REPORT OF FEASIBILITY STUDY FOR SUEZ CANAL EXTENSION PROJECT OF THE ARAB REPUBLIC OF EGYPT

July 1975

Japan International Cooperation Agency

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PREFACE

In compliance with the request of the Government of Arab Republic of Egypt, the Government of Japan undertook to conduct a feasibility study for the First Phase Suez Canal Extension Project as part of Japan's overseas technical cooperation, and entrusted the Japan International Cooperation Agency with its execution.

The Agency, on commission from the Government of Japan, organized a survey team comprising ten experts led by Mr. Yoshio Haraguchi, Director-General, Third District Port and Harbor Construction Bureau of the Ministry of Transport, and dispatched it to Egypt during the period from November 30 to December 25, 1974.

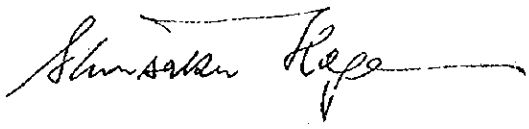
During its stay in Egypt, the team carried out various survey activities and prepared an interim report which was presented to the Government of Egypt. After its return to Tokyo, the team engaged in the arrangement and examination of data collected during the survey as well as in the reviewal of the project, and compiled its findings into this final report.

It will give me great pleasure if this report proves instrumental in promoting the Suez Canal Extension Project and at once serves to enhance the economic development of Egypt and the friendly relations between Japan and Egypt.

On this occasion, I wish to express my deep gratitude to the Government and officials concerned of the Arab Republic of Egypt for the valuable and positive assistance they have extended to the team throughout the survey period.

Shinsaku Hogen
Director-General
Japan International Cooperation Agency

July 1975



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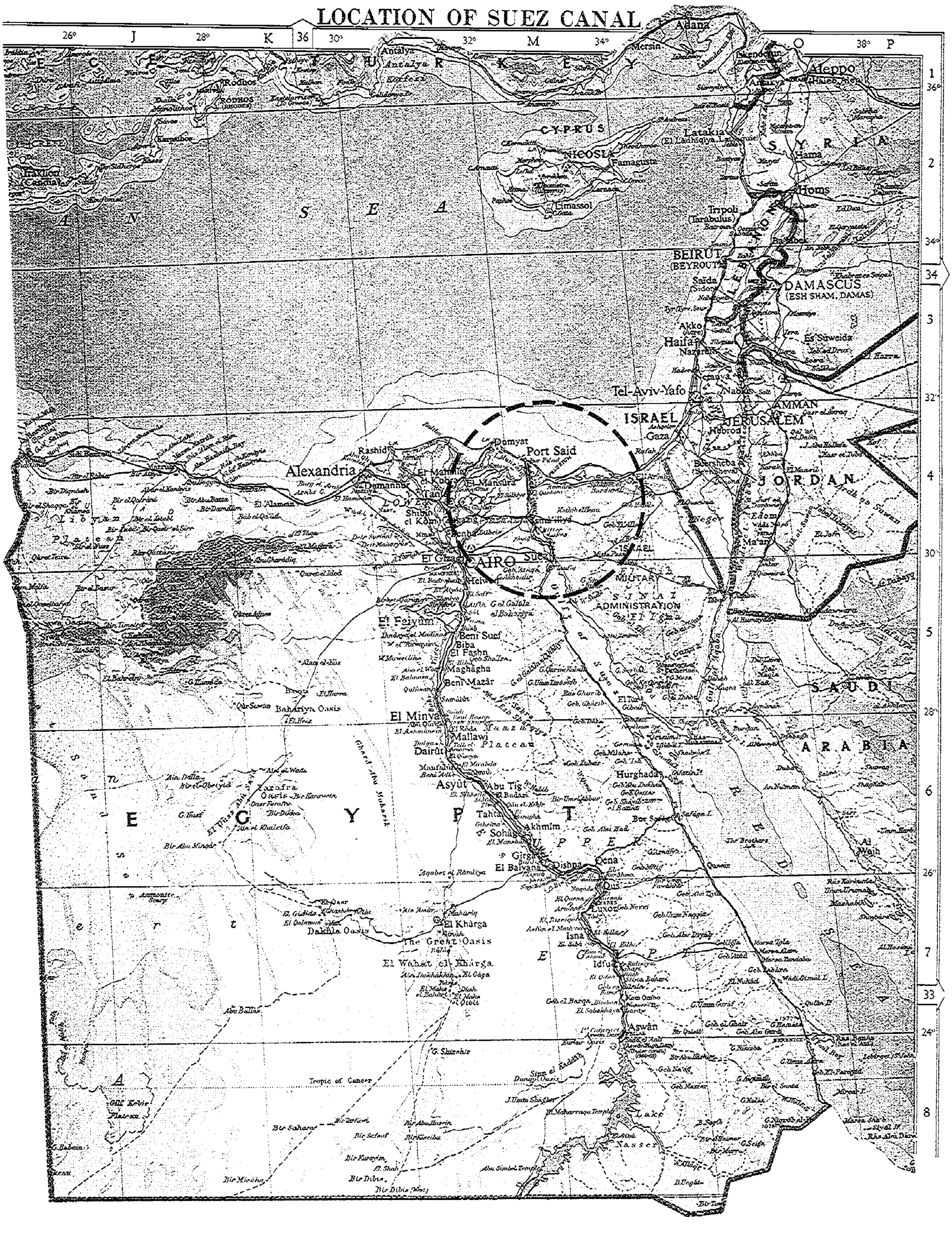
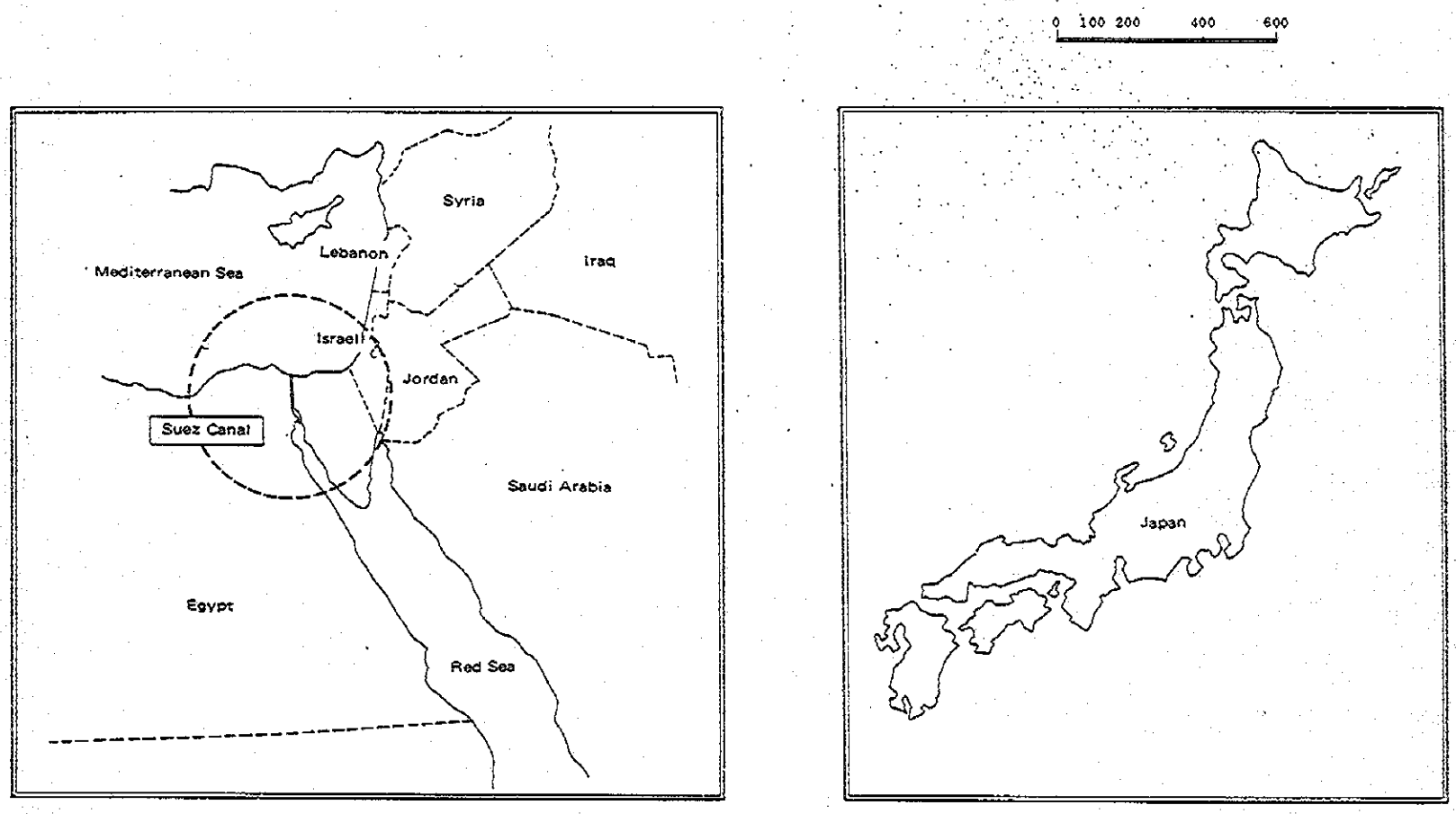
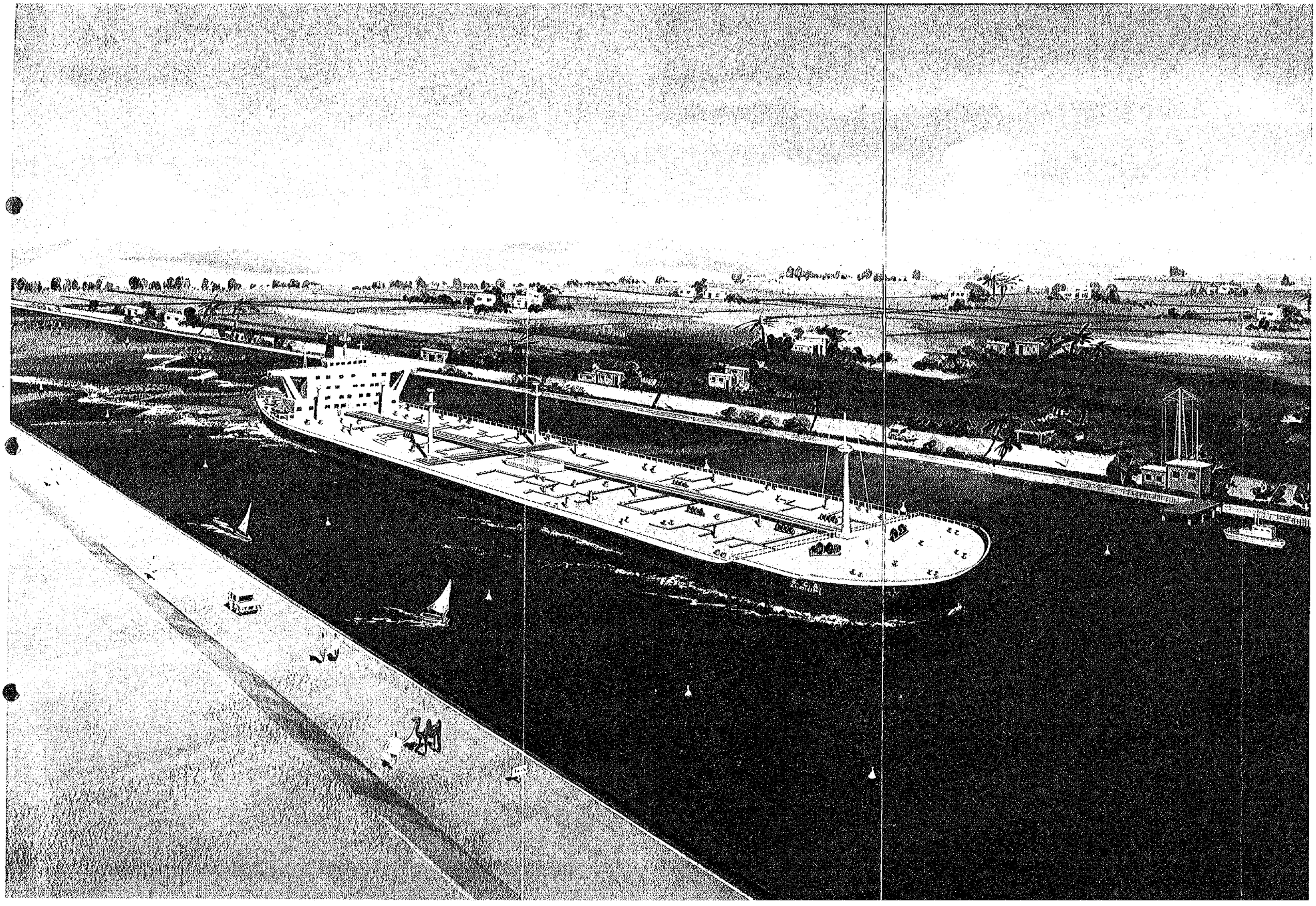
LOCATION OF SUEZ CANAL



Location Map of the Suez Canal





CONVERSION TABLE

Conversion of currencies at official rates

Currency unit	=	Egyptian Pound (L.E)
US$ 2.56	=	L.E. 1.00
US$ 1.00	=	L.E. 0.39
¥767.26	=	L.E. 1.00

Conversion of foot to meter

Foot (ft)	Meter (M)
1.00	0.30
3.3	1.00
3.8	11.6
4.0	12.2
5.3	16.1
6.7	20.4

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5. Contents of the feasibility study for the second phase Canal extension project (in English).
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INTRODUCTION

Port and harbour technology in Japan has been highly appreciated by not only the Suez Canal Authority but Egyptian government officials concerned. It is believed that this is an outcome of Japan's continued technical assistance in the development of ports and harbours in Egypt since 1960.

All efforts have been exerted to reopen the Canal around June, 1975. In parallel with the reopening of the Canal which allows the passing of 60,000 DWT class large vessels, the first phase Canal Extension Project will be embarked upon for the purpose of accommodating 150,000 DWT class leviathans. For this first phase project, yen loan will be extended together with the participation in the project of Japanese enterprises.

In December 1973, Special Envoy Miki visited the countries in the Middle and Near East. He commited to extend yen loans to the Egyptian Government for the extension of the Suez Canal. Now the reopening of the Canal is in the offing, and the conclusion of the yen loan agreement for the first phase project has been urged.

Eight years have passed since the Japanese port and harbour experts left Suez, and the fourth Middle East War has just ended. Naturally, the information about the status quo of the Canal is meagre, and it is necessary to conduct a reconnaissance study for the collection of minute data.

It was thus decided to dispatch to Egypt a feasibility study team comprising ten expert members from December 1 to 23, 1974.

The survey covered various sectors, including technology, economics, finance, and ship operations, in close cooperation with the Suez Canal Authority, and succeeded in raising substantive results.

Some members of the team visited OECD Headquarters and EC Headquarters to acquire what was prospected about the petroleum consumption in Europe and in the world as a whole. It is my great pleasure to submit herewith a detailed report of the survey.

On behalf of the survey team, I would like express my deep gratitude to the officers of the Suez Canal Authority for their unlimited assistance and warm hospitality extended to the team during its stay in Egypt.

Yoshio Haraguchi
Leader,
Japanese Survey Team for the Suez Canal
Extension Project

FORMATION OF THE TEAM AND ASSIGNMENTS

(Title as of Dec. 1974)

Leader	General Administration	Yoshio Haraguchi Director-General, 3rd District Port Construction Bureau, Ministry of Transport
Member	Ship Operation (Planning Group)	Shosaku Kodama Director-General, Deck Course Department, Institute for Sea Training, Ministry of Transport
Member	Route Planning (Planning Group)	Akio Kogo Head, Shimizu Port Construction Office, 5th District Port Construction Bureau, Ministry of Transport
Member	Dredging and Soil (Technical Group)	Shozo Tokunaga Port Construction Inspector, Construction Division, Bureau of Ports and Harbours, Ministry of Transport
Member	Working Craft (Technical Group)	Masao Ohyabu Head, Yokohama Machinery Equipment Office, 2nd District Port Construction Bureau, Ministry of Transport
Member	Hydrology & Hydraulic Engineering (Technical Group)	Shigeru Murata Chief, 3rd Work, Section Kobe Port Construction Office, 3rd District Port Construction Bureau, Ministry of Transport
Member	Ports & Harbours Economics (Economic Group)	Yasuyuki Nakayama Construction Specialist of Design Group, 5th District Port Construction Bureau, Ministry of Transport

Member	Economic Analysis (Economic Group)	Takashi Hashikawa Assistant Chief, Overseas Economic Cooperation Fund
Member	Financial Analysis (Economic Group)	Toshihiro Sakurai Assistant Chief, Overseas Economic Cooperation Fund
Member	Services & Coordination	Minoru Takase Japan International Cooperation Agency

ITINERARY OF THE SURVEY TEAM

Nov. 30 (Sat.)	Departed Tokyo.
Dec. 1 (Sun.)	Arrived at Cairo Airport, Egypt. Paid courtesy call at Japanese Embassy and met Ambassador Wada, and held a meeting.
Dec. 2 (Mon.)	Paid courtesy call at Suez Canal Authority (Cairo), acknowledged the survey schedule, and submitted a questionnaire.
Dec. 3 (Tues.)	Visited Suez Canal Authority and received explanation and data on the Canal and its extension project.
Dec. 4 (Wed.)	Engaged in survey activities within Cairo-Ismailia-Cairo section. Explanation provided by Suez Canal Authority (Ismailia). Inspected Lake Timsah and the Canal. Visited the Research Centre of the Authority.
Dec. 5 (Thur.)	Had a discussion at Suez Canal Authority, and analyzed data.
Dec. 6 (Fri.)	Data analysis.
Dec. 7 (Sat.)	Engaged in suruey activities to cover Cairo-Ismailia-Port Said section. Had a discussion at Suez Canal Authority (Ismailia). Held a meeting at Port Said. Put up at Port Said.
Dec. 8 (Sun.)	Engaged in survey activities to cover Cairo-Ismailia-Port Said section. Inspected the Canal and Port Said. Listened to Suez Canal Authority (Said Port) about the existing circumstances. Had a discussion at Suez Canal Authority (Ismailia). Put up at Ismailia.
Dec. 9 (Mon.)	Engaged in survey activities to cover Ismailia-Suez-Cairo section. Inspected the Canal. Received information at the Suez Canal Authority about the existing circumstances. Visited Port Tewfik and the Canal. Returned to Cairo.
Dec. 10 (Tues.)	Data collection at Suez Canal Authority (Cairo) and Arab Petroleum Pipeline Company.
Dec. 11 (Wed.)	Held a general meeting at Suez Canal Authority (Cairo).

Dec. 12 (Thur.)	Held a joint meeting at Suez Canal Authority (Cairo).
Dec. 13 (Fri.)	Prepared the framework of the interim report, and analyzed data.
Dec. 14 (Sat.)	Data collection at Suez Canal Authority (Cairo), and held a meeting
Dec. 15 (Sun.)	Leader and two team members left Cairo for OECD (Paris) and EC (Brussel) for related investigations, and put up in Paris. The remaining seven members engaged in the preparation of the interim report and data callection.
Dec. 16 (Mon.)	The group dispatched to Europe collected data and information at OECD, Parid, and put up there. The remaining group continued with the preparation of the interim report and data collection.
Dec. 17 (Tues.)	The dispatched group collected data at OECD (Paris) and moved to Brussel, and put up there. The remaining group made survey activities in Cairo-Ismailia-Cairo section, and collected data at Suez Canal Authority (Ismailia).
Dec. 18 (Wed.)	The dispatched group collected data and information at EC (Brussel), and put up in Brussel. The remaining group continued with the preparation of the interim report.
Dec. 19 (Thur.)	The dispatched group collected data at EC (Brussel) and returned to Cairo. The remaining group continued with the preparation of the interim report.
Dec. 20 (Fri.)	Held a meeting, completed the interim report, and briefed the Japanese Embassy (Ambassador Wada) of the report.
Dec. 21 (Sat.)	Explained to the Authority on the interim report. Banqueted the officers of the Authority.
Dec. 22 (Sun.)	Prepared for return home. Suez Canal Authority banqueted the survey team.

Dec. 23 (Mon.)	Departed Cairo Airport.
Dec. 24 (Tues.)	In flight.
Dec. 25 (Wed.)	Arrived at Tokyo. Held a meeting at the Ministry of Foreign Affairs for the representatives of related agencies in explanation of the interim report.

I. SUMMARY OF THE SURVEY AND CONCLUSIONS

I. SUMMARY OF SURVEY AND CONCLUSIONS

The Suez Canal provides a shortcut between Europe and Asia. The route connecting Arabian Gulf and Rotterdam takes a haul some 40% shorter than going around Cape Town. The project that purposes the enlargement of the Canal for large vessels will never remain without influencing the shipping and shipbuilding in the world. The closure of the Canal for seven years odd since 1967 has prompted the mammothization of tankers.

It also has brought about a large change in the dry cargo ships as represented by containerization.

The Canal Extension Project and its implementation should therefore presuppose close investigation into the size, number and cargo of the vessels expected to pass through the Canal. The Survey Team organized by the Japanese government conducted a feasibility study of the First-Phase Canal Extension Project (hereafter abbreviated to the "first phase project") which is going to be implemented immediately after the reopening of the Canal, and the result is herewith submitted to the Egyptian Government in hopes that Japanese government and private enterprises may contribute much toward the project in terms of finance and technology and further friendly relations between the two countries.

The feasibility study on the first phase project was conducted from both economic and technical points of view on the assumption that there would be no obstacles standing in the way of reopening and the execution of the project.

As regards the types of cargoes and vessels passing through the Canal, the effects of the first phase project were forecast and compared with the case that the project is set at naught, in order to assess the benefits from the implementation of the project. Based on the results of the analysis, internal rate of return was calculated.

Field survey:—

The reconnaissance covered almost every part of some 160 km strip along the Canal. But a good number of strategic sites and war-damaged roads and buildings made it difficult to see details of every area. Near the strategic sites, photographing was also banned. During the field survey, the team had a chance to inspect the status quo of the Canal and the progress of work for reopening, and was deeply impressed by the workers who were removing by hand and with trolleys the sand which had embanked the camps in an attempt to expose 75 m-pitch bollards along the Canal.

The first phase project is scheduled to be started after reopening of the Canal, and seems to have no particular problems to speak of.

It should be added by the way that the sand banks piled up as forts on the east bank toward which the dredging is to be carried out must be removed prior to dredging work otherwise to be impeded. In this matter, the Suez Canal Authority agreed to have its Egyptian contractors clear them away.

Technical survey:—

Technical matters, the volume of soil to be dredged, and work costs were discussed according to the data presented by the Authority.

As regards the dredging work, it was found that the soil conditions is different between northern, middle and southern parts; the northern part has soft clay constituting the delta of the Nile, the middle part forms a desert of fine sandy layer, and the southern part is composed of compacted sand gravel layer partly including hard aqueous rock extending from the mountains on the west bank of the Canal. Port Tewfik and the shallows in the Red Sea 8 km south thereof are composed of rock-containing sand gravel layer, and are expected hard to dredge with a pump dredger. The boring is therefore urged there for soil examination. The Suez Canal Authority is planning the drilling survey and studying the execution method. Since submerged blasting is planned, the dredging will not be infeasible.

The sector between Port Tewfik and Bitter Lakes (where contractors from Japan will undertake the dredging) presents a hard sand gravel layer, but its dredging is feasible by pump dredger.

Bitter Lakes originally formed an inland sea which had often been connected to the Red Sea, and have several meters of crystal salt in the bottom. This salt can also be dredged away. However, because of a large expanse of the anchorage (something like 20 km^2), the dredging volume will become enormous.

As regards the northern part, the Suez Canal Authority has a dredging plan of its own, and the dredging will be easy as soil condition indicates.

The dredging volume in the first phase project is as follows.

Total volume to dredge:	Approx. 470 million m^3
Volume to excavate ashore:	Approx. 67 million m^3
Total costs:	Approx. US$ 820 million (incl. foreign currency amounting to approx. US$ 510 million)

As a gigantic volume of soil is to be dredged away, it is important how the Suez Canal Authority takes control over the work for the smooth and balanced execution even if the work has no problem from the technical viewpoint. The work period is set at 3 years, and it is likely that the part directly undertaken by the Authority will outstrip the Authority's mobility to manage in such a short period of time. Thus, that part should be reviewed, along with a survey of the capability of wrecked dredging vessels. The surpluses may have to be teamed by international bidding.

In order to complete the work in three years, 25 to 30 dredging boats will have to be put into operation simultaneously along the Canal when it is high time, and it is desired to take proper coordination of work so as not to hinder navigation.

The eastern slope and the bottom of up to 10 m deep can be excavated any time, but the part just under the route must be dredged with care because of the limitation to the working time.

While the Authority states that the disposal of war-left explosives will not do harm to navigation, the dredging should be done with utmost care as small but very perilous explosives are possibly hidden into the slopes and berms. The dredging may be completed in three years if the above precautions are observed.

Examination of ship operation:—

Once the first phase project has been completed, the water depth will be increased from 15.0 m to 19.5 m, permitting the passage of 150,000 DWT class oil tankers. In anticipation of such large vessels, it cannot be too early to prepare for necessary systems immediately.

First, the pilots must be reared up and trained. Secondly, the tugboats must be built, and tug masters trained. Thirdly, the convoys system must be exmained.

The Suez Canal Authority has been endeavouring to study hydrographic problems arising from the passage of large vessels through a narrow waterway and the accompanying maneuvering problems. Considering its lack of experience in large vessels, it is highly desired for the Authority to go through such problems in 3 years and prepare a safety navigation plan scrupulously lest tanker accidents should happen. Japan's experience in the maneuvering of supertankers and tugboats and in the building of tugboats will do much toward the promotion of technology in Egypt in this respect. The Authority requested the team to nurture its tug masters in Japan.

The waterway between Bitter Lakes and Tewfik, which is affected by tidal current, is most problematic in maneuvering large vessels. At Port Tewfik, the current velocity is about 1.5 m/sec., which may be increased by 10% when the waterway is expanded.

It is wise and far-sighted that the Authority has determined to operate large vessels there at a reduced speed of 9 to 12 km/hr for increased safety of the new convoys system.

The length of the double channel section in the Canal determines the transit capacity of the Canal. Namely, the longer the length, the larger will become the capacity.

The comparison of the present capacity with the capacity after the first phase project is given in the following table in terms of the number of bottoms, where the mammothization of vessels is taken into account for the capacity after the project.

Capacity (estimated by Authority)	Southbound	Northbound	Total (bottoms/d.)
At the time of reopening	39	42	81
After First-Phase Canal Extension Project	35	42	77

The capacity of the Canal can be assessed by calculating the number of vessels allowed to enter the Canal from each entrance with the intervals of departure fixed. Specifically, supertankers and large-sized container carriers are planned to depart at an interval of 15 min., ordinary tankers at an interval of 10 min., and freighters of 500 DWT or larger at an interval of 5 min. Then, the time intervals of departure are summed up. When the sum reaches about 5 hrs which is the maximum allowable departing time zone, the number of vessels departed thus far stands for the Canal capacity in the direction for which those vessels are bound.

As seen in the above table, the Canal has plenty of reserve capacity. For example, navigation of 5 bottoms of 150,000 DWT class tanker a day and 5 bottoms of 60,000 DWT class tanker a day will result in the transportation of 1 million tons a day of crude oil or 360 million tons a year.

Economic analysis:—

Things around the transportation of petroleum have changed during the closure of the Canal.

Before closure of the Canal, tankers accounted for 70% of Canal proceeds, but after reopening, oil transportation by small tankers of not more than 60,000 DWT is almost unlikey.

The ever-increasing oil price since 1973 and the resultant slowdown of oil consumption have seriously hit the shipping circles; at the end of 1974, the shipping world was glutted with idle vessels and forced to slow down the operating speed, accordingly.

Such being the circumstances, the forecast of benefits from the reopening and enlargement of the Canal is hard.

Be that as it may, the team tried analysis and projection in due consideration of data available from Egypt, Japan, OECD Headquarters and EC Headquarters as well as the results of research by World Bank and UN.

As regards SUMED Pipeline Project to connect Suez and the Mediterranean Sea, the team visited the Arab Petroleum Pipeline Company for the purpose of taking its effects into consideration for the said forecast.

According to the Pipeline Project, crude oil transported by tankers larger than 150,000 DWT will be conveyed from the Red Sea to Alexandria through pipelines. The laying of pipelines with a transportation capacity of 80 million tons a year will be started shortly.

The team's study disclosed that the cost of oil transported by medium-sized tankers via the Suez Canal on each of the routes connecting Arabian Gulf to North America and the Mediterranean Sea to North Europe would be higher than by supertankers going round Cape Town. One example will be enough.

If crude oil is to be transported from Arabian Gulf to New York, oil cost by a 150,000 DWT class tanker via the Canal is US$ 6.0 per kiloliter as against US$ 5.9 per kiloliter by a 300,000 DWT class tanker via Cape Town (Note that canalage is counted in the above computation). For Europe, particularly southern part, transportation through the Canal by 150,000 DWT class tankers is by far the more advantageous.

It is therefore concluded that the Canal should be deepened and widened at once for supertankers to pass through for transportation of oil.

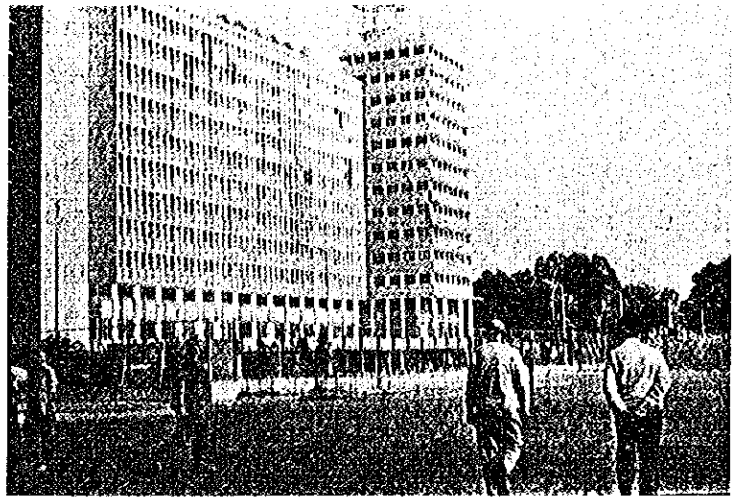
The benefits from the implementation of the first phase project are evaluated as differences in proceeds from the case where the project is discarded. Assuming that the life of the project is 30 years, the proceeds will amount to some L.E. 1,700 million (US$ 4,200 million) during that period, bringing about 12% of internal rate of return against a total investment of L.E. 320 million (US$ 820 million) and operating expenditures of L.E. 250 million (US$ 650 million).

It is considered from the financial point of view that during the period from the reopening till the completion of the first phase project when the canal revenues will go down because of reduced oil transportation, most of the fund required for the extension work will have to be supplied from abroad. It is therefore mandatory to prompt the conclusion of foreign loan agreement and appropriation of domestic funds.

Conclusion:–

The essential parts of the survey have been related above. The First Phase Canal Extension Project has a large volume of soil to be dredged, but will be accomplished on schedule as there is little or no problem technically. Also, it is concluded that the project is feasible from the economic viewpoint.

It goes without saying that the Suez Canal Authority is quite warrantable in the administration and performance of the Project as it has an experience of having dredged 30 million m^3 of soil in a matter of one year.



Ismailia Office of the Suez Canal Authority

Survey Team Members in Discussion (from Left to Right: Director Adel and Vice Director Amman of the Suez Canal Authority)

II. RECOMMENDATIONS

II. RECOMMENDATIONS

1. The volume of dredging work to be directly undertaken by the Authority is too large for the working crafts to complete in three years. It is therefore recommended to whittle away extras by hiving them off to successful bidders to balance the work volumes on the schedule.

2. It is of paramount importance to prompt foreign loan agreement and measures for appropriation of domestic funds for the purpose of the first phase project with all possible dispatch.

3. Since the volume of oil and the number of vessels passing through the Canal will increase, navigation aids should be amplified and improved for safety. Sure measures should be provided against pollution, fire and explosion hazards due to collision and oil spill.

III. GENERAL DESCRIPTION OF THE SURVEY

III. GENERAL DESCRIPTION OF THE SURVEY

1. Purposes and Objectives of the Survey

All-out efforts have been poured into the Canal for its reopening around June 1975 to permit transit of 60,000 DWT class vessels. Also, the First-Phase Canal Extension Project is going to start in time with the reopening with a view to accommodating 150,000 DWT class vessels.

For the first phase project, the extension of yen credit is expected, together with participation of Japanese contractors.

In December 1973, the then Deputy Prime Minister Miki visited the middle Eastern nations as a special envoy and in Egypt he deliberated on the extension of yen credit for the canal expansion work. As the canal reopening work has made a marked progress since then, it is urged to sign the agreement concerning yen credit for the first phase project.

Eight years have passed since Japanese experts specializing in port and harbour technology left Suez, and the fourth Mid-East War was seen during that period. Naturally, there is little information about the existing state of the Canal, which called for close field survey of the Canal. It was on March 3, 1974 that Israeli troops pulled back from the Canal, and it was in September of the same year that the Authority's headquarters returned to Ismailia from Cairo.

It was reported that almost all of explosives like mines were disposed of although there still were places in the Cana Zone staked out from strategic viewpoint. This made it possible to dispatch a feasibility study team comprising ten experts to Egypt for the period from December 1 to 23.

The survey covered various sectors including technology, economics, finance and ship operation with the wholehearted assistance from the Suez Canal Authority, and raised achievements more than expected.

Some members of the team were also able to visit OECD Headquarters and EC Headquarters and investigate the prospects of petroleum consumption in Europe and in the world as a whole.

This report purposes to process these data, make clear the status quo of the Canal, analyze the feasibility of the First-Phase Canal Extension Project from the viewpoint of technology, economics, finance and ship operation, confirm that the conclusion of a yen loan agreement and the construction work by Japanese contractors will entail no

problems, and also to make recommendations concerning the project in order to ever foster the friendly and cooperative relations between Japan and Egypt.

2. Scope of the Survey

The activities of the survey team covered the study on the feasibility of the First-Phase Canal Extension Project which is to be launched in time with the reopening of the Canal.

As regards the future projects including the Second-Phase Canal Extension Project, the team confined itself to hearing their outline. Their feasibility will be appraised by the investigations the Suez Canal Authority is going to conduct.

Table 3-2-1 Suez Canal Extension Projects

Projects by the Authority	Max. navigable vessel		Canal section (m^2)
	Draft (ft)	(DWT)	
Reopening	40	60,000	1,850
First-Phase	53	150,000	3,200
Second-Phase	67	250,000	4,200 ~ 4,400
Third and subsequent projects that may be needed in future	72	—	—

3. Background of the Survey

3-1 Background of the Survey

The relations of Japan with the Suez Canal have been deepened rapidly since July 1952 when Egypt nationalized it.

This is partly due to the strenuous efforts shown by both governments toward closer ties and mainly because the Egyptian government leaders have been interested in what Japan has demonstrated in her restoration since the end of the War.

Twice in 1958 and 1959, Japanese missions conducted a field survey of the Canal, and exhibited Japan's high level of port and harbour technology, corroborating the the necessity of technical cooperation between the two countries.

As is expatiated in Section 3-2, the dispatch of Japan's port and harbour engineers began in 1960 and amounted to 14 in the following some 6 years during which they did much toward technical cooperation at sites.

From 1961 to 1969, an attache for port and harbour technology was stationed at the Japanese Embassy in Cairo in order to contribute to the improvement of the Canal.

On the other hand, trainees from Egypt have been participating in the port and harbour technical training courses sponsored by JICA without any interruption even during the Mideast War.

In addition, in the private sectors, particularly shipbuilding concerns, technical training courses have been extended to Egyptian trainees.

In August 1961, Perta-Ocean Construction Co., Ltd. bid off the Canal work for the first time, and successfully completed the site work in six years overcoming technical problems from which other mighty foreign businesses flinched.

The outbreak of the Mideast War in June 1967 forced suspension of the technical cooperation, except for the acceptance of port and harbour trainees.

On the day of the outbreak of the War, Penta-Ocean Construction made the lowest bid for the canal expansion work, which naturally was postponed. By virtue of the company's continued efforts, that work was included in the project cooperation agreement signed on December 5, 1974.

"Oil diplomacy" led by the Arab nations since around the end of 1973 greatly shocked not only European countries but also Japan, the largest oil importer in the world. Japanese government sent the then Deputy Prime Minister Miki as a special envoy to middle Eastern countries and tried to consolidate the friendly relations with the Arab nations. In December 1973, Special Envoy Miki was given a chance to meet with President Sadat in Cairo, debated with him on the extension to Egypt of a US$ 284 million (approx. ¥76,000 million) loan for the expansion of the Suez Canal, and promised to extend US$ 140 million (¥38,000 million) for the First-Phase Canal Extension Project.

Following Miki's visit to the Arab nations, Deputy Prime Minister Hatem came to Japan, and reconfirmed the yen loan of ¥38,000 million.

In 1974 when the Middle East turmoil was quelled, the Egyptian government started with the preparation of reopening of the Canal, and it became necessary to review the First-Phase Canal Extension Project in detail for which the said loan is to be given.

According to the plan by the Suez Canal Authority and the results of survey by the team, the restoration of Canal is likely to be completed by the middle of 1975. The Authority's plan only covers the work that aims at the reopening of the Canal.

Since the armies of Egypt and Israel stood vis-a-vis to each other dividing the Canal for years, many of Canal facilities were lost, and the shape of the Canal was changed.

The closure of the Canal for seven and odd years has drastically changed the world's shipping pattern, particularly in the size and quantity of tankers. Some fear that much cannot be expected of the reopening of the Canal which permits the passage of tankers of less than 60,000 DWT class only. The Suez Canal Authority has pushed forward various investigations for fear of this, but now seemingly is deeply involved in the reopening work putting it off as a second consideration. The Suez Canal Authority has recognized the urgent need of the implementation of the First-Phase Canal Extension Project, and the dispatch of Japan's mission has been expected by the Authority.

As explained in the foregoing, eight years have passed since the evacuation of Japanese port and harbour engineers. The information about the Canal after the end of the Fourth Mideast War was little, though a contact about the survey of the Canal state and expansion project was made in June 1971 once for all.

As a consequence, it was decided to look over the existing state of the Canal for the move toward its restoration and to conduct a feasibility study for the First-Phase Canal Extension Project as early as possible. According to an official telegram, it was decided that all the formalities concerning the yen loan for the first phase project should be attended to by the Suez Canal Authority.

For this reason, the Suez Canal Authority was contacted through the Japanese Embassy in Cairo for the purpose of organizing a Japanese survey team and sending it to Egypt as early as possible.

3-2 Diplomatic Background

It was in 1956 when Egypt declared the nationalization of the Suez Canal.

U.K., France and Israel tried an armed intervention into the Canal zone in an attempt to bring it under international control, but failed. In 1957, all the alien armies were forced out of the zone. Thus, the Suez Canal has been put under the control of the Suez Canal Authority of Egypt since 1957, and two years later or in 1959, Japan's relation with the Canal began.

In the same year, Mr. Saburo Endo, a member of the House of Councillors, visited the United Arab Republic in the capacity of a diplomatic inspector and had a talk with Mr. Abu Bakr, Director of General Affairs Department, the Suez Canal Authority, who wished earnestly that Japan would participate in a planned large-scale Canal expansion

program. Prior to his visit to the U.A.R., the Ports and Harbours Bureau of the Japanese Ministry of Transport dispatched a survey team led by Mr. Niizuma on a special mission to examine the actual conditions of the Canal. Fully realizing the significance of Mr. Bakr's request and of the capital opportunity that Japan might possibly promote the firendly relations between the two countries through technical and economic assistance in the expansion of the Canal attracting the world attention, discussions over discussions were continued by the International Engineering Consultants Association in close cooperation with the authorities concerned including the Ministry of Foreign Affairs and the Ministry of Transport.

French and British consultants, like Grenoble-based Neypic, had firm grip on the technical business of the Canal, leaving little or no allowance for Japan to get into.

In March 1960, the International Engineering Consultants Association dispatched a team led by Mr. Yonekichi Yanagisawa to Cairo, and the team, together with Mr. Ohtao, Technical Counsellor at the Japanese Embassy in the United Arab Republic, conducted a survey for the expansion and reconstruction of the Canal and introduced Japan's port and harbour technology.

The Suez Canal Authority recognized the superiority of Japan's port and harbour technology through discussions and became earnest over the technical cooperation with Japan.

For example, Japan proposed its own construction method as against the Authority's plan for sheet piling, and it was accepted and put to practice in July same year. Japanese trade houses had the chance to bid off steel sheet piles of as much as 13,000 tons.

On the occasion of its return home, the team requested Mr. Younes, Chairman of the Suez Canal Authority, to come and see what Japan's technology and industrial activities are all about and also proposed the exchange of port and harbour engineers between the two countries. In February 1961, the exchange of port and harbour engineers began between the two countries. First, the Ministry of Transport dispatched Mr. Kinouchi and Mr. Kusaka, and the Suez Canal Authority sent to Japan two naval engineers at Port Fouad.

All the expenses for that exchange were borne by the Japanese Ministry of Foreign Affairs.

The engineers dispatched to the Suez Canal Authority (Ismailia) and technical attachés sent to the Japanese Embassy since then are as shown in the following list.

