

Table S.5.2 Possible Alternative Waterway Transportation System

Navigation Route	Trans Shipment		No.	Vessel Type				Construction, Operation and Maintenance Cost		No.
				for Iron Ore Export		for Other Cargo Export				
				Route	Vessel Type	Route	Vessel Type			
Rio Grande Channel	Alternative P	Transfer Vessel	P1	RG-BG-OA	Panamax	RG-BG	Handymax		P1	
			P2		Handymax				P2	
			P3		Small Handy				Small Handy	P3
	Alternative A	Without Transfer Vessel	A1	RG-BG	Handymax	RG-BG	Handymax		A1	
			A2		Panamax				A2	
			A3		Capesize				A3	
	Alternative B	New Port at Boca Grande	B1	RG-BG	Handymax	RG-BG	Handymax		B1	
			B2		Panamax				B2	
			B3		Barge Train				B3	
			B4		Barge Train		Barge Train		B4	
	Combination of Macareo / Rio Grande Channel	Alternative C	Transfer Vessel	C1	RG-BG-OA-MC	Panamax(OT,RT)	RG-BG		Handymax	C1
				C2	MC	Barge Train				C2
C3				Small Handy		C3				
C4				Handymax		C4				
C5				Pamamax		C5				
Alternative D		New Port at Pt. Pescadores	D1	MC	Barge Train	RG-BG	Handymax	D1		
			D2		Small Handy			D2		
			D3		Handymax	MC	Handymax	D3		
			D4		Pamamax			D4		
Macareo Channel										

Legend:

RG: Rio Grande Channel
BG: Boca Grande
MC: Macareo Channel

OA: Ocean Atlantic
OT: Outer-going Transportation
RT: Returnway Transportation

O/M Cost for dredging is calculated as amount of present value for 30 years.

× 1,000,000 in dollars

5.4.3 Future Waterway Transportation System

(1) Iron ore Transportation in Future

The exported iron ore in the region has been declining in the past two decades, and is forecasted to decline further because of Venezuelan policy of is encouraging export oriented steel industries and the introduction of value added industries. In fact, according to the plan of Ferrominera, the forecasted volume of exported iron ore would decline gradually to 4 million tons until 2003 but would remain the same thereafter. The future transportation system based on the forecast cargo volume, taking into consideration the remaining life time of Transfer Vessel and Shuttle Vessels, should be either Alt. P1 or Alt. A2 among the above mentioned alternatives for the following four periods.

Table S.5.3 Future Waterway Transportation System in Orinoco Delta (Target Year 2020)

Transport Cargo	Period	Navigation System	Remarks
Iron Ore	① Period: Present-2003	The navigation route should be along Rio Grande. While existing Transfer Vessel (TV) and two shuttle vessels are still in operation, the existing transportation system with TV should be maintained.	Same as the present transportation system
	② Period: 2003-2007	The navigation route should be along Rio Grande. With retirement of the Transfer Vessel, two existing Shuttle Vessels will be in operation.	The Transfer Vessel will be 30 years old in 2003 and annual maintenance costs including maritime insurance premium will be increasing rapidly. In this period the volume of exported iron ore is estimated at 4 million tons. The decision has to be made whether to maintain the existing transfer system or not, on the basis of both final destinations and their imported volumes.
	③ Period: 2007-2013	The navigation route should be along Rio Grande. With retirement of one shuttle vessel, remaining shuttle vessel will be in operation.	Exporting to the destinations in Europe, one option is that a Panamax size carrier, loading at Puerto Ordaz within the allowance of the depth of the channel, making a direct trip to the final destination. Another is that a Panamax size carrier, partially loading at Puerto Ordaz, and additionally loaded from the Shuttle Vessels at Boca de la Serpiente to full capacity.
	④ Period: After 2013	The navigation route should be along Rio Grande. After 2013, in the time after the retirement of both existing Transfer Vessel and two existing Shuttle Vessels.	It would be desirable that a Panamax size carrier, fully loaded at Puerto Ordaz, makes a direct trip to the final destination. It should be noted that the use of Panamax size carriers makes competitive sense in the world freight market if appropriate final destinations are chosen.

