### 13.2.3 River Ports

#### (1) Organization

Matters on operation, maintenance and management of the ports shall be carried out by each regional authority at the concerned cities/towns under the overall supervision of the State of Piauí. New divisions responsible for the matters shall be established in each regional office of concerned cities/towns, where construction of ports in the channel is scheduled.

#### (2) Function

The following functions shall be assigned to the above division :

- Exchanging/transmitting information and arranging coordination with other ports,
- Operation, maintenance and management of cargo handling equipment and
- Operation, maintenance and management of port facilities.

#### (3) Staffing

Proposed allocation of staff members in Scenario 1 is shown in Table 13.2.3. The other scenarios' cases are presented in Tables A5.2 in Appendix 5.

**Table 13.2.3 Staff Allocation of Each Port Office in Scenario 1**

| Liaison Offices | Staff members | | | |
|---|---|---|---|---|
| | Manager | Office Supporting Staffs | Technician | Labor |
| 1 Parnaíba | 1 | 3 | 3 | 10 |
| 2 Luzilandia | 1 | 2 | 3 | 10 |
| 3 Porto | 1 | 2 | 3 | 5 |
| 4 Miguel Alves | 1 | 2 | 3 | 5 |
| 5 Uniao | 1 | 2 | 3 | 5 |
| 6 Teresina | 1 | 5 | 5 | 20 |
| 7 Palmeiras | 1 | 2 | 3 | 5 |
| 8 Amarante | 1 | 2 | 3 | 5 |
| 9 Floriano | 1 | 5 | 5 | 15 |
| 10 Guadalupe | 1 | 2 | 3 | 10 |
| 11 Ulucui | 1 | 5 | 5 | 15 |
| 12 Libeiro Goncalves | 1 | 5 | 5 | 15 |
| 13 Santa Filomena | 1 | 2 | 3 | 10 |
| Total | 13 | 39 | 47 | 130 |

### 13.2.4 Navigation Aids

As previously introduced, the management/administration of any structures installed in the Parnaíba river is under the role of AHINOR at São Luis. No exceptions are the navigation aids for safe maneuvering of vessels utilizing the channel. Once the transporting operation by vessels is commenced, AHINOR shall perform their duties on the above responsibility with periodical patrols along the channel.

The actual scheme will be followed by offices to be newly established for maintenance/management of the channel later described in next subsection. The establishment, tentatively called the General Administrative Office of the Parnaíba river, shall be newly organized including seven site offices, where the actual execution of the responsibilities will be promoted.

### 13.2.5 Channel and the River

#### (1) Organization

The whole coordination on the management of the Parnaíba river shall be supervised by the existing AHINOR. The following organizations will be linked together in the project program.

- Existing Channel Administrative Authority in north-east Brazil at Sao Luis
- Newly planned General Administrative Office of the Parnaíba river at Teresina and
- Newly planned site stations/offices of the above at the following seven locations: Parnaíba, Luzilandia, Miguel Alves, Teresina, Amalante, Ulucui and Santa Filomena.

#### (2) Function

The following functions shall be assigned to the newly planned General Administrative Office of the Parnaíba river :

- Official statements on the information of river/channel,
- Planning various activities and budget management,
- Supplying materials and equipment and
- Coordination with other related authorities.

In association with the above, the seven site stations/offices shall execute the following duties in Scenario 1 :

- Periodical inspection of structures in the channel, including navigation aids, groins, etc.
- Maintenance and repair/mending,
- Storing materials and equipment and
- Collection of general information on the river/channel, its arrangement and transmission.

#### (3) Staffing

The following staff members shall be assigned to the newly planned General Administrative Office of the river Parnaíba river in case of Scenario 1.

- Administrative/Management Officers : 5
- Engineers/technicians : 15

The seven site stations/offices shall have at least the following personnel :

- Officers : 3 posts/office x 7 offices = 21
- Engineers/Technicians : 7 posts/office x 7 offices = 49

**(4) Essential equipment**

The organization shall be equipped with the following to provide a service of a satisfactory standard :

- Presentation Board for showing information on the river/channel,
- Vehicles for patrols,
- Vessels/Boats for patrols,
- Equipment for wireless communication and handy tele-communication, and
- Other office equipment

# 14. IMPLEMENTATION SCHEDULE AND COST ESTIMATION

# 14. IMPLEMENTATION SCHEDULE AND COST ESTIMATION

## 14.1 Implementation Schedule

There are four stages in the development of the project, i.e. engineering stage, tendering stage, construction stage, and operation stage. Fig. 14.1.1 shows the overall implementation schedule during the project year. The major work items of each stage are as follows :

### (1) Engineering Stage

The engineering stage includes survey, basic design, detailed design, and preparation of tender documents for the construction of the required facilities for the river navigation of the Parnaíba river. It will take about three years for this stage.