Roster of experts dispatched to Egypt

1. Survey teams

1958	Niizuma survey team
1960	Yanagisawa survey team
1974	Haraguchi survey team

2. Experts

Sept. ~ Oct. 1960	Susumu Kurata Chief, Soils Laboratory, Port and Harbour Research Institute, Ministry of Transport
Oct. ~ Nov. 1960	Yasumaru Ishii Director, Soils Division, Port and Harbour Research Institute, Ministry of Transport
Feb. ~ Aug. 1961	Hiroshi Kusaka Deputy Head, Kobe Port Construction Office, 3rd District Port Construction Bureau, Ministry of Transport
Feb. ~ Sept. 1961	Masatoshi Kiuchi Deputy Director, Machinery Division, Ports and Harbours Bureau, Ministry of Transport
Oct. 1961 ~ Jan. 1962	Senri Tsuruta Director, Hydraulic Engineering Division, Port and Harbour Research Institute, Ministry of Transport
Dec. 1961 ~ June. 1962	Satoshi Hayashi Laboratory Chief, Soils Division, Port Harbour Research Institute Ministry of Transport
Mar. ~ Sept. 1963	Shigeo Morimoto Chief Inspector of Port Construction, Construction Division, Ports and Harbours Bureau, Ministry of Transport
Mar. ~ Sept. 1963	Yoshiyuki Ito Laboratory Chief, Hydraulic Engineering Division, Port and Harbour Research Institute, Ministry of Transport

Mar. ~ Oct. 1964	Yoshio Haraguchi Head, Yokohama Investigation and Design Office, 2nd District Port Construction Bureau, Ministry of Transport
Sept. 1964 ~ Apr. 1965	Toshiyuki Nishimura Deputy Director, Machinery Division, Ports and Harbours Bureau, Ministry of Transport
Sept. 1964 ~ Apr. 1965	Shoji Sato Laboratory Chief, Hydraulic Engineering Division, Port and Harbour Research Institute, Ministry of Transport
Mar. ~ Oct. 1964	Masayuki Aoyama Deputy Director, Division of Disaster Prevention, Ports and Harbours Bureau, Ministry of Transport
Mar. ~ Oct. 1966	Fumio Okuyama Deputy Head, Shimonoseki Investigation and Design Office, 4th District Port Construction Bureau, Ministry of Transport
June.~ July. 1966	Yoshiaki Kurusu Technical Counsellor, Ports and Harbours Bureau, Ministry of Transport

3. Embassy staff

Jan. 1961 ~ June 1965	Hiroji Ohtao (from Port and Harbour Research Institute, Ministry of Transport) (4 yrs. & 5 mos.)
Sept. 1965 ~ Feb. 1969	Masao Ohno (from Bureau of Ports and Harbours, Ministry of Transport) (3 yrs. & 6 mos.)

Acceptance of Egyptian engineers by Japan is as follows. JICA's training courses have been continued even during the closure of the Canal when the dispatch of engineers from Japan to Egypt was suspended.

Table 3-3-1 Number of Persons Dispatched from Egypt to Japan

Year	Port & Harbour Engineering Course	Port & Harbour Seminar	Individual Training	Total
1962	–	1	–	1
1963	2	1	–	3
1964	1	0	–	1
1965	1	2	–	3
1966	1	1	–	2
1967	–	1	–	1
1968	1	1	–	2
1969	2	1	–	3
1970	1	1	3	5
1971	1	0	–	1
1972	2	1	–	3
1973	0	1	–	1
1974	1	1	–	2
Total	13	12	3	28

Note: OTCA (now reorganized to JICA):–
Port & Harbour Engineering Course (meant for engineers), 4 mos.
Port & Harbour Seminar (meant for port and harbour administrators), 2 mos.

3-3 Principal Undertakings by Private Businesses for the Suez Canal

(1) Construction of a 3,400 HP tugboat at Kure Shipyard.

(2) Guidance by Yawata Iron & Steel in the Z-sheet pile driving.

(3) Ishikawajima-Harima Heavy Industries awarded an order for a 10-ton crane for delivery to Port Fouad Shipyard.

(4) Electrolytic protection work by Nakagawa Boshoku K.K. at Port Fouad outfitting quay.

(5) Yawata Iron & Steel awarded an order for 1,000 tons of Z-sheet piles in 1960.

(6) Kinoshita Sansho and Mitsubishi Shoji awarded an order for 13,000 tons of steel sheet piles.

(7) Mizunogumi (now renamed Penta-Ocean Construction Co., Ltd.) succeeded in an

international bid for the dredging and revetment work of the Canal for the first time as a Japanese undertaker via Kinoshita Sansho (now renamed Mitsui & Co., Ltd.), and was awarded an order for 5,600,000 m^3 of dredging work and 13 km of revetment during the period of August, 1961 to December, 1963 at a cost of 2,100 million yen financed by the World Bank.

(8) Mizunogumi set up the"Suez", a 5,000-ton dredger, at Port Fouad Shipyard by the hand of Ishikawajima-Harima Heavy Industries, and succeeded in pump dredging of the sand gravel layer in the southern part of the Canal, overcoming technical problems European undertakers winced at, thus demonstrating Japan's excellent technology.

(9) Mizunogumi was renamed Penta-Ocean Construction Co., Ltd., and undertook the dredging of 1,631,000 m^3 from the Canal. A total of 930 million yen for the work was accommodated by the Arab Economic Development Fund and the Quait Fund.

(10) Penta-Ocean Construction Co., Ltd. undertook and completed the 560,000 m^3 dredging of the Canal at a cost of 580 million yen in the period of December 1965 to April 1967. The outlays were accommodated by the same sources as above.

(11) Israeli troops launched into an attack on June 6, 1967 when Penta-Ocean Construction Co., Ltd. won the first place in a bid for the dredging work (approx. 40 million m^3) for the coming Canal extension project. The cost was quoted at 13,780 million yen, but seven years of closure have passed without signing the contract. During that period of closure, the company continued its efforts to keep the contract effective. Its endeavour turned out to be a success. Now the reopening of the Canal is imminent, and the company finally has concluded the contract with the Suez Canal Authority.

The company's attitude toward their duties has always attracted the admiring attention from all who are sure of it, and the President of Egypt went so far as to say, "Diligence of Japanese is worth following."

Japanese undertakings, technology and eagerness have been highly acclaimed.

(12) Others

Around 1961, a German consultants company undertook a planning job for the extension of the Authority's workshop at Port Fouad, and Japanese businesses failed to bid off its implementation work, losing a good chance of technical and economic cooperation. In this kind of technical cooperation, the role of consulting business is preponderant; namely, the consulting abilities have become a must of eligibility for

participation in the bidding or undertaking.

It is therefore urged that the upbringing of consulting businesses be promoted not only from the national viewpoint, but also by active participation of private entrepreersnu in such activities.

At present, Pacific Consultants International is cooperating with British and Norwegian consultants in the search of canalage system and in the examination of the feasibility of the Second-Phase Canal Extension Project, and the Japanese Government's support to it is strongly hoped for.

3-4 Inter-Governmental Affairs which Prompted the Dispatch of the Survey Team

Mideast War broke out in June 1967, followed by the Fourth Mideast War in October 1973. The Egyptian troops marched towards the Sinai peninsula. Since the peace of Middle and Near East leads to the stabilization of the world's economy and peace, the United States and other powers intervened to separate Egyptian and Israeli troops from each other. In March 1974, Israeli troops pulled back off the bank of the Canal, marking a first step toward the reopening of the Canal.

President Sadat gave priority to the reopening and rehabilitation of the Canal, and took measures to return the refugees reportedly numbering 1 million to their homes in the canal zone, as well as for stabilization of national living and improvement of foreign trade balance in order to regain the national strength.

The Suez Canal Authority immediately set about the Canal rehabilitation work. In April 1974, it started the relocation of its headquarters to Ismailia from Cairo. Unfortunately, however, the housing conditions in Ismailia are still poor so that many officials are commuting between Ismailia and Cairo. The Ismailia Headquarters are being cured of bullet marks.

Such being the circumstances, the reopening work of the Canal and the negotiations for resuming the suspended dredging work were started immediately after a pause of the War in October 1973.

In October – November period of 1973, Egyptian government debated with the Japanese Embassy and made arrangements concerning the canal extension work to be undertaken by Japan.

The Egyptian government requested Japan's economic cooperation for want of foreign currency reserves. The Ports and Harbours Bureau of the Japanese Ministry of Transport examined problems incidental to the work, construction costs, etc., and

realized the necessity of a feasibility study. After due consideration, the Ports and Harbours Bureau decided on November 12, 1973 to conduct a feasibility study.

Around that time, the world was confronted with a grave problem – the Oil Crisis. The oil producing countries in the Middle East were amassing diplomatic power on the strength of their ability to control the oil exports and prices, and the international affairs were beginning to turn around the Middle East.

The Japanese government sent Special Envoy Miki to the Middle East for promoting friendly relations with the countries there.

On December 18, 1973, he met with President Sadat, and agreed to extend to the extension work of the Suez Canal a loan of 38,000 million yen ($ 140 million) at an interest rate of 2% for a term of 25 years of which 7 years are a period unredeemed.

In February 1974, the Egyptian government sent Deputy Prime Minister Hatem to Japan, and reconfirmed the yen loan of 38,000 million yen at a meeting in Tokyo.

It was determined to resume the extension work in May-October, 1974, and the Suez Canal Authority and the Egyptian government started examination of the work volume and work cost.

The work volume was increased more than that planned 7 years before, and determination of unit dredging cost went through with several negotiations as the commodity prices and wages had changed drastically as compared with those 7 years before.

In this matter, the Egyptian government established a ministerial committee comprising 11 ministerial members, who upon deliberation determined to entirely entrust the Suez Canal Authority with the task of performing the work and deciding on the terms and conditions of loan, etc. (October, 1974)

Negotiations were had between the Suez Canal Authority and Penta-Ocean Construction, Ltd., and an agreement valued at 50,300 million yen for the dredging of some 112 million m^3 was concluded.

According to an Embassy source, the sea-sweeping work by naval forces of U.S.A., U.K., France and U.S.S.R. was under way without any hitch as of October 18, and would be completed toward the end of November. It was also reported that the salvage work of wrecked ships would be carried out in three to four months after completion of mine sweeping.

On October 31, 1974, Minister in Charge of Economic Cooperation Amin informed the Japanese government via Ambassador Wada of the preparedness of the Egyptian government to welcome the visit of a feasibility study team from Japan before the end of the year and also of the commitment to negotiate for E/N and L/A with all possible

dispatch.

About one year passed since Special Envoy Miki's visit to Cairo, and the Canal reopening schedule was on the track. Correspondents in Egypt were quoted in newspapers here as saying that the Canal would be reopened in March 1975.

When it was reported that three Mecca pilgrimage vessels sailed from Port Said for Suez, the conclusion of the yen loan agreement for the canal extension work became a matter of urgent need.

As regards the dispatch of a survey team, a meeting sponsored by the Ministry of Foreign Affairs was held on October 24 to discuss the matter with the Ministry of Transport and Japan International Cooperation Agency (hereafter called the "JICA"), and it was concluded that the schedule be arranged following the policy of dispatching a team.

On October 29, JICA sponsored a meeting with the Ministry of Transport, Ministry of Foreign Affairs, and the Overseas Economic Cooperation Fund, and it was decided to dispatch a joint team of JICA and the Overseas Economic Cooperation Fund.

On the other hand, Mr. Adel, Director of Engineering Department of the Suez Canal Authority, conveyed to the Japanese government through the Embassy in Egypt their wishes to have a JICA-led feasibility study team come and to extend all possible conveniences to the team, such as provision of data and information and arrangements for field survey, while explaining that they had been out to reopen the Canal. Thus, the formation and period of survey of the team were informally decided on November 7.

Namely, it was decided to complete the survey before the end of 1974 by a 10-member team.

According to a November 14 report from Cairo, the Suez Canal Authority was hoping for the team to investigate the tempo, scale and economic feasibility of the Canal extension project, and the effects of pipeline and mommothization of tankers in as short a period as possible.

As regards the reopening of the Canal, it was also reported that the Suez Canal Authority was anixious for commodity loans including lights and tugbots. The Embassy in Cairo commented on the matter that technical cooperation between the two countries has a long history and this assistance project will become the best example.

In mid-November, the dispatch schedule was almost finalized, and rooms were booked for the survey team at a hotel in Cairo where accommodation facilities were stringent because it fell on the diplomatic and sight-seeing season. Thus, the team was ready for departure.

On November 24, schedule of meetings proposed by the Authority was acknowledged, along with a letter saying that the field survey would be permitted to cover a considerably large part of the Canal though strategic limitations were still existent.

On November 29, an inaugural rally for the team was observed at JICA.

IV. MIDDLE EAST WAR AND THE SUEZ CANAL

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Trend to Reopening of the Canal

The Suez Canal, which was opened on November 17, 1869, was nationalized on July 26, 1956 and has since been placed under the control of the Suez Canal Authority.

During the Middle East War which broke out in June 1967, many Egyptian vessels were sunk by the Israeli attack, and ordinary large merchant vessels locked in the Canal numbered as many as fifteen. As the result, the Canal was virtually closed and has remained closed for the subsequent seven years.

The condition of the Suez Canal in 1966 was as follows.

Length:	From light beacon to light house at the entrance of Port Said	11 km
	From light beacon at the entrance of Port Said to Ismailia	78 km
	From Ismailia to Port Tewfik	84 km
	Total	173 km
Width:	On water surface	200 m
	Between buoys in the channel	110 m
	Minimum width of the section with a depth of 11 m	90 m
Maximum Allowable Draft of Transit Vessels:		38 ft (11.58 m)
Maximum Tonnage of Transit Vessel Recorded in the Past:		147,000 DWT oil tanker (in ballast)

At present, the Canal presents remnants of war damages in many places, notable among which are the embanked forts on both banks which were built by the Egyptian and Israeli troops.

The Suez Office of the Suez Canal Authority was totally destructed just as the city of Tewfik, and all the signal stations were likewise destroyed except one which was half broken.

Nevertheless, the reopening work is now in smooth progress in the entire canal zone, and the Suez Canal Authority which returned from Cairo in September has already embarked on its normal services while engaging in the rehabilitation of buildings.

Three workshops were rebuilt and some of them have started running with the machines and equipment returned from the place of evacuation. Salvage of working crafts sunk during the war is also in progress, and it is now in the stage of checking

whether they can be repaired to the service condition.

Sweeping of all fairways was conducted three times by the British, French, U.S. and Russian forces. The Suez Canal Authority now guarantees that the Canal is free from the explosion of mines. All sunken vessels in the Canal were removed by the end of December '74 excepting small pontoons and tugboats which are being removed by the Authority's crane.

Four pilgrimage ships (draft : 17 ft) have already passed from Port Said to Tewfik. It is expected that large vessels now locked in the Canal will be removed in January or February, 1975.

The pilot and working craft services are also restored to the pre-war level at various ports of Asia and Africa, where they are offered for technical cooperation, ready for the reopening of the Canal.

Although the reopening of the Canal is much hoped for because of the shortage of foreign currency reserve, this shortage is hampering the restoration of the tugboats and navigation aids. However, as Egypt gained a more secure footing after the oil crisis and received offers for economic and technical cooperation in the Canal rehabilitation from many countries of the world in addition to the loan agreement which has already been concluded with the African Development Bank and the World Bank, there is high probability that the Canal will be reopened from about June 1975.

There are no particular problems which are likely to produce tension between Egypt and Israel. When Israel agrees, therefore, Sinai peninsula will be returned to Egypt. Syria and Lebanon which are on the east side of Israel are not on good terms with Israel, but Egypt seems to be hoping that the dispute between these Arab countries and Israel will be solved through diplomatic negotiations without involving her.

Throughout its stay in Egypt, the team noted the strong enthusiasm evinced by the Egyptian government for reopening the Canal. It was observed that Egypt was hoping for the reopening at the earliest possible date, although the government was stressing the crisis as a diplomatic gesture.

V. EXISTING STATE OF THE SUEZ CANAL

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1. Natural Conditions

1-1 Climate

Egypt has a so-called arid climate of which the desert and the sun are most symbolic.

In this country, the atmospheric temperature divides itself into two seasons, summer and winter. In summer which lasts from April through October, it is very hot and the air is dry. Winter lasts from November through March, during which the temperature is high in the daytime but declines in the nighttime. At the turning of the seasons, a sirocco accompanied by a dust storm often hits the country as cyclones developing in the south crawl up north. This is well known as "khasin," the hot southwesterly wind frequently bringing a high temperature exceeding 40°C. Generally speaking, however, the northwesterly wind prevails in Egypt through the year.

As is usual with the arid climate, the temperature is subject to a large difference which becomes more and more conspicuous from north to south. In summer, the daytime temperature is very high in the desert and often rises beyond 50°C.

The north wind blowing from the Mediterranean Sea in winter brings some rain. Since this rain falls only in a limited part of the delta area and the Mediterranean coasts, the inland area is virtually devoid of any rainfall throughout the year.

Climate of the Isthumus of Suez stands in between the Mediterranean climate and arid weather, and it is more like the former.

It is known through past experience that storms arise almost periodically in the neighbourhood of the Suez Canal. These storms are given names as shown in Table 5-1-1.

However, since both the storms and rainfall are negligible as seen in Table 5-1-6, operation of dredgers is possible almost at any time of the year.

The meteorological statistics of Port Said and Suez, located at the northern and southern ends of the Canal respectively, are shown in Tables 5-1-2 ~ 5-1-6. In Port Said, the annual average of the highest daily temperature is 25.6°C and that of the lowest daily temperature is 17.7°C, the annual rainfall is 79 mm, the annual average wind speed is 3.7 m/sec, and the annual average humidity is 74%. In Suez, the annual average of the highest daily temperature is 28.8°C and that of the lowest daily temperature is 16.5°C, the annual rainfall is 21 mm, the annual average wind speed is 4.3 m/sec,

and the annual average humidity is 65%.

Table 5-1-1 Storm Table

No.	Name of Storm	Date of Occurrence	Duration	Remarks
1	El Getas	Jan. 11	3 days	Rain
2	Al Feedah Kabera	Jan. 19	5 "	Too Windy
3	El Karam	Jan. 28	3 "	Rain
4	El Shams Saghera	Jan. 18	5 "	"
5	Al Hassaem	Jan. 10	7 "	"
6	Al Shams Kabera	Jan. 20	3 "	
7	Bard El Agouaga	Jan. 25	6 "	
8	Al Khamaseen	Jan. 29	50 "	Warm
9	Al Nafta	Jan. 18	2 "	"
10	El Saleeba	Jan. 21	3 "	
11	Al Kanasa	Jan. 26	3 "	Too much rain
12	Kasem	Jan. 6	7 "	Too Windy
13	El Feeda Saghera	Jan. 20	3 "	
14	Saleeb	Jan. 27	3 "	

Source: Suez Canal Authority

Table 5-1-2 Weather Statistics of Port Said (1)

(1901 to 1945)

Month	Temperature					Rainfall				Mean Wind Velocity	Mean Relative Humidity
	Average of Highest Daily Temperature	Average of Lowest Daily Temperature	Daily Average	Highest	Lowest	Total	Number of Days with 0.1 mm or More Rainfall (day)	Number of Days with 1.0 mm or More Rainfall (day)	Maximum Daily Rainfall		
	°C	°C	°C	°C	°C	mm	day	day	mm	m/s	%
Jan	18.8	10.6	13.7	29.0	3.0	18	4.6	3.5	36.7	3.8	76
Feb.	19.8	11.2	14.3	33.1	2.3	12	2.9	2.4	58.0	4.4	75
Mar.	21.3	13.3	16.2	38.1	2.7	9	2.2	1.9	20.0	4.3	73
Apr.	23.6	15.7	18.7	40.4	9.2	6	1.0	0.8	35.0	4.3	73
May.	26.5	18.6	21.8	45.0	10.2	3	0.6	0.6	28.4	3.8	73
Jun.	29.3	21.5	24.6	43.9	14.2	1	0.1	0.4	33.0	3.3	75
Jul.	31.3	23.2	26.4	38.1	19.0	0	0.0	0.0	Negligible	3.3	77
Aug.	31.8	23.8	26.9	37.2	20.6	0	0.0	0.0	Negligible	3.4	76
Sep.	30.6	22.8	25.8	40.1	17.5	0	0.1	0.1	1.8	3.3	73
Oct.	28.7	21.1	23.9	37.6	13.0	3	0.7	0.6	17.0	3.5	72
Nov.	25.1	17.6	20.4	36.5	9.3	11	2.3	1.8	48.0	3.6	73
Dec.	20.7	12.6	15.6	29.8	0.0	16	3.8	3.4	53.0	3.6	76
Average	25.6	17.7	20.7	37.4	10.1	7	1.5	1.3	27.6	3.7	74

Source: Report of Dredging Survey of the Suez Canal.

Table 5-1-3 Weather Statistics of Port Said (2)

(1901 to 1945)

Month	Frequency of Wind by Direction (%)								
	N	NE	E	SE	S	SW	W	NW	Calm
Jan.	6.1	11.3	4.3	5.3	5.1	32.8	15.0	19.6	2.8
Fab.	4.9	18.4	4.0	6.2	3.3	23.0	13.9	25.8	0.5
Mar.	11.0	25.3	7.4	5.9	2.6	11.4	7.4	28.9	0.1
Apr.	10.9	34.9	7.4	4.7	1.6	6.6	5.2	28.8	0.2
May.	20.8	32.1	7.5	4.0	1.1	4.0	3.8	26.6	0.1
Jun.	22.8	23.0	2.6	1.4	0.5	4.9	5.3	39.6	0.2
Jul.	17.8	5.2	0.4	0.4	0.3	7.0	12.3	56.4	0.2
Aug.	20.2	7.8	0.3	0.3	0.3	6.0	10.9	54.2	0.0
Sep.	25.3	13.1	1.9	0.8	0.8	4.5	6.5	47.1	0.0
Oct.	17.7	36.5	3.2	2.9	1.1	6.8	3.2	28.4	0.2
Nov.	11.8	33.7	4.7	3.4	2.4	13.8	6.6	23.6	0.3
Dec.	4.5	15.7	4.8	6.6	5.5	30.9	11.0	20.6	0.4
Average	14.5	21.4	4.0	3.5	2.1	12.6	8.4	33.3	0.2

Source: Report of Dredging Survey of the Suez Canal.

Table 5-1-4 Weather Statistics of Suez (1)

(1921 to 1945)

Month	Temperature					Rainfall				Mean Wind Velocity	Mean Relative Humidity
	Average of Highest Daily Temperature	Average of Lowest Daily Temperature	Daily Average	Highest	Lowest	Total	Number of Days with 0.1 mm or More Rainfall (day)	Number of Days with 1.0 mm or More Rainfall (day)	Maximum Daily Rainfall		
	°C	°C	°C	°C	°C	mm	day	day	mm	m/s	%
Jan.	19.9	9.4	13.8	26.0	1.4	2	1.3	0.9	6.8	3.8	68
Feb.	21.0	10.0	14.6	30.5	2.7	2	1.1	0.7	12.0	4.0	66
Mar.	24.0	12.1	17.1	34.2	3.6	4	0.8	0.6	16.0	4.4	63
Apr.	28.3	14.8	20.5	42.5	7.9	1	0.4	0.2	8.0	4.4	60
May.	32.5	18.6	24.4	43.8	10.7	1	0.2	0.2	12.3	4.4	59
Jun.	34.9	20.9	26.9	43.6	15.6	0	0.2	0.1	2.0	4.6	61
Jul.	36.3	22.7	28.4	42.2	18.4	0	0.0	0.0	0.0	4.4	62
Aug.	36.2	23.1	28.5	42.9	18.9	0	0.0	0.0	0.0	4.5	65
Sep.	33.5	21.3	26.3	39.9	15.7	0	0.0	0.0	2.7	4.6	67
Oct.	31.0	19.2	24.0	42.6	12.2	2	0.6	0.5	11.0	4.3	68
Nov.	26.5	15.5	20.0	41.1	8.5	5	0.8	0.6	32.3	4.0	69
Dec.	21.7	10.8	15.4	30.0	3.6	4	1.0	0.7	28.5	3.7	68
Average	28.8	16.5	21.7	38.3	9.9	2	0.5	0.4	11.2	4.3	65

Source: Report of Dredging Survey of the Suez Canal.

Table 5-1-5 Weather Statistics of Suez (2)

(1921 to 1945)

Month	Frequency of Wind by Direction (%)								
	N	NE	E	SE	S	SW	W	NW	Calm
Jun.	35.4	5.4	3.9	5.1	15.3	5.9	5.7	13.7	9.9
Feb.	34.7	5.8	3.0	4.6	17.3	6.2	7.6	13.5	7.3
Mar	47.0	4.2	2.1	3.6	14.7	4.2	3.0	15.6	5.6
Apr.	55.4	4.5	1.7	3.1	12.3	2.8	2.4	13.7	4.1
May.	63.9	3.8	0.8	1.2	9.3	2.0	1.1	13.2	4.7
Jun.	77.9	3.4	0.5	0.8	4.7	0.7	0.6	9.6	1.8
Jul.	78.5	5.4	0.2	0.2	4.0	0.3	0.2	8.9	2.3
Aug.	81.8	4.6	0.3	0.1	1.7	0.4	0.1	8.0	3.0
Sep.	83.4	4.6	0.2	0.3	1.5	0.1	0.3	8.4	1.2
Oct.	69.4	4.2	0.9	1.4	4.2	1.0	0.8	13.3	4.4
Nov.	60.2	4.7	2.0	1.9	6.1	2.2	2.6	13.3	7.0
Dec.	41.4	6.6	3.4	3.6	13.5	3.1	3.6	12.2	12.6
Average	60.8	4.8	1.6	2.2	8.7	2.4	2.3	11.9	53

Source: Report of Dredging Survey of the Suez Canal.

1-2 Geographical Phenomena

The history of the Isthmus of Suez goes back to the Tertiary period and the Quaternary period of the Cenozoic era. It is believed that at the end of the Tertiary period, which is estimated to have terminated about 2 million years ago, the Red Sea in the south of the Canal was connected to the Mediterranean Sea and there was created a strait.

The isthmus assumed the present shape by the sedimentation and elevation which took place in later years as a result of the actions of the ocean, wind and the Nile. Even after the creation of the isthmus, Bitter Lakes and the Red Sea were at a time open to each other but later disjoined. Lake Menzala, a vast marsh area extending to the north of the isthmus, came into being as a result of the earthquakes in the ancient ages and the Mesozoic era.

1-2-1 Topography

The Suez Canal has a total length of 162 km. Huge marshy areas embracing Lake Menzala extend along both sides of the Canal in the 40 km section from Port Said. Lake Menzala is very shallow and a sizable portion of its area is exposed above the water at time of low tide. Lake Timsah is located in the 76 ~ 85 km section point and Bitter Lakes in the 97 ~ 134 section from Port Said. Both sides of the canal and lakes are covered with deserts. However, there are found strips of green land ranging in width from 500 to 2,500 m along the west coast in the 76 ~ 115 km section and in the 134 ~ 155 km section. The highest elevation along the coast of the Canal is found in El Gisr, but is it only about 17 m. The greater part of the land stretching from the west coast of the Canal is a flat desert area, although Mt. Attaqa rising 890 m above sea level is found about 20 km west of Suez. On the east coast, a flat desert area extends within 10 km from the Canal and lakes, and steep mountains rising more than 100 m above sea level are found east of this desert area.

The sea bed in the offing of Port Said has a comparatively mild slope which is 1/300 up to a water depth of 6 m and 1/1,300 where the depth is larger than that.

1-2-2 Geology

The following facts were disclosed by the preliminary boring survey of the Suez Canal.

Soil in the neighbourhood of Port Said entrance channel is composed of fine drift

sand carried by the Nile. Soil in the 62 km section from Port Said, on the other hand, consists of sandy silt up to a depth of 10 m and brownish hard clay between depths of 10 m and 50 m. The internal friction angle in this section is about 25°.

The section from the 62 km point to Port Tewfik is comprised of a variety of soils such as sandy gravel, fine sand, limestone, granite, etc. The internal friction angle in this area is about 30°. Rock salt is found on the bottom of Great Bitter Lake. In the southern area stretching from Little Bitter Lake to Suez, the strata are very complicated and composed chiefly of hard clay containing brown gravels and partly of sand and rocks. The rocks include quartz schist, clay-slate, conglomerate, sandstone, limestone, granite, etc.

At Port Said, depositions of silt and sand both containing organic substances are found in upper layers. These layers have a high percentage of moisture content and a large compressive ratio because they contain large amounts of organic substances.

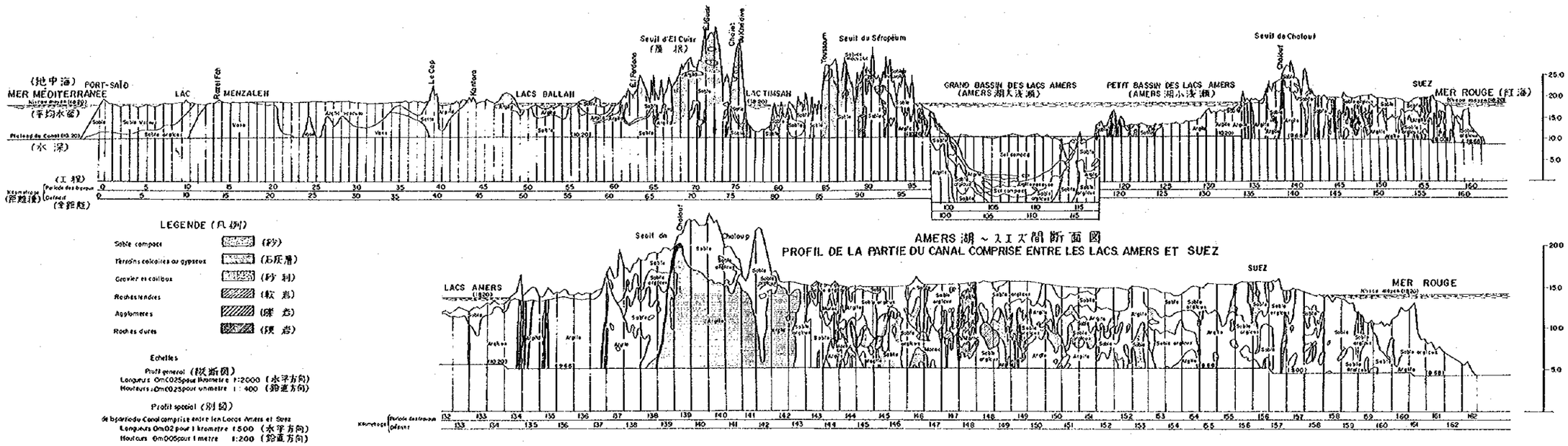
The canal geology included in the 'Introduction to the Environments of the Suez Canal (Kinouchi and Kusaka, 1963)" is very useful for conceptual comprehension of soil nature in the canal zone, so that is it shown in Fig. 5-1-1.

Table 5-1-6 Weather Table of Suez

Month	Rainfall		Average Wind Speed		(Number of Stormy Days)	Number of Days with Visibility of Less than 3.7 km at 0800 hrs
	Average Rainfall (mm)	Number of Days Recording More than 1.0 mm of Rainfall	0800 (m/s)	1400 (m/s)		
Jan.	2.5	0.9	1.5	2.6	–	0.2
Feb.	2.5	0.7	1.5	2.6	–	0
Mar.	5.1	0.6	2.1	2.6	–	0.6
Apr.	0	0.2	2.6	2.6	–	0
May.	0	0.2	2.6	2.6	–	0
Jun.	0	0.1	2.6	3.1	–	0
Jul.	0	0	2.1	2.6	–	0
Aug.	0	0	2.1	3.1	–	0
Sep.	0	0	2.1	3.1	–	0
Oct.	2.5	0.5	2.1	2.1	–	0
Nov.	5.1	0.6	1.5	2.1	–	0
Dec.	5.1	0.7	1.5	2.1	–	0.5
Average	–	–	2.0	2.6	–	–
Total	22.8	5	–	–	–	1
Observations	25				–	5

Notes: 1. Observations made in 5 to 25 years during the 1917 ~ 1945 period.
2. Observations made at Egyptian Standard Time.
3. Height above mean sea level-10.1 m.

運河地質地形断面図
PROFIL EN LONG DU TRACE D'EXECUTION DU CANAL MARITIME ET COUPE GEOLOGIQUE DU TERRAIN SUR L'AXE DU CANAL



AMERS 湖 ～ スエズ間断面図
PROFIL DE LA PARTIE DU CANAL COMPRISE ENTRE LES LACS AMERS ET SUEZ

Fig. 5-1-1 Geology of the Suez Canal

1-3 Marine Phenomena

Tide and current velocity are the major facts of marine phenomena which should be taken into consideration in planning the construction and operation of the Canal.

The datum plane traditionally used for tidal level measurement in the Canal is the line marked 20 m beneath the sea surface on the base liner marker which was installed at Suez when the Canal was constructed by Lesseps.

The following table shows the tidel levels recorded at both ends of the Canal, i.e., Port Said and Port Tewfik.

Table 5-1-7 Tidal Table of the Suez Canal

Unit: m

	Port Said	Port Tewfik
H.H.W.L	18.60	19.50
L.L.W.L	17.40	17.00
H.W.L	18.49	19.00
L.W.L	18.09	17.50

Source: Suez Canal Authority.

Table 5-1-8 Monthly Average Level of the Suez Canal

	Port Said	Port Tewfik		Port Said	Port Tewfik
Jan.	18.013	18,355	Jul.	18,115	18,169
Feb.	17,993	18,351	Aug.	18,146	18,144
Mar.	17,953	18,313	Sep.	18,120	18,097
Apr.	17,956	18,319	Oct.	18,085	18,197
May	17,979	18,309	Nov.	18,086	18,391
Jun.	18,036	18,211	Dec.	18,076	18,407

Source: Suez Canal Authority

According to the above data, the tidal range reaches 0.4 m at Port Said and 2.0 m at Port Tewfik. The highest tidal level, called storm tide, is caused by depression and wind setup.

The general tendency is that the mean level is higher at the Red Sea than at the Mediterranean Sea, so that a feeble northward flow is generated and joined by the flow

caused by tide in the whole canal.

The values of H.W.L and L.W.L at respective points along the Canal are shown in Table 5-1-9.

Table 5-1-9 Tidal Levels along the Suez Canal

	H.W.L.	L.W.L	Remarks
Port Said	18.49	18.09	
Raz El Ech	18.45	18.11	15 km from Port Said.
34 km from Port Said	18.39	18.14	
El Ferdan	18.33	18.22	65 km from Port Said.
Ismailia	18.30	18.26	Timsa Lake.
Deversoir	18.27	18.25	North bank of Great Bitter Lake, 97 km from Port Said.
133 km from Port Said	18.30	18.20	South bank of Great Bitter Lake.
Chalouf	18.43	18.07	146 km from Port Said.
Port Tewfik	19.00	17.50	

Source: Suez Canal Authority.

The above table indicates that the effects of tide are larger in the southern region of the Canal lying between Little Bitter Lake and Suez than in the northern canal region, but it diminishes in Bitter Lakes. The tidal current has a maximum velocity of 30 cm/sec and 40 cm/sec in the north of Bitter Lakes and at Port Said, respectively. At Suez, it has a mean velocity of 100 cm/sec and a maximum velocity of 150 cm/sec.

Other factors to be considered are the oceanic conditions at the entrance of the Canal.

At Suez, both wind and wave are very mild so that the canal construction or operation calls for no particular consideration except for tidal level and tidal current which are described above.

At Port Said, the tidal level and tidal current pose no problems, but wind and wave exert a large influence on the construction and operation of the Canal.

Data of wind and wave at Port Said are shown in Tables 5-1-10 ~ 5-1-11.

Table 5-1-10 Wave Data (Port Said)

Unit: %

Wave Direction / Wave Height	WNW		NW		NNW		N		NNE		NE		NEE		E		TOTAL	
3.0 m and more	0.03	8.82	0.24	70.59	0.07	20.59	–	–	–	–	–	–	–	–	–	–	0.34	100.00
2.0 m and more	0.96	40.85	1.25	53.19	0.14	5.96	–	–	–	–	–	–	–	–	–	–	2.35	100.00
1.0 m and more	125.0	42.68	12.61	43.05	2.41	8.23	0.10	0.34	0.08	0.27	0.13	0.44	1.08	3.69	0.38	1.30	29.29	100.00
0.5 m and more	28.10	31.23	37.16	41.30	9.07	10.08	2.41	2.68	3.84	4.27	2.59	2.88	5.37	5.97	1.44	1.60	89.98	100.00

Notes:
1. Columns on the left show the occurrence ratios of waves by height and direction to the annual total number of occurrence which is taken at 100.
2. Columns on the right show the occurrence frequencies of waves by direction in accordance with specific height of waves.
3. The annual maximum wave height is 4 m with a period of 8 sec.
4. The maximum wave height recorded in the last 10 years is 6 m with a period of 11 sec.

Table 5-1-11 Wind Data (Port Said)

Unit: %

Wind Direction / Wind Speed	WNW		NW		NNW		N		NNE		NE		ENE		E		TOTAL	
11 m/s and more	0.41	25.47	0.52	32.40			0.14	8.70	0.07	4.35	0.07	4.35	0.40	24.84			1.61	100.00
9 m/s and more	2.55	29.72	2.53	29.49	0.54	6.29	0.41	4.78	0.28	3.26	0.48	5.59	1.43	16.67	0.36	4.20	8.58	100.00
7 m/s and more	8.34	27.10	10.21	33.18	2.32	7.54	1.75	5.69	1.00	3.25	2.16	7.02	3.72	12.09	1.27	4.13	30.77	100.00
5 m/s and more	20.22	26.87	20.88	27.75	6.84	9.09	5.15	6.84	5.52	7.34	5.86	7.79	8.18	10.87	2.59	3.44	75.24	100.00

Notes:
1. Columns on the left show the occurrence ratios of winds by speed and direction to the annual total number of winds which is taken at 100.
2. Columns on the right show the occurrence frequencies of winds by direction in accordance with specific speed of winds.
3. The annual maximum wind speed is 15 m/sec.
4. The maximum wind speed recorded in the last 5 years is 18 m/sec.
5. Prepared from the data made available by the Suez Canal Authority.

Table 5-1-10 shows that about 83% of all waves higher than 50 cm are in WNW ~ NNW. As to waves higher than 1 m, about 94% are in WNW ~ NNW.

As to the wind, about 55% of all winds with a speed of 5 m/sec and higher are in WNW ~ NW and about 58% with a speed of 11 m/sec and higher are in WNW ~ NW.

The wave set up by these winds ranges from ±25 cm to ±40 cm.

The tidal current in the vicinity of the entrance channel of Port Said flows from west to east, with the surface current registering a maximum speed of 60 cm/sec and the bottom current a maximum of 40 cm/sec.

2. Suez Canal

2-1 Excavation, Maintenance and Management of the Canal

The Canal was opened on November 17, 1869 by the hands of the peoples of foreign and Arab countries who worked laboriously over a period 10 and half years and 22 days.

The Canal has undergone as many as 10 repair works as well as ceaseless maintenance works in the period of 100 years or so after it was first opened.

For the purpose of introducing the history of the Canal, the outline of the plans established in the past is described below together with the trend of the amount of soil generated by the cutting and dredging works which occupy the larger part of the canal works.

(1) Establishment of the primary plan in 1858

The Supreme Works Council established the excavation plan of the Canal. The major technical data of this plan are as follows. Water depth: 8 m, bottom width: 22 m, water surface width: 58 m, places for vessels to pass each other: provided at intervals of 10 km with the width increased by 5 m over a distance of 300 ~ 500 m.

The work was started on April 25, 1859 and completed on November 17, 1869. The total amount of excavated soil was 74 million m^3 excluding the residual soil amounting 3 million m^3 or so. Upon completion of this work the Canal permitted transit of vessels with a draft of up to 5 m.

(2) Establishment of the 1st improvemnet plan in 1876

The details of the plan were as follows.

(1) The length of the ship exchange was increased to 1,000 m.

(2) The places of the ship exchanges were increased.

(3) The curves were improved.

(4) The southern channel (Bitter Lakes – Suez) was widened.

(5) Anchorages were constructed at Port Said and Suez harbours.

(6) Stone dykes were constructed.

(3) Establishment of the 2nd improvement plan in 1884 ~ 1885

This plan was adopted by the Suez Canal International Advisory Works Commission, and aimed at providing double channels to the Canal. The estimated amount of soil to be dreged and excavated was 107 million m^3 or so. But, the amount actually dredged and excavated was only 37 million m^3. By the execution of this plan from 1887 to 1904, the water depth and the bottom width were increased to 9 m and 37 m respectively, and curved sections were also improved.

(4) Establsihment of the 3rd improvement plan in 1901

The details of this plan were as follows.

(1) The depth was increased to 9.5 m (However, this was changed to 10.5 m in 1906)

(2) The gradient of the underwater slope was set at less than 1 : 3.

(3) 11 ship exchange places were newly installed.

(5) Establishment of the 4th improvement plan in 1908

(1) The depth was increased to 11 m.

(2) The bottom width at a water depth of 10 m was increased to more than 45 m.

(6) Establishment of the 5th improvement plan in 1912

The contents were as follows.

(1) The depth was increased to 12 m.

(2) The bottom width at a water depth of 10 m was increased to more than 60 m.

(7) Establishment of the 6th improvement plan in 1921

(8) Establishment of the 7th improvement plan in 1948

The details of the plan were as follows.

(1) The depth was increased to 12.5 m.

(2) Construction of Ballah bypass was undertaken.

(3) The depth of the tanker anchorage at Timsah Lake was increased from 10 m to 12 m.

(4) Improvement of the anchorage for forming convoys at Port Said Harbour was undertaken.

World War I broke out in 1939.

(9) The 8th improvement plan in 1954

This plan was established to permit the transit of vessels of 38,000 DWT (draft 36 ft) through the Canal.

(1) Construction of Port Said bypass was undertaken.

(2) Construction of Kabret bypass was undertaken.

(3) The depth was increased to 14.6 m.

(4) The bottom width at a depth of 11 m was increased to 80 m.

(5) The width of refuge place was increased.

After the abovementioned improvement, Compagnie Universelle du Canal Maritime de Suez was nationalized on July 26, 1956 and the Suez Canal Authority was established.

The technical data of the Canal as of August 1956 were as follows.

