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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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TECHNO-ECONOMIC STUDY ON FISHMEAL PROCESSING

UC/MIC/89/184/11-01 and 11-02

FEDERAL STATES OF MICRONESIA

Technical report: Assessment of the present and future conditions for the establishment of a fishmeal industry in the FSM*

Prepared for the Government of the Federal States of Micronesia
by the United Nations Industrial Development Organization

Based on the work of Pierre Lamendour, fishmeal processing expert
and Karl Heinz Behm, fish industry economist/marketing expert

Backstopping officer: B. Galat,
Agro-based Industries Branch

* This document has not been edited.

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COMMENTS

(by the project backstopping officer)

Reviewing all the data provided in the study on fishmeal processing by the UNIDO experts Messrs. Pierre Lamendour and Karl Heinz Behm upon the request of the Government of the Federated States of Micronesia we are of the opinion that FSM is very rich in marine resources which are to be processed into food, animal fishmeal and other industrial products.

We share the experts' view that FSM should be assisted in the establishment of pilot fish processing and quality control facilities. The introduction of modern technology would enable this country to utilize the abundantly available seafish resources for food and animal fishmeal.

It is advisable to establish in the country a tuna pilot processing plant with a quality control laboratory and fishmeal processing line and to utilize the tuna wastes and by-catch of fish for the production of fishmeal of high quality for domestic consumption and for export.

These technical assistance activities will lead to an investment-oriented large-scale project dealing with the processing of tuna and production of fishmeal. UNIDO is prepared to assist the Federated States of Micronesia in the proposed technical assistance.

INTRODUCTION

Between August 13 and October 27, 1990 a mission by order of UNIDO was conducted by the UNIDO consultants, Mr. Pierre Lamendour/Fish Meal Processing Expert and Mr. Karl Heinz Behm/Fish Industry Economist/Marketing Expert in close cooperation with the FSM National Fisheries Corporation at their request in Kolonia on Pohnpei.

In view of the fact that the consultants were not able to start their mission at the same time they only had opportunity of a common cooperation of one week. During this time the consultants agreed each other in all technical as well as the economical points.

The purpose of this mission was to assess the present and future conditions for establishing a fish meal industry in the Federated States of Micronesia (FSM) and advising the National Fisheries Corporation (NFC) - a public corporation created by the FSM Government to promote the development of pelagic fisheries and related industries - about the different possibilities for realizing such project. Since the request was made to UNIDO by the FSM Authorities about two years ago the fisheries situation has changed and part of the expert job description is obsolete.

Tuna cannery is not envisaged any more but tuna loining in each of the four States is planned.

Initially a small fish meal plant is planned in the FSM.

In the next step one larger fish meal plant will be set up adjoining to the tuna loining plants in each of the four States.

Different aspects are to be considered : Economical, social and environmental.

If not processed into fishmeal, fish waste should have to be dumped into the sea and this could create a major pollution for the Islands.

Fish meal industry - if economically viable - will help the FSM international trade balance by producing export goods at world market price and by avoiding import of an expensive constituent of livestock feed used in the Islands.

Remarks: The Calculations base on information, made by the representatives of the National Fisheries Corporation, respectively on information of present offers of high-technology fish meal plants. In this report, only metric system (S.I.) is used. The FSM currency is the US Dollar (US$).

SUMMARY OF RECOMMENDATIONS

1. Fish meal industry in the Federated States of Micronesia looks not only viable but quite profitable provided the following conditions are fulfilled.

- Free raw material in adequate quantity is available
- The market of the produced fish meal is guaranteed.

Therefore the tuna loining plant and a live-stock feed plant should be erected together in order to imply each other.

2. For reasons of economy a fish meal plant with a capacity of 40 - 60 raw material per 24 hours should be taken into consideration because the difference of investment to a 15 tons plant is only small.
All offers and quotations for the fish meal plant have to be checked very carefully with the help from an expert. A visit to existing plants could be arranged with equipment manufacturers, if needed.

3. When erecting the fish meal plant an expatriate expert in fish processing and fish meal will have to be recruited for one year to stay on site for assistance to train Local Staff and operate the factory the first time.

4. Market investigation in the region is necessary to determine prices and quantities of fish meal to be sold in the Asia - Pacific area.

5. A quality control laboratory will have to be set up for food export control and certification.

ACKNOWLEDGEMENT

The authors wish to express their sincere thanks for all the assistance given them by the staff of the National Fisheries Corporation of the FSM in particular, Mr. Christer S. Friberg without whose help this report could not have been completed.

V.1. GENERAL INFORMATION

A. Location and geography

The Federated States of Micronesia is comprised of the states of Pohnpei, Truk, Yap and Kosrae. The country consists of some 607 islands scattered over an area covering over 1.6 million square kilometers in the Western Pacific Ocean between the Equator and 16 degrees north latitude and between 135 and 166 degrees east longitude. It is 5,172 km from Honolulu, 1,651 km from Guam, 3,600 km from Manila and 4,197 km from Tokyo. The National Capitol, Palikir, is in the State of Pohnpei.

The State of Pohnpei, (previously named Ponape), consists of a large volcanic island along with small islands and widely scattered coral atolls. The total land area of Pohnpei is square 214.5 kilometers and the capital is Kolonia.

The State of Chuuk, (previously named Truk), consists of seven major island groups, the largest being Truk Lagoon which is a complex of volcanic islands. The State includes many islands, of mountainous and volcanic origin, surrounded by coral rings forming lagoons of over 1,287 square kilometers and the capital Weno (Moen).

Yap State which is the most western State consists of Yap proper and outer islands, the largest being Ulithi and Woleai. The total land area of the State is 82.2 square kilometers and the capital is Colonia.

Kosrae State is the most eastern state of the Federation and consists of one island with a total land area of 68.8 square kilometers. The capital is Tofol.

The climate is tropical and temperatures generally range from about 23 degrees C to about 30 degrees C and are relatively uniform. Trade winds provide cool breeze except during some parts of summer and fall. The amount of annual rainfall varies greatly among the islands, ranging from as high as 838 cm in some parts of Pohnpei to as low as 279 cm in Yap. Mean humidity averages about 80 percent. Almost all the islands experience definite wet and dry seasons.

The people of the Federated States of Micronesia are Micronesians but they differ in physical characteristics, customs and languages and, to an extent, the division into four states recognizes these differences. While all the people of FSM are Micronesians, locally they are called Pohnpeian, Trukese and so forth. The contact with American, European, and Japanese cultures has had a significant impact on the life style of the people.