On the other hand there would be other options in exporting to the destinations in Europe. One option is that a Panamax size carrier, loading at Puerto Ordaz within the allowance of the depth of the channel, making a direct trip to the final destination. Another is that a Panamax size carrier, partially loading at Puerto Ordaz, and additionally loaded from the Shuttle Vessels at Boca de la Serpiente to full capacity. In case of the retirement of Transfer Vessel, it would be desirable that two Shuttle Vessels directly transfer the iron ore to Cape size carriers at Boca de la Serpiente if requested to by Cape size carriers. Three Shuttle Vessel trips are sufficient to transfer the volume of iron ore for a Cape size carrier although it would take approximately 10 days for a Cape size carrier to be fully loaded.

(2) Other Cargo Transportation in the Future

Cargoes other than iron ore are forecasted to increase to 22 million tons per year in 2020 from 10 million tons per year at present. The sizes of ships are almost all Small Handy class at present and this will likely remain unchanged up to 2020 according to the investigations on kinds of cargoes. Even if ship sizes are larger than the Small Handy, they would probably be no more than Handymax class because most Panamax size carriers are not equipped with self-loading/unloading systems.

(3) Channel Capacity in relation to the Waterway Transportation

In one view, the channel is an indispensable transportation infrastructure for development for the region and thus it is important to maintain the channel as an access route to America and Europe. The carriers navigating the channel, as mentioned above, would be Panamax size class for transporting the iron ore and up to Handymax size class for transporting other cargoes.

The total annual traffic in each direction of the channel is estimated at more than 1,100 vessels in 2010 and around 1,300 vessels in 2020. The MTC report pointed out that the traffic capacity of the channel was 1,100 vessels per year in each direction, which would be insufficient also in future. When the traffic is foreseen to exceed 1,100 vessels, it would be desirable to introduce a convoy system and the crossing zone as necessary.

(4) Pilot and Traffic Control

In addition to an increase in pilots to accommodate growing future traffic, it would be desirable to introduce the vessel traffic management system (VTMS), so as to easily identify the positions of all vessels within the Canal and their movement control. The vessel traffic management system (VTMS) consists of control center, stations and buoys (refer to Supporting Report).

There is a project proposed by INC for introducing a GPS assisted navigational aid at a modest operational cost. In the long run, these efforts and costs will be compensated by the possible reduction in maritime insurance costs.

5.4.4 Ports in Future

(1) Port Development

The port capacity for the specialized cargo seems to be adequate for the present and foreseeable future demand that is forecasted within the range of the peak load recorded in the past. However the San Felix Terminal is located in the east district, almost 10 to 20 km away from the growing industrial zone in the west of city center, and its annual capacity of 200,000 tons seems to be inadequate to meet the foreseeable future demand. A large scale industrial port complex zone development is planned by CVG in the area west of SIDOR. As this development plan includes some multipurpose terminals for public use, the timing of these new terminals should coincide with the actual demand.

(2) Port Management

Venezuela is now in the middle of the age of decentralization and privatization, and Venezuelan ports other than in Puerto Ordaz were handed over to the State governments, among which there are several cases of State-owned autonomous enterprises taking charge as the port management body. Furthermore, in the course of privatizing the CVG owned enterprises, SIDOR was privatized and allowed to keep its own port facilities.

However, there is no single entity in Puerto Ordaz that is in control of planning, coordination, management and operation as port authority for the common objectives of serving the cargo transportation demands.

A port authority should be established. The function of the port authority would cover a wide range of port activities related to development, maintenance, administration and management of port facilities as well as the enhancement of port use. This function is important for achieving sustainable economic growth of the region and consequently for accomplishing the country's development strategy. INC is in charge of maintenance, management and operation of the Canal. The maintenance of both an adequate depth and adequate width of the channel based on the information on vessels navigating the channel both at present and in future should be conducted. Consequently, channel maintenance would become efficient and costs would be minimized. In this sense, the establishment of a port authority would be helpful to INC.

5.4.5 Ports for Regional Use in the Delta Area

The regional road transportation network does not cover the majority of the Lower Orinoco Delta area: a minor portion of the population is sparsely scattered in small towns or villages along the waters of effluents of Orinoco River. Accordingly, small boat navigation has been playing an important role in passenger transportation for business and cargo transportation for livelihood commodities.

A report by PDVSA-DAO developed a practical program to improve the regional transportation system by proposing an integrated waterway networks linking the centers of production, consumption, and tourism for both the passenger and cargo transportation by small boats. Six principal and 14 secondary routes are identified for development.