(1)	Length of Port Side channel	9 km
(2)	Distance from Port Said lighthouse to Ismailia	78 km
(3)	Distance from Ismailia to Suez Channel Entrance	83 km
(4)	Suez Channel	4 km
(5)	Overall length of the route	174 km
(6)	Water surface width (standard)	150 m
(7)	Water surface width (minimum)	120 m
(8)	Distance between channel buoys	75 m
(9)	Bottom width at a water depth of 10 m (minimum)	60 m
(10)	Maximum allowable draft	10.67 m
(11)	Sectional area of the Canal	1,200 m^2

(10) Revised 8th improvement plan in 1957

This plan was established to allow transit of vessels of 45,000 DWT (draft 37 ft), and implemented in the 7.077 km ~ 67.000 km section and Timsah Lake – 97.850 km section. The details were as follws.

(1) The width of water surface was increased by an average of 30 m.

(2) The depth was increased to 15.50 m.

(3) Existing revetments and mooring posts were replaced by new ones.

The amount of the abovementioned improvement works was as follows.

Amount of excavated soil: 4 million m^3 or so, amount of dredged soil: 30 million m^3 or so, removal and installation of revetments: 50 km, shifting and new

installation of mooring posts: 252 pieces

(11) Establishment of a new plan in 1959

This plan was intended to be started in 1959 for attainment of the following ultimate objectives.

(1) Provision of double channels over the total length of the Canal.
(2) Transit of 65,000 DWT class tankers (draft 45 ft).
(3) Improvement of pilot service and wire & radio communication facilities.
(4) Arrangement of working crafts including dredgers.
(5) Expansion and improvement of manufacturing and repair facilities of ships and machinery.
(6) Introduction of modern equipments for the purpose of improving the service.
(7) Improvement of rescue services.

The following are the major objectives of the 5 year plan which was executed for completion in 1963.

(1) Expansion of the bottom width at a depth of 11 m to 90 ~ 100 m.
(2) Increase of the depth for transit of vessels with a draft of 37 ft.
(3) Expansion of the water section of the Canal to 1850 m^2.
(4) Improvement of pilot service in Port of Suez harbour.
(5) New installation of tugboat bases for rescue service.
(6) Establishment of a research centre.
(7) Improvement of workshop equipment at Port Fouad.
(8) New installation of a 25,000 ton floating dock.
(9) Arrangement of working crafts and tugboats for rescue service.
(10) Arrangement of fire fighting appliances.
(11) Arrangement of buildings.
(12) Arrangement of radio equipments.
(13) Improvement of telephone line between Port Said and Port Tewfik.
(14) Arrangement of large capacity quay at Port Said harbour.

Table 5-2-1 Maximum allowable Draft of Transit Vessel

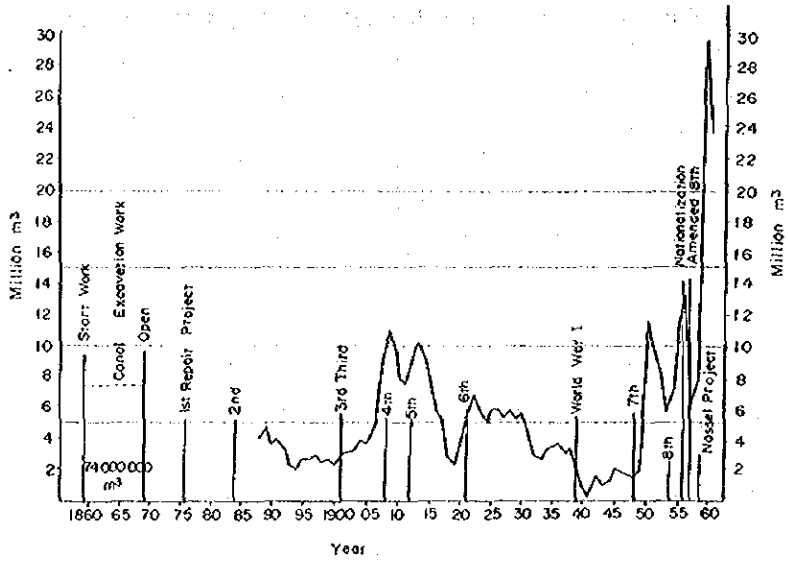
Year and Month	Maximum Draft (ft)
1961 . Jan.	35.5
1961 . Feb.	36
1961 . Apr.	36.5
1961 . May	37
1964 . Feb.	38

Table 5-2-2 Amount of Dredged Soil of the Suez Canal (1888 ~ 1954)

Unit: m^3

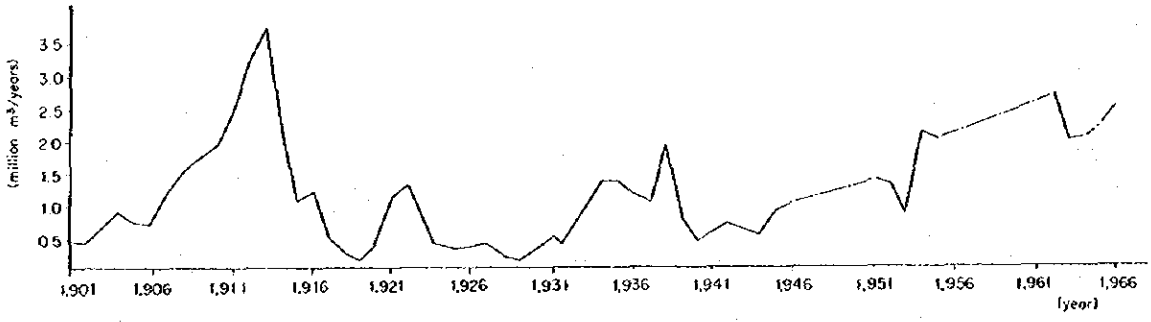
Year	Annual Amount of Dredged Soil	Year	Annual Amount of Dredged Soil	Year	Annual Amount of Dredged Soil
1888	3,974,336	1913	9,915,407	1938	3,394,751
89	4,736,819	14	9,046,113	39	2,250,863
90	3,749,242	15	7,478,701	40	1,038,885
91	3,946,658	16	5,693,111	41	407,438
92	3,419,902	17	5,338,884	42	1,806,547
93	2,109,005	18	2,844,032	43	1,077,217
94	2,042,278	19	1,995,550	44	1,162,625
95	2,735,338	20	3,434,170	45	2,040,343
96	2,620,347	21	5,321,159	46	1,831,925
97	2,919,260	22	6,884,082	47	1,763,924
98	2,440,785	23	5,567,512	48	1,754,043
99	2,669,446	24	4,949,381	49	2,145,298
1900	2,344,524	25	5,896,657	50	11,581,736
1901	2,945,408	26	5,791,699	51	9,313,634
2	3,204,606	27	5,388,578	52	8,380,477
3	3,164,743	28	5,909,007	53	5,750,841
4	3,938,358	29	5,267,739	1954	7,223,847
5	3,680,810	30	4,566,688	Total	304,292,054
6	5,011,448	31	4,267,610	1955	11,800,000
7	8,914,524	32	2,996,824	56	18,300,000
8	11,251,789	33	2,705,629	57	4,900,000
9	9,842,482	34	3,169,674	58	6,600,000
10	7,863,826	35	3,418,972	59	30,000,000
11	7,417,870	36	3,802,049	60	24,000,000
12	9,635,120	37	3,139,508		

Source: "Introduction to the Suez Canal"



Source: "Introduction to the Suez Canal"

Fig. 5-2-1 Trend of Annual Amount of Dredged Soil



Notes: Prepared by the data presented by Canal Authority.

Fig. 5-2-2 Trend of Maintenance Dredging Volume

Table 5-2-3 Trend of Maintenance Dredging Volume at Port Said

Year	Amount of dredged Soil (thousand m^3/year)	Year	Amount of Dredged Soil (thousand m^3/year)	Year	Amount of dredged Soil (thousand m^3/year)
1874	180	06	683	37	1,077
75	140	07	1,115	38	1,958
76	184	08	1,570	39	714
77	176	09	2,010	40	384
78	147	10	1,997	41	–
79	102	11	2,477	42	712
80	182	12	3,219	43	66
81	209	13	3,745	44	578
82	193	14	2,244	45	862
83	160	15	1,106	46	1,016
84	89	16	1,266	47	–
85	163	17	428	48	–
86	228	18	112	49	–
87	158	19	37	50	448
88	164	20	731	51	1,359
89	151	21	1,151	52	1,214
90	361	22	1,396	53	544
91	291	23	488	54	–
92	274	24	445	55	2,165
93	251	25	227	56	1,898
94	225	26	436	57	–
95	275	27	366	58	–
96	341	28	184	59	–
97	530	29	135	60	–
98	476	30	320	61	–
99	432	31	531	62	2,722
1900	384	32	480	63	2,059
01	252	33	551	64	2,119
02	410	34	550	65	2,552
03	610	35	1,427	66	2,671
04	920	36	1,146		
05	713				

Source: Suez Canal Authority

(12) Trend of Construction and Dredging works

The Suez Canal is an open channel excavated through a desert and lakes. Therefore, excavation and dredging were the major works. The amount of soil moved by dredging or excavation since the Canal construction was started in 1857 is shown in Fig 5-2-1. As to the annual amount of dredged soil, the values are known for the period from 1888 to 1960, and are shown in Table 5-2-2. Further, the trend of the maintenance dredging volume at the Entrance Channel of Port Said harbour, which is important for satisfactory maintenance and operation of the Canal, is shown in Table 5-2-3 and Fig. 5-2-2.

In principle, improvement works have been teamed to contractors, while maintenance works have been executed directly by the hand of the Suez Canal Authority.

Since local contractors have no capability for the required dredging work, cooperation of foreign contractors must be sought for any dredging work exceeding the capacity of the Authority.

However, shore works including revetments, roads, buildings, etc. are executed by local contractors specialized in civil engineering and building.

2-2 Dimensions of the Canal

The Suez Canal connects the Mediterranean Sea with the Red Sea. The entrances of the Canal are Port Said on the Mediterranean Side and Port Tewfik of Suez on the Red Sea side.

Firstly, the route of the Canal will be explained. Fig. 5-2-4 shows the Canal route. The lengths of the routes are as follows.

- o From the channel outside the Port Said harbour to Port Tewfik: 173.5 km
- o From the lightbeacon to the lighthouse in the entrance of Port Said: 11.0 km
- o From Port Said harbour to Port Tewfik: 162.5 km

For the purpose of indicating the locations of respective points along the Canal, the distances measured from the lighthouse at Port Said harbour are adopted.

The Canal passes through three lakes midways. According to the aforesaid method of indicating the positions, the Canal passes through Timsah Lake in the 76 km ~ 81 km, section, Great Bitter Lake in the 97 km ~ 120 km, section and Little Bitter Lake in the 120 km ~ 134 km section.

Further, 3 bypasses are provided to the Canal. The Port Said bypass is between the points 50 km ~ 62 km, and the Kabret bypass between the points 114 km ~ 123 km.

At Port Said, the Entrance Channel of about 11 km long extends linearly in the NE direction. Here, the effect of wind and wave coming from WNW ~ NNW is significant, so that the western breakwater (2.8 km, submerged at the head) is installed practically parallel to the Entrance Channel. Further, the eastern breakwater of 1.8 km long is installed on the eastern side of the Entrance Channel for the purpose of assuring the space to form convoys.

The convoys going southward are formed at this harbour. Therefore the greater part of the harbour area is used for this purpose. Mooring buoys for 38 berths are provided, and ships are moored by the buoys and anchors at 9 of the 38 berthes, while they are moored to face the Canal axis at all other berthes.

The Canal is bent about 45° against the Entrance Channel at Port Said harbour and goes southward straightly.

Midways, the Port Said bypass branches at the points 3 km ~ 7 km. After that, however, the Canal goes directly southward through the marshy area of Lake Menzala till the point of 50 km is reached. At the points 50 km ~ 62 km, the route changes the direction slightly eastward. The Ballah bypass exists in this section. The first southbound convoy waits in the western channel of this bypass until the northbound fleet passes by. At the point of 62 km, the route turns again westward till it reaches Timsah Lake. El Ferdan railway bridge crosses the Canal at the point of 68 km.

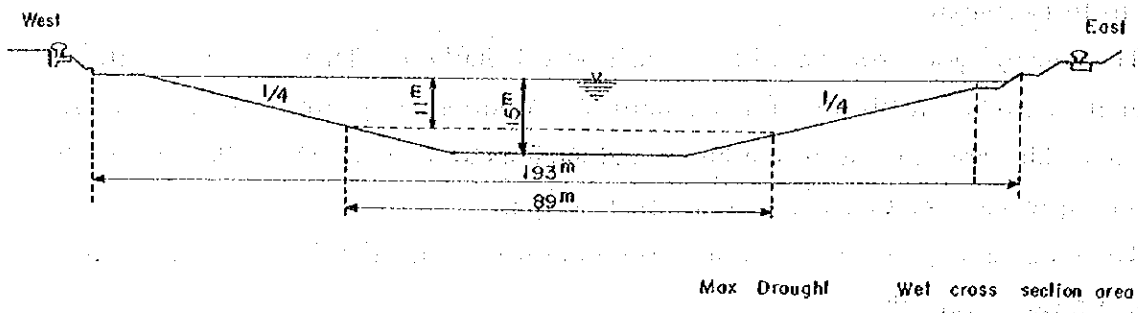
Ismailia, the centre of the Canal operation, is situated on the west coast of Timsah Lake, and the Canal Authority's headquarters faces this lake. At about the centre of the lake, the route turns east by about 90° and increase in width. An anchorage is provided in the estern end of the lake.

After leaving Timsah Lake, the route leads to Bitter Lakes, crossing it in the 97 km ~ 134 km section. Great Bitter Lake has North Anchorage and South Anchorage. The southbound convoy No. 2 waits in South Anchorage until the northbound convoy enters Bitter Lakes, and then sails for Suez through Kabret by-pass.

After the 134 km point, the Canal takes a straight southward course, turning westward by about 45° at 158 km point and passing Port Tewfik, and then reaches the Red Sea.

Fig. 5-2-3 shows the typical cross-section of the Canal. As seen in this figure, the Canal has a water depth of 15.0 m, a channel width of 193 m, and a slope grade of 1/4. However, the channel with at a depth of 11 m (which is adopted by the Suez Canal Authority) is 89 m.

Both the water depth and the slope grade very largely over the entire length of the Canal, the former ranging from 13.5 to 16.0 m and the latter from 1/4 to 1/25. The slope grade is 1/4 in the northern part where the soil is loose and soft, but ranges from 1/3 to 1/25 in the southern part where the soil condition improves.



Source: "Introduction to the Suez Canal."

Fig. 5-2-3 Typical Cross-section (30 km point)

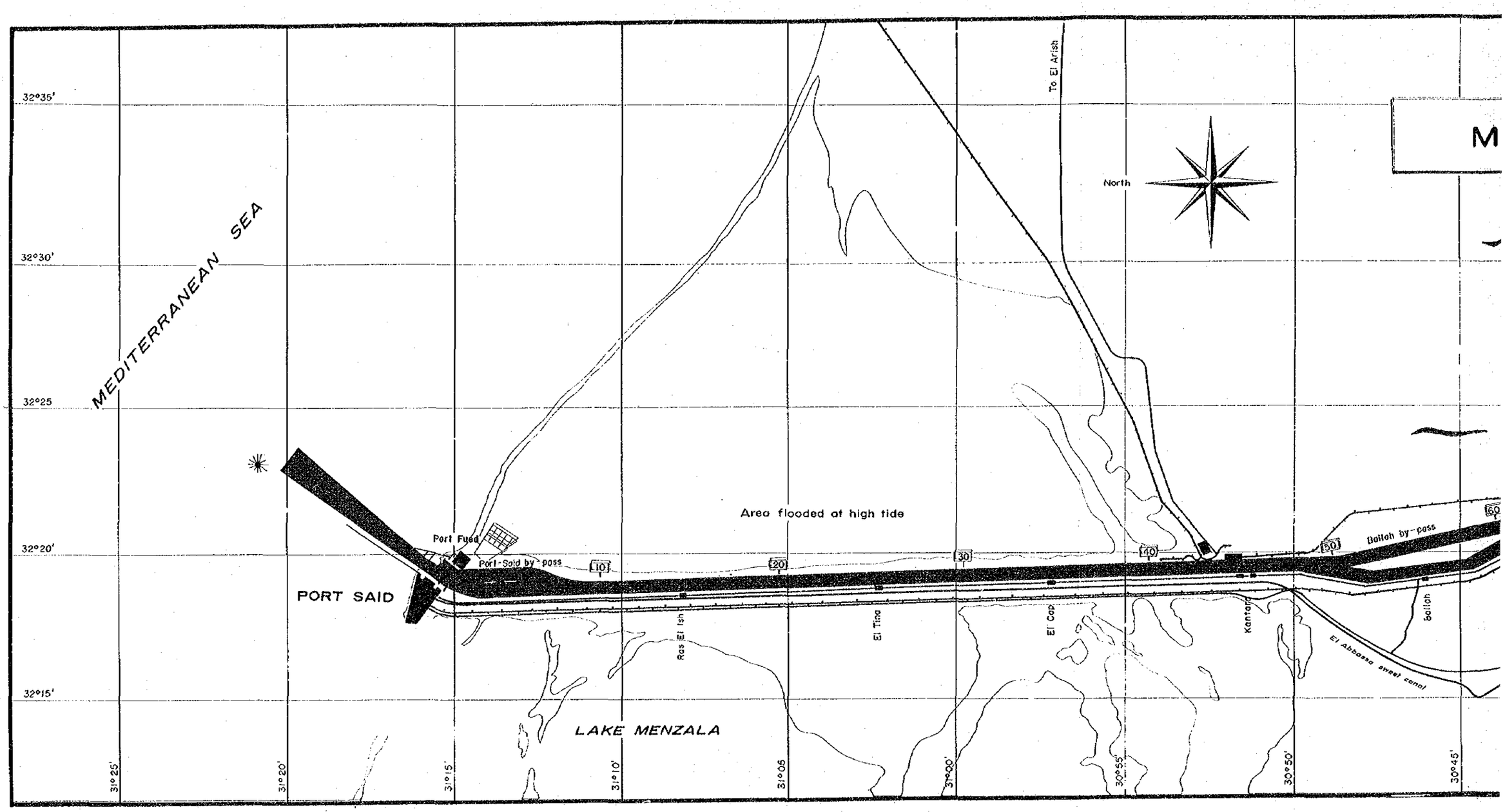
2-3 Suez Canal after Middle East War

After the outbreak of the Fourth Middle East War on October 16, 1973, Egyptian and Israeli troops stood vis-a-vis on the banks of the Suez Canal, engaging in repetitive and fierce offensive as well as defensive operations. As a result, the Canal and towns along it were afflicted with heavy war damages.

Through the cooperation of the Suez Canal Authority, the team was given the opportunity to visit the Suez Canal and its vicinities and observe the destruction of war and laborious restoration effort of the Egyptian people. During this visit, which is briefed below, the team was deeply impressed by the elaborate effort exerted jointly by the Authority and Egyptian people for early reopening of the Canal.

In Port Said, one of the Authority's workshops is located. This workshop is the centre of the Authority's shipbuilding, machine manufacturing and repair activities, and many private factories affiliated with the Authority are found in its proximity. These facilities were the target of attack by Israeli ground and air forces. However, it was not possible to see the extent of their destruction because the team sailed on the Canal in a motor launch without landing at Port Fouad.

At Port Fouad which is at the northern end of Port Said bypass, the team observed the landed remains of a sunken vessel and a Greek floating crane moored nearby which seemed to have engaged in the salvage of the vessel.


32°35'
32°30'
32°25
32°20'
32°15'
MEDITERRANEAN SEA
To El Arish
North
M
Area flooded at high tide
Port Fuad
Port-Said by-pass
PORT SAID
10
20
30
40
50
60
Ballah by-pass
Ras El Ish
El Tina
El Cap
Kantara
Ballah
El Abbassa sweet canal
LAKE MENZALA
31°25'
31°20'
31°15'
31°10'
31°05
31°00'
30°55'
30°50'
30°45'

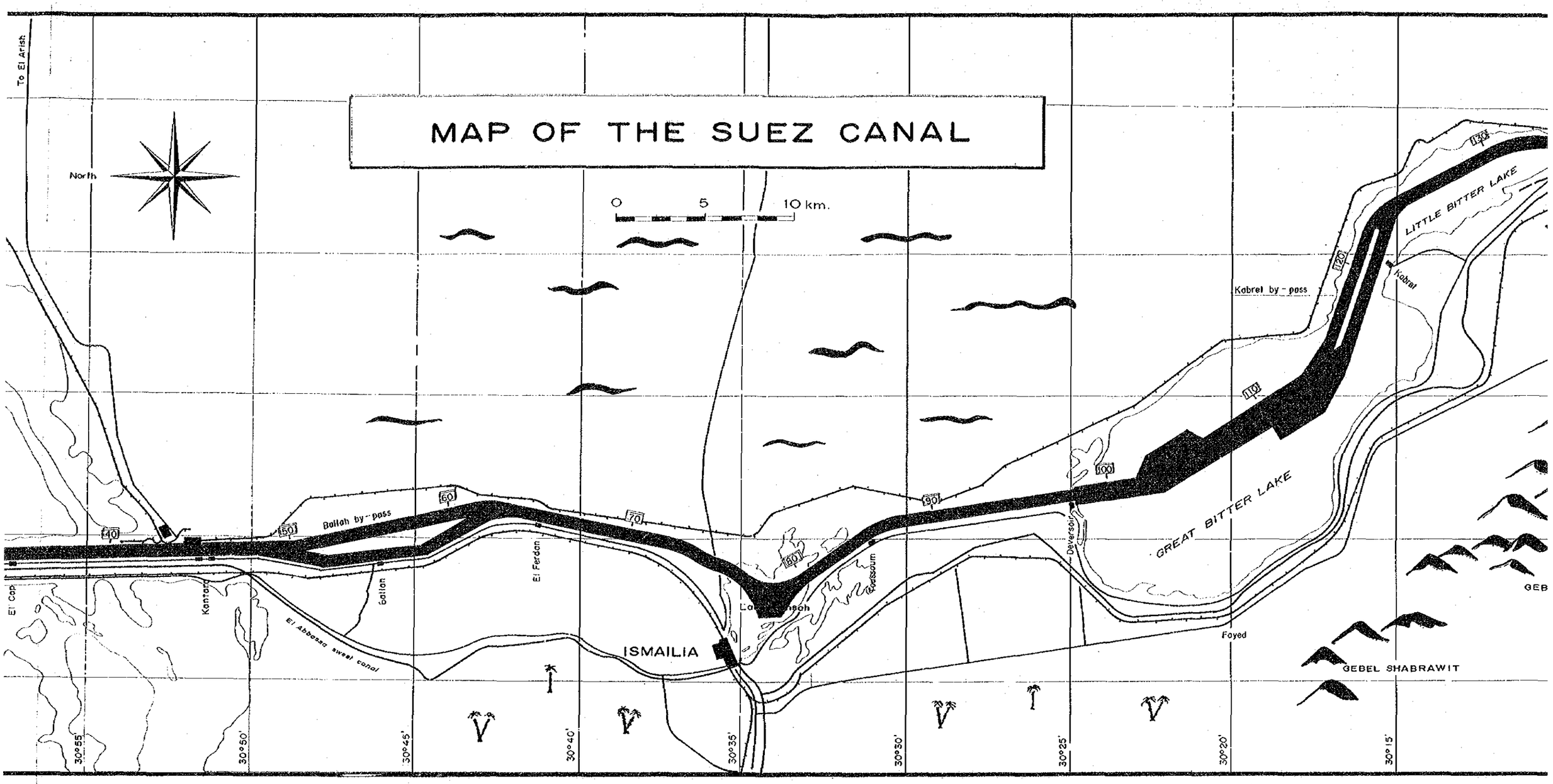


Fig. 5-2-4 Map of the Suez Canal

ANAL

LITTLE BITTER LAKE

GREAT BITTER LAKE

Kabret by - pass

Kabret

Geneifa

El Shallufa

Kaubri

Canal of the Pharaohs

SUEZ

Port Taufiq

RED SEA

GEBEL GINEIFA

GEBEL SHABRAWIT

GEBEL ATTAQA

Cair Suez road

Deversoir

Foyed

Principal roads

Railways

Sweet water canal

30°30'

30°25'

30°20'

30°15'

30°10'

30°05'

30°00'

29°55'

29°50'

The water and oil supplying facilities on the Port Said side were also destroyed. The greater part of the oil tanks with a capacity of about 30 thousand tons were completely damaged.

Residential and shopping districts in Port Said were not so heavily damaged as those in Ismailia and Suez, except for some buildings along the Canal.

Port Said and Ismaila are linked by two roads (Treaty Road and the Authority's exclusive road) and by a railway. A road bridge constructed on the route of Treaty Road at the entrance of Port Said was completely destroyed during the war, but it was noted that restoration work was in smooth progress. The Authority's exclusive road and the railway, which run on the west side of the embankment along the Canal, were also completely destructed. The team found that rails had been stripped off in some sections.

Treaty Road, which leads southward from Port Said to Ismailia along the western coast of the Canal, runs through the marshy area of Lake Menzala.

This road was completely restored to its original paved condition, with Lake Menzala extending on its west. Between the east side of Treaty Road and the Canal, there extends a marshy area ranging from 50 to 100 in width. In this marshy area, there were many hollows created by cannon balls and bombs and they were as large as 5 to 20 m in diameter.

5 to 20 m high bunkers built by Egyptian and Israeli troops were found stretching far along both banks of the Canal.

Town of Qantara where one of the important signal stations is located was totally demolished, with heaps of stones and rubbles scattered all over leaving no place for man to live. The team noted that some people who had evacuated the town was living in shelter tents in the marshy zone with nothing spread on the ground.

There used to be a ferry base at Qantara for railway connection between African side and Asian side. The Authority' staff explained that the ferry base buildings on both sides war destroyed and there were no means to cross the Canal to the Asian side.

Ismailia's wer damage was heavier than in any other cities. Since it was one of the most beatiful cities in Egypt, its destruction presented a sharp and gloomy contrast to what the city once used to be. On entering the city, the team found nothing but stones and rubbles and discovered that there were virtually no buildings which escaped the Israeli attack. Walls of all residential houses had bullet marks, suggesting fierce street battles that had taken place in the city.

The Authority's hospital constructed along the Canal was also attacked and its function was completely suspended.

Three water towers found on a small hill were also bombed and not in serviceable condition. However, the Authority's Central Administration building which faces Timsah Lake was not afflicted with any servere damage, and it appeared that all the important documents and materials had been transferred to safe places just before the war.

The Authority s enthusiastic effort for reopening the Canal was manifested in the accelerated progress of repair of buildings and relocation and arrangement of documents and materials. This feverish restoration effort was also observed at the Authority's Research Centre where the rearrangment of laboratories was pushed forward at a rapid pace and the test equipment and apparatuses were returned and placed in original positions.

The team sailed on Timsah Lake in a launch to inspect the Canal and Ismailia. In the lake, an American freighter (approx. 50,000 DWT) and a French warship which had engaged in the sweeping work were observed, and remains of some ten pusher barges were found in a number of places on the coast. A burnt dredger was found moored to the berth of the Authority's workshop on the coast of Timsah Lake. In the neighbourhood of this workshop, bunkers were found on the Asian side revetment of the Canal with mooring posts completely buried in them.

As the team left Ismailia and proceeded south for Suez, the bunkers became higher than in other districts and their height ranged form 15 to 20 m. Seeing these bunkers, the team felt that the Canal had probably been silted with sand falling down when they were built. In some place, revetment and bunkers were found broken.

Nevertheless, restoration work was actively going on in other places where salvage boats were in active operation and earth-moving machines such as clamshell bulldozers and back-hoes were busy in removing bunkers. It appeared, however, that manual labour was by far the most powerful means of restoration.

In the Ismailia – Suez section, the team proceeded along the Canal but could reach only as far as midway in Bitter Lakes.

The signal station at Toussoum situated at the 87 km point was not completely destroyed. In Bitter Lakes, about five foreign vessels were found locked up in the Canal.

From Bitter Lakes on, the team took an overland route through the desert.

In Suez, the team was astonished at the awful war calamities. The city had completely disappeared, leaving nothing but remains of tanks and buildings. Holes as large as 5 m in diameter were found in bombed buildings. Destruction of war was dreadful specially in the area along the Canal. The oil plants and fertilizer plants in Port Ibrahim were damaged heavily, and so were the Authority's Suez Office and Workshop which were located along the Canal. However, machinery and equipment including machine

tools were not damaged because they had been transferred to safe places. When the team visited Suez, machines were being brought back to plants and reinstalled. In these plants as well as in the temporary Suez Office of the Authority, the team was deeply impressed by the bright attitude of the people engaged in the restoration work in great spirits and high hopes for future.

While seeing round Port Tewfik, the team observed two pilgrimage ve ·ls of about 3,000 gross tons moored to the quay and was reminded of a newspaper report that "three pilgrimage vessels passed the Suez Canal for the first time after its closure" which the team had read one week before its departure.

As described above, the Canal and its vicinity were considerably damaged, but the team is happy to note here that both the Authority and the Egyptian people are enthusiastilly and happily engaged in the restoration of war-damaged facilities in full hopes for early reopening of the Canal.

The restoration work will enter into the stage of full operation in the months to come.

3. Utilization of the Canal

3-1 Transit Vessels

Tables 5-3-1 through 5-3-6 show the utilization status of the Suez Canal by the number and net tonnage of transit vessels and amount of cargoes registered during the period from the Canal's nationalization on July 26, 1956 to 1965.

Table 5-3-1 Number of Transits, Net Tonnage & Goods Traffic

Year	Number of Transits	Number of Classes of Vessels		Net Tonnage	Goods Traffic	Directions	
		Tanker	Other Vessels			South Bound	North Bound
				(000 tons)	(000 tons)		
1957	10,958	–	–	89,911	81,323	14,104	67,219
1958	17,842	9,588	8,254	154,479	139,373	24,943	114,430
1959	17,731	9,211	8,520	163,386	148,254	26,505	121,749
1960	18,734	9,755	8,979	185,322	168,883	29,253	139,630
1961	18,148	9,125	9,023	187,059	172,394	32,795	139,599
1962	18,518	–	–	197,837	182,397	31,207	151,190
1963	19,146	9,656	9,490	210,498	193,532	34,050	159,482
1964	19,943	9,766	10,177	227,991	210,981	38,518	172,463
1965	20,289	9,663	10,626	246,817	225,442	42,001	183,441

Source: Suez Canal Authority

Table 5-3-2 Daily Average Number & Net Tonnage of Transiting Vessels

Year	Number of Transits	Numbers of Classes of Vessels		Net Tonnage	Distribution of Vessels By Net Tonnage	
		Tanker	Other Vessels		Tanker	Other Vessels
				(000 tons)	(000 tons)	(000 tons)
1957	46.6	25.5	21.1	393,000	275,000	118,000
1958	48.9	26.3	22.6	423.000	295,000	128,000
1959	48.6	25.2	23.4	448,000	313,000	135,000
1960	51.2	26.7	24.5	506,000	362,000	144,000
1961	49.7	25.0	24.7	512,000	364,000	148,000
1962	50.7	25.8	24.9	542,000	390,000	152,000
1963	52.5	26.5	26.0	577,000	417,000	160,000
1964	54.5	26.7	27.8	623,000	454,000	169,000
1965	55.6	26.5	29.1	676,000	502,000	174,000

Source: Suez Canal Authority

Table 5-3-3 Annual Number of Transits of Tankers by Direction

Condition	South Bound		North Bound		Total	
	1964	1965	1964	1965	1964	1965
Loaded	528	668	4,675	4,504	5,203	5,172
In Ballast	4,382	4,233	181	528	4,563	4,491
Total	4,910	4,901	4,856	4,762	9,766	9,663

Source: Suez Canal Authority

Table 5-3-4 Average Load of Oil Products per Loaded Tanker

Year	Loaded Tanker	
	North Bound	South Bound
1957	19,228 (tons)	8,643 (tons)
1958	20,734	10,416
1959	22,990	11,654
1960	24,606	15,187
1961	26,594	17,647
1962	27,454	17,268
1963	28,880	17,216
1964	31,360	16,674
1965	34,953	16,934

Source: Suez Canal Authority

Table 5-3-5 Annual Number of Transiting Tankers by Dead Weight (1965)

Dead Weight	South – North		North – South	
	Number		Number	
	In Ballast	Loaded	In Ballast	Loaded
up to 12,000	71	78	37	80
12,001 ~ 14,000	39	48	26	119
14,001 ~ 16,000	12	63	66	30
16,001 ~ 18,000	26	300	192	88
18,001 ~ 20,000	29	283	231	65
20,001 ~ 22,000	13	228	176	72
22,001 ~ 26,000	36	138	85	115
26,001 ~ 30,000	3	175	169	10
30,001 ~ 34,000	5	518	468	22
34,001 ~ 38,000	14	470	431	43
38,001 ~ 42,000	–	396	390	1
42,001 ~ 46,000	–	291	296	5
46,001 ~ 50,000	4	417	413	11
50,001 ~ 55,000	3	472	435	5
55,001 ~ 60,000	1	306	328	–
over 60,000	2	321	490	2
Total	258	4,504	4,233	668

Source: Suez Canal Authority

Table 5-3-6 Transiting Vessels, by Flag

(1964, 1965)

1964		1965	
Flag	Proportion of Net Tonnage to Total Transiting	Flag	Proportion of Net Tonnage to Total Transiting
British	19.5%	Liberian	19.6%
Liberian	16.4%	British	16.8%
Norwegian	13.1%	Norwegian	15.2%
French	6.9%	French	6.5%
Italian	6.7%	Italian	5.8%
Greek	5.6%	Greek	5.1%
Dutch	5.0%	Dutch	3.9%
German (Fed)	3.7%	Russian	3.5%
U.S.A	3.3%	German (Fed)	3.3%
Swedish	3.3%	Panamanian	3.0%
Panamanian	3.0%	U.S.A	2.8%
Russian	2.7%	Swedish	2.8%
Danish	2.7%	Danish	2.4%
Spanish	1.4%	Spanish	1.2%
Indian	1.1%	Japanese	1.2%
Others	5.6%	Others	6.9%
Total	100 %	Total	100 %

Source: Suez Canal Authority

3-2 Sailing Method

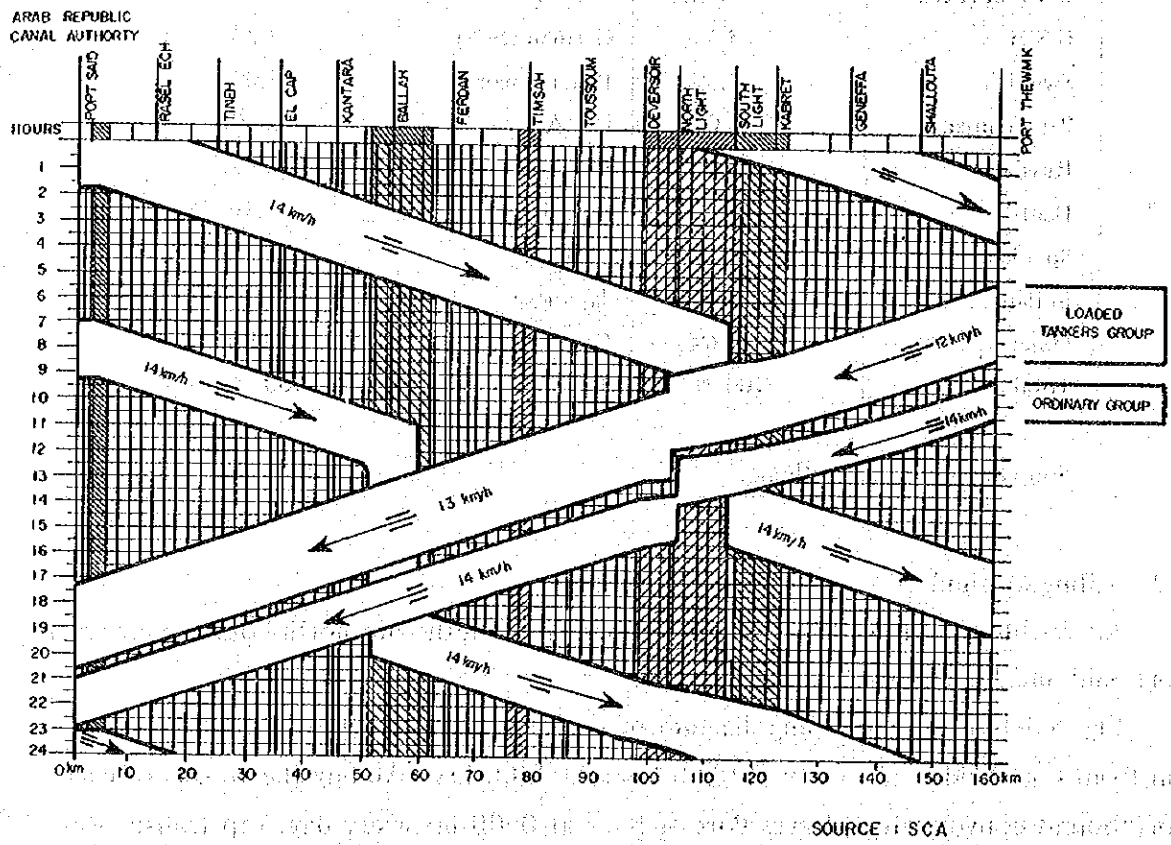
All vessels transiting the Canal are formed into south- and north-bound convoys at Port Said and Suez, respectively.

Fig. 5-3-1 shows the sailing diagram of convoys sytem. The southbound convoys sail from Port Said twice a day at 0700 hrs and 2300 hrs. Among the vessels of each northbound convoy which leaves Port of Suez at 0500 hrs every day, top transit priority is given to tankers, followed by cargo vessels and passenger steamers.

Distance between convoys and speed are restricted as follows for the sake of sailing safety.

Table 5-3-7 Distance between Convoys and Speed

Type of Vessel	Interval (Time) (Distance)	Speed
Gas-Free Tankers & General Cargo vessels	5 min. 1000 m	14 km/h
Small Tankers (Up to 18 thousand DWT)	10 min. 2000 m	13 km/h, but restricted to 12 km/h between Little Bitter Lake and Suez.
Large Tankers (Exceeding 18 thousand DWT)	10 min. 3500 m	



Source: Suez Canal Authority

Fig. 5-3-1 Sailing Diagram of Existing Convoys System

The northbound convoy generally sails from Suez to Port Said without stopping on the way, and the time required for transit is approximately 15 hours.

On the other hand, the first southbound convoy which leaves Port Said at 0700 hrs. stops in the western channel of Ballah Bypass located 52 km from Port Said, stays there until the northbound convoy passes by, starts sailing again for Suez after the last vessel of the northbound convoy passes the 60 km point from Port Said. The convoy which clears Port Said at 2,300 hrs. proceeds to the south anchorage of Great Bitter Lake and likewise stays there until the northbound convoy passes by. When the last vessel of the northbound convoy enters Great Bitter Lake, the southbound convoy sails from Kabret Bypass and proceeds to Suez.

The entire Canal is divided into four sections, i.e., Port Said area, Port Said ~ Ismailia, Ismailia ~ Port Tewfik, and Port Tewfik ~ Suez Gulf. The pilots take turns at Timsah Lake in the Canal.

The Transit Control Office of the Suez Canal Authority at Isamailia receives from minute to minute report on the transit conditions of convoys from the eleven signal stations established at intervals of about 10 km along the Canal. The office prepares a daily transit chart so as to be able to issue proper instructions in case any accident such as stranding or collision arises.

3-3 Utilization of Water Surface

Utilization status of the water areas of the Suez Canl is briefly introduced below.

3-3-1 Port Said Harbour

This harbour was completed in time with the opening of the Canal and has since been developed with the Canal. Although it is under the jurisdiction of the Suez Canal Authority, all its facilities are leased to government offices and private organizations except for those required for transit services. A plan of this harbour is shown in Fig. 5-3-2.

The harbour's main function is to provde smooth transit services, but it also exhibts the multiple function of a commercial, military, bunker and fishing port. In addition, the harbour is designated as a free port area.

The greater part of the harbour area is allocated to the formation of convoys, and there are a total of 31 berths for accommodating vessels of various sizes. A 1,750 m long wharf has been built recently where ten vessels of a 10-meter draft can be moored and a mobile crane is installed for loading and unloading of cargoes. Port Said Harbour

ranks among the most important harbours in the country. The New Port Said Bypass is planned to be built to the east of Port Fouad under the Second Extension Project.

3-3-2 Port Fouad

At Port Fouad located on the opposite bank of Port Said, there is a shipyard capable of building vessels of different kinds such as cargo vessels ranging in gross tonnage from 4,000 to 6,000 tons and tankers of 12,000 ~ 18,000 DWT. The shipyard is provided with a 25,000 ton floating dock, "El Nasr," which is capable of undertaking periodical and as well as emergency repair of various types of ships of up to 55,000 gross tons.

Table 5-3-8 Record of Past Operation of Port Fouad Shipyard

	1963	1964	1965
Number of Vessels	31	59	86
Gross Tonnage (Ton)	750,000	637,000	702,000

Source: Suez Canal Authority

3-3-3 Ferry Boat Base

There are four ferry boat bases to cross the Canal. They are located at Port Said, Qantara, Timsah and Shallufa, and administered by the Suez Canal Authority. The largest of these is the one at Port Said where two ferry boats are put in plying service every five minutes.

3-3-4 Ismailia

Ismailia is situated on the northwestern shore of Timsah Lake, approximately at the centre of the Suez Canal. The Central Administration of the Canal is located here. Pilots who board the transit vessels take their shift at this point. The Canal Authority at Ismailia has a small exclusive workshop and a lifting slipway with a capacity of 1,422 tons.

