter season against that in summer season

Table 15 Growing-out Operation Plan 2 (Experimental Barachois)

	Phase I	Phase II	Phase III
	1988 - 1990	1991, 1992	after 1993
Nursery operation for a cycle in summer season			
Nursery pond	$525m^2$ x 1	$525m^2$ x 1	$525m^2$ x 1
Number of fry released	20,000(80,000/yr)	30,000(120,000/yr)	30,000(120,000/yr)
Stocking rate	$30pcs/m^2$	$57pcs/m^2$	$57pcs/m^2$
Rearing duration	60 days	60 days	60 days
Growth	Pl 20 - 0.7g	Pl 20 - 0.7g	Pl 20 - 0.7g
Survival rate	25%	35%	40%
*1 Number of juvenile produced	500 (10,000)	10,500 (21,000)	12,000 (24,000)
Total weight	3,500g	7,350g	8,400g
Density in weight	$6.7gr/m^2$	$14.0gr/m^2$	$16.0gr/m^2$
Growing-out operation for a cycle in summer season			
Area of barachois	$7,000m^2$	$7,000m^2$	$7,000m^2$
*2 Number of juvenile released	10,000(20,000)	21,000(42,000)	24,000(48,000)
Stocking rate	1.4 pcs/m^2	3 pcs/m^2	3.4 pcs/m^2
Growing-out duration	170 days	170 days	170 days
Growth	0.7g - 30g	0.7g - 35g	0.7g - 40g
Survival rate	40%	50%	60%
Number of shrimp produced	4,000	10,500	14,400
Total weight of shrimp	120 kg	368 kg	576 kg
Density in weight	17 g $/m^2$	53 g $/m^2$	82 g $/m^2$
Harvest efficiencpy	70%	80%	90%
Effective production	84 kg	294 kg	518 kg
*3 Production cycles in a year	2	2	2
*4 Total weight of shrimp in winter season	(60%) 72kg	(70%) 258kg	(80%) 461kg
Effective products in winter season	50kg	206kg	415kg

	Phase I	Phase II	Phase III
	1988 - 1990	1991, 1992	after 1993
Total weight of shrimp in a year	192kg	626kg	1,037kg
Total annual production	134kg	500kg	933kg
Productivity per year	19g $/m^2$	71g $/m^2$	133g $/m^2$

Note : *1 Figure in ( ) - Total number of juveniles produced in summer cycle

*2 Figure in ( ) - Total number of juveniles released in a year

*3 One cycle in summer season and another in winter season

*4 Figure in ( ) - Percentage of production in winter season against that in summer season

3-3-4 Training Plan

Technical training and instruction will be needed when commercialization is to be realized. Training for the public applicants should be planned to carry out in the station, whilst arrangement for securing technical trainers or instructor is very important.

Considering the existing state in Mauritius, two special technical trainer or instructors in the fields of seed production and growing-out will be enough for the time being.

In and after 1990 a two-month course of field training in seed production and growing-out skills will be give separately, with two trainees taking part in each course.

3-3-5 Personnel Plan

The responsible person in charge of the operation will be Assistant Director/Divisional Scientific Officer under the Director of the Albion Fisheries Research Centre, but the administration will be executed in the headquarters office of the Centre.

Operation is mainly classified into seed production and growing-out, and the operation of each section will be taken charge of by a Scientific Officer, respectively, with co-operation of the Divisional Scientific Officer.

Table 16 Personnel Plan

Section	Title and/or Designation	Number
Technical Supervision	Assistant Director/ Divisional Scientific Officer	1
Seed Production	Scientific Officer	1
	Technical Officer	3
	Field Worker	4
Growing-out	Scientific Officer	1
	Technical Officer	2
	Field Worker	4
Training	Technical Trainer	2
Maintenance	Assistant Engineer	1
	Driver	1
Total		20

Besides, about 300 man-day/year of temporary workers will be necessary.

CHAPTER IV

BASIC DESIGN

Chapter IV BASIC DESIGN

4-1 Design Policy

The followings are the basic policy set for the basic design of marine shrimp culturing facilities and materials and equipment of the Project:

(1) To study fully the content of the request from the Mauritian Government and to make the most appropriate design in compliance with its objectives and function.

(2) To make such design as to save labour and energy and to minimize the managerial and operational cost borne by Fisheries Division.

(3) To design so that the maximum functioning of the facilities by carried out with minimum costing.

(4) To make a lay-out design taking into consideration an possible future expansion, as the core for development of marine shrimp culture industry.

(5) To design the facilities taking into consideration the lay-out, appearance and colours in harmony with the existing building and nature, since they will be an adjoining building to the existing Albion Fisheries Research Centre which was granted by the Japanese Government.

(6) To make design taking into account the laws and regulation in Mauritius, custom, topographical condition and climate, etc.

4-2 Construction Plan

4-2-1 Basic Design Condition

The following design bases are set according to the results of the field survey on the basic design condition.

(1) Design bases for facilities on the ground

Temperature	31.2°C - 16.9°C
Humidity	78% - 61%
Maximum wind gust	36.1 m/sec (1960)
Rainfall	727 mm/year
Soil bearing	12.5 ton/m² (long term)
Seismic force	None
Regulation	Japan Architect Regulation
Generater for emergency	Three phase, four line, 400 V Single phase 230 V, 50 Hz

(2) Design bases for aqua-engineering facilities

Waves	Ho = 5.4 M, T = 10 sec
Tide level	H.W.L. D.L. + 0.61 M M.S.L. D.L. + 0.37 M L.W.L. D.L. ± 0.00 M
Soil condition	Sand
Quantity of river flow	Dry season 0.5 m³/min Rainy season 2.0 m³/min
Quantity of pumping up from well	0.5 m³/min/unit

4-2-2 Site and Layout Plan

(1) Site Condition

The planned site of the present construction project consists of a trapezoid land of 150 m x 60 m x 500 m, the Belle Eau River running parallel to the above land and its river bed. The site is a flat area stretching 4m above sea level. From the center of the site to the north lies stone pavement of the ruins of former salt pans. After tree trimming and removing of the stone along with surface soil and weeds will leave the site flat, with an area of 5.25 ha.

An access road to the Albion Fisherie Research Centre runs parallel to the site, making access to the site quite easy.

(2) Fundamental Policies of Layout Plan

The facilities included in the present project are: (1) Technical office building; (2) hatchery complex; (3) culturing area; and (4) facilities and equipment related to the above.

The technical office building and the hatchery complex shall be built adjacent to the existing Albion Fisheries Research Centre. The culturing facilities shall be built to the north of the technical office building and the hatchery complex, securing an empty lot between the two buildings for seed production in the future.

Facilities for fresh water and sea water intake, required for the culturing facilities shall be laid out to guarantee efficient water intake and low construction cost. The layout and size of the roads in the promises must be determined to allow maximum efficienty. Weirs shall be constructed along the Belle Eau River. The area between the existing upstream bridges shall be used as a fresh water reservoir. It shall be used as an experimental Barachois after providing a net fence on the river-mounth side.

4-2-3 Construction Plans for the Technical Office Building and the Hatchery Complex

The following facilities shall be built in the block:

1.	Hatchery Complex	442.2 m^2
2.	Technical Office Building	413.5 m^2
3.	Machine House	25.6 m^2

(1) Floor Planning

1) Hatchery Complex

The hatchery complex aims at seed production of marine shrimp. The complex has zoo- and phyto-plankton culture tank, hatchery tank, post larval tank and maturation tank made of reinforced concrete, arranged in the most efficient way.

Table 17 Hatchery Complex

Name	Planned Area	Remarks
Hatching Tank	2.5m x 2.5m x 3 tanks = 18,75m^2	made of RC, 2m deep
Post larval Tank	2.5m x 5m x 3 tanks = 37.50m^2	" , 2m deep
Maturation Tank	2.5m x 5m x 3 tanks = 37.50m^2	" , 2m deep
Zooplankton Culture Tank	2.5m x 2.5m x 3 tanks = 18.75m^2	" , 0.8m deep
Phytoplankton Culture Tank	1.25m x 2.5m x 6 tanks= 18.75m^2	" , 0.8m deep

2) Technical Office Building

This facility is so planned as to have functions of technical management on hatchery and growing-out operation of marine shrimp and also to be organically applied along with the basic study section of the existing Albion Fisheries Research Center.

Table 18 Facilities of Technical Office Building

Name of Room	Planned Area	Remarks
Divisional Scientific Officer Rm.	$26.3m^2$	1 person
Scientific Officer Rm.	29.3	2 persons
Technical Officer Rm.	60.8	6 persons
Wet Lab.	73.6	Experimental aparatus, desk, sink
Plankton Culture Rm.	10.4	Culture-shelf, sink, aeration, air condition
Workshop	33.6	
Electric Rm.	19.4	Incoming panel & distributor emergency generator
Cold Storage	20.4	Prefablicated cold storage for raw feed & compound feed
Storage	28.4	for equipment of lab. & Culture pond
Duty Rm.	15.8	2 persons
Observation Rm	16.2	Second store
Others	79.3	Stairway room, etc.
Total	$413.5\ m^2$	

3) Machine House

The intake pit, elevated reservoir and pump room shall cluster in one location to guarantee supply of city water and smooth circulation of sea water and brackishwater, required for seed production. The aeration system for supplying air to the tanks shall also be set in the machine house.

(2) Sectional Planning

1) Hatchery complex

Since abundant natural lighting is required for seed production and checkered skylight is set, the roof truss shall be of steel structure with pitch maintaining the lowest underbeam height possible. In order to facilitate transfer of fry from the hatching tank to the post larval tank with gravity, the floor height of the hatching tank shall be approx. 80 cm higher than that of the post larval tank.

2) Technical Office Building

Since the height of ceiling is generally high in Mauritius, eaves are set at 3.65 m from the ground so that the height of room ceiling can be 2.7 m, and also ventilation through the loft is considered. Floor level will be enough of 20 cm because influence of moisture from the ground is not necessary to be considered. Since the most of entrances are on the east side, 1.5 m wide canopy is set on that side for the rainy weather.

3) Machine House

Since gravity is used to facilitate water supply to each facility, the height of the machine house shall be 3.7 m, with a 2.5 m high elevated tank support provided on the roof.

(3) The following aspects have been taken into consideration when planning each section of the facilities:

i) The average temperature in summer exceeds 25°C, with the highest temperature reaching 31.2°C and the lowest reaching 20.9°C. The temperature therefore will not become a big problem.

ii) The average annual rainfall is a scanty 727 mm. The site is located in one of the driest areas in Mauritius. Thus, humidity is also low.

iii) Reinforced concrete block structures abound in the area. A ready-mixed concrete and a hollow concrete block plants are located nearby, thus guaranteeing adequate quantity and quality.

1) Roofing

The technical office building and the machine house shall have reinforced concrete roofing, while the reinforced concrete block buildings shall have a flat roof with reinforced concrete slabs. Both roofs shall adopt membrane waterproofing and thermal insulation. The hatchery complex shall have roof truss to promote intake of natural lighting, and therefore shall be sloped roof of vinyl chloride sheet steel lined with thermal insulation. Fiber reinforced plastic (FRP) sheets of the same type shall be used for a skylight.

2) Wall

The wall shall have reinforced concrete and reinforced concrete block structure with plaster finish, the most popular methods used in the area. These methods shall be adopted due to the easy availability of the necessary materials and the workmen. The main facilities shall also adopt these methods because of the same reason.

3) Door and Window

Since the construction site is located on the seashore, aluminum products shall be used mainly for the doors and windows. The hatchery complex requires ventilation during the summer. Thus, glass louver, typically used in the tropics, shall be used since it promotes the use of abundant natural light and ventilation. An insect screen shall be provided outside the windows.

4) Floor

In Mauritius, most floor materials are imported. The floor shall have cement mortar finish, except for the office and laboratories, etc. which shall have a vinyl asbestos tile floor and the toilet which shall have a mozaic tile floor.

5) Internal Finish

The wall shall have a painted cement mortar finish. The toilet shall have a semi-porcelain tiled wall. The ceiling shall be board-lined in the office and laboratories or for the purpose of concealing pipings. In all other areas, it shall be of exposed concrete finish.

6) Finishing Plan by Facility

i) Hatchery Complex

Reinforced Concrete Structure:

Single-story
Total floor area : 442.2 m^2

Finish Schedule

External Finish :
Roof : Vinyl chloride sheet steel roof deck (partially using transparent FRP skylight)
Base, Wall : Acrylic organic spray tile
Door & Window : Aluminum produce

Table 19 Internal Finish:

Room	Floor	Skirt	Wall	Ceiling	Remarks
Building	Concrete trowel finish	Cement mortar	C.B	Roof deck	Movable louver, grating
Tank	Waterproof cement	--	Waterproof cement		Shade curtain, Shade cover agitator

Skylight window is not set on the part of Maturation Tanks because they are shaded, and shading curtain is set between Maturation Tanks and Post Larval Tanks.

ii) Technical Office Building

Reinforced Concrete Structure

Two-story partially
Total floor area: 413.5 m^2

Finish Schedule

External Finish :

Roof	: Membrane waterproofing (with thermal insulation)
External wall	: Cement mortar finish with acrylic organic spray tile
Base	: Cement mortar finish
Door & window	: Aluminum product

Table 20 Internal Finish

ROOM	FLOOR	SKIRT	WALL	CEILING	REMARKS
Divisional Scientific Officer Room	Vinyl tile	Soft skirt	Cement mortar EP	Acoustic board	Blind.
Scientific Officer Room	Ditto.	Ditto.	Ditto.	Ditto.	Ditto.
Technical Officer Room	Ditto.	Ditto.	Ditto.	Gypsum board	Ditto.
Laboratory (wet)	Waterproof mortar	Cement mortar VP	Cement mortar VP	Ditto.	Blind, grating, sink, stone table
Plankton Culture Room	Ditto	Ditto	Ditto	Ditto	Sink, grating, shelf
Workshop	Concrete trowel finish	-	CB	Exposed concrete	
Electric Room	Ditto	-	Ditto	Ditto	
Cold Storage	Ditto	-	Ditto	Ditto	Alminum prefabricated cold storage shelf, hurdle
Toilet	Mozaic tile	-	Semi-porcelane tile	Asbestos board UP	
Storage	Concrete trowel finish	-	CB	Exposed concrete	
Duty Room	Vinil tile	Soft skirt	Cement mortar VP	Gypsum board	Sink, closet
Observation Room	Cement mortar	Cement mortal	Cement mortar	Exposed concrete	
Stair way	Ditto	Ditto	Ditto	Ditto	Non-slip type

iii) Machine House

Reinforced Concrete Structure

Single-story	:	25.6 m^2
Water reservoir	:	95 m^3

Finish Schedule

External finish	:	Waterproof cement mortar
External wall	:	Acrylic organic spray tile
Door & window	:	Aluminum product
Water reservoir	:	Acrylic organic spray tile
Elevated tank	:	FRP product

Table 21 Internal Finish

ROOM	FLOOR	SKIRT	WALL	CEILING	REMARKS
Pump Room	Trowel-finish concrete	---	CB	Concrete exposed	
Water Tank	Waterproof cement mortar	---	Waterproof cement mortar	---	

(4) Structural Planning

1) Structural System

i) Hatchery Complex

The hatchery complex shall be of reinforced concrete structure with steel trussed roof.

ii) Technical Office Building

The technical office building shall have a rigid frame reinforced concrete structure.

iii) Machine House

The machine house shall be made of rigid frame reinforced concrete structure.

2) Structural Design

i) Applicable Standards:

Japanese Architectural Standards

Japanese Industrial Standards

ii) Foundation

As a result of the site boring survey, the existence of approx. 10 m-deep sand layer with a medium-level relative density and underlying basalt rock, has been confirmed. The planned construction site, therefore, is expected to hold short-term loads of 20-30 ton/m^2 and long-term loads of 10-15 ton/m^2. Therefore, direct foundation work, where the foundation is directly supported on the ground, shall be adopted.

iii) Seismic Factor

There has been no earthquakes reported in Mauritius. Earthquakes are omitted even from official investigations. Therefore, they are not taken into account in the current project.

iv) Wind Pressure

The following statistical data (during 1876-1983) is available from the local observatory:

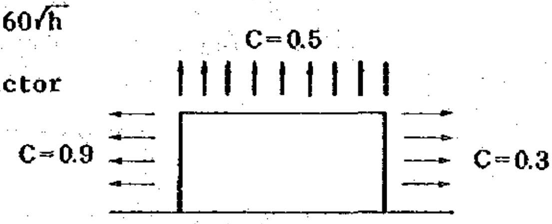
Number of cyclone attack:	68
Wind velocity over 35 m/sec:	2
Wind velocity over 30 m/sec:	4
Wind velocity over 25 m/sec:	9
Wind velocity over 20 m/sec:	20
Wind velocity over 15 m/sec:	55

The maximum wind velocity was registered on February 20, 1960, reaching 36.1 m/sec.

