11.3.5 Barge System

(1) General

During the last 80's, new seaports have been built in El Dikheila in order to facilitate larger sea-going vessels and to allow further development. According to the port master plan in Egypt, the port of Dikheila is planned to eventually take over the majority of deep-sea port function from Alexandria port. Since the new port located at 5 km west of the port of Alexandria, the port deems suitable to serve for inland water transport through Nobaria canal. However, until now the connecting waterways to this new port have not yet been provided or completed. As a result, when expected future flows of bulk cargo or container are going to be transported from the port, the inland water transport sector will not be able to capture its market share because of lack in connection infrastructure. In this point of view, it is of paramount importance to provide any means of connection between the ports of Alexandria and Dekheila to enhance the use of Nobaria canal for cargo transportation to/from the greater Cairo area.

In this respect, a feasibility study and detailed engineering study (Two Canal Study for Nobaria Canals) was carried out to connect El Dikheila port with the Greater Cairo for possible transportation of coal in about 1 million tons per annum and has recommended to construct a river port at the lake of Maryut extended by new canals from Nobaria canal in combination of new conveyer belt system for coal transportation in order to bypass the already developed city area. But, there are still some arguments or issues for further considerations for this project.

Based on the future demand projection formulated by JICA Study Team, the major cargo expected from Dikheila port to be transported by inland waterway in future is container cargo (and also wheat, coal is other potential cargoes, which are transported by railway form Dikheila port at present). One of alternative choices for consideration is opening of coastal connection between Alexandria and Dikheila and the transport connection by barges should be taken into consideration by introduction of newly designed coastal-inland water sailing barge.

In July 2000, MOT has made an OT basis contract with Egytrans for development of Cairo based container terminal at Ather El Nabi Port in Cairo including the exclusive right of transporting containers. This development project expects to handle 25,000 TEU containers in the first phase at the river port. The basic operation plan by Egytrans includes future additional container route from Damietta in the 2nd phase development.

Besides, MOT has announced that more river container terminals (Abu Zaabal, Assyut and Qena, etc.) will be established along River Nile (Press Release by MOT in Al Ahram dated October 11, 2001). When these container terminal projects or other infrastructure projects in Nile Delta area are implemented, a considerable increase in container cargo transportation through inland waterway transport can be largely expected. Therefore, the realization on these current movements to enhance the use of inland waterway for container would require a provision of safe, reliable and efficient waterway system network with introduction of new barge for container cargo in economical way of operation.

(2) Existing Barge System

1) Current Type of Barge

Since early 60's, old type of barge has been replaced by introduction of twin-ship units in combination of one pusher barge and one dumb barge. Majority of the twin-ship units are used for transport of dry bulk cargo as well as liquid cargoes. Therefore, in present river-oriented barge system, there is neither normal type of barge unit suitable for transporting container cargoes through inland waterway transport networks nor specifically designed type of barge which can safely navigable for short distance along coastal way between the ports of Alexandria and Dikheila.

Depending on type of barge, the currently used twin-ship barge unit is capable of 650 - 850 tons of cargoes at a draft of 1.4 to 1.8 m. A reliable and safe inland waterway transport system supported by effective way of transport operation is essential means to cope with needs for transporting raw materials or other industrial/agricultural products.

2) General Dimensions

Barge units to be used in Egyptian inland waterway transport are governed their dimensions by such existing well-developed inland waterway infrastructure as locks, permissible water drafts or width of waterway and physical constraints under existing bridge structures which cross the waterway. In particular, the navigation locks govern the length and breadth of barge or barge fleet and the permissible water depth limits maximum allowable draft of barge. Therefore, newly introduced barge must be designed in sizes to be allowed within these constraints without excessive enlargement of existing waterways. The conditions of inland waterway also govern maximum permissible barge sailing speed to prevent high resistance and excessive increase of draft, which is called as "squat" effect. The normal speed at inland waterway transport may range in about 8 - 15 km/h maximum in the Nile Delta canals and River Nile respectively.

In Egyptian inland waterway, maximum dimensions of new cargo barges are restricted per RTA Decree Nr. 254 to Ministerial Decree Nr.282/1998 as follow and, therefore, all the dimensions of existing fleet of barge fall within these limitations with a few exceptions at present.

- Overall Length : not exceeding 51 m
- Beam : not exceeding 7.6 m including fender
- Height : above water surface not exceeding 3.5 m
- Draft : maximum operation draft of 1.6 m

The above dimensions of barges are just suitable for existing lock size of 116m × 16m in order to accommodate two units of pusher and dumb barge side by side (total 4-single units). This will be the one of main reasons why this size of barge is so common in view of efficient saving of water discharge by lock operation.

3) Review on Barge Fleet Currently Used

Currently used barge fleets for IWT in Egypt consist of the following various types.

- Pusher barge and pushed dumb barge
- Self propelled barge
- Pusher tug and pushed dumb barges
- Towing tug and towed dumb barges

Each type of barge system will be commented as follows:

(Pusher Barge and Pushed Dumb Barge – Twin Unit Type)
This type composes of pusher barge and pushed dumb barge having the same width to be connected together with longitudinal direction. Generally, this type of barge is owned and operated by public sector companies. About 50 m length and 7.5 m width of each unit is most common dimensions to be capable of 650 to 850 dead weight tons. Engine power provided with this type is mostly 400 Hp. It requires five (5) crews for the pusher and in addition two (2) sailors for the dumb barge.

(Self-Propelled Barge)
This single unit type is so designed to have dimensions suitable for present waterways and locks. Vessel weight is dependent upon barge length, which governs the required hull strength. Because of this and draft/width limitations, most Egyptian barge units fall into the dimensions of about 50 to 52 m long and 2.2 to 2.5 m hull depth. This type is powered by 180 to 250 Hp engine with single screw and the load capacity ranges from 400 to 450 tons.

Generally 5 crews are required and therefore labor cost per unit cargo load is basically higher. The advantages of this type will be characterized by:

- This type can sail more easily in difficult waterways than twin unit type owning to full control of maneuvering by single unit
- This type can moor along ocean going vessels in port for delivery/receipt of

cargoes with full control of sailing

(Pusher Tug and Pushed Dumb Barges)

Pusher tug is used to push dumb barges of various sizes or numbers and therefore the length or width of this type barge fleet is dependent upon number of dumb barges tied together with pusher tug. The load capacity of his type ranges from 400 to 450 tons for standard barge dimensioned by 50 m long, 7.5 m width and a draft 1.3 to 1.8 m. This type presents no trim problems in light condition, no waiting time for pusher in cargo operation on/from dumb barge, effective way of maintaining pusher tug unit but also suffers such disadvantages as difficulty in sailing at open water area or certain pattern arrangement of pushed dumb barges which are tied together with pusher tug.

(Towing Tug and Towed Dumb Barges)

This barge system composes of towing tug for a number of towed dumb barges with various combinations in sizes and dimensions. But, this type will present some unsuitable characters such as difficulty in steering control, high unit power requirement per dead weight for tug unit, etc. Even in still water area, steering control of convoy in sharp bent of waterway at entering lock or mooring along quay is so harder than other types of barge fleets are.

(3) New Barge for Possible Development

An important trend in future cargo demand for inland water transport may be transport of some commodities in break-bulk and containers instead of those in bags. Plans for special types of barges for these commodities can be only developed, implemented and financed in close cooperation with inland waterway transport companies or potential clients.

In considering present situation of barge system and potential future cargoes and transport route by inland waterway, possible development of new barge may be targeted at the following type and mode of transport:

- Barge being capable of carrying larger unit load of containers or dry bulk per barge in view of transport economy

  Unit load capacity per barge is of paramount importance to introduce container cargo transport by inland waterway in a fierce competitive market among modes of inland transport. This may be accomplished by new barge system having wider beam with suitable draft, which could be designed within tolerable deviation of dimensions to be allowed by the present constraints of inland waterway. It must be developed in line with sophisticated network system to materialize less time spending, reliable and safe transport operation supported by door-to-door regular service for clients.

- Coastal-going container cargo carrier barge for direct connection between Dikheila

Port and Beheiry/Nobaria Canals

It has to be studied under what conditions new designed barges, which directly sail along coastal line from Dekheila to the entrance lock at Alexandria and directly link with the greater Cairo, can be introduced for such specific cargo as container or bulk cargo (possibly wheat and coal) to be transported by inland waterway.

Among major cargo commodities, which are suitable for inland waterway transport, the Study Team do focus an introduction of new barge for container and dry bulk based on the future cargo demand projected in this study. If other specific cargoes necessitate an adoption of new barge fleet, then the building of additional barges or new types of barges may be developed through in-depth study on the design and projection for future potential cargo demand.

(4) Conceptual Design of New Barge

1) Rules and Regulations

The following rules and regulations may be applicable for designing new type of barges:

a) Rules of Classification Society: Hull strength Inspection and Testing
b) Domestic Navigation Rules by RTA: Rules in Egyptian Inland Waterway Navigation
c) International Convention for Coastal Barges, where applicable
   - SOLAS (International Convention for Safety of Life at Sea), 1974 and amendments
   - MARPOL (International Convention for Prevention of Pollution from Ships), 1973 and amendments
   - International Convention on Load Lines, 1966

2) Design Criteria

Newly introduced barge must suit or be conditioned within allowance for various constraints, which are inevitably imposed by the present inland waterway infrastructures:

a) Full Load Draft: 1.6 m or less

The permissible water depth may be considered 1.8 m maximum along Nobaria canal in almost whole year except for closure period.

b) Air Draft: not more than 4.4 m

The 1st class waterway requirements of not less than 6m for air clearance above water level under bridges may govern navigability of inland waterway. However, actual permissible air draft may not be more than 4.4m for passing through existing lower elevated bridges in Cairo area such as Imbaba Bridge for safety.

c) **Beam Width: not more than 12 m**

The 1st class waterway requirements of 35m wide for two navigable waterways may govern navigability of barge having wider beam up to 12m. Besides, barges of 12m beam can pass through existing bridges having minimum navigable widths of 14 m (Desert Road Bridge at Alexandria) along Beheiry and Nobaria Canals.

d) **Length Overall: not more than 102 m**

New barge must be so dimensioned to allow for lock accommodation by existing standard size of lock chamber having 116m length and 16 m width (and water draft 1.8 m maximum). However, actually useable maximum length of lock will be limited to 102 m because of dead spaces for gate doors operation including suitable clearance of fore and aft of barge.

3) Comparative Case Study on New Barge System

The previous review on the barge fleet currently used in Egyptian inland waterway leads us to the conclusion that the type of barge to be developed in future will be twin unit barge (pusher barge and pushed dumb barge) or self propelled single unit. Therefore, the Study Team will focus on these two types of barge system in succeeding study for possible development of new type of barge suitable for Egyptian inland waterways.

Coastal navigation between Dikheila and Alexandria ports will require specialized type of barge being capable of sailing coastal way. Based on the future cargo projection by JICA Study Team, the study will focus on development of container cargo carrier barge from/to Dikheila port (Barge Type I) and non-coastal barge for transporting bulk cargoes from/to Alexandria or Damietta port (Barge Type II). Each type of barge is dimensioned as follows.

	Type I (Coastal)	Type II (Non-coastal)
Cargo Type	Container	Bulk
LOA	100m	100m
Beam	12m	12m/7.5m
Draft	1.6m	1.6m

The findings and results of study on suitable type of coastal sailing container carrier (the above type I) will be equally applicable to non-coastal container barge which may serve for Alexandria or Damietta ports. Therefore, the study on non-coastal container barge will be unnecessary to be specifically carried out herein on comparative study basis.

For the above two types of barge development, three alternatives for each type were studied for comparison and the following points of technical aspects are incorporated in determining basic dimensions or major specifications of each alternative of barge in this study.

- Navigability along present IW and Locks
- Hull Strength for Seaworthiness or in Still Water
- Cargo Loading Capacity (Dead Weight Tonnage)

And such other factors as:

- Stability of Barge
- Maneuverability
- Economical Way of Navigation Speed

Considering economy of sailing and environmental aspects, engine power of 600 Hp is adopted equally to pusher barge or single unit barge so as to sail at about allowable speed of 7 knots minimum. Standard block coefficient Cb = 0.9 in Egypt is commonly used in this study work.

4) Type I (Coastal Sailing Container Carrier Barge)

In case of container transport, the maximum size of permissible beam width (=12m) will be most suitable for new barge in view of efficiency of container transport. Therefore, each alternative of barge is considered 12 m beam. But, navigation of coastal area is required for barges to have sufficient longitudinal strength of hull against sea waves. In general, the increase of barge length results in disadvantage since 2-times increase of barge length means 4-times increase of bending moment on the mid-ship of hull.

Since the depth of barge is an important element to govern hull strength and safety for maneuvering, it seems better for coastal sailing barge to have an increased depth of barge with provision of enough freeboard in an effective way to reinforce longitudinal hull strength of barge. Selected dimensions of each alternative are shown in Figure 11.3.10.

(a) Selection of Alternatives for Type I (Coastal Sailing Container Barge)

- **Alternative 1 (Alt. 1): Twin Unit Type (Coastal Sailing in Both Pusher and Dumb Barges)**

There may be two alternative methods of coastal sailing, either pushing or towing dumb barge for twin-unit type to connect between Dikheila and Alexandria ports. But, since more practical way of coastal sailing by this twin unit type will be pushing dumb barge, this alternative is represented by a combination of pusher and dumb barge tied together by specially reinforced and improved coupler device. As shown in Figure 11.3.10 A, wider sized twin-unit of 12 m pusher and dumb barges, both of which are capable of coastal navigation, is studied in this alternative. Both pusher and dumb barges are dimensioned 50 m length in this alternative.

- **Alternative 2 (Alt. 2): Twin Unit by Coastal Going Pusher and Non-coastal Dumb Barge**

Only self-propelled pusher of wide size of 12 m will be used for coastal navigation between Alexandria and Dikheila. At Alexandria Port, the pusher is connected/disconnected with non-coastal dumb barge for canal & river navigations to/from Cairo. As shown in Figure 11.3.10 B – D, the following dimensional combination of each alternative is studied for comparison.