3-3-5 Port of Suez

Port of Suez consists of Marakeb, Port Tewfik, Port Ibrahim, Petroleum Basin, Attaqa and Adabiya. Of these, Marakeb and Port Tewfik alone are under the control of

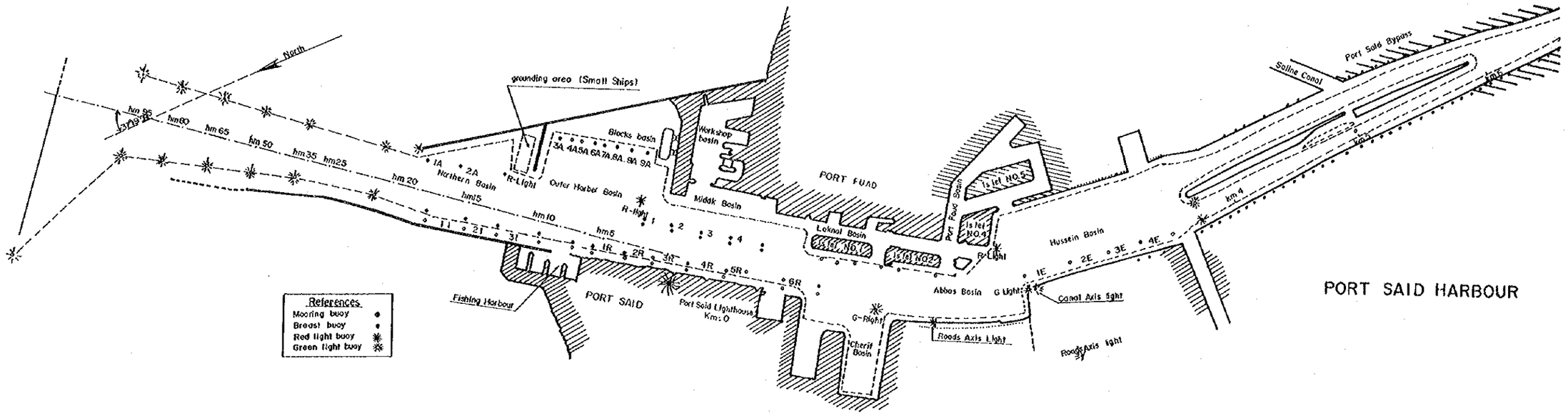


Fig. 5-3-2 Plan of Port Said

Suez Canal Authority and all others are placed under the jurisdition of the Ministry of Port and Lighting.

(1) Marakeb

Marakeb, located on the Asian side of the Canal entrance, is a wharf built by the British Navy for military purposes when the Canal was managed by the Compagnie Universelle du Canal Maritime de Suez. At present, it is placed under the control of the Suez Canal Authority and used for berthing passenger boats. It has a total length of about 930 m and a water depth of 8.4 m.

(2) Port Tewfik

This is a small crafts basin belonging to a workshop of the Suez Canal Authority and has a water depth of 5 m. A branch office of the Canal Authority, a signal station, and a radio station which only handles communications regarding transit vessels are located at this port.

(3) Port Ibrahim

This is best equipped basin for small crafts and has a depth of 9.5 m. The quay-wall has a water depth of 9.5 m and a length of about 350 m. Other parts of the whar. are used for mooring small vessels and have a depth of 5 m. There are installed three mobile cranes with a maximum lifting capacity of 35 tons for loading and unloading of cargoes. This port is administered by the government.

(4) Petroleum Basin

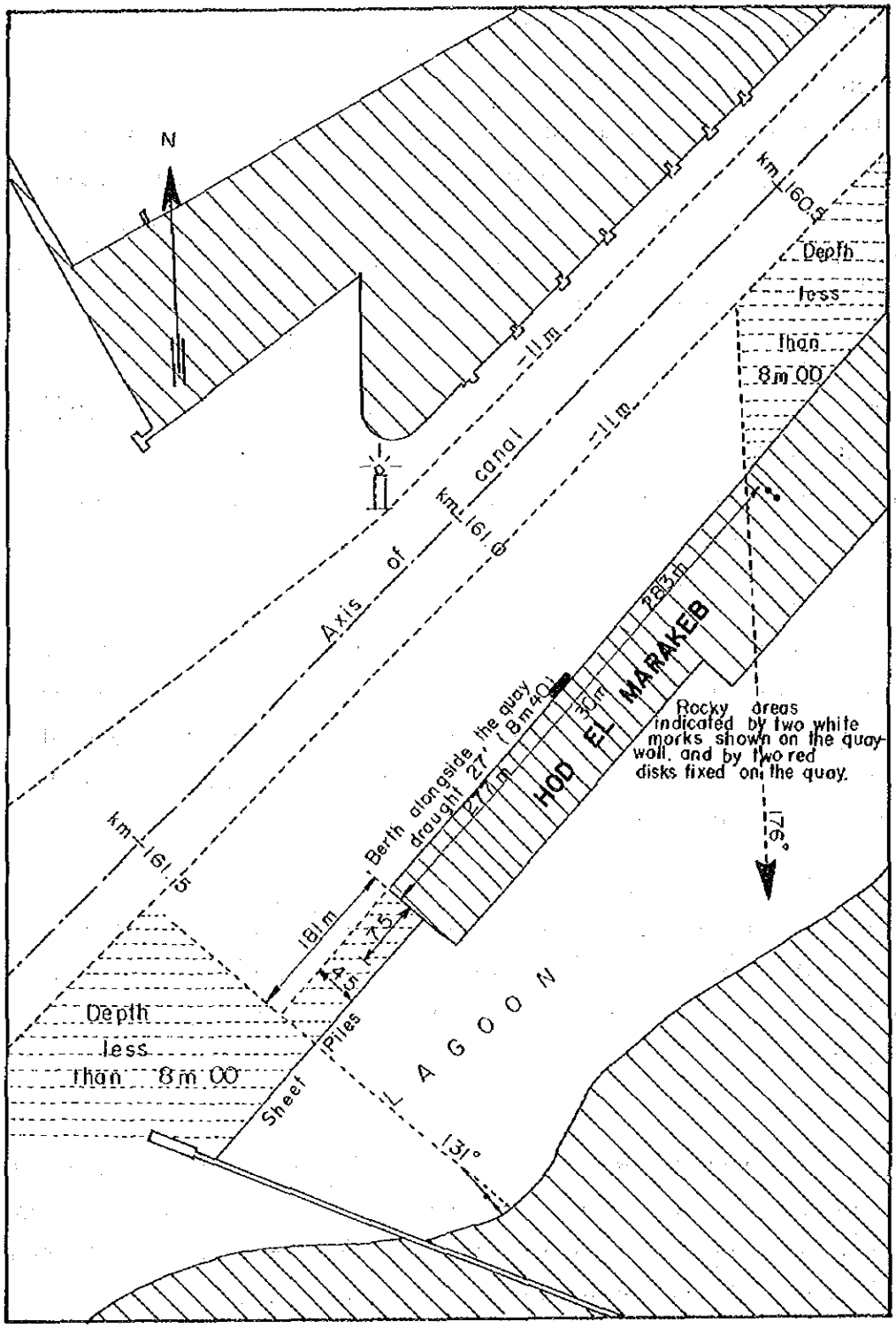
This basin is situated inside the western breakwater of Port Ibrahim. There are laid five submarine pipes through which petroleum is delivered to the refinery. The water depth of the channel and basin is 9 m. Shell, Caltex, Falcom and Governmental have their factories here.

(5) Attaqa

This is a port for the exclusive purpose of shipping stone materials from Mt. Attaqa and a simple loading facility is located at two jetties. Transportation of stones from Attaqa quarry to the port is done by dump trucks. There is a wharf of about 200 m with a 5 m water depth. Behind the port, there is a railway siding.

(6) Adabiya

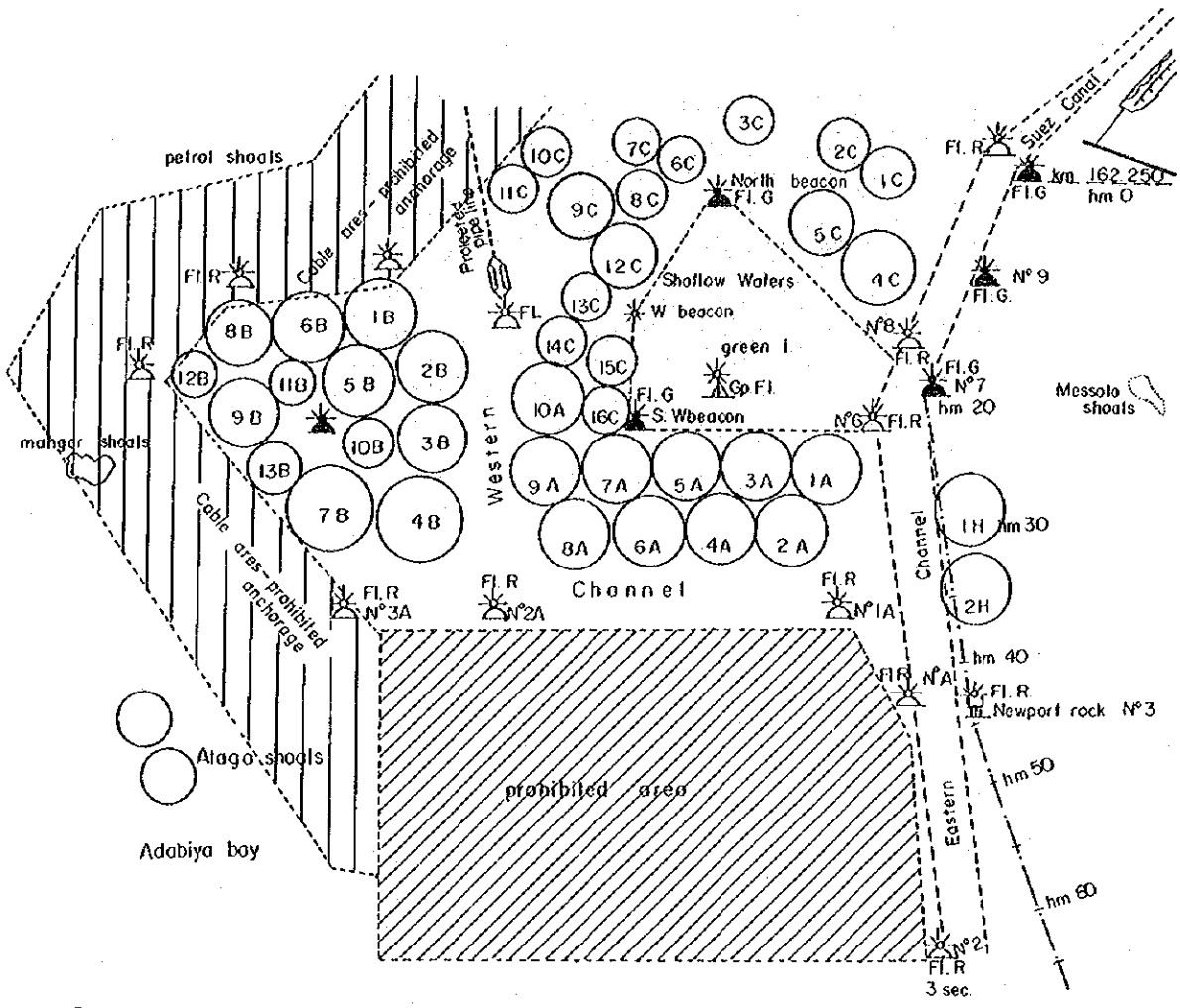
This is a naval port having six level ruffing cranes. There are occasions that a commercial vessel is permitted to usé this port for certain special cargo.



Source: Suez Canal Authority

Source : S.C.A.

Fig. 5-3-3 Plan of Port Tewfik & Marakeb



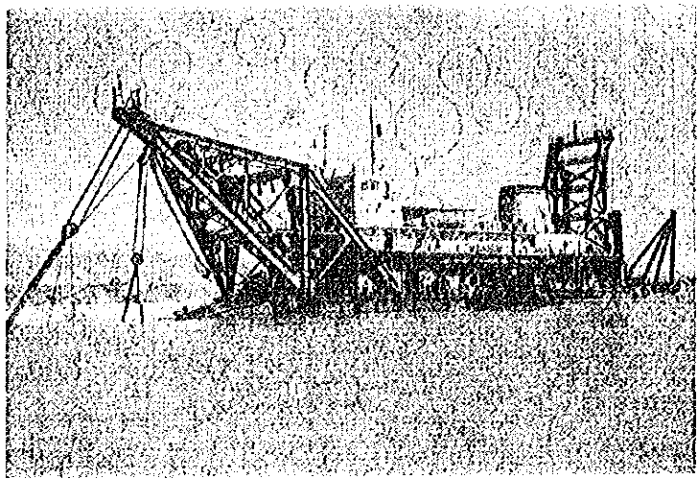
Source : S.C.A.

Fig. 5-3-4 Anchorage Positions at Port of Suez

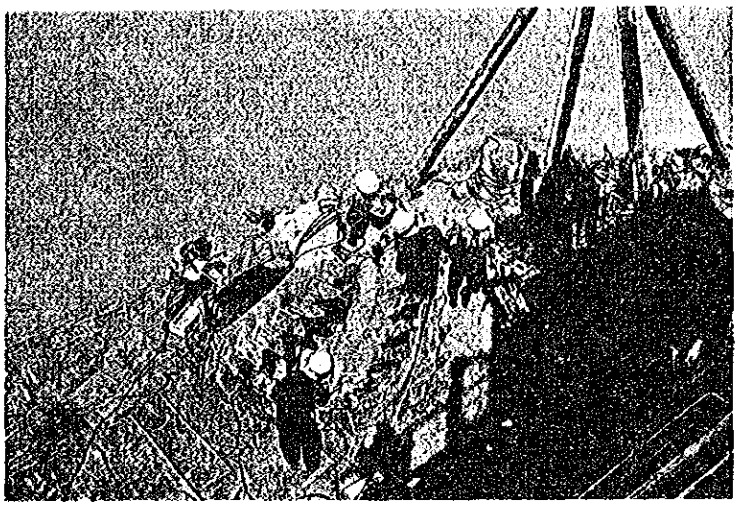
4. Outstanding Problem

The foregoing is a summary of the current status of the Canal. The prevailing problem is that there has been conducted no precise investigation on the degree of war damages and plans for restoration. Buildings of workshops and offices are being restored, but investigations of sand deposit in the fairway, amount of sand turbidity, and damages of revetment have not yet been undertaken. In addition, various survey data still remain where they were transferred during the war and it is said some of them were lost.

When the reopening of the Canal is completed, more attention can be given to records and documents. Therefore, it is considered that a little more time is required before embarking on the investigations and reconsolidation of data.



The "Suez" Actively Participating in the Canal Extension Work



Cutter Head of the "Suez"

VI. SUEZ CANAL AUTHORITY

VI. SUEZ CANAL AUTHORITY

1. History and Organization

1-1 History

Since it was opened on November 17, 1869, the Suez Canal was managed for almost a century by "Compagnie Universelle du Canal Maritime de Suez" which was formed by Ferdinand de Lesseps, a Frenchman who acted as the major promoter of the canal construction.

However, after the revolution, when the United States and the United Kingdom withdrew their promise to provide the construction fund of Aswan High Dam in 1956, the Egyptian government declared the nationalization of the Canal on July 26 of the same year to raise the dam construction fund. At that time, the government issued the "Decree Law respecting the Nationalization of Compagnie Universelle du Canal Martime de Suez (Decree Law No. 285 of 1956)". Thereafter, the Canal was placed under the jurisdiction of the Suez Canal Authority which was established in accordance with the provisions of the "Decree Law respecting the Statutes of the Suez Canal Authority (Decree Law No. 146 of 1956)" put into effect in July 1957. (In the follewing pages, the Suez Canal Authority may sometimes be referred to as 'S.C.A.") According to the Nationalization Law. S.C.A is defined as follows.

"The management of the Suez Canal Authority shall be undertaken by an independent organization which shall be a juridical person belonging to the Ministry of Commerce. The said organization shall be established by a decree issued by the President of the Republic and shall retain all rights required for the management of the Canal without being bound by governmental regulations. The organization shall have the independent budget which shall be prepared on the same principles as applied to any commercial enterprises. Provided, however, that the balance sheet covering each fiscal year shall be subject to the auditing by the government."

As is clear from the above definition, S.C.A. is an independent legal enterprise having its own budget, and is free from most of government regulations which are applied to public and private enterprises. However, its annual budget must be checked by the Ministry of Finance and the Ministry of Planning and must further be approved by the Presidential Dercree. The management of S.C.A. is conducted by the Board of Directors (consisting of a Chairman and eight directors) and the Chairman appointed by the President and serving concurrently as the Managing Director.

Within the framework of the government organization, S.C.A. is placed under the supervision of the Minister of State for Cabinet Affairs, a member of the Diet. The team was informed, however, that S.C.A. is usually placed under the direct control and supervision of the Prime Minister (See References).

1-2 Organization

The headquarters of S.C.A. is located in the city of Ismailia situated at the centre of the Canal, and has branch offices at Port Said and Port Tewfik which are in charge of field business and services. S.C.A. also has a liaison office in Cairo which is responsible for public relations affairs.

Organization of S.C.A. is briefly illustrated in Fig. 6-1-1. Responsibilities of each department of S.C.A. are as follows.

(a) Planning and Follow-up Department – Preparation of long-range plans concerning the Canal and S.C.A. as well as overall after-care of business conducted by each department.

(b) Engineering Department – Technical research, design, planning and dredging.

(c) Administrative Departmnet – General, financial and personnel affairs and welfare.

(d) Workshops Departmnet – Repair and renewal of floating equipment, repair of vessels, and shipbuilding. Has factories at Port Tewfik, Ismailia, and Port Fouad (Main factory – Port Said).

(e) Procurement Department – Procurement of materials and machinery, and management of stores.

(f) Transit Department – Administration and control of transit through the Canal and communication.

(g) Affiliated Companies Department – Management and control of related enterprises and factories placed under the supervision of S.C.A.

(h) Works Department – Maintenance of the Canal, and execution of all projects.

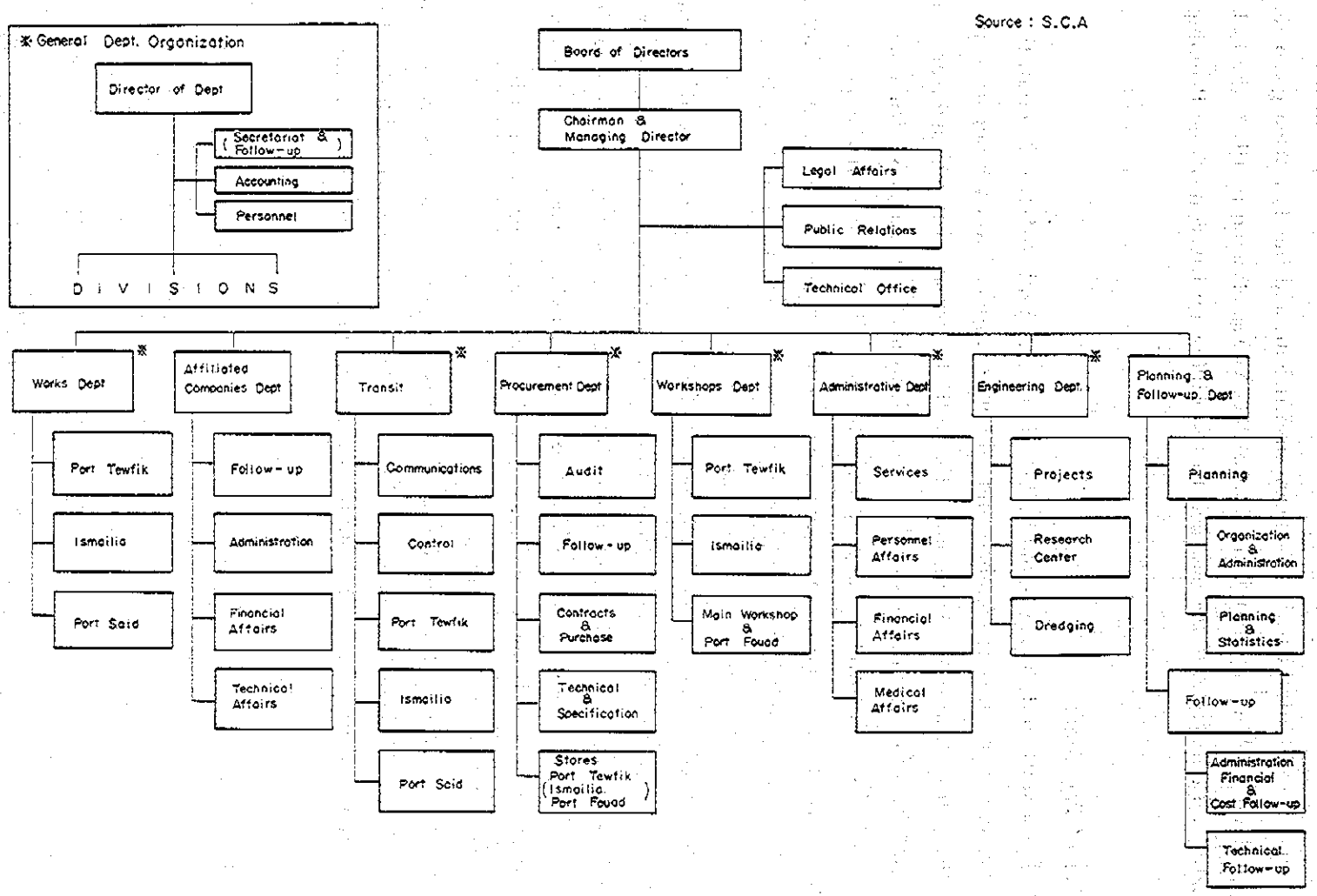


Fig. 6-1-1 Organization Chart of S.C.A. (As at December 1974)

Besides the above eight departments, there are legal, public relations and technical offices which report directly to the Managing Director.

Each department has an accounting section and a personnel section, and its activities are independent within the sphere of its budget. Therefore, inter-departmental communication and coordination has thus far been insufficient, and this has often given rise to various problems. When the reorganization of S.C.A. was effected in 1974, the task of coordinating all departments was assigned to the Follow-up Division of the Planning Department.

1-3 Number of Personnel

S.C.A. has a staff of 1,800 men and 9,800 labourers. Table 6-1-1 ~ 2 shows the number of personnel (both staff members and labourers) assigned to each department.

After the nationalization of 1956, more than 400 British and French engineers and pilots, who had held important posts in Compagnie Universelle du Canal Maritime de Suez, left Egypt. The technical vacancy thus created was filled by Egyptian engineers who had been serving in the government and army. These engineers have been enthusiastically discharging their duties, and it is now often said that S.C.A. has outstripped all government offices in the number and capability of engineers.

During the closed period of the Canal, most of S.C.A. staff engaged in various kinds of public works (irrigation works in particular) in and outside Egypt. Pilots and tug-masters went out of the country to work in other Middle Eastern countries such as Kuwait and Syria as well as in African countries like Tanzania and Lybia. They even advanced to Asian districts including Hong Kong. Now that the Canal reopening work is in smooth progress, they are returning home.

The seven-year period during which the Canal was closed has seen conspicuous mammothization trend of tankers and marked technical progress. To cope with this new trend, S.C.A. will be required to increase the number of its personnel and give them suitable training.

Table 6-1-1 Number of Personnel by Department, S.C.A. (As at December 1974)

Unit: person

	Menagement				Staff Member											
	Chairman & Managing Director	Director	Advisor	Deputy Director	Engineer	Adminis-trator	Doctor	Pharma-cist	Pilot	Harbour Officer	Technician	Tug Master	Clerk	Typist	Tele-phonist	Total
Planning Dept.	1	1	2	3	10	52	–	–	–	–	13	–	52	24	–	158
Engineering Dept.	–	1	–	3	84	6	–	–	–	–	48	10	38	11	–	20
Administrative Dept.	–	1	–	5	–	97	33	9	–	–	24	–	111	48	–	328
Transit Dept.	–	1	–	2	22	26	–	–	231	14	22	47	118	30	2	515
Workshops Dept.	–	1	–	2	87	13	–	–	–	–	80	–	37	12	–	232
Procurement Dept.	–	1	–	3	13	37	–	–	–	–	24	–	65	19	–	162
Works Dept.	–	1	–	3	63	14	–	–	–	–	42	–	47	17	–	187
Legal Office	–	1	–	1	–	13	–	–	–	–	–	–	4	4	–	22
Affiliated Companies Dept.	–	1	–	1	2	9	–	–	–	–	–	–	7	4	–	24
Total	1	8	2	23	281 (19)	267 (10)	33 (2)	9 (1)	231 (86)	14	253 (13)	57 (5)	479 (16)	169 (16)	2	1,829 (161)

Notes: Figures in parentheses indicate the numbers of employees currently working outside Egypt.

Source: Suez Canal Authority.

Table 6-1-2 Number of Labourers by Department, S.C.A. (As at December 1974)

Unit: person

	1st Class Labourer	2nd Class Labourer	Ordinary	Total
Planning Dept.	22	114	617	753
Engineering Dept.	774	1,041	432	2,247
Administrative Dept.	86	60	182	328
Transit Dept.	357	849	134	1,340
Workshops Dept.	1,329	1,133	202	2,664
Procurement Dept.	97	80	251	428
Works Dept.	622	484	944	2,050
Legal Office	–	–	2	2
Affiliated Companies Dept.	–	–	5	5
	3,287	3,761	2,765	9,817

Notes: 1st Class – Most skilled workers.
Ordinary – Office boy, etc.

Source: Suez Canal Authority.

2. Canal Operation and Management

2-1 Canal Management

S.C.A.'s main function is to undertake the transit management in conformity to the Rules of Navigation (the latest Rules before the closure was the one issued in December 1964) and to carry out maintenance and improvement works of the Canal and ports and harbours.

Vessels transiting the Canal are grouped into southbound and northbound convoys at Port Said and Suez under the instruction of S.C.A. staff (i.e., port and harbour officers, pilots, signalling officers, etc.) in accordance with the Rules of Navigation and the Sailing Schedule of Convoys System established by S.C.A. These vessels must have a pilot aboard in ports and in the Canal. The navigation of the convoys is controlled by Ismailia Navigation Control Office which receives navigation data from the 12 signal stations established along the Canal.

Dredging constitutes the greater part of the Canal maintenance work. S.C.A. is also responsible for protection of bulkheads and jetties, alignment of signals and flags, and maintenance of working crafts and tugboats. To carry out these works smoothly, S.C.A. has its own dredgers and workshops.

2-2 Related Works

Another important work is the management of Port Said. This port was constructed when the Canal was opened, and has since shared development and progress with the Canal. Because of its close relationship with the navigation control in the Canal, Port Said and the Canal have been managed as an integrated whole since the days of Compagnie Universelle du Canal Maritime de Suez.

Additional and incidental works which S.C.A. carries out in the canal zone include the following.

(1) Management of Port Tewfik

Port Tewfik constitutes a part of Port of Suez and has been used chiefly as a basin for small crafts of S.C.A.'s workshop.

(2) Water Supply

S.C.A. undertakes control and management of waterworks of Port Said, Ismailia and Suez. Water source is the Nile. Water is led for a distance of about 200 km from the neighbourhood of Cairo through the sweet water canal which is under the jurisdiction of the government.

(3) Educational Facilities

For the purpose of providing education for the children of its staff, S.C.A. owns and runs nurseries, kindergardens, primary schools, and junior high schools in the above-mentioned three cities. Promotion of compulsory education is one of the important policies enforced by the government, and these schools were opened immediately after the rehabilitation work was commenced.

(4) Hospital

There was a hospital in Ismailia which was built during the days of Compagnie Universelle du Canal Maritime de Suez. This hospital was equipped with the best medical facilities in the whole Middle East, but its building was completely destroyed during the war and has not been restored to date.

(5) Ferry Service

There were four ferry boat bases to cross the Canal, i.e., Port Said, Kantara, Timsah and Shallufa. At present, the Port Said base is in operation and two ferry boats are plying back and forth frequently.

(6) Related Companies

S.C.A. undertakes capital investment and management participation in its affiliated companies and also supervises or dispatches its officers to such companies.

The following are the S.C.A.-affiliated companies.

a. Shipbuilding and repair ···	Suez Maritime Arsenal, Timsah Shipbuilding Company, and Canal Naval Construction.
b. Repair and metal processing ·····	Port Said Engineering Company, and Canal Harbour Works.
c. Lease of facilities and services for vessels ····	Canal Mooring and Projector Company.

2-3 Suez Canal Toll System

The dues and charges collected from transit vessels in 1967 when the Canal was still in operation are explained in the following items.

It may as well be mentioned here that in the U.N. Declaration of April 24, 1957, it was stated that should the dues be increased within 12 months, the raise should not exceed 1%. After the nationalization, however, the dues were raised by 1% each in 1961, 1965 and 1967.

(1) Transit Dues

Transit dues were collected from transiting vessels exceeding 300 gross tons. Calculation was worked out by multipyling 43.73 piaster/1 SCNRT by the Suez Canal Net Registered Ton (SCNRT) which will be explained later. For vessels in ballast, a rate of 19.94 piaster/1 SCNRT was adopted.

(2) Berthing Dues

Dock charges at Port Said, Ismailia and Port Tewfik were 0.3123 piaster/1 SCNRT per day, but transit vessels were not required to pay these dues for the first 24 hours.

The charges were calculated at a rate of 0.12485 piaster/1 SCRNT commencing on the tenth day after arrival at any of these ports.

(3) Pilotage Dues

Pilotage dues were not charged to vessels transiting the Canal. However when a vessel came into the docks at Port Said or Port Tewfik, the established day- or night-time pilotage dues were collected in accordance with the SCNRT classification.

Table 6-2-1 Pilotage Dues

SCNRT	Day Pilotage	Night Pilotage
~ 2,000 SCNRT	L. E 7.491	L. E 11.237
2,000 SCNRT ~ 4,000 "	L. E 9.988	L. E 14.982
4,000 " ~ 10,000 "	L. E 14.982	L. E 22.473
10,000 " ~	L. E 18.728	L. E 28.716

Source: Suez Canal Authority.

(4) Overtime Pilotage Dues

The overtime dues were collected when a pilot was kept on board longer than was required for pilotage.

(5) Charges for Changing Berth

When a vessel changed berth, charges for changing berth were collected according

to the SCNRT classification.

Table 6-2-2 Changes for Changing Berth

SCNRT	Charges
~ 2,000 SCNRT	L.E. 3,746
2,000 ~ 4,000 "	L.E. 6,243
4,000 ~ 10,000 "	L.E. 8,740
10,000 ~	L.E. 12,485

Source: Suez Canal Authority.

(6) Towage Dues

Vessels towed or escorted by a S.C.A.-approved tugboat were required to pay towage dues of 3.7453 piaster/1 SCNRT in addition to the transit dues.

(7) Charges for Harbour Tugs

When a S.C.A.'s tugboat was employed for purposes of mooring, changing the anchorage, departing, towing, refloatation, etc. charges for harbour tugs were collected. The rates are shown in Tables 6-2-3 and 6-2-4.

However, no charges were collected for tug services which S.C.A. recognized as being necessary for transit vessels.

Table 6-2-3 Charges for Harbour Tugs

SCNRT	Fixed Charges	
	1 Tug	2 Tugs
~ 2,000 SCNRT	L.E. 4,994	L.E. 7,491
2,000 ~ 4,000 "	L.E. 7,491	L.E. 11,237
4,000 ~ 10,000 "	L.E. 12,485	L.E. 18,728
10,000 ~	L.E. 18,738	L.E. 31 213

Source: Suez Canal Authority.

Table 6-2-4 Tariff for the Hire of Tugboats

Tug	H. P	Tariff	
		Waiting (m/m)/Hour	While under way (m/m)/Hour
Salvage Tug Boats	3,000~3,500 H.P	35,000	54,500
	3,500~5,000 H.P	72,000	105,500
	over 5,000 H.P	97,000	139,000
Harbour Tug Boats	800 H.P	8,500	12,500
	1,600 H.P	16,500	26,500

Source: Suez Canal Authority.

These dues and charges were collected according to the net tonnage of transiting vessles.

The net tonnage employed for calculation, however, is something peculiar to the Suez Canal, and it was decided according to the rules which were suggested by the International Tonnage Committee at its meeting held at Constantinople in 1873.

To be more specific, the tonnage of a vessel is determined by capacity with 1 net ton taken at 100 cubic feet (2.83 m^3). The net tonnage in the Suez Canal (which is abbreviated to SCNRT) is obtained by deducting the following spaces from the gross tonnage.

a. Space for boarding facilities or crew whether it be found over or beneath the upper deck, provided that it should not exceed 10% of the gross tonnage.

b. Space for engines, provided that it should not exceed 50% of the gross tonnage.

The following are the details of income earned by Canal operation during the period from July 1966 through June 1967. As seen, the transit dues account for the greatest portion of the total revenues.

Transit Tolls 1966/1967

Unit: L.E. 1,000

1. Transit Charges	
a. Transit dues	93,596
b. Berthing dues	28
c. Charges for changing anchorage	2

	d. Charges for tugboat service	5
	e. Overtime pilotage dues	1
	f. Others	6
	Subtotal	93,638
2.	Port Charges (Port Said)	
	a. Pilotage dues	12
	b. Berthing dues	20
	c. Charges for tugboat service	7
	d. Facilities rental	21
	e. Charges for lease of dock	3
	f. Miscellaneous	17
	Subtotal	80
3.	Miscellaneous Income (Navigation)	
	a. Charges for rescue towage, etc.	803
4.	Others	1
	GRAND TOTAL	94,522

These charges and dues are paid by users to S.C.A. from their non-resident account at banks in Egypt or in nominated free currency.

3. Financial Status

3-1 Fiancial Status before Closure

S.C.A. had constantly earned considerable profit until 1967. Annual canalage income reached about US$200 million in the 1960's. When this amount is compared with the Egypt's total export value (US$500 ~ 600 million) and with the export value of cotton which is the major export item (US$200 ~ 300 million), it can be readily seen that the canalage is an importance source of foreign currency earnings.

In the two-year period prior to the closing of the Canal, S.C.A. earned an annual toll income of more than L.E. 90 million and an annual income of about L.E. 3 million from supplementary business. On the other hand, maintenance and management cost of the Canal was L.E. 12 million (12 ~ 13% of total income) per year which included administration cost, public service cost, interest on loan, depreciation expense, etc. S.C.A. paid to the government a 5% royalty against the total income (same rate as imposed on

Compagnie Universelle du Canal Maritime de Suez), statutory income tax (18.7% of the net profit in 1966), and payment to National Treasury (called "government share" which corresponds to the dividend paid to shareholders during the days of Compagnie Universelle and which is alloted each year by the government budget). The ratio of these expenditures to the total income was 54% in average (See Table 6-3-1. Comparative Income Statement).

Table 6-3-1 Comparative Income Statement of S.C.A. (1964 ~ 1973)

Unit: L.E. 1,000

		July 1964 ~ June 1963		July 1964 ~ June 1963		July 1964 ~ June 1963		July 1964 ~ June 1963		July 1964 ~ June 1963		July 1964 ~ June 1963		July 1964 ~ June 1963		July 1964 ~ June 1963		July 1964 ~ June 1963	
		Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
DEBIT	Maintenance and Management Expenses	8,084	9.3	8,941	8,319	8.5	6,713	57.4	6,560	63.5	5,693	52.1	5,898	48.3	9,228	49.9	6,099	47.0	
	General Administration Expenses	1,711	2.0	2,123	2.2	1,732	1.8	1,721	14.7	1,744	16.9	1,830	16.8	1,838	15.0	2,917	15.8	1,878	14.5
	Canal and Port Said Working Expenses	2,106	2.4	2,115	2.2	2,061	2.1	1,296	11.1	1,236	12.0	967	8.8	794	6.5	1,167	6.3	738	5.7
	Canal and Port Said Harbour Expenses	814	0.9	840	0.8	705	0.7	280	2.4	263	2.5	235	2.2	283	2.3	484	2.6	309	2.4
	Maintenance of Equipment	1,871	2.2	2,126	2.3	2,215	2.3	1,801	15.4	1,730	16.7	1,328	12.2	1,694	13.9	2,751	14.9	1,843	14.2
	Public Services Activity	1,583	1.8	1,737	1.8	1,606	1.6	1,615	13.8	1,587	15.4	1,333	12.2	1,289	10.6	1,909	10.3	1,331	10.3
	Director's Remuneration	16	0.0	7	0.0	6	0.0	5	0.0	5	0.0	6	0.1	6	0.0	–	–	11	0.1
	Interest on Loan (Government and Central Bank)	–	–	–	–	–	–	–	–	–	–	929	8.5	1,687	13.8	3,283	17.7	2,474	19.1
	Interest on Loan (IRBD and KFAED)	1,306	1.5	1,282	1.4	1,307	1.3	1,313	11.2	1,131	10.9	1,123	10.3	995	8.1	1,303	7.0	763	5.9
	Royalty	4,314	5.0	4,716	5.0	4,393	5.0	–	–	–	–	–	–	–	–	–	–	–	–
	Other Expenses	1.542	1.8	73	0.1	54	0.1	597	51.	417	4.0	1,061	9.7	1,306	10.7	1,697	9.2	1,063	8.2
	Depreciation Expenses	2,381	2.8	1,866	2.0	2,213	2.3	2,349	20.1	2,225	21.5	2,109	19.3	2,325	19.0	2,955	16.0	1,804	13.9
	Others	–	–	–	–	–	–	17	6.1	–	–	–	–	–	–	–	–	500	3.9
	Income Tax	18,110	21.0	23.120	24.5	23.352	23.9	–	–	–	–	–	–	–	–	45	0.2	258	2.0
	Government Share	46,923	54.4	51,583	24.7	52,209	54.4	–	–	–	–	–	–	–	–	–	–	–	–
	Net Revenues from Operations	3,596	4.2	2,734	2.9	4,499	4.6	–	–	–	–	–	–	–	–	–	–	–	–
	Total	86,271	100.0	94,323	100.0	97,853	100.0	11,694	100.0	10,338	100.0	10.921	100.0	12,217	100.0	18,511	100.0	12,972	100.0
CREDIT	Total Transit Tolls	83,102	96.3	91.305	96.8	94.522	96.6	126	1.1	141	1.4	88	0.8	86	0.7	10	0.1	43	0.3
	Revenues from Related Business	3,102	3.6	3,013	3.2	3,319	3.4	1,816	15.5	2,303	22.3	1,474	13.5	2,836	23.2	4,004	21.6	4,050	31.2
	Water Works Revenue	464	0.5	537	0.6	543	0.6	372	3.2	364	3.5	85	0.8	68	0.6	178	1.0	105	0.8
	Miscellaneous Revenue	1,907	2.2	1,627	1.7	1,554	1.6	790	6.8	1,083	10.5	857	7.8	2,285	18.7	3,194	17.3	3,611	27.8
	Others	731	0.8	849	0.9	1,222	1.2	654	5.6	856	8.3	532	4.9	483	4.0	632	3.4	334	2.6
	Net profit Carried from the Previous Year	67	0.0	5	0.0	12	0.0	32	0.3	8	0.1	126	1.2	148	1.2	140	0.8	146	1.1
	Net Loss from Operations	–	–	–	–	–	–	9,720	83.1	7,886	76.3	9,233	84.5	9,147	74.9	14,357	77.6	8,614	66.9
	Total	86,271	100.0	94,323	100.0	97,853	100.0	11,694	100.0	10,338	100.0	10,921	100.0	12,217	100.0	18,511	100.0	12,972	100.0

Source: Suez Canal Authority.

Notes: Fiscal year 1972 had 18 months because of the change of the closing month.

3-2 Financial Status after Closure

SCA's income after the closure of the Canal has been limited to that from supplementary business. Great effort has been exerted to obtain revenues specially from technical assistance and other services to outside parties.

The contents of miscellaneous revenues earned before and after the closure are compared below.

Miscellaneous Revenues

Unit: L.E. 1 thousand

	1966/67	1971/72
Electric Revenues	154	85
Medical Treatment Revenues	25	4
Ferry Boat Revenues	7	0.3
Different Revenues	164	141
Equipment's Location Revenue	185	488
Diving Equipment's Location	4	2
Works for Others Revenue	297	2,047
Cash Sales	38	255
Pilotage Revenue	405	6
Floating Dock "El Nasr"	267	27
Construction of Motor Boats for Others	7	32
Others	1	106.7
Total	1,554	3,194

However, since the annual income was limited to L.E. 2 ~ 4 million, the operational loss had to be covered by government subsidy and loan from the Central Bank. This government subsidy was a loan advanced at an annual interest rate of 4.5% (no interest after 1973) on repayment terms to be determined by future negotiation between the government and S.C.A. As to the loan from the Central Bank, the interest rate is also 4.5% per annum but the refundment terms are not yet decided (See Table 6-3-1 – Comparative Income Statement).

3-3 Loans Introduced

S.C.A. borrowed US$56.5 million in 1959 as canal extension fund from IBRD (International Bank for Reconstruction and Development) at an annual interest rate of 6%, repayable over a period of 15 years including three years grace period. In 1963,

S.C.A. again borrowed 9.8 million diners (L.E. 12.9 million) from the Kuwait Fund for Arab Economic Development (KFAED) at an annual interest rate of 4%, repayable over a period of 16 years including four years grace period.

During the closed period, payment of both principal and interest was effected in accordance with the loan agreement, and the full amount of the loan from IRBD was repayed in September 1974.

4. Outstanding Problems

Although the Canal was closed for seven years and toll income ceased during that period, S.C.A. has exerted every effort to earn income from technical services and other activities, and made all endeavours to maintain its organization in good shape in anticipation of early reopening of the Canal, and this can be readily evidenced by the data introduced in the foregoing pages.

When the Canal is reopened and brings about foreign currency income, all financial problems will be solved.

The problem of raising the fund for reopening the Canal was nearly solved during the team's stay in Egypt. The team was informed that S.C.A. had a good prospect for securing the necessary fund.

At present, S.C.A. is planning to raise the toll rates drastically after reopening in order to cope with the global rises in commodity prices. For this purpose, S.C.A. has requested the following consultants teams to establish new toll rates compatible with the estimated number of transit vessels. Each team is expected to present the results to S.C.A. in January or February 1975.

1) Norwegian Shipping Consultant Team.
2) Cecotrat (Soframer) of France.
3) Arab League Maritime Training Institute.
4) ARAC of Egypt.
5) Pacific Consultants International of Japan.