Calculations shall therefore base on the maximum wind velocity of 60 m/sec.

P (wind pressure) = C.q kg/cm^2
q (velocity pressure) = $60\sqrt{h}$

C = wind pressure factor
h = height (m)



v) Material

Cement:	Ordinary Portland cement
Coarse aggregate:	Crushed stone
Fine aggregate:	Sand or coral sand
Concrete:	Specified concrete strength at 28 days shall be FC=180kg/cm^2
Reinforcement:	SD30
Structural steel:	SS40

vi) Calculation of the Cross Section

The calculation and drawings of cross sections shall base on the criteria of the Japanese Association of Architects, taking appropriate measures for local conditions.

(5) Machinery Planning

1) Water Supply System

A water supply system must be provided for the supply of city water to the technical office building. Meanwhile, sea water and brackish water (including freshwater supply for producing brackishwater) for the hatchery facilities must also be supplied.

i) Amount of Water Supply

City water : 5 m^3/day
Sea water for hatchery complex: 100 m^3/day
Fresh water: 75 m^3/day
City water for personnel:
Officers : 11 officers x 150ℓ/day = 1,650ℓ
Workers : 9 workers x 100ℓ/day = 900ℓ
Total : 2,550ℓ

Sea Water for the hatchery: Maximum water supply capacity shall be determined by adding the daily tank flow rate to the amount that can fill 1/3 of 159 m^3 tank within 4 hours.

Fresh water used for preparing brackishwater for the hatchery: The amount of freshwater shall be 1/2 the volume of seawater used. Freshwater used for cleaning the machinery must be considered.

ii) Water Supply System

a) City Water

Water supply to the project site shall be branch of the existing city water line and stored in the water reservoir. Water is then pumped to the elevated reservoir with the pump and then supplied to appropriate places by the force of gravity.

b) Sea Water

Sea water is transferred from a sea water reservoir into the water reservoir by a pump, then to the elevated reservoir from which it is distributed by the force of gravity to distribute it to wherever it is needed. Sea water for producing brackish water is drawn by gravity supply, from the water reseroir.

c) Fresh Water

Fresh water drawn from borehole wells shall be sent to the sedimentation tank cum reservoir tank. Water is then supplied to the brackish water reservoir by means of gravity supply.

d) Brackish Water

As stated earlier, the brackish water is sent to the elevated reservoir after mixing. It is then supplied to appropriate areas by gravity force.

2) Drainage System

i) Sewage

Sewage is treated by a septic tank according to the Mauritian standards, then released to the ground through an absorption pit.

ii) Waste Water

Waste water shall be directly led to an absorption pit.

iii) Rain Water and Storm Drainage System

Rain water and storm drainage shall be led to the outside of the premises, and eventually drained to the sea.

3) Sanitary Fixture

Japanese-made sanitary fixtures are scheduled to be used at the project site.

4) Ventilation System

Although natural ventilation is mainly employed, the toilet shall be ventilated mechanically to remove the odor. Ceiling fans shall be provided in the office and laboratory.

5) Air Conditioning System

A separate-type air conditioner/heater shall be installed in the plankton culture room to maintain constant temperature and moisture.

6) Aeration System

A central air supply system shall be used to aerate the water tanks. The system must have a capacity of supplying $180m^3$/hr of air to each tank.

7) Cold Storage

The cold storages shall have sufficient capacity to maintain the temperatures of 2°C and -2°C for compound and raw feed, respectively. A separate-type refrigerating equipment is recommendable.

(6) Electric Power System

1) Service Wiring and Transformation System

Electrical power supply work required for the construction shall be undertaken by Mauritius.

2) Emergency Power Generating System

An emergency power generator shall be provided for unexpected power failures. The generator must have sufficient capacity to supply power to the hatchery complex, experiment apparatuses, aeration system, cold storages, general water supply system, water intake facilities for the culture facilities, etc.

3) Electric Distribution system

The power distribution system to be provided for the current facilities shall be as follows:

Trunk line:	3-phase, 4-wire 400/230V. 50Hz
Power circuit:	3-phase, 3-wire 400V, 50Hz
Lighting circuit:	Single-phase, 2-wire 230V, 50Hz

A power control board shall be provided for power supply, while a lighting distributing board shall be provided for the lighting circuit to control the operation

4) Lighting Fixtures

Fluorescent lamps shall be used mainly, which can provide the following illumination. A hand lamp may be used when necessary.

AREA	LUMINOUS FLUX
Office, laboratory, etc,	200 LUX
Storage, corridor, toilet, etc,	50 LUX
Hatchery and feeding tank, etc.	100-500 LUX

The hatching tank and the post larval tank shall have lighting which allows luminous control with a switch.

5) Observation System

The facility of the observation system include a light projector which shall be operable through the observation post.

6) Telephone System

Only the conduit piping shall be installed to provide a telephone line to the technical office building.

7) Outdoor Lighting System

Necessary street lights shall be provided in the premises.

8) Measures to prevent injuary from salt

PVC and dipped galvanized steel should be used for wiring materials to prevent salt damage.

4-2-4 Culturing Facilities Planning

The culturing facilities shall consist of the following units:

(1) Culture pond
(2) Seawater intake facility
(3) Freshwater intake facility (including wells and weirs)
(4) Water supply and discharge channel, water gates, etc.
(5) Experimental Barachois (including net fence)
(6) Accessories

(1) Culture Pond Planning

The current project shall be planned to culture not only P. monodon but also other seawater shrimp which can be cultured by sea water only.

All walls of the culture ponds shall be of reinforced concrete structure, with their bottoms covered with sand over vinyl sheet.

The size and structure of various ponds are listed below, classified by the usage.

Table 22 Culture Ponds

Pond No.	Dimensions WxLxD (m)	Area (m^2)	Volume (m^3)	Structure type
Growing-out Pond No. 1 to 2	40x75x1.5	3000x2=6,000	4500x2=9,000	R.C. wall Bottom is covered with sand over vinyl sheet
Nursery Pond No. 1 to 2	17.5x30x1.5	525x2=1,050	788x2=1,576	Ditto
Breeder Pond No. 1 to 2	17.5x30x1.5	525x2=1,050	788x2=1,576	Ditto
Experimental Pond No.1 to 6	10x25x1.2	250x6=1,500	300x6=1,800	Ditto
Total		9,600	13,950	

All of the culture ponds shown in Table 22 are planned for the use of either seawater or brackishwater.

(2) Plans for Seawater Intake

1) Intake volume

The maximum intake volume has been obtained by assuming that all the tanks are used for seawater. With the current project, the volume of intake water varies according to the water exchange rate and seawater or brackish water to be used. The pump capacity shall be designed to accommodate variation in intake volume in the most economical manner. The intake volume for various design cases is listed below.

a) The case, maximum design quantity of only seawater intake (Qmax); water exchange rate is 30%/day

$Q_{max} = 13,950 \times 0.3 \approx 4,185\ m^3/day = 174\ m^3/hr = 2.9\ m^3/min$

Hence, Qmax shall be 3.0 m^3/min.

b) The case, proper use of brackishwater and seawater, maximum water exchange rate is 30%/day, proportion of mixing seawater and freshwater is equivalent.

$$11{,}475\ m^3 \times 0.3 \times 1/2 + 2{,}475\ m^3 \times 0.3 = 2{,}464\ m^3/day$$

$$\fallingdotseq 103\ m^3/hr$$

$$\fallingdotseq 1.7\ m^3/min.$$

$$Q = 2.0\ m^3/min$$

c) The case, volume of intake (Qmin) of proper use of brackishwater and seawater, minimum water exchange rate is 15%/day.

$$Q = 1.0\ m^3/min.$$

2) Seawater Intake Method

Three intake methods are available, which are pump suction method, gravitational intake with pipeline and the open channel method. Considering the site environment, ease of construction and maintenance, gravitational intake method with pipeline shall be adopted. An intake tower shall be provided at the tip of the intake line (inlet) for its protection.

3) Intake Location

The sea in front of the project site has rich growth of coral. The waters in the lagoon is relatively shallow (-0.5 to 1.0m deep). In order to intake sea water of constant temperature and quality, it is advisable to intake from outside the reef. However, cyclone-proof construction and the long pipeline tend to increase the construction cost. The survey of the sea in front of the project site revealed a constant pH and salt concentration throughout the year. Thus, a 1m-deep point within the lagoon has been selected to be the intake point.

4) Intake Pipes

The intake pipes have been determined on a basis of maximum intake volume and flow rate in the pipe. The flow rate has been determined to minimize accumulation of floating sands during a cyclone attack.

The intake pipes shall be buried for added safety. It may be made of oncrete, steel, PVC or FRP. Due to the ease of construction, maintenance and economy, it has been decided to use PVC.

5) Measures to Eliminate Marine Animal's Adhesion:

To prevent adhesion of marine organisms in the intake pipe, the pipe interior shall be cleaned by special equipment. A jet pump with the flow rate of 1.0 m^3/sec and an internal pressure of 5.0 kg/m^2, and a cleaning equipment shall be provided.

6) Intake Pit

A net screen and a sedimentation tank shall be installed on the intake pit to prevent trouble caused by floating matter. The suction pipes shall be adequately spaced to prevent mutual interference.

7) Capacity and Number of Pump

Three pumps, each with capacity 1.0m^3/min, are installed in order to supply either maximum necessary volume of 3.0m^3/min or minimum volume of 1.0m^3/min in the pump house. The pumps shall be diesel-driven. A fuel tank therefore shall also be provided. Since all three pumps are never operated simultaneously during normal operation, spares shall not be provided.

8) 36m^2 of pump house in which three pumps for seawater intake are installed, and 15m^2 of pump house for seawater supply to hatchery complex from seawater reservoir are planned. The structure of the former is RC of post and beam, concrete block wall and that of the latter is concrete block. The pump floor level shall be determined by the pump suction capacity and topography of the site.

(3) Freshwater Intake Planning

1) Intake Volume should be planned in the case of using all culture ponds including growing-out ponds, nursery ponds, breeder ponds and experimental ponds as brackishwater ponds.

a) Maximum intake volume of freshwater (Qmax); brackishwater is mixed equivalently by seawater and freshwater, and maximum water exchange rate is 30%/day.

$$13{,}950\ m^3 \times 03. \times 1/2 = 2{,}092.5\ m^3/day$$
$$\fallingdotseq 87\ m^3/hr$$
$$\fallingdotseq 1.45\ m^3/min$$

However, it scarcely occurs that brackishwater is used in all the ponds with 30% of water exchange rate, and so:

$$Qmax = 1.4\ m^3/min$$

b) Minimum intake volume (Qmin): water exchange rate 15%/day

$$Qmin = 0.7\ m^3/min$$

2) Freshwater Intake Methods and Respective Intake Volume

Minimum and maximum intake volume from Belle Eau River is expected to be 0.5 m^3/min and 2.0 m^3/min respectively. Shortage of freshwater from the river shall be supplemented by underground water through borehole well.

Therefore intake volume of river and well is planned as follows:

River water:	Max. 2.0 m^3/min	Min. 0.5 m^3/min.
Well water :	Max. 0.9 m^3/min	Min. 0.2 m^3/min.

3) River Water Intake Facilities

An open channel shall be installed on the Belle Eau River to allow a maximum intake of 2.0 m^3/min. The water is brought to the intake pit and taken up by pump. Three pumps have the capacity of 0.7 m^3/min and 7PS/unit, adjustable by the flow rate of the river. One pump is reserved considering full continuous operation to intake freshwater only from the river in rainy season.

The pump shall be diesel-operated and a fuel tank shall be provided in the pump room. The pump floor level shall be determined according to the pump suction capacity and topography.

A weir shall be built downstream to raise the water level, thus facilitate water intake and also preventing backflow of seawater. The weir will be earth dam type to prevent leakage.

Watergates shall be provided on the weir to protect it during a flood or at a time of high water level. The weir top shall be as high as the height of the foundation concrete of an upstream bridge. This design eliminates the risk of having higher water levels further upstream the bridge.

4) Ground Water Intake Facilities

Three wells shall be provided for ground water intake. The intake volume from each well shall be 0.5 m^3/min. Three 5.5 kW/unit pumps with the capacity of 0.5 m^3/min shall be provided. The wells shall be dug on the left bank of the Belle Eau River and spaced sufficiently apart to prevent interference during pumping. The water shall be brought to the culturing pond by PVC pipelines.

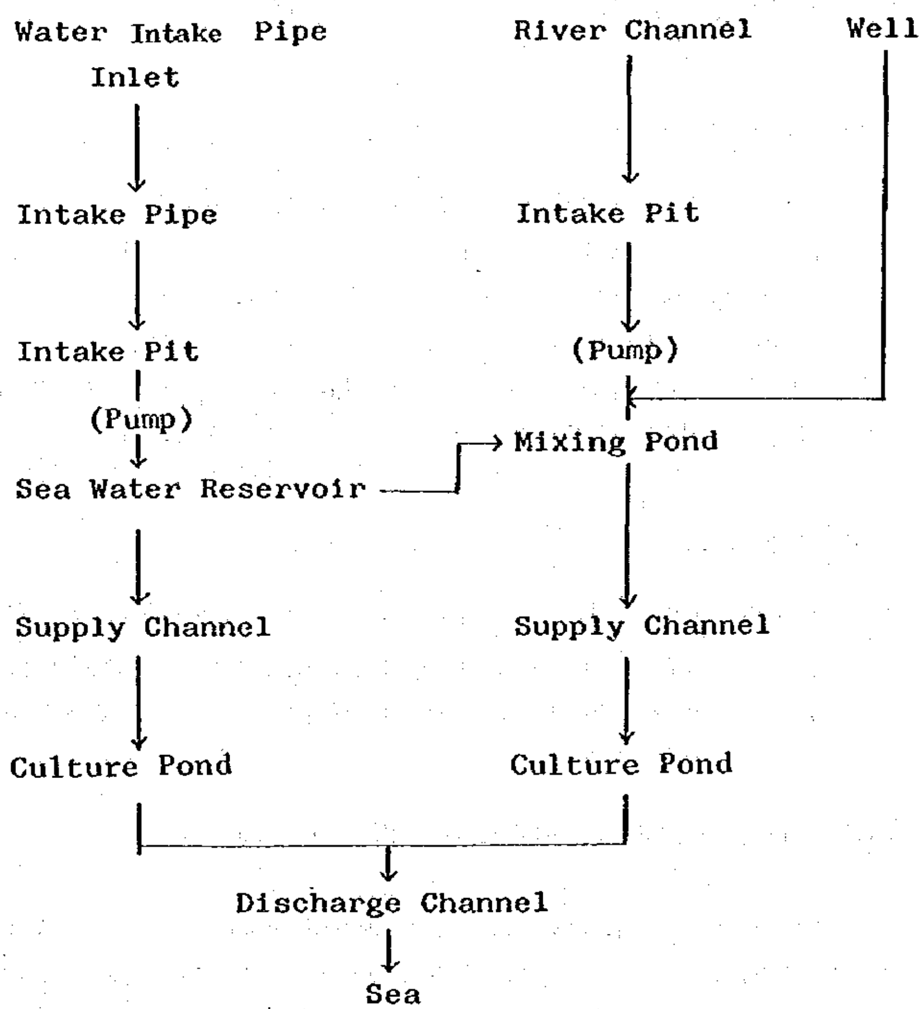
5) Pump House

A 36 m^2 pump house in which three pumps are installed for river water intake, and three 4 m^2 pump houses for three wells are planned. The structure of the former is RC of post and beam, and block wall.

(4) Water supply and Discharge Channel Planning

Sea water is stored in a sea water pond after its intake, then transferred to a mixing pond to produce brackishwater by mixing with fresh water. Part of the sea water is led to the culturing pond through the water channel pipe. Fresh water shall be directly supplied into the mixing pond. The brackish water is introduced into the culturing pond through an open channel. Fig. 2 shows the water flow diagram. The water supply channel has been designed with sufficient width and depth to guarantee a high water level even at the end of the channel to supply the required amount of water. Watergates shall be installed along the channel to optimize the separate or combined use of sea water and brackish water. The channel shall have a structure which allows easy control of the flow rate and maintenance. Drainage from each pond is collected into reinforced concrete open channel, then drained directly into the sea.

Figure 2 Schematic Flow Diagram of Water Supply and Drainage Channel



(5) Experimental Barachois Planning

An experimental Barachois shall be constructed in the 7000m² waterway at the mouth of the Belle Eau River. The experimental Barachois shall be provided with a net fence near the mouth to prevent escaping of shrimp. At the beginning an inner jetty was planned to be constructed to protect the net fence from high waves at cyclone but it was canceled because it was found that the influence of waves coming in could be diminished by the topography if net fence is set further from the river mouth. Net fence is planned to be set by chain sinker and floats with four fixed piles from the engineering and economic point of view.

(6) Accessories

As accessories of culture pond facilities, electric equipment such as switch box for paddle wheel, etc. shall be installed.