	Pusher	Dumb	Total
Alt. B	50.0 m	50.0 m	100 m
Alt. C	62.5 m	37.5 m	100 m
Alt. D	75.0 m	25.0 m	100 m

It is basically deemed that the pusher barge will transport container cargoes in origin from or destination to Dikheila port while the dumb barge for container from/to Alexandria.

- **Alternative 3 (Alt. 3): Self Propelled Single Unit**

Self-propulsive unit barge having 12m wide and 100m long will be studied as shown in Figure 11.3.10 E for coastal as well as canal navigation to/from Cairo. In order to keep forward visibility, a wheelhouse will be located at the foremost of upper deck, covered by front bulwark against waves during coastal navigation.

(b) Examination of Alternatives

- **Alt. 1: Twin-unit type barge (costal sailing in both pusher and dumb barge)**

Coastal sailing by either pushing or towing dumb barge may be possible method of coastal connection for this twin-unit type between Dikheila and Alexandria ports. The methods may be applied depending on the extent of sea wave roughness, which may be represented by the Beaufort Scales for example. The method of pushing dumb barge requires specially designed coupling device to tie pusher together with pushed dumb barge. This device must be fully reinforced in strength and suitably improved to tie both barges together, probably in flexible way to suitably absorb any differences in relative movements between both barges which may be exerted by waves actions. But, there is not available such proven device to be applicable for this type of barge so far.

Based on the data on wave climate at the port of Alexandria, the Study Team considers that the method of coastal sailing by either pushing or towing may not practically applicable for all weather conditions and, because of maintaining safe maneuvering by either pushing by means of connection joints (coupler) or towing dumb barge by ropes, may inevitably include the likely occurrence of cancellation for barge navigation in certain days under stormy weather condition during winter season in particular. This consideration obviously offers disadvantage in view of reliable regular transport service requirement for container in particular.

The use of tug barge towing dumb barge by means of tow ropes may be applicable under very calm sea conditions but will be unsuitable to use under rough weather because of the following considerations and will never be recommended to apply:

1) Steering control is very difficult. There is no way for backing capacities and reduction of sailing speed or stopping control requires utmost caution in steering control.
2) Each barge unit will show hydrodynamic movement individually. Particularly in rough wave conditions, each barge unit may move completely different way of movement due to irregularity of wave actions.

Among other technical subjects on Alt. 1, technical key issue is the connection joints such as couplers to be developed for possible tying pusher together with pushed dumb barge for safe coastal sailing by twin unit type of pusher and pushed dumb barge system. Since there is no specific precedence in the use of such joint device, a materialization of fully reinforced and improved device will decisively require in-depth study or experiment by using prototype model in view of sufficiency in strength for excessive stresses by waves, structural flexibility for irregularity of movement and seaworthiness, etc. Moreover, being unlike other alternatives that only single unit barge sails along coastal way, this twin unit is not easier in coastal maneuvering in view of strong influence by sea wave actions in particular.

The above considerations will lead us to the conclusions that:

1) pusher and pushed dumb barge system is preferable for twin unit barge by using improved coupling device for coastal sailing,
2) but the twin barge system as equipped with such improved mechanism and structures of joint coupler will result in a costly development as shown in Table 11.3.1

- **Alt. 2: Coastal going type pusher and (non-coastal) conventional type dumb barge**

For this alternative, three cases of length variation for each barge unit have been studied within 100m total length of self-propelled pusher for coastal service and non-coastal dumb barge. The total price of the two barges and prices per TEU were also calculated for comparison. Among these three cases of container barge, Case B (combination of 50 m pusher plus 50 m dumb barge) is most advantageous in price base. Total capacity of container in combination of pusher and dumb barge will be 88 TEU's per unit.

- **Alt. 3: Self-propelled single unit**

In order to enable coastal navigation between Dikheila and Alexandria (about 3 miles), self propelled single unit barge having overall length of more than 50m is studied and within common, permissible and practical extent of hull strength requirement, it can be technically judged that the overall length of barge could be lengthened to 100m. Under this length of barge, the depth of barge (2.3m in case of conventional barges) is required to be increased to 3.8m having 2.2m freeboard at 1.6m full load draft under the condition that the hull construction will be suitably reinforced.

It should be noted however that this output concept derived from our study is applicable only for barges to be used at short time coastal navigation and seems not enough for long time or ocean going navigation. This alternative could be capable of lading 96 TEU's container boxes by one unit of barge.

(c) Findings

Three alternatives (5 cases) were examined for container carrier barge and the dimension and price for each alternative is shown in Table 11.3.9. The following findings will be commented.

- Total capacity of container load in combination of pusher and dumb barge (Case A to D) will be 88 TEU's while the total loading capacity of single unit barge (Case E) is 96 TEU's.

- In Alternative 1, dumb barge needs to be united with pusher barge by specially reinforced/improved couplers. It results in the most expensive due to its costly development of special coupling. In addition, this type (pusher and pushed dumb barge) apparently offers disadvantage in view of more difficulties in coastal maneuvering than other types of alternatives which are able to sail as single unit. Therefore, this type is not recommended to apply.

- Among three cases (alternative combination of barge length of pusher and dumb, B to D) for Alternative 2, Case B (a combination by each 50 m unit barge) will be the most economical.

- Excluding Alternative 1, which is the most expensive and not recommended to apply, there is not so much difference in barge construction cost among alternatives as well as in term of price per unit cargo load.

- Twin units (pusher and pushed dumb barge) for Case A to D of alternatives 1 & 2 requires connecting and disconnecting each unit of barge at Alexandria Port after/before maritime lock. This will take a considerable time because dumb barge can not move individually and the pusher barge have to help her on/off berth for cargo loading/unloading. It needs cumbersome tying/untying operation to be established in barge navigation schedule and will eventually decrease barge service level.

Alternative 3 (Case E: single unit self-propulsive case) may be selected as the most advantageous type as shown in Table 11.3.9 since this type does not need any time or cumbersome operation to connect/disconnect pusher together with dumb barge. In addition, this single unit type offers easier maneuverability owing to full control by single unit than other alternatives.

Coastal sailing barge may be constructed by use of mild steel plate of 12-15mm thickness for barge hull members. Double skin hull is used for basic structure of barge and the bottom skin plates will be spaced at not less than 0.70m intervals for maintenance and repair works. The hull is to be designed to have enough strength for normal high waves and in due design consideration of stability and maneuverability.

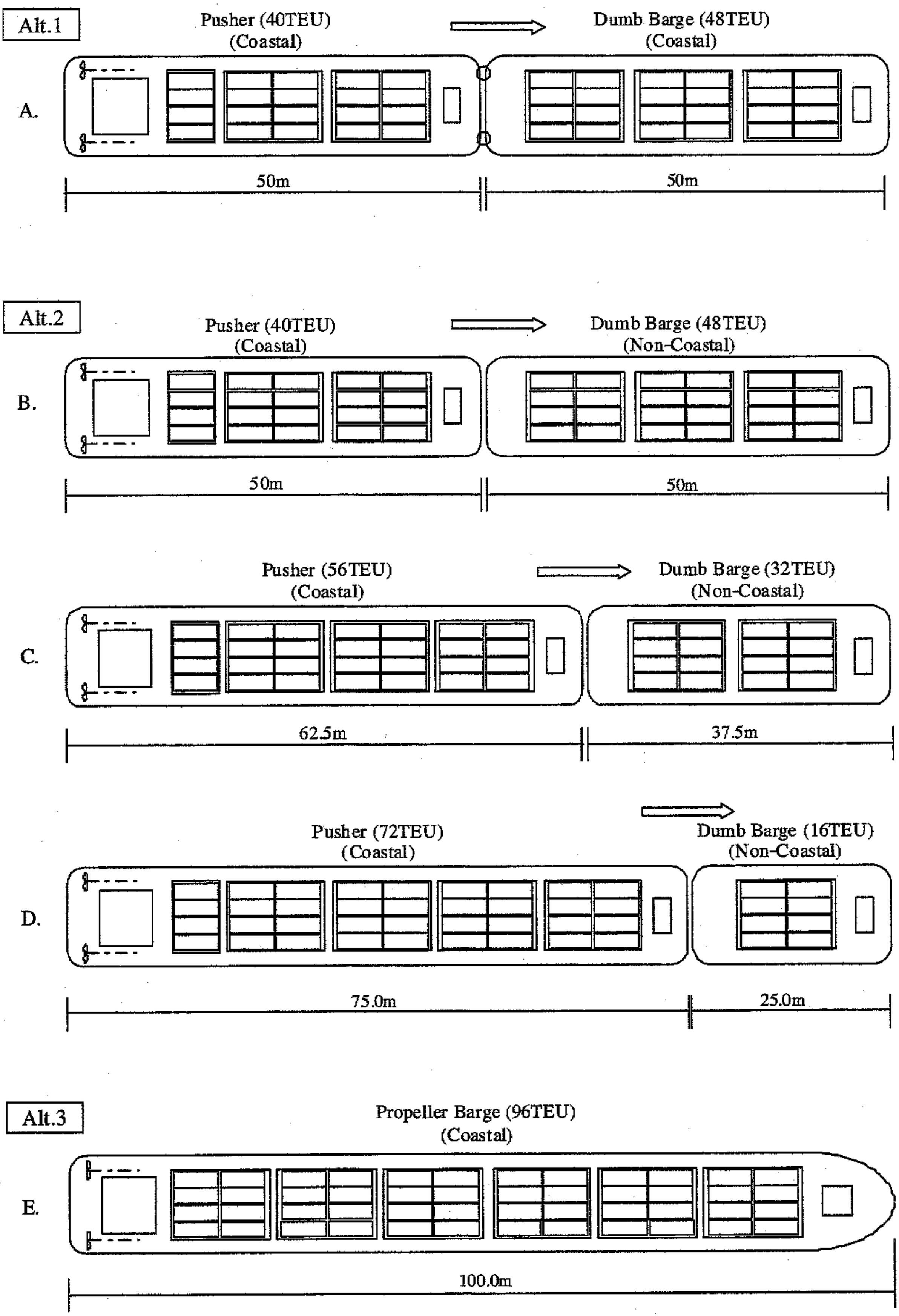
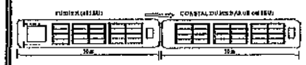
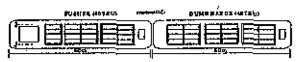
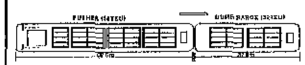


Figure 11.3.10 General Arrangement of Container Barge

Table 11.3.9 Comparison of Alternatives for Container Barge

Alternative	Alternative 1		Alternative 2						Alternative 3
Case	A		B		C		D		E
									
Type of Barge	Pusher	Dumb Barge	Pusher (Coastal)	Dumb Barge (Non-Coastal)	Pusher (Coastal)	Dumb Barge (Non-Coastal)	Pusher (Coastal)	Dumb Barge (Non-Coastal)	Self-Propelled (Coastal)
Length (m)	50.0	50.0	50.0	50.0	62.5	37.5	75.0	25.0	100.0
Beam (m)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Depth (m)	2.8	2.8	2.8	2.3	3.1	2.3	3.4	2.3	3.8
draft (m)	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Dead Weight (ton)	620	650	620	700	770	520	910	350	1,260
TEU	40	48	40	48	56	32	72	16	96
Price (1,000 LE)	1,962	1,155*	1,962	681	2,229	508	2,512	338	2,869
Total TEU	88.0		88.0		88.0		88.0		96.0
Total Price (1,000LE)	3,117		2,642		2,737		2,850		2,869
Price in 1000LE/TEU	35.4		30.0		31.1		32.4		29.9*
Cost Advantage	5		2		3		4		1
Remarks	* including the cost of coupler								* Ave. unit price: 26.4 kLE/TEU

Source: JICA Study Team

5) Type II (Non-coastal bulk barge)

The type II intends to transport bulk cargoes from/to Alexandria or Damietta ports. Each alternative to be compared in this study is river sailing barge (non-coastal sailing). In general, almost all Egyptian typical type of barges have provided suitable depth for sailing inland waterway where no wave is expected through navigation route and therefore have a standard depth of 2.2 to 2.3 m average.

Since non-coastal barge is used in still water area, the hull depth of 2.3m which is adopted in the present type of barge will be considered sufficient in view of hull strength for the range of barge length up to 100m. Selected alternatives for bulk carrier are shown in Figure 11.3.11.

(a) Alternatives for Type II (Non-coastal bulk barge)

Each alternative is river sailing barge (non-coastal type) aiming at transporting bulk cargo from/to Alexandria or Damietta Port.

- **Alternative 1 (Alt. 1): Conventional Twin-unit type of 7.5m beam**

  This alternative represents the present type of barge for comparison with other alternatives. Self-propelled pusher of 7.5 m beam will be used to push dumb barge as shown in Figure 11.3.11 A for dry bulk barge. A combination of 50 m pusher and 50 m dumb barge represents this type of alternative.

- **Alternative 2 (Alt. 2): Conventional Twin-unit type of 12m beam**

  Self-propelled pusher of wide beam 12m will be used to push dumb barge as shown in Figure 11.3.11 B for dry bulk barge. A combination of 50 m pusher and 50 m dumb barge represents this alternative.

- **Alternative 3 (Alt. 3): Self-propelled single unit of 12m beam**

  Self-propulsive navigation single unit barge having 12m beam and 100m long will be studied as shown in Figure 11.3.11 C for dry bulk barge. To keep forward visibility, wheelhouse will be located at foremost of upper deck.

(b) Examination of Alternatives

- **Alt. 1 & 2: Twin-unit type in combination of pusher and dumb barge**

  Self-propelled pusher connected with conventional type dumb barge for both alternatives is considered. Difference between Alt. 1 and Alt .2 is only width of barge and the total length of each alternative is 100m. The total price of two different alternatives as well as unit price (price per cargo load) was calculated for comparison. In these two cases of bulk barge, Alt. 2 (12m beam) is more advantageous than Alt. 1 (7m beam) in unit price per load basis although the difference is very narrow.

