SUMMARY
THE ADDITIONAL EVALUATION STUDY
FOR
THE ASEAN ROCK SALT-SODA ASH PROJECT
IN
THE KINGDOM OF THAILAND

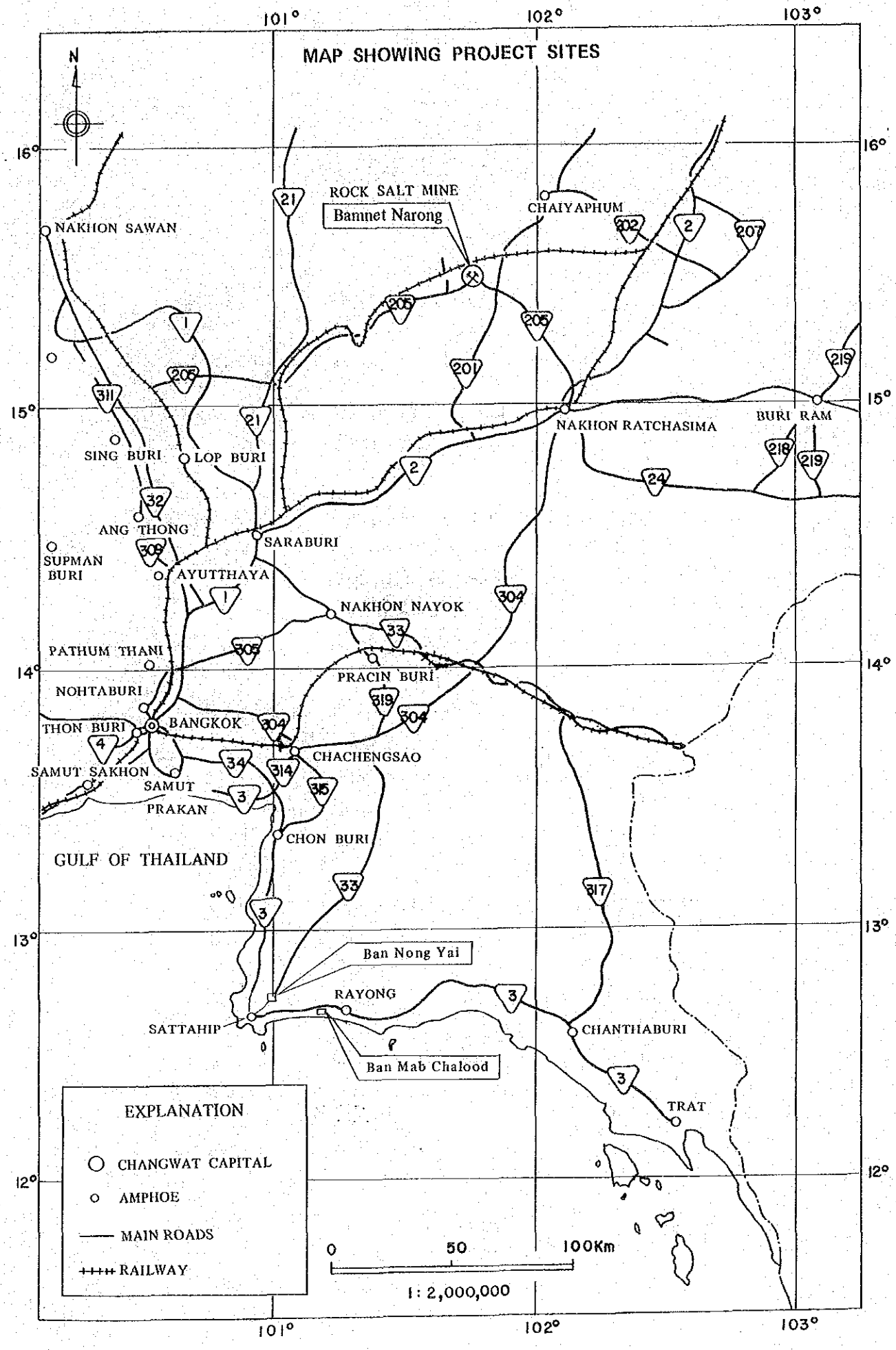
MARCH 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

SUMMARY
THE ADDITIONAL EVALUATION STUDY
FOR
THE ASEAN ROCK SALT-SODA ASH PROJECT
IN
THE KINGDOM OF THAILAND

MARCH 1982

JAPAN INTERNATIONAL COOPERATION AGENCY


MAP SHOWING PROJECT SITES
N
101°
102°
103°
16°
15°
14°
13°
12°
NAKHON SAWAN
ROCK SALT MINE
Bamnet Narong
CHAIYAPHUM
NAKHON RATCHASIMA
BURI RAM
SING BURI
LOP BURI
ANG THONG
SUPMAN BURI
SARABURI
AYUTTHAYA
NAKHON NAYOK
PATHUM THANI
PRACIN BURI
NOHTABURI
THON BURI
BANGKOK
CHACHENGSAO
SAMUT SAKHON
SAMUT PRAKAN
CHON BURI
GULF OF THAILAND
Ban Nong Yai
RAYONG
SATTAHIP
Ban Mab Chalood
CHANTHABURI
TRAT
EXPLANATION
CHANGWAT CAPITAL
AMPHOE
MAIN ROADS
RAILWAY
0
50
100Km
1 : 2,000,000

ABBREVIATIONS ETC.

General

GOT	Government of Thailand
C & F	Cost & Freight
CIF	Cost, Insurance & Freight
FOB	Free on Board
IRR	Internal Rate of Return
B	Baht
MSL	Mean Sea Level

Exchange Rate

US$1 = B20.5 in 1980
US$1 = B23.5 in 1981

Organizations

EGAT	Energy Generation Authority of Thailand
IEAT	Industrial Estate Authority of Thailand
NEB	National Environment Board
PAT	Port Authority of Thailand
PEA	Provincial Electricity Authority
PTT	Petroleum Authority of Thailand
TSR	Thai State Railway

Units

KVA	Kilovolt-ampere
KW	Kilowatt
KWH	Kilowatt-hour
MW	Megawatt (Million Watt)
MMBTU	Million BTU (MM = million, M = thousand)
MSCFD	Thousand SCF per Day
MSCF	Thousand SCF
QUEN	1,500 kg
RAI	0.16 ha
SCF	Standard Cubic Feet, 1SCF = 0.0283 Nm^3
SCFD	Standard Cubic Feet per Day
M/T, t	Metric Ton
T/Y, t/y	Ton per Year