The cost of this survey will be covered by the loan from IRBD. The new system will be established on the basis of survey results with account taken of various factors such as mammothization of tankers and their low freight, fluctuations of petroleum prices, petroleum transport cost by SUMED pipelines, etc. Since the world's petroleum situation is changing rapidly from day to day, establishment of a new canalage system deserves serious attention and will also affect the forecast of the canal income and ex-

tension works.

It involves extreme difficulty to forecast the future financial condition before the survey results are made available. In this report, however, the future demand and income are estimated on the bais of the existing rates.

It leaves no doubt that S.C.A.'s financial footing will change considerably if the rates of royalty and taxes to be paid to the government are changed by actions taken from the political viewpoint. Over one half of the total income of S.C.A. used to be paid to the government. If the amount to be paid to the government can be varied according to the income, then S.C.A. will be free from any financial problem.

In conclusion, it can be said that there is no specific problem either in organization or in financing. However, military and diplomatic issues not treated in this report remain the biggest problems confronting S.C.A.

VII. TRANSPORTATION COST COMPARISON WITH ALTERNATIVE PROJECT

VII. TRANSPORTATION COST COMPARISON WITH ALTERNATIVE PROJECT

1. Outline

As described earlier, Suez Canal was nationalized in 1956, and was closed in 1967 because of the Middle East War. Since then, the relationship among Asia, the Middle East and Western Europe has greatly transformed as compared with the past. Consequently, the role of Suez area to connect east and west has completely changed. The improvement of the living standard in European countries has increased the energy consumption drastically resulting in their greater dependence on petroleum resources in Middle East countries. For the supply of energy, especially for the stabilized supply of petroleum, voyage by big size tanker round Cape Town has been stressed. At the same time, the importance of Suez area as a more economical and effective seaway is being placed under a new light.

To be concrete, it is the reopening and extention of Suez Canal and the construction of SUMED pipe line.

In this chapter, the crude oil transportation costs via SUMED pipeline, Cape Town route and Suez Canal route are compared in order to examine the convenience and superiority of this project.

2. SUMED Pipeline

2-1 Background

The most important reason why the Egyptian government has decided to construct SUMED pipeline is the necessity of transporting over 60 million tons of petroleum through some other routes than Suez Canal after extention because of ever increasing petroleum demand in western Europe, and the construction of pipeline will not compete with the reopening of Suez Canal because the present demand itself far greater than the transportation capacity of the Canal.

The second reason is the judgement that it is a weak point for Egypt to have no other petroleum transportation route than Suez Canal as was seen from the fact that the oil rifinery plant located at Mex near Alexandria was forced to move to Suez because of the Canal closing, and the possibility of earning foreign currency even if Israel shuts Sinai territory. The third reason is the fact that most of recent big-size tankers are fully loaded and cannot pass Suez Canal. The forth reason is the fact that Israel has brought about a vast benefit through the construction of similar pipe line.

In any event, SUMED pipeline construction was decided in 1973. Negotiation with European countries and U.S.A. had been continued regarding the accommodation of necessary fund until it was agreed based on the cooperation of Arab petroleum producing countries that Saudi Arabia, Kuwait and Abdabi would raise 60 million dollars each, Qatar 20 million dollars and Egypt 200 million dollars. No clear information was obtained on the timing of the construction start, and the rumor that steel pipe material had been already purchased was not confirmed.

Some more obstacles may exist, but the realization of SUMED pipe line construction is almost certain.

2-2 Project Contents (Ref. Fig. 7-2-1)

(1) Pipeline of a total length 320 km from Ain Sunkhna at the shore of Suez Bay to Sidi Kreir at the west of Alexandria. The pipe diameter is 42".

(2) For the initial stage 40 million tons annual transportation capacity through one pipeline, then 80 million tons through two lines, and finally, (with the reinforcement by booster pumps) 120 million tons are planned.

(3) As gulf facilities at Suez Bay side, two underwater pipelines 48" in diameter and 5.1 km in length, one underwater pipeline 42" in diameter and 3.4 km in length, each equipped with a single mooring buoy for 250 thousand DWT class tankers, as well as tanks with total capacity of 100,000 m^3 are to be provided.

(4) As gulf facilities at Mediterranean Sea side, two underwater pipelines 48" in diameter and 8.2 km in length, three underwater pipelines 42" in diameter and 5 km in length, each of the former with a single mooring buoy for 250 thousand DWT class tankers and each of the latter with that for 120 thousand DWT class tankers as well as tanks with total capacity of 100,000 m^3 are to be provided.

(5) Pumps with a capacity of over 1,000 HP are to be arranged in accordance with each transportation capacity.

(6) Electrical power equipments, telephone and telecommunication equipments and other control equipments are to be arranged.

(7) Total construction budget is US$ 348 million (at the time of 40 million tons annual transportation capacity).

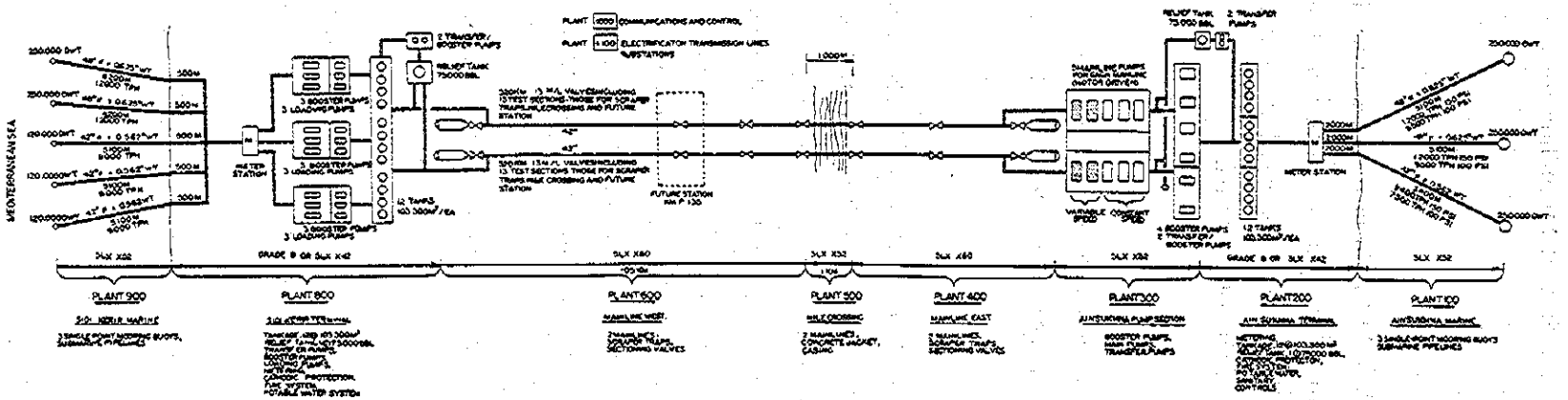


Fig. 7-2-1 SUMED Pipeline

2-3 Transportation Cost

Transportation cost is estimated at the time of 80 million tons annual transportation capacity.

2-3-1 Construction Cost

The total construction budget of US$ 348 million includes every facility except the second pipeline. If this amount is added, it adds up to US$ 400 million. Annual cost including the interest is US$ 30 million when calculated at an annual interest rate of 6.0%, residual value 10% and durable years of 30 years.

2-3-2 Operation

Personnel expenditure, equipment maintenance and repair cost, insurance fee, fuel cost constitute administration cost. This is considered to be US$ 65 million per year.

2-3-3 Tanker

The cost is to be calculated based on 250 thousand DWT class tanker which transports petroleum between Ras Tannura and Genova via the pipeline. A voyage at Suez Bay side requires 14 days. When 345 working days are assumed per year, 24.6 voyages are possible. Therefore, in order to transport 800 million tons of petroleum per year, total thirteen 250 thousand DWT class tankers are necessary. Similarly, since a voyage at Mediterranean Sea side requires 8 days, total 8 same class tankers are necessary. Annual vessel cost of this class tanker is US$ 6.4 million. Total vessel cost of the tankers transporting petroleum for both ways amounts to US$ 133 million. The total voyage cost amounts to US$ 26 million.

Thus, the cost related to tankers is calculated at 159 million U.S. dollars.

2-3-4 Transportation Cost

The transportation cost between Arabian Gulf and Geneva via the pipeline line calculated based on the above results is 3.2 dollars/kl.

3. Big Size Tanker

3-1 Increasing Size

It is needless to say that tanker sizes are increasing, and this tendency had been further accelerated after 1965.

At one time this tendency seemed to be weakened for the prevention of ocean contamination by IMCO's tanker regulation, but in 1972, a supertanker of 477 thousand DWT was introduced (See Fig. 7-3-1).

This tendency resulted from the promotion of large size tanker adoption by ship owners all over the world in order to decrease the crude oil transportation cost which is inversely proportional to the increasing size of a tanker.

Fig. 7-3-2 shows total tankers in the world in 1968, 1970 and 1972 by their sizes. Naturally the number of oil tankers below 100 thousand DWT class is the largest, but it must be noted that the second size is 200 ~ 300 thousand DWT class. Fig. 7-3-3 showing tonnage by size indicates this tendency more clearly.

While the total tonnage of oil tankers below 200 thousand DWT class is almost constant between 1968 ~ 1972, that of 200 ~ 300 DWT class has increased by more than 15 times. It can be concluded that main oil tankers are 250 thousand DWT class and this fact is taken into consideration for the examination of this project.

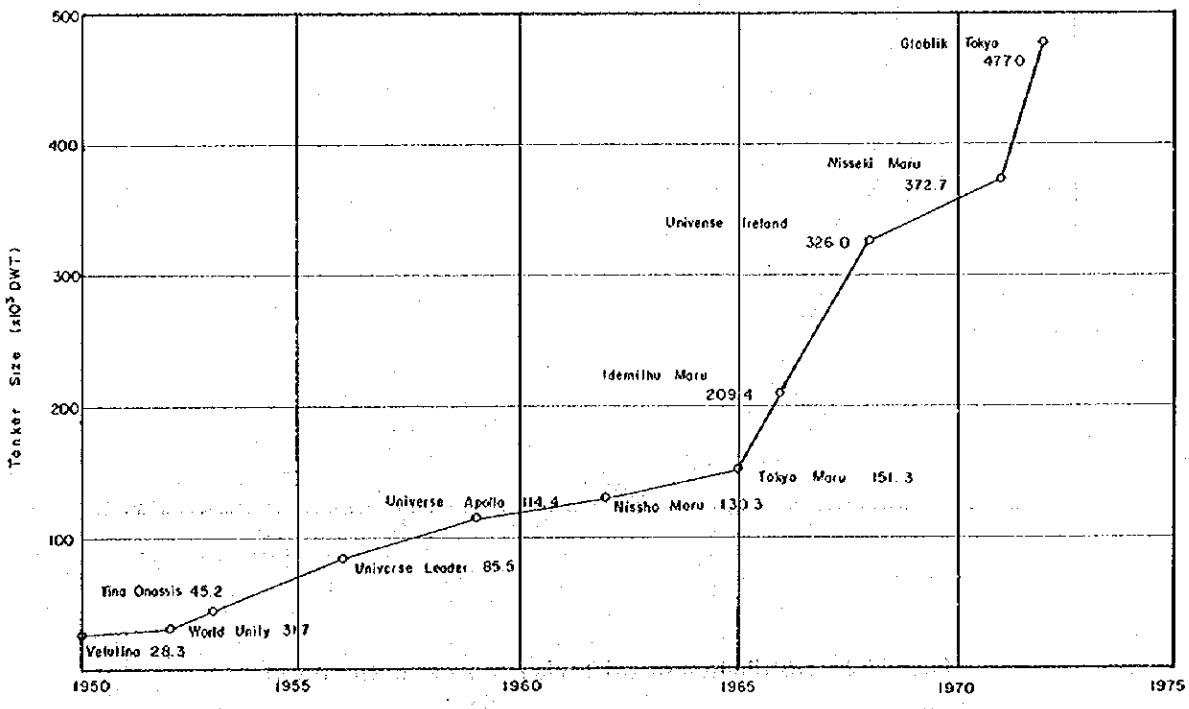


Fig. 7-3-1 Appearance of Mammoth Oil Tanker (The Maximum Size in the World)

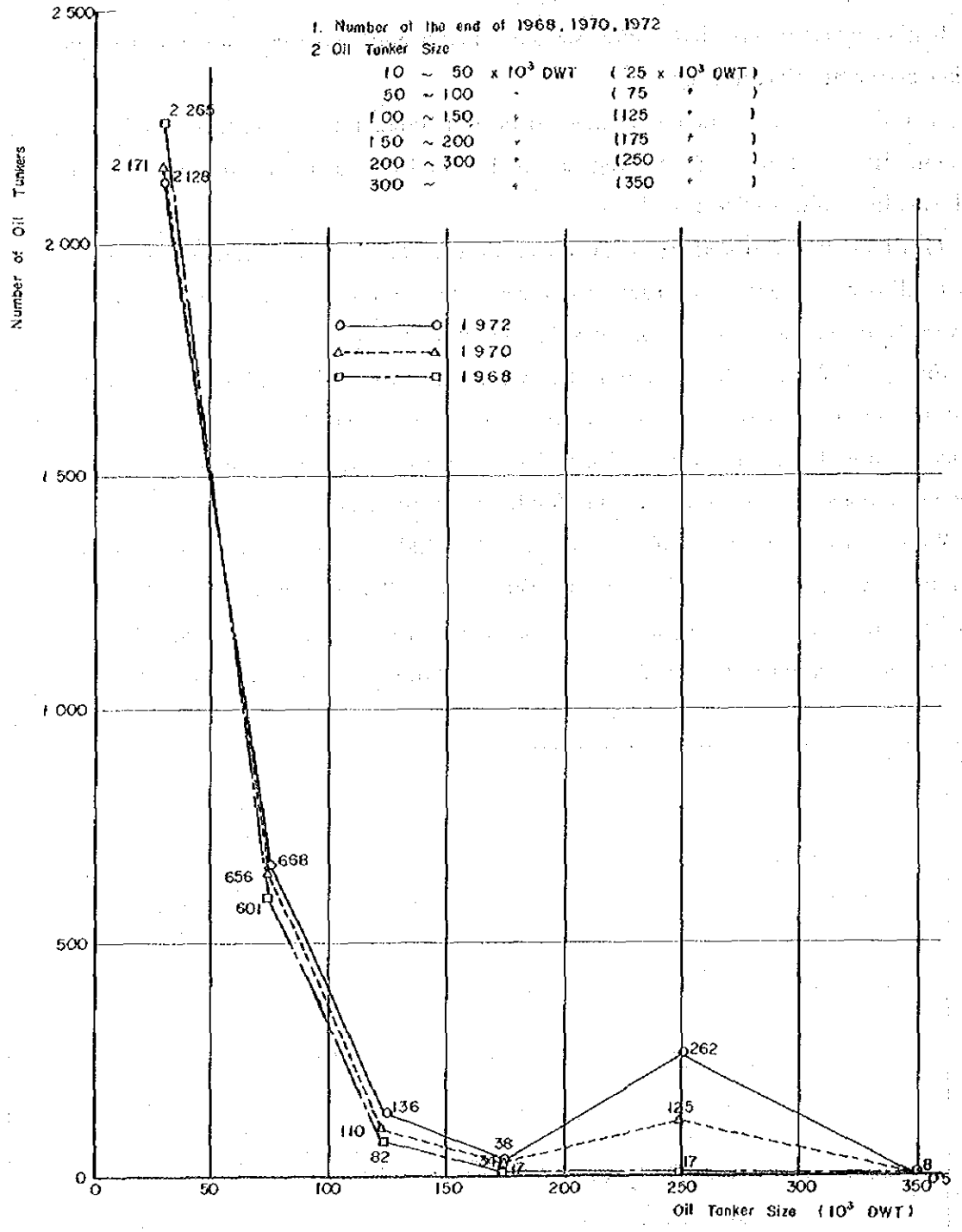


Fig. 7-3-2 Distribution of Oil Tanker Number in the World

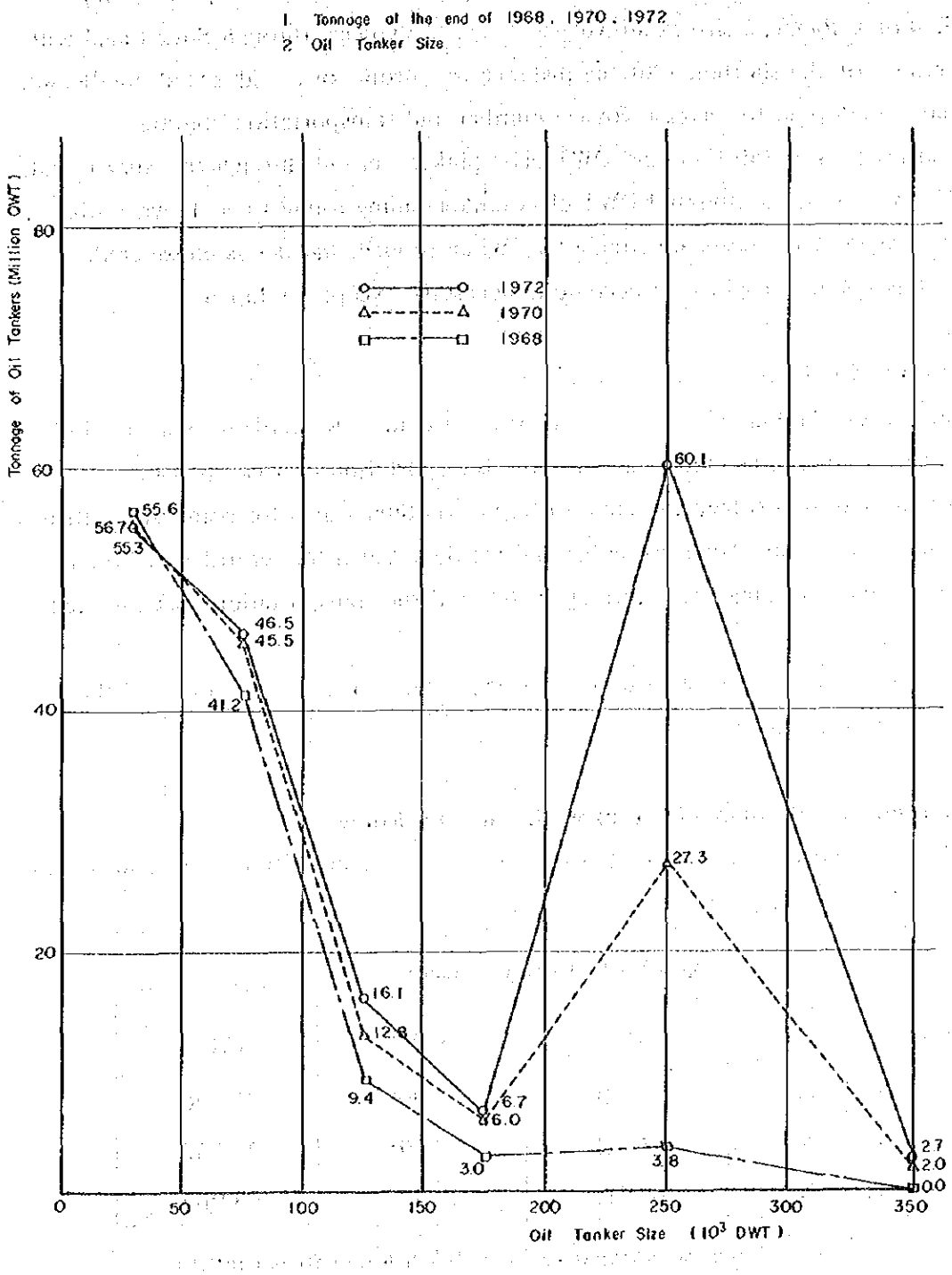


Fig. 7-3-3 Distribution of Oil Tanker Tonnage in the World

The reopening and extension of the Suez Canal will greatly affect this tendency. Especially as to the tankers for Europe, a different tendency from the past history is expected. For instance, a size exclusively used for the voyage through Suez Canal will appear because of the shortening of the distance to Europe, or a high speed middle size tanker may be adopted to increase voyage number and transportation volume.

For instance, if a 250 thousand DWT class tanker can sail through the Suez Canal, it will be equal to a 500 thousand DWT class tanker sailing round Cape Town route when the transportation costs are compared. When tonnage balance is considered, larger size tankers are imagined to become unnecessary except for Japan.

3-2 Transportation Cost

Three routes (Arabian Gulf – Genova, Arabian Gulf – Rotterdam, Arabian Gulf – New York) were chosen as model cases for the transportation cost comparison.

Three cases were assumed for each route, i.e. via Suez Canal for going and returning (S/S) and round Cape Town for going and via Suez Canal for returning (C/S) and round Cape Town for going and returning (C/C); and the transportation cost for each was calculated.

As to the tanker size, existing tankers of 45.5, 84, 134, 228, 266 and 477 thousand DWT were referred to.

3-2-1 Transportation Volume by Tanker Size and by Route

Table 7-3-1 shows that in case of A.G. – G., S/S is about 40% of C/C, and in case of A.G. – N.Y., it is only 70%.

Table 7-3-1 Seaway Distance (Sea miles)

Route \ Via	S/S	C/S	C/C
A.G. ~ G.	9.548	15.909	22.270
A.G. ~ R	13.260	17.995	22.730
A.G. ~ N.Y.	16.916	20.441	23.966

Note: The Suez Canal is assumed to be 160 km long (86 sea miles).

Assuming the travelling speed of an oil tanker at 15 kt on open sea and at 6 kt within the Canal, and taking the number of days for loading and unloading of petroleum into consideration, the annual voyage numbers by route and course are shown

in Table 7-3-2 which indicates that the biggest is 10.6 voyages to Genova in Mediterranean Sea through Suez Canal for going and returning, and the smallest is 4.9 voyages to New York at the east coast of U.S.A. via Cape Town for going and returning.

If simply a case of transportation by tankers of same size is considered, the transport capacity difference is nearly doubled.

Table 7-3-2 Annual Voyage Numbers

Route \ Via	S/S	C/S	C/C
A.G. ~ G	10.6	7.0	5.2
A.G. ~ R	8.0	6.3	5.1
A.G. ~ N.Y.	6.5	5.6	4.9

From the above, annual transportation volume by tanker size, by route and by course is obtained. (See Table 7-3-3.)

Table 7-3-3 Annual Transportation Volume

Unit: Thousand KL

Route	Via \ Tonnage	x 10^3 DWT 45.5 Thousand KL (51.7)	84 (95.5)	134 (152.3)	228 (259.1)	266 (302.3)	477 (542.0)
A.G. ~ G.	S/S	548.0	1,012.3	1,614.4	2,746.5	3,204.4	5,745.2
	C/S	361.9	668.5	1,066.1	1,813.7	2,116.1	3,794.0
	C/C	268.8	496.6	792.0	1,347.3	1,572.0	2,818.4
A.G. ~ R.	S/S	413.6	764.0	1,218.4	2,072.8	2,418.4	4,336.0
	C/S	325.7	601.7	959.5	1,632.3	1,904.5	3,414.6
	C/C	263.7	487.1	776.7	1,321.4	1,541.7	2,764.2
A.G. ~ N.	S/S	336.1	620.8	990.0	1,684.2	1,965.0	3,523.0
	C/S	289.5	534.8	852.9	1,451.0	1,692.9	3,035.2
	C/C	253.3	468.0	746.3	1,269.6	1,481.3	2,655.8

Note: 0.88 DWT = 1 KL

3-2-2 Transportation Cost by Ship Size and by Route

Transportation cost usually consists of the following.

- Vessel Cost
  - Vessel cost .... Crew cost, repair cost, cost of articles for ship, office expenses, insurance
  - Ammortization
  - Interest
- Voyage Cost ..... Fuel cost, tonnage tax, port charges.

Table 7-3-4 shows annual transportation cost per tanker by tanker size.

Table 7-3-4 Annual Transportation Cost per Tanker Unit: U.S.$ 1 million

Route \ Tanker Size / Via		x 10^3 DWT 45.5	84	134	228	266	477
A.G. ~ G.	S/S	3.04	4.05	5.23	7.29	7.92	10.31
	C/S	3.17	4.30	5.55	7.82	8.50	10.95
	C/C	3.31	4.56	5.87	8.36	9.08	11.59
A.G. ~ R.	S/S	3.12	4.20	5.42	7.60	8.26	10.69
	C/S	3.22	4.39	5.66	8.00	8.69	11.16
	C/C	3.31	4.57	5.90	8.39	9.12	11.64
A.G. ~ N.Y.	S/S	3.19	4.35	5.61	7.91	8.60	11.06
	C/S	3.27	4.49	5.78	8.20	8.92	11.41
	C/C	3.34	4.62	5.96	8.50	9.24	11.76

Table 7-3-5 Transportation Cost per 1 Kl (U.S. $/KL)

Route \ Tanker Size / Via		x 10^3 DWT 45.5	84	134	228	266	477
A.G. ~ G.	S/S	5.53	4.00	3.23	2.67	2.47	1.80
	C/S	8.77	6.43	5.20	4.30	4.03	2.90
	C/C	12.3	9.17	7.40	6.20	5.77	4.10
A.G. ~ R.	S/S	7.53	5.50	4.43	3.67	3.40	2.47
	C/S	9.87	7.30	5.90	4.90	4.57	3.27
	C/C	12.6	9.40	7.60	6.37	5.90	4.20
A.G. ~ N.Y.	S/S	9.50	7.00	5.67	4.70	4.37	3.13
	C/S	11.3	8.40	6.77	5.67	5.27	3.77
	C/C	13.2	9.87	8.00	6.70	6.23	4.43

Table 7-3-5 shows the results of calculation of transportation cost per 1 kl using Table 7-3-4 and the foregoing transportation volume.

3-2-3 Suez Canal Toll Rate

SCA is now carrying out a close examination on the toll system but the team examined the transportation cost using the old toll rate based on the results of an interview with SCA. The old toll rate is as follows.

Northbound (loaded)	L.E. 0.44/kl
Southbound (in ballast)	L.E. 0.20/kl
Total	L.E. 0.64/kl

Fig. 7-3-4 ~ 6 illustrate the results of additions of Suez Canal tolls to the transportation costs in Table 7-3-5 by each tanker size.

As it is apparent from these tables, the value of Suez Canal decreases as the distance increases. For instance, from Fig. 7-3-4 (Arabian Gulf – Genoa), the transportation cost of 60 thousand DWT class tanker via the Suez Canal, which is the largest possible size (full load) sailing through the Canal when it is reopened, is almost equal to that of 320 thousand DWT class tanker via Cape Town. On the other hand, from Fig. 7-3-6 (Arabian Gulf – New York) the transportation cost of the same tanker is about equal to that of 110 DWT class tanker via Cape Town.

Fig. 7-3-5 (Arabian Gulf – Rotterdam) shows an intermediate tendency between Fig. 7-3-4 (Arabian Gulf – Genova) and 7-3-6 (Arabian Gulf – New York). The transportation cost of 60 thousand DWT class tanker via Suez Canal for going and returning is equal to that of 160 thousand DWT tanker via Cape Town for going and returning. It is equal to that of about 100 thousand DWT tanker via Cape Town and Via Suez for going and returning.

The transportation cost of a 150 thousand DWT tanker (full load) via Suez for going and returning, which is the largest possible size that can sail through the Canal after completion of the First Phase Project, is equal to that of a 400 thousand DWT tanker via Cape Town for going and returning.

When a 150 thousand DWT tanker is allowed to sail through Suez Canal with full load, a tanker of less than 400 thousand DWT via Cape Town cannot compete economically with the 150 thousand DWT tanker on the Arabian Gulf – Rotterdam route.

This fact indicates the effect of the Suez Canal development.

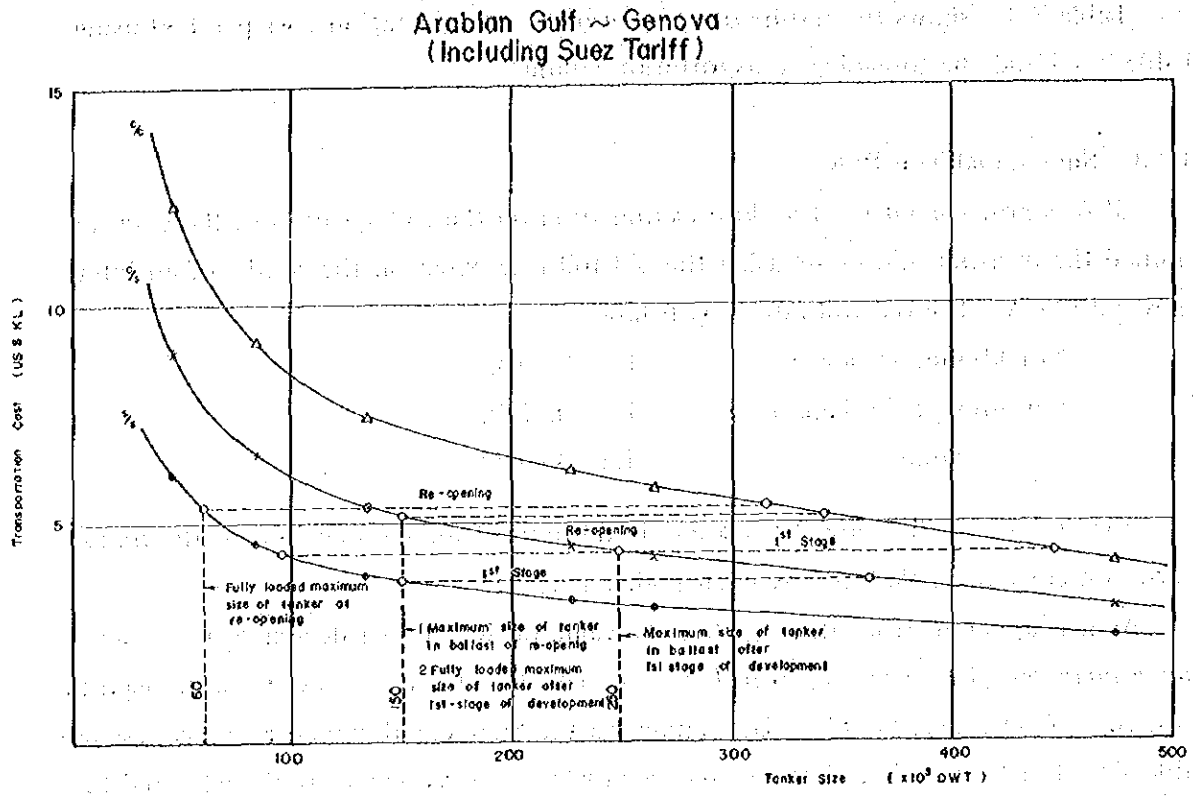


Fig. 7-3-4 Transportation Cost-Tanker Size

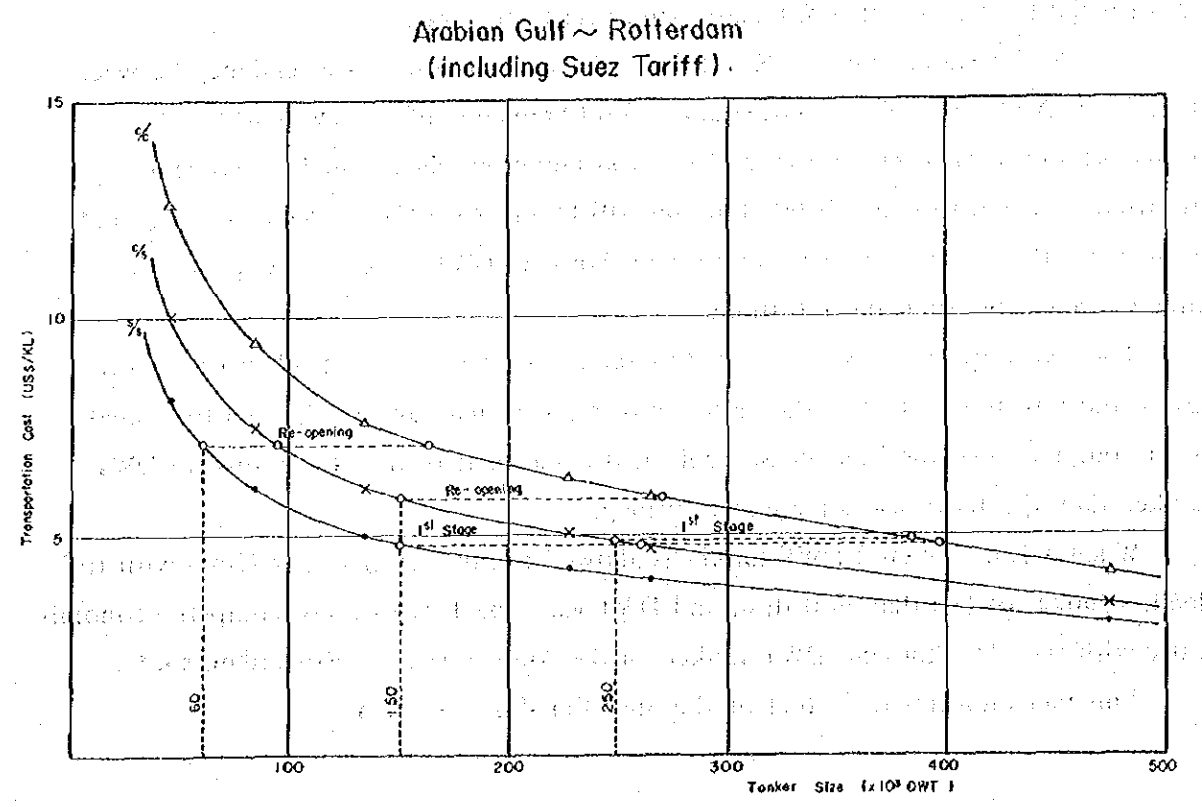


Fig. 7-3-5 Transportation Cost-Tanker Size

When each Fig. is examined, the transportation cost via Suez Canal is found to be the cheapest.

Taking Fig. 7-3-4 for instance, the transportation cost via Suez Canal of a 60 thousand DWT class tanker for both directions is about equal to that of a 130 thousand DWT tanker which uses Suez Canal only for returning and that of a 320 thousand DWT tanker via Cape Town for going and returning.

Moreover, in the same Fig., when a 150 thousand DWT tanker can sail through Suez Canal for both going and returning, the transportation cost is less than the cost of transporting crude oil by a 500 thousand DWT tanker via Cape Town.

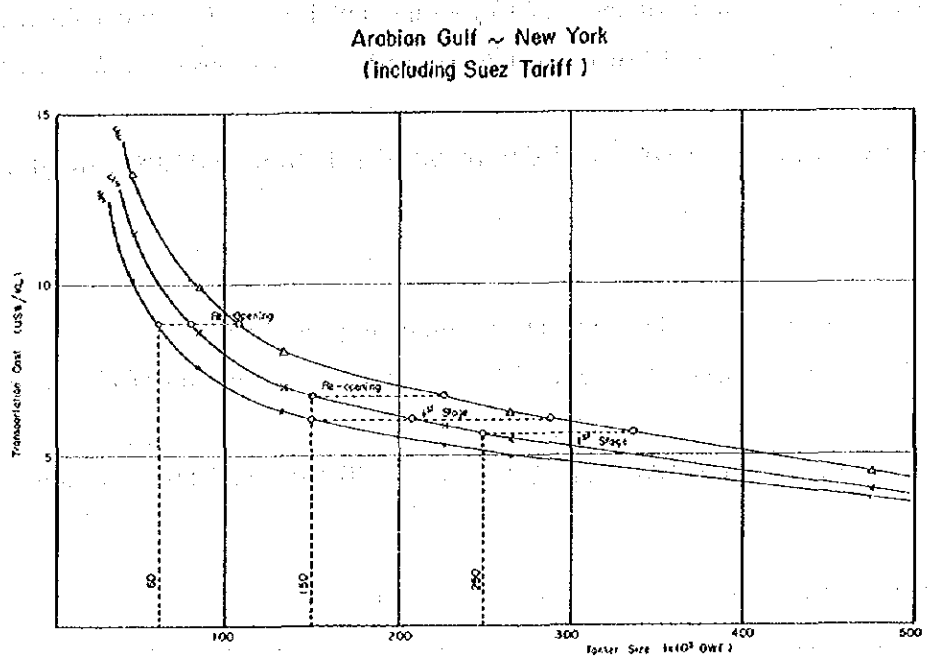


Fig. 7-3-6 Transportation Cost-Tanker Size

4. Comparison of Transportation Cost

(1) The transportation cost of crude oil via SUMED pipeline between Arabian Gulf and Genova is 2.8 U.S. dollars/kl which is about equal to that of a 200 thousand DWT tanker via the Suez Canal. Therefore, it was decided to examine the benefit of this project at the safer side, i.e. by deducting 80 million tons of SUMED pipeline capacity from the volume of crude oil transported via the Canal.

(2) Followings are the expected advantage of tanker size at the reopening time of the Suez Canal and at the completion of this project. Tankers below 60 thousand DWT

are relatively old, and advantageous in transportation economy as compared with new and large tankers. For this reason, the transportation cost of tankers below 60 thousand DWT is replaced with that of 60 thousand DWT tanker.

1. At the re-opening time (See Fig. 7-4-1 ~ 3)

(A.G. ~ G.)

a. Transportation by a tanker of over 320 thousand DWT via C/C is most favorable.
b. S/S of below 60 thousand DWT, C/S of 60 ~ 130 thousand DWT, and C/C of 130 ~ 320 thousand DWT are equivalent.

(A.G. ~ R.)

a. Transportation by a tanker of over 270 thousand DWT via C/C is most favorable.
b. C/S of 100 ~ 150 thousand DWT and C/C of 150 ~ 270 thousand DWT are the next.
c. S/S of below 60 thousand DWT and C/S of 60 ~ 100 thousand DWT are almost equal.

(A.G. ~ N.Y.)

a. C/C transport of over 230 thousand DWT tanker is most favorable.
b. C/S of 80 ~ 150 thousand DWT and C/C of 150 ~ 230 thousand DWT are the next.
c. S/S of below 60 thousand DWT and C/S of 60 ~ 80 thousand DWT are almost equal.

2. At the completion of the project (See Fig. 7-4-4 ~ 6)

(A.G. ~ G.)

a. S/S transport of 100 ~ 150 thousand DWT tanker and C/C of 450 thousand DWT tanker are most favorable.
b. S/S of below 100 thousand DWT, C/S of 150 ~ 250 thousand DWT and C/C of 250 ~ 450 thousand DWT are almost equal.

(A.G. ~ R.)

a. C/C transport of over 400 thousand DWT tanker is most favorable.
b. S/S of below 150 thousand DWT, C/S of 150 ~ 250 thousand DWT and C/C of 250 ~ 450 thousand DWT are almost equal.

(A.G. ~ N.Y.)

a. C/C transport of over 340 thousand DWT tanker is most favorable.

b. C/S of 210 ~ 250 thousand DWT, C/C of 290 ~ 340 thousand DWT are the next.

c. S/S of below 150 thousand DWT, C/S of 150 ~ 210 thousand DWT and C/C of 250 ~ 290 thousand DWT are almost equal.