- **Alt. 3: Self-propelled single unit**

As studied on single unit coastal sailing container barge (Alt. 3, Case E), the overall length of this alternative is increased to 100m by economical viewpoint of carrying capacity while maintaining hull depth of 2.3 m.

(c) Findings

The dimension and price for bulk barge for each alternative of barge is shown in Table 11.3.10.

- Load capacity of each alternative differs as follows:-

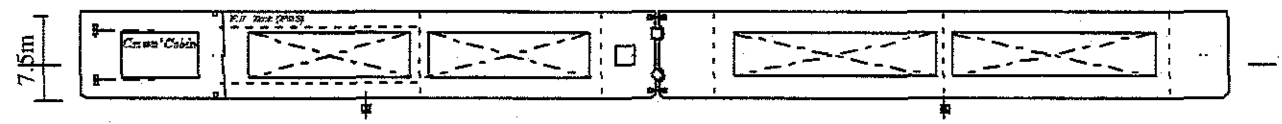
Load Capacity of Each Alternative (ton)

Alternative	Pusher	Dumb	Total
1	420	440	860
2	670	710	1,380
3	1,450	—	1,450

- The above three Alternatives (3 Cases) were compared in prices and it is found that Alternative 2 is the most expensive among alternatives.

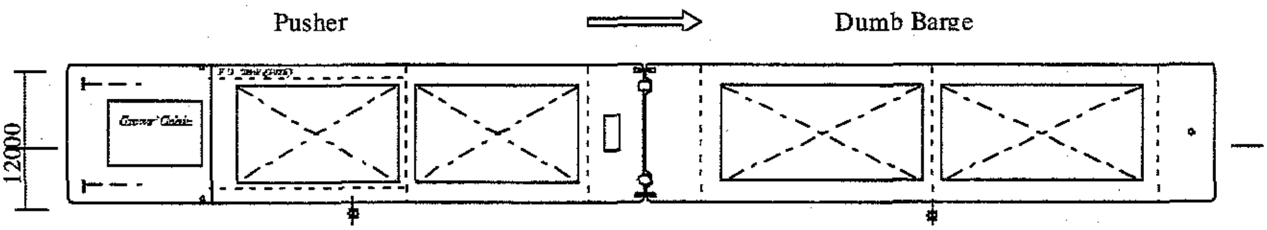
- Alternative 3 (Self-propelled Single Unit) will be considered the most advantageous in term of its price per unit cargo load as shown in Table 11.3.10. Moreover, Alternative 3 "Single unit type" does not need any time or cumbersome operation to connect/disconnect together with dumb barge and in addition can offers easier maneuvering owing to full control by single unit.

A.



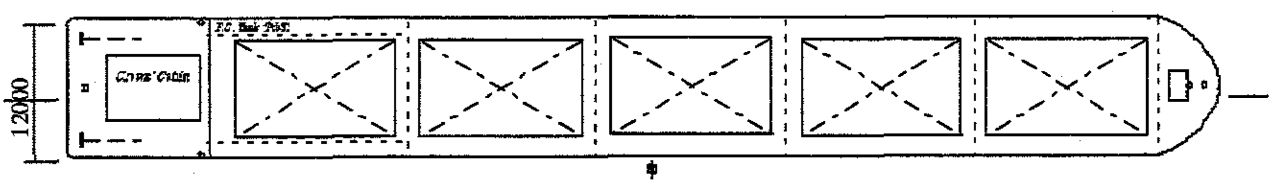
LxBxDxd = 50.0 x 7.5 x 2.3 x 1.6 (m)
Dead Weight = 860 t in total

B.



LxBxDxd = 50.0 x 12.0 x 2.3 x 1.6 (m)
Dead Weight = abt. 710 t (dumb barge)
= 670 t (pusher)

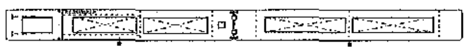
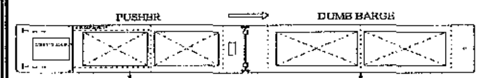
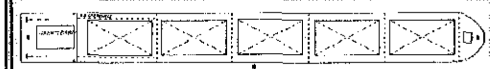
C.



LxBxDxd = 100.0 x 12.0 x 2.3 x 1.6 (m)
Dead Weight = abt. 1,450 tons

Figure 11.3.11 General Arrangement of Bulk Barge

Table 11.3.10 Comparison of Alternatives for Bulk Barge

Alternative	Alternative 1		Alternative 2		Alternative 3	
Case	A 		B 		C 	
Type of Barge	Pusher (Non-Coastal)	Dumb Barge (Non-Coastal)	Pusher (Non-Coastal)	Dumb Barge (Non-Coastal)	Self-Propelled (Non-Coastal)	
Length (m)	50.0	50.0	50.0	50.0	100.0	
Beam (m)	7.5	7.5	12.0	12.0	12.0	
Depth (m)	2.3	2.3	2.3	2.3	2.3	
draft (m)	1.6	1.6	1.6	1.6	1.6	
Dead Weight (ton)	420	440	670	710	1450	
Main Engine (Hp)	400	-	600	-	600	
Price (1000LE)	1,115	404	1,746	638	2,083	
Total Dead Weight	860		1380		1450	
Total Price (1000LE)	1,519		2,384		2,083	
Pricein 1000LE/DW	1.77		1.73		1.44	
Cost Advantage	3		2		1	

Source: JICA Study Team

6) Recommendations on New Barge System

(a) Type of Barge Recommended

Based on the above findings through comparisons on alternatives for each type of barge, the single unit type of "self-propelled barge" is the most suitable for future type of barge to transport both container and bulk cargoes. Among others, single unit barge will present the following advantages:-

1) This type requires neither extra time nor cumbersome operation for tying/untying pusher with dumb barge
2) This type can more easily navigate in difficult waterways owning to simple maneuverability
3) This type can directly moor along ocean-going vessel in port to deliver or receive cargoes with full maneuvering control by single unit
4) The number of crew per cargo load is reduced remarkably. It will be estimated that single unit barge requires 6 crews for a captain, a mechanic, an assistant mechanic, two sailors and a guard while 7 crews for twin barge are needed for 5 crews and additional 2 crews for a sailor and a guard to be provided with dumb barge.

It is recommended to introduce new type of barge in the following design concept:

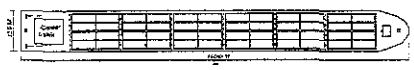
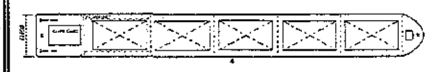
- Deletion of twin unit concept and adoption of self-propelled single unit type of barge
- Smaller design draft (d = 1.6 m) to suit all seasonable water draft available
- Increase barge length to 100 m in line with deletion of twin unit barge concept
- Increase barge beam to 12 m within beam allowance for two way traffics under the present 1st class waterway of 35 m width

The single unit type is adopted to the transport cost bases for modal split analysis as presented in Chapter 10.

Figure 11.3.12 and Figure 11.3.13 provide the profile of general arrangement and midship section for each barge. In case of container transport from/to Dikheila port, single unit type of barge is applied to transport container cargo from Dikheila and Alexandria port individually. Therefore, non-coastal single unit container carrier of 12m beam is also studied for container transport from Alexandria or Damietta ports.

From the above discussions, the recommended type of barges for both container and dry bulk cargoes were summarized in Table 11.3.11.

Table 11.3.11 Summary of Recommended New Barge Systewm

Cargo Type	Container		Dry Bulk
Case			
Type of Barge	Self-Propelled	Self-Propelled	Self-Propelled
	Non-Coastal	Coastal	Non-Coastal
Length (m)	100.0	100.0	100.0
Beam (m)	12.0	12.0	12.0
Depth (m)	2.3	3.8	2.3
draft (m)	1.6	1.6	1.6
Air Draft (m)	4.35	4.35	-
Dead Weight (ton)	1,430	1,260	1,450
Nr. of Container (TEU)	96	96	-
Main Engine (Hp)	600	600	600
Complement (p)	6	6	6
Speed (knot)	7	7	7
Total Price (1000LE)	2,190	2,869	2,083
Price/Unit	22.8x 1000LE/TEU	29.9x1000LE/TEU	1.44x1000LE/DW

Source: JICA Study Team

(b) Special Arrangement and Equipment for New Barges

Newly proposed larger sized barges for coastal as well as non-coastal navigation should be equipped with the following equipment and fittings. Necessary equipment applicable will be different depending upon type of ship, navigation area, kind of cargo, etc. The summary of special arrangement and equipment for new barges is shown in Table 11.3.12.

Table 11.3.12 Special Arrangement and Equipment

Items	Container Barge		Dry Bulk	Remarks
	Coastal	Non-coastal	Non-coastal	
a) Fore-end wheel house (Container barge)	O	O	△	In order to keep foreword visibility, wheel house shall be located fore-end of the barge, where the maneuvering such as rudder steering and main engines remote-control can be carried out. For dry bulk barges, it is of course applicable if necessary.
b) Water Ballast Tank (Container Barge only)	O	O	×	Purpose of water ballast is to get necessary draft for suitable clearance under bridges when passing through Imbaba and other lower bridges in Nile River, but not necessary to use during the navigation in canals. Therefore, ballasting has to be done only before passing these bridges, when necessary. Double bottom should be used for ballast tank and fresh water shall be used for ballast as much as possible. Ballast tanks should be equipped with: • Sea chest for direct filling with deck stand for valve operation • Electric motor driven ballast pump(s) for discharge • Sounding pipe and other piping arrangement • Draft Gauge, if available
c) Navigation Lights and Search Light for night navigation (All barges)	O	O	O	
d) Electric Power Supply by Generator (All barges)	O	O	O	• Ballast pumps driving (container barges), search light, and navigation lights • Remote control of steering, and main engines revolution, etc
e) Fuel Oil Tank (All barges)	O	O	O	Marine diesel oil shall be used and wing tanks will be used for fuel oil tanks. The use of double bottom as fuel tank seems unsuitable to prevent oil leakage when an accident such as grounding in shallow water.
f) Container Fittings (Container barge only)	O	O	×	Fittings for positioning and rocking devices will be provided. Lashing equipment will be equipped, if necessary.
g) Fire Fighting Equipment (All barges)	O	O	O	This should be provided as required by Classification Society.
h) Fittings for Coastal Navigation (Coastal barge only)	O	×	×	Life saving equipment is as required. Anti-fouling paint for bottom area of shell plate should be applied.
i) Accommodation for Crew (All barges)	O	O	O	Cabins for 6-crew with air conditioning are to be provided.
j) Suitable fenders which protects side shell of barge. (All barges)	O	O	O	

O : Necessary
△ : Necessary in case
× : Unnecessary

(c) Considerations for Development

Introduction of new type of barge system capable of larger unit load per barge is one of the key factors for recovery of present IWT sector activities. As regards container cargo handling by IWT sector, wide beam container carrier barge will be mandatory in term of efficiency and productivity of transport to cope with market competition among other inland transport modes. It should be stressed that:

1) New type of barge could be only developed, implemented and financed in close cooperation among IWT sector concerned.
2) For enhancement of efficiency and productivity of IWT, new barge system is to be developed in line with improvement in software aspects such as less turn around time of barge operation through 24 hrs operation properly supported by navigation aids, reliable and safe transport regular services and door-to-door services for the client properly connected with secondary inland transport.

Apart from the above special arrangement and equipment for new barge, the following commentaries are also provided for possible development of new type barge recommended herein.

- **Twin Engines System**

In general, vessel like barges has twin engines and twin propulsions because large sized propellers are not suitable for shallow water. This twin engines system is also very helpful for easier maneuvering so that the turning at its position can be possible without any thrust support system. Therefore, twin engines system is recommended in consideration of physical conditions as well as maneuverability in existing waterway.

- **Main Engine Power**

From economic (fuel oil consumption) and environmental viewpoint, main engine power should be as smaller as possible. For this study, 600 Hp engine is recommended for future barge system. This engine enables to sail with about 6 knots (11km/h) while 7knots (13km/h) is expected by applying 800 Hp engine. For navigation of canals, navigation speed is limited to 8km/h and therefore the engine more than 600 Hp capacity is not necessary. However, 800 Hp engine might be used for non-coastal container in River Nile where the speed limitation is 15km/h.

c) Egyptian Building Shipyard for New type barges of 100m Length

Present Egyptian shipyard may be utilized to build new type of barges of 100m long since it is reported that present Egyptian shipyard is equipped with building facilities of two berths of 180m × 28m, and two dry docks of 158.5m × 18.9m and 267m × 39.6m size for repair, for instance.

- **Institutional Arrangement**

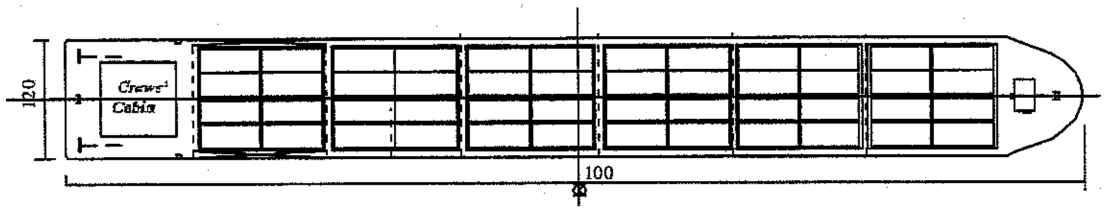
This study recommends that unit type of new barge, of which overall length is 100m. All necessary steps for authorization of new type of barge including amendment of Ministerial Decree should be taken in due course.

- **Succeeding Steps for Study and Design**

This study result presents basic dimensions, concept or general specifications of new type of barge to be recommended for future barge. An introduction of the recommended type of barge must be subjected to such succeeding stages of works as basic design or detailed design of barge for possible implementation.