B. MARINE RESOURCES OF THE FSM AND THEIR USE

Marine Resources constitute the largest natural resources of the Federated States of Micronesia (FSM). Tuna and associated species have been harvested in quantities of over 100,000 tons and values exceeding US$100 million per year from the FSM 200-miles Exclusive Economic Zone, which covers over 1.2 million square miles. While some development will occur based on harvests of bottom reef and inshore marine resources, the FSM's greatest long-term potential lies in the full explanation of its large pelagic tuna stocks. While the commercial fishery in the FSM conducted by foreign fishing vessels is highly developed the local commercial fishery is still in an early stage of development. The locally operated commercial fishery within the FSM includes more than 50 smaller vessels utilizing long-line, pole-and-line and bottom fishing methods. The vessels range in size from 1.5 - 30 tons and are all fitted with modern equipment. The FSM Government issues licences to foreign vessels for fishing within the rich 200 mile EEZ. Presently over 100 purse seiners and 300 long-line vessels are operating within the area.

The number of manufacturing industries in the FSM are few and the Government is actively promoting the development of an industrial base economy, which includes small scale and medium scale industries. There is a lot of room for improvements in this areas of fishing, processing and marketing. Therefore the erection of a fish meal plant should be one of the first steps in setting up a modern fish processing industry in order to use the rich resources of fish for the population and improvement of the economy of the FSM.

C. THE IMPORTANCE OF FISH MEAL FOR THE ECONOMY

In the fishing industry the utilization of offal and trash fish, which may account for up to 50% of the catch, has become an economic factor of some significance. As a result the proportion of the world catch that is converted into fish meal is constantly growing Fish meal is used primarily as a fodder for poultry and pigs. The meal contains 60 - 75% of protein, of which at least 90% is digestible. The fat content normally varies between 4 and 10%.

The protein composition of the fish meal is one of the best of all protein sources known today. It contains all important amino acids necessary for building up the body. In addition, Fish meal contains an unidentified growth factor. Animals feed on fish meal therefore grow more quickly than when fed on protein from other sources.

D. THE FISHMEAL PRODUCTION METHODS

The methods of producing fish meal are very different. They reach from simple methods to highly developed ones. The most simple method of producing fish meal is that by drying fish through air. The possibility of this application however is only limited to lean fish.

The raw material is placed for drying in the sun (sea-shore) where it will be exposed to the sunbeams for a long time. After drying the fish is grinded and a meal of fibrous' quality is the result of this metnod. Apart from the circumstantiality of this method the quality of the air-dried fish meal is low. The content of white of egg seldom amounts 55%, the fish meal is large polluted with sand and the content of moisture is very high. conditional on the high content of moisture the fish meal, produced by this method, is very limited in its shelf life and falls a victim of the decay of bacterium rapidly. As a sterilization not took place during this process the product often is infected with salmonellas. Although this method of production of fish meal hardly requires investments and skilled labour it can not be considered as it not fulfills the requirements of a commercial fish meal.

Therefore a high-technology plant only comes into question which safes the production of fish meal of high quality and which comes up to the conditions of pollution control.

For this reason a comparison of the economics of operating a low-technology versus a high-technology plant was not effected as this would only lead to confusion in the economical view.

2. FISH MEAL PLANT

Two different scenarios have been considered in this study.

1. One fish meal plant in Pohnpei processing by-catch from tuna vessels transshipping in Pohnpei Harbour.

2. One fish meal plant in each State of the FSM i.e. four plants, each processing by-catch from transshipment and waste (offals) from fish processing plants.

A. Use of by-catch

As said previously, large quantities of tuna are harvested in FSM waters and transshipment is more and more taking place in the FSM ports. This being progressively a condition to obtain fishing licences in the FSM Zone.

Transshipment consists of taking the frozen fish from fishing vessels holds, sorting and landing them for storage in cold storage to await a reefer vessel which would ultimately deliver them to a final destination for processing. Transshipment could be a more simple operation when fishing and reefer vessels are transferring the catch from ship-to-ship whereby the sorting work was done onboard.

At the present moment, all non-tuna (by-catch) would be discarded or sold on the local market. If the by-catch is discarded, it has to be dumped at sea, thereby polluting the area and attracting sharks and the fishing vessels would also have to pay for the operation in dumping. If sold on the local market, the local fishermen would be disturbed as prices of fish most likely would go down significantly.

The FSM authorities have therefore been considering processing by-catch into fisn meal.

In the study we assume that fish transshipped in Pohnpei would range from 20,000 to 60,000 tons annually.

We also assume that by-catch is an estimated 5% of total fish transfer and on this basis we calculate the fish meal operation.

B. Fish meal operation

Equipment

We must keep in mind that these days environmental protection is considered very important in the world community. This is one of the main reasons why fish meal plants are considered to process by-catch that otherwise could create environmental hazard. On the other hand, a fish meal plant could also bring pollution like malodor or waste disposals (stick water, fish oil, etc.). This implies that a deodorizing unit and a concentrator are included in the plant equipment, whereby pollution will be reduced to an acceptable minimum.

The National Fisheries Corporation (NFC) has recently received different quotations from well known companies manufacturing fish meal equipment which we are using as a reference in this study.

A standard fish meal plant includes the following items:

Bin or hopper

The bin receives the raw material to be processed. Normally this item is not part of a quotation as it has to be custom-made depending on the building situation.

Screw conveyor

The screw conveyor brings the raw material from the hopper to a crusher or mincer. The hopper could be located on top of the mincer and therefore the conveyor is not needed.

Mincer or hasher

Fish or offals have to be chopped in small parts before entering the cooker so that heat can penetrate more evenly and quickly inside the raw material.

Pump or screw conveyor

Depending on the raw material and the mincer, a pump or a screw conveyor is used to feed the cooker.

Cooker

Raw material has to be "cooked" to brake the fat cells and coaguliate the proteins and this liberates the oil and water from the fish. To maintain the quality of proteins, temperature of the fish mass is usually between 90-95 degree C.

The cooker should be of a continuous indirect cooker type. This type is designed as a cylinder having a steam or gas flue heated jacket throughout and a heated rotor designed as a screw conveyor with hollow flights. Each manufacturer has its own design but the general idea is always there.

Most cookers are provided with automatic temperature control equipment.

A pre-heater could be added using waste heat from an evaporator or a dryer.

Strainer conveyor

From the cooker, the fish pulp is conveyed to a press through a strainer conveyor which ensures free drainage of liquid. At the bottom of the conveyor, free liquid can go through a screen while the solids are conveyed to the press. The liquid is pumped to a strainer or a centrifuger.

Press

The purpose of the press is to squeeze out as much liquid as possible from the solids.