Products

AC	Ammonium Chloride
K	Potash
MSG	Monosodium Glutamate
N	Nitrogen
P	Phosphate

TABLE OF CONTENTS

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

1. STUDY OBJECTIVE

1–1 Background

The Japan International Cooperation Agency (JICA) submitted its report "Evaluation Study Report for ASEAN Rock Salt – Soda Ash Project in the Kingdom of Thailand" to the Government of Thailand (GOT) in March, 1981. Thereafter, the GOT, at the recommendation of the Committee on the Development of Heavy Industries in the Eastern Seaboard, of which the Prime Minister was the Chairman, decided that either of the following two locations was to be selected as the location of the soda ash plant:

(1) Ban Mab Chalood* (Rayong Province)
(2) Ban Nong Yai (Chonburi Province)
* including Mab Ta Phud

Subsequently, the GOT requested the Government of Japan (GOJ) to undertake an additional study of technical and economic aspects of the two locations (September, 1981).

For this purpose, JICA dispatched the preliminary study mission to Thailand in order to confirm the reason why Thailand is unable to select one of two candidate sites to be the location for the soda ash plant and to determine the scope of the additional study, by which the study is limited to assess the location study by direct factors such as technical and economical points of views and not by indirect factors such as political and social impact factors. The Minutes of Meetings held with the Thai counterparts team were signed and JICA study team was dispatched to Thailand in November 1981.

The Minutes of Meetings and Interim Report submitted by the study team are provided hereunder as APPENDIX–I.

1–2 Objective and Scope of Study

The Minutes of Meetings indicates that the objective of the study is to be as follows.

(1) The study would comprise a technical and economic evaluation of the two locations, in order to obtain data which will be used by the GOT, in conjunction with other selection criteria, to select the location of the plant site.

(2) On the basis of the "Evaluation Study Report for ASEAN Rock Salt – Soda Ash Project in The Kingdom of Thailand" of March, 1981, investigation of the

following would be undertaken at the proposed plant sites, in order to evaluate the sites from the viewpoint of technical and economic feasibility of their use.

1) Locational conditions
2) Conceptual design of the plant and related facilities
3) Estimation of the required investment, and preparation of the financial plan
4) Financial and economic analysis
5) Comparison of the two sites

2. ASSUMPTIONS FOR THE STUDY

For studying the technical and economic aspects of the two potential sites, it is assumed that the GOT adopts the following four basic policies.

(1) Supply of utilities and related infrastructure is to be made by the GOT to each site in equal manner.

(2) Sattahip is to be used as the harbor in the cases of both potential sites, and the GOT will develop Sattahip as a Deep Sea Port by the time the soda ash plant begins operation.

(3) An adequate land area is to be available at Sattahip, for the warehouse, storage and material handling facilities required for the project. (Study was also made of the case wherein such land area is not available.)

(4) According to the Supplementary Agreement of the ASEAN Rock Salt – Soda Ash Project (Thailand) initialled at the 12th meeting of ASEAN Economic Ministers, the Thai Shareholders Entity will be responsible for off-taking the total amount of ammonium chloride produced from the soda ash plant and surplus rock salt produced at the rock salt mine based on three shift operation. The transfer price of the rock salt output of 1.8 million metric tons shall be to attain an Internal Rate of Return on Investment after tax of 12.7% for the Rock Salt Mine.

The selling price of ammonium chloride to be paid by the Thai Shareholders Entity shall be based on the import parity price of urea from the ASEAN Urea Projects of Indonesia and Malaysia multiplied by the proportional nitrogen contents.

3. FORMULATION OF THE ALTERNATIVE CASES FOR STUDY

In addition to the alternative choice of plant site location, there is a choice to be made regarding the source of supply of ammonia. The alternative cases for study have been defined as follows in view of this situation.

3–1 Ammonia Supply Source and Price

The soda ash plant will require about 130,000 T/Y of ammonia, as a raw material. There is no source of supply in Thailand, but at present the GOT is negotiating with a group of private firms of other countries for establishment of a joint venture for a fertilizer complex project which would utilize natural gas from the Gulf of Thailand and would include ammonia among its products.

Therefore, while ammonia may be imported possibly from a natural gas based fertilizer plant in Indonesia, it may be possible to obtain a supply of ammonia from this source.

For this Study, the following two alternatives were compared:

(1) Importation from Indonesia (or elsewhere)
(2) Supply from the proposed fertilizer complex

It should be noted that ammonia will be purchased at the price of US$235/ton(1985 price) whether imported or locally produced in accordance with the Supplementary Agreement.

3–2 Case Studies

The following matrix represents the combination of alternatives studied and their designations used in the study report.

Ammonia Source / Plant Site	Importation	Domestic (Fertilizer Project)
Ban Mab Chalood	BMCI	BMCD
Ban Nong Yai	BNYI	BNYD

4. PROJECT OUTLINE

4–1 Rock Salt Mine

(1) Proposed mine site: Bamnet Narong (225 km NE of Bangkok)

(2) Mining method: Room and pillar method

(3) Scale of mine production: 1.8 million T/Y (2,000 T/D per each 8-hour shift; working three shifts, 300 work days a year.)

(4) Utilities: Power to be supplied by EGAT/PEA, water to be supplied from a swamp in the general vicinity of the mine.

(5) Destination and method of shipments: 1.8 million T/Y is to be shipped by rail to the destinations as shown below.

Destination	Annual Quantity	Distance from Mine (km)
Soda Ash Plant	600,000	
Ban Mab Chalood		493.8
Ban Nong Yai		480.0
Exports	1,000,000	
Sattahip Port		485.5
Domestic Market	200,000	
Bangkok		291.5

(6) Others: According to the GOT's indication, the housing facilities shall be excluded from the scope of the rock salt mine portion of the Project.

4–2 Soda Ash Plant

(1) Proposed plant site: Ban Mab Chalood (Rayong Province) or Ban Nong Yai (Chonburi Province).

(2) Soda ash production process and scale of production: Full Ammonium Chloride Process; 400,000 T/Y of each of soda ash and ammonium chloride.