4-2-5 Material and Equipment Planning

In selecting the materials and equipment, emphasis has been placed on the ease of maintenance, appropriate technology matching local engineering level, efficiency and minimal requirements. The material and equipment, if not satisfactory when procured locally, shall be procured in Japan to maintain good quality. The material and equipment procurement plans for each section are outlined below.

(1) Materials and Equipments for Research and Training Sector

1) Plankton Net	;	for Zooplankton & Phytoplankton, each 1 set
2) Balance	;	10 mg - 300 g, 0.1 g - 300 g, 0.1 g - 500 g, each 1 set
3) Microscope	;	6.6 - 40 magnification with camera, 1 set
4) Microscope	;	200 magnification for plankton, 1 set
5) Water analyser	;	1 set
6) Thermometer	;	6
7) Salinity analyser	;	2 set
8) Salinometer	;	Portable, Digital 1 set
9) DO meter	;	Do:0-20 mg/litre, O_2: 0-25%, Temp. 0-50°C, 1 set
10) PH meter	;	1 set
11) Current meter	;	
12) ORD meter (Conductivity Potential)	;	Digital 0 - $\pm$ 1999 mv 1 set

13) Caliper ; 30 cm, 2

14) Micro pipet ; 1-5 m-litre, 5-10 m-litre, each 2

15) Camera ;

16) Labo-cart ; for 120 kg, 2

17) 4WD Vehicle ; Wagon type, diesel engine, 1

18) Others

(2) Materials and Equipments for Hatchery Sector

1) Mobile tank for plankton culture and experimental rearing of larva ; FRP, 2 tons x 4, 1 ton x 8

2) Artemia hatching tank; FRP, 0.2 tons x 2

3) Refrigerator ; 500 L for room

4) Net screen box for hatching tank and post larval tank with net; 6 set

5) Spare net for the above (4); 50 u, 100 u, 250 u, each 3

6) Fry transfer container; 1 ton x 1

7) Truck for mother shrimp and fry transportation; 1 ton x 1

8) Equipment for aeration; 1 set

9) Cover sheet for maturation tank; 5 m x 3 m, 3 sets

10) Others

(3) Materials and Equipments for Growing-out Sector

1) Tide gauge ; 1 set

2) Paddle wheel ; with 1.5 KW moter and 50 m cable, 8 sets

3) Vertical pump ; 5.5 KW, 1 set

4) Flat bottom boat; 4 m long, 5 HP outboard engine, 2 sets

5) Examination and harvesting gear;

   i) Drag net; 16 mm mesh, 1 set
   ii) Cast net; 8 mm & 16 mm mesh, each 1 set
   iii) Spare net for drag net & 2 types of cast net
   iv) Electric harvesting net; 1 set

6) Harvesting equipment;

   i) Net box with plastic net; 2 sets
   ii) Bag net ; 3 sets
   iii) Scoop net; 3 sets
   iv) Spare net for above three

7) Automatic feed spreader; battery type, 1 set

8) Feed container ; 3

9) Live shrimp transfer container; 1 ton x 1

10) Chilled water container for fresh shrimp transfer; 1 ton x 2

11) Ice crasher ; 1 set

12) Feed grinder ; 1 set

13) Aqualung ; 1 set

14) Wireless phone ; 2 sets

15) Spare fence net for Barachois; 2 sets

16) Fork-lift ; 500 kg, 1 set

17) Truck for feed transportation & shipping of shrimp; 2 tons x 1

4-2-6 Basic Design Drawings

(1) *General Arrangement of Facilities*

(2) Arrangement of Building

(3) Technical Office Building, Hatchery Complex & Machine House (Floor Plan)

(4) Ditto (Elevation, Section)

(5) Water Supply System

(6) Drainage System

(7) Aeration & Electricity System

(8) Culture Pond (Floor Plan)

(9) Culture Pond (Detail)

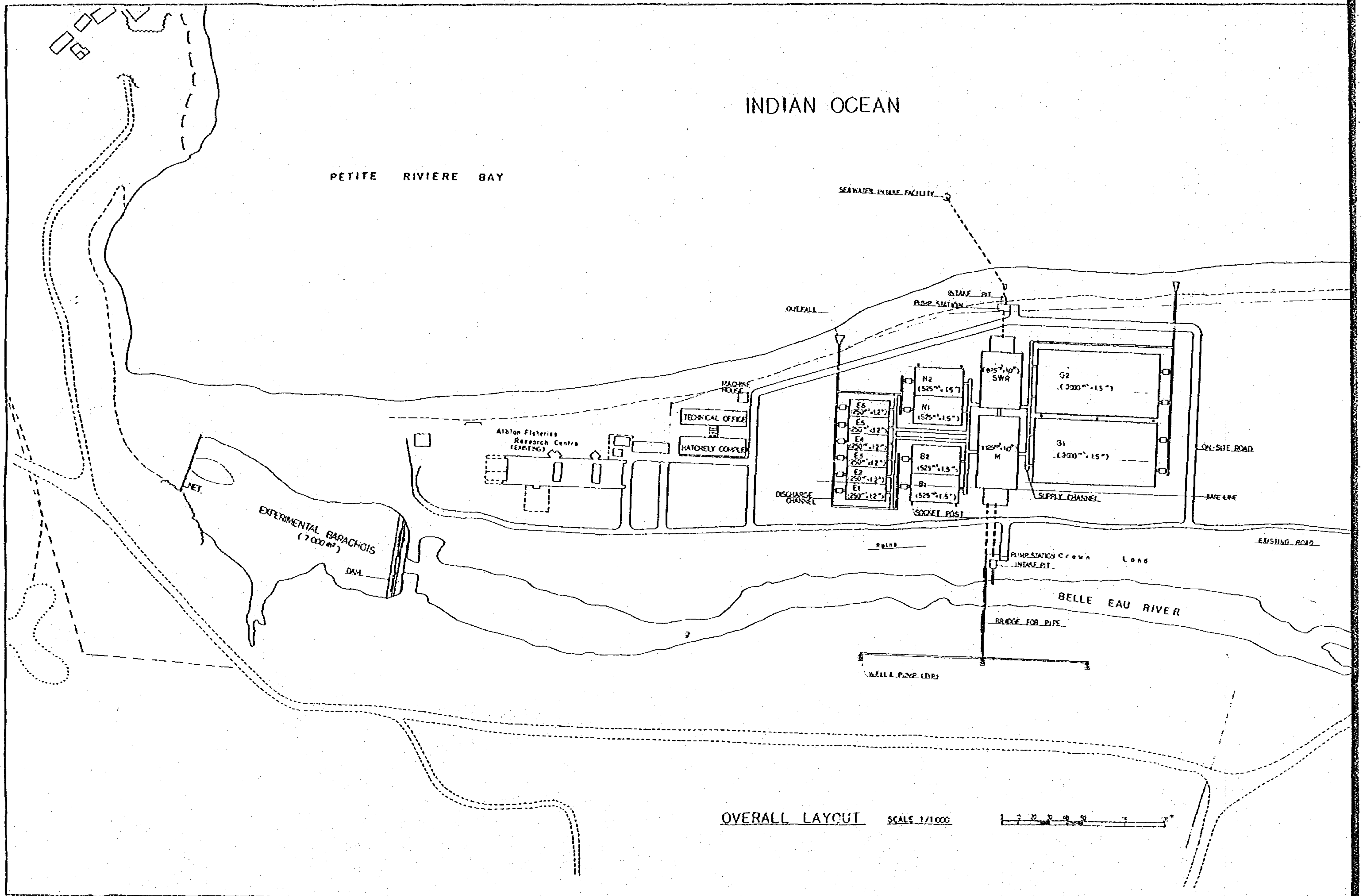
(10) Seawater Reservoir & Mixing Pond (Detail)

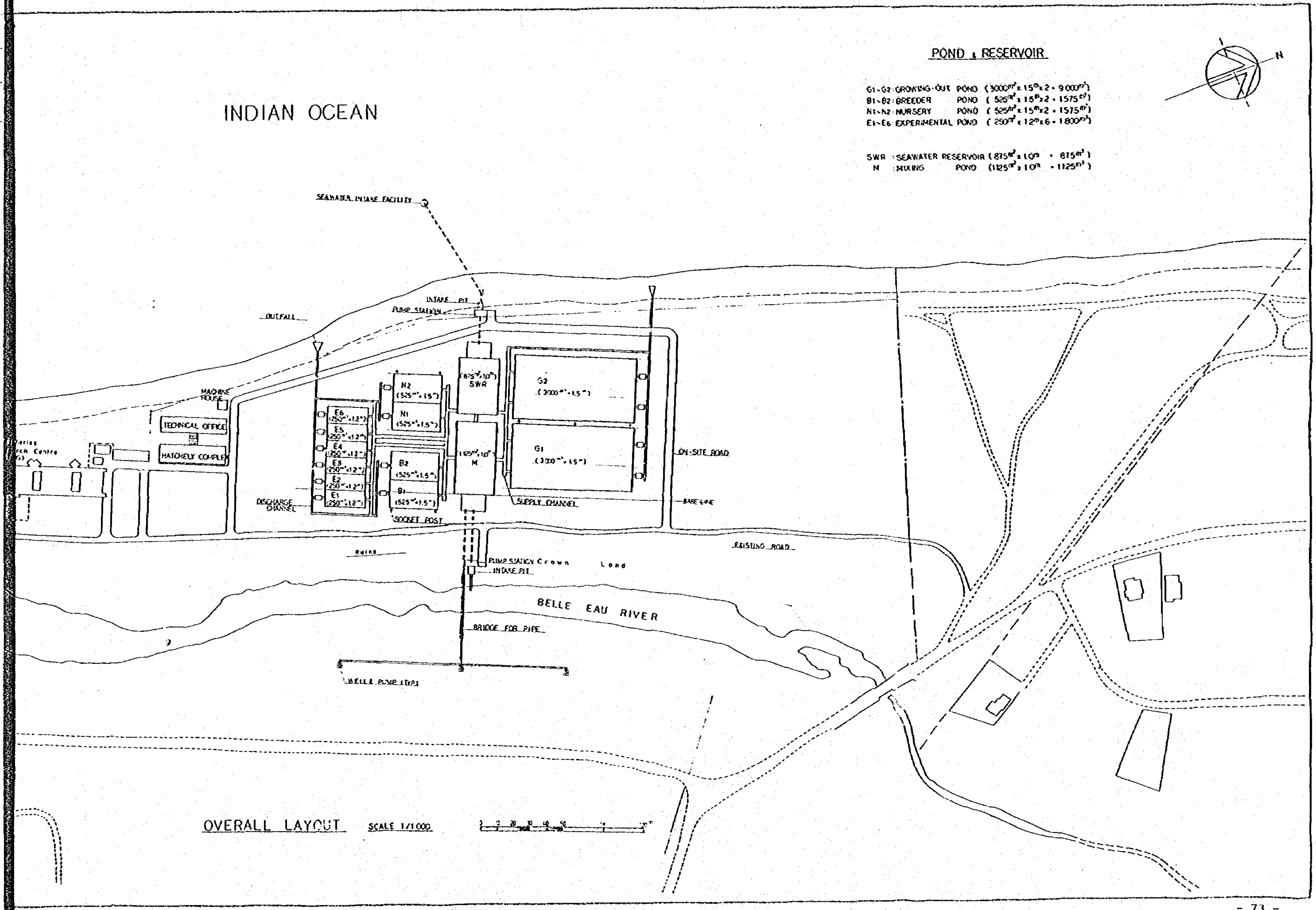
(11) Seawater Intake Facilities (Floor Plan & Detail)

(12) Seawater & Freshwater Intake Pit

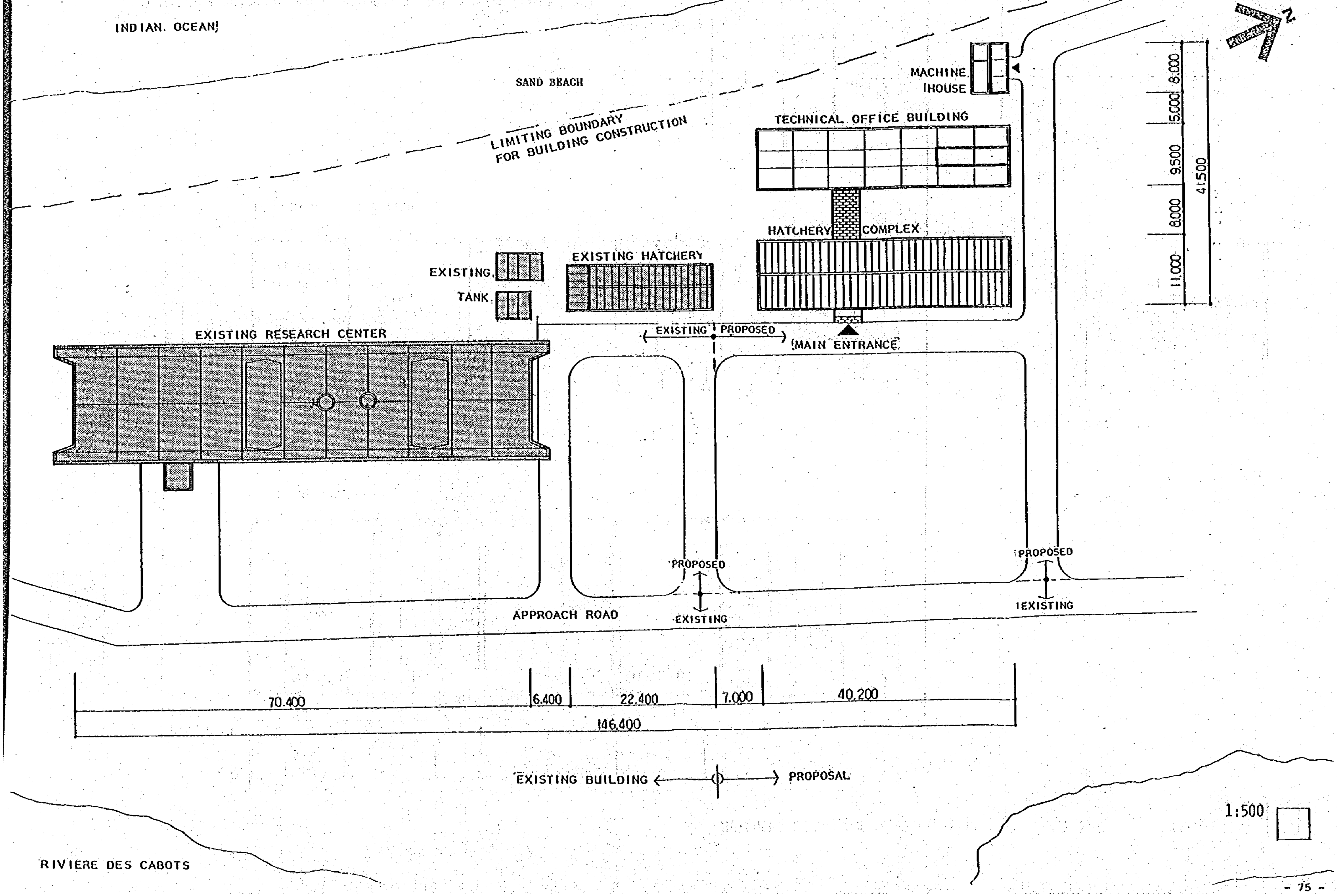
(13) Water Supply & Discharge Channel, Road (Detail)