A press is usually provided with two tapered screws rotating inside a cage. This means an increasing and continous pressure forcing the liquid through the screen. The solid part released by the press is called the "press cake" which has to be milled before being conveyed to the dryer. The liquid part (or press liquor) is pumped to a centrifuger.

Centrifuger

The press liquor and the liquid from the strainer conveyor are heated up to 90 - 95 degrees C before being centrifuged. The centrifuger separates the liquid into three parts:

Part 1. The stick water can be thrown out into the sewer but is mostly pumped into a concentrator, as it contains a high percentage of protein. If released into the sewer system it would pollute the environment.

Part 2. The fish oil will be refined ("polished") or - if not in marketable quantity - used as fuel in the boiler.

Part 3. The solid parts will go into the dryer togetner with the pulps.

Dryer

The dryer could be of direct or of indirect type.

In a direct type dryer the heat comes from flue gas or from the flame burner, which is in direct contact with the pulp. The main problem with the direct type dryer is the malodor that cannot be easily suppressed.

Most dryers are of indirect steam or flue gas types. These dryers consist of either a steam or flue gas heated cylindrical jacket and a screw type rotor providing good agitation and heat transfer to the pulp inside.

The pulp coming out from the dryer usually passes a vibrating sieve, including a magnet, to remove extraneous objects like pieces of wood, fish hooks, nails etc.

Mill

Fish meal is then milled, anti-oxidant added and ready for sale in bulk.

In this operation the mill is called "dry mill" while the mill after press operation is called "wet mill".

The mill is most often of the hammer mill type but different grinding models are used.

Bagging

At final stage fish meal is mostly sold in bags, particularly in retailing. Bagging devices usually include weighing equipment, which could be either automatic or semi automatic.

Concentrator

Stick water coming from the centrifuger contains a high percentage of proteins and can be concentrated to fish soluble. Concentration is made in double, triple, or quadruple effect concentrations, heated by steam produced by the boiler.

When concentrated, the stickwater is introduced in the fish pulp entering the dryer.

This is schematically the standard fish meal process and most manufacturers have their own idea about equipment.

3. FIRST SCENARIO

In this scenario only by-catch will be used as raw material for fish meal and the fish meal plant will have a capacity to process 12 - 15 tons of raw material per day.

Investment

Standard equipment as described above is presently quoted FOB at US$789,000.00.

Freight Including insurance is estimated at 12% of FOB value.

Installation costs is about US$100,000.00.

The cost for a complete building of 200 sq.m. is estimated at US$300/sq.m. or US$60,000.

Total Investment:

Equipment	US$	789,000.00
Freight and Insurance		95,000.00
Installation.....		100,000.00
Building		60,000.00
Total		$1,044,000.00

A. First option: 20 years depreciation

1. Operation cost

1.1 Fixed Cost

Depreciation.

We assume that FSM can obtain an interest free loan from the Investment Development Fund (IDF) on 20 years provided the equipment is of U.S. origin. In the first option we calculate the annual depreciation on a 20 year basis and without interest.

Depreciation 5%/year on US$1,044,000	52,200.00
Insurance (2%/total investment)	20,880.00
Maintenance and repair (5%)	52,200.00
1 skilled plant mechanic	
3 US$/hour x 220 days/year x 8 hours/day.....	5,280.00
Lease on Land	1,000.00
Total	US$131,560.00

1.2 Variable Cost

Assumptions:

By-catch is 5% of total fish transshipped.
Fish meal yield is 25% of raw material (Bycatch in this case).
Fish oil yield is 5%.

Heavy fuel oil is not available in FSM and therefore diesel oil has to be used in boilers.

Consumption:

Diesel Oil, 55kg/t raw material	US $250/t
Electricity, 40kw/t	US $0.15/kw
Fresh water, 10 m.3/t*	US $0.40/m 3

* The low water requirement is based on the assumption that cooling is by sea water.

1.2.1. Unskilled labour

3 shifts of 2 unskilled workers working 8 hours/day and hour rate being US$2.

Daily cost 3 x 2 x 8 x 2=96US$/day worked. We will consider different options depending on the volume of catch transferred per year in Pohnpei harbor.

Fish Transferred	By-catch (5%)
20,000/t	1,000/t
30,000	1,500
40,000	2,000
50,000	2,500
60,000	3,000

All the tonnage of by-catch is to be used as raw material in the fish meal plant. Working days vary according to the supply schedule of raw material. The plant capacity is 12 tons with a maximum of 15 tons per day.

Raw Material	Days Worked	Cost of Labor
1,000 tons	85	x 96 = US $ 8,160.00
1,500	125	= 12,000.00
2,000	160	= 15,360.00
2,500	200	= 19,200.00
3,000	220	= 21,120.00

1.2.2 Fuel

Diesel Oil price: US $250 per ton

Consumption: 55kg per ton of raw material

Raw Material/year	Fuel/year	Cost of fuel/year
1,000tons	55 tons	13,750 US$
1,500	82.5	20,625
2,000	110	27,500
2,500	137.5	34,375
3,000	165	41,250

1.2.3 Electricity

Electricity price: 0.15 US$ per kw.

Consumption 40kw per ton of raw material

Raw mat. t/year	Kilowatt/year	Cost of Electricity/yr
1,000 tons	40,000 kw	US$6,000.00
1,500	60,000	9,000.00
2,000	80,000	12,000.00
2,500	100,000	15,000.00
3,000	120,000	18,000.00

1.2.4 Fresh Water

Fresh water price: US$0.40 per cu.m.

Comsumption: 10 cu.m. per ton of raw material, provided sea water is used for cooling.

Raw Material t/yr	Cu.m./yr	Cost of Water/yr
1,000 tons	10,000	US$4,000
1,500	15,000	6,000
2,000	20,000	8,000
2,500	25,000	10,000
3,000	30,000	12,000

VARIABLE COSTS US$/YEAR

Material (By-catch)	Labour	Fuel	Electric	Fresh Water	Total Variable Cost
1,000 t	8,160	13,750	6,000	4,000	31,910
1,500 t	12,000	20,625	9,000	6,000	47,625
2,000 t	15,360	27,500	12,000	8,000	62,860
2,500 t	19,200	34,375	15,000	10,000	78,575
3,000 t	21,120	41,250	18,000	12,000	92,370

Annual Production Cost US$

Material (By-catch)	Total Variable Cost	Fixed Cost	Total Annual Production Cost	
1,000 t	31,910	131,560	163,470	US$
1,500 t	47,625	131,560	179,185	
2,000 t	62,860	131,560	194,420	
2,500 t	78,575	131,560	210,135	
3,000 t	92,370	131,560	223,930	