(3) Required raw materials and utilities supply:

Raw Material	Consumption per ton of soda ash produced	Required Annual Amount
Salt (100% NaCl)	1,371 kg	548,400 t
Ammonia	320 kg	128,000 t
Carbon dioxide gas	332 Nm^3	132,800 Nm^3
Quicklime	46 kg	18,400 t
Caustic soda (or soda ash)	42 kg (60 kg)	16,800 t (24,000 t)

Utilities	Consumption per ton of soda ash produced	Required Annual Amount
Power	496 KWH	198.4 MWH
Water	25.6 m^3	10.24 MMm^3
Fuel Natural Gas (Fuel Oil)	5.3 SCF (0.208 m^3)	2.11 MMSCF (83.2 Mm^3)

(4) Raw materials and utilities, and their transportation and receiving method:

1) Rock salt: A rock salt storage yard is to be provided within the soda ash plant site, and hopper wagons are to be used to transport rock salt from the mine to the storage yard.

2) Carbon dioxide gas: To be supplied by a pipeline from the PTT gas processing plant in Mab Ta Phud to the soda ash plant, with both the compressor installed at the PTT end and the pipeline deemed to be part the present Project.

3) Ammonia: For this study, two alternatives are conceivable; importation of ammonia from Indonesia, and acquisition from a new fertilizer complex to be built in Thailand.

In the case of importation, ammonia receiving storage facilities are to be constructed at Sattahip Deep Sea Port and ammonia is to be unloaded by means of a pump aboard the ammonia tanker and an unloading arm installed as part of the port facilities provided within the scope of this Pro-

ject. The ammonia is to be conveyed by a pipeline to the soda ash plant site at whichever location is selected.

In the case of domestic production, ammonia should be pumped from the fertilizer complex to the soda ash plant at the expense of the Project, but in the event that the soda ash plant is located at Ban Mab Chalood, use can be made of the latter's storage facilities and in the Ban Nong Yai case, it is not possible to use the fertilizer complex's storage, so a storage facility is to be constructed within the soda ash plant site. In either event, the buffer tank will be constructed within the soda ash plant site.

4) Quicklime: To be purchased from local producers.

5) Caustic soda (Soda ash): Soda ash produced in the plant is to be used. (Caustic soda shall be used at initial start-up.)

6) Power: PEA/EGAT will supply 230kv power to the boundary of the plant site.

7) Water: The Royal Irrigation Department (RID) will construct intake facilities at the reservoir at Dok Krai, and a pipeline from there to the Rayong area. Water will be supplied to each plant's boundary line from a storage pond in Rayong.

8) Natural gas: Natural gas will be supplied by a pipeline from the PTT to each plant site boundary.

(5) Products shipping facilities

The quantity and form of products to be shipped are as follows.

Product	Annual quantity	Form
Soda ash	400,000 t	Bulk Bagged
Ammonium chloride	400,000 t	Bagged (using large size bags to be returned after delivery)
Rock salt	1,000,000 t	Bulk

These products are to be shipped to domestic markets and to export markets.

For bulk products, rock salt and soda ash are transported by railway from the mine and the soda ash plant respectively to the storage facilities in the Sattahip Deep Sea Port. From there, they are transported by belt conveyors to the ship loader on the pier for loading.

For the shipment of bagged products to domestic market, they will be moved by belt conveyors from the storage points in the plant to trucks and/or freight cars. In the case of export, the bagged products are to be moved by trucks and/or freight cars to the storage facilities in the Port. Trucks will be used to transport bagged products to the pier, where the ship's derricks will be used for loading to the ship.

(6) Infrastructure

1) Railway:

Rock salt will be transported by rail from the mine to the soda ash plant, and the port of shipment, Sattahip. Soda ash produced at the plant will be transported by rail to Sattahip, from which it will be exported.

The following facilities are included in this Project.

1.	Rock salt mine railway spur	5.7 km
2.	Soda ash plant railway spur	
	Ban Mab Chalood	0.8 km
	Ban Nong Yai	5.0 km

The required number of locomotives and hopper wagons, to be supplied by the GOT, are as follows.

1.	Main locomotive	9 cars
2.	Marshaling locomotives	3 cars
3.	Hopper wagons for rock salt	184 cars
4.	Hopper wagons for sada ash	18 cars

The specifications for hopper wagons for rock salt and for soda ash are to be identical.

In addition to make use of existing railway lines, it will be necessary to make use of the following lines which are now either being constructed or planned.

1. Chachengsao – Sattahip (under construction; estimated date of completion, end of 1983).
2. Phu Ta Luang – Rayong (being planned; the GOT expects construction will be completed during 1985).

2) Port and harbor

Assuming that the Sattahip Deep Sea Port, which the GOT has decided to construct, is completed and ready for use by the time that this Project begins functioning, its facilities shall be used. Even in this event, the installation and construction of facilities for storage, bulk materials loading, belt conveyors and ship loaders are to be a part of the present Project.

(7) Implementation schedule of the Project

The commercial operation of the Project is assumed to be commenced by the middle of 1985.

5. LOCATIONAL CONDITIONS AT THE TWO PROPOSED SODA ASH PLANT SITES

5–1 Ban Mab Chalood

At Ban Mab Chalood, there are existing facilities in the form of the PTT Dew Point Control Unit, and it is planned that a PTT gas separation plant and a fertilizer complex will be constructed here in connection with Eastern Seaboard Development Plan through establishment of an industrial estate for heavy industry. This area is between the National Highway No. 3 and the shore line facing the Gulf of Thailand. It is 31 km from Sattahip (see Figure 1).

5–2 Ban Nong Yai

Ban Nong Yai is located adjacent to the National Highway No. 3 on the north side, 8 km from the Sattahip Deep Sea Port. The area is inland from the Gulf and in the military safety zone. Permission for the use of the land has been obtained from the Thai Navy. For disposal of waste effluents, the site is 5km by the shortest direct line to the Gulf, traversing the site of Navy installations (see Figure 1).

5–3 Physiographical and Geological Features at Each Site

Ban Mab Chalood is level land, with elevations varying by 5–6m from low to high points.

Ban Nong Yai is also level, fan-shaped and surrounded by hills of about 200m high.

Physiographically and geologically there is essentially no difference between the two sites. That is, the surface soil is about 0.3m thick and contains organic matter, below which there are alternating layers of sandy soil and sandy silt to about 30.0m below MSL, after which rock is encountered.

Therefore it is judged that it will not be necessary to drive piles for the plant foundation at either site.

6. CONCEPTUAL DESIGN OF PLANT FACILITIES AT THE ALTERNATE SITES

6–1 Introduction

The facilities required for the plant may be divided into the following three general categories.