(14) Other Facilities Standard Cross Section

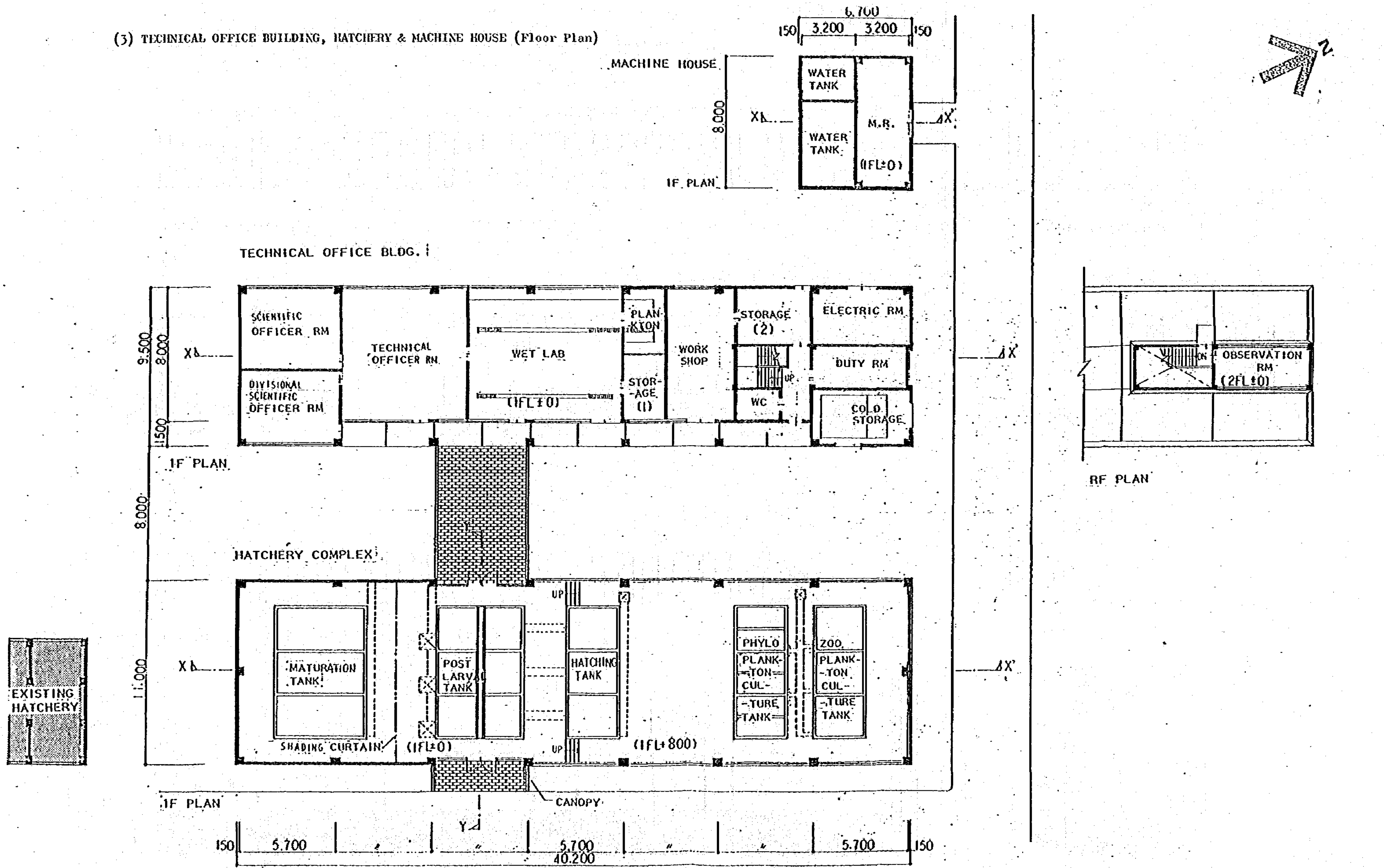

INDIAN OCEAN
PETITE RIVIERE BAY
SEAWATER INTAKE FACILITY
INTAKE PIT
PUMP STATION
OUTFALL
MACHINE HOUSE
TECHNICAL OFFICE
HATCHERY COMPLEX
Albion Fisheries Research Centre (EXISTING)
N2 (525m²×1.5m)
N1 (525m²×1.5m)
SWR
M
G2 (3000m²×1.5m)
G1 (3000m²×1.5m)
E6
E5
E4
E3
E2
E1
B2 (525m²×1.5m)
B1 (525m²×1.5m)
DISCHARGE CHANNEL
SOCKET POST
SUPPLY CHANNEL
ON-SITE ROAD
BASE LINE
EXISTING ROAD
PUMP STATION
INTAKE PIT
Crown Land
BELLE EAU RIVER
BRIDGE FOR PIPE
NET
EXPERIMENTAL BARACHOIS (7000m²)
DAM
OVERALL LAYOUT
SCALE 1/1000


INDIAN OCEAN
POND & RESERVOIR
G1~G2 : GROWING-OUT POND (3000m² x 1.5m x 2 = 9,000m³)
B1~B2 : BREEDER POND (525m² x 1.5m x 2 = 1575m³)
N1~N2 : NURSERY POND (525m² x 1.5m x 2 = 1575m³)
E1~E6 : EXPERIMENTAL POND (250m² x 1.2m x 6 = 1800m³)
SWR : SEAWATER RESERVOIR (875m² x 1.0m = 875m³)
M : MIXING POND (1125m² x 1.0m = 1125m³)
N
SEAWATER INTAKE FACILITY
INTAKE PIT
PUMP STATION
OUTFALL
MACHINE HOUSE
TECHNICAL OFFICE
HATCHERY COMPLEX
DISCHARGE CHANNEL
SOCKET POST
SUPPLY CHANNEL
ON-SITE ROAD
BASE LINE
EXISTING ROAD
Crown Land
PUMP STATION
INTAKE PIT
BELLE EAU RIVER
BRIDGE FOR PIPE
WELL & PUMP (TYP.)
OVERALL LAYOUT
SCALE 1/1000

(2) ARRANGEMENT OF BUILDING

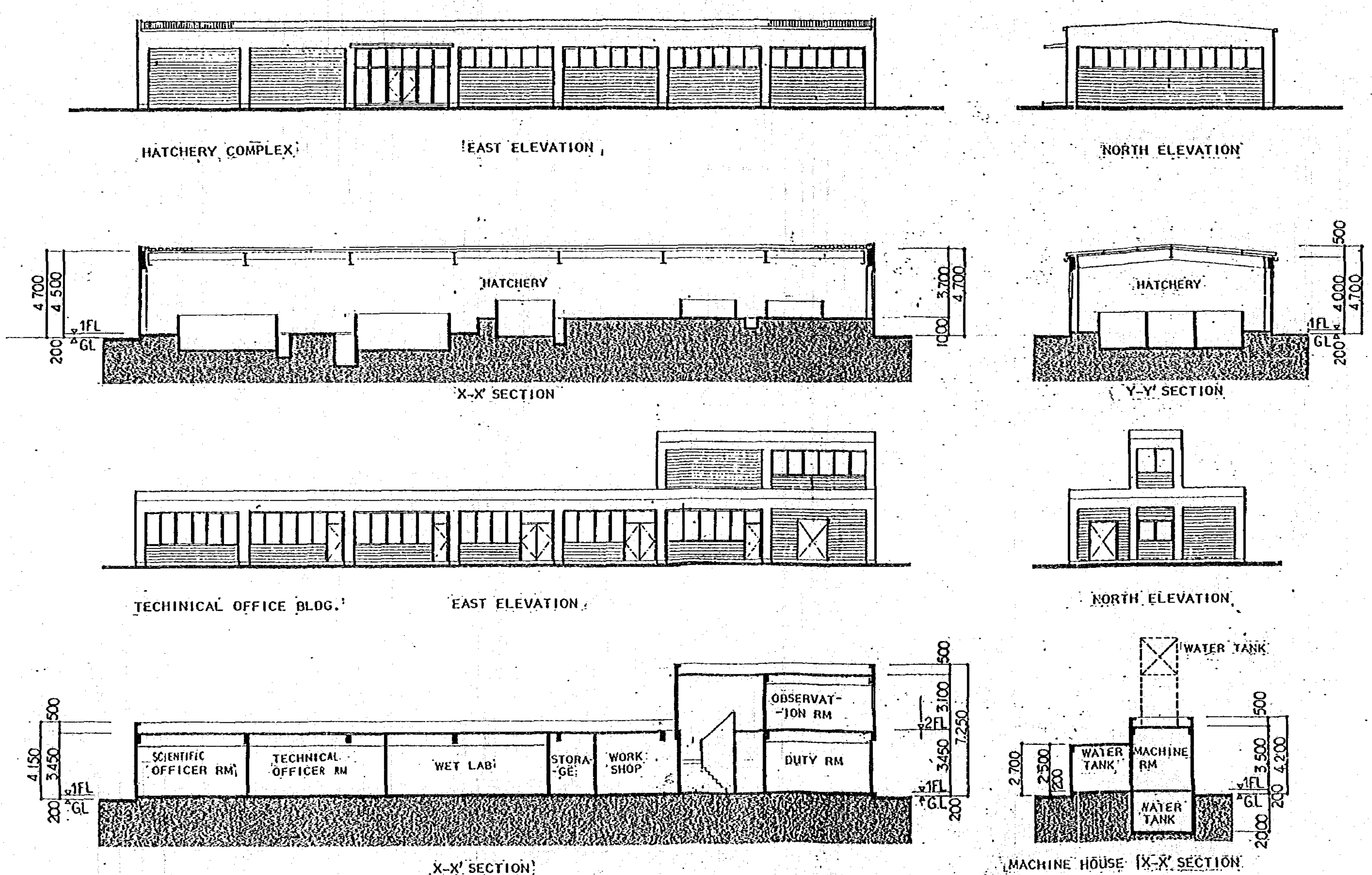


(3) TECHNICAL OFFICE BUILDING, HATCHERY & MACHINE HOUSE (Floor Plan)



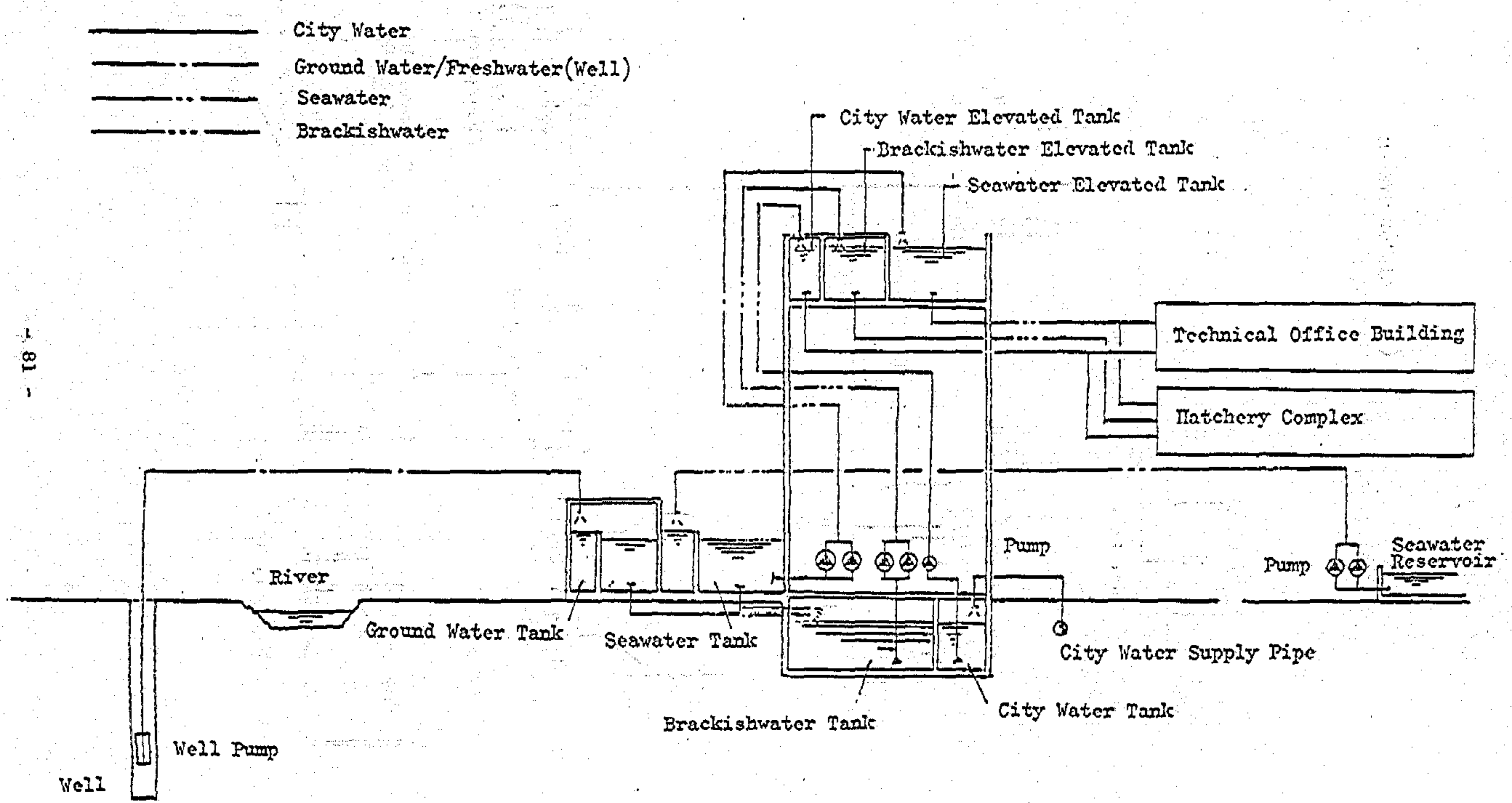
HATCHERY COMPLEX & TECHNICAL OFFICE ③ PLAN 1:200

(4) TECHNICAL OFFICE BUILDING, HATCHERY & MACHINE HOUSE (Elevation, Section)