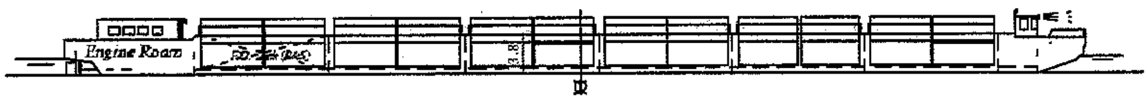
As far as container carrier barge is used to serve for transport from/to Alexandria and Dikheila ports, the rehabilitation project for extension of maritime lock at Alexandria port forms one of prerequisites for possible introduction of new barge which is dimensioned in 100 m long and 12 m wide.

4-Rows, 2-Tiers, 12-Bays



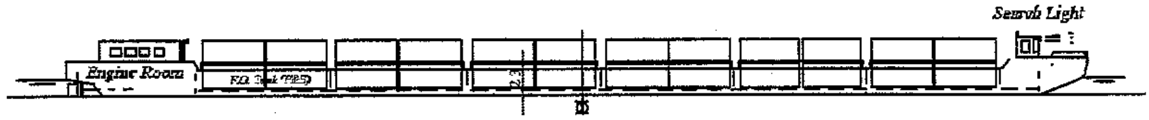
Coastal Type

LxBxDxd = 100.0 x 12.0 x 3.8 x 1.6 (m)
Container TEU = 2x4x12 = 96 TEU
Dead Weight = abt. 1,260 tons
Main Engine = 300 ps x 2 sets
Complement = 6 p

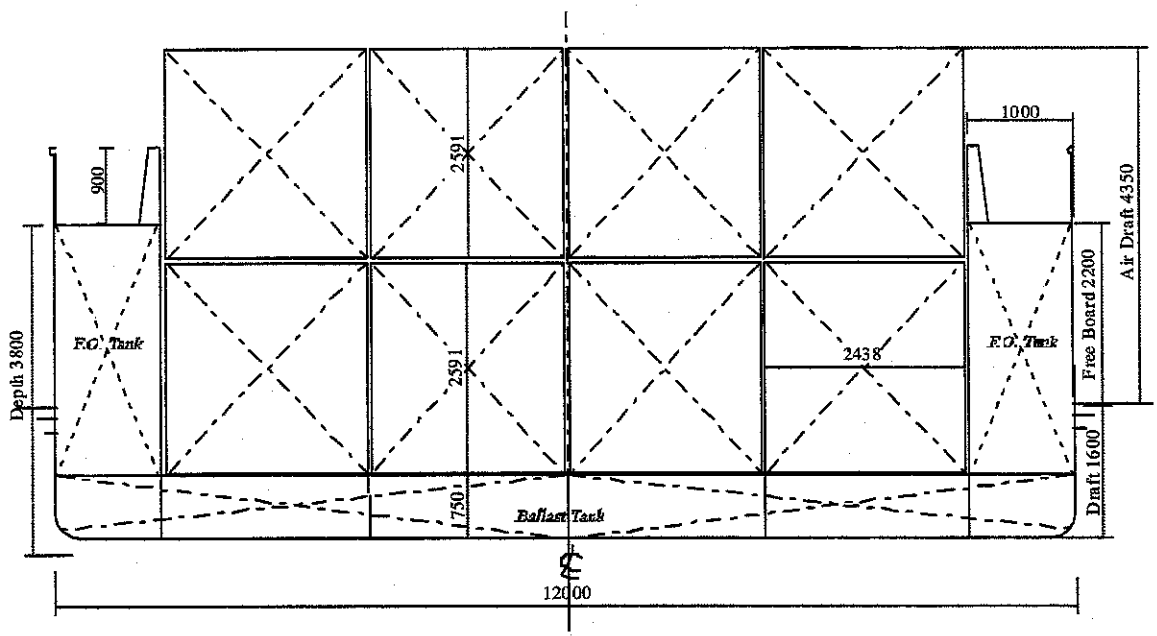


Non-Coastal Type

LxBxDxd = 100.0 x 12.0 x 2.3 x 1.6 (m)
Container TEU = 2x4x12 = 96 TEU
Dead Weight = abt. 1,430 tons
Main Engine = 300 ps (400 ps for Damietta) x 2 sets
Complement = 6 p



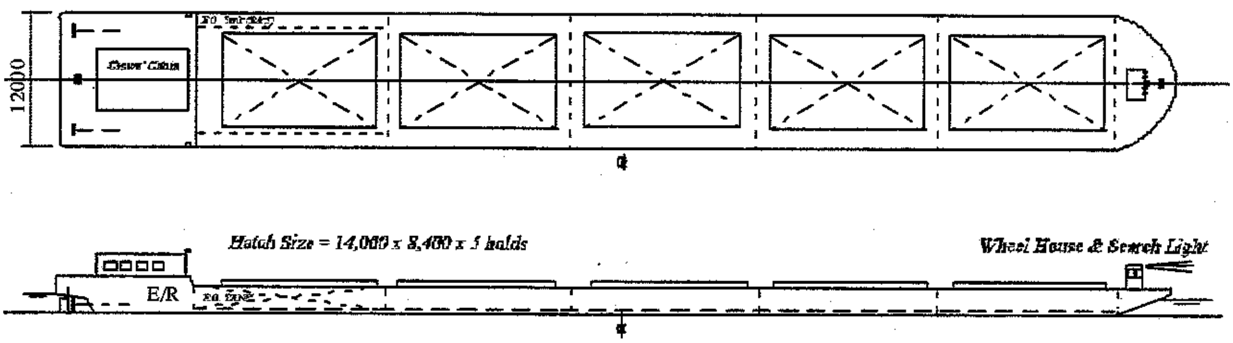
General Arrangement



Midship Section

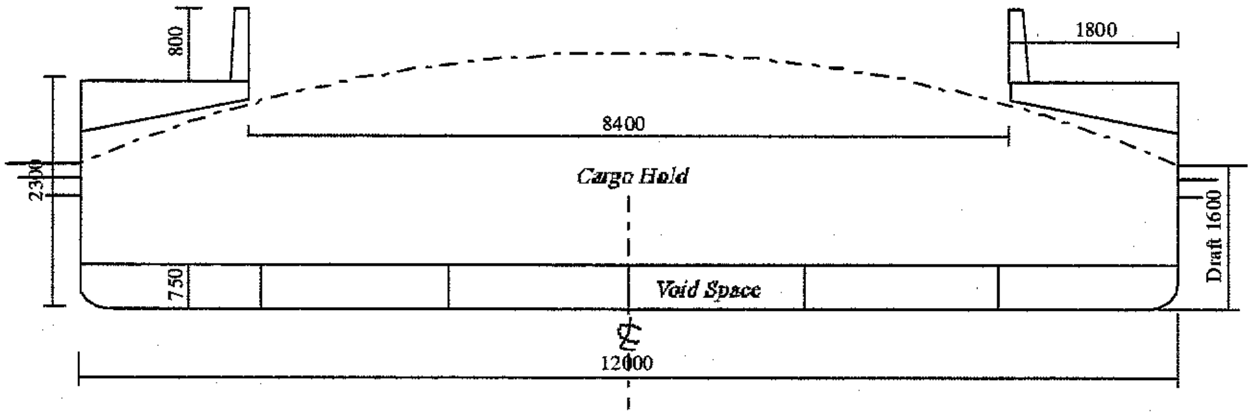
Loa = 100.00 m
B = 12.00 m
D = 3.80 m
d = 1.60 m
Container TEU = 2x4x12 = 96 TEU
Main Engine = 300 ps x 2 sets
Speed = 6 knots
Complement = 6 p

Figure 11.3.12 Container Barge



LxBxDxd = 100.0 x 12.0 x 2.3 x 1.6 (m)
Dead Weight = abt. 1,450 tons

General Arrangement



Midship Section

Loa = 50.00 m/100.0 m
B = 12.00 m
D = 2.30 m
d = 1.60 m
DW = abt. 710 t (dumb barge)
= abt. 670 t (pusher barge)
= 1,450 t (100 m barge)
Main Engine = 300 ps x 2 sets
Speed = 6 knots
Complement = 6 p

Figure 11.3.13 Bulk Barge

11.3.6 Barge Operation in the Delta for 2020

This sub-section summarizes barge operation methods/system such as lock operation, barge navigation. In the master plan, two significant changes of IWT system are proposed, namely introduction of 24-hours lock operation and enlargement of barge. Above changes and other improvement measures will facilitate drastic modal shift to IWT, combined with institutional support of government initiatives.

- There are two purposes of this sub-section, first one is summarizes barge operation when new wider barges move in opposite directions and pass each other.
- Second purpose is to estimate lock capacity and canal capacity to increase in future traffic for 2020. As well known, IWs capacity depends on lock's capacity, and the master plan reaches same conclusion.

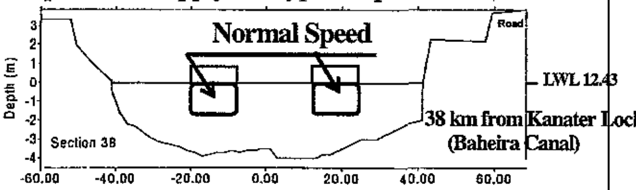
(1) Barge Operation

The master plan proposes the following operation of barges which aims at securing smooth and safe navigation when wider barge is introduced in the Delta Area (see Figure 11.3.14 below).

Figure 11.3.14 Barge Operation in 2020

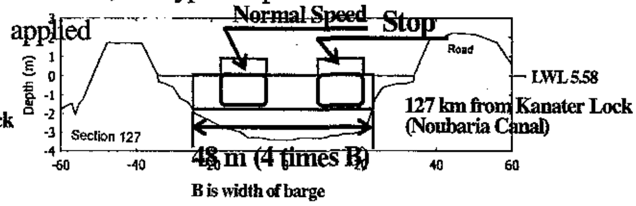
- The barges moving in opposite directions can pass each other at normal speed.

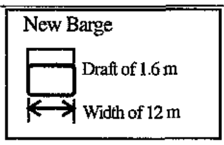
#In the full length of Baheira Canal, it is possible to apply this type of operation.



- When barges moving in opposite directions encounter each other, one barge should slow-down and stop, the other can navigate at normal speed

#In Noubaria Canal between Boulin and Janakless, this type of operation can be applied



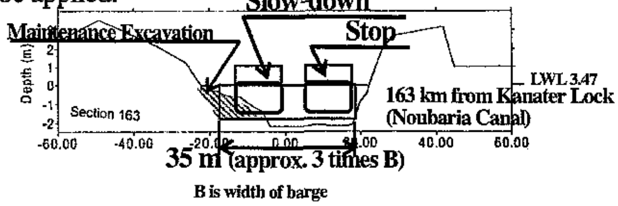


Note : the following cross-sections in Alex./Cairo IW are based on JICA's sounding survey in 2002.

- When barges moving in opposite directions encounter each other, one barge should slow-down and stop, the other can navigate at a reduced speed.

#In Noubaria Canal between Janakless to Alex., this type of operation will be applied for new wider barges.

#In Damietta Branch, this type of operation will also be applied.



Needless to say, proposed barge operation is considered taking account of the following aspects:

- To minimize dredging volume for canal widening
- To reduce adverse effect on bank erosion

According to the above-mentioned operations, IW capacities are likely to decrease due to stop or slow-down of barges. Therefore, capacities of canal are examined in later section.
Moreover, barge operation at Boulin area will be separately considered because barge traffic will be complicated at the crossing of Alexandria/Cairo IW and a new Bolin Canal.

(2) Capacity of Locks

There are 11 locks in the two major IWs. The capacities of IWs are practically determined by longest operational cycle-time among all locks.

Operational cycle time of lock mainly depends on needed time for water-filling/discharge into /from lock chamber.

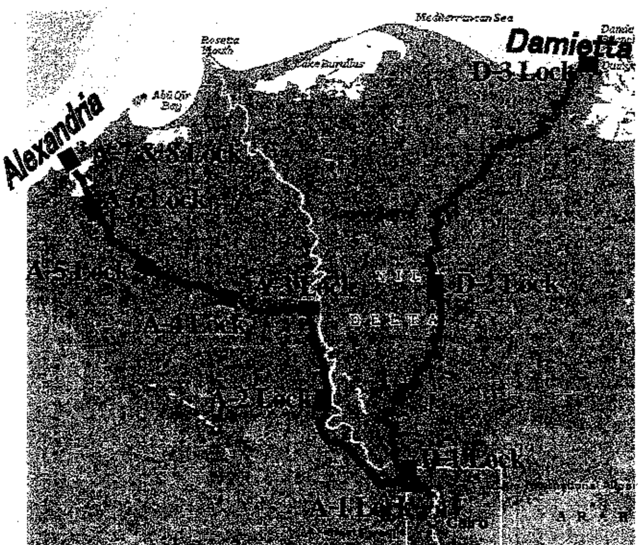


Figure 11.3.15 Location map of Locks

- ➢ The locks with the longest cycle-time are shown in Table 11.3.13 below.
- ➢ Capacities of Alex./Cairo IW, and Damietta/ Cairo IW are estimated at 32 units and 36 units per day, respectively (see Table 11.3.13 below).

  Here, it is assumed that operations of water-filling/discharge will be improved by introduction of mechanical system such as pumping system.