(1) Process plant facilities
(2) Utilities facilities
(3) Off-site facilities

Details on requirements for process plant facilities and utilities facilities are provided in Table 1. Details for off-site facilities are provided in Table 2.

Requirements for process plant facilities and utilities facilities are identical to those determined by the Previous Report, and are the same for either site now under consideration.

6–2 Process Plant

The plant is to be designed for the Full Ammonium Chloride Process, and to have production capacity of 1,200 T/D of soda ash, and 1,200 T/D of ammonium chloride as a byproduct.

6–3 Utilities Facilities

The following are included as utilities facilities

(1) Water treatment facilities
(2) Power receiving facilities
(3) Cooling tower facilities
(4) Boiler facilities
(5) Instrumentation and plant air facilities
(6) Emergency power generating facilities
(7) Waste water treatment facilities

6–4 Off-Site Facilities

The common facilities and off-site buildings and structures as listed in item 3.2 and 3.3 in Table 1 are the same at whichever of the two site locations. However, raw materials and products handling facilities are different. Yet, the following export related facilities will be the same for both sites.

(1) Within the soda ash plant site

1) Soda ash storage facilities (4 silos of 4,000 tons each)
2) Soda ash hopper wagon loading facilities

(2) At Sattahip Deep Sea Port

1) Rock salt hopper wagon unloading facilities
2) Soda ash hopper wagon unloading facilities
3) Rock salt storage facilities (50,000 T capacity)
4) Soda ash storage facilities (5 silos of 4,000 tons each)
5) Rock salt belt conveyor
6) Soda ash belt conveyor
7) Ship loader

6--5 Conceptual Design of Off-Site Facilities for Each Location

As shown in Table 2, the items for which substantial differences exist are the following.

	Ban Mab Chalood (BMC)		Ban Nong Yai (BNY)	
	Ammonia imported	Ammonia domestically produced	Ammonia imported	Ammonia domestically produced
Length of carbon dioxide pipeline (m)	1,000	1,000	24,000	24,000
Ammonium storage capacity (ton)				
— Plant site	500	500	500	1,000
— Sattahip	5,000	—	5,000	—
Length of ammonia pipeline (m)	31,000	1,000	8,000	23,000
Length of waste water ditch (m)	1,000	1,000	5,000	5,000
Length of railway siding (m)	800	800	5,000	5,000

As is shown in the above table, in the event that ammonia is imported, ammonia storage capacity for 5,000 tons at the Sattahip Deep Sea Port would be required. In addition, there would be a difference in the length of ammonia pipeline required for different cases.

7. ESTIMATION OF CAPITAL REQUIREMENT

7–1 Difference in Capital Requirement for the Soda Ash Plant for Each Alternative

For the alternatives under consideration, the capital requirement for the rock salt mine remains the same. A difference exists only in regard to the soda ash plant, and in particular the off-site facilities. The differences among the alternatives, therefore, are as shown below (taking up only the soda ash plant).

Capital Requirement for The Soda Ash Plant in Each Alternative Plan
(Excluding interest during construction)

(Unit: US$1,000)

Case	Foreign Currency	Domestic Currency	Total
BMCD	222,693	82,207	304,900
BMCI	240,362	85,358	325,700
BNYD	229,226	90,129	319,355
BNYI	232,944	90,576	323,520

From the above, the capital requirement is lower in the case of acquiring ammonia from the proposed fertilizer plant as compared to importing the ammonia.

Regarding the difference between the two possible locations, in the event that a domestic supply of ammonia is used, siting the soda ash plant at Ban Mab Chalood requires less capital investment, whereas in the case of importation of ammonia, Ban Nong Yai siting requires less investment.

7–2 Total Capital Requirement for the Entire Project

The total capital requirement for the entire Project, including both the rock salt mine and the soda ash plant, has been calculated using three rates of interest, namely 4%, 5% and 6% per annum, with the results as shown in Table 3.

8. FINANCIAL ANALYSIS

8–1 Base Data for Financial Analysis

(1) Sales price: (1985 prices)

Soda ash	US$225/T (Ex-factory price to Thailand)*
Ammonium chloride	US$150/T (Ex-factory price to Thailand)*
Rock salt	US$11.42/T (Ex-mine price)**

Notes: * For soda ash to be exported to ASEAN countries (except Thailand), the prices as shown below (estimated on the basis of CIF competitive price in each destination) are used.

Destination	CIF Price	(US$/ton) Ocean Freight
Thailand	225	–
Singapore	229	15
Malaysia	230	17
Indonesia	229	19
Philippines	225	23

** Ex-mine price calculated on the basis of the Supplementary Agreement for the ASEAN Rock Salt – Soda Ash Project (Thailand).

(2) Raw materials and utilities prices:

	1980 Prices	1985 Prices
Ammonia (imported or locally produced)	–	US$235/T
Carbon dioxide gas	–	0
Quicklime	US$20/T	US$ 28/T
Soda ash	–	US$225/T
Power	US$0.076/KWH*	US$0.092/KWH
Water	US$0.08/$m^3$	US$0.108/$m^3$
Natural gas	–	US$4.6/MMBTU (fuel oil equivalent, US$181.6/$m^3$)

Note: * 1981 price

(3) Railway freight

	1981 Rate	1985 Rate
Rock Salt		
B.N.*–Sattahip	US$8.38/T	US$10.19/T
B.N.*–BMC	US$8.52/T	US$10.36/T
B.N.*–BNY	US$8.23/T	US$10.00/T
Soda Ash		
BMC–Sattahip BNY–Sattahip	US$0.7/T	US$ 0.85/T

Note: * Bamnet Narong

(4) Assumptions

Corporate tax	:	Waived for 8 years, thereafter 40% of taxable income
Import duty, business tax	:	Waived
Depreciation and amortization	:	Straight-line method for 15 years, with zero salvage value
Terms and conditions of loan	:	Grace period, 3 years; repayment over the period of 15 years; interest rates: 4%, 5%, 6%

8–2 Rock Salt Mine

As per the Supplementary Agreement for the Project, the rock salt mine will have a production capacity of 1.8 million tons/year and the product rock salt shall be off-taken by the soda ash plant and the Thai Rock Salt – Soda Ash Shareholders Entity at the price set forth to attain Internal Rate of Return on Investment (IRROI) after tax of 12.7% of the rock salt mine.