2. Output

Fishmeal

Fish meal coming out of the plant should meet the following characteristics:

Protein content	min 65%
Moisture	max 12%
Fat	max 12%
Ash	max 20%

From raw fish like by-catch from tuna fishing the yield (depending of species processed) would be:

Fish meal	25%
Fish oil	5%

Raw Material	Fish Meal	Fish Oil
1000 tons	250 tons	50 tons
1500	375	75
2000	500	100
2500	625	125
3000	750	150

3. Sales.

Projected Fish Meal Needs in FSM *:

	Animal Feed. tons/year			Fish Meal (10%)	
	Pigs	Poultry	Total	1987	1992
Pohnpei					
1987	418	218	636	64	
1992	660	1734	2394		240
Chuuk					
1987	80	120	200	20	
1992	790	1814	2604		260
Yap					
1987	50	150	200	20	
1992	175	371	546		55
Kosrae					
1987	50	150	200	20	
1992	175	371	546		55
Total Fish Meal in 1987				124 tons	
& in 1992					610 tons

To manufacture 610t of fish meal, 2,500 tons of raw material (by-catch) are needed and this requires transshipment of 50,000 tons of fish. Therefore we can say that all the fish meal produced will be consumed locally.

Prices of fish meal C&F Pohnpei range from US$660 to US$950 per ton depending on quality and origin.

In our calculation - to be on the safe side - we use the lowest price.

* Source: Mr. Haresh Patel, FSM Animal Production Officer

Sales and profits:

Fishmeal/Tonnage	250	375	500	625	750
Sales US$	165,000	247,500	330,000	412,500	495,000
Production Cost	163,470	179,185	194,420	210,135	223,930
Benefits	1,530	68,315	135,580	202,365	271,070

B. 2nd Option:

Depreciation of equipment over 10 years.
Building depreciation remains over 20 years.

Fixed Cost.

Depreciation: Equipment 10%	78,900.
Building 5%	3,000
(Freight & Ins.)+installation (10%of total ins.)	19,500
Insurance (2% of total investment)	20,880
Maintenance and repair (5% of total inv.)	52,200
Skilled mechanic	5,280
Lease on Land	1,000
Total.....	US $180,760

Variable costs do not change from previous option.

Raw Material	Variable Costs	Fixed Costs	Total	Sales	Benefits or loss
1000t	31,910	180,760	212,670	165,000	(47,670)
1500	47,625	180,760	228,385	247,500	19,115
2000	62,860	180,760	243,620	330,000	86,380
2500	78,575	180,760	259,335	412,500	153,165
3000	92,370	180,760	273,130	495,000	221,870

This second option is more normal than the first one as within industry standards depreciation is 10 years on fixed equipment and 20 years on buildings.

Beside this, using fish oil as fuel in boilers mixed with heavy fuel oil on a fifty fifty mix is very common. As in the FSM diesel oil is at present the only heavier fuel available we have to investigate if it can be mixed with fish oil or not and thereby reducing the operation costs.

5. SECOND SCENARIO

The request for this mission was presented to UNIDO sometimes ago and quite recently FSM authorities have considered a new scenario as some frozen tuna, instead of being transshipped, will be landed and processed into loins ("loined").

The process will include the following steps:

Fish landing
Cold Storing
Thawing
Butchering (heads cut and viscera removed)
Cooking in Steam boxes
Cooling
Cleaning and separating the four loins from bones, dark meat, skin, & etc.
Freezing the loins.
Storing in cold rooms and shipping for canning

The offals from butchering i.e. raw heads and viscera and from cleaning i.e. cooked bones, dark meat and skin will be used for fish meal. We assume that there will be one loining plant in each of the four States: Pohnpei, Chuuk, Yap, and Kosrae.

Each plant will be designed to process 10,000 tons of frozen tuna.

It is expected that the output will be 5,000 tons of loins. From the operation offals, raw and cooked, will amount to 4,000 tons a year which will be processed in a fish meal plant contiguous to the loining plants.

(10% of the round tuna weight drips off the fish as mixture of water and oil during the cooking operation).

It is estimated that the total catch landed or transshipped is in excess of 120,000 tons, evenly divided up among the four states. The by-catch in each state will therefore be 1500 tons which can be absorbed by the fish meal industry.

Total raw material for each fish meal plant will be:

By catch	1,500 tons
Offal from loining	4,000 tons
Total.....	5,500 tons

INVESTMENT

The small plant planned in the first scenario will not suffice and we need another size of fish meal plant on a basis of 220 working days a year. The theoretical plant capacity is based on the following calculation:

$$\frac{5{,}500 \text{ tons}}{220 \text{ days}} = 25 \text{ tons per day}$$

However, we must be ready to absorb peak periods and the capacity of the plant should therefore be at least 50% higher as we can use a figure of 35 tons per 24 hours. The difference in price between a 35 ton versus a 40-60 ton plant is insignificant.

From different quotations we can see that equipment price is US$1,000,000 for one 40-60 ton per day capacity plant.

Investment

Equipment	US$1,000,000
Freight and Insurance 12%	120,000
Installation	100,000
Building 200 sq m. x $300 sq.m	60,000
Total Investment	US$1,280,000

In this scenario we consider a 10 years depreciation for the equipment.

A. Operation Cost

1. Fixed Cost.

Depreciation of equipment 10 years	122,000
of building 20 years	3,000
Insurance 2% x 1280000	25,600
Maintenance and repair 5% x 1,280,000	64,000
Manager 1000 US$/month	12,000
Lease on Land	1,000
Total Fixed cost	US$ 227,600

2. Variable Cost

We consider the normal processing of 5,500 tons per year of raw material.

Fuel (diesel oil) 55kg/t x 5,500t x 250$/t	75,625
Water 10m 3/t x 5,500t x $0.40/m 3	22,000
Electricity 40kw/t x 5,500t x US$0.15/kw	3 ,000
Workers: 8 men x 8h/day x US$2/hr x 220dys	28,160
Total Variable Cost	US$158,785

3. Total Annual Cost

Fixed cost	227,600
Variable cost	158,785
Total	US $386,385

B. Production

The fish meal plant will be processing two different types of raw material:

- Bycatch
1,500 tons of bycatch will be processed with a yield of:

Fish meal	25%
Fish oil	5%
or a production of fish meal	375 tons
Fish oil	75 tons

-offals from loining plant
4,000 tons of offals will be processed with a yield of:

Fish meal	30.00%
Fish Oil	2.15%
Fish meal	1,200 tons
Fish Oil	86 tons

Production of one fish meal plant will then be:

Fish meal	1,575 tons a year
Fish oil	161 tons a year

C. Sales and profits

Out of 1,575 tons of fish meal 150 tons will be consumed by the local market at US $660/t.