Table 11.3.13 Capacities of Lock

	Alex/Cairo IW	Damietta/Cairo IW
Lock with the longest cycle-time	A-6 Lock, Cycle time will be 0.75 hour	D-1 Lock, Cycle time will be 0.67 hour
Lock Capacity	32 twin-units per day	36 twin-units per day

Note: Cycle-time includes open/close time of gates, water-filling/discharge time, and enter/leave time of twin-units.
Twin-units with beam of 12 m are assumed to be the new-type barges

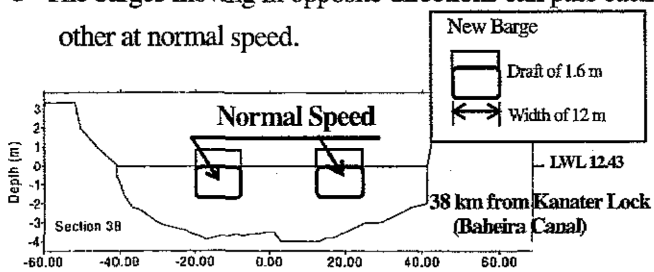
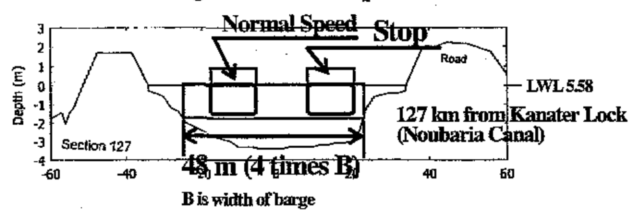
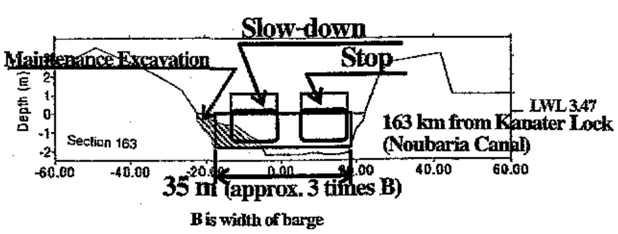
As for lock capacity, details are described in Appendix-11.6.

(3) Capacity of Canal

In the case of two-way operation, capacity of canal will be generally unrestricted with sufficient width. However, it is often necessary for barges moving in opposite directions to stop or slow down when passing each other. Under such conditions with narrower stretch, IW capacities are likely to decrease.

- Capacities of IWs are indicated as follows: Alex./Cairo IW has the capacity of **210 units per day** and the capacity of Damietta/Cairo IW is estimated at **160 units per day,** respectively (see Table 11.3.5.14 for Alex./Cairo IW).
- Meanwhile, when modal-shift is realized, it is **forecasted that a max. of 32 units** will navigate Alex./Cairo IW and **a max. of 13 units** will pass through Damietta/Cairo IW. Here, a maximum number of units is computed in consideration of some congestion due to seasonal or daily fluctuations of barge traffic (see Appendix-11.6 for detail).
- Therefore, in terms of canals' navigation, traffic capacity can sufficiently meet increase in the traffic of barges for 2020. However, capacities of Egyptian IWT will be restricted by lock operation as shown in above-shown Table 11.3.13.

Table 11.3.14 Capacities of Canals and Barge Operation

<table>
<tr><th></th><th>Type of Two-Way Operation</th><th>Capacity of Traffic Volume</th></tr>
<tr><td>Full Two-Way Operation</td><td>The barges moving in opposite directions can pass each other at normal speed.

</td><td># In the full length of Beheiry Canal (A-1 to A-3 lock), it is possible to apply this type of operation.
Capacity of barge traffic is almost unrestricted (768 units per day).</td></tr>
<tr><td rowspan="2">Semi Two-Way Operation</td><td>When barges moving in opposite directions encounter each other, one barge should slow-down and stop, the other can navigate at normal speed

</td><td># In Nobaria Canal between Bolin (A-3) and Janakless (A-5), this type of operation can be applied
Capacity is estimated at about 430 units per day.
Minor maintenance works are required such as excavations.</td></tr>
<tr><td>When barges moving in opposite directions encounter each other, one barge should slow-down and stop, the other can navigate at a reduced speed.

</td><td># In Nobaria Canal between Janakless (A-5) to Alex.(A-7&8), this type of operation will be applied for new wider barges.
Capacity is estimated at about 210 units per day.
Some maintenance works are required such as excavations.</td></tr>
</table>

Note : above cross-sections in Alex./Cairo IW are based on JICA's sounding survey in 2002.

11.4 Improvements of Managerial and Operational System of IWT

11.4.1 General

To promote IWT it is essential that the managerial and operational system should be improved. Egyptian Government policy places great emphasis on environmental preservation and energy conservation. In the process of improving the IWT system, environmental issues need to be taken into consideration.

Study Team approaches these matters from the following aspects.

- Government's inducement measures on promotion of Modal-shift
- Government's program to tackle environmental issue
- Responsibility of public Sector
- Enhancement of Market Principle

11.4.2 Inducement Measures on IWT to be introduced by the Government

(1) Government initiatives to promote Modal-Shift

1) Establishment of Soft-Loan program to support IWT

Barge transport will be facilitated by private investment. Therefore, it will be important to enhance the incentives for the investment in barge transport as much as possible.

What the study team proposes as one of the effective measures for this is the establishment of a fund to provide low interest loans to private barge operators willing to build new barges. For that purpose it is recommended that MOT set up "IWT Promotion Fund".

This requires a considerable sum of money at the beginning. However, loans provided from the fund will be repaid by borrowers in the long run, and the fund can be continuously operated.

It might also be possible to obtain funding from overseas countries or international aid agencies.

2) A similar example in Japan

In Japan we have a similar scheme to support operators for building ships. The Corporation for Advanced Transport and Technology (CATT), which was established by the Japanese Government, the CATT participates in join construction project for shipbuilding. The CATT and operator jointly place shipbuilding orders with shipyards, sharing the cost. Upon completion, the ships are placed under the joint ownership of CATT and the operator concerned and are operated by the latter. The cost borne by the CATT is redeemed by the operator throughout the period of joint ownership (usually, the life of the ship)

Scheme

In case of building barges the period of joint ownership is 12years and the rate of repayment is 1.90% per a year.

The relationship between CATT and the operator is depicted in the following Figure 11.4.1.

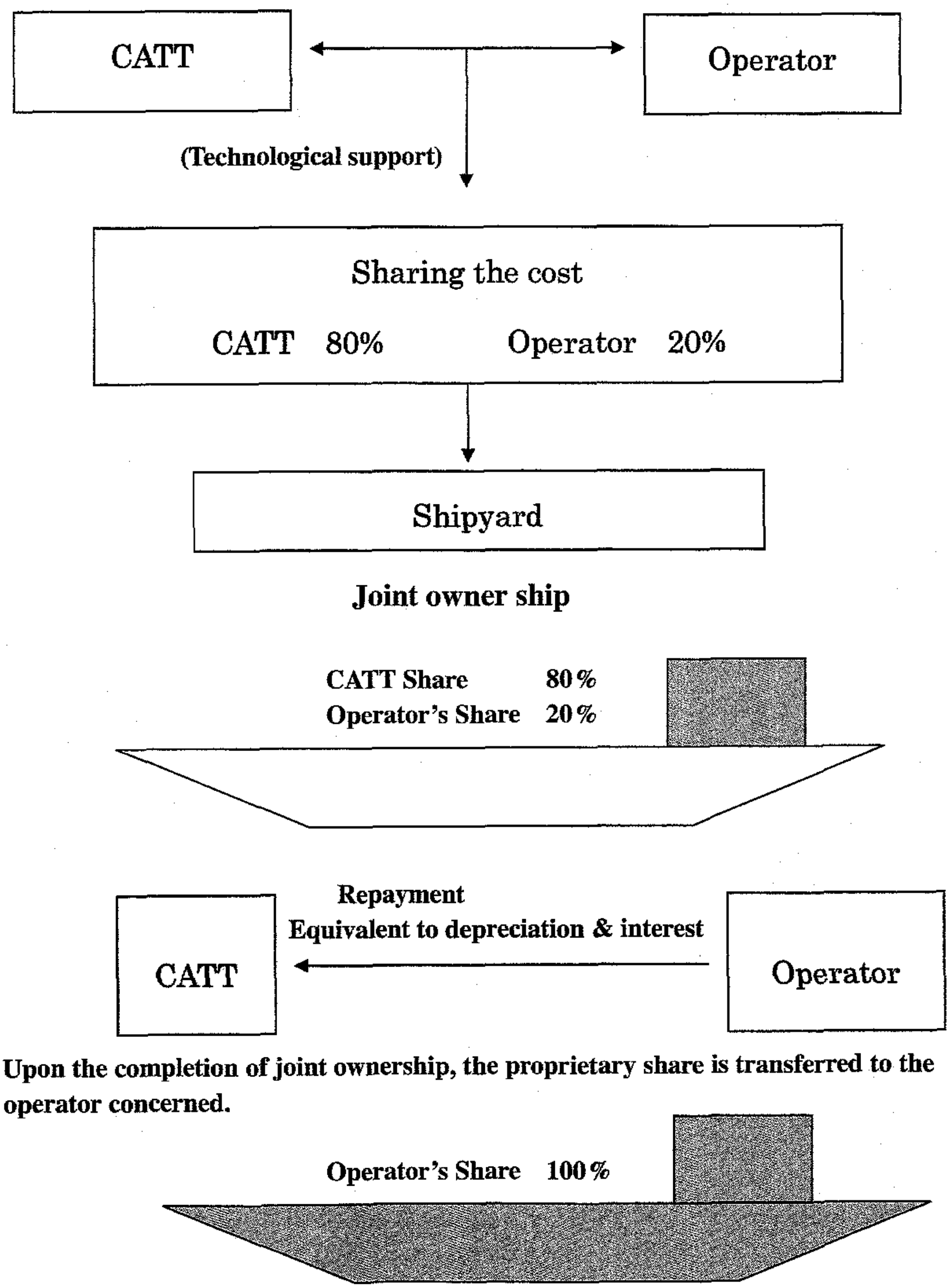


Figure 11.4.1 Japanese Scheme of Financial Assistance to Shipbuilding

Merits of the joint construction scheme

1 When the CATT and an operator jointly share the cost of building a ship, the completed ship is jointly registered, hence the operator does not need security.

2 Experts in the CATT extend technological assistance for designing ships, supervising construction work, and inspecting and maintaining service after completion. They provide guidance for the enhancement of ship safety and modernization.

In the above-mentioned scheme, it is easy for private companies, especially new comers, to join this business.

3) A tentative plan in Egypt

Egyptian government will set up "IWT Promotion Fund" in RTA for introduction of new barges.

For example, in line with the new barge system proposed in the Master Plan, we estimate that is about 44 new barges will be required. (19 container barges, 25 bulk barges). Assuming that the construction cost for new container barge is 3 million LE per one unit and the cost of a new bulk barge is 1.7 million LE, total cost reaches about 100 million LE. And assuming that the private sector will raise half of the required fund, the remaining 50%, or 50 million LE, should be covered by the "IWT Promotion Fund".

A) Governmental investment

Government investment for the Fund will be provided through RTA to operators. The initial government investment could be spread across three years to lighten the financial burden.

Taking the number of required barges (container barges) into consideration, the provisional investment plan would be as follows:

Year	Governmental investments
2010	20 million LE
2011	15 million LE
2012	15 million LE

(In case all facilities will be completed in 2011)

B) Period of Loan

24 years (Equivalent to depreciation period for barges)

C) Rate of the loan

6% (Equivalent to Easy-Loan in Egypt)

D) Scheme

RTA participates in joint barge construction projects through the Fund in order to promote IWT. RTA and operators jointly place shipbuilding orders with shipyards, sharing the cost 50:50. Upon completion, the barges are placed under the joint ownership of the RTA and the operator concerned and are operated by the latter. The cost borne by RTA is redeemed by the operator throughout the period of joint ownership and the fund can be continuously operated.

(2) Government program to tackle environmental issues

According to the latest Study of MOT, the fuel consumption in road transport is about three times more than that by river transport, and regarding the capital cost, the one pound productivity in IWT case is four times more than the one pound productivity in the road transport. Furthermore IWT is not only an environmental mode of transport, it also comes at a lower social cost in terms of "accidents" and preserving the environment. To further protect the environment, the government should take countermeasures to control the increasing number of vehicles. For example the government could strengthen the current system as follows;

- Inspecting automobiles
- Certification system for garages for automobiles
- Regulations against overloading of trucks
- Prohibition of transport of dangerous cargo

Furthermore the government could introduce an environmental protection tax in future.

(Tax levied on motor fuel sales, carbon and sulfur emission and so on)

11.4.3 Role-sharing between Public and Private Sectors

(1) Responsibility of Public Sector

The responsibility of the public sector is to consider development infrastructures from a national perspective and provide the private sector with a sound competitive environment without excessive interventions which are detrimental to fair competition.

Furthermore the study team would like to propose that a kind of committee composed of related government agencies be established to coordinate matters regarding the use of water resources of the Nile River. It is considered reasonable to put priority of water distribution on irrigation or food production. However, from the point of view of IWT, if water distribution to IW was decreased to the extent that navigable water depth could not be maintained, IWT would be completely suspended. Since this will be the same also for sightseeing cruises, it is vital to set up a committee to discuss and pursue the optimum use of the water resources.

This committee should include the following members;

- RTA (River Transport Authority)
- MOT (Ministry of Transport)
- MWRI (Ministry of Water Resources and Irrigation)
- NWRC (National Water Research Center)
- NRI (Nile Research Institute)
- Ministry of Tourism

Main functions of this committee should be as follows

- Adjustment for issues from water level setting of river and canal
- Adjustment for issues from river and canal maintenance and construction works
- Supervision of IWT activities

And it is essential that the committee is given the authority to adjust issues by the Presidential Decree.

(2) Enhancement of Market Principal

a) Quick privatization of General Nile River Transport Company

At present, General Nile River Transport Company handles to two-thirds of all cargo transported by inland waterways. The company currently owned by the State, is now preparing to be completely privatized. As it is, they have made efforts to be attractive for investors by reducing the number of personal and clearing off idle facilities. By means of this state company's privatization, IWT markets will be more competitive. This is very useful for the sound development of IWT markets.

b) Promotion of Market Principal

Following economic reforms, MOT has coordinated less strict competition between the three transport means to organize the transporting of the important transported cargos as the ration commodities, fertilizers and the petroleum materials. Government has given subsidies to three transport modes respectively. But this policy might be changed to trigger competition in the market.

To put it concretely subsidies to the transport sector should be reconsidered to promote fair competition among three transport modes (IW, railway, road).