This price is assessed through the sensitivity analysis of IRROI varying the sales price of rock salt to find followings:

Production Capacity of the Mine (t/y)	Sales Price at Ex-Mine (US$/ton)
1,800,000	11.42
1,200,000	15.72

8–3 Soda Ash Plant

The IRROI for each alternative are shown below.

Case	Internal Rate of Return (IRR, %) for Each Alternative (Soda Ash Plant)	
	Before Tax	After Tax
BMCD	10.01	8.97
BMCI	8.90	7.93
BNYD	9.30	8.31
BNYI	9.09	8.11

The difference in IRROI principally stems from differences in capital requirement. In the case of domestic production of ammonia siting the soda ash plant at Ban Mab Chalood provides a higher IRR, whereas in the case of importation of ammonia Ban Nong Yai siting gives higher IRROI.

8–4 Entire Project

The Internal Rate of Return for the entire Project, including the rock salt mine and the soda ash plant, are as follows,

Case	Internal Rate of Return (IRR, %) for Entire Project	
	Before Tax	After Tax
BMCD	10.02	8.94
BMCI	9.07	8.04
BNYD	9.42	8.37
BNYI	9.24	8.20

The results for the entire project demonstrate the same ranking as in the case of the soda ash plant alone, for the reason that the rock salt mine does not differ case to case.

For the alternative case of producing 1.2 million tons/year of rock salt, following results are obtained.

(1) Ex-mine price of rock salt: US$15.72/ton
(at IRROI after tax of the rock salt mine 12.7%)

(2) IRROI (%)

Case	Before Tax	After Tax
BMCD	9.45	8.37
BMCI	8.51	7.50
BNYD	8.86	7.82
BNYI	8.67	7.65

9. CONCLUSION

9–1 Comparison of Alternatives

(1) Ranking in order of capital requirements (excluding interest during construction) and internal rate of return is shown below.

Rank	Case	Capital Req't (US$1,000)	Internal Rate of Return After Tax (%)
1	BMCD	355,546	8.94
2	BNYD	370,001	8.37
3	BNYI	374,166	8.20
4	BMCI	376,366	8.04

The requirement for ammonia transport and storage costs would be lower in the case where ammonia is supplied from the proposed fertilizer complex. Consequently the IRROI for the said alternatives is higher than those where ammonia is imported.

From the above, it can be concluded that, in the case of importation of ammonia, siting of the soda ash plant at Ban Nong Yai is preferable, whereas in the case of ammonia supply from the proposed fertilizer plant, Ban Mab Chalood siting is preferable.

(2) In all cases, the IRROI after tax for the entire project is higher than the minimum 8% requirement for the ASEAN Industrial Projects set by the ASEAN Economic Ministers.

(3) In any case in order to be able to implement this Project, it is essential to install storage facilities for rock salt and soda ash at Sattahip Deep Sea Port.

In case that such facilities could not be provided at the Port, it is not possible to select Ban Mab Chalood as a soda ash plant site. Alternatively, however, Ban Nong Yai site could possibly be used, by installing one each belt conveyor for rock salt and soda ash for direct loading from the plant to ships berthed at the Sattahip Port.

In such a case construction cost for these belt conveyors, in 1985 price, is estimated as follows.

	(Unit: US$1,000)
Foreign currency	48,327
Domestic currency	10,020
Total	58,347

This increase in construction cost would substantially reduce the IRROI to an unacceptable level as follows:

	Base Case	Alternative Case
Case BNYD	8.37%	5.5%
Case BNYI	8.20%	5.4%

This indicates the necessity for the government to provide the rock salt and soda ash storage facilities at Sattahip Deep Sea Port. In view of the large amount of rock salt and soda ash to be exported to the ASEAN and the non-ASEAN countries, it is also imperative in all cases that the Sattahip Port be expanded.

(4) In view of the fact that water, power and natural gas will be supplied to the Plant by the GOT, the choice in siting the soda ash plant should take into account the differences in the delivery distances for these utilities as shown below:

Distances from the Main Utilities Systems to the Battery Limit of the Soda Ash Plant

	Ban Mab Chalood	Ban Nong Yai
Water pipeline (m)	3,000	3,000
Power cable (m)	2,000	24,000
Natural gas pipeline (m)	1,000	24,000

9–2 Evaluation of the Project

Evaluation of the Project shows that the Project is technically and financially feasible, however, the GOT has to undertake followings:

(1) Sattahip Deep Sea Port expansion must be completed by the time this Project begins operations.

(2) The water and power supply projects must be implemented in parallel to construction work for this Project.

(3) Facilities for transport of rock salt and soda ash (locomotives, hopper wagons, extension of railway line) must be provided in time before the Project become operational.

(4) There must be a guarantee that carbon dioxide gas will be supplied from PTT gas separation plant free of charge.

(5) A source of supply of ammonia price according to the Supplemental Agreement of the ASEAN Rock Salt – Soda Ash Project (Thailand), must be assured before the Project is implemented.

(6) Low-priced supply of natural gas from PTT must be assured.

10. RECOMMENDATIONS

This project is extremely dependent on external factors. That is,

(1) Port and harbor facilities: It is dependent on completion of the Sattahip Deep Sea Port project.

(2) Fuel: Natural gas must be supplied by a pipeline from PTT facilities.

(3) Rock salt (and caustic soda) rail transport: In addition to relying on the use of locomotives and hopper wagons owned by the national railway, in the event that the plant site is at Ban Mab Chalood the Project must also rely on a new line laid between Phu Ta Luang and Rayong. (It is assumed that the line between Chachengsao and Sattahip, now under construction, is completed as planned.)

(4) Water: The Project must rely on water intake by RID and water supply by IEAT.

(5) Power: The Project must rely on power generation by EGAT/PEA and power supply by IEAT.

(6) Ammonia: The Project must rely on either importation or supply from the fertilizer complex now being planned.

As a consequence of this dependence on external factors,

(1) It is advisable that a project company be established as soon as to take over the Project from the Thai Shareholders Entity.

(2) Overall coordination with the proposed fertilizer project is necessary, not only because of the question of ammonia supply but also of the competitive relationship between the products of the two projects.