Local sales will be US$660 x 150 tons = US $99,000

The remaining 1,425 tons will have to be sold on the world market.

We must consider different FOB price possibilities

		Sales	Cost	Profit
US$400/t	x 1425t + 99000 =	669,000	- 386,385	US$282,615
350	x 1425 + 99000 =	597,750	- 386,385	211,365
300	x 1425 + 99000 =	526,500	- 386,385	140,115

5. SOCIAL BENEFITS

A. Employment.

For a fish meal plant, being highly automatic, direct employment is not very significant within the plant itself. Total workers in three eight hours shifts would not exceed eight to ten men. Animal feed which would be locally prepared, using the fish meal and different inputs like coconut, corn, soya, minerals, etc., would employ some additional workers.

B. Country foreign exchange balance

Using national resources - fish in this case - instead of importing foreign products that can be manufactured locally at comparative prices, the foreign trade balance will be improved.

The export of manufactured products with value added will also improve the balance in trade.

When the four loining plants are in operation - one in each of the four states - the import substitution in US$ will be:

4 states x 150 tons x US $660 = $396,000

The total value of export depending on FOB prices will be:

US$400/t X 1,425t x 4 =	US	$2,280,000
350/t X 1,425t x 4 =		1,995,000
300/t x 1,425t x 4 =		1,710,000

FURTHER ECONOMICAL CONSIDERATIONS

In completion to the calculations previously made and in consideration of the possibilities of export of fish meal the further calculations shall show how the economy could be more efficiently.

For this reason a comparison of a 15 tons-fish meal plant versus a 50 tons fish meal plant is required. To this the costs per 1 ton of fish meal will be compared.

All calculations base on 220 working days per year and 5 tons of raw material for 1 ton of fish meal. It is assumed that the fish meal plant works in 3 shifts and the raw material required is available.

Costs per 1 ton of Fish Meal Of a 15 Ton-Fish Meal Plant.

The annual production capacity of this plant amounts 3 tons of fish meal per 24 hours X 220 working days = 660 tons/yr

1.1 Raw material

The raw material is free of charge as it is by-catch and offal of a loining plant.

1.2 Packing material

$$\frac{\text{1000kg fish meal}}{\text{50kg/paper-bag}} = 20$$

20kg/paper-bag x 1US$/bag = 20US$/ton

1.3 Fixed cost per 1 ton of fish meal

As stipulated in option 2nd the fixed costs with a depreciation of equipment over 10 years and building depreciation over 20 years amounts a total of 180.760 US$/year.

$$\frac{\text{180.760 US\$}}{\text{660 tons}} = \text{273,800US\$/ton}$$

1.4 Variable costs

Electricity: 40kw/t x 5tons of raw material x 0.15US$/kw = 30US$/ton.

Diesel Oil: 55kg/t x 5tons of raw material x 250US$/ton = 68.75US$/ton.

Fresh Water: 10m 3/t x 5tons of raw material x 0.40US$/m 3 = 20US$/ton.

Total = 118,75US$/ton

1.5 Labor Costs = 30US$/ton

1.6 Summary of all costs per 1 ton of fish meal

Raw material	-0-
Packing material	20US$
Fixed costs	274US$
Variable costs	120US$
Labor costs	30US$
Total	444US$

Rounded off 450US$/ton

2. COSTS PER 1 TON F FISH MEAL OF A 50-TONS FISH MEAL PLANT

The annual production capacity of this plant amounts 10 tons of fish meal per 24 hours x 220 working days = 2,200t/year.

2.1 Raw material

It is assumed that the raw material is also free of charge in this calculation.

2.2 Packing material

The costs of packing material are the same like a 15 tons fish meal plant, that is to say 20US$/ton.

2.3 Fixed costs per 1 ton of fish meal

The fixed costs of a 50 tons fish meal plant only differ slight because the investment of such a plant is rather the same like a 15 tons fish meal plant.

$$\frac{227,600\text{US\$}}{2,200\text{tons}} = 103\text{US\$/ton}$$

2.4 Variable costs

Electricity: 60kw/t x 5tons of raw material x 0.15US$/kw = 45US$/ton.

Diesel: 70kg/t x 5tons of raw material x 250US$/t = 87,5US$/ton.

Fresh Water: 15m 3/t x 5tons of raw material x 0.40US$ = 30US$/ton.

Total = 162.50US$/ton

2.5 Labour costs = 30US$/ton

2.6 Summary of all costs per 1 ton of fish meal

Raw material	-0-
Packing material	20US$
Fixed costs	103US$
Variable costs	162US$
Labor costs	30US$
Total	315US$
	Rounded off 320US$/ton

The comparison shows, that the profitability of the product is increasing with the quantity of production because the fixed costs are reducing with the quantity.

Therefore the product, produced in a 40-60-tons fish meal plant is more profitable than the product of a 15 tons fish meal plant, provided the required raw material is available. The annual demand of fish meal in the FSM is projected with about 600 tons in the next few years, that is to say, that a fish meal plant of 15-tons would fulfills this requirement. However due to the small difference of investment between a 15 tons plant and a 40-60-tons one the 40-60-tons plant should be taken into consideration.

This plant has the advantage that an increase of production of fish meal is possible at any time.

Fish meal is dealt at present in the Pacific Area at prices between 660US$ and 730US$ FOB per on tone depending on quality, origin and distance to the supplier. The costs of transport have to be calculated on average with about 200US$/ton, that is to say, that the import-price C & F Pohnpei would be 860 until 950US$/ton. In consideration of an annual demand of about 600 tons of fish meal for livestock feed and a production price of 320US$/ton of fish meal the Government could economize the follwing costs:

600 tons of fish meal x 900US$ (average price of import) =

540,000US$

600 tons of fish meal x 320US$ (production costs) =

192,000US$

Price difference between import and self-made product:

540,000US$ - 192,000 US$ = 348,000US$

The remain of 1,200 tons of fish meal should be exported at an average price of 650US$ FOB Pohnpei.

1,200 tons of fish meal x 330US$ (difference between FOB price and production costs) =

396,000US$

Total profit: 348,000 + 396,000 = 744,000US$

With more favourable prices FOB Pohnpei an increase of profit is possible.

C. Country Meat Production Improvement

In our project, to make calculations, we have considered the average price of imported fishmeal, into the FSM, at US$660 per ton. The present local selling price for fish meal could be reduced through local production which would help improve the economics of raising livestock and result in lower prices of meat. Most likely meat consumption would increase and provide a better diet to the people of the FSM.