Each transport mode would thus have to offer should provide better services at lower prices for customers to successfully compete with other modes.

As the method of competition it would be useful for operator to set cheaper freight and give advantages for big clients.

In addition to fostering a competitive environment, licenses for transportation, stevedoring, warehousing as well as combined licenses should be issued to interested private companies. This will make it easier for new comers to participate in IWT businesses.

(3) Strengthening IWT Business

To date, the importance of studying the transport market, and the role of marketing has been ignored. Moreover IWT has failed to meet the needs of customers, and as a result the volume of cargo transported by IWT has gradually been decreasing. Naturally the financial state of IWT business has been adversely affected.

IWT business needs strong organized framework to attract more cargos to this sector. At present there is no IWT association established.

It is necessary that a nationwide association to strengthen IWT business in future.

Main functions of this association would be as follows;

- Adjustment issues of IWT operators
- Marketing of IWT market
- Appealing to Government
- Lobbing for IWT promotion
- PR activity for IWT

And it is important for IWT business to secure highly qualified workers to make preparations for 24-hour operation of IWT. In this respect, the conditions of barge crew should be improved. For example, it is necessary to introduce attractive salary systems, increase the level of comfort on barges and provide substantial trainings in order to attract the best workers.

11.4.4 Management & Repair for Inland Waterway Infrastructure

(1) General

Future container cargo service into inland waterway transport by new barge or new introduction of day & night operation may require suitable and upgraded cargo transport system operation, otherwise future potential cargo may shift to other transport modes. When inland waterway transport should offer better or improved performance of operation through the proposed improvements on inland waterway system, the sector may acquire the increased amount of cargo in future and the management and operation by the sectors on infrastructure of inland waterway would become of paramount importance for safe, reliable and effective operation. Such new task as container cargo transport, 24 hours operation or newly renovated full scale river port operation would decisively lead to needs in reorganization and improved performance of the sector in order to cope with the likely competition among inland transport modes in terms of such services as door-to-door, better price, fast and regular delivery without delay, etc.

The likely lack of well functioned organization and properly coordinated system will impose critical constraints for further development of the sectors. The proposed improvements on infrastructures and barge transport operations of inland waterway will definitely require adequate well-trained and experienced personnel, management and organizational structures to function properly and effectively among the sector's participants, inland waterway transport barge companies, in particular.

Besides, the improved performance may require an adoption of cost consciousness for more effective and productive operation in management and operation, which is expected to be exercised through the organizational structure of RTA and the inland waterway transport companies as well. In longer term basis, the sector's organizational structure, personnel and training requirements may be prerequisites for upgrading performance of operation as a basis for further expansion of the sector's transport activities. Therefore, the sector's personnel should be fully trained to perform improved role and assignment to cope with changing conditions of cargo transport through business minded exertion. A lack of well-trained personnel sometimes prevents RTA and the water transport companies from executing their tasks properly and effectively.

Furthermore, it would be better to specially emphasis that inland waterway transport can only increase its share and performance among other transport systems if it could offer their clients reliable transport services. Suitable barges should be made available at the right moment and reasonable transport time and cost should be guaranteed in an effective way of barge transport operation. In case when the inland waterway transport has to be followed by delivery on trucks, the transport companies should be able to offer and control the whole transport chain from loading, water transport, unloading, temporary storage at a certain river port to final delivery by door-to-door services. In this point of view, private inland water transport companies should realize such integrated water transport services for their clients together with necessary administrative procedures. In cases when final delivery by road or railway is required, local truck operators or national railway company should be made available for effective inland transport connection.

(2) Basic Considerations and Objectives

1) Role of RTA for Maintenance and Repair

As the Egyptian waterway network is primarily an irrigation system, MWRI is at first responsible for operation and maintenance of the waterways and locks as well as for the regulation of water discharges and the corresponding water levels. RTA for overall planning & execution of inland waterway transport is responsible for management and repair of infrastructure and other facilities which are particularly relevant with inland waterway transport activities, such as:

- navigation lock in Beheiry-Nobaria canal,
- dredging and bank protection in navigable canals,
- navigation aids,
- public river ports, and
- development and improvement of inland transport waterways

2) Dredging along the Upper River Nile Waterway

The JICA Study Team carried out cross section survey at 30 locations at Upper River Nile between Cairo and Asyut during the 1st Field Study in Egypt. The result of the survey shows that some parts of each surveyed location are insufficient in water depth for navigation due to the delayed maintenance in past years and be needed to receive considerable extent of maintenance dredging.

As River Nile is considerably wide enough for navigation, the navigational conditions will have to be improved in structural way to provide a safe and desirably stable fairway with a water depth of 2.3 m to 2.5 m for permissible draft 1.8 m during whole year. This requires an extensive dredging and maintenance in full consideration in hydrological aspects. It can be only be realized through full understandings of the nature of River Nile water flow regime, for which a series of hydrological studies may be recommended to be carried out to investigate how a fairway of 2.3 – 2.5 m depth and about 100m width can be maintained as stable as possible for years. But, more or less, recurrent dredging and provision of navigation aids supported by a regular sounding program, can provide realistic solutions to maintain safe and easy navigation for barge transportation.

3) Dredging in the Nile Delta Canals

According to the cross section survey along Beheiry and Nobaria Canal done by JICA Study Team, the downstream portion of Nobaria Canal, i.e. the portion from the middle section between Janaklis and Nahda locks down to the lake of Maryut, indicates a continuous shortage of water depth along the waterway for navigation due to insufficient supply of water discharge from the upstream of canal or River Nile. Besides, some parts of up- and down-stream of each lock are also revealed the need of spot dredging due to riverbed sedimentation or unevenness of bed level.

Minimum water depth and channel width required for navigation is determined in consideration of safe and easy navigation for standard type of barge during whole year. Since a certain extent of siltation of canals and changes in riverbed are natural processes that could not easily be eliminated, the execution of recurrent dredging will be one of prime tasks to be carried out by RTA. But, in medium or long term basis, all efforts should be exerted for guarantee to a permissible draft of 1.6 or favorably 1.8 m throughout the year corresponding with an available water depth of at least 1.8 m along the whole waterways for the year except for closure period by irrigation works.

However, unlike the River Nile which is considerably wide enough to allow a continuous and full scale of dredging along the River flow without essential reduction of water level, it should be kept in mind that the whole cross sectional dredging along Beheiry/Nobaria canal, of which width is nearly in the same order as one for the required fairway channel, inevitably results in the water level reduction of the canal section with no or only a minor increase in the desired water depth for navigation afterwards. Therefore, extensive capital dredging should be succeeded with hydraulic studies with closely measured and well monitored pilot dredging in a certain reach of the waterway, otherwise the results of such dredging might well fail behind the expectations.

4) Establishment of Maintenance and Repair Program

As the number of mechanical and electrical equipment owned by RTA is likely to increase in future owing to the increased transport cargo, there will be a growing strong need for a maintenance and repair department in technical sector of RTA. It should consist of deployment of experienced engineers, trained technicians and their supporting staffs who can do the following tasks and activities, such as:

- regular inspection, preventive maintenance and simple repair works on locks,
- recurrent sounding, survey and inspection of waterway, removal of obstacles, maintenance dredging and navigation lights, buoys, cranes, service vessels and other equipment,
- maintenance and repair of civil facilities

In line with increasing demand in future, RTA should reinforce and establish such a maintenance and repair unit of group within the organization to carry out preventive and small scale of maintenance & repair work by itself. This unit should also be supported with the required equipment and personnel such as skilled technicians and other work forces. At present, although RTA has a well equipped sounding boat, etc., the capability of the equipment are not fully utilized.

5) Needs for Training Personnel

There is an apparent need for training some group of personnel for upgraded performance of maintenance activities in future. At present, RTA may suffer from lacking technicians who can repair and maintain its locks, equipment and service vessels. As a result, even simple repairs have to be unnecessarily delayed till being carried out by contractors or maintenance and repair works is neglected.

(3) Strategic Plan for Maintenance & Repair

1) Reinforcement of RTA Technical Division & Technical Personnel

The organization structure should be subjected to adjustment in emphasizing importance of maintenance and repair for navigation waterway, lock and other facilities. Also, the number of skill personnel should be reallocated properly to obtain a proper level of services for market expectation in continuous and higher level of transport through inland waterway.

Presently, RTA technical personnel are fully developed and amply sufficient to cope with present level of task requirements, but it is observed that the sector is required to attract the following types of personnel who are essential and most importance for upgrading future performance in possible new tasks and activities in management and repair of inland waterway infrastructure:

- skilled technicians to operate for day-and night, maintain and repair locks supported by proper use of RTA's equipment (lock gate equipment, cranes, dredger),
- experienced engineers or its supporting staffs to inspect, survey & study, design and supervise such civil related works,
- technical personnel who carry out such waterway management as recurrent sounding and survey works, schedule planning of maintenance dredging and removal of obstacles, and systematic implementation of navigational aids facilities, and
- Staff personnel for administration & management of newly developed river port at Cairo.

2) Execution Plan for Maintenance & Repair

The inland waterway needs to continuously maintain such infrastructure of waterway as navigable fairway, locks, river ports and other related facilities. Therefore, in view of the above basic considerations and objectives, a maintenance & repair program for inland waterway should be formulated aiming at the following major pattern of maintenance dredging and repair works:

(Navigable Waterway)

1) Relatively larger scale of dredging along River Nile to be carried out for periodical maintenance on middle term basis
2) Middle scale of dredging along channel locating in Maryut Lake to be carried out for periodical maintenance on middle term basis
3) Small scale of spot dredging at each lock or up- and downstream of the lock where there is a tendency of ease waterbed materials deposition due to presence of lock or to irregularly scour waterbed to form unevenness of bed surface
4) Small scale of leveling unevenness of channel bottom or spot dredging of high bottom levels for predetermined minimum water depth requirement particular in the stretches

where the water depth shows shallower than the requirement for the whole years due to lack of water supply in Nobaria Canal downstream (north) from midway between Janaklis and Nahda Lock

(Civil and ME Facilities)

1) Regular preventive maintenance program should be introduced and implemented based on defined maintenance and repair scheme supported by manning and equipment utilization framework.
2) Middle scale of maintenance, overhaul of lock or ME equipment should be carried out periodically based on inspection report for maintenance and repair in annual basis
3) Small scale of maintenance and repair should be executed by RTA for cleaning lock chamber, gate niches, repair gate and gate operation system.

3) Close Coordination with MWRI

MWRI is responsible for maintenance of waterway for irrigation purpose and the supervision of dredging or some of construction works in navigable waterways is presently executed by RTA in cooperation with MWRI. Therefore, a close coordination between RTA and MWRI will be mandatory in programming maintenance dredging scheme and its implementation for effective and proper maintenance of the waterway in view of both for irrigation and barge navigation.

4) Share of RTA Role & Subletting of Full Scale of Works

Navigation Projects Section in RTA's Civil Engineering Department is responsible for providing and maintaining navigable waterway in sufficient water depth and width, which includes survey works, dredging, provision of navigation aids. But, in view of skill and work experience of RTA personnel, the role of RTA for maintenance dredging should be clearly concentrated in small scale of or simple spot maintenance dredging, for which the organization and staff personnel should be reinforced to effectively carry out regular inspection, monitoring and minor or small scale of maintenance dredging.

As regard maintenance & repair works for locks and equipment, all the efforts of RTA mechanical and electrical staffs should be exerted to small scale of maintenance and repair on daily or regular basis.

RTA should provide necessary inspection and monitoring of inland waterway and its infrastructure to maintain sufficient navigability and should usually prepare dredging, maintenance or repair scheme based on inspection of facilities or monitoring on hydrographic features of waterway and usability of equipment. RTA carries out design and execution of only small and simple scale of maintenance and repair works and, except for minor scale of maintenance and repair, a full scale of such works as maintenance dredging or overhaul repair should be done by outside qualified contractor under subletting these works to be done effectively and timely without any delay. RTA should concentrate its efforts in design, preparation of tender documents and supervision of maintenance dredging and repair works for subletting such works.

5) Needs for Training Technical Personnel

In order to cope with necessary regular maintenance and repair of existing facilities, Maintenance Section should be reinforced in view of work force required to carried out regular inspection, periodic monitoring including surveying and minor scale of maintenance dredging and repair works. In particular, in order to improve water depth by regular maintenance dredging on the basis of regular surveys and sounding, particularly lock maintenance including immediate up- and down-stream of lock, RTA should be provided with well skilled and trained group of staff personnel in the technical field of waterway navigation and necessary equipment for swift implementation of maintenance dredging so as to reduce downtime for lock operation while maintenance dredging is done at or near the lock. This group of personnel should also execute proper works to immediately remove obstacles, such as sunken boats. In this respect, it will be appropriate and will be required to provide a regular training program for RTA technical staff aiming acquisition of higher management and efficiency in maintenance and repair works.

(4) Maintenance & Repair Program

All the regular maintenance and repair works should be implemented based on defined work program. As regards maintenance of safe waterway in particular, regular sounding programs should be set up and carried out in bottleneck sections in order to check available water depths to indicate shoals and to prepare relocation of navigation aids and dredging works. Necessary spare parts for normally used equipment and machinery should be kept in sufficient number for periodical breakdown or replacement.

Regular maintenance & repair program may be established under the following scheme of works.