TO BANGKOK

N

TO WATER RESERVOIR

TO BANGKOK

RESIDENTIAL ZONE

GREEN BELT ZONE

WATER WORKS

230kv POWER LINE

INSTITUTE ZONE

PTT GAS PROCESSING PLANT

SUBSTATION

WASTE WATER TREATMENT PLANT

POND

INDUSTRIAL ZONE

RESIDENTIAL ZONE

ROUTE 3

RAIL WAY

NEW ROAD

PROPOSED BAN MAB CHALOOD SITE

INDUSTRIAL ZONE

PROPOSED FERTILIZER PLAWT

GREEN BELT ZONE

TO RAYONG

ROUTE 3

PROPOSED BAN NONG YAI SITE

MILITARY RESERVTION

(U TAPHAO AIRFIELD)

TOWN

TOWN

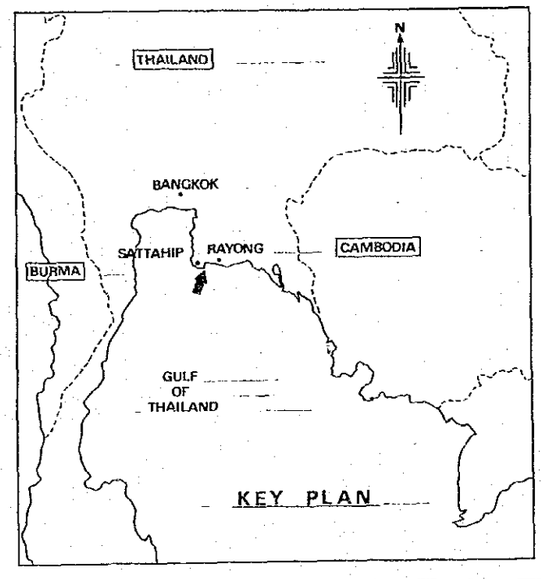
SATTAHIP CITY

SATTAHIP COMMERCIAL PORT

GAS PIPELINE

GULF OF THAILAND

0 1 2 3 4 5 KM



THE ASEAN ROCK SALT · SODA ASH PROJECT IN THAILAND

LOCATION OF THE TWO PROPOSED SITES

JICA

FIG. 1

N

ROYAL THAI NAVY RESERVATION

BAGGED SODA ASH PRODUCT WAREHOUSE

ROYAL THAI NAVY BOUNDARY

ROCK SALT STORAGE YARD

BULK STOCK YARDS

SILO

DIKE

IMPORT AMMONIA PIPELINE

TO PLANT SITE

BOUNDARY

RAIL WAY

BULK EXPORT/IMPORT BERTHS

IMPORTED AMMONIA STORAGE TANK

BERTH FOR THE ASEAN R/S, S/A PROJECT

BULK STOCK YARDS

MSL−14.5m

TAPIOCA/MAIZE BERTHS

TAPIOCA/MAIZE STORAGE AREA

TRUCK UNLOADING AREA

AREA FOR LIGHT INDUSTRIES AND WAREHOUSING

LIGHTER BERTH

MSL−6.0m

TAG PENS

MARINE OPERATORS

BULK BERTHS

TURNING BASIN

600m

PORT CONTROL

TERMINAL OPERATORS

WAREHOUSE

BULK MATERIAL STOCK PILE AREA

BULK BERTHS

ROAD

PORT SERVICE BUILDINGS

KOMO ISLAND

MSL−14.5m

TO STORAGE YARD

BREAK WATER

OIL PIPELINE

OIL JETTY

GULF OF THAILAND

APPROACH CHANNEL

MSL−14.5m

PLAN

0 100 200 300 400 500M

700TON/HR. CAPACITY UNLOADER

▽MSL+3.5m

30.000DWT VESSEL

▽MSL±0.0m

▽MSL−14.5m

SIDE VEIW OF BERTH

0 10 20 30M

THE ASEAN ROCK SALT·SODA ASH PROJECT IN THAILAND

THE PROJECT AREA IN SATTAHIP COMMERCIAL PORT

JICA

FIG. 2

FIG. 3 SENSITIVITY ANALYSIS (CASE: BMCD)