6. ENVIRONMENTAL IMPACT STATEMENT

There could be many environmental problems from a fishing industry but these can be minimized by the latest in technology in equipment and processing.

A. Fish waste and by-catch

In the near future many fisheries projects are to be implemented in FSM and all of them could cause environmental problems by not utilizing discarded fish and offals.

To avoid potential pollution the fish meal plant is the sole solution, as all other ways of getting rid of waste create problems.

In any case, waste cannot be dumped on land or within the reef barrier as the tide would bring the waste ashore and result in severe problems.

If fish waste is to be dumped outside the reef barrier it would require the use of a costly garbage boat operation. The thousands of tons of waste dumped would attract sharks and other predators to such an extent any effort to develop tourism including reef diving would fail to succeed. Effort during the past years to develop tourism such as hotels, restaurants, airlines, boat trips, etc. would have been wasted

B. Waste water

When processing raw fish into loins, a mixture of blood, water and oil comes from the fish and goes down into the sewer. It would have to be passed through filters and/or sewage processing plant before being rejected in the sea as clean water. The sizable sewage treatment plants required for such an operation are costly, cause smell and need large land areas for construction. To process water used in cleaning, which is mixed with stick water, a larger water treatment plant is needed. We must consider that a loining plant processing 40-45 tons raw material a day produces as much sewage as a town with 2,000 inhabitants and in addition fish oil requires a special process before waste water treatment starts. Unless treated fish oil would clog sewer pipes over longer periods.

A fish meal plant associated to a processing plant can solve waste water problems as all liquids coming from fish cooking can be strained. Some fish meal plant equipment can recycle water to the point that the resulting clean water can be reinjected into the circuit even to be used in the boiler to produce steam. That way the need for fresh water in the fish meal plant is reduced to practically nothing. This could be very important in places where fresh water is limited.

C. Malodor

Years ago, fish meal plants were well known for their bad smell but nowadays different systems are used to eliminate such nuisance. All quotations now offer equipment for the removal of malodor, which are either included in the price or optional.

Deodorization is no more a problem in fish meal plants and odours are brought down to a very acceptable level inside the building and not perceptible outside.

Besides, by-catch or offals from the loining plant can be processed immediatly and transformed in odorless fish meal

D. Architecture

The fishmeal plant will be about 200 sq.m and a part of the larger processing building. Its architecture will match that of the loining plant which will be much more significant in size and therefore predominant.

As there will not be fumes or oily stain outside the building, it will be easy to keep it clean.

E. General Cleanliness

Raw material for the fish meal plant will be:

By-catch from tuna transshipment.
Waste from the loining plant.

As the by-catch will still be frozen when dumped into the hopper, preceeding the mincer, there will not be any blood dripping or any other waste.

As for the waste from the loining plant, it will be transferred to the hopper, by a screw conveyor, through the wall separating the two plants.

All the fish meal produced by the processing plant will be stored in bags neatly stacked on pallets. The pallets will be brought to the storage area by fork lift and there should not be any spillage around the plant and the surroundings will be clean. The areas surrounding the processing plant could include lawns, trees and flower arrangements to make the environment more attractive.

7. QUALITY CONTROL

To promote the manufacturing of food products the FSM authorities must set up an internationally recognized quality control system. This system should include the control of fish and other sea food products when landed including handling and processing and also cover inspection of equipment and buildings used in the industry. Samples of products have to be taken before and after processing and analysis have to be made to check the sanitary state of the products.

Approving certificates should be issued for all food products before export and included in export procedures.

As far as fish meal is concerned quality certificate will indicate:

Protein content
Fat or oil content
Moisture

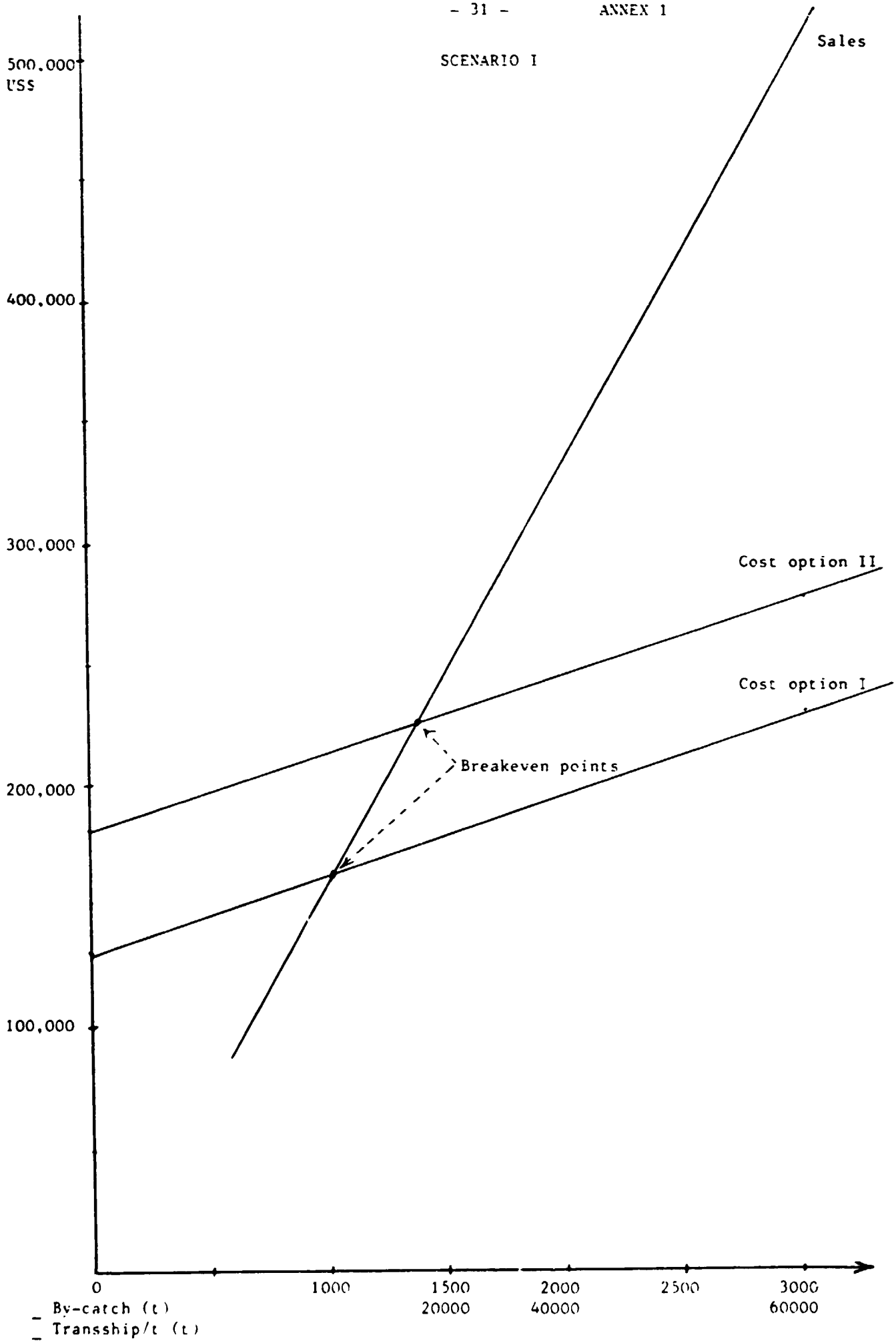
Other information can be provided on request.