The project for the 20 port improvement is given high priority. Those ports are categorized into 3 groups as Type I, II, III with costs of 300 to 680 million Bs, 150 to 200 million Bs, and 30 million Bs respectively. Alternatives systems for ship passage through the Manamo Dam are also included.

5.4.6 Case Study for Barge Transportation System in Macareo Channel

In order to get a clear view of barge navigation along the Macareo channel, a case study was conducted using barge train transport system for iron ore from Puerto Ordaz to the sea, instead of Shuttle Vessels system (Panamax Size) through the Rio Grande channel. The basis of the study is determined considering the future exportation demand of iron ore according to the reduced Cargo Throughput Forecast of 4 million tons in year 2003 for Alt.C2 and Alt.D1 in Table S.5.2.

(1) Characteristics of Macareo Channel

The Macareo channel of 194km long is branched off at the Ya-ya section of Rio Grande channel and flows northeast ward to the sea with approximately 14% of Rio Grande discharge. The width of channel is in the range of 400-700 m. In view point of vessel transportation along Macareo channel, smaller size vessels like barge trains could navigate without any large scale improvement works. Though it has a 8 m water depth in average below LWL, the both ends of the channel reaches close to the Barrancas and to the river mouth are shallow with only 4.5-5.0m depth. Still maintenance dredging is not necessary for barge transportation. In case of the alternative for the new port construction in the coast of Macareo estuary, continuous dredging work is required to maintain the navigable depth (14 km in length) for access and berthing of oceangoing vessels.

(2) Barge Transportation Planning

As for iron ore transportation by barge trains in Macareo channel, two possible alternatives are envisaged for transferring iron ore from barge to oceangoing vessel through either existing transfer vessel (Alternative C2) or in a new port to be constructed at the channel estuary (Alternative D1).

For the Alternative C2 of the transfer vessel placed at Boca Serpiente in the sea, Marine barge is required due to the difficulty of navigation in ocean with waves. The existing transfer vessel can be used till the termination of its durable life. Then, it shall be replaced with a new transfer vessel to continue large shipments to oceangoing vessels and maintain the competitive shipping cost. Loading facilities to transfer vessel are also needed at Pt. Pescadores, in addition to the replacement of existing transfer vessel (cape size) equipped with unloading facilities to oceangoing vessels.

In the Alternative D1, a new port with berthing, loading, unloading facilities as well as stockyard are required at Pt. Pescadores in the estuary along with continuous maintenance dredging of 14 km in length and 17 m in depth, for allowing the access of 150,000DWT oceangoing vessel.

For both alternatives, loading facilities to barge trains are required at Puerto Ordaz.

The cost of Alternative C2 and D1 are about US\$ 102 million and 144million respectively as shown in Table S.5.4. Annual operation and maintenance cost is calculated for Alternative C2 and Alternative D1 as US\$ 5.7 million and 12.1 million, respectively. Accordingly the Alternative C2 is economical as the barge system in Macareo channel in viewpoint of low initial investment cost.

Table S.5.4 Barge Transportation Facilities

Alternative	(1) Continuous use of TV(Alt.C2)	(2) NEW PORT(ALT.D1)
1.Barge Transportation Facility		
(1)Puerto Ordaz Port	•Ship loader	•Ship Loader
(2)Barge Trains	•Marine Barge	•River Barge
(3)Transfer Vessel Station	•Replacement of TV •Ship loader	•New Port (pier, loader, unloader, stockyard) •Dredging of ocean route 14km long and port for ocean going vessel
2.Construction Cost	•102 million US\$	•144 million US\$
3.Operation and Maintenance Cost	•5.7 million US\$/year	•12.1 million US\$/year

(3) Maintenance Dredging Volume in the Rio Grande Channel

The present navigation condition with 10.2 m depth during the dry season is restricted due to rock exposures on river bed. Accordingly, even Handymax vessel with 11.8 m draft can not navigate with full cargo load. Therefore, after shifting iron ore transportation by Panamax vessel to Macareo channel, if Handymax vessels for the non-iron ore transportation are required to maintain present navigable condition in the alternatives C2 and D1, 10.2 m depth along Rio Grande, same as at present, should be maintained. In this case, the annual maintenance dredging in Rio Grande channel would be same for the alternatives P1, C2 and D1. It could be, moreover, emphasized that if the depth of 10.2 m during the dry season is kept along Rio Grande in the alternatives of C2 and D1 in order to maintain as present navigation condition for Handymax size vessels, the annual maintenance dredging volume would not be reduced as 1.488 million m³ in the Rio Grande than the alternatives P1.