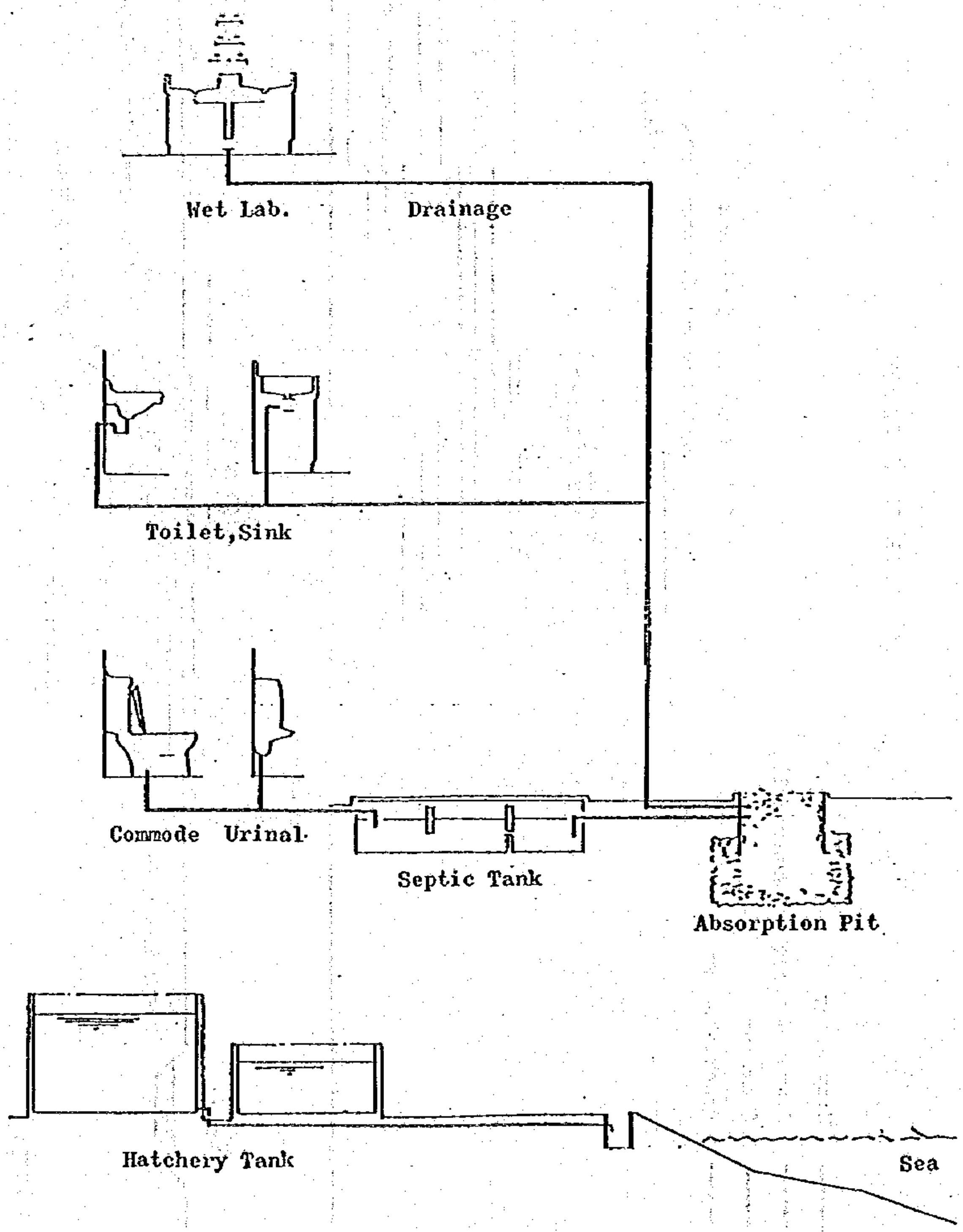


HATCHERY COMPLEX & TECHNICAL OFFICE ● ELEVATION &SECTION 1/200

(5) WATER SUPPLY SYSTEM

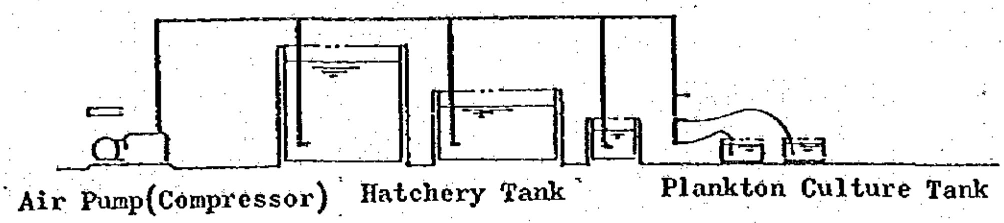


(6) DRAINAGE SYSTEM

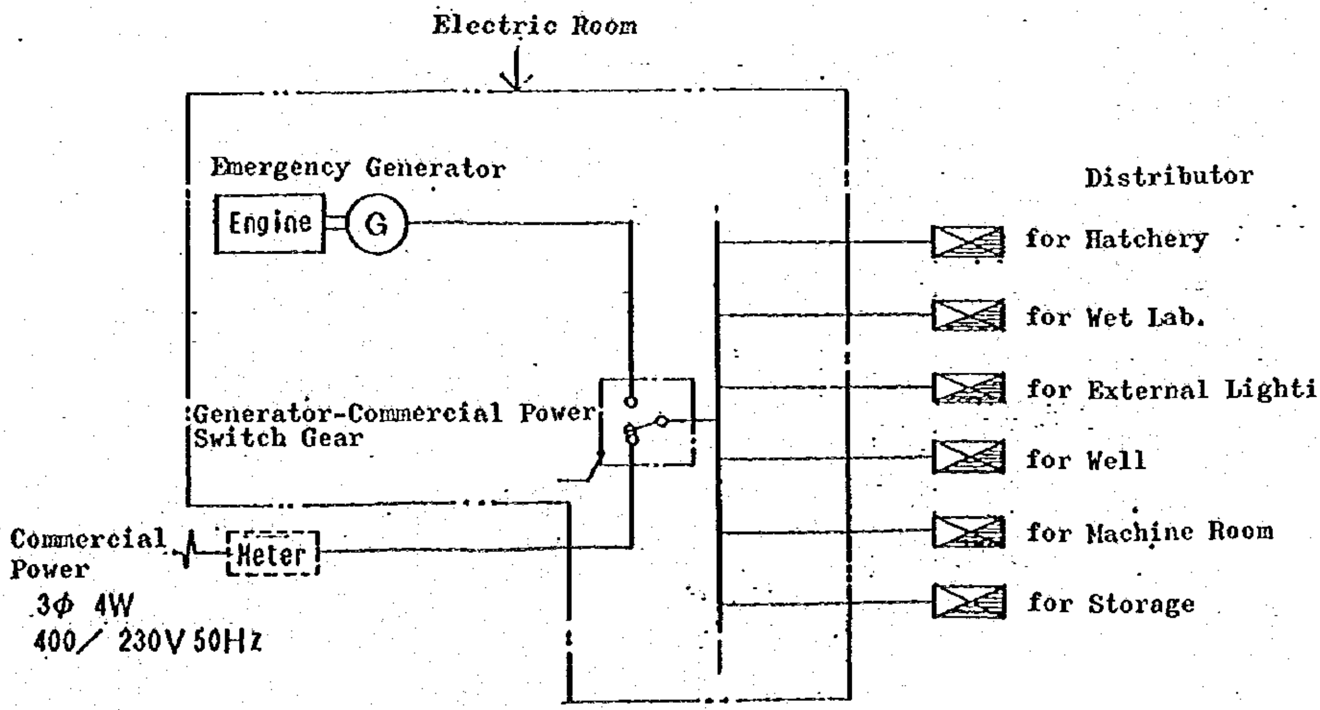


(7) AERATION & ELECTRICITY SYSTEM

Aeration System



Electric Supply System

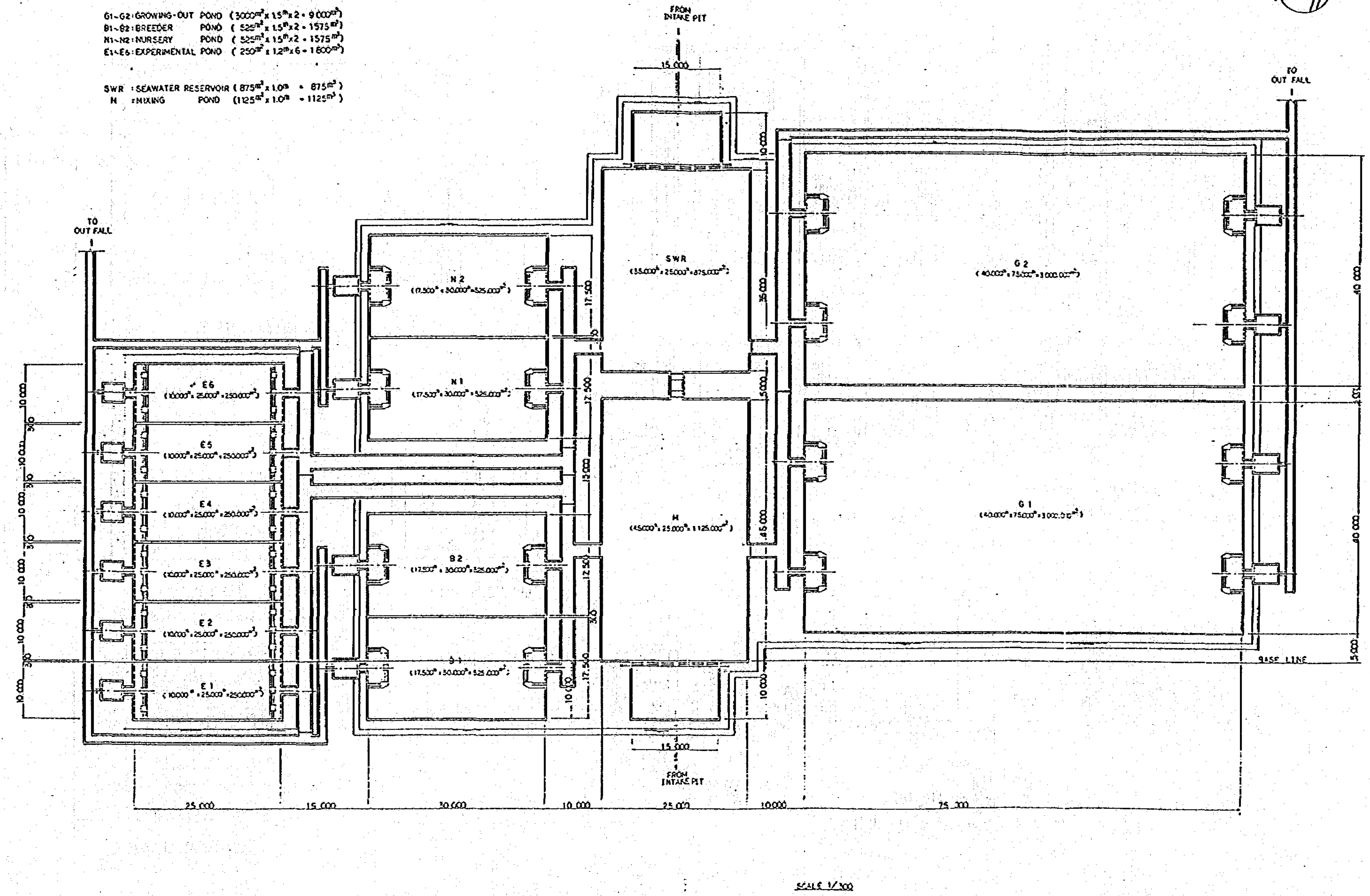


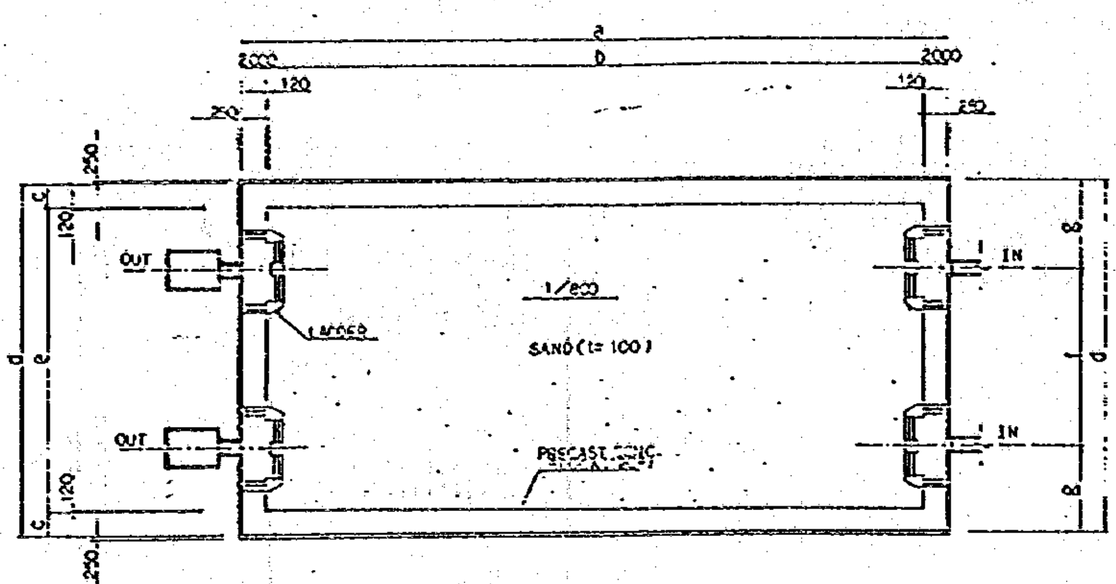
(8) CULTURE POND (Floor Plan)

POND & RESERVOIR

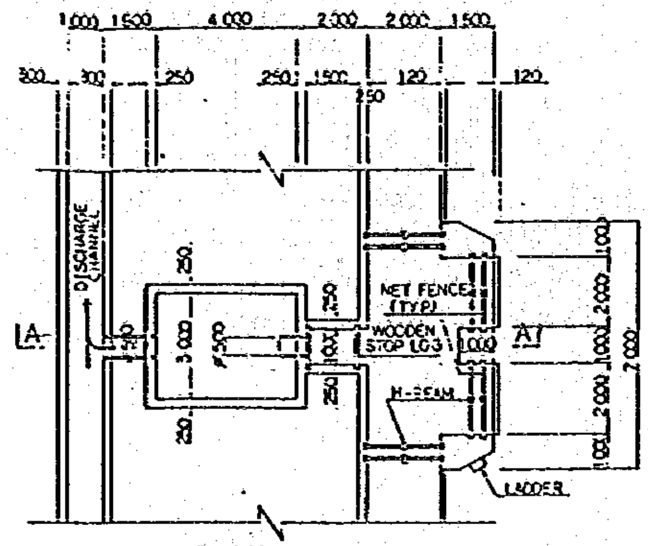
G1~G2 : GROWING-OUT POND ($3000m^2 \times 1.5^m \times 2 = 9000m^3$)
B1~B2 : BREEDER POND ($525m^2 \times 1.5^m \times 2 = 1575m^3$)
N1~N2 : NURSERY POND ($525m^2 \times 1.5^m \times 2 = 1575m^3$)
E1~E6 : EXPERIMENTAL POND ($250m^2 \times 1.2^m \times 6 = 1800m^3$)

SWR : SEAWATER RESERVOIR ($875m^2 \times 1.0^m = 875m^3$)
M : MIXING POND ($1125m^2 \times 1.0^m = 1125m^3$)

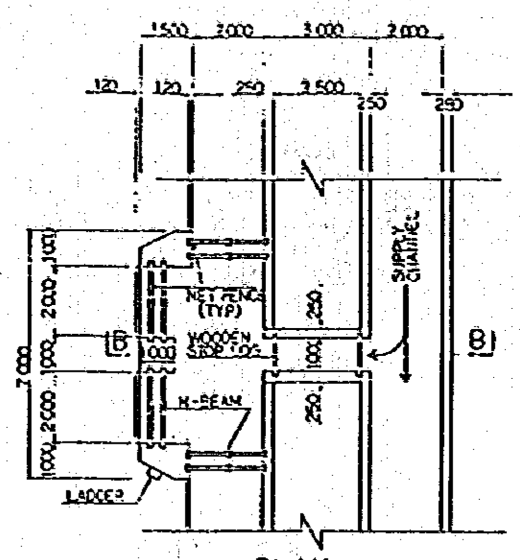




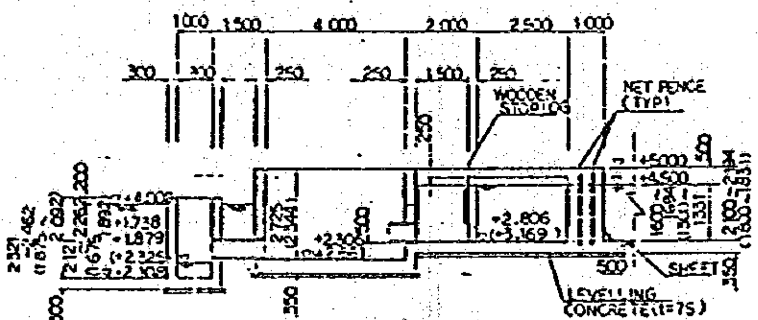
PLAN (TYPE I)



PLAN

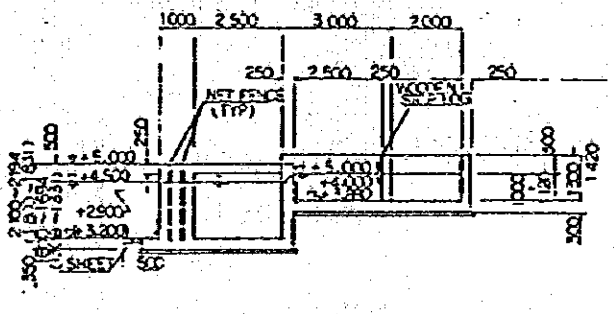


PLAN



A - A SECTION

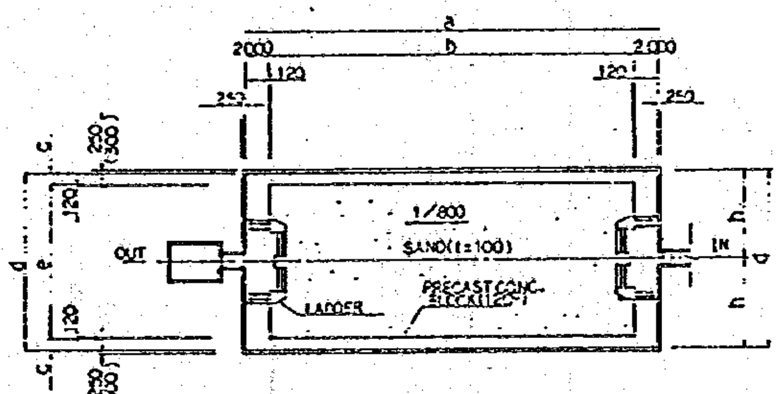
OUTLET DETAIL SCALE 1/100



B - B SECTION

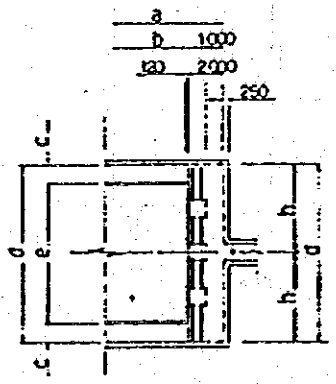
INLET DETAIL SCALE 1/100

NOTE : ( ) IS FOR E1~E6 POND.