All fish meal not meeting international standards should be destroyed or under certain conditions used locally to feed livestock.

First grade products are a must from the start if FSM wants to build up a reputation for export of food products and receive the highest prices.

Beside this official quality control procedures there should be a very simple quality control laboratory included in the plant office building to obtain daily informations about the fishmeal characteristics so that at any time the manager can control the plant production.

SCENARIO I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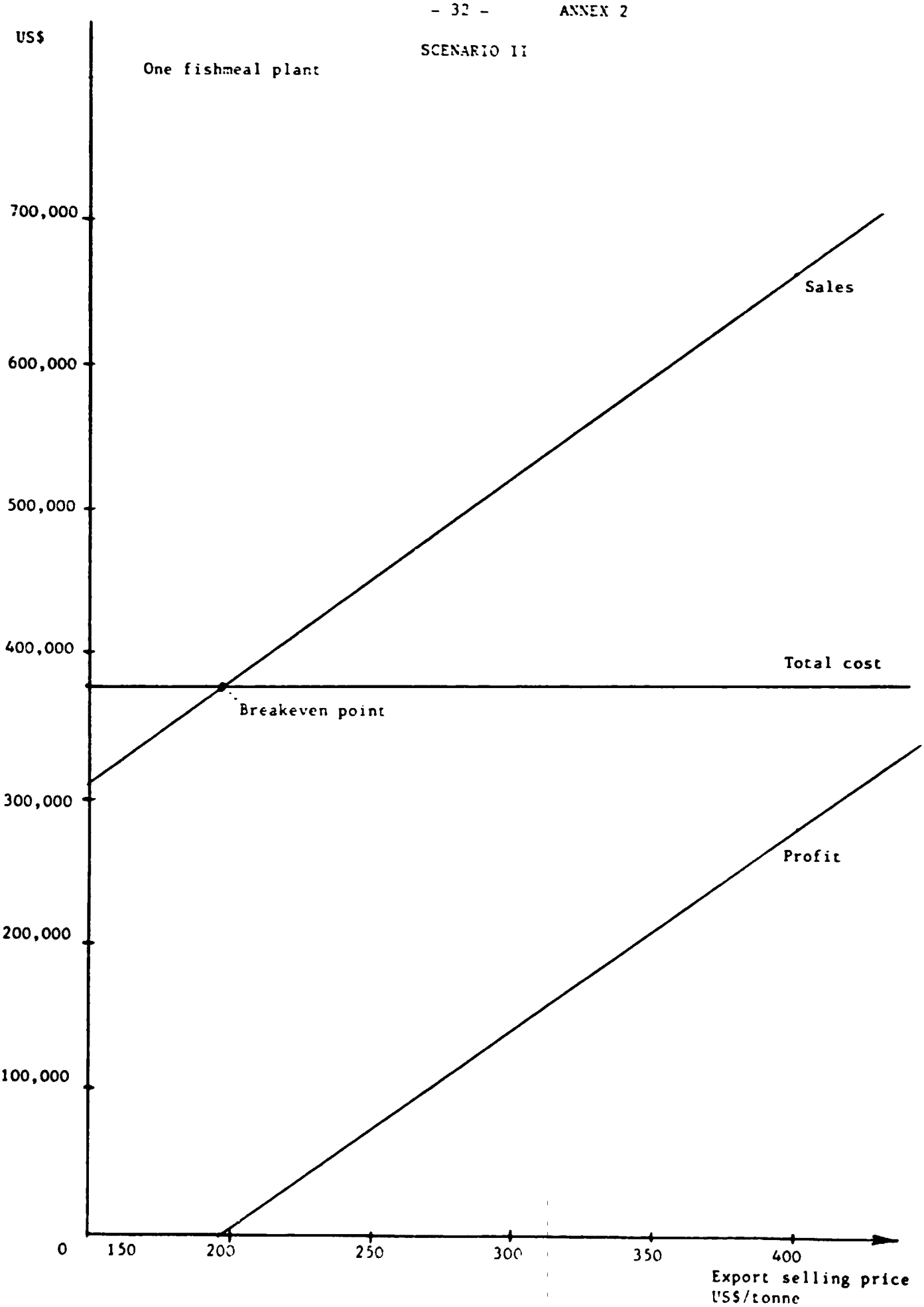
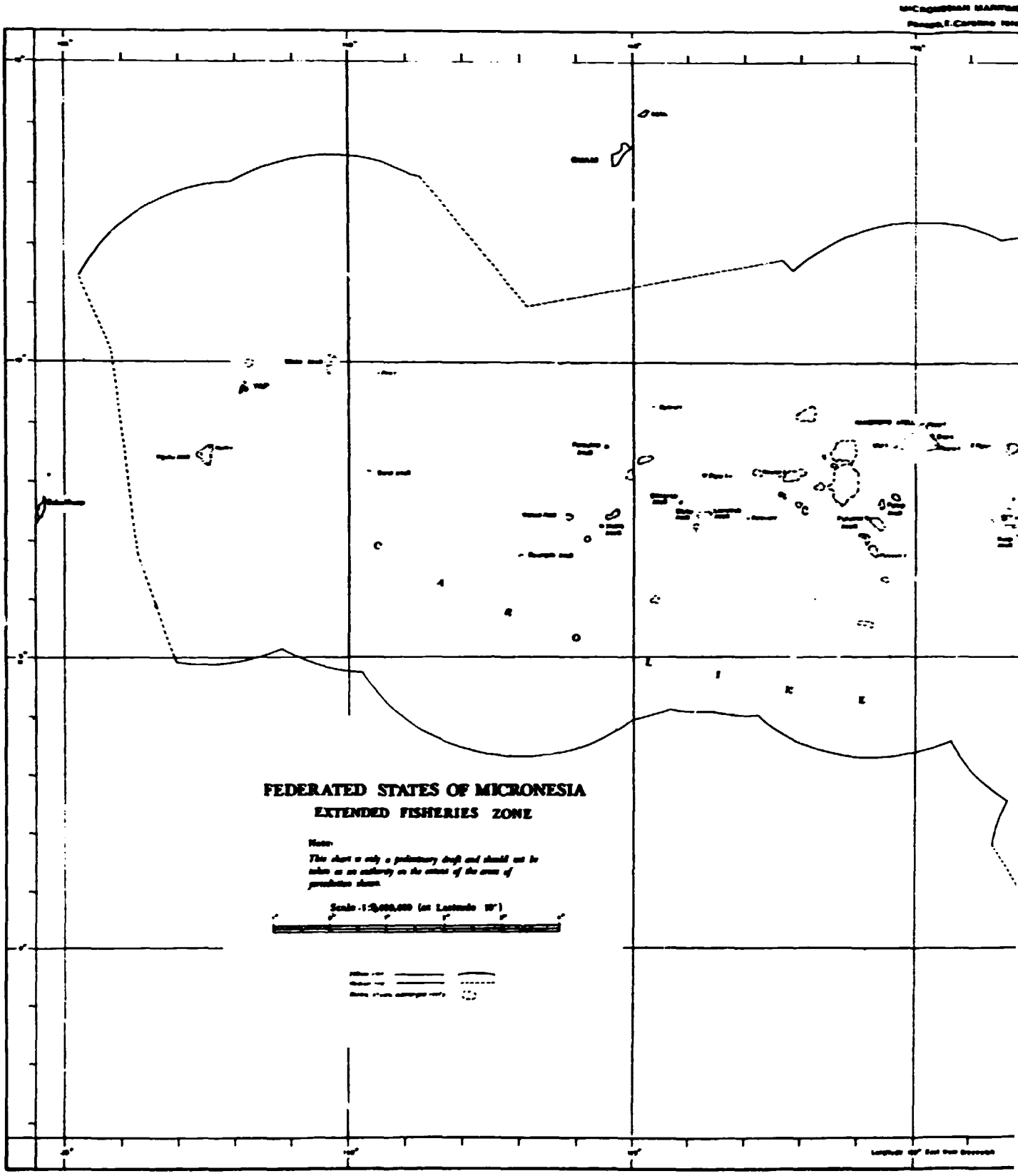
US$
400,000
300,000
Cost option II
Cost option I
Breakeven points
200,000
100,000
0
1000
1500
2000
2500
3000
20000
40000
60000
By-catch (t)
Transship/t (t)