(4) Environmental Impact Evaluation

The Mariusa National Park and Orinoco Delta biosphere reservation area are located in the State of Delta Amacuro between the Macareo channel and the Mariusa channel. They are representative of the physiographics unit of the Orinoco Delta occupied by marshes and swamps. The both alternative C2 and alternative D1 would cause some adverse impacts due to the barge navigation whereas alternative D1 would cause further adverse impacts associated with the new port construction and dredging in the 14 km long ocean route for cape size oceangoing vessels. In case of providing new ports or navigation route in / around the area of Orinoco Delta National Park, the examination of environmental regulation, INPARQUE will be indispensable.

There are 18 Warao villages with population of 770 along the Macareo Channel. Their local transportation is mainly through the Macareo channel and the proposed barge navigation might affect their life. As a measure to mitigate the impacts of barge navigation, it is needed to make an effort to prevent the disturbance of local transportation and fishery industry. In case of alternative D1, the selected reclamation area shall be located away from the valuable aquatic ecosystem. The construction camps and the offices should have adequate water supply, sewage treatment and solid waste disposal systems. In order to prevent the social problems, the workers should be strictly supervised so as not to interfere with local affairs of the villagers. Regarding the dredging, a suitable disposal site should be selected to dispose the large amount of dredged spoils so that environment is less affected.

It is envisaged that adverse impact on the environment by alternative C2 is insignificant, though alternative D1 causes some significant impacts on aquatic environment. Taking into consideration of impacts on environment, Alternative C2 is preferable.

(5) Economic Evaluation

The project cost is composed of new facilities construction cost and channel improvement cost. The benefit is composed of the change of maintenance dredging cost due to the replacement from Panamax type to Handymax type vessel for the navigation in the Rio Grande Channel and the change in the shipping cost due to the replacement from Panamax type vessel to barge train. The cost and benefit analysis concluded that both Alternatives using the Macareo Channel are not viable economically due to the negative or very slight benefit as shown in Table S.5.5.

Table S.5.5 Results of Economic Analysis

Alternative	Alt. C2 (TV)	Alt. D1 (New Transfer Port)
Project Cost	US\$ 95,139,000	US\$ 133,920,000
O/M Cost	US\$ 5,239,000	US\$ 11,212,000
Maintenance Dredging Benefit	-US\$ 3,868,000 (Reduction of Maintenance Dredging)	US\$ 2,335,000 (Increase of Maintenance Dredging)
Shipping Cost	+ US\$ 3,056,000 (Increase of Shipping Cost)	+ US\$ 1,637,000 (Increase of Shipping Cost)
Total	-US\$ 812,000 Very Slight Benefit	US\$ 3,972,000 Negative Benefit

(6) Impacts on Regional Economy

【Alt.C2】 : As Alternative C2 will not bring any changes in the areas along the Macareo Channel, it will hardly provide any benefit relating to the regional development.

【Alt.D1】 : The construction of a transfer port at the mouth of the Macareo Channel (Alt.D1) will initially create a community (housing and shops, etc.) of people involved in the export of iron ore. Major regional development centering on this port, however, cannot be anticipated because of the fact that the physical conditions (swampy topography) will result in the spread of infrastructure (roads, etc.) only in the hinterland. Nevertheless, it will be possible to use this port as a fishing port, provided that certain fishery-related facilities (cold storage and processing plants, etc.) are constructed. It would be possible to create a key coastal fishery base on the northeastern coast of Venezuela through the active link of this port with Port Guiria. From the medium to long-term perspective, this port may well become an important transportation base for the domestic as well as international trade of goods which will result from the planned development of the Orinoco-Apure Axis.

(7) Comprehensive Evaluation and Recommendation

It is judged that Alternative C2 of the transfer vessel placed at Boca Serpiente in order to transport iron ore by barge in the Macareo channel lacks economic/financial viability and its implementation is not justifiable under the present conditions.

The examination of the possible implementation of Alternative D1 of a new port at Pt. Pescadores in the future, however, shall be studied when the timing is deemed to be appropriate from the viewpoint of not only the iron ore transportation but also the basin-wide development, the progress and maturity of the development of the Orinoco-Apure Axis.