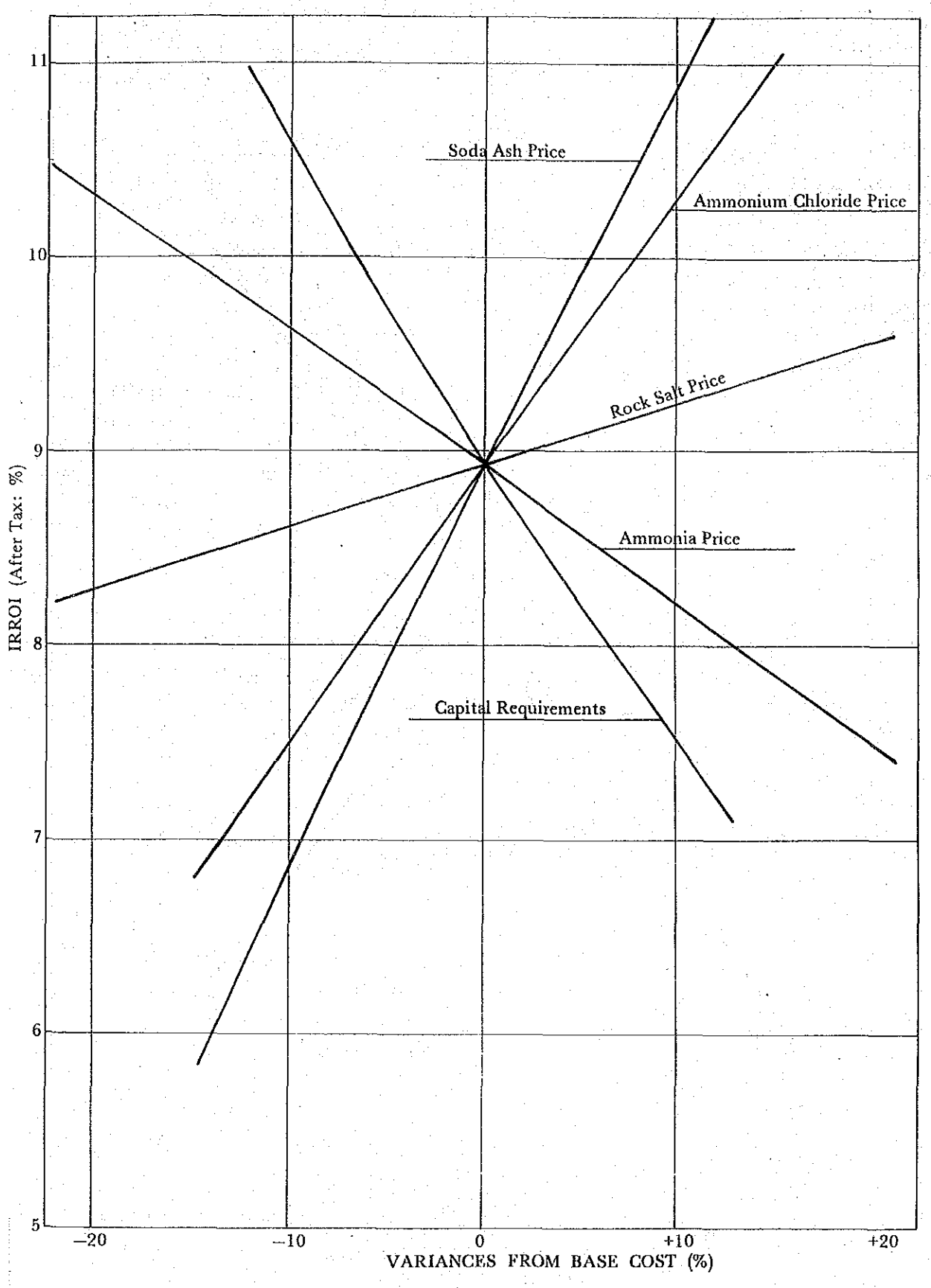


FIG. 4 SENSITIVITY ANALYSIS (CASE: BNYI)

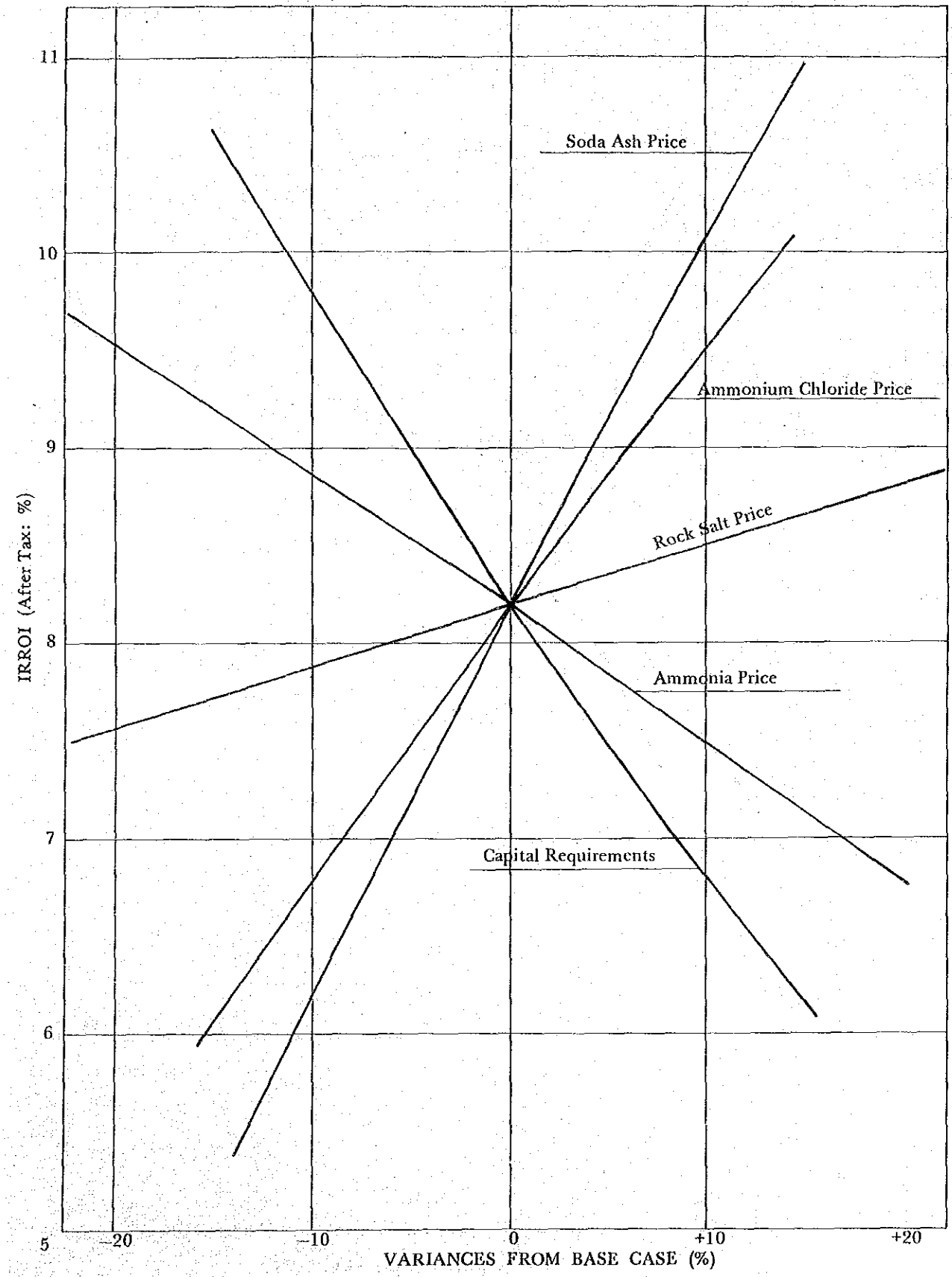


TABLE 1 FACILITIES INCLUDED IN THE PROJECT SCOPE

Facilities			Rated Capacity
1.	Process Plants	Soda Ash	1,200 t/d
		Ammonium Chloride	1,200 t/d
2.	Utilities Plants		
	1) Demineralizer		880 m^3/h
	2) Main substation		20,000 KW
			(25,000 KVA)
	3) Cooling tower		8,000 m^3/h
	4) Steam boilers		55 t/d x 2 sets
	5) Instrument and plant air		960 Nm^3/h
	6) Emergency diesel generator		750 KW
	7) Effluent treatment		
	8) Utilities distribution		
3.	Off-site Facilities		
3.1	Raw materials and products handling and storage		
	See Table 2		
3.2	Common Facilities		
	1) Equipment and machines for maintenance and workshops		
	2) Equipment for laboratories		
	3) Drinking water and fire-fighting system		
	4) Intercommunication system		
	5) Lighting and lightening system		
	6) Miscellaneous equipment and machines for common facilities		
3.3	Off-site Building and Structures		
			Total Floor Area
	1) Maintenance shop		1,680 m^2
	2) Laboratory		360 m^2
	3) Local laboratories	30 m^2 x 5	
	4) Gatehouses	50 m^2 x 2	
	5) Garage		150 m^2
	6) Administration office		1,250 m^2
	7) Cafeteria and locker room		1,400 m^2
	8) Warehouses	1,400 m^2 x 2	
	9) Workshop		2,000 m^2
	10) First aid house		200 m^2
	11) Maintenance and engineering office		1,000 m^2
	12) Fencing	as required	
3.4	Utilities during construction	as required	