SCENARIO II

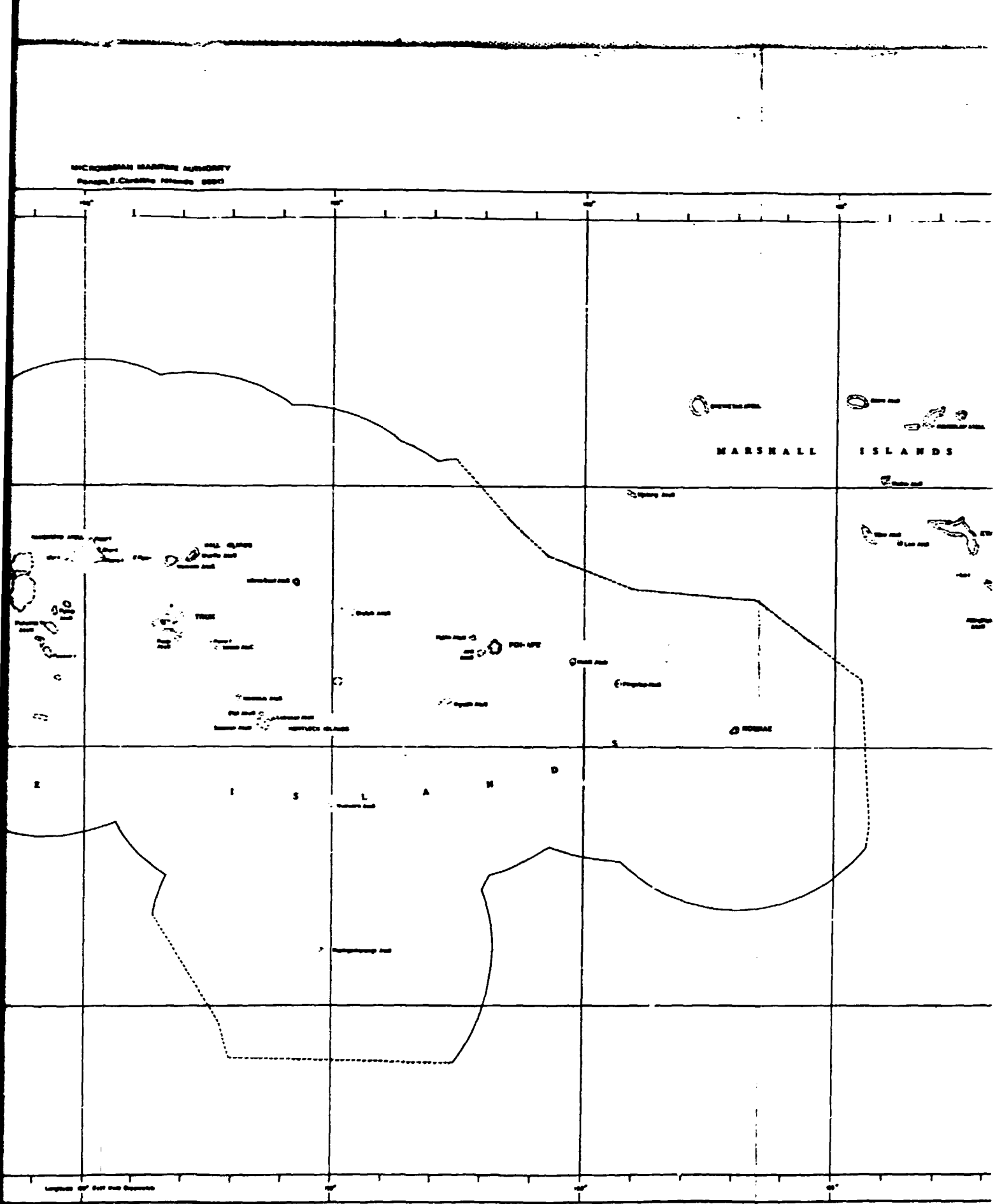
One fishmeal plant



ANNEX 3



SECTION 1



SECTION 2