Table 11.4.1 Maintenance and Repair Program For Inland Waterway Infrastructure

Categories	Activities	Frequency	Execution
Maintenance Program	Annual Schedule	Every year	RTA
	Mid-term Schedule	Every 5 years	RTA
Daily Inspection	Sediments in & Around Lock	Daily	RTA
	Obstacles along Waterway	Daily	RTA
	Equipment Operation & Repair	Daily	RTA
Monitoring	Inspection Survey	Immediate	RTA
	Spot Survey and Sounding	Every 3 months	RTA
	Workability of Equipment	Every 3 months	RTA
	Full Scale of Sounding Survey	Every 3 years	Contractor
Preventive Maintenance	Spot Dredging	Periodic by Calendar or Accumulate Operation Hour	RTA
	Leveling of Bottom Level	Periodic by Calendar or Accumulate Operation Hour	RTA
	Complete Drain of Lock Chamber	Every 1 year	RTA
	Full Scale of Dredging	Every 10 years	Contractor
	Overhaul of Lock	Every 5 years	Contractor
Corrective Maintenance	Clean-up of Lock Bottom	Immediate	RTA
	Removal of Obstacles	Immediate	RTA
	Maintenance/Repair below WL	Immediate	RTA

11.5 Economic Analysis on Proposed Projects in Master Plan

11.5.1 Design and Cost Estimate of Projects

(1) Basis of Design and Cost Estimate

Each infrastructure improvement projects, which are envisaged in the master plan for Inland Waterway System for the year 2020, is subject to preliminary design/cost estimate. The proposed improvements in the master plan will comprise of the following components for each inland waterway among Nile Delta network:

Improvement A: Cairo-Alexandria Waterway (Beheiry/Nobaria Canals Route)
- Component 1: Extension of Alexandria Maritime Lock
- Component 2: Dredging and Navigation Aids System along Beheiry/Nobaria Canals from Alexandria to Cairo
- Component 3: Cairo River Port at Ather El Nabi

Improvement B: Damietta Branch Waterway (Damietta Route)

Improvement C: Upper Nile-Kafr El Zayat-Alexandria Waterway
- Component 4: New Connection Canal at Bolin between Beheiry/Nobaria Canals and Rosetta Branch

Based on discussions in previous Sub-Chapter 11.3, preliminary design and cost estimate is done for components 1 to 4 for the above proposed scheme of inland waterway improvements in this study.

1) General Design Criteria for Inland Waterway Transport Facilities

Engineering design criteria will be decisive to specific project requirements that will be envisaged for possible development in the study so that design and cost estimate for projects could be prepared for assessment of the project feasibility. This section will deal with design bases for inland waterway transport facilities, which are generally discussed herein-under based on current situation on inland water transport system as presented in Part I of this report:

(a) Dimensions of River Fleet Convoy

The existing river transport fleet operation is discussed in Sub-Chapter 6.6 of Part I, which shows the following characteristics:

1) Among twin-ship unit, the largest convoy is 102 m long, 7.5m wide and 1.8 m draft. But, the predominant class of fleet convoys are 100 m or less in length with the same width and draft as the above. This fleet convoy is the type of twin-ship consisting of one motor barge pushing one dumb barge, each of which is 50m long, 7.5 m wide and 1.8 m maximum draft.

2) Among others, the frequent used type of barge is self-propelled barge having 40 to 45 m length, 7.3 to 7.5 m width and 1.55 to 1.6 m draft.

In view of current situation of river fleet convoys, it will be appropriate to adopt the above largest convoy for designing future canal facilities since it is mandatory that the inland waterway system be comparable in all regions and the fleet convoys could be exchangeable and mutually supportive each others.

In design works, a due consideration is also paid for possible introduction of new types of barges as proposed for container carrier barge or coastal/river sailing barge. But, it should be understood that the proposed new barge could be developed under the present constraints of existing navigation waterway system based on which new barge should be designed and, therefore, specific criteria for new barges may not be necessary to be incorporated in this engineering study.

(b) Canal Dimensions

The canal width necessary for dominated fleet convoy to sail is dependent upon the bend radius of canal alignment. Basically, the canal in two-way traffic for dominated fleet convoy is required 35 and 2.3 m minimum water depth as required for the 1st class waterway. Minimum vertical clearance under bridge has been fixed as 6 m above maximum water level by Ministerial Decree No. 282/1998.

But, as far as water draft along Nobaria canal is concerned, the waterway having at least 35 m width and 2.0 m water draft is applied to possible dredging works for Improvement A: Beheiry/Nobaria Canal Route in consideration of insufficiency in water draft which is stemmed out from inevitable shortage of water supply to the downstream end of Nobaria canal as discussed in this Chapter.

(c) Lock Dimensions

In order to accommodate largest type of fleet convoy currently used, the proposed dimensions of lock is about 116 m in overall length for providing allowance of opening of a leaf, and miter gate thickness and some margin for both end of convoy, 17 m wide and 2.3 m water depth. The lock proposed herewith as well as the present standard lock chamber (116 m x 16 m) deems capable of accommodating one new type of twin barge unit having wider beam of 12 m, which is proposed in this study. The height of lock chamber should be determined in due consideration of water level variation at up- and down-stream of lock as well as average retaining water level.

2) General Principles for Cost Estimate

(a) Unit Cost Estimate

The related prices of materials, construction machinery and equipment locally available in the country are derived from determination of specific requirements for the envisaged location and the magnitude of the project with due consideration of construction program for possible implementation. Unit costs in terms of currently prevailing costs as of February 2002 are estimated through counterchecking precedents of construction works executed in Egyptian market in recent years. The following major cost components are included in this cost estimate to obtain construction cost:

- Currently prevailing costs of locally available construction materials
- Local costs of fuel and electricity
- Local costs of major civil construction work
- Present level of salaries and wages for manpower costs

(b) Importation of Material and Equipment

For river port construction or other projects related to inland waterway, ordinary construction materials, equipment or machinery could be procured in Egyptian market. But, such specific equipment as mobile cranes, navigation aids, gate opening mechanics etc. is cost component to be imported from outside manufacturing countries.

(c) Engineering Service for Project Implementation

In common infrastructure projects, engineering services will be required to carry out detailed design of proposed facilities, preparation of tender documents and construction supervision. RTA under MOT, in principal, undertakes engineering services necessary for repair and maintenance of their own facilities and minor construction projects as well. But, in case of the project that requires professional technique or judgment on structural design, method of execution, construction cost estimate or tender and construction supervision, fully experienced professional consultants may be employed for proper execution of project.

(d) Exchange Rate of Currencies

Exchange rate of Egyptian Pound (L.E.) against US dollars (US$) was devaluated in the last year and the current exchange rate of L.E.4.6 against US$ as of the year 2002 is used for cost estimate. The project cost is expressed in Egyptian pound (L.E.) for foreign currency portion and local currency portion and the total amount of project cost will be also expressed in L.E. in this cost estimate.

(2) Design of Each Component

1) Component 1: Extension of Alexandria Maritime Lock

Small Maleh lock should be extended offshore for about 60m to provide sufficient lock chamber length in order for barges to pass this lock with keeping sufficient vertical air clearance. New lock chamber is capable of accommodating two units of twin barge of 102m long, 7.5 m wide and 1.8m draft as well as proposed new barge of wider beam. Possible extension of small Maleh lock will be designed under the following design criteria:

Objective Barge:	Present Twin Barge Unit
Water Level at Beheiry Canal:	HHWL+0.48m
	HWL+2.90
	MWL +0.00m
	LWL+0.27m
Water Level at Lake Maryut Side:	MWL-2.50m
Navigation Lock:	One number of Lock Chamber
Length of Lock Chamber:	116 m
Width of Lock Chamber:	16m (= present width)
Retaining Water Level:	Maximum 2.98m, Average 2.5m
Minimum Water Depth at Lock Chamber:	2.3 m
Vertical Clearance:	6.0 m above water level

2) Component 2: Dredging and Navigation Aids from Cairo to Alexandria

(a) Canal Dimensions to be dredged

The cross section survey conducted by the Study Team at 1 km interval along Beheiry/Nobaria canal indicate many shallow spots in Nobaria Canal at Sector 5 (139 km to 178 km between Janaklis and Nahda locks) and Section 6 (179 km to 200 km between Nahda and Alexandria end locks) during low water season. Therefore, as discussed in 11.3.2, a dredging work for obtaining navigable way of 35 m wide and 1.8 water draft is required for proposed Improvement.

In order to provide sufficient keel clearance, it is recommended to dredge the waterway to have water depth of 2.0 m with necessary side slope of 1:2 though there is an argument on possible no increase or only small increase in the desired water depth for navigation after execution of dredging. At canal section where side slope of 1:2 is not possible to suitably provide for deepening dredging due to constraint of available canal sectional width, it is recommended to provide such section of waterway with bank protection in line with dredging work.

Based on cross sectional profiles obtained at 1 km interval along Beheiry/Nobaria canal by Study Team, capital dredging volume required for inland waterway improvement is roughly estimated as presented in Appendix 13-1. The likely volume of capital dredging for a case of navigable waterway having 2 m water depth and 35 m width to allow permissible draft of 1.6 m at minimum water level is estimated 355 thousands m3.

(b) Maintenance Dredging

Beheiry/Nobaria Canals are deeper than normally required for navigation except for certain distance along up- and down-stream Nahda locks where the extent of capital dredging is estimated as above. Some extent of maintenance dredging including those at lock approaches will be necessary to be carried out under recurrent basis by years. In estimating the required volume of maintenance dredging for Beheiry/Nobaria Canals, the following assumptions will be considered:

- The volume of capital dredging herein estimated (V=355,410 m3) would have been stemmed out from the delay of required maintenance dredging which should have been executed in past 10 years.
- The necessity of maintenance dredging along the canal will be likely caused by certain extent of bank erosion. Therefore, once the bank protection shall be provided, the canal section will no more require any maintenance dredging along the sides of canal section afterward owing to provision of bank provision.
- The estimation of the above capital dredging indicates that the bank of the canal where capital dredging is required is 58 sections (58 x 2 =116 km each bank length) and the bank section of canal where the bank protection is scheduled to provide is 21 numbers per each side of canal bank (21 x 1=21 km bank length). Therefore, among the canal bank where the bank erosion likely occur, the side bank of 21 km length will be no more eroded in future owing to presence of side bank protection.

Based on these assumptions, annual amount of maintenance dredging will be roughly estimated to be 355,410 x 1/10 x (116-21)/116 = 29,107 m3/year. This maintenance dredging will be reflected into the OM cost used for project evaluation.

(c) Navigation Aids

The requirements for navigational aids for day and night operation are discussed in 11.3.

3) Component 3: River Port at Ather El Nabi

(a) Quay

The details on possible development plan for river port at Ather El Nabi are presented in the report on "Cairo Container Terminal: Review and Updating of Existing Feasibility Study" prepared and drafted by SWECO International in September 1999. The evaluation of the study report indicates that existing quay deck of 13 cm thick has to be reinforced for possible quayside cargo handling operation by mobile cranes in the scheme of newly proposed river port for container and general cargo handling.

Therefore, the likely stacking cargo in layers on existing quay should be restricted in the proposed river port operation in consideration of the above restraint in load capacity of existing quay structure. Besides, new river port development at Ather El Nabi needs a provision of possible reinforcement and rehabilitation for existing quay (310m plus 150 m) together with construction of new quay (230m long) for handling container and general cargoes based on study on berth requirements given in Appendix.

(b) Other Conditions

It is recommended that design water depth at Branch Canal should be 2.3 m which is measured from minimum water level (+15.04 m) and therefore capital dredging be carried out to the level of +15.04 – 2.3 = +12.7m in order for present barge convoy to be accessible during the whole year.

4) Component 4: New Connection Canal

The existing spillway has to be deepened and widened for new connection canal to have a standard dimensions for the 1st class waterway. A navigation lock has to be provided to adjust water level difference between Beheiry/Nobaria canals and Rosetta Branch, which is estimated 6.5m water head. In due consideration of canal requirements for the 1st class navigation waterway, the following design criteria for new connection canal is recommended in this study.

(Navigational Channel) to be equipped with navigation lock and barrage
Channel Width: 35 m at the bottom of waterway
Minimum Water Depth: 2.3 m under Minimum WL
Barrage: water discharge through regulator: Max. 50.4 m3/s, Average 30 m3/s
Bank Protection: 1 to 1 slope with proper slope surface protection
Vertical Clearance: 6.0 m above Maximum WL

(Lock) to be capable to accommodate present twin barge unit
Length of Lock Chamber: 116m
Width of Lock Chamber: 17m
Retaining Water Level: Max.7.35m, Average 6.5m
Minimum Water Depth at lock Chamber: 2.3 m

Maintenance dredging will not be required along new connection canal at Bolin since widening and deepening of canal is constructed with a provision of bank protection except for the likely occurrence of minor deposit at canal bottom for the portion of approach to lock head. But, maintenance dredging will be definitely required for newly dredged fairway along Rosetta Branch due to such change of waterway as meandering of river flow pass.

The Study Team estimate that the likely annual volume of 3 % of the capital dredging will be in necessity to maintain fairway in designated width and depth and, therefore, an annual spending of 173 thousand L.E. (for dredging 21,600 m3 annual) will be considered for maintenance dredging along Rosetta Branch.

(3) Preliminary Cost Estimate

1) General Considerations

Project cost for constructing infrastructures includes such cost components as construction cost, procurement of equipment and machinery, engineering service, physical or price contingencies and other costs for project administration, etc. Recent data and survey results related to unit prices of materials, construction costs were obtained through the first field survey in Egypt during December 2001 to March 2002.

The project cost will be broken down into foreign and local currency components in consideration of possible sources for necessary input materials, equipment and work forces.

Preliminary cost estimation for Master Plan is carried out based on preliminary engineering design for proposed facilities, considering construction methods and construction work program, which are scheduled based on site conditions of project or the nature of the project, etc. Besides, the project cost will be estimated to meet requirements for possible finance for the project in line with international standards.

In cost estimate for projects formulated in this study, necessary cost to procure engineering services will be added at a rate of about 2.5% to 10 % against total construction cost or procurement cost of machinery and equipment.

The contingencies for project consist of physical and price contingencies. Amount of Contingency is normally taken at a rate of 10 % of the total cost for construction and 3 % for procurement of equipment.

2) Cost Estimate for Each Component of Proposed Improvement

Component 1: Extension of Existing Alexandria Lock (Small Lock)

Cost: 1,000 L.E.