TABLE 2 SHORT SPECIFICATION OF OFF-SITE FACILITIES

Item	Laem Chabang	Ban Nong Yai		Ban Mab Chalood	
		Ammonia Import	Ammonia Domestic	Ammonia Import	Ammonia Domestic
1. Carbon Dioxide Supply (from PTT)	20,000 Nm^3/h	20,000 Nm^3/h		20,000 Nm^3/h	
Pipe Line Length (m)	61,000	24,000		1,000	
2. Ammonia Storage Capacity (tons)					
at Plant Site	5,000	500	500	500	500
at Port Area		5,000	—	5,000	—
3. Ammonia Pipe Line Length (m)	1,000	8,000	23,000	31,000	1,000
4. Rock Salt Storage (tons)		20,000		20,000	
at Plant Site	70,000				
at Port Area		50,000		50,000	
5. Soda Ash Storage (tons)					
5.1. Bulk Storage (Silo)		16,000		16,000	
at Plant Site	36,000				
at Port Area		20,000		20,000	
5.2. Bagged Product Storage		18,000		18,000	
at Plant Site	36,000				
at Port Area		18,000		18,000	
6. Ammonium Chloride Storage at Plant Site (tons)	36,000	36,000		36,000	
7. Handling & Transportation					
7.1. At Plant Site					
7.1.1 Rock Salt Train Unloading (t/y)	1,200,000	600,000		600,000	
7.1.2. Soda Ash Train Loading (t/y)	None	400,000		400,000	
7.2. At Port Area					
7.2.1. Rock Salt					
i. Train Unloading (t/y)	= Plant Site	600,000		600,000	
ii. Belt Conveyor to Ship Loader (m)	1,875	500		500	
7.2.2. Soda Ash					
i. Train Unloader (t/y)	None	400,000		400,000	
ii. Belt Conveyor to Ship Loader (m)	1,410	500		500	
7.7.3. Railway Sidings at Plant Site (m)	3,200	5,000		800	
8. Draining Ditch Length (m)	1,000	5,000		1,000	

TABLE 3 TOTAL CAPITAL REQUIREMENT FOR EACH ALTERNATIVE

		Interest 6%			Interest 5%			Interest 4%		
		F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
Rock Salt Mine		26,838 (49.65%)	27,213 (50.35%)	54,051 (100%)	26,239 (29.09%)	27,213 (50.91%)	53,452 (100%)	25,633 (48.52%)	27,213 (51.48%)	52,866 (100%)
Soda Ash Plant	Case BMCD	243,193 (74.74%)	82,207 (25.26%)	325,400 (100%)	239,587 (74.45%)	82,207 (25.55%)	321,794 (100%)	236,060 (74.17%)	82,207 (25.83%)	318,267 (100%)
	Case BMCI	262,262 (75.45%)	85,358 (24.55%)	247,620 (100%)	258,410 (75.17%)	85,358 (24.83%)	343,768 (100%)	254,642 (74.89%)	85,358 (25.11%)	340,000 (100%)
	Case BNYD	250,698 (73.56%)	90,129 (26.44%)	340,827 (100%)	246,921 (73.26%)	90,129 (26.74%)	337,050 (100%)	243,227 (72.96%)	90,129 (27.04%)	333,356 (100%)
	Case BNYI	254,696 (73.77%)	90,576 (26.23%)	354,272 (100%)	250,870 (73.47%)	90,576 (26.53%)	341,446 (100%)	247,128 (73.18%)	90,576 (26.82%)	337,704 (100%)
Total Capital Requirement	Case BMCD	270,031 (71.16%)	109,420 (28.84%)	379,451 (100%)	265,826 (70.84%)	109,420 (29.16%)	375,246 (100%)	261,693 (70.51%)	109,420 (29.49%)	371,133 (100%)
	Case BMCI	289,100 (71.97%)	112,571 (28.03%)	401,671 (100%)	284,649 (71.66%)	112,571 (28.34%)	397,220 (100%)	280,272 (71.34%)	112,571 (28.66%)	392,866 (100%)
	Case BNYD	277,536 (70.28%)	117,342 (29.72%)	394,878 (100%)	273,160 (69.95%)	117,342 (30.05%)	390,502 (100%)	268,860 (69.61%)	117,342 (30.39%)	386,222 (100%)
	Case BNYI	281,534 (70.50%)	117,789 (29.50%)	399,323 (100%)	277,109 (70.17%)	117,789 (29.83%)	394,898 (100%)	272,761 (69.84%)	117,789 (30.16%)	390,570 (100%)

Note: F.C. = Foreign Currency Portion, L.C. = Local Currency Portion
Plant Site; BMC = Ban Mab Chalood, BNY = Ban Nong Yai
Ammonia Source; I = Import, D = Domestic

TABLE 4 SENSITIVITY ANALYSIS ON OVERALL PROJECT
(Rock Salt Mine: 1,800,000 t/y)

(%)

Case	IRR (Before)	IRR (After)
BMCD	10.02	8.94
BNYI	9.24	8.20
BNYD	9.42	8.37
BMCI	9.07	8.04

Sensitivity		Case BMCD		Case BNYI	
		Before	After	Before	After
IRR on Equity	4%	—	14.76	—	13.05
	5%	—	14.26	—	12.57
	6%	—	11.87	—	10.13
Investment	10% up	6.52	7.52	7.76	6.82
	10% down	11.74	10.58	10.93	9.80
Sales R/S	20% up	10.69	9.57	9.89	8.82
	10% up	10.36	9.26	9.57	8.51
	10% down	9.68	8.61	8.90	7.88
	20% down	9.33	8.28	8.56	7.56
Sales S/A	10% up	12.05	10.88	11.22	10.08
	10% down	7.81	6.87	7.07	6.19
Sales A/C	10% up	11.46	10.31	10.65	9.53
	10% down	8.50	7.50	7.74	6.80
Ammonia	20% down	11.46	10.31	10.65	9.54
	10% down	10.75	9.63	9.95	8.87
	10% up	9.27	8.22	8.50	7.51
	20% up	8.49	7.50	7.74	6.80