PLAN (TYPE II)

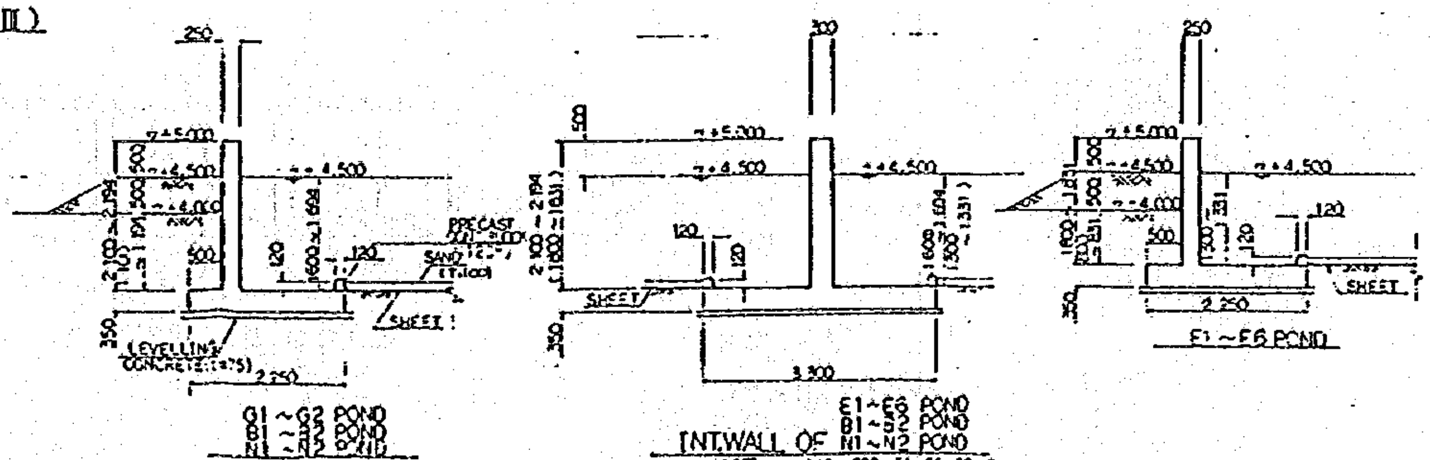
NOTE : ( ) IS FOR INT.WALL



PART PLAN (TYPE III)

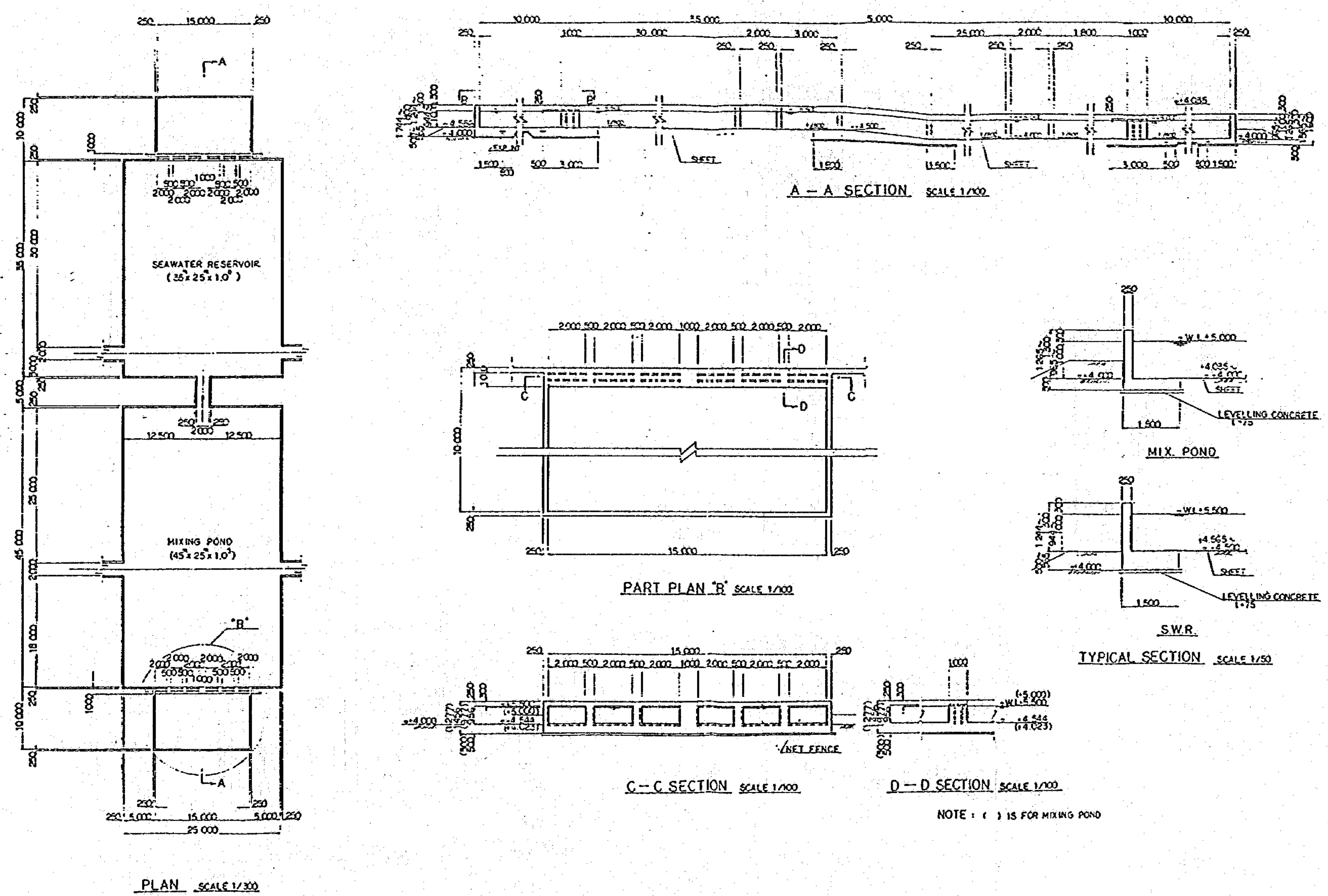
POND / TYPE / DIM.	G1~G2	B1~B2 N1~N2	E1~E6
	TYPE I	TYPE II	TYPE III
a	75 000	30 000	25 000
b	71 000	26 000	23 000
c	1 380	1 380	1 380
d	40 000	17 500	10 000
e	37 240	14 740	7 240
f	19 000	-	-
g	10 500	-	-
h	-	8 750	5 000

SCHEDULE OF POND

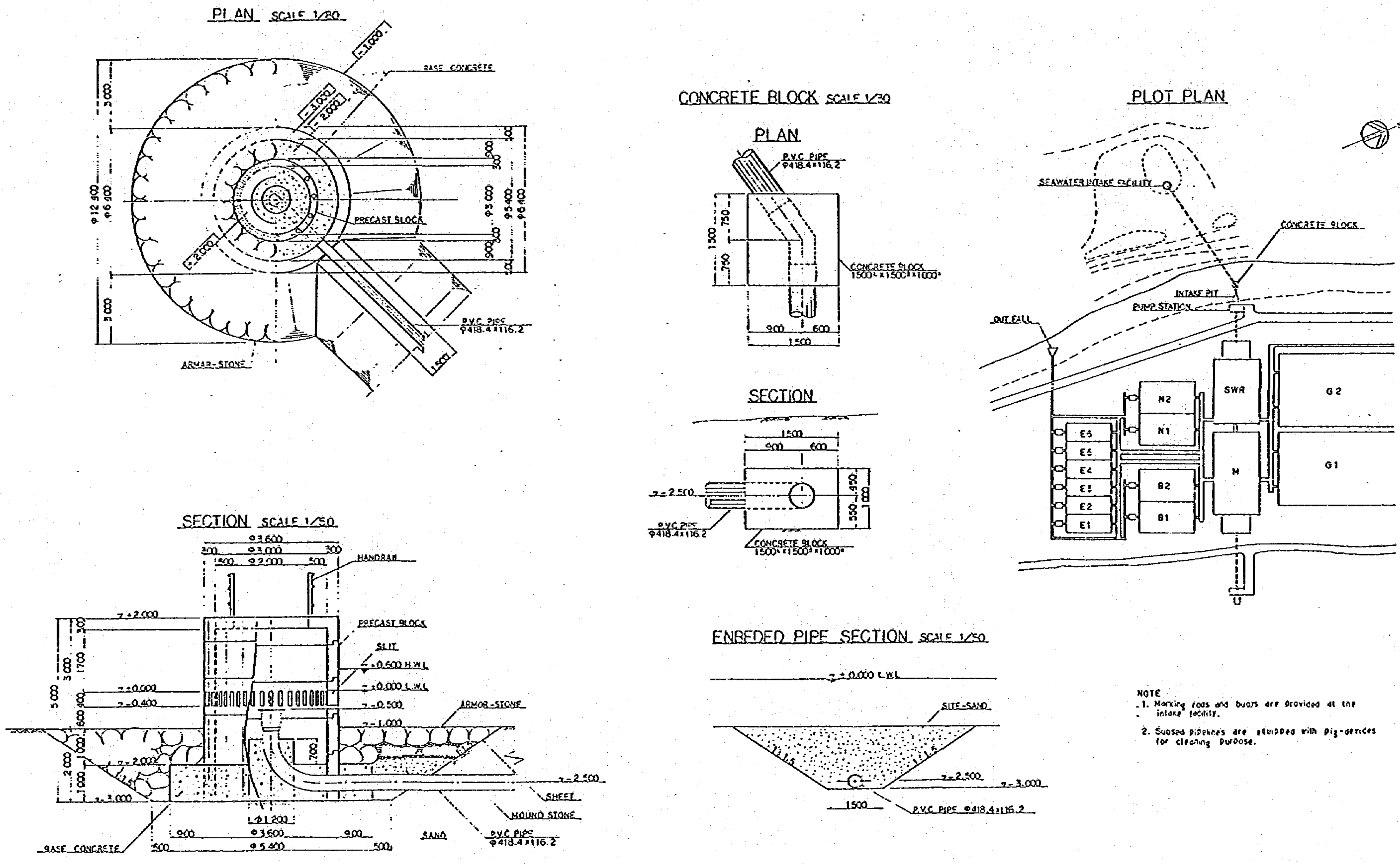


TYPICAL CROSS SECTION SCALE 1/50

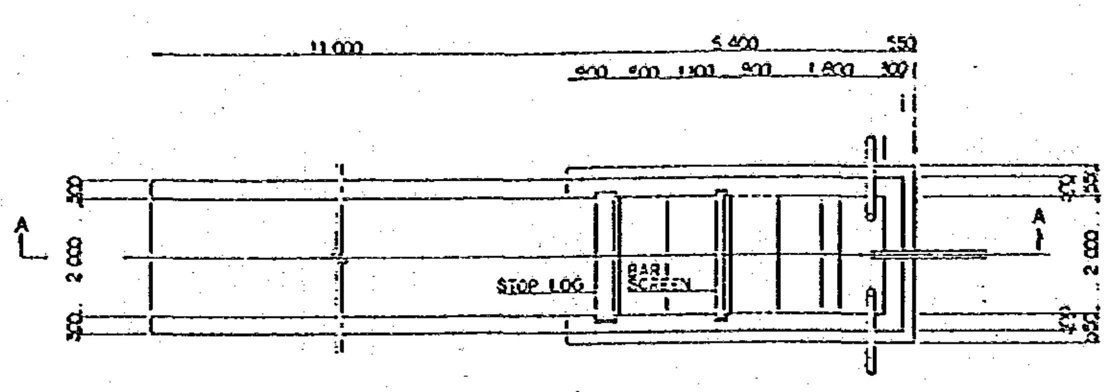
(10) SEAWATER RESERVOIR & MIXING POND (Detail)



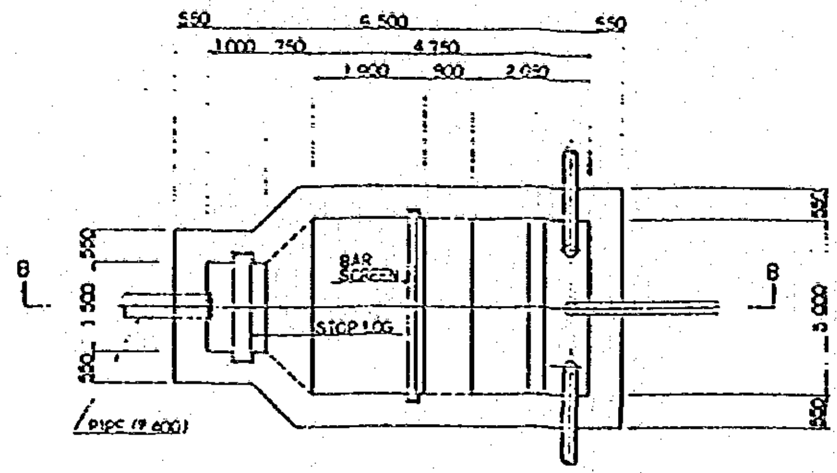
(11) SEAWATER INTAKE FACILITIES (Floor Plan & Detail)