Item	Description	Unit	Q'ty	Cost	Local/C	Foreign/C
A	Civil Works					
1	Construction & Demolition of Sheet Piled Cofferdam and Dewatering	l.s	1	27,140		
2	Excavation of Seabed and Rocks	l.s	1	1,380		
3	Renovation of Existing Lock Wall	l.s	1	16,560		
4	New Lock for Upper Lock Head	l.s	1	13,800		
5	Bumper Dolphin with Light Beacon	nr	1	380		
	Sub Total of Civil Works			59,260	35,794	23,466
	Engineering Service Cost (= 6 % of Civil Works)			3,556	1,778	1,778
	Contingencies (= 10% of Civil Works & Engineering)			6,281	3,757	2,524
	Total Cost of A			69,097	41,329	27,768
B	ME Equipment for Upper Head	l.s	1	8,000	2,000	6,000
	Engineering Service Cost (= 5 % of ME Cost)			400	160	240
	Contingencies (= 3 % of ME Cost & Engineering)			252	65	187
	Total Cost of B			8,652	2,225	6,427
	Total of Component 1			77,749	43,554	34,195

Component 2: Dredging and Navigation Aids along Cairo-Alexandria Route

Cost: 1,000 L.E.

Item	Description	Unit	Q'ty	Cost	Local/C	Foreign/C
A	Dredging Work					
1	Dredging	cu.m	356,000	8,188		
2	Bank Protection (t=80 cm)	l.m	22,000	20,460		
	Sub Total			28,648	25,579	3,069
	Engineering Service Cost (10 % of Sub Total A)			2,865	1,433	1,432
	Contingencies (10% of Sub Total A and Engineering)			3,151	2,701	450
	Total Cost of A			34,664	29,713	4,951
B	Navigation Aids					
1	Lateral Light Beacon with Solar Battery for the River Nile	nr	80	3,680		
2	Ditto but for Beheiry/Nobaria Canal	nr	400	4,800		
3	Cardinal Mark Lighted Buoy by Solar Battery with Mooring Chain and Sinker	nr	30	360		
4	Traffic Signal Light at Lock (300mm dia.)	nr	14	1,610		
5	Traffic Signal Light at Bridge	nr	210	3,360		
4	Spare Lateral Light Beacon for the Nile River	nr	8	312		
5	Ditto but for Beheiry/Nobaria Canal	nr	40	480		
6	Spare Cardinal Light Buoy without Mooring Chain and Sinker	nr	6	22		
7	Spare Traffic Signal Light at Lock	nr	4	388		
8	Spare Traffic Light at Bridge	nr	12	144		
	Sub Total			15,156	3,031	12,125
	Engineering Service Cost (2.5% of Sub Total B)			379	76	303
	Contingencies (3% of Sub Total B and Engineering)			466	93	373
	Total Cost of B			16,001	3,200	12,801
	Total Cost of Component 2			50,665	32,913	17,752

Component 3: Cairo River Port (Ather El Nabi) Cost: 1,000 L.E.

Item	Description	Unit	Q'ty	Cost	Local/C	Foreign/C
A	Container Terminal (Civil Works)					
A1	Development at RTA Area					
1	Site Clearance	sq.m	55,000	55		
2	Rehabilitation of Existing Quay	lin.m	310	930		
3	Structural Reinforcement of Existing Quay	lin.m	310	11,560		
4	Container Terminal Yard Pavement and Utility Supply	sq.m	55,000	5,500		
A2	Development of South Area					
1	Site Clearance	sq.m	90,000	135		
2	Rehabilitation of Existing Quay	lin.m	35	105		
3	Structural Reinforcement of Existing Quay	lin.m	35	1,305		
4	Container Terminal Yard Pavement and Utility Supply	sq.m	55,000	6,600		
A3	Terminal Buildings, Fence and Gate	l.s	1	2,250		
A4	Dredging Canal	cu.m	115,800	1,390		
A5	Aids to Navigation	l.s	1	200		
A6	Access Road	l.s	1	3,000		
B	General Cargo Terminal (Civil Works)					
1	Site Clearance	sq.m	25,000	38		
2	Rehabilitation of Existing Quay	lin.m	115	345		
3	Structural Reinforcement of Existing Quay	lin.m	115	4,300		
4	New Construction of General Cargo Berth	lin.m	230	18,400		
5	General Cargo Terminal Yard Pavement and Utility Supply	sq.m	25,000	2,000		
6	Buildings, Fence & Gate	l.s	1	1,300		
7	Miscellaneous	l.s	1	1,500		
	Sub Total of Terminal Civil Work (A + B)			60,913	42,630	18.283
	Engineering Service Cost (=8% of Civil Works)			4,873	3,411	1,462
	Contingencies = (10% of Civil Work & Engineering)			6,579	4,604	1,974
	Total Cost			72,364	50,645	21,719
C	Cargo Handling Equipment					
1	Movable Quayside Crane for Container	nr	4	34,480		
2	RTG Container Yard Transfer Crane	nr	11	56,100		
3	Tractor Head	nr	12	5,520		
4	Trailer	nr	12	2,760		
5	Truck Crane for General Cargo Handling	nr	4	12,800		
6	Lift Truck	nr	8	1,840		
	Sub Total of Equipment			113,500	22,700	90,800
	Engineering Service Cost (=2.5 % of Equipment)			2,838	568	2,270
	Contingencies (=3% of Equipment & Engineering)			3,490	698	2,792
	Total Cost			119,828	23,966	95,862
	Total Cost of Component 3			192,192	74,611	117,581

Component 4: New Connection Canal at Bolin and Dredging Rosetta Branch up to Kafr El Zayat

Cost: 1,000L.E.

Item	Description	Unit	Q'ty	Cost	Local/C	Foreign/C
A	New Connection Canal					
1	Excavation for Deepening and Widening Existing Spillway	cu.m	208,000	3,120		
2	Navigation Lock Construction including Island Guard Wall	l.s	1	33,600		
3	Barrage Construction	l.s	1	9,400		
4	Canal Bank Protection	sq.m	25,000	2,500		
5	Mooring Dolphin	nr	4	156		
6	Canal Bridge	l.s	1	1,500		
7	Miscellaneous	l.s	1	400		
B	Dredging along Rosetta Branch	cu.m	720,000	5,760		
	Sub Total of New Canal & Dredging Rosetta Branch (A+B)			56,436	38,158	17,878
	Engineering Service Cost (=8% of Civil Works)			4,515	3,053	1,462
	Contingencies (=10% of Civil Works & Engineering)			6,095	4,121	1,974
	Total Cost			67,046	45,332	21,714
C	Mechanical and Electrical Equipment					
1	ME for Lock	l.s	1	16,000		
2	ME for Barrage	l.s	1	6,000		
	Sub Total of ME Equipment			22,000	5,500	16,500
	Engineering Service Cost (=5% of ME Cost)			1,100	440	660
	Contingencies (=3% of ME Cost & Engineering)			693	178	515
	Total of Cost			23,793	6,118	17,675
	Total Cost of Component 4			90,839	51,450	39,389

11.5.2 Preliminary Economic Analysis

(1) Purposes and Methodology of Economic Analysis

The purpose of this section is to appraise the economic feasibility of the projects proposed by the Master Plan for the development of the inland waterway system in Egypt from the viewpoint of the national economy before conducting a feasibility study of the projects to be proposed by the Short-Term Plan. This section focuses on whether the benefits of the projects exceed those that could be derived from other investment opportunities in Egypt.

In this study, the Economic Internal Rate of Return (EIRR) and the benefit/cost ratio (B/C ratio) based on a cost-benefit analysis is used to appraise the feasibility.

(2) Prerequisites for the Economic Analysis

1) Base Year

Costs and benefits estimated in the economic analysis are expressed in the price as of some fixed year throughout the "Project Life" mentioned below. The year is called as "Base Year". In this analysis, the year 2002 was adopted as the "Base Year" since the costs of the projects were prepared on the bases of current price as of the same year.

2) Project Life

Taking account of the sum of construction period and subsequent operation period relating to the projects, 30 years was adopted as the "Project Life".

3) Foreign Exchange Rate

The exchange rate adopted for this analysis is as follows US$1.00 = LE4.6

4) "With-the-project" Case and "Without-the-project" Case

In the preliminary economic analysis, the two projects, viz. Alexandria-Cairo IWT Project and New Boulin Canal Project.

A cost-benefit analysis was conducted on the difference between the "With-the-project" case in which an investment is made and the "Without-the-project" case in which no investment is made, that is; the benefits and costs arising from the investment for the projects were compared.

a) "With-the-project" Case

In "With-the-project" case, the following investment corresponding to the respective projects will be made:

Alexandria-Cairo IWT Project
- Maritime Lock will be renovated.
- Navigation aids to enable night navigation between Alexandria Port and Ather El Nabi Port will be prepared.
- Dredging and bank protection execution for keeping of the suitable depth and width of channels for the proposed barge types.
- Ather El Nabi Port will be developed so as to enable to provide public port services

New Boulin Canal Project
- New Boulin Canal will be created so as to connect Boulin and Rasheed Branch

In addition to the above investment for the two projects, it was assumed in the analysis that barges specialized for container transport will be built and be in operations by barge operators.

In the "With-the-project" case, the cargo volumes will be allocated into IWT as shown in Tables 10.2.45 – 10.2.47.

b) "Without-the-project" Case
In "Without-the-project" case, no investment will be made for IWT as follows:

- Maritime Lock will not be renovated.
- Navigation aids to enable night navigation between Alexandria Port and Ather El Nabi Port will not be prepared.
- Ather El Nabi Port will remain as it is without any development.
- Dredging and bank protection execution will not be executed.
- Rasheed Branch will be left disconnected with Boulin in IWT.

In the "Without-the-project" case, except for "traditional IWT pattern" such as coal/coke and molasses, the cargo volumes shown in Tables 10.2.45 – 10.2.47 will not be allocated into IWT. Instead, they will be transported by other transport modes, viz. road and railway, as currently they are.

(3) Benefits of the Project

As benefits to be brought about by the projects, the following items are identified:

a) Savings in inland transport costs
b) Reduction of pollution by converting road transport into IWT with less emission

In this study, items from "a)" is considered to be countable in monetary benefits, and were adopted in these cost-benefit analyses. The item "b)" is mentioned qualitatively in this study.

Savings in inland transport costs will be generated from converting road transport or railway transport into IWT with less transport costs to be brought by the investment for the two projects, viz. Alexandria-Cairo IWT Project and New Boulin Canal Project. The respective total benefits by project are obtained by summing up by cargo item and route (see in Tables 11.5.1. and 11.5.2).

Table 11.5.1 Annual Benefits of Alexandria-Cairo IWT Project in 2020

Cargo Item and Route	Modal Shift	Volume	Unit Benefit	Sub Total
		'000 MT, '000 TEU	LE/MT, LE/TEU	'000 LE
Bulk Cargo (Grains) from Alex. Port to Imbaba Port	from Road to IWT	751	12	8,707
Break-bulk Cargo from Alex. Port to Ather El Nabi Port	from Road to IWT	410	6	2,432
Containers between Alex. Port and Ather El Nabi Port (unit in TEUs)	from Road to IWT	147	103	15,101
Total		1,308		26,239

Source: Estimated by the Study Team

Note: The number of containers is expressed in terms of laden containers

Table 11.5.2 Annual Benefits of New Boulin Canal Project in 2020

Cargo Item and Route	Modal Shift	Volume	Unit Benefit	Sub Total
		'000 MT	LE/MT	'000 LE
Raw Phosphate from Sibaya	from Railway to IWT	319	17	5,334
Sulfur imported via Alex Port	from Road to IWT	131	13	1,662
Super Phos. exported via Alex. Port	from Road to IWT	130	10	1,265
Grease imported via Alex. Port	from Road to IWT	30	10	289
Total		611		8,550

Source: Estimated by the Study Team

Note: Benefits are expressed in current price

(4) Costs of the Projects

The initial investment costs for Alexandria-Cairo IWT Project and New Boulin Canal Project are 228.0 and 80.1 in million LE, respectively. In the estimation of EIRR and B/C, management/operations and maintenance costs were considered as well as the initial investment costs.

(5) Results of Preliminary Economic Analysis

1) Calculation of the EIRR

The economic internal rate of return (EIRR) based on a cost-benefit analysis was used to appraise the economic feasibility of the said projects. The EIRR is the discount rate that makes the costs and benefits of a project during the project life equal. The formula is as follows:

$$\sum_{i=1}^{n} \frac{Bi - Ci}{(1+r)^{i-1}} = 0$$

where, n: Period of economic calculation (project life)

i: Year

Bi: Benefits in the i-th year

Ci: Costs in the i-th year

r: Discount rate

The resulting EIRRs of Alexandria-Cairo IWT Project and New Boulin Canal Project are 16.6% and 12.1%, respectively.

2) Calculation of the Benefits-Costs Ratio

Assuming social discount rates of 10%, the respective Benefits-Costs ratios (B/C ratio) of the projects were computed. The resulting B/C ratios of Alexandria-Cairo IWT Project and New Boulin Canal Project are 1.54 and 1.19, respectively.

(6) Evaluation of the Projects

The leading view is that the project is feasible if the EIRR exceeds the opportunity cost of capital. Considering the opportunity cost of capital in each country, it is generally considered that a project with an EIRR of more than 10% is economically justifiable for infrastructure or social service projects. Apart from the precise definition of the opportunity cost in economics, however, it is not easy to practically find the opportunity cost in individual country, and hence, the yield on long-term credit adjusted from current price to real price by using deflator could be referred as substitute for the invisible opportunity cost. Current interest rates on long-term credit in Egypt as of December 2001 are 9% in Treasury Bill for over one year,. On the other hand, the average GDP deflator in the last three years is in the range of 3 - 4%. Thus, the opportunity cost of Egypt could be considered to be at most 6%. From the above, the figure of 10% as the EIRR criterion is considered to be reasonable on the safety side evaluation.

The resulting EIRRs of both projects are 16.6% and 12.1% and exceed the above-mentioned criterion. Thus, both projects are judged economically justifiable.