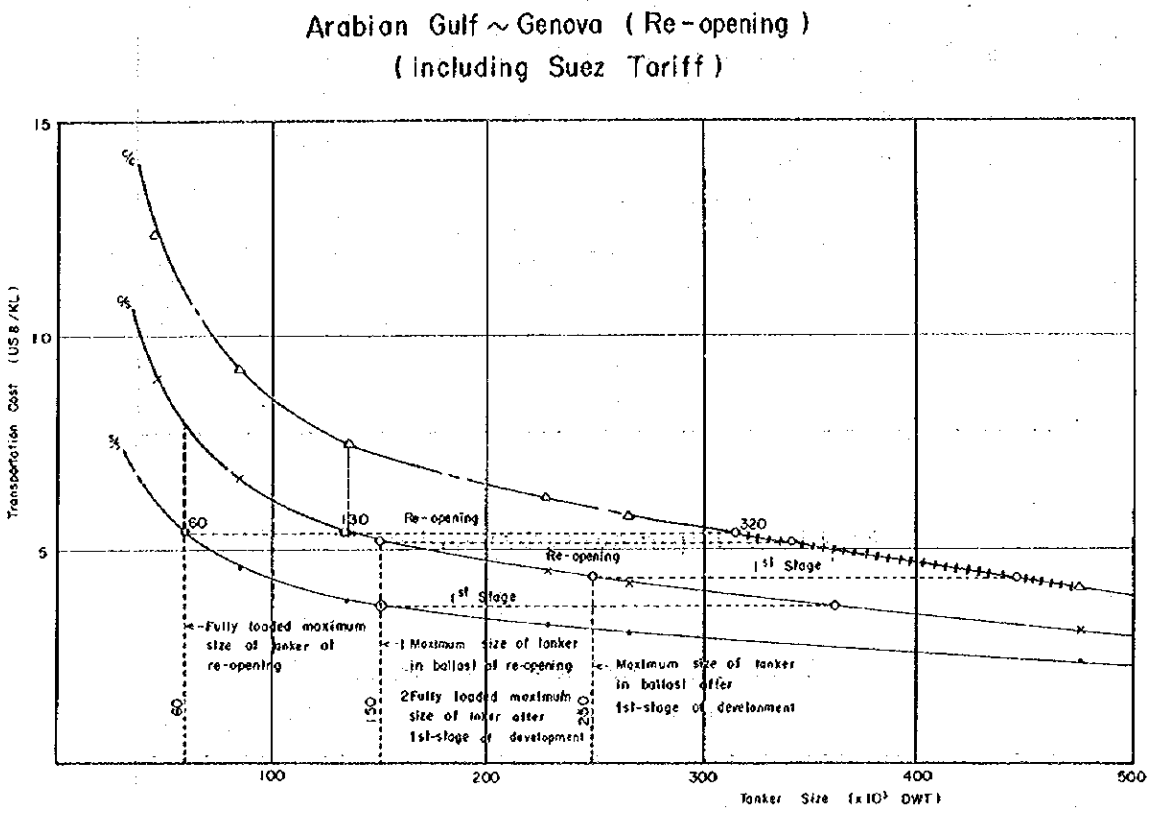


Fig. 7-4-1 Transportation Cost-Tanker Size

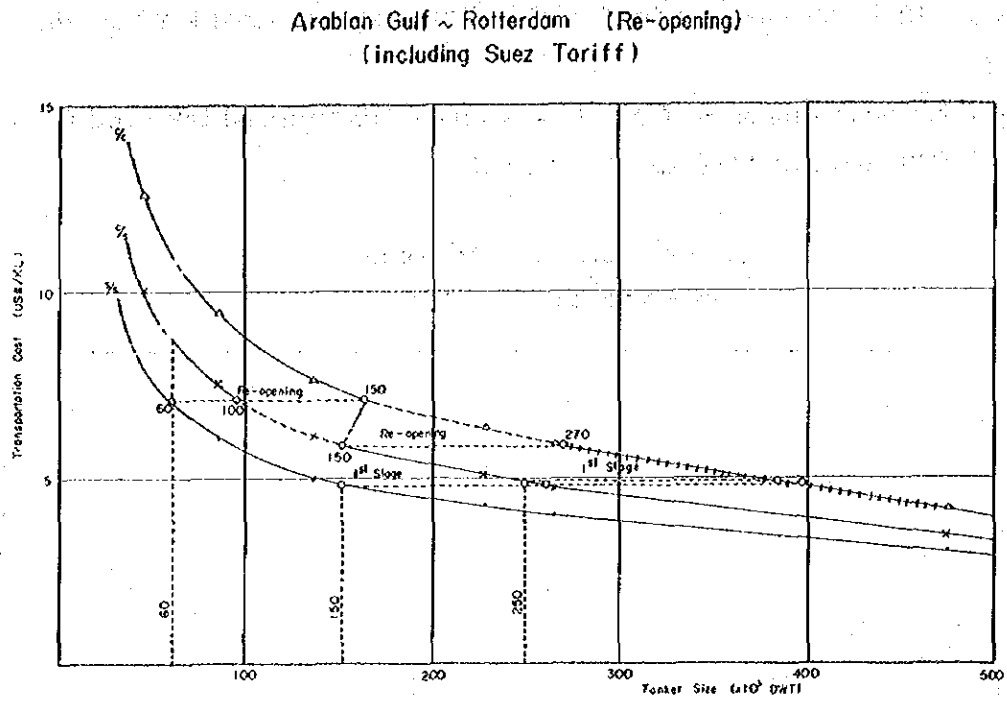


Fig. 7-4-2 Transportation Cost-Tanker Size

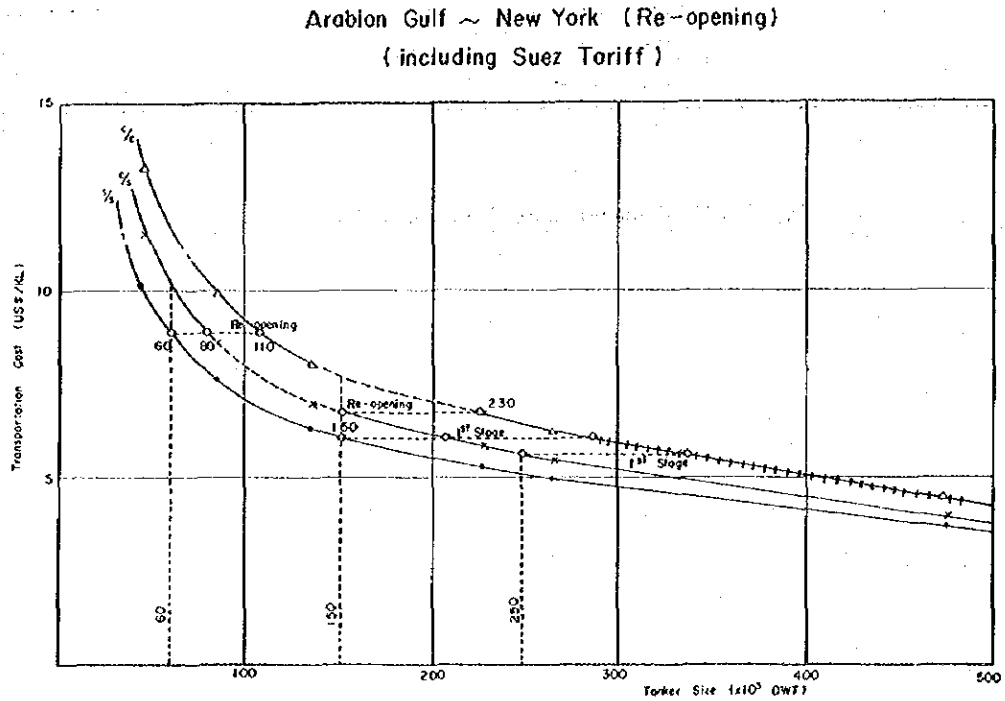


Fig. 7-4-3 Transportation Cost-Tanker Size

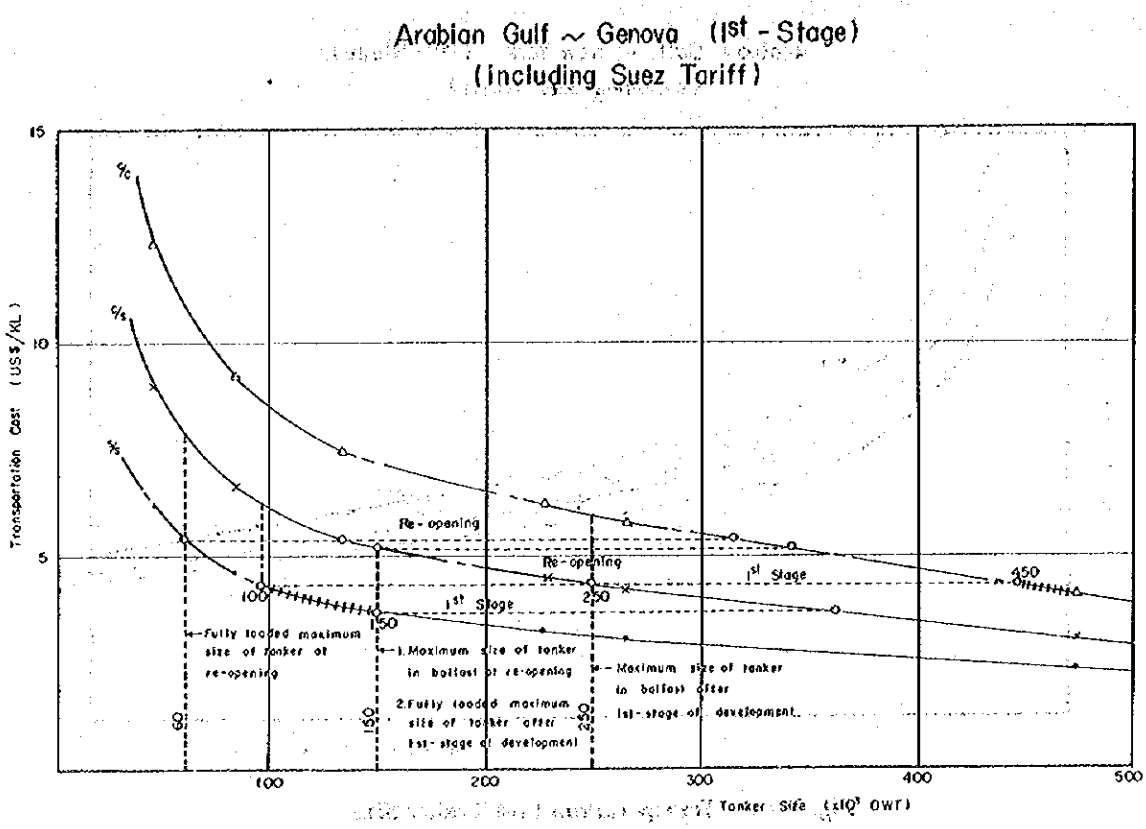


Fig. 7-4-4 Transportation Cost-Tanker Size

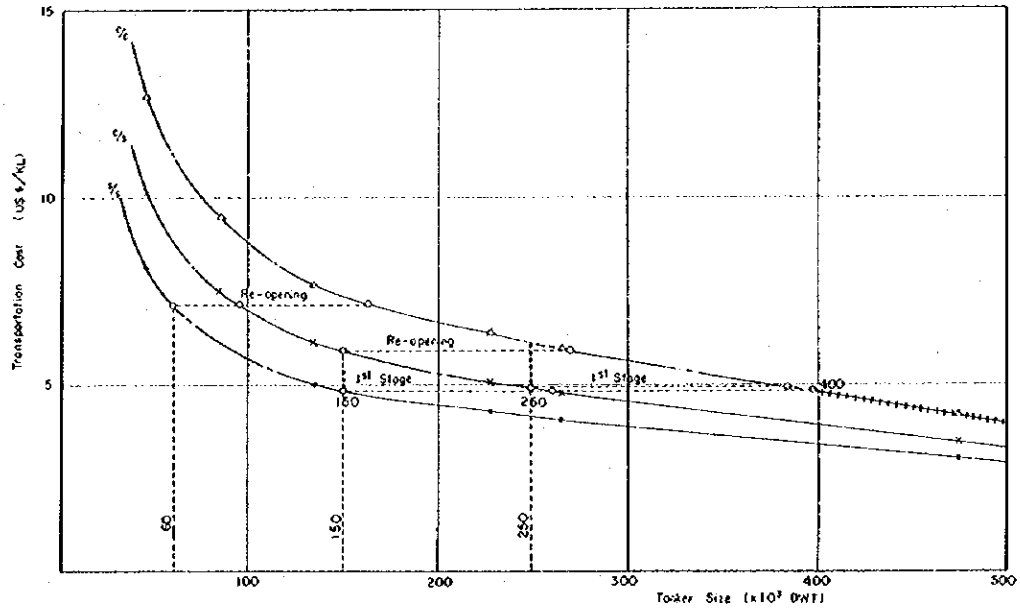


Fig. 7-4-5 Transportation Cost-Tanker Size

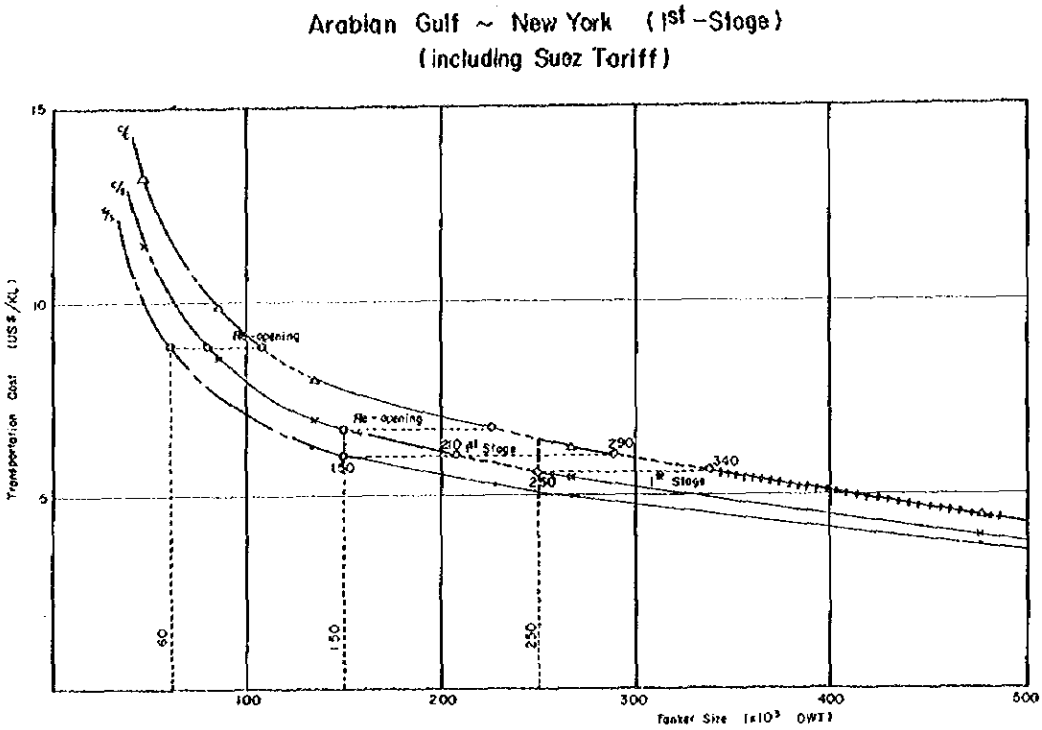


Fig. 7-4-6 Transportation Cost-Tanker Size

VIII. PETROLEUM DEMAND AND SUPPLY FORECAST

VIII. PETROLEUM DEMAND AND SUPPLY FORECAST

1. World's Energy Demand and Supply

Since OPEC decided to raise crude oil price up to US$ 10.00/barrel resulting from the crisis due to petroleum production control triggered by Middle East War IV in October, 1973, demand and supply of energy in the world, especially those of petroleum, have entered into a new phase. According to the latest forecast by OECD, it is reported that petroleum import volume in OECD countries may decrease in 1980 and 1985 as compared with that of 1972 if the current petroleum price is maintained.

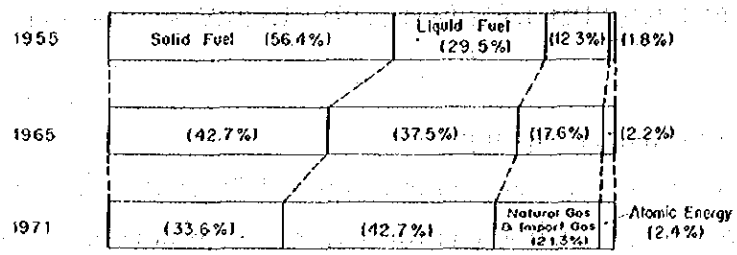
The object of this project is to bring about benefits to Egyptian economy and international shipping industry by letting large size tanker (60 thousand DWT ~ 150 thousand DWT) from Arabian Gulf to Europe and U.S.A. sail through the Suez Canal instead of going round Cape Town which is the current course. Therefore, it is no exaggeration to say that the success of the project wholly depends on the increased volume of crude oil passing through the Canal after it is extended. In order to grasp this increasing volume, it is necessary to forecast international energy demand and supply status, especially the protroleum demand and supply status. For this purpose, past energy demand and supply structure was reviewed, then demand and supply forecasts by OECD and other related organization were examined so that the team's forecast may be based on these examinations.

1-1 Changes in Energy Demand and Supply

Total energy consumption in the world is 49.67 million Kl (As of 1971, converted to petroleum), and the consumption per head is 1.34Kl/head. Average annual rate of growth in total energy consumption was 4.9% in 1955 ~ 1965, 5.3% in 1965 ~ 1971, and 5.1% in 1955 ~ 1971. Over 50% of total energy was consumed in U.S.A. and west European countries, and about 60% of petroleum was consumed in these countries (free world). (Both figures are for 1971).

Seen by energy type, the rate of solid fuel has decreased, while the consumption of liquid fuel and natural gas has increased as shown in Fig. 8-1-1.

Especially, the growth of liquid fuel is remarkable, but new energy source such as atomic energy is also inclined to grow. (See Fig. 8-1-1).



(Note) The Figure Drew up from "United Nations: World Energy Supplies. Series J NO.3, NO.8 and NO.16".

Fig. 8-1-1 Change in the Composition of Primary Energy Sources

1-2 Trends in Petroleum Demand and Supply

1-2-1 Changes in Supply and Demand

According to 1972 edition of BP Statistical Review of the World Industry, total petroleum consumption in the world in 1972 was 3 billion kl. Since world population in 1972 was 3.8 billion, petroleum consumption per head was 0.78 kl/head. It was 0.4 kl/head in 1960 so that it grew almost twofold in 12 years. Average annual growth of consumption was 7.2% in 1950 ~ 1960, 8.0% in 1960 ~ 1970, and 6.5% in 1950 ~ 1970.

Consumption by major countries are, U.S.A. – 30%, West Europe – 27%, Soviet, East Europe & China – 15%, Japan – 9%.

U.S.A.'s consumption had been growing by 4% each year through the 1950's and 1960's, but during 1970 ~ 1972 the annual growth rate was 5.5%.

In West Europe, the annual growth had been over 12% until the 1960's because of the promotion of convertion from coal to petroleum, but in 1970's it was about 6%. (See Table 8-1-2).

Table 8-1-1 Actual Consumption of Primary Energy Source (Converted to Petroleum Million kl)

	World	U.S.A.	West Europe	Japan	Soviet	Others
1955	2.254	900	508	46	309	491
1965	3.650	1.254	732	123	580	961
1971	4.967	1.629	971	239	778	1.350

Note: 1. Source: United Nations: World Energy Supplies Series J. No. 3, No. 8, No. 9, No. 16

2. Rate of growth in world total energy consumption is 4.9% in 1958 ~ 1965 and 5.3% in 1965 ~ 1971.

Table 8-1-2 World Oil Consumption Volume

(Million kℓ)

	1950		1960			1970			1971			1972		
	Consumption Volume	Ratio	Consumption Volume	Ratio	1950~1960 Average Annual Growth	Consumption Volume	Ratio	1960~1970 Average Annual Growth	Consumption Volume	Ratio	Ground over Previous Year	Consumption Volume	Ratio	1970~1972 Average Annual Growth
U.S.A.	377[6]	60[5]%	560[3]	45[0]%	4.0[0]%	832[3]	31[0]%	4.0%	861[0]	30[4]%	3.4%	926[8]	30[3]%	5.5%
West Europe	73[1]	11[7]	237[2]	19[0]	12.5	734[3]	27[4]	12.0	768[8]	27[1]	4.7	823[0]	27[0]	5.9
Japan	2[9]	0[4]	34[2]	2[7]	28.0	232[0]	8[6]	21.0	257[2]	9[1]	10.9	278[4]	9[1]	10.0
U.S.S.R., East Europe, China	52[2]	8[4]	169[4]	13[6]	12.5	392[0]	14[6]	8.8	423[4]	14[9]	8.0	463[4]	15[2]	8.9
Others	118[3]	19[0]	244[7]	19[7]	7[2]	472[5]	18[4]	6[8]	525[5]	18[5]	11[2]	563[8]	18[4]	9.2
Total	624[1]	100	1,245[8]	100	7[2]	2,683[1]	100	8.0	2,835[0]	100	5.7	3,056[3]	100	6.5

Note: 1. BP Statistical Review of the World Industry (1960, 1970, 1972)

On the other hand, the oil production volume was 2.58 billion kl in 1970, and 3.22 billion kl in 1972, and 3.22 billion kl in 1973 according to each year end issue of Oil & Gas Journal. Breakdown by territories is, 1.24 billion kl in Middle East which accounts to 39% of total production in the world, 669 million kl in North America (including Canada and Mexico) which is 21%, 560 million kl in Soviet and other communists area which is 17%, 330 million kl in Africa which is 10%, and 270 million kl in Latin America which is 8%. In West Europe, the production volume is only a little over 20 million kl. (For actual results in 1973, see Table 8-1-3). Production volume growth in Middle East has to be noted.

As to the estimated oil deposits, the possible production period in the world in 1973 is over 30 years as is seen from Table 8-1-4. Especially in Middle East Area, the possible production period is estimated to be 45 years which is the longest in the world.

In Kuwait or Saudi Arabia which has much oil deposits, the possible production period is as long as 50 ~ 60 years. This indicates the possibility that the flow of crude oil from Middle East to Europe and America will last several tens of years from now.

Import and export data by territory is shown in Table 8-1-5. According to the result of 1972, the largest importing area was West Europe, then came Japan and America. On the other hand, the largest exporter was Middle East, then came Africa and Caribbean area.

Table 8-1-3 World Oil Production Volume

(Million kℓ)

	1950		1960		1970		1973		Remarks
	Volume	%	Volume	%	Volume	%	Volume	%	
North America	329^{5}	50^{6}	454^{2}	37^{4}	650^{3}	25^{2}	664^{3}	20^{6}	Including Camada, Mexico
Latin America	102^{4}	15^{7}	198^{9}	16^{4}	274^{5}	10^{6}	270^{8}	8^{4}	
West Europe	4^{2}	0^{6}	16^{7}	1^{4}	20^{7}	0^{8}	23^{0}	0^{7}	
Middle East	102^{6}	15^{8}	304^{7}	25^{1}	790^{8}	30^{7}	$1,239^{7}$	38^{5}	
Africa	2^{6}	0^{4}	16^{0}	1^{3}	348^{2}	13^{5}	334^{3}	10^{4}	
Far East, Oceania	14^{3}	2^{2}	32^{6}	2^{7}	81^{6}	3^{2}	130^{2}	4^{0}	
U.S.S.R., Communist Area	49^{9}	7^{7}	192^{6}	15^{8}	413^{1}	16^{0}	560^{3}	17^{4}	
Others	–		–		–		26^{7}	0^{8}	
Total	650^{5}	100	$1,215^{7}$	100	$2,579^{1}$	100	$3,222^{5}$	100	

Notes: Prepared from each year-end issue of "Oil & Gas Journal".

Table 8-1-4 Proved Petroleum Reserves and Exploitable Years by Area

Unit: Million KL

	1950			1960			1970			1973			Ultimate Exploitable Reserves
	Reserves	Share	R/P	Reserves	Share	R/P	Reserves	Share	R/P	Reserves	Share	R/P	
North America	4,245	34.7%	13th year	6,485	13.5%	14th year	8,103	8.7%	12th year	7,587	7.6%	11th year	61,000
United States	3,919	32.0	12	5,332	11.1	13	5,885	6.3	11	8,517	5.5	10	
Canada	191	1.6	38	795	1.7	26	1,709	1.8	23	1,498	1.5	15	
Central and Latin America	1,677	13.7	16	3,627	7.6	18	3,652	3.9	13	4,459	4.5	16	31,000
Venezuela	1,511	12.3	17	2,941	6.1	18	2,226	2.4	10	2,226	2.2	11	
Europe	46	0.4	12	274	0.6	16	590	0.6	28	2,544	2.5	11	3,000
United Kingdom	–	–	–	–	–	–	159	0.2	–	1,590	1.6	17.667	
Middle East	5,233	42.7	51	29,122	60.9	95	54,788	58.7	69	55,679	55.8	45	124,000
Abdabi	–	–	–	40	0.1	–	1,876	2.0	51	3,419	3.4	46	
Bahrein	25	0.2	13	40	0.1	13	101	0.1	25	57	0.1	15	
Iran	1,113	9.1	29	5,565	11.6	91	11,130	11.9	51	9,540	9.6	27	
Iraq	835	6.8	104	4,293	9.0	75	5,088	5.5	58	5,009	5.0	46	
Kuwait	1,749	14.3	83	9,858	20.6	105	10,669	11.4	67	10,176	10.2	61	
Neutral Zone	–	–	–	954	2.0	119	4,086	4.4	146	2,783	2.8	94	
Qatar	80	0.6	40	397	0.8	40	684	0.7	33	1,047	1.0	32	
Saudi Arabia	1,431	11.7	45	7,950	16.6	110	20,432	21.9	103	20,988	21.0	49	
Dubai	–	–	–	–	–	–	156	0.2	31	398	0.4	31	
Oman	–	–	–	–	–	–	270	0.3	14	835	0.8	53	
Africa	32	0.3	11	1,288	2.7	81	11,887	12.7	34	10,703	10.7	32	16,000
Algeria	–	–	–	826	1.7	83	4,770	5.1	84	1,215	1.2	20	
Angola	–	–	–	5	–	–	80	0.1	13	239	0.2	26	
Egypt	32	0.3	11	87	0.2	22	716	0.8	38	815	0.8	78	
Libya	–	–	–	318	0.7	–	4,643	5.0	24	4,055	4.1	33	
Nigeria	–	–	–	24	0.1	24	1,479	1.6	26	3,180	3.2	27	
Far East and Oceania	248	2.0	18	1,734	3.6	53	2,290	2.5	28	2,487	2.5	19	14,000
Indonesia	175	1.4	22	1,511	3.2	60	1,590	1.7	32	1,670	1.7	22	
Australia	–	–	–	–	–	–	318	0.3	32	366	0.4	15	
U.S.S.R. and Communist Area	766	6.2	15	5,327	11.1	28	12,000	12.9	29	16,377	16.4	29	70,000
U.S.S.R.	696	5.7	16	5,009	10.5	29	8,745	9.4	23	12,720	12.7	26	
China	3	–	–	119	0.2	20	3,116	3.3	260	3,180	3.2	76	
World's Total	12,247	100.0	20	47,857	100.0	40	93,310	100.0	36	99,836	100.0	31	319,000

Notes: 1. The ultimate exploitable reserves was obtained from the paper submitted by Lewis G. Weeks to the Sixth Meeting of the World Oil Conference in 1963.

2. Proved petroleum reserves = Amount estimated to be recoverable by the existing techniques under the current economic condition.

3. Ultimate exploitable reserves = Estimated reserves (future "proved reserves") incorporated in the following formula.
Reserves = Past production + Proved reserves + Future "proved reserves"

Source: Year-end issues of "Oil and Gas Journal."

Table 8-1-5 World Export and Import (1972)

(Million kℓ)

	Export			Import			Remarks
	Crude Oil	Refined Oil	Total	Crude Oil	Refined Oil	Total	
America	–	13^{1}	13^{1}	128^{5}	146^{5}	275^{0}	
Canada	49^{6}	13^{3}	62^{9}	45^{2}	7^{8}	53^{0}	
Caribbean Sea Area	65^{0}	145^{0}	210^{0}	66^{1}	1^{7}	67^{8}	
West Europe	–	18^{9}	18^{9}	770^{2}	45^{2}	815^{4}	
Middle East	924^{2}	58^{9}	983^{1}	7^{0}	–	7^{0}	
Africa	311^{2}	1^{4}	312^{6}	1^{7}	5^{8}	7^{5}	
Japan	–	1^{2}	1^{2}	237^{5}	40^{0}	277^{5}	
Asia	46^{4}	17^{4}	63^{8}	94^{5}	33^{3}	127^{8}	
Australia	0^{6}	0^{6}	1^{2}	13^{1}	5^{5}	18^{6}	
U.S.S.R., East Europe, China	36^{5}	36^{5}	73^{0}	20^{9}	1^{2}	22^{1}	
Others	4^{0}	1^{7}	5^{7}	52^{8}	21^{0}	73^{8}	
Total	$1,437^{5}$	308^{0}	$1,745^{5}$	$1,437^{5}$	308^{0}	$1,745^{5}$	

As to OD between territories, the export destinations from Middle East are as follows;

The largest is to West Europe which is about 500 million kℓ, then to Japan which is 220 million kℓ. To the United States in 1972 was 2.7 million kℓ which is relatively small. Export to Latin America (and other areas in the western hemisphere) was rather large, amounting to 6.5 million kℓ, which is considered to include a large amount of oil refined in Latin America for export to the United States.

Import sources of European and American countries which are closely related to this project are as follows;

In case of America, largest source is Caribbean area, and the relative importance of Middle East is not high. West Europe depends on Middle East for 60% of the total import of 820 million kℓ, and on Africa for 20%. (See Table 8-1-6)

Table 8-1-6 Petroleum Volume of Transfer (1972)

(Million Kℓ)

	America	Canada	Other Western Hemisphere	Western Europe	Africa	Southeast Asia	Japan	Australia	Other Eastern Hemisphere	Others	Total Export Volume
America	–	1.7	4.0	3.7		0.5	2.3	2.0	2.0		13.0
Canada	62.9										62.9
The Caribbean Area	131.6	30.1	9.2	31.6	0.2	0.5	0.5			5.8	209.9
Other Western Hemisphere	2.6		1.4				1.7				5.8
Western Europe	9.2	0.8			2.3				1.1	5.2	18.8
Middle East	27.5	14.5	64.6	497.0	26.6	73.3	218.6	15.0	35.0	10.4	983.1
North Africa	13.3	1.7	14.5	158.3	0.5		0.2		12.7		201.5
West Africa	15.3	4.0	16.8	67.8			4.0		1.7	1.1	111.0
Southeast Area	10.4		0.5	0.2	0.5		48.1	3.1			63.2
U.S.S.R./Eastern Europe	1.1		7.5	56.2	4.3		1.4		2.3		73.0
Other Eastern Hemisphere	0.5			0.2		1.7	0.2				2.9
Total Import Volume	274.9	53.0	118.9	815.4	34.8	76.2	277.5	18.5	53.3	22.6	1,745.5

1-2-2 Recent Supply-Demand Trend

Middle East War IV broken out in October 1973 made the future supply of petroleum extremely unstable and invited the so-called "oil crisis". The Arab countries convened the general meeting of OAPEC (See Note 1) in October 1973 in Kuwait, and executed the curtailment of oil production for purposes of "using petroleum as a weapon for the currently progressing Arab /Israel dispute" (extracted from the resolution adopted at the OAPEC meeting on October 17, 1973). At around the same time, the six countries (Abdavi, Iran, Iraq, Kuwait, Qatar, Saudi Arabia) of the OPEC (See Note 2) had agreed upon an increase in the official price of crude oil by 70% (See Note 3) which ushered in the age of high-priced crude oil.

Note: 1. OAPEC stands for Organization of Arab Petroleum Exporting Countries and it was formed in January 1968 immediately after the Middle East War III (the 6-Day War). The objectives of the formation of this organization are:

(1) Adjustment of economic and oil policies among the allied nations.

(2) Mutual cooperation in order to solve various problems in the oil industry of the allied nations.

(3) Promotion of joint business related to the oil industry by the allied nations. The countries included in the organization are ten countries, that is, Saudi Arabia, Kuwait, Iraq, Qatar Libya, Abdavi, Algeria, Bahrein, Egypt, and Syria.

Note: 2. OPEC stands for Organization of Petroleum Exporting Countries. In September 1960, Venezuela, Saudi Arabia, Kuwait, Iran and Iraq declared the establishment of OPEC in an effort to oppose the lowering of the official price of petroleum. The objectives of the formation of OPEC are:

(1) To establish a joint policy covering petroleum companies.

(2) To restore the lowered price to the original level.

(3) When the official price is to be revised, it should be confered, in advance of the implementation, with the governments of oil producing countries.

(4) Necessity of an international assignment for the production and export of oil. The countries joined the organization are, besides the aforementioned five countries, Qatar, Indonesia, Libya, Abdavi, Algeria, Nigeria, and Ecuador, or total of 12 countries.

Note: 3. The reasons to increase the official price of crude oil are:

(1) The Teheran Agreement (deciding a 2.5% increase per year to fill the gap created by inflation) has become obsolete due to the accelerated inflation on a world-wide basis, and therefore, an amendment to the Agreement became necessary.

(2) It is necessary to inhibit the unreasonable excess profits on the side of the petroleum companies.

Thereafter, the production curtailment was alleviated; however, the official price of crude oil continued to go upward. During October 1973 and January 1974, the price for the Middle East crude oil was increased from US$3.011/barrel to US$11.651/barrel (resolved at 6 Nations Conference at Teheran in 1973), or by four times.

Since the time when the crude oil became so high-priced, the demand for petroleum by each country in the world became less due to the economy mood in consumption invited by the economic recession and ever-increasing commodity prices. For example, following indicates the demand for petroleum by major oil consuming countries during the first half of 1974:

America	January ~ May 1974	6.1% decrease compared with the same period of the previous year.
Italy	January ~ May 1974	10.0% decrease compared with the same period of the previous year.
England	January ~ April 1974	7.7% decrease compared with the same period of the previous year.
France	January ~ May 1974	10.0% decrease compared with the same period of the previous year.
West Germany	January ~ June 1974	15.0% decrease compared with the same period of the previous year.

The future trend of the oil prices is inviting a keen attention since it will directly affect the world-wide economy and seal the fate of the oil industry in the world.

Should the price of crude oil continue to climb upward, all the countries consuming oil must further cut their consumption and develop substitution energy. OECD which occupies a major portion of the total oil consumption is now establishing a new oil policy as a long-term countermeasure and the U.S.A. as well as the EC countries are also preparing an oil policy on a separate basis. These are very important for the future prospects covering the oil demand.

1-2-3 New Estimate for Oil Supply & Demand

Occasioned by the oil crisis, various estimations have been made covering the supply and demand of oil by each organization. The team visited OECD and EC at mid-December 1974 to collect the related data and information on this matter. Hereunder, these data together with additional new information will be introduced.

(1) "Energy Prospects to 1985" by OECD

OECD issued the "Energy Prospects to 1985" on January 13, 1975. The work has been progressing since 1972 in order to establish a long-range estimate for energy and it was finalized by OECD allied countries when the oil crisis broke out in Autumn of 1973. The works take the following assumptions with respect to the price of oil imported by the OECD countries. (import price per barrel)

1) US$9/barrel in 1972 (can be converted into a price at the end of 1974 as US$10.80/barrel.)
2) US$6.00/barrel in 1972 (can be converted into a price at the end of 1974 as US$72.00/barrel.)

It assumes the above two cases. However, it also assumes as its premise that the decrease in oil consumption will not lead to the slow down of the economic growth rate.

According to the report, the import volume of oil by the OECD countries prior to the outbreak of the oil crisis was 1,220 million tons. Taking the case of a $9/barrel, the import volume will become 1,080 million tons in 1980 and 1,070 million tons in 1985, both of which are lower than the 1972 level. This decrease in importation by those countries is supported by foreseeable facts that the total energy consumption should decrease due to the high price, and substitution energy such as natural gas, coal, atomic power, water power and geothermal energy will be developed on a rapid basis since they compete with oil in cost. Compared with the estimated value established prior to the oil crisis, the US$9/barrel estimation takes a 12% decrease in the total energy consumption in 1985 and a 60% decrease in volume of oil importation. The decreased portion is going to be filled by increased oil production as well as by natural gas, coal, atomic power, geothermal energy, etc. (See Table 8-1-7)

The demand and supply prospect of oil for OECD Europe and the U.S.A. is shown in Table 8-1-8. According to the prospect shown in this table, on an assumption that a $9/barrel be maintained through the future, the Western Europe will decrease their import in 1985 while the United States will become an exporting country.

Table 8-1-7 OECD Primary Energy Requirement

(Million tous, %)

	1972	1980			1985			Remarks
		Base Case	$6 Case	$9 Case	Base Case	$6 Case	$9 Case	
1. Volume	3,463	5.067^{6}	4.786^{0}	4.600^{2}	6.420^{5}	5.966^{6}	5.650^{5}	
(1) Oil (Imported Oil)	1.917^{3} (1.224^{3})	2.910^{3} (2.014^{3})	2.444^{8} (1.446^{4})	2.173^{8} (1.084^{4})	3.571^{1} (2.634^{0})	2.810^{9} (1.661^{9})	2.451^{6} (1.071^{6})	
(2) Gas	744^{5}	952^{6}	993^{5}	1.086^{3}	1.107^{8}	1.197^{0}	1.244^{8}	
(3) Solid Fuels	669^{8}	780^{8}	898^{5}	889^{9}	951^{0}	1.048^{2}	1.036^{1}	
(4) Nuclear & Hydro	131^{4}	423^{8}	449^{1}	450^{1}	790^{6}	910^{2}	917^{6}	
2. Composition	100^{0}	100^{0}	100^{0}	100^{0}	100^{0}	100^{0}	100^{0}	
(1) Oil (Imported Oil)	55^{4}	57^{4}	51^{0}	47^{3}	55^{6}	47^{1}	43^{4}	
(2) Gas	21^{5}	18^{8}	20^{8}	23^{6}	17^{3}	20^{1}	22^{0}	
(3) Solid Fuels	19^{3}	15^{4}	18^{8}	19^{3}	14^{8}	17^{6}	18^{3}	
(4) Nuclear & Hydro	3^{8}	8^{3}	9^{4}	9^{8}	12^{3}	15^{3}	16^{2}	

Notes: 1) Base case requirements are the values prospected by OECD prior to the oil crisis.

2) Prepared from "Energy Prospect to 1985" (OECD) of 1975.

The report is stressing the importance and the necessity of cooperation for an energy policy among the OECD countries in order to switch the energy structure as follows:

1) Efforts to economize energy.
2) Improvement of self-sufficiency in energy by the OECD countries as well as mutual accommodation of energy among them.
3) Preparation for establishment of an organization for financial and fund stabilization to import energy.
4) Cooperation concerning research and development of energy.
5) Cooperation in the environmental problems.

Also, the report points out that the OECD countries and the OPEC countries are in the mutually supplementing relationship. Therefore, the cooperation between the two will benefit the world-wide economy, and the necessity to greatly increase the economic and technical assistance ~~to~~ the non-oil-producing countries still on the way for development will be promoted.

Table 8-1-8 Oil Forecast by OECD (Million ton)

Year	Consumption/ Production	Europe			U.S.A.		
		Base Case	6U.S.$/ Barrel	9U.S.$/ Barrel	Base Case	6U.S.$/ Barrel	9U.S.$/ Barrel
1972	Consumption	730[7]			824[8]		
	Production	19[8]			560[3]		
	Imported Supply	718[4]			254[6]		
1980	Consumption	1,140	900	780	1,120	980	860
	Production	190	220	240	580	650	720
	Imported Supply	950	680	540	540	330	140
1985	Consumption	1,440	1,120	970	1,310	1,000	940
	Production	250	290	300	580	750	870
	Imported Supply	1,190	830	670	730	250	△70

Notes: 1. Prepared from "Energy Prospect to 1985 by OECD."
2. Base case requirement corresponds to $3.00/barrel.
3. Crude oil price in 1972 is adopted.

(2) Community Energy Policy ~ Objectives for 1985

The EC announced the Community Energy Policy compiled by the EC Committee on December 17, 1974. The policy is a guideline to promote respective domestic policies of the EC countries. This is also important for both the suppliers and consumers of energy in the EC as their guidelines. The summary of the policy is as follows:

As to overall objectives:

1) By 1985, the degree of reliance upon the imported energy shall become 50% of the current level.

2) If it is possible at all, the degree of reliance upon imported energy shall be lowered to 40% (60% in 1975). In this case, the supply structure will become as shown in Table 8-1-9.

As to respective energies:

3) Relating the energy demand,
   a) A 15% decrease shall be effected by 1985 against the estimated value made in 1973 through the improvement of the usage efficiency.
   b) The structure of energy consumption shall be improved toward the use of energy of higher reliability so that the dependency on electricity will be increased to 35% in 1985 on the assumption of the development of atomic energy.

4) Relating the energy supply,
   a) As to solid fuels, 180 million tons of coal will be produced and 40 million tons of coal will be imported from third countries in 1985. The production of brown coal and peat will be increased by 30 million tons.
   b) At least 175 million tons, or 225 million tons if such figure will be feasible, of natural gas will be produced in 1985 in addition to 95 ~ 115 million tons which will be imported from third countries.
   c) As to atomic energy, the scale of production will be increased to at least 190 million tons, or 240 million tons, if such figure is feasible, in 1985.
   d) As to the hydro-dynamic and geothermal energy, the production will reach 45 million tons in 1985.
   e) As to the petroleum energy, while the conversion to other energies will be accelerated, the scale of production will be at least 180 million tons in 1985.

The importation from third countries will be 550 million tons against 640 million tons in 1973, or, in case the dependency on other energy sources will be further increased, the importation may also be reduced to 420 million tons. In such case, the rate of importation of petroleum against the total energy demand will be 38 ~ 28% (61% in 1973) and 75 ~ 70% against the demand for petroleum.

f) As to other types of energies, in addition to the development of existing energies, it is also necessary to promote the policy for research and development aiming at the conversion to new energy sources as a long-range plan.

The following are the appeals to the member states.

5) The member states are urged to pay full attention to these aims when they establish their energy policies.

Table 8-1-9 Total Primary Energy Requirements in % (Note 1)

	For the Record		1985 Objectives	
	1973 Estimates	(Note 2) 1985 Initial Forecast	50% Dependence	40% Dependence
Solid fuels	22.6	10	17	17
Oil	61.4	64	49	41
Natural gas	11.6	15	18	23
Hydro-electric and geothermic power	3.0	2	3	3
Nuclear energy	1.4	9	13	16
Total requirement	100	100	100	100

Notes: 1. Requirement = Internal consumption + exports + bunkers

2. Source: "Prospects of primary energy demand in the community (1975 ~ 1980 ~ 1985)" supplemented by an estimate made in January 1973 for the Member States.

The above is the common energy policy of EC. The estimation, however, is based upon the assumption that the existing price of crude oil of 10 ~ 11 U.S.$/barrel will be maintained and that the annual growth rate of economy and energy consumption up to 1985 will be 5% and 3.5% respectively.

Table 8-1-10 Objective of Energy Demand and Supply of EC (1985)

(Million ton)

Item	Minimum	Maximum
1. Total Energy	1,475	1,475
2. Production	800	900
1) Solid Fuel	(210)	(210)
2) Natural Gas	(175)	(225)
3) Hydro-electric, Geothermic Power	(45)	(45)
4) Oil	(180)	(180)
5) Nuclear Energy	(190)	(240)
3. Imported Supply	675	575
1) Solid Fuels	(40)	(40)
2) Natural Gas	(95)	(115)
3) Oil	(540)	(420)
Energy Dependence	46%	40%

Note: Prepared from the data of EC Energy Ministers' Committee.

(3) General Message of U.S. President in 1975

President Ford referred to the subjugation of energy crisis of U.S.A. in his Annual State of the Union Message to Congress on January 15, 1975. The message described the energy policy in 1975. The team wishes to introduce here the President's Message as it is based upon the long-range perspective to 1985.

President Ford established the following nationwide target of energy plan for the purpose of coping with a state resembling the petroleum embargo in 1973.

1) To reduce the importation of petroleum by 100 million barrels by the end of 1975 and by 200 million barrels by the end of 1977.

2) To conquer the weakness of bringing about economic confusion by the petroleum supply from foreign countries by the end of 1985.

3) To develope the technology and the resources relating the energies so that a substantial part of the demand for energy in the free world may be supplied by the end of this century.

For the purpose of attaining the abovementioned target, the following long-range countermeasures for reducing the consumption are proposed in addition to the revision of laws to make possible the conversion to coal at power plants, introduction of sur-

charge to be levied on the importation of petroleums, as well as the development of continental shelves, etc.