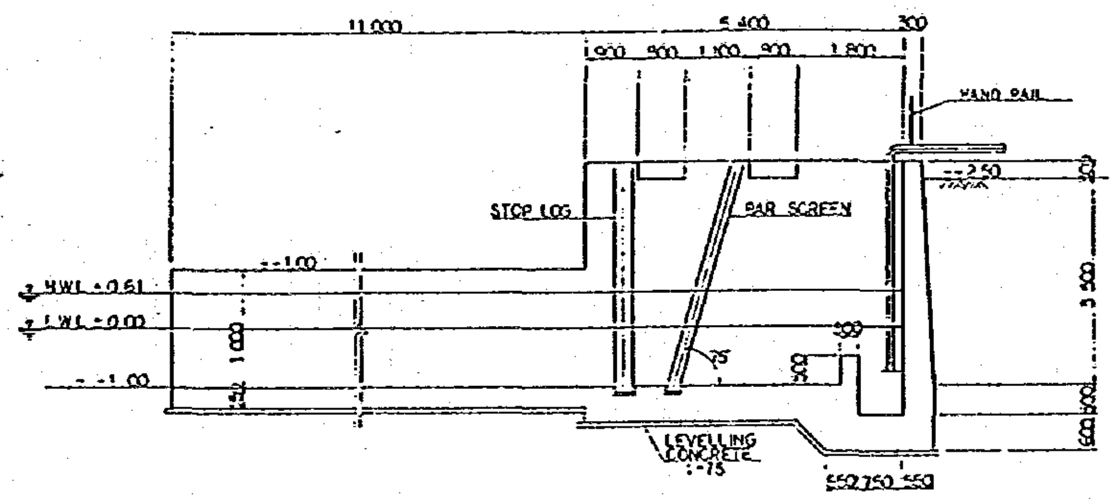
(12) SEAWATER & FRESHWATER INTAKE PIT



PLAN

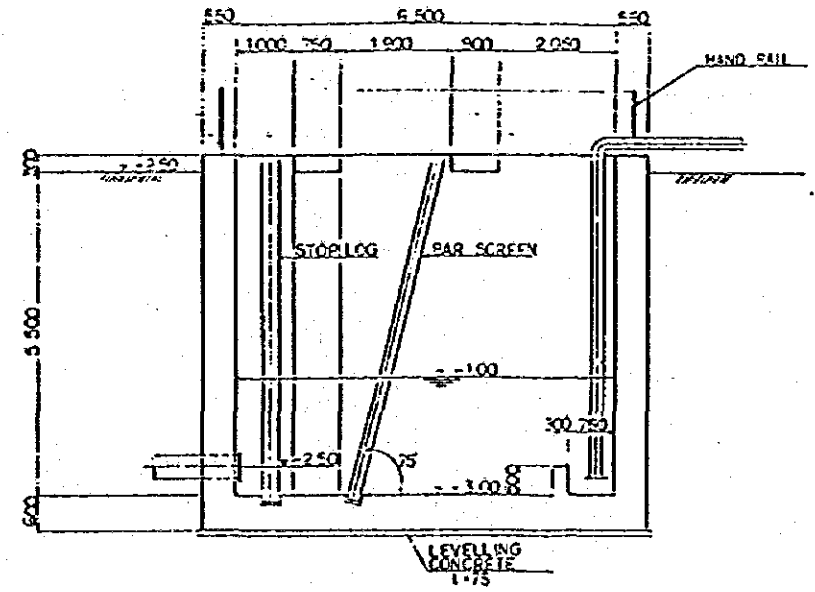


PLAN



A – A SECTION

RIVER SIDE

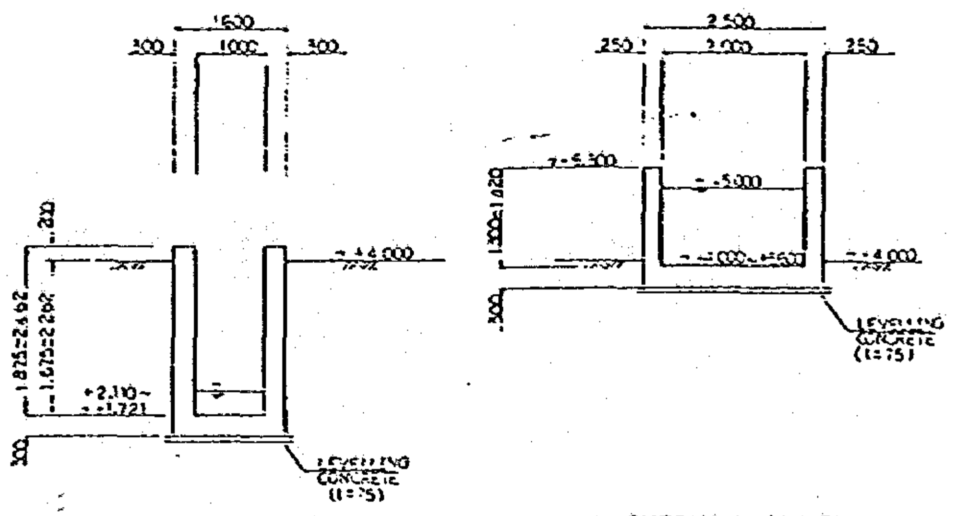


B – B SECTION

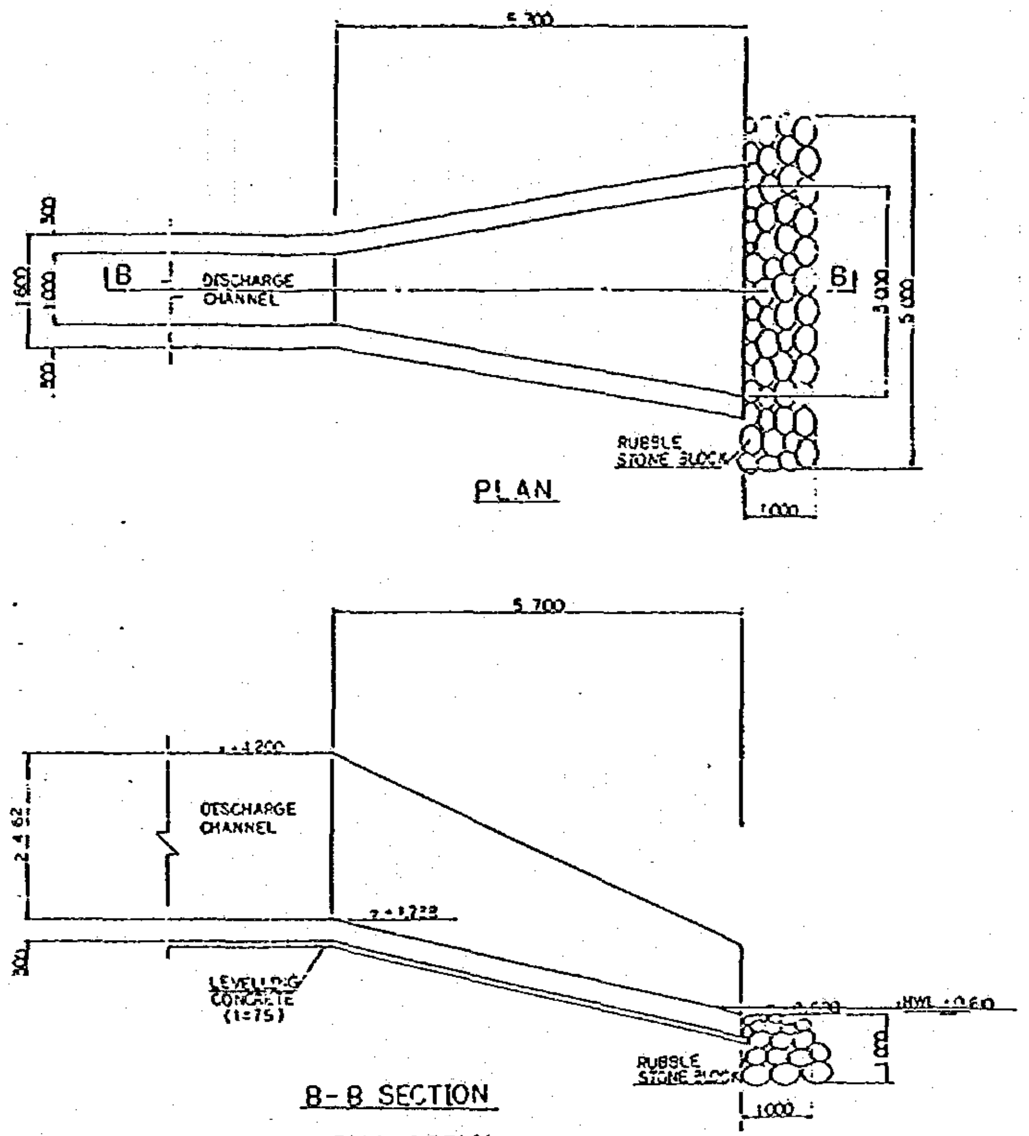
SEA SIDE

SCALE 1/60

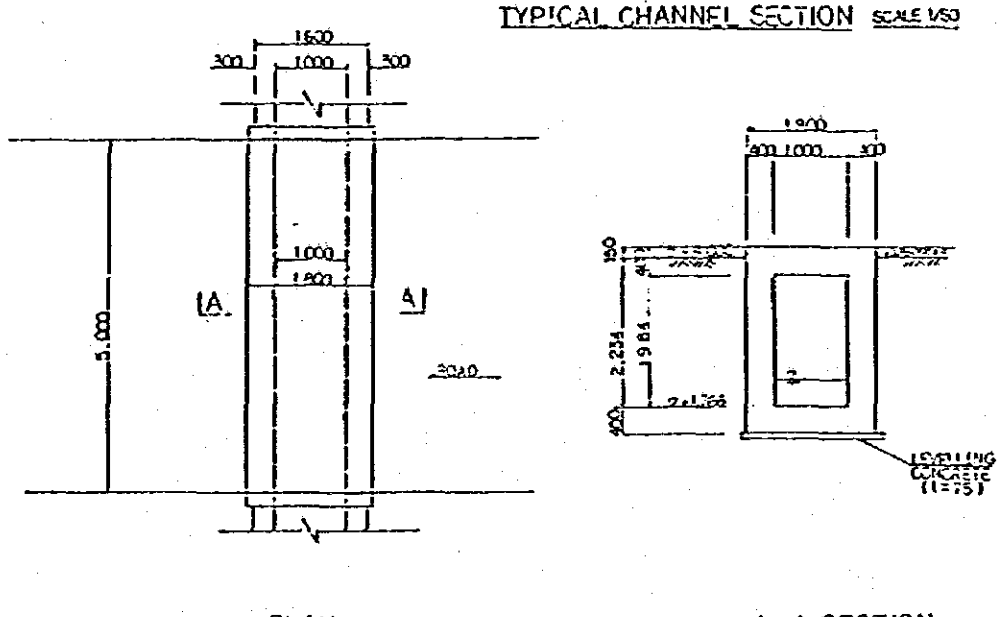
(13) WATER SUPPLY & DISCHARGE CHANNEL, ROAD (Detail)



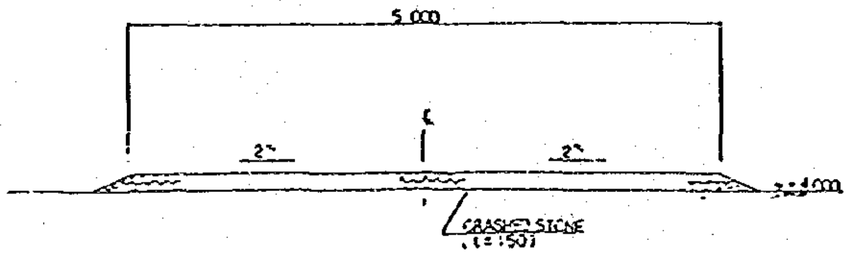
TYPICAL CHANNEL SECTION SCALE 1/50



OUT FALL DETAIL SCALE 1/50

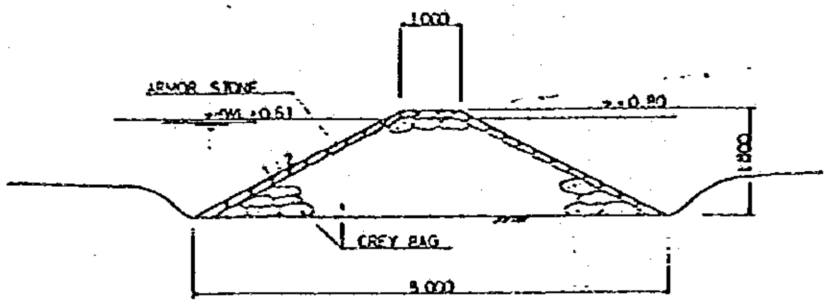


DISCHARGE CHANNEL AT ROAD CROSSING SCALE 1/50

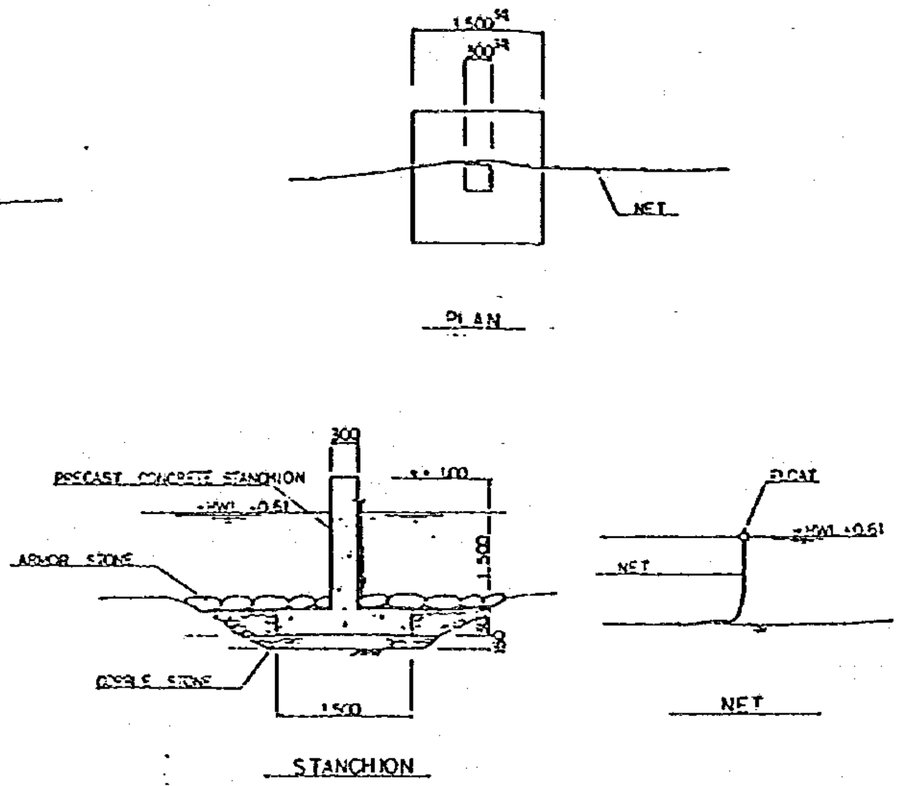


SCALE 1/30

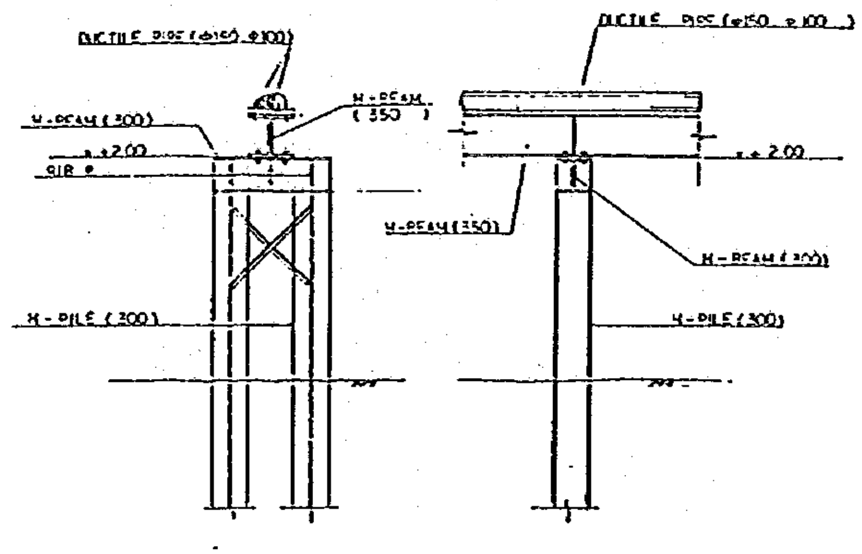
(14) OTHER FACILITIES STANDARD CROSS SECTION



DAM SCALE 1/50



NET & STANCHION SCALE 1/50



BRIDGE FOR PIPE SCALE 1/30

4-3 Implementation Plan

4-3-1 Local Conditions

The results of the site survey revealed that the following conditions must be considered when planning to build a marine shrimp experimental station.

(1) Construction Material:

Mauritius is a volcanic island producing large quantities of basalt rock. The coarse and fine aggregates used for concrete can be supplied adequately by removing the rubble from sugar cane fields. However, the removal of coral sand for use in fine aggregates is restricted by law.

Although cement is imported, there is a sufficient amount of stock. Ready-mixed concrete is abundantly supplied by two local companies. Secondary concrete products such as concrete blocks and pipes are also produced locally. However, Hume concrete pipes with reinforcement as produced in Japan, are not produced in Mauritius. As for the PVC pipes for water supply and drainage, both pressure and no-pressure type pipes are available up to the diameter of 200mm. Valves are all imported. Lumber and steel products are also imported and they are relatively expensive.

(2) Labour:

The wage of unskilled labor is Rs. 60/day and abundant labour is available. Skilled workers such as carpenters, truck drivers, bulldozer drivers and iron bar workmen are also available in large numbers. Securing skilled drivers of heavy vehicles and machinery such as large cranes, however, is difficult.

(3) Construction Machinery:

There is sufficient supply of land-use vehicles and machinery such as the bulldozer and back-hoe. Although 36-ton and 15-ton truck cranes are available, their number is limited. Procurement of truck cranes may be difficult if other construction projects are progressing in the country. No crawler-cranes are available.

(4) Applicable Laws:

Both civil work and construction are based on the British standards. Due to the lack of laws and regulations in Mauritius governing the type of civil and construction work involved in the current project, Japan's architectural and construction laws, regulations and various standards shall be applied as a principle.

(5) Local Contractor:

There are several local contractors with abundant experience in road and building construction. Construction of bridges under the assistance of the Africa Development Bank has been undertaken by a local contractor. Mauritian contractors possess engineering skills and knowledge as much as Japanese contractors operating in small cities or towns. Local contractors, however, lack experience in underwater or water surface construction such as construction of water intake facilities, etc.

(6) Sea Transport between Japan and Mauritius:

Only one Japanese company has a regular once-a-month ocean liner service from Japan to Port Louis.

(7) Customs Clearance and Land Transportation of Port Louis:

The harbor of Port Louis is well equipped and allows loading/unloading. The administration and control of the harbor is under the jurisdiction of the Mauritius Marine Authority. The Authority has experienced two free-grant port repair works in the past. It therefore may be thoroughly familiar with and adept in customs clearance and land transportation. It is expected that unloading of material and equipment and delivery of these goods to the project site may take about two weeks.

4-3-2 Special Notes on Implementation Plan

As for access to the site, there is a simplified paved road (the access road to the Albion Fisheries Research Centre and an unpaved road running adjacent to the site. Both roads can be used for the current project. However, they are both narrow roads, requiring some kind of traffic control such as allowing each road to one-way traffic, etc. Although there is only scanty rainfall at the site, there are many rainy days warranting special attention in controlling the quality of concrete and operations, since the project contains a lot of concrete work. Work on seawater intake facilities and other water work must be timed well, avoiding the cyclone season (Dec. - April).

This project involves the construction of various facilities such as the seawater and freshwater intake systems, weirs, net fence (experimental Barachois), and well boring in addition to the main construction work for the technical office, hatchery complex buildings and culture experimental ponds. The work is to be carried out in the widely scattered area. The complicacy of the work necessitates careful planning to ensure the most efficient use of construction machinery.

4-3-3 Construction Method

The work schedule for the construction of marine shrimp culture experimental station shall be divided into the followings:

1) Technical Office Building

i) Foundation work
ii) Form work and reinforcement work
iii) Concrete work
iv) Block masonry work
v) Waterproof work
vi) Door and window work
vii) External finish work

viii) Internal finish work

ix) Plumbing work

x) Electrical work

2) Hatchery Complex

i) Foundation work (including boring for each tank)

ii) Form work and reinforcement work

iii) Concrete work

iv) Steel frame work

v) Roofing

vi) Door and window work

vii) External finish work

viii) Plumbing work

ix) Electrical work

3) Culturing Facilities

i) Excavation

ii) Form work and reinforcement work

iii) Concrete work

iv) Road work

v) Accessory work (electric work, etc.)

4) Sea Water and Fresh Water Intake Facilities

i) Temporary work

ii) Excavation

iii) Piping

iv) Form work and reinforcement work

v) Concrete work

vi) Accessory work (pump installation, etc.)

5) Weir, Net Fence

i) Boring

ii) Pile driving work

iii) Rubble mound work

iv) Concrete work

Due to the shallowness of the sea water intake facility construction site and unavailability of working vessels, construction shall proceed by using land-use machinery by first building temporary roads by means of rubble mound work. All other underground work shall also be performed using land-use machinery.