1) Establishment of standards regarding compulsory heat insulation effect at newly constructed buildings.

2) Suspension of regulations against environmental pollution for 5 years with the aim of improving the economy of fuel of automobiles.

Lastly, it is also suggested that it is desirable to realize the following items in the coming 10 years as the energy plan of U.S.A.

(1) Operation of 200 major nuclear power plants.
(2) Exploitation of 250 new major coal mines.
(3) Operation of 150 major coal-burning power plants.
(4) Operation of 30 new major oil refineries.
(5) Operation of 20 new major liquefied coal plant.
(6) Exploitation of several thousands of new oil fields.
(7) Realization of an effective air-conditioning system in 1800 million households.
(8) Massproduction of economic passenger cars requiring a low fuel cost.

(4) Consideration

Abovementioned 3 lines of perspective for demand and supply may be said to have a similar tone. In other words, any of the perspectives assumes that the importation of petroleum in the region in the 1980's will be lower than the level in 1972, and at the same time includes a non-political warning toward the Arab states who pushed forward the resource nationalism with petroleum as an arm.

Further, excepting the general message of U.S. president, all of the perspectives are simple calculations based on the price mechanism of petroleum without considering the energy policies of various countries. Therefore, these reports are only one of the models. In addition, the reports tend to lay stress on the advantage as a whole rather than to consider advantages of individual member states of OECD and EC. Such tendency will be rather natural when the characteristics of the reports are considered. However, it will be difficult to determine whether, say, United Kingdom will export her petroleum from the North Sea. There arises a political problem.

Be that as it may, the most important problem will be the trend of the price of crude oil. For example, according to the calculation mechanism of OECD, the energy consumption will decrease with the rise in the price of crude oil and the competitive power of the substitute energies will rise with decreasing amount of imported crude oil.

Therefore, the future trend of the crude oil price which is at present 10 ~ 11 U.S.$/barrel deserves attention. A conference on the price of crude oil is scheduled to be held between the consuming countries and producing countries of petroleum this year. However, the conclusion of this conference is not to be assumed beforehand. There is an assumption that the price will be reduced to the original figure because of the surplus production of crude oil in recent years. On the other hand, there is also an assumption that the existing high price will be continued. Furthermore, agreement on price, if even concluded at such conferences as mentioned above, will only have a short-range effect on long-life projects like the one under consideration.

Even under such conditions, it is necessary to have a perspective for demand and supply based on some assumptions in order to evaluate this project. As described in the EC report, the assumption is made to the effect that the importation of coal and natural gas will increase according to the decrease of the importation of petrol. If this assumption is accepted with account taken of the recent mammothization of LNG carriers, it can be said that the Canal will play in important role in the flow of natural gas from Australia and other areas to Europe. The only conclusion that the team can draw from the above assumption is that a compromise may be possibly reached between consumer and supplier-countries and the crude price could settle somewhere between the current level and the price before October, 1973. To be more specific, 6 U.S.$/barrel forecast by OECD may serve as a reference figure.

2. Forecast of Demand and Supply of Petroleum

Since the petroleum flow affecting the project is from Middle East to U.S.A. and Western Europe, the team made a forecast of the demand and supply in these two regions. Forecast of demand and supply in Japan was also made because it is necessary to examine tanker bottoms.

The methodology and conception of the forecast are as follows.

(1) The forecast of demand and supply of petroleum should be made on the basis of the positioning of the petroleum in the overall demand for energies. Here, however, the team adopted the method of observing the growth of demand for petroleum. Such decision was adopted because the calculated values can be checked with the values issued otherwise from OECD, etc. As to the rate of growth, a rate somewhat lower than recorded in the past was adopted referring to the actual results and the future prospects by relevant organizations.

(2) Relatively reliable figures were adopted for the amounts self-supported in respective regions.

(3) The difference between the demanded amount and the self-supported amount depends upon importation from petroleum producing countries. The amount of importation from oil producing countries excepting Middle East was determined by the actual result in the past and the oil reserves etc., while the remaining amount was assumed to rely upon Middle Eastern countries.

(4) In case there exists competition between the tanker transportation and the pipeline transportation, it is assumed that the full capacity of pipelines will be given priority, and the remaining amount will be transported by tankers.

The method and results of forecast are described by regions in the following section.

2-1 Western Europe

i. Demand

The rates of annual growth in the past are 12% in the 1960's and 5.9% in 1970 ~ 1972. The annual growth rate in the period from 1972 to 1985 is estimated to be 3.0%. As the result, the demand for petroleum turns out to be 930 million tons in 1980 and 1,070 million tons in 1985 against 730 million tons in 1972.

ii. Production in Western Europe

At present, the production in Western Europe is 20 million tons or so. However, the development of oil field in North Sea is expected in the future. The production is expected to be started in 1975. According to the estimation of OECD, the total amount of production in 1985 will be more than 300 million tons in the region of United Kingdom and Norway. The reliable figure of production in EC is estimated to be 180 million tons. As described above, the estimations of OECD and EC include a considerable degree of political considerations. In this report, therefore, an estimated value of 190 million tons (140 million tons on British side plus 50 million tons on Norwegian side) is adopted referring to the reliable estimation of EC and the perspective of Mr. Takao Tomidate of Nippon Energy Economy Research Institute. (See Table 8-2-1).

Table 8-2-1 Perspective of Worldwide Crude Oil Production

	1980	1985
Middle East		
Saudi Arabia	1,200 ~ 1,300	1,200 ~ 1,300
Iran	700 ~ 750	650 ~ 700
Iraq	500 ~ 600	600 ~ 800
Kuwait	200 ~ 250	200 ~ 250
Abu-Dhabi	250	250
Qatar	50	50
Others	100	120
Middle East Total	3,000 ~ 3,300	3,080 ~ 3,470
Africa		
Libya	200 ~ 250	250 ~ 300
Algeria	100 ~ 130	100 ~ 120
Nigeria	300	300
Others	150	200
Africa Total	750 ~ 800	850 ~ 920
Western Semisphere		
U.S.A.	1,200 ~ 1,400	1,500 ~ 1,700
Venezuela	100 ~ 130	320 ~ 370
Others	500	570 ~ 600
Western Semisphere Total	2,000 ~ 2,220	2,390 ~ 2,670
Western Europe	350 ~ 400	430 ~ 480
Asia and Oceania	300 ~ 350	400
Free World Grand Total	6,400 ~ 7,000	7,150 ~ 7,940

Source: Takao Tomidate, Nippon Energy Economy Research Institute, "Crude oil policies of Middle Eastern, European and American countries" (The "Energy," July 1974 issue.)

iii. Importation

As the regions of importation, there are African countries and U.S.S.R. in addition to Middle Eastern countries. The amount of importation from African countries and U.S.S.R. is estimated to be 270 million tons in 1980 on the basis of the actual results and underground reserves. As to the values after 1980, it is anticipated that the demand in Southern and Western African countries will increase so that large amount of oil supply will not be expected from African countries. So, some decrease of importa-

tion is assumed, while the amount imported from U.S.S.R. is assumed to be constant.

iv. Transportation by pipelines and tankers

The oil from Middle East is transported to Western Europe by means of pipelines and tankers. As described before, it is assumed that the transportation by pipelines will have the priority. Actually, it is anticipated that competition from tankers will confront the Israeli pipeline and the SUMED pipeline. In this report, however, pipeline transportation is given priority to the limit of its capacity. By the way, the SUMED pipeline is estimated to start its service in 1977 with a capacity of 40 million tons which will increase to 80 million tons in 1979. Accordingly, the transportation amount by tankers is assumed to be 290 million tons in 1980 and 410 million tons in 1985.

v. Transportation of petroleum products

As regards transportation by tankers, the volume of petroleum products transported by smaller tankers is calculated. Annual rates of 10% up to 1980 and 15% up to 1985 are assumed on the basis of the actual result in 1972. The transportation volume of crude oil is calculated by substracting this volume of petroleum products.

vi. Distribution between Northern Europe and Southern Europe

As to the transportation volume of crude oil, it is also necessary to divide it into two; the volume transported through Suez Canal and that going round Cape Town. So, it becomes necessary to divide the volume for Europe also into two; the volume destined to Northern Europe and that destined to Southern Europe (European coast of Mediterranean Sea). This distribution is made on the basis of the actual results since 1972 with account taken of the development of oil field in North Sea.

The Results of calculation based on the abovementioned assumptions are given in Table 8-2-2.

2-2 U.S.A.

i. Demand

The rate of annual growth in the past is 4.0% in 1960's and 5.5% in the period of 1970 ~ 1972. The rate of growth since 1972 up to 1985 is assumed to be 1.5%. As the result, the estimated demand for oil is 930 million tons in 1980 and 1,000 million tons in 1985 against 820 million tons in 1972.

ii. Production in the U.S.A.

The amount of domestic production in 1972 is 560 million tons. However, on

Table 8-2-2 Projected Oil Demand and Supply for Europe, 1975 ~ 1985

(Million ton)

Demand Supply	1972	75	76	77	78	79	80	81	82	83	84	85	Remarks
1. Demand	730[7]	798[4]	822[4]	847[1]	872[5]	898[6]	925[6]	953[4]	982[0]	1,011[4]	1,041[4]	1,073[0]	Annual rate of increase : 3.0%
2. Supply													
1) Indigenous	19[8]												
North Sea (B)		10	20	50	75	90	100	110	115	120	125	140	British ①
North Sea (N)		10	20	30	35	40	50	50	50	50	50	50	Norway ①
Others		20	20	20	20	20	20	20	20	20	20	20	
2) Imports	718[4]												
Africa		185	186	188	190	195	200	195	190	190	185	180	
Russia & Others		70	70	70	70	70	70	70	70	70	70	70	
Middle East of which pipe lines		503	506	489	473	484	486	508	537	561	592	613	
・Existing pipe lines		110	120	120	120	120	120	120	120	120	120	120	Tapline, Israeli line, IPC line etc.
・SUMED		–	–	40	40	80	80	80	80	80	80	80	
Tankers		343	386	329	313	284	286	308	337	361	392	413	
・Oil products	6[5]	9	10	11	12	13	17	20	23	26	30	34	Annual rate of increase ~1980 10% ~1985 15%
・Crude Oil		384	376	318	301	271	269	288	314	335	362	379	②
・North Europe		260	250	195	174	150	141	155	169	182	196	207	① + ② × 0.7 − ① . . . . ③
・South Europe		124	126	123	127	121	128	133	145	153	166	172	② − ③

the same basis as applied for Western Europe, domestic production in 1980 and 1985 is assumed to be 640 million tons and 800 million tons, respectively.

iii. Import

In the United States, the weight of Middle East as the importation region is not, at present, so large as in Western Europe. The dependency on the Caribbean countries, Africa and Canada for importation is high. However, increase of production in a large degree cannot be expected of the Caribbean countries when the underground resources, etc. are considered. So, the exportation to U.S.A. from those countries will be reduced to zero in 1980. As to Canada, the exportation to U.S.A. is assumed to drop to zero in 1985 because of the expected growth of domestic consumption. As to African countries, practically the same conception as applied to Western Europe is adopted. As the result, the amount exported from Middle Eastern countries to U.S.A. is assumed to be 120 million tons in 1980 and 100 million tons in 1985.

By the way, some of the abovementioned volumes will be transported by means of the pipeline connecting Middle East with Mediterranean Sea. However, the priority of pipeline transportation is given to Western Europe, while all the transportation to U.S.A. is assumed to resort to tankers only. Further, the petroleum products exported from Middle East to U.S.A. are omitted from the estimation as the amount is not prospected large.

Further, the following flow pattern is assumed for petroleum supply to U.S.A.

Middle East $\xrightarrow[\text{Mammoth Tankers}]{\text{Crude Oil}}$ South America ..... (Refining) ..... $\xrightarrow[\text{Smaller Tankers}]{\text{Products}}$ ..... U.S.A.

In this case, the flow of crude oil from Middle East to U.S.A. is naturally reduced in amount. However, the flow of crude oil from Middle East to South America increases so that the value of the Suez Canal will remain practically the same as in case of the transportation to U.S.A. So, it was judged that the validity of the project would remain unchanged even if transportation of crude oil from Middle East to U.S.A. is taken as the basis for evaluation.

The calculation result on the abovementioned basis is shown in Table 8-2-3.

2-3 Japan

The forecast result obtained by the same concept and method as Western Europe and U.S.A. is shown in Table 8-2-4.

Table 8-2-3 Projected Oil Demand and Supply for North America (1975 ~ 1985)

(Million tons)

Demand Supply	1972	75	76	77	78	79	80	81	82	83	84	85	Remarks
1. Demand	824[8]	862[5]	875[4]	888[5]	901[9]	915[4]	929[1]	943[1]	957[2]	971[6]	986[1]	1,000[9]	Annual increasing rate : 1.5%
2. Supply													
1) Indigenous	560[3]	600	600	610	620	630	640	670	710	740	770	800	
2) Imports													
Canada		31	41	50	58	64	70	56	42	28	14	–	
Africa		54	61	67	73	77	80	80	80	80	80	80	
Indonesia		15	15	16	17	18	19	20	20	20	20	20	
Caribbean Area		76	71	65	57	44	–	–	–	–	–	–	
Middle East		87	87	81	77	90	120	117	105	104	102	101	

Table 8-2-4 Projected Oil Demand and Supply for Japan (1975 ~ 1985)

Demand Supply	1972	75	76	77	78	79	80	81	82	83	84	85			Remarks
1. Demand	245[4]	258[9]	273[1]	288[2]	304[0]	320[7]	338[4]	357[0]	376[6]	379[3]	419[2]	442[2]	466[6]	492[2]	Increasing rate 5[5]%
2. Supply															
Indigenous	0[7]			1[0]	1[2]	1[5]	2[0]	2[3]	2[5]	3[0]	4[0]	5[0]	6[0]	7[0]	
Imports				287	303	319	336	355	374	396	415	437	461	487	
Indonesia				49	51	53	55	57	59	62	64	67	69	72	
Others				9	10	10	11	11	11	12	12	13	14	15	Excluding A.G.
Middle East				229	242	256	270	287	304	322	339	357	378	400	

IX. FIRST-PHASE SUEZ CANAL EXTENSION PROJECT

IX. FIRST-PHASE SUEZ CANAL EXTENSION PROJECT

1. Project Description

The First Phase Canal Extension Project is planned to be executed in the manner illustrated in Figs. 9-1-1 ~ 9-1-2.

Part of the project cost is planned to be covered by the yen loan extended from Japan and part of the dredging work is expected to be undertaken by Japanese enterprises. Table 9-1-1 shows the relationship of the first phase project with other Canal development projects.

Table 9-1-1 Suez Canal Development Projects

Project	Water Depth	Sectional Area of Canal	Maximum Draft	Maximum Tonnage of Transit Vessel
Reopening of Canal	15.5	1.850	40	60.000
First-phase Canal Extension Project	19.5	3.200	53	150.000
Second-phase Canal Extension Project	23.5	4.200	67	250.000
Next Step	–	–	72	–

In view of the mammothization of tankers observed in past years, it is considered that the number of 60,000 DWT class tankers transiting the Canal after its reopening will drop below the level maintained before its closure. Unless the Canal is expanded to permit the transit of highly economical supertankers, therefore, it is not likely that the Canal operation will bring about any increase of revenues.

Hence, it is urgently needed to promote the first phase extension project and proceed to the second phase project without delay.

Even when the first phase project is completed after a work period of about 3.5 years, it is probable that supertankers (250,000 – 500,000 DWT) serving on the Arabian Gulf – North America route will incur a lower freight by going round Cape Town than by transiting the Canal, and this makes it imperative to proceed to the second-phase project immediately after completion of the first-phase project.

The following works are covered by the first-phase project.

1) Dredging

The sectional area of the Canal will be increased over its entire length to four

TYPICAL CROSS SECTION AT Km. 61.000

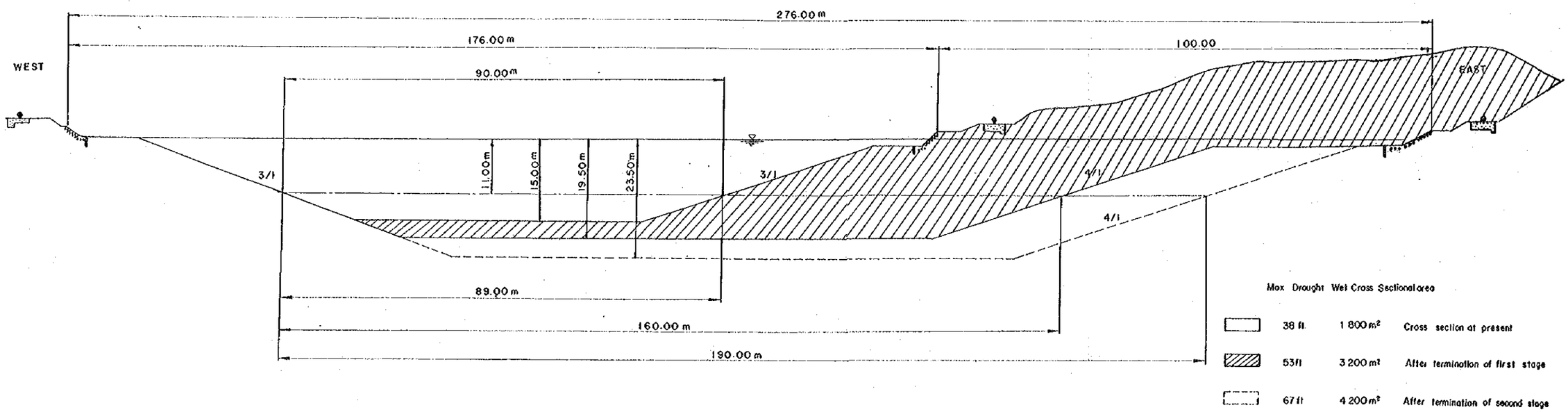


Fig. 9-1-1 Project for Suez Canal Development

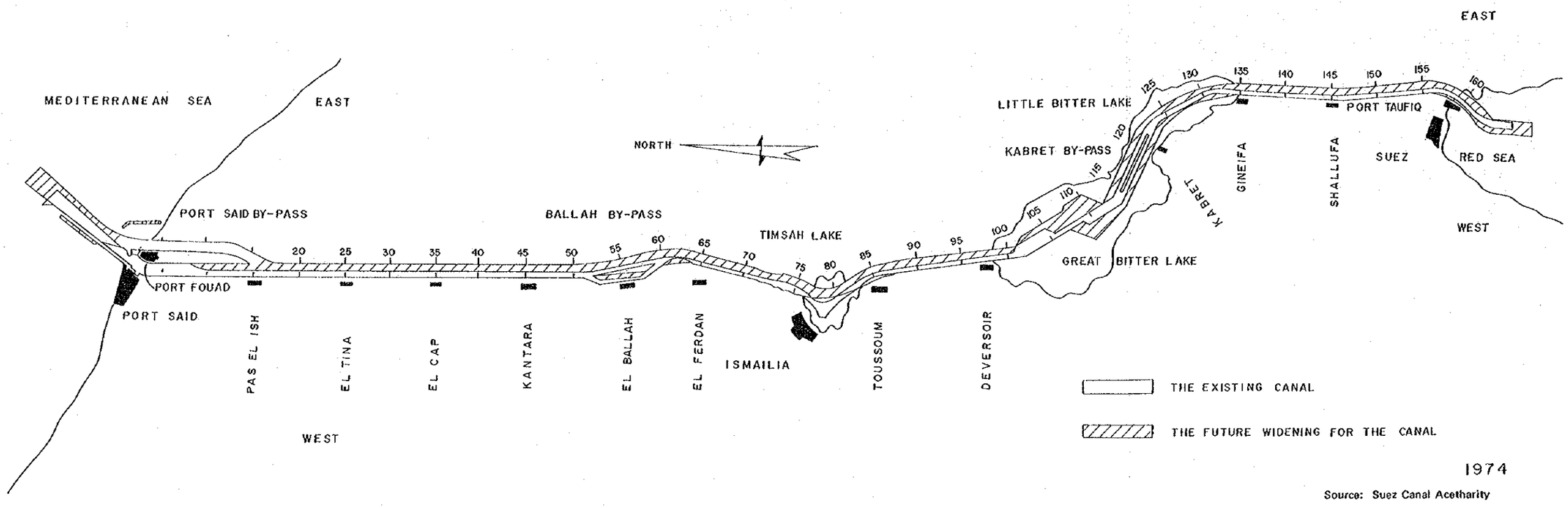


Fig. 9-1-2 Division of Dredging Work Sections

times the wet sectional area of the largest vessel transiting the Canal.

2) Revetment

The revetment work will be executed with an allowance provided on the eastern coast so that the second and subsequent projects may be implemented smoothly, Since this means that no revetment will be constructed under the second phase or subsequent projects, the economic evaluation of the project should preferably cover the revetment work. In this report, however, it is treated as an appurtenant work to the first phase project.

3) Earthwork

The banking provided on the eastern coast for military purpose will be removed.

4) Breakwater

At Port Said, the breakwater will be extended along with the extension of the existing fairway.

5) Anchorage

Dredging of the route, anchorages and refuge place of convoys will be undertaken at Port Said, Bitter Lakes, Suez Bay, and the Red Sea.

6) Navigation Aids

Navigation aids will be reinforced to provide greater navigation safety for large vessels transiting the Canal after it is reopened. For this purpose, some of the buoys and marks will be relocated suitably.

7) Tugboat Service
8) Pilot Service

} These services will be improved to assure large transiting vessels of greater navigation safety.

9) Oil Pollution Preventive Devices, Etc.

To provide against any accident resulting from oil leakage, these devices will be installed in sufficient numbers.

2. Forecast of Transiting Vessels

2-1 Tankers

2-1-1 Tanker Bottoms

Mammothization of tankers proceeded at a rapid pace during the closure period of the Canal. In 1976, the largest tanker in the world was the "Idemitsu-maru (Japan)" which had a gross tonnage of 209,000 DWT. At present, the "Globit Tokyo (United Kingdom)" having a gross tonnage of 477,000 DWT is known as the world's largest tanker. Before the Canal was closed, virtually all tankers sailing from Middle East to Europe and America made use of the Canal. The closure of the Canal compelled these tankers to go round Cape Town, which gave rise to mammothization of tankers in pursuit of the benefit of scale. As a result, nearly 70% of the total bottoms of tankers in the world registered a tonnage of 60,000 DWT or larger in 1973, all which are now too large to transit the Canal in full load condition (See Table 7-3-3). While the Canal Development Project aims at permitting the transit of tankers exceeding 150,000 DWT in the ultimate stage, such large tankers are known to account for almost 40% of all tankers now in service in the world. This means that these supertankers cannot utilize the Canal even after the completion of the first-phase project.

There is another noteworthy problem confronting the world's tanker transport industry. As described in Chapter VIII (Trend of Demand and Supply of Petroleum), the high growth rate of the crude oil market, observed before the global oil crisis, can no longer be expected for future. Nevertheless, tankers are being built or planned to be built on orders placed before the oil crisis. In addition, the reopening of the Canal will result in the reduction of the transit time, and this in turn will create surpluses of bottoms. If tankers are continued to be built on previously placed orders, the surpluses will reach an exhorbitant degree.

Table 9-2-1 shows the results of calculation of tanker bottoms required for the estimated oil flow in 1975 and 1985. As can be seen in this table, tankers under construction in 1975 can fill the crude oil transport demand in 1985. Table 9-2-2 shows that the tanker bottoms will exceed 300 million tons in 1975. It is to be noted that this value, which can be attained by the end of 1975, includes the bottoms to be reduced by scrapping after depreciation (estimated at about 10%). If tankers for which orders have already been placed are included, the total bottoms in 1978 will exceed 400 million tons, and surplus tanker bottoms will surpass 100 million tons in the same year judging from the result of trial calculation shown Table 9-2-1. Even if account is taken of the 5% annual retirement of vessels due to completion of depreciation, it leaves no doubt that surplus of tanker bottoms will not be smaller than 50 million tons.

Table 9-2-1 Estimated Requirement of Tanker Bottoms (1975 & 1985)

	Unit	1975			1985		
		Via Suez (1)	Via Cape (2)	Medium ((1)+(2))/2	Via Suez (3)	Via Cape (4)	Medium ((3)+(4))/2
1 Ton · nautical mile	10^{12}	5^{7}	7^{8}	6^{8}	7^{1}	9^{2}	8^{2}
2 Tanker requirement per ton · nautical mile	10^{-6}DWT	36^{3}	36^{3}	36^{3}	36^{3}	36^{3}	36^{3}
3 Tanker requirement	10^{6} DWT	210	280	250	260	330	300

Notes:
1. The above table shows approximate figures based on a trial calculation worked out with attention directed to the oil flow in three major regions of the world, i.e., Western Europe, the United States and Japan.
2. The tanker requirement per ton · nautical mile was estimated on the basis of actual oil flow in the said three regions in 1972. It was assumed that the values shown would provide balance between tanker bottoms and oil flow.
3. It was considered that the required tanker bottoms could be represented by the mean of tanker requirements via Suez and via Cape Town.
4. Ton · nautical mile 1 is the product of the crude oil flow and the distance between the major exporting regions (Middle East, Africa and Indonesia) and Western Europe, the United States and Japan.

Table 9-2-2 World Tanker Fleet

(Million DWT)

	1973	%	1974	%	1975	%	1978	%
10,000 ~ 35,000	37^{5}	17^{5}	40^{6}	15^{7}	42^{2}	13^{5}	42^{8}	10^{4}
35,000 ~ 59,999	27^{4}	12^{8}	30^{8}	11^{9}	31^{9}	10^{2}	33^{0}	8^{0}
60,000 ~ 99,999	37^{8}	17^{7}	38^{0}	14^{7}	42^{3}	13^{5}	49^{4}	12^{0}
100,000 ~ 149,999	18^{0}	8^{4}	23^{6}	9^{1}	31^{8}	10^{2}	43^{4}	10^{6}
150,000 ~ 199,999	7^{2}	3^{4}	7^{6}	2^{9}	8^{9}	2^{8}	13^{8}	3^{4}
200,000 ~ 249,999	53^{4}	25^{0}	62^{6}	24^{2}	70^{5}	22^{5}	76^{6}	18^{6}
250,000 ~ 299,999	26^{5}	12^{4}	48^{2}	18^{6}	64^{8}	20^{7}	85^{6}	20^{8}
300,000 ~	4^{6}	2^{2}	7^{4}	2^{9}	20^{8}	6^{6}	66^{7}	16^{2}
Total	213^{3}	100	258^{8}	100	313^{2}	100	411^{3}	100

Source: John I. Jacobs & Company Limited, "World Tanker Fleet Review," (31. Dec. 1973).

It is not clear what will be the reaction on the part of the tanker operators against such surplus. At least, however, they will not construct new tankers at the risk of suffering surplus. The team therefore decided to base its forecast on the following assumptions.

(1) Building of the tankers ordered after 1976 will be either postponed till the tanker market becomes stabilized or converted to other types of ships.

(2) Of the tanker bottoms of 300 million DWT in 1975, about 10% will be removed from the bottoms as retired ships in the period of 1975. Further, after the year 1975, about 5% of the bottoms will be removed every year. However, the team considers that the replacement of these bottoms will be made by newly built ships without exception.

(3) Some of the tankers scheduled to be built in 1976 are already under construction, and these tankers are assumed to be the replacement of retired ships described in Item (2) above.

2-1-2 Oil Flow Volume through the Suez Canal

The oil amount passing through Suez Canal was estimated for two cases: the case where the first phase project is executed, and the case where the canal is opened again to resume the pre-closure transit conditions.

For this purpose, the following conditions were assumed.

(1) All petroleum products destined for Europe and America from Middle East will be transported by tankers of 35 thousand DWT or smaller, i.e., via the Suez Canal.

(2) As regards crude oil, a cost comparison by tanker size was made among the following three courses (See Chapter .VII – Transport Cost Comparison with Alternative Project).

i) Via Cape Town for going and returning (C/C).

ii) Via Suez Canal for going and returning (S/S).

iii) Via Suez Canal for going and via Cape Town for returning (C/S).

On the strength of this cost comparison, transport priority was given to C/C course if supertankers are most advantageous, and then to C/S or S/S.

(3) In case no cost difference is found among the three courses, transport priority was determined according to the ratio of tonnage of tankers whose size is suited to each

Table 9-2-3 Transported Oil Volume by Tanker Size

Arabian Gulf ~ Genova

<1st Stage Plan>

		S/S ②	S/S ①	C/S ②	C/C ②
Transport Volume	85	54.0	49.3	38.0	Mil ton 30.7 ② (122.7) (172)
	84	51.3	49.3	36.2	29.2 ② (116.7) (166)
	83	45.6	49.3	32.1	25.9 ② (103.7) (153)
	82	42.1	49.3	29.7	23.9 ② (95.7) (145)
	81	36.8	49.3	25.9	20.9 ② (83.7) (133)
	80	34.6	49.3	24.4	19.7 ② (78.7) (128)
	1979	31.5	49.3	22.2	17.9 ② (71.7) (121)
Transport Capacity, 1975		115.8 (44%)	49.3 (100%)	81.8 (31%)	65.2 (25%) Mil ton
Annual Number of Voyages		10.6	10.6	7.0	5.2
Tanker Bottoms 1975		11.5	4.9	12.3	Mil DWT 13.2 Total 419

100 200 300 400 500

Tanker Tonnage

<Re-opening>

		C/S ②	C/C ②	C/C ①
Transport Volume	85	43.0	82.8	12^8 ② (159^2) (172)
	84	41.4	79.7	12^8 ② (153^2) (166)
	83	37.9	72.9	12^8 ② (140^2) (153)
	82	35.7	68.7	12^8 ② (132^2) (145)
	81	32.5	62.5	12^8 ② (120^2) (133)
	80	31.1	59.9	12^8 ② (115^2) (128)
	79	29.2	56.3	12^8 ② (108^2) (121)
	78	30.8	59.4	12^8 ② (114^2) (127)
	77	29.8	57.3	12^8 ② (110^2) (123)
	76	30.6	58.9	12^8 ② (113^2) (126)
Transport Capacity, 1975	1975	32.3	58.6	4^4 2 (119^9) (124)
	1974	53.9 (27%)	99.3 (49%)	4.4 Mil ton
	1975	63.2 (27%)	123.0 (52%)	12.8
Annual Number of Voyages		7.0	5.2	5.2
Tanker Bottoms (1974)		(8.1)	(20.1)	(0.9) Mil DWT (33.9)
1975		9.5	24.9	2.6 Total 41.9

100 200 300 400 500

Tanker Tonnage

Arabian Gulf ~ Rotterdam

<1st Stage Plan>

		S/S ②	C/S ②	C/C ②	C/C ①
Transport Volume	85	98.2	57.3	49^1	2^4 ② (204^6) (207)
	84	92.9	54.2	46^5	2^4 ② (193^6) (196)
	83	86.2	50.3	43^1	2^4 ② (179^6) (182)
	82	80.0	46.6	40^0	2^4 ② (166^6) (169)
	81	73.2	42.7	36^7	2^4 ② (152^6) (155)
	80	66.5	38.8	33^3	2^4 ② (138^6) (141)
	79	70.8	41.3	35^5	2^4 ② (147^6) (150)
Transport Capacity, 1975		177.1 (48%)	104.7 (28%)	89^1 (24%)	2^4 (100%)
Annual Number of Voyages		8^0	6^3	5^1	5^1
Tanker Bottoms 1975		23.3	17.5	18.4	0^5 Total 59.7

100 200 300 400 500

Thousand DWT

<Re-opening>

		S/S ②	C/S ②	C/C ②	C/C ①
Transport Volume	85	33.4	43.0	82.8	12^8 ② (159^2) (172)
	84	32.2	41.4	79.7	12^8 ② (153^2) (166)
	83	29.4	37.9	72.9	12^8 ② (140^2) (153)
	82	27.8	35.7	68.7	12^8 ② (132^2) (145)
	81	25.2	32.5	62.5	12^8 ② (120^2) (133)
	80	24.2	31.1	59.9	12^8 ② (115^2) (128)
	79	22.7	29.2	56.3	12^8 ② (108^2) (121)
	78	24.0	30.8	59.4	12^8 ② (114^2) (127)
	77	23.1	29.8	57.3	12^8 ② (110^2) (123)
	76	23.8	30.6	58.9	12^8 ② (113^2) (126)
Transport Capacity, 1975	1975	28.7	32.3	58.6	4^4 2 (119^9) (124)
	1974	48.3 (24%)	53.9 (27%)	99.3 (49%)	4.4 Mil ton
	1975	49.3 (21%)	63.2 (27%)	123.0 (52%)	12.8
Annual Number of Voyages		10.6	7.0	5.2	5.2
Tanker Bottoms (1974)		(4.8)	(8.1)	(20.1)	(0.9) Mil DWT (33.9)
1975		4.9	9.5	24.9	2.6 Total 41.9

100 200 300 400 500

Tanker Tonnage

Arabian Gulf ~ North America

<1st Stage Plan>

	S/S ③	C/S ③	C/S ②	C/C ③	C/C ②	C/C ①
	28.4	5.3	37.2	10^6	11.6	7.9 ③ (44.3) (101)
	29.0	5.4	37.2	10.9	11.6	7.9 ③ (45.3) (102)
	30.2	5.7	37.2	11.4	11.6	7.9 ③ (47.3) (104)
	30.9	5.8	37.2	11.6	11.6	7.9 ③ (48.3) (105)
	38.6	7.2	37.2	14.5	11.6	7.9 ③ (60.3) (117)
	40.5	7.6	37.2	15.2	11.6	7.9 ③ (63.3) (120)
	21.3	4.0	37.2	7.9	11.6	7.9 ③ (33.3) (90)
	81.1 (64%)	15.4 (12%)	37.2	30.3 (24%)	11.6	7.9
	6.5	5.6	5.6	4.9	4.9	4.9
	13.3	2.9	7.0	6.5	2.5	1.7 Total 33.9

100 200 300 400 500

Thousand DWT

<Re-opening>

	S/S ③	C/S ③	C/S ②	C/C ②	C/C ①	
			18.8	16.1	66.1	2 (34.9) (101)
			19.4	16.5	66.1	2 (35.9) (102)
			20.5	17.4	66.1	2 (37.9) (104)
			21.0	17.9	66.1	2 (38.9) (105)
			27.5	23.4	66.1	2 (50.9) (117)
			29.1	24.8	66.1	2 (53.9) (120)
			12.9	11.0	66.1	2 (23.9) (90)
			5.9	5.0	66.1	2 (10.9) (77)
			8.0	6.9	66.1	2 (14.9) (81)
			111.3	9.6	66.1	2 (20.9) (87)
			21.0	19.4	46.6	2 (20.9) (87)
			28.7 (52%)	26.5 (48%)	46.6	
	24.7 (63%)	14^9 (37)	35.1 (54%)	29.8 (46%)	66.1	
	6.5	5^6	5.6	4.9	4.9	
	(3.9)	(2^4)	(5.4)	(5.7)	(10.0)	Total (27.4)
	4.0	2^7	6.6	6.4	14.2	33.9

100 200 300 400 500

Thousand DWT

Notes: 1. The transport capacity is the product of tanker bottoms, voyage number and leading rate (0.95).

2. Figures on the extreme right in the column of transport volume indicate the annual total transport volumes, and those given immediately on the left are the total transport volumes via second or third priority routes.

course (In Table 9-2-3, the course symbol, S/S, C/C and C/S, is followed by its priority order which is enclosed by a circle).

(4) All tankers serving on each route (Middle East – Northern Europe, Middle East – Southern Europe, and Middle East – America) were assumed to be larger than 35,000 DWT, and their bottoms were set as follows according to the route-wise ton-nautical miles.

Middle East – Northern Europe:	22% of world's total tanker tonnage	
" – Southern Europe:	15.5%	"
" – America :	12.5%	"
TOTAL :	50%	"

(5) Tanker bottoms for each year were alloted to the following year. For instance, tanker bottoms for 1974 were alloted for crude oil transportation in 1974. For 1976 and subsequent years, however, bottoms for 1975 were alloted.

The oil transport volume through the Canal as calculated on the above assumptions is as follows.

After completion of first phase project in 1985: 260 million tons
for S/S course and 140 million tons for C/S course.

After reopening of the Canal : 70 million tons
for S/S course and 100 million tons for C/S course.

These figures will suffice to convince anyone of the effect of the first phase project (See Table 9-2-4).

2-1-3 Estimated Number of Transit Tankers

(1) Tankers for Petroleum Products

The amount of petroleum products passing the Canal was converted to the daily transit amount, and this was divided by the mean tanker size to obtain the number of transit tankers. The mean tanker size was set at 10 thousand DWT up to 1980 and 12 thousand DWT for 1985. Annual number of tankers is shown in Table 9-2-6.

(2) Crude Oil Tankers

The amount of cruide oil carried by tankers of respective sizes through the Canal was converted to the daily transit amount by referring to Table 9-2-3, and this daily transit amount was divided by the mean tanker size to obtain the number of tankers.

The median of respective tanker sizes was adopted as the mean tanker size. Annual number of tankers is shown in Table 9-2-6.

As a result of this operation, it is assumed that in 1985, 18 small tankers and 2 larger tankers of up to 150 thousand DWT will transit the Canal daily in both directions.

Table 9-2-4 Oil Volume through the Canal

(Million ton)

	Oil Products	Crude Oil						Total		Remarks
		A.G–Genova		A.G–Rotterdam		A.G–U.S.A				
	(s/s)	s/s	c/s	s/s	c/s	s/s	c/s	s/s	c/s	
1975	9	– 28.7	– 32.3	– 48.0	– 77.8	– –	– 21.0	– 85.7	– 131.4	
76	10	– 23.8	– 30.6	– 16.1	– 57.5	– –	– 11.3	– 49.5	– 99.4	
77	11	– 23.1	– 29.8	–	– 35.4	– –	– 8.0	– 34.1	– 73.2	
78	12	– 24.0	– 30.8	–	– 29.7	– –	– 5.9	– 36.0	– 66.4	
79	13	80.8 22.7	22.2 29.2	70.8 –	41.3 23.2	21.3 –	44.2 12.9	185.9 35.7	104.7 65.3	
80	17	83.9 24.2	24.4 31.1	66.5 –	38.8 20.8	40.5 –	44.8 29.1	207.9 41.2	107.6 81.0	
81	20	86.1 25.2	25.9 32.5	73.2 –	42.7 24.6	38.6 –	44.4 27.5	217.9 45.2	113.0 84.6	
82	23	91.4 27.8	29.7 35.7	80.0 –	46.6 28.3	30.9 –	43.0 21.0	225.3 50.8	119.3 85.0	
83	26	94.9 29.4	32.1 37.9	86.2 –	50.3 31.9	30.2 –	42.9 20.5	237.3 55.4	125.3 90.3	
84	30	100.6 32.2	36.2 41.4	92.9 –	54.2 35.6	29.0 –	42.6 19.4	252.5 62.2	133.0 96.4	
85	34	103.3 33.4	38.0 43.0	98.2 –	57.3 38.6	28.4 –	42.5 18.8	263.9 67.4	137.8 100.4	

Notes: The upper figures indicate the oil volume after the Canal reopening and the lower ones after completion of the first phase project.

Table 9-2-5 Revenue by Tankers through the Canal

(Million)

	Oil Volume (ton)				SCNRT				Revenue (LE)				Benefit (LE)
	1st Stage Plan		Re-opening		1st Stage Plan		Re-opening		1st Stage Plan		Re-opening		
	s/s	c/s	s/s	c/s	s/s	c/s	s/s	c/s	s/s	c/s	s/s	c/s	
1975			85.7	131.4			36.0	55.2			22.9	11.0	
76			49.5	99.4			20.8	41.7			13.2	8.4	
77			34.1	73.2			14.3	30.7			9.1	6.1	
78			36.0	66.4			15.1	27.9			9.6	5.6	
79	185.9	104.7	35.7	65.3	78.1	44.0	15.0	27.4	49.7	8.8	9.6	5.5	43
80	207.9	107.6	41.2	81.0	87.3	45.2	17.3	34.0	55.5	9.0	11.0	6.8	47
81	217.9	113.0	45.2	84.6	91.5	47.5	19.0	35.5	58.2	9.5	12.1	7.1	49
82	225.3	119.3	50.8	85.0	94.6	50.1	21.3	35.7	60.2	10.0	13.5	7.1	50
83	237.3	125.3	55.4	90.3	99.7	52.6	23.3	37.9	63.4	10.5	14.8	7.5	52
84	252.5	133.0	62.2	96.4	106.1	55.9	26.1	40.5	67.5	11.1	16.6	8.1	54
85	263.9	137.8	67.4	100.4	110.8	57.9	28.3	42.2	70.5	11.5	18.0	8.4	56
1986~2008													1,288
Total													1,639

Notes: Benefit is the balance obtained by deducting the revenue after the first phase project from that expected after the Canal reopening.

2-2 Ordinary Vessels

Dry cargoes traded between east and west which are currently transported via Cape Town will pass the Canal when it is reopened. The reopening will also activate the operation of liners and trampers (including ore carriers) serving on Europe – Asia routes. It is also probable that the operation of LNG carriers and coal carriers will become active with the augmented importation of natural gas and solid fuels as a result of the expected change of energy structure in Europe and the United States.

Forecast of general vessels (dry cargo carriers) is made on the basis of the new situation described above.

2-2-1 Estimate of Cargo Volume through the Canal

The volume of cargo through the Canal was 66 million tons in 1966 when the Canal was still open. Of this volume, 40% went northward and 60% southward, the former consisting chiefly of general cargoes and the latter of ores and metals. The annual growth during the period from 1955 to 1966 was 27% for northbound cargoes and 7.1% for southbound cargoes. The annual growth rate of the world trade (dry cargoes) was 7.5%, which almost coincides with the growth of southbound cargoes. Northbound cargoes, however, registered a growth rate about one-third of the world trade during the same period.

2-2-2 Estimate of Cargo Volume through the Canal

The future cargo volume through the Canal was estimated by the following method.

(1) The future cargo traffic was obtained from the volumes of north- and south-bound cargoes in 1966 by employing the annual average growth rate.