4-3-4 Scope of Work

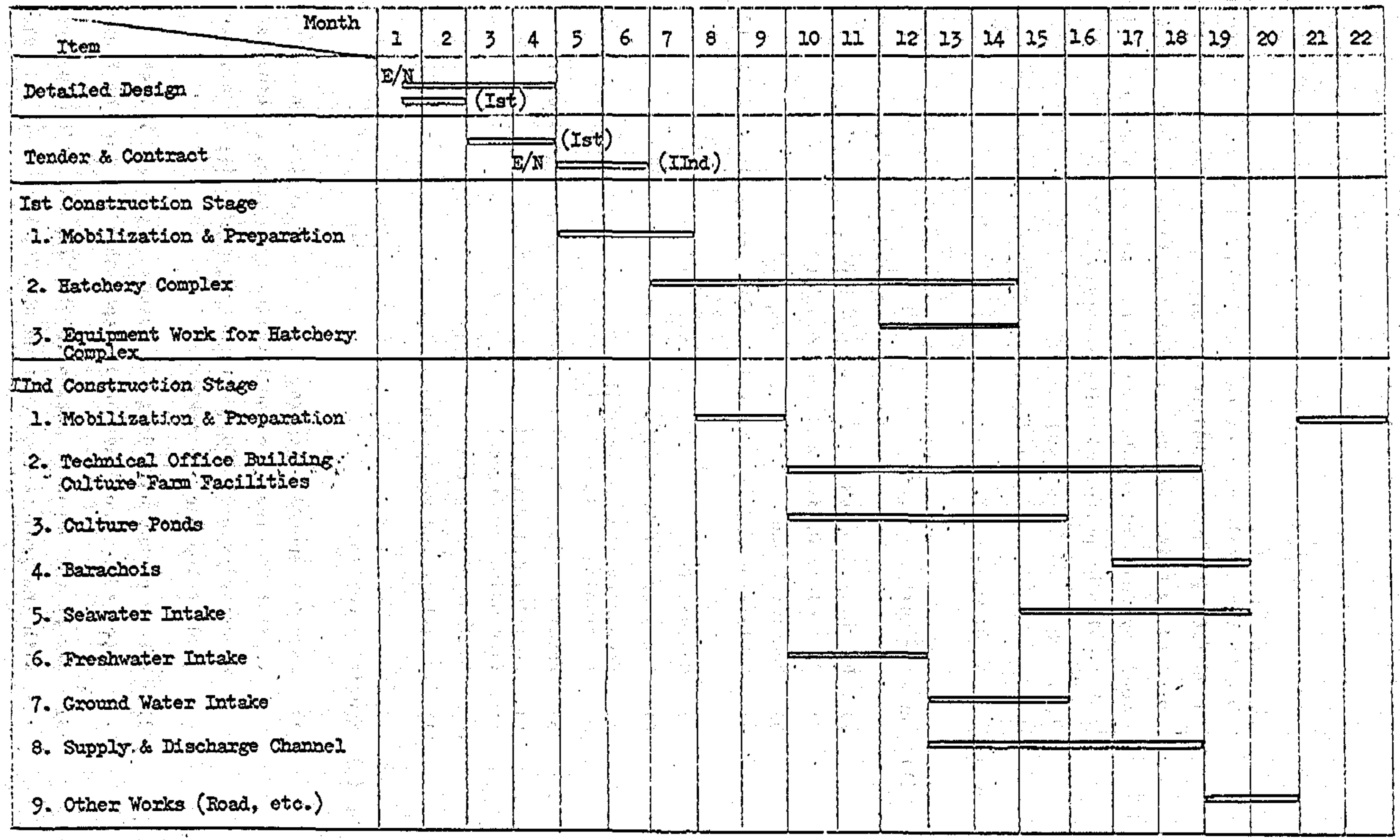
(1) Japanese Portion:

1) Hatchery Complex : 442.2 m^2
2) Techinical Office Building: 413.5 m^2
3) Machine House : 25.6 m^2
4) Facilities and Equipment inside the above Bldg. ((1), (2), (3)) : 1 set
5) Culture Pond : 9,600 m^2
6) Seawater Intake Facility : 1 set
7) Freshwater Intake Facility: 1 set (Including Wells and Weires)
8) Water Supply and Drainage Channel, Water Gates, etc. : 1 set
9) Experimental Barachois : 7,000 m^2 (Including Net Fence)
10) Outdoor Accessories : 1 set
11) Materials and Equipment : 1 set

(2) Mauritian Portion:

1) Assume responsibility for provision of facilities including vegitation clearance and leveling & grading, fencing, supply of electricity with 100 kVA transformer and city water, access road, telephone and drainage.
2) Ensure prompt unloading and customs clearance for the goods imported by the constructed Japanese firms for the Project.
3) Exempt the Japanese nationals visiting Mauritius in connection with the project from customs duties, taxes and the relevant fiscal dues.
4) Accord the necessary permits and licences for carrying out the project.

4-4 Implementation Schedule



4-5 Management and Operation Cost

Management, operation and maintenance of the facilities will be carried out by the Ministry of Agriculture, Fisheries and Natural Resources. Working expenses will be budgeted by the Ministry and executed by the Albion Fisheries Research Centre, but this budget should be executed separately from the original one for the Centre.

Operation cost comprises the expenditures for pilot test and basic experiment, personnel expenditure for technical operation and office expenses, but the personnel expenditure for the staff excepting site worker is to be combined into the budget of the Fisheries Division of the Ministry.

Annual operational cost is calculated by phase, and the expected revenue and/or value of harvested shrimp and distributed fry as well as the balance, substantial operation cost, are shown in Table 23. Incidentally, price escalation of personnel expenditure and office expenditure is set at 10% annually.

Table 23-1 Annual Expenditure

Rs

	Phase I	Phase II	Phase III
Personnel Expenditure	600,000	660,000	726,000
Office Expenditure	260,000	286,000	315,000
Feed	31,000	64,000	102,000
Electricity	400,000	400,000	400,000
Fuel	110,000	110,000	110,000
Other Operational Cost	20,000	30,000	50,000
Repair	20,000	50,000	60,000
Total:	1,441,000	1,600,000	1,763,000

Table 23-2 Annual Revenue

	Phase I	Phase II	Phase III
Fry for distribution (pcs)	-	340,000	1,900,000
Value (Rs)	-	97,000	543,000
Shrimp Production (kg)	527	1,663	2,744
Value (Rs)	75,000	238,000	392,000
Total Value	Rs.75,000	Rs.335,000	Rs.935,000

Note: Price of fry : US$0.02 or Rs.0.286 per piece
Price of shrimp : US$10.00 or Rs.140 per kg

Table 23-3 Balance of Budget and Revenue

	Phase I	Phase II	Phase III
Rs	1,366,000	1,265,000	828,000
US$	96,000	88,000	58,000

Note: Actual annual operation cost is about ¥11,400,000

Breakdown of Personnel Expenses

Unit: Rs

Title and/or Designation	Number	Monthly	Annually	Total
Assistant Director/Divisional Scientific	1	7,000	84,000	84,000
Scientific Officer	2	4,000	48,000	96,000
Technical Officer	5	2,500	30,000	150,000
Field Worker	8	1,500	18,000	144,000
Technical Trainer	2	2,500	30,000	60,000
Assistant Engineer	1	2,500	30,000	30,000
Driver	1	1,500	18,000	18,000
Total	20			582,000
Casual Labour (man-day)	300	60/man-day		18,000
Grand Total				600,000

Breakdown of Office Expenses

Unit: Rs

Item	Base of Estimate	Amount
Travel	Rs. 5,000/month	60,000
Office Supply	Rs. 3,000/month	36,000
Electricity, Water Supply	Rs. 2,000/month	24,000
Communication	Rs. 2,000/month	24,000
Welfare	5% of Personnel Expenditure	30,000
Transportation	Rs. 5,000/month	60,000
Others		26,000
Total		260,000

Breakdown of Feed Cost

1) Feed for breeder production

Phase	Number	Increase in Weight	Conversion Ratio	Quantity	Price	Amount
I	360	150g -50g = 100 g	2.0	72 kg	Rs.30/kg	Rs.2,160
II	560	150g -40g = 110 g	2.0	123 kg	"	Rs.3,690
III	800	150g -40g = 110 g	2.0	176 kg	"	Rs.5,280

2) Artemia for hatchery operation

Phase	Number of Fry	Feeding Rate	Quantity	Price	Amount
I	216,000	100g /10,000	2.2 kg	Rs. 700/kg	Rs.1,540
II	672,000	50g /10,000	3.4 kg	Rs.1,000/kg	Rs.3,400
III	2,304,000	40g /10,000	9.2 kg	Rs.1,200/kg	Rs.11,040

3) Compound feed for hatchery operation

Phase	Number of Fry	Feeding Rate	Quantity	Price	Amount
I	216,000	500g /10,000	11 kg	Rs. 60/kg	Rs. 660
II	672,000	400g /10,000	27 kg	"	Rs. 1,620
III	2,304,000	400g /10,000	92 kg	"	Rs. 5,520

4) Compound feed for nursery operation

Phase	Weight of Juvenile	Conversion Ratio	Quantity	Price	Amount
I	29 kg	8.0	232 kg	Rs. 15/kg	Rs. 3,480
II	58 kg	6.0	348 kg	"	Rs. 5,220
III	66 kg	6.0	396 kg	"	Rs. 5,940

5) Compound feed for Growing-out Operation in Ponds

Phase	Total Weight of Shrimp	Conversion Ratio	Quantity	Price	Amount
I	414 kg	2.0	828 kg	Rs. 10/kg	Rs. 8,280
II	1,185 kg	2.0	2,370 kg	"	Rs.23,700
III	1,866 kg	2.0	3,732 kg	"	Rs.37,320

6) Compound feed for Growing-out Operation in Barachois

Phase	Total Weight of Shrimp	Conversion Ratio	Quantity	Price	Amount
I	192 kg	2.0	384 kg	Rs. 10/kg	Rs. 3,840
II	626 kg	2.0	1,252 kg	"	Rs.12,520
III	1,037 kg	2.0	2,074 kg	"	Rs.20,740

7) Feed for Basic Experiment

Phase	Hatchery Operation	Nursery & Growing-out Operation	Amount
I	Rs. 5,000	Rs. 6,000	Rs.11,000
II	Rs. 6,000	Rs. 8,000	Rs.14,000
III	Rs. 6,000	Rs. 10,000	Rs.16,000

Feed Cost by Phase

RS

Phase	Breeder	Hatchery	Nursery	G. Pond	Barachois	Experiment	Total
I	2,160	2,200	3,480	8,280	3,840	11,000	30,960
II	3,690	5,020	5,220	23,700	12,520	14,000	64,150
III	5,280	16,560	5,940	37.320	20,740	16,000	101,840

CHAPTER V

PROJECT EVALUATION

CHAPTER V PROJECT EVALUATION

This project is expected to be hopeful by the persons concerned of the Mauritian Government, as it would bring a hope to the sluggish coastal fishing in Mauritius. The significance and necessity of this project were already stated, and in this chapter, the direct and secondary effects in the case of the project's implementation, are assessed by forecasing the effects from the standpoint of technical, economic and social sides respectively.

5-1 Technical Evaluation

The current fish culture techniques in Mauritius, especially on common carp, grass carp, silver carp and freshwater giant prawn, have almost reached the commercial stage. This is the result of past performances in extending continued development efforts after introduction of techniques concerned in 1970's. Especially the technical development is most active at the La Ferme Freshwater Aquaculture Station, which was completed in 1984 by the funding cooperation among EC countries, and the above station is being oriented as the core of industrialization through establishment of seed mass-production and growing-out techniques. On the other hand as to the marine-water aquaculture, only the culture of fish and shell-fishes is being conducted by utilizing Barachois. However, the technical development for marine shrimp culture has been taking place since 1983 when the Albion Fisheries Research Centre was completed, and by now the techniques for seed production by artificial hatching and its growing-out, though it is of experimental scale, have been developed. As stated earlier this success has become a moment to this project, but the present research centre (Albion) is only capable of conducting the research on a test scale, and the transfer to the research on a pilot scale is considered to be necessary. As a result of the study the basic design study mission has judged that from the confirmation of importance and necessity of marine shrimp culture in Mauritius, its technical development, especially for commercialization is indispensable.

This project is expected to bring a rapid development of marine shrimp culture techniques, same as the La Ferme Freshwater Culture Centre, and is foreseen to accelerate its commercialization. Also in Mauritius there are a lot of Barachois scattered at different locations, which are formed by utilizing the natural topography and volcanic stones, and the possibility of their enlargement is very much probable so that realization of their commercialization can be expected. Thus, not only improvement of the techniques regarding marine shrimps can be expected, but also as their secondary effects paving the way to the seed production of other marine crustacea and fish and development of their culture techniques will become possible.

5-2 Economic Evaluation

Currently in Mauritius the catch of marine shrimp includes only 40 tons of lobster and 25 tons of cultured freshwater giant prawn, totally 65 tons. On the other hand the shrimp consumption is about 300 tons including 150 tons of imported dried shrimp, 80 tons of frozen shrimp and 65 tons of domestic ones. Frozen and dried shrimp are mainly imported from Madagascar and India, and so the paying out foreign currency becomes rather a burden of the economy in Mauritius.

Under the circumstances, if the 500 ha - target by 1995 - becomes operational as the farms of commercial scale, its economic effect will be as following. The current market price of shrimp in Mauritius is US$12/kg due to its rather high marketing expense such as air freight, etc., but here in this assessment US$10/kg was adopted taking into consideration by the price forecast in 1990.

Table 24 Expected Production of Culture Shrimps

Type of Farm	Potential Area (ha)	Production per Unit Area (ton/ha)	Cycle (year)	Production (ton)	Construction Cost (US$)
Farms on land *	350	1.7 in summer 1.3 in winter	2	1,050	7,000,000 (20,000/ha)
Barachois	150	0.7 in summer 0.6 in winter	2	195	1,500,000 (10,000/ha)
Total	500 **			1,245	8,500,000

Note: * refer to Chapter for area by type of farm

** rather conservative potential area

The value of approximately 1,245 tons production will be US$12.45 million. Comparing this value with those of artisanal fishery (logoon fishery) and bank fishery in Mauritius, US$2.7 million and 5.7 million (1984), respectively, the value of cultured shrimp production will be four times of that of artisanal fishery and more than double of that of bank fishery. This means shrimp culture industry will become the most promissing new fishery industry.

At the same time it will bring on saving foreign currency and a partial earning of foreign currency. Needless to say, operational profit from this station is not considered to occur due to the character of research organization. As indicated before, management and operation cost in Phase III is Rs. 1,763,000, and the value of fry and shrimp production estimated Rs. 935,000, and consequently the balance or substancial operation cost will be Rs. 828,000 (¥11,592.000).

Total expenditure of this station from Phase I to III when commercialization of marine shrimp culture is realized, is estimated Rs. 8,200,000 (about ¥120 million or US$570,000) including Rs. 4,100,000 for Phase I (3 years), Rs. 2,500,000 for Phase II (2 years) and Rs. 1,600,000 for Phase III (2 years).

Appropriateness of such an investment for the investigation development should be judged comprehensively by the expectation of marine shrimp culture industry, financial aspects such as profitability, saving and earning of foreign currency and also social aspects such as accelaration of employment, practical application of unused and/or low production land. It is further considered that "Capture Fishery" is not so promissing in future but rather "Culture Fishery" should be promoted. Evaluation is done here from only economic point of view but marine shrimp culture project should be considered more importantly from comprehensive aspects such as scale of industry, profitability, contribution to financial aspect.

This project is judged to be preferential because although about US$600,000 is necessary for the development, US$12,400,000 is expected annually and this development cost will not be excessive.

Effectiveness of this project as a model is examined. Based on the operational cost of the station by phase, balance of the revenue and expenditure including only the cost of productive operation is estimated in Table 25.

Table 25 Trial Calculation of Balance of Revenue & Expenditure

Rs. x 1,000

Item		Phase I	Phase II	Phase III
Revenue	Shrimp	75	238	392
	Fry	0	97	543
	Total	75	335	935
Expenditure	*1 Personnel Expenses	186	205	225
	*2 Office Expenses	26	29	32
	Feed	31	64	102
	*3 Electricity	133	133	133
	*4 Fuel	73	73	73
	*5 Other Operational Cost	10	15	25
	Repair	20	50	60
	Total	479	569	650
Balance		-404	-234	285

Note *1 Practical worker for production

Responsible person in charge of hatchery 1, Rs. 48,000

Field worker for hatchery 3, Rs. 54,000

Responsible person in charge of growing-outl, Rs. 48,000

Field worker for growing-out 2, Rs. 36,000

Total Rs.186,000

*2 1/10 of total amount of the station

*3 1/3 of total amount for the station

*4 2/3 of total amount for the station

*5 1/2 of total amount for the station

According to this trial, the operation becomes profitable in Phase III when the pilot production will be steadily practised, and be functioned as a demonstration model for commercial production of marine shrimp culture.

Necessary number of fry for 1,245 tons of the expected shrimp production is roughly estimated at 130,000,000 considering of the technical improvement. In order to produce this number of fry, it is necessary to expand the facilities of this station. Expansion can be done by utiliting the space lots around the planned hatchery and the north of the culture ponds including the adjacent governmental property. If the expansion of this station is realized, the station will be the centre or nucleus of shrimp culture industry in Mauritius.

In such a case, production of fry is estimated to be US$2,600,000 (US$0.02/pc), and the operation will be profitable even including accumulated development cost.