(2) The annual average growth rate was determined by the growth rate of the world trade in the 1966 ~ 1972 period (6.9%) as modified by the value of elasticity (See Table 9-2-7), which is ratio of the volume of northbound cargoes or southbound cargoes to that of the world trade (northbound – 2.5%, southbound – 6.5%).

The cargo volume obtained by the above method is as large as 150 million tons in 1980 and 200 million tons in 1985 (See Table 9-2-8).

2-2-3 Number of Vessels through the Canal

Calculations were worked out in the same way as applied to the number of transit tankers. Considering the recent mammothization of dry cargo vessels, the average vessel size was assumed to be 12 thousand DWT in 1980 and 15 thousand DWT in 1985.

The number of transit vessels through the Canal, as calculated by the above method, is 36 ~ 38 from 1975 to 1985 (going and returning), which is larger by 6 ~ 7 than the figure before the Canal closure when 30 vessels passed the Canal daily.

The numbers of tankers and ordinary vessels expected to transit the Canal in convoys are shown in Table 9-2-9.

Table 9-2-6 Annual Number of Tankers through Canal

(number/day)

	A.G–Genova	A.G–Rotterdam	A.G–U.S.A	Total			Remarks
				Laden	Ballast	Total	
1975							
~ 30,000	3			3	3	6	Oil Products
~ 60,000	1^{7}	2^{8}	–	5	5	10	Crude Oil
~150,000	1^{0}	2^{2}	0^{5}	–	4	4	
Total				8	12	20	
1980							
~ 35,000	5			5	5	10	Oil Products
~150,000	2^{7}	2^{1}	1^{3}	7	7	14	Crude Oil
~250,000	0^{4}	0^{6}	0^{8}		2	2	
Total				12	14	26	
1985							
~ 35,000	9			9	9	18	Oil Products
~150,000	3^{4}	3^{1}	0^{9}	8	8	16	Crude Oil
~250,000	0^{5}	0^{8}	0^{7}		2	2	
Total				17	19	36	

Table 9-2-7 Cargo Traffic through the Canal (1955–1966)

(Million ton)

	1955	1960	1965	1966	Remarks
(Northbound)					
Cereals	2.5	2.7	2.7	1.8	
Ores and Metals	5.3	8.2	7.1	6.5	
Vegetable Oils	1.8	1.9	1.4	1.6	
Textiles	1.7	1.8	1.9	1.8	
Others	9.2	10.6	15.2	15.8	
Total	20.5	25.2	28.3	27.5	
(Southbound)					
Cement	2.7	1.1	1.2	1.4	
Fertilizers	2.5	4.0	5.2	6.7	
Metals	3.8	5.6	4.7	5.0	
Others	9.2	15.5	23.0	25.7	
Total	18.2	26.2	34.1	38.8	

Source: "Suez Canal Report."

Table 9-2-8 Projected Dry Cargo Traffic through the Canal

(Million ton)

	rate of increase	1966	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Northbound	2.5%	27.5	34.3	35.2	36.1	37.0	37.9	38.9	39.8	40.8	41.8	42.9	44.0
Southbound	6.5	38.8	68.4	72.8	77.6	82.6	88.0	93.7	99.8	106.3	113.2	120.5	128.4
Total		66.3	102.7	108.0	113.7	119.6	125.9	132.6	139.6	147.1	155.0	163.4	172.4
Net Tonnage			118.1	124.2	130.8	137.5	144.8	152.5	160.5	169.2	178.3	187.9	198.3
SCNRT			120.5	126.7	133.4	140.3	147.7	155.6	163.7	172.6	181.9	191.7	202.3
Revenue (Mil.LE)			52.7	55.4	58.3	61.3	64.5	68.0	71.5	75.4	79.5	83.8	88.4

Notes:
1. The following rate of increase were employed (Rate of increase of world trade from 1966 to 1972 was 6.9%).
   1 Northoound – 6.9%/27.8% ≒ 2.5%
   2 Southbound – 6.9%/1.06% ≒ 6.5%
2. Net tonnage was obtained by multiplying the actual volumes of cargoes in both directions by 1.15.
3. SCNRT stands for "Suez Canal Net Registered Tonnage" which is the basis for toll calculation.
4. Revenue was calculated on the basis of the current toll rates of the Canal.

Table 9-2-9 Estimated Daily Number of Transit Vessels

	1965	1975		1980		1985		Remarks
		North-bound	South-bound	North-bound	South-bound	North-bound	South-bound	
Tankers	13	8	12	12	14	17	19	
(18,000 DWT and larger)	(5)	(3)	(3)	(5)	(5)	(9)	(9)	Oil products tanker
(Smaller than 18,000 DWT)	(8)	(5)	(9)	(7)	(9)	(8)	(10)	Crude oil tanker
Ordinary Vessels	30	15	15	19	18	19	19	Ordinary Vessels
Total	43	23	27	31	32	36	38	

Notes: 1. Figures for 1965 are the actually recorded numbers.
2. Figures for 1975 are the estimated numbers after Canal reopening.
3. Figures for 1980 and 1985 are the estimated numbers after completion of the first phase project.

3. Channel Plan

In view of the mammothization trend of tankers as well as Europe's growing demand for petroleum from the Arabian Gulf, the Suez Canal Authority determined to permit in 1975 the transit of vessels with a 38-ft. (11.5 m) draft as had been assured until June 5, 1967, the day before the Canal had been closed, and also mapped out a project which aims at expanding the Canal after its reopening to increase the max. allowable draft to 67 ft (20.4 m) so that the Canal would allow passage of all tankers of up to 250,000 DWT in half load and any larger tankers in ballast.

This extension project is to be carried out in two stages, of which the first phase project is intended to increase the submarine sectional area of the Canal to 3,200 sq.m. and the max. allowable draft to 53 ft (16.2 m). Completion of the project will permit all tankers of up to 150,000 DWT to transit the Canal in full-load and any larger ones of up to 250,000 DWT to transit in half-load or ballast.

3-1 Plan of Channel Alignment

(1) To enlarge the canal width at a 11-meter water depth from 89 m. to 160 m (Standard width at the 30 km point).

(2) To form smooth curves with a radius of 5000 m or larger on all bends of waterways (Note 1).

(3) To widen main fairways off Port Said Harbor and Port Tewfik until both reach

the 19.5 m contour line.

(4) To widen both the east and west branch canals of Ballah By-pass and Kabret By-pass.

(5) To expand both North Anchorage and South Anchorage of Great Bitter Lake to 20 sq. km.

Deepening work is to be performed in time with widening, for the north side of North Anchorage to 18 m (11 berths) and the south side to 19.5 m (9 berths), and South Anchorage to 15 m (25 berths).

3-2 Sectional Plan

(1) To perform dredging to increase the canal water depth from 15.0m to 19.5m, so that it can permit a 53 ft (16.2 m) draft vessel to transit at her normal cruising speed of 12 km/h to 14 km/h.

(2) To provide the submarine bank slope in the vicinity of the 61 km point with a standard gradient of 1 : 4 on the north and 1 : 3 on the south

(3) To enlarge the submarine transverse sectional area from 18.50 sq.m to 32.00 sq.m.

Note (1): The waterway bends described Item in (2) above are listed below.

Bend No. 1	51 km point (distance from Port Said Lighthouse)
No. 2	53 km point
No. 3	57 km poin
No. 4	62 km point
No. 5	73 km point
No. 6	Between 73 km point and Lake Timsah
No. 7	85 km point (Toussoum)
No. 8	120 km (Approx. 1.8 km east of Kabret Signal point)
No. 9	130 km (Approx. 5.1 km SSE of the southern end of No. 8 Bend)
No. 10	Between 155 km and 160 km

3-3 Determination of Canal Section

(1) Depth of Canal

The following relation is established between the depth of the Canal and the

maximum draft of transit vessels.

$$\frac{h}{d} \geqq 1.15$$

where,

h: Depth of the Canal.

d: Draft of vessels.

Above means that the Canal depth should have an allowance of as much as 15% or larger under the vessel draft. Actual data are shown in the following table.

	Design Depth	Design Draft	(h/d)	Max. Allowable Draft
During Closure of Canal	15.0 m	38 ft = 11.6 m	(1.30)	13.0 m (42 ft)
At Reopening of Canal	15.5 m	40 ft = 12.2 m	(1.27)	13.4 m (44 ft)
After 1st-phase Extension Project	19.5 m	53 ft = 16.1 m	(1.22)	16.9 m (55 ft)
After 2nd-Phase Extension Project	23.5 m	67 ft = 20.4 m	(1.17)	20.6 m (67.5 ft)

The value of (h – d) is 3.3 m at reopening, 3.4 m after the 1st phase project, and 3.1 m after the 2nd-phase project. These values consist of the following elements.

1.	Squatting by Transiting Vessel	80 cm
2.	Wind Setup	30 cm
3.	Pilot Leg	30 cm
4.	Silting	60 cm
	Sub-Total, 1 through 4	200 cm
5.	Other Allowances	120–150 cm

It is most desirable that a 15% allowance of submarine depth be secured for the vessel draft plus squatting. When the first phase extention project is completed, this condition can be filled since the design depth will be 19.5 m = (16.1 m + 0.8 m) × 1.15). After the second phase project, however, the design depth will be about 1 m short against the necessary allowance because the required depth will be 24.4 m = (20.4 m + 0.8 m) × 1.15. The absolute value of allowance, too, is approximately 30 cm smaller than attained after the 1st phase project.

(2) Canal Section

The larger section the Canal assumes, the easier it becomes for a vessel to pass it with less resistance against her motions. However, the project cost sets limits on it. When the Canal sectional area is taken at A and its ratio to the wet sectional area (a) of the largest transit vessel at n = A/a, it is found that the ratio is an important factor in determining the sectional area of the Canal.

Under the project, the value of n is set at 4.0 to design both the width and depth of the section in proportion thereto. The slope grades on both submarine sides of the Canal are designed to be either 1 : 4 or 1 : 3, which are both seen in sketches of sections where n = 4.0 can be exhibited.

The section determination is to begin with the determination of the fairway width as soon as the minimum water depth is established. The fairway width is to be represented by the distance between marker buoys on both sides of the fairway, and since these buoys have customarily been placed to indicate points of 11 m water depth, they display the width of section with an 11 m water depth. Every time fairways were enlarged, the buoys along the east bank, or on the Asian side, were moved toward east.

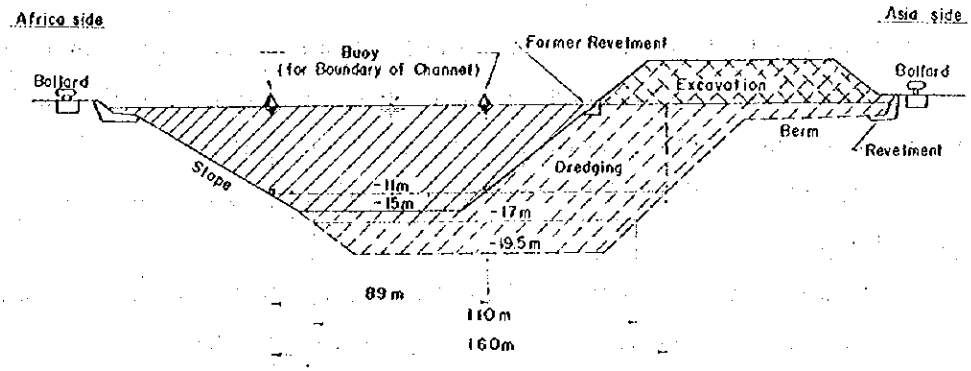


Fig. 9-3-1 Traverse Section at 30-km Point of the Canal (First Phase Extention Project)

In the transverse section at 30 km point, the fairway width which is 89 m at the Canal reopening will be increased to 160 under the first phase project. Other sections where the fairway width varies from 60 m to 120 m at present will also be extended towards east just as at the 30 km point.

Originally, it was planned to attain a width twice as large as, or even larger than,

that of the largest transit vessel at her draft (11 m around 1966). Hence, a width of 90 m (≒ 2B) is to be attained for vessels with a draft of 16 m and a squatting of 0.8 m. Although different sectional shapes were planned for different parts of the Canal depending on the soil nature and flow condition, the submarine sectional area is designed to be 3,200 sq. m for a 160 m travelling width between marker buoys on both sides.

A new revetment with mooring bollards on the back was designed to be provided farther to the east in consideration of the second phase project. In order to permit a barge to haul its mooring rope to these bollards when two vessels pass each other, a water area called "berm" which is approximately 1 m in depth and 56 m in breadth of provided.

(3) Sectional Area

The sectional area is determined so that a/A = 1/4 can be established with minor variations for each location as exhibited in the drawings, but it will be necessary to make some more detailed comparison and review as to the water depths, breadths and slope grades at a number of different sections. It may also be necessary to make a further review of the section of those parts embracing connections to lakes and port entrances as well as curvatures.

In respect of these points, however, the Suez Canal Authority has already made scrupulous field studies over many years and has decided on the sections on the basis of a number of hydraulic model tests and other types of experiments.

On account of its tight schedule, the team only had the time to be informed of the results of such tests.

The section area ratio a/A is explained at length in relation to the vessel's cruising speed, derived wave and returning current in Section 1-2 of Chapter XI.

4. Navigations Plan

4-1 Formation of Convoy

A northbound convoy is to be formed at Suez and a southbound convoy at Port Said, under the directions of the Port Office depending on the mooring or anchoring location and draft of each vessel. The following is the Convoys System prepared by the Canal Authority.

Northbound Convoy (from Suez):

Group Loaded Tanker

Ⓐ { (1) Up to 18,000 DWT (10 vessels)
(2) Larger than 18,000 DWT (5 vessels)

Ⓐ' (3) Mammoth Tanker (5 vessels)

Group Ordinary Tankers in ballast to be formed into the leading row.

Ⓑ { Tanker in Ballast
General Cargo Ship (22 vessels)
Passenger Boat

Southbound Convoy (from Port Said):

Convoy No. 1 Group Ordinary

Gas-free tankers to follow the tail end.

{ Tanker in Ballast
General Cargo Ship (20 vessels)
Passenger Boat

Convoy No. 2 Same as Convoy No. 1 (15 vessels)

4-2 Navigation Schedule

4-2-1 Northbound Convoy

The daily sailing order of convoys is as follows. The tanker group of 18,000 DWT or smaller sizes in Group Ⓐ leaves first, in which the leading ship sails from Port Tewfik (162.255 km) at 05:00 hrs. Next, the group of tankers larger than 18,000 DWT and the mammoth tanker group in Group Ⓐ' are to proceed in that order, with the last one to leave at 09:30 hrs. As a rule, the tanker groups are to travel as far as Port Said without a stop.

Group Ⓑ is to leave Port Tewfik at 11:00 hrs in the order of tankers in ballast, general cargo ships and passenger boats, reorganized at North Anchorage in Great Bitter Lake into vessels bound for the outer ocean and ones calling at Port Said, so that the latter can take the lead and the former should follow, and to leave Great Bitter Lake again for Port Said.

4-2-2 Southbound Convoy

Convoy No. 1 is to leave Port Said (3.710 km) at 00:00 hrs., then to anchor at South Anchorage in Great Bitter Lake in order to wait for the northbound convoy to pass by. The leading vessels are to leave for Suez after the passenger boats at the tail

end of the northbound convoy enter Great Bitter Lake.

Convoy No. 2 is to leave Port Said at 7 o'clock, then to be moored at Ballah Loop in order to wait for the northbound convoy to pass by. After the vessel at the tail end of the northbound convoy passes the 60-km point, the leading vessel is to begin proceeding for Suez.

Needless to say, all transit vessels exceeding 500 GT in size should have a pilot aboard (mandatory) and in addition, not only are the transit vessels regulated in their navigation by Rules of Navigation as established by the Canal Authority, but also their movements are watched and controlled by the signal stations along the western bank of the Canal and the Authority's Navigation Control Center at Ismailia.

4-2-3 Navigation Schedule and Its Review from Hydraulic Points of View

Following review has been attempted of the navigation schedule in order that a future convoy plan could be developed from the hydraulic points of view by estimating the changes in tidal current with the changing Canal sections.

The calculations employed in this review produce but a rough estimate that is good only for seeing general trends. As to the concrete values, therefore, more detailed analyses should be tried out to determine them more accurately.

If a large vessel sails on the Canal, the tidal current therein will cause her to change the maneuvering methods.

This problem need to be considered particularly for the waterway lying between the Suez Bay and Bitter Lakes where the tide levels change violently. Therefore, the effect of expanding the Canal section on the tidal current therein was studied by a simple method which produced the following results. The amount of tidal current is anticipated to increase approximately by 10%, which is not considered to cause any difficulty in ship manoeuvering.

Further, when the 2nd-phase project is carried out, the increased tidal current will be absorbed by the expanded water area, causing no significant changes in the current speed.

Although it seems that some more limiting factors need to be taken into account, these calculations can be considered accurate enough at present from the standpoints of ship maneuvering and revetment maintenance. If at all possible, more accurate results may well be obtained through checking them in tide current calculations as may be conducted with an electronic computer.

In such a case, it is desirable that the tidal current destribution inside the Suez Bay be simulated, and that an analysis be made on the variations in the tidal current within the 8 through 10 km to the south of Tewfik.

The great diurnal range at Port Tewfik is 1.46 cm on Vernal and Autumnal Equinox Days. It is 40 cm at Port Said Harbor and 10 to 20 cm in Bitter Lakes. This difference involves fear of changing the tide current pattern inside the Canal by enlarging the Canal section and it is considered the most extreme between Port Tewfik and Bitter Lakes.

At present, the tidal current near Port Tewfik has a mean velocity of 1.0 m/sec and this is considered to increase to 1.5 m/sec. on Vernal and Autumnal Equinox Days.

If it increases any more, manoeuvering of large vessels may be seriously impaired and therefore, the changes likely to ensue from the extension of section are estimated below.

Since these are rough estimates obtained by reading a table, more accurate conclusions should be reached through hydraulic calculations.

Improved Condition	Maximum Draft	Sectional Area	Hydraulic Mean Depth
Present	38 ft	1800 m^2	10.0 m
Re-Open	40	1850	—
1st Phase Project	53	3200	13.3
2nd Phase Project	67	4200	15.6

Using the tidal current formulae included in the Port Structure Design Standards, U and its maximum value U-max can be expressed as follows.

$U = U\text{-max} \cdot \cos \frac{2\pi}{T} t$.

where, $T = 4.7 \times 10^4$ seconds.

$U\text{-max} = \frac{2\pi}{T} \cdot \frac{A}{Bh} a$.

Bh = Wet cross section.

a = Tidal range in the Bay; 6 cm on the average.

A = Water area of the Bay; 2.5×10^8 m^2 at Bitter Lakes.

a_0 = Tidal range outside the Bay, 1.46 m at Tewfik.

$a/a_0 = 0.041$.

$a_0/h = 0.146$ (where h stands for the hydraulic mean depth of the waterway).

When the resistance value C is obtained from

$$\frac{A}{CST}\sqrt{\frac{a_0}{g}} = 5 \text{ (from Table)}$$

$C = 0.22$ (where, S is sectional area of 1,800 m²)

$$\text{U-max} = \frac{6.28}{4.4 \times 10^4} \cdot \frac{2.5 \times 10^8}{1{,}800} \cdot 0.06$$

$$= 1.16 \text{ (m/sec)}$$

This indicates the calculated value of the present current speed. This value seems somewhat smaller than the actual measurement, but when the current speed distribution within a section is considered, it does not conflict with the maximum current speed at 1.5 m/sec.

1) Current Speed Anticipated after the First Phase Project

First, the tide level difference inside the bay is to be assumed.

$a_0/h = 0.108$

$$\frac{A}{CST}\sqrt{\frac{a_0}{g}} = \frac{2.5 \times 10^8}{0.23 \times 3{,}200 \times 4.47 \times 10^4}\sqrt{\frac{1.46}{9.8}} = 2.93$$

From $a/a_0 = 0.08$ (by Table), the tide level difference is anticipated to increase to 11.7 cm. This value is almost twice as large as the former 6 cm value.

The current speed:

$$\text{U-max} = \frac{2\pi}{4.47 \times 10^4} \cdot \frac{2.5 \times 10^8}{3200} \times 0.117$$

$$= 1.28 \text{ m/sec}$$

Or, it results in a 10% increase.

2) When a similar check is tried for the 2nd-phase project;

$a_0/h = 0.094$

$$\frac{A}{CST}\sqrt{\frac{a_0}{g}} = \frac{2.5 \times 10^8}{0.23 \times 4200 \times 4.47 \times 10^4}\sqrt{\frac{1.46}{9.8}}$$

$$= 2.23$$

$a/a_0 = 0.105$ (by Table)

This leads to an anticipation of tide level difference at 15.3 cm, which shows a lower rate of increase than in the 1st-phase project.

The current speed:

$$\text{U-max} = \frac{2\pi}{4.47 \times 10^4} \times \frac{2.5 \times 10^8}{4200} \times 0.153$$

$$= 1.28 \text{ m/sec}$$

Here, it is indicated that no further changes in the current speed will occur due to a

large enlarging rate of the sectional area.

Through the foregoing process, rough as it may be, the problem of tidal current arising from the extension of section can be concluded to be not very serious.

4-3 Navigations Control

4-3-1 Convoy System Planned by the Canal Authority

Upon completion of the first phase project, the Canal will permit passage of tankers of 150,000 DWT in full load and larger tankers of up to 250,000 DWT in half load or in ballast.

To take full advantage of the augmented Canal capacity, the Canal Authority has established a new sailing diagram (see Figs. 9-4-1 & 9-4-2) which is intended for smooth daily formation of convoys, efficient and safe transit of as many vessels as possible.

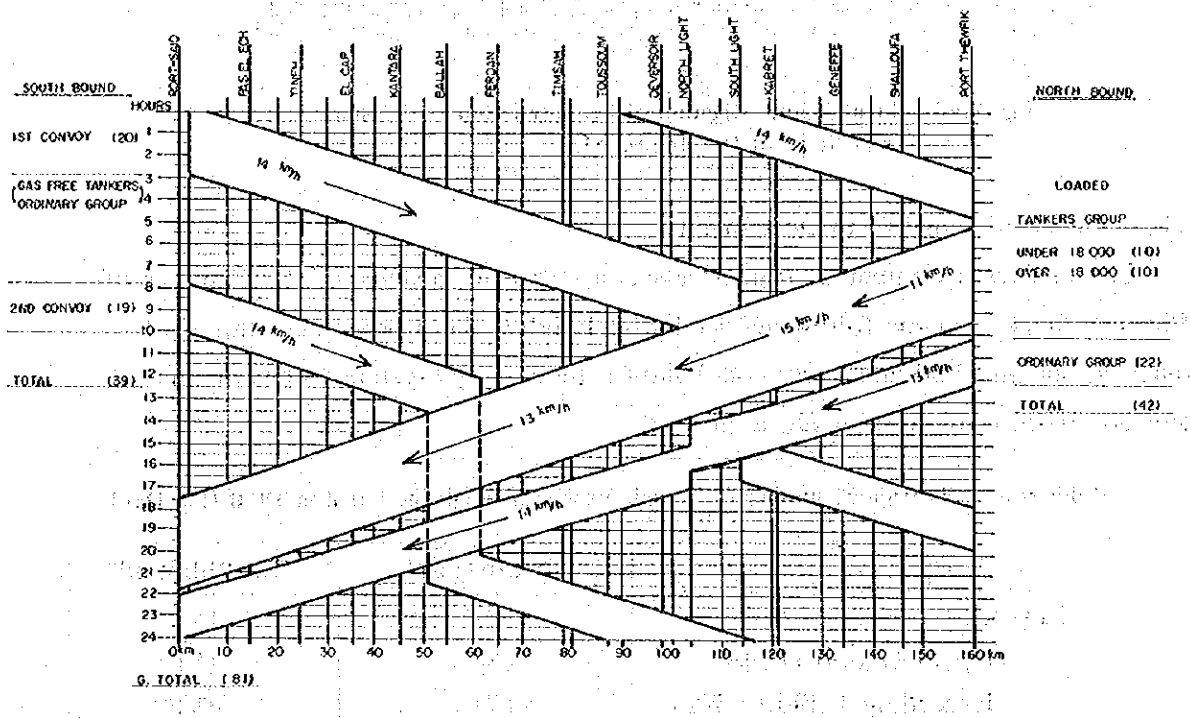


Fig. 9-4-1 Fleet Sailing Diagram of Existing Convoys System (Reopening Stage)

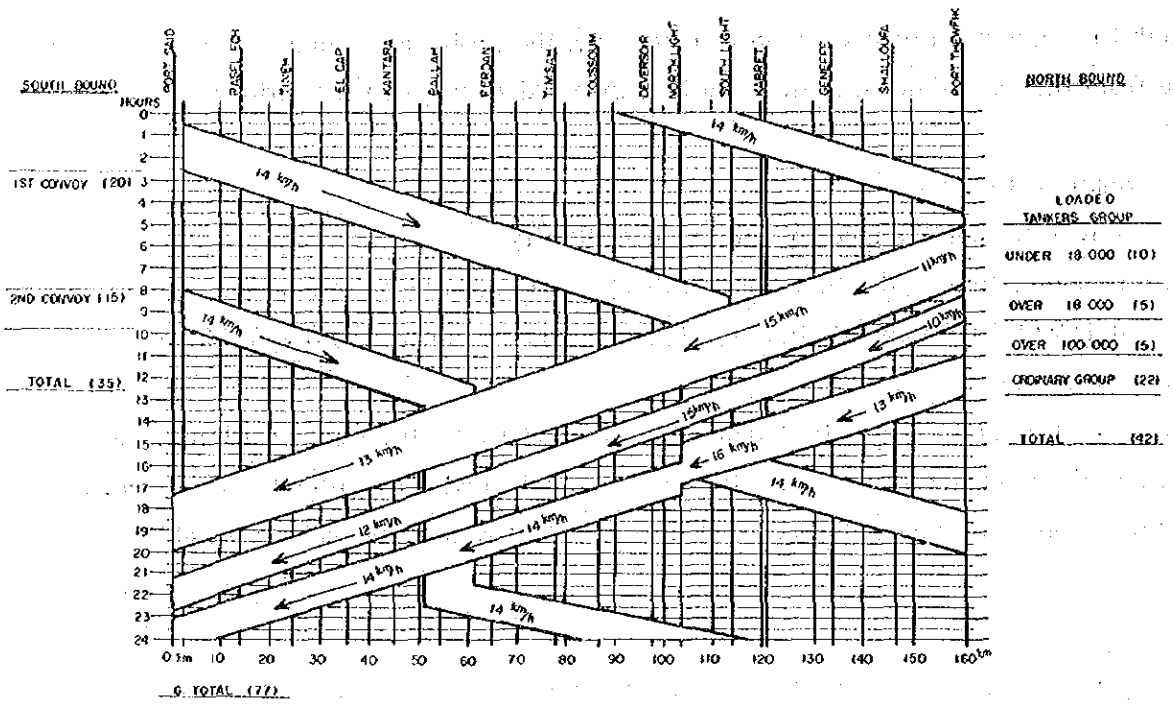


Fig. 9-4-2 Fleet Sailing Diagram of Proposed Convoys System (1ST-Stage of Development)

4-3-2 Check of Canal's Traffic Capacity

The projected number of transit vessels and traffic capacity of the Canal as of 1980 are checked in the following. Table 9-4-1 shows the prospected number of transit vessels in 1980 and Table 9-4-2 shows the convoys system to be introduced after completion of the first phase project.

Table 9-4-1 Projected Number of Transit Vessels through the Canal in 1980 (Per Day)

Type	Northbound	Southbound
Tanker	12	14*
(Up to 18,000 DWT)	(5)	(5)
(Exceeding 18,000 DWT)	(7)	(9)*
Ordinary Vessels	19	18
Total	31	32

Note: * includes 2 tankers of 250,000-DWT class.

Tabie 9-4-2 Proposed Convoy Plan of the Suez Canal Authority
(After Completion of 1st-Phase Project)

Convoy Designation	Departure of Leading Vessel	Time Interval between Departures	Departure of Last Vessel	Transit Time	Type	Capacity* (Vessel/day)
Southbound	hrs.	min	h m	h m		
No. 1	0:30	130	2:40	17:30	Ordinary Vessel Small Tanker	20
No. 2	8:30	110	9:50	19:00	Ordinary Vessel Large Tanker in Ballast	15
Northbound						
No. 1	5:00	220	7:40	12:20	Tanker of up to 18,000 DWT	10
No. 2	8:10	80	9:30	13:00	Tanker exceeding 18,000 DWT (Tanker exceeding 100,000 DWT)	10 (5)
No. 3	11:00	110	12:50	12:00	Ordinary Vessel	22

* Estimate by S. C. A.

(1) Check of Northbound Transit Capacity

The Canal's transit capacity for northbound tankers is shown in the following table.

Table 9-4-3 Traffic Capacity (Northbound)

Type	Time Interval between Departures	Number	Separation
Tanker of up to 18,000 DWT Tanker exceeding 18,000 DWT up to 100,000 DWT	220 min.	15	15.7 min
Tanker exceeding 100,000 DWT	80	5	20
Ordinary Vessel	110	22	5

Total planned transit capacity amounts to 42 vessels with sufficient intervals provided between departures. The plan sets the cruising speed between Tewfik and Little Bitter Lake as low as 11 km/h, 10 km/h and 13 km/h, so as not to cause any serious problem.

Generally speaking, there is a fluctuation in the daily numbers of transit vessels and considerable congestion could occur depending on the navigational problems of vessels and weather condition. Experience tells that the maximum number of transit vessels is 1.35 times the average.

If this value holds true in future, the peak of daily traffic will be 42 in 1980 as shown in Table 9-4-4, which can be generally deemed to pass safely.

Table 9-4-4 Daily Peak Traffic (Northbound)

Type	Peak Daily Traffic of Northbound Vessels	Interval between Departure
Tanker (Up to 18,000 DWT)	6	14.7 min
Tanker (Exceeding 18,000 DWT Up to 100,000 DWT)	5	
Tanker (Exceeding 100,000 DWT)	5	76
Ordinary Vessel	26	4.4
Total	42	–

The southbound traffic involves many large tankers in ballast as well as 250,000 DWT class tankers which, if fully loaded, must go round Cape Town. These large tankers are vulnerable to difficulty in manoeuvering because of their large volume above water surface. As shown in Table 9-4-5, the Authority's northbound traffic plan was mapped out with the cruising speed set at 14 km/h. It is likely, however, that the plan will give rise to some manoeuvering problem of gas-free supertankers loaded only with ballast because they will be required to sail at the said speed at intervals of only about 7 minutes as well as to stop on the way to allow the northbound convoy to pass by.

Table 9-4-5 Traffic Capacity (Southbound)

	Peak Daily Traffic of Southbound Vessels	Number of Vessels	Time Interval between Departures
Convoy No. 1	130 min	20	6.8 min
Convoy No. 1	110	15	7.8

Since the daily traffic of southbound transit vessels averages 32, it can be said that the Canal can meet the transit demand if the vessels are operated on schedule, although they may have to wait longer than notified. However, it is necessary to take the daily peak traffic into consideration in order to check if 135% of the average demand can be filled each day.

(2) Check of Daily Peak Traffic of Southbound Vessels in 1980

Table 9-4-6 shows the daily peak traffic of southbound vessels prepared in the same manner as applied to northbound vessels.

Table 9-4-6 Peak Daily Traffic (Southbound)

Type	Number of Ships on a Peak Day	Departure Separation
Tanker (Up to 18,000 DWT)	6	7.2 min
Tanker (Exceeding 18,000 DWT Up to 100,000 DWT)	5	
Tanker (Exceeding 100,000 DWT)	8	
Ordinary Vessel	24	4.8
Total	43	

Ordinary vessels are planned to lead at intervals of about 5 minutes and cruise at a speed of 14 km/h with a distance of 2.9 km maintained between them. In the case of large tankers, however, this cruising speed of 14 km/h is liable to generate excessive backwash and returning current as discussed in the section dealing the revetment erosion. It is to be noted that such excessive backwash or returning current is sure to call for a large-scale revetment repair work.

It will therefore be necessary to include large tankers in Convoy No. 1 and decrease their speed in the southern part where tidal current prevails. Further, in order to permit a greater number of southbound vessels to pass the Canal, the tail-end group of Convoy No. 1 should stay overnight at Ballah bypass and sail again on the next morning with Convoy No. 1 (See Fig. 9-4-3). In this case, a vessel leaving Port Said at 9:40 hrs will arrive at Tewtik at 21:00 hrs of the following day, spending 35 hrs and 20 min for the voyage. This plan calls for the availability of an ample space at both Ballah and Bitter Lakes bypasses.

If priority is given to large tankers for inclusion in Convoy No. 1, then only smaller vessels will have to be moored at these bypasses, and this means that nothing more need to be planned than to berth about 37 vessels at intervals of 270 m along the 10 km long bypass. Inclusion of tankers over 18,000 DWT in Convoy No. 1 will secure a departure time interval of 10 min and a distance of 2.3 km between tankers. In this case, the same 10 min interval can be secured for tankers under 18,000 DWT and a 5 min interval for ordinary vessels, thus making it possible for all vessels to transit the Canal smoothly.

The above discussion leads to the conclusion that the completion of the second phase project before 1980 is of great importance, and that the construction of Port Said bypass should be started before the first phase project is completed.

It can be said in conclusion that the current convoys sailing plan can remain in force until about 1980 if minor but necessary changes are effected upon completion of the first phase project on the basis of a careful and detailed study aimed at safer navigation and if suitable navigation aids are additionally installed after investigating hydraulic and manoeuvering problems.

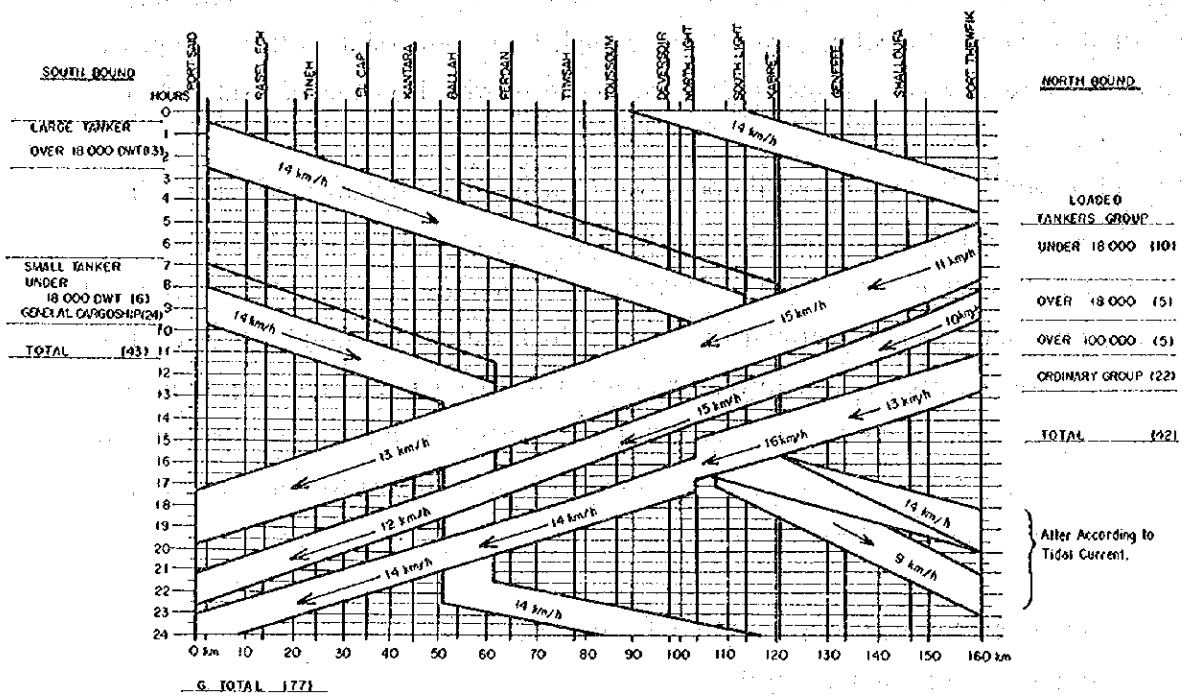


Fig. 9-4-3 Fleet Sailing Diagram of Improved Convoys System (1st-Stage of Development)

(3) Review of Anchorage at Bitter Lakes

The southbound convoy is scheduled to wait for the northbound convoy to pass by between Bitter Lakes and Kabret By-pass. For this purpose, provision of a major anchorage in Bitter Lakes is planned. The number of vessels to be berthed in this anchorage is calculated below using the 1980 traffic. Assuming a peak day traffic to be 35% more in number than the average, it can be said that a convoy moored at Bitter Lakes would most likely comprise the following types of vessel.

Tanker over 18,000 DWT	23
(Tanker over 250,000 DWT)	(2 ~ 3)
Ordinary Cargo Boat	12
Total	25

The northbound convoy is not planned to stop at Bitter Lakes except in an emergency, so that quantitative estimation of vessels to be berthed at Bitter Lakes is difficult. Nevertheless, if an accident occurs between Port Said and Bitter Lakes when the velocity of tidal current is large between Bitter Lakes and Tewfik, the northbound

convoy that has already left Tewfik, if any, will have to sail to Bitter Lakes and stop there. For this reason, a berthing space large enough to accommodate a fleet composed of two or three vessels with engine trouble should be provided on the east side of the fairway, too.

It will be when the leading northbound vessel causes an accident near Deversoir that the largest number of detained boats concentrate in this part of the Canal. Assuming that succeeding vessels are immediately instructed not to proceed to Tewfik and that those which have already entered the Canal, which cannot be moored to the bank due to the fast tidal current, are allowed to proceed to Bitter Lakes and stop there, vessels in the Canal would be tankers under 150,000 DWT totalling about 20 in number.

Hence, if a space for these tankers is secured, it would suffice to cope with any energy mooring of the northbound convoys.

4-4 Facilities for Pollution Control and Navigation Aids

4-4-1 Facilities for Pollution Control

As comings and goings of large-sized tankers augment in such a restricted waterway as the Suez Canal, some sort of sea accident (collision, stranding, fire, explosion, etc.) becomes unavoidable. When a tanker runs into a sea accident it often results in the loss of cargoes. Furthermore, since many of dry - cargo ships engaging in domestic or foreign trade are expected to come and go, it is advisable to establish appropriate measures that should be taken in case a hazardous accident happens.

According to a trial calculation, the maximum volume of crude oil to be discharged is estimated at 10,000 tons even in the case of accident of a large-sized ship, and the average is believed far less than this figure. On account of the fact that the bed of the Suez Canal except the South Entrance - Kabret section is mostly composed of soft and fine sand or silt, damages may rarely reach tanks even in case of stranding or bottoming. At the worst, it will suffice to expect the damage of one or two tanks. In collision the volume of escaping oil will be larger and one or two tanks are liable to be pierced through and lacerated. At any rate, however, it is hardly conceivable that any large volume of oil will flow out since the Canal is calm at all times. Hence, the plan will be worked out to attain the capacity for disposing with 10,000 tons of discharged crude oil.

From the above-mentioned points of view, it is considered necessary to;

1) Install sets of oil-disposing machinery and equipment (dispersant spraying equip-

ment) along the Canal.

2) Utilize lightweight and portable type booms in order to prevent discharged oil from reaching protected areas at the river-mouth or harbors.

3) Prepare devices to collect oil drifting in the waterway or inside harbors, or suspended on the sea surface after secluded by booms.

4) Prevent the dispersion, employing oil fence,

5) Fill up the function of high-speed fireboats, and

6) Strengthen the "organization" in accordance with the counterplan against accident.

It is understood that S.C.A. is conducting further studies on pollution-preventive facilities so as to complement the existing ones, and the team places much expection on S.C.A.'s activities.

4-4-2 Navigation Aids

Safety in manoeuvering a vessel calls not only for complete mastery of the performance of the vessel, but also for accurate grasping of its position and speed. To grasp the vessel's position and speed, there should be provided buoys to indicate the waterway, ranges to show the vessel's course, and marks and flags to warn the vessel against dangerous objects or shallows.

The team was informed that S.C.A. is planning to rearrange and improve existing conical buoys, can buoys, current buoys, light buoys, light beacons, leading and axis lights, fixed framework beacons, mooring limit signposts and rock signposts, etc. when the canal will be reopened in 1975.

Along with the progress of the first phase project, these nautical marks are also to be relocated or newly or additionally installed.

Moreover, aside from seven powerful salvage tugboats to be used for towing vessels or assisting the ship-steerage, various types of tugboats for port services are to be equipped or increased in number.

Enforcement of policies is now under consideration on the improvement of radio phone system for the navigation control within the Canal through the direct and swift communication between a pilot on a navigating vessel and the Ismailia Central Navigation Control Office, as well as on the Radio Wave Navigation Support System (for

example, in the case of the Rotterdam Waterway it is so designed by use of DECCA that a rectilinear portion of the DECCA hyperbola passes just at the center of waterway).

On the other hand, those signal stations along the Canal that were destroyed during the Middle East War ought to be reconstructed urgently.

Table 9-4-7 Dimensions of Tanker

Gross Tonnage	Dead Weight Tonnage	Full Loaded	In Ballast	Partly Loaded	Length (O.A.)	Breadth	Depth
		m	m	m	m	m	m
34.215	60.550	12.00	–	11.47	234.0	33.2	16.4
57.706	100.800	14.83	8.40	14.50	262.0	40.4	20.9
61.564	103.929	15.00			258.49	38.0	21.2
96.229	153.140	16.60	9.50	15.815	294.0	46.2	25.0
103.997	195.120	17.80	9.80	16.00	313.0	50.8	24.2
107.320	209.302	17.685			342.0	49.8	23.2
122.000	257.000	20.55	10.00	17.685	(p.p.) 314.0	54.8	26.4
155.000	310.000	22.30	10.25	20.10	(p.p.) 335.0	56.0	29.0
148.824	331.827	24.782	10.40	20.40	346.6	53.3	32.0

Notes: Partly Loaded . . . . . (80%)