a. Survey for the lock resumption
   - Checking of the concrete structure soundness
   - Checking of the load conditions

b. Survey for the port construction
   - Site selection survey
   - Topographic and hydrographic survey at the river ports area
   - Boring at the river port area

c. Survey for the navigational channel
   - Longitudinal hydrographic survey of the Parnaíba river
   - Data collection about the local knowledge for the river navigation
   - Topographic and hydrographic survey of the mooring basin near the locks

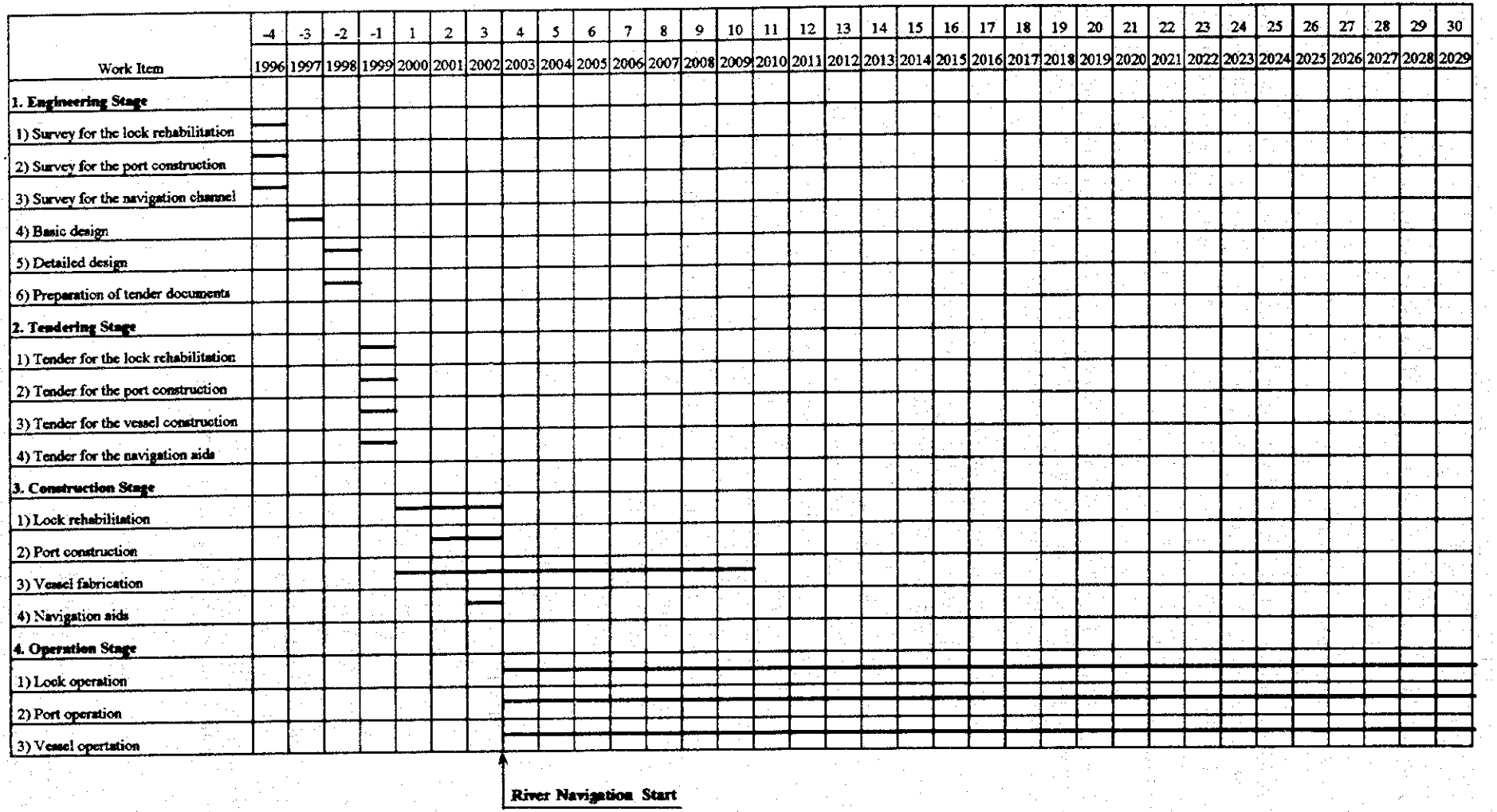
d. Basic and detailed design
   - Lock resumption
   - River ports
   - Vessel procurement
   - Navigation aids
   - Spur dikes if necessary

e. Preparation of tender documents
   - Lock resumption
   - River ports
   - Vessel procurement
   - Navigation aids
   - Spur dikes if necessary

### (2) Tendering Stage

On the basis of the prepared tender documents, tenders will be made for the lock resumption, port construction, and vessel procurement. One year is reserved for this stage.

# Fig. 14.1.1 Implementation Schedule



### (3) Construction Stage

Construction stage will take about three years, three years for the lock resumption, two years for the port construction, and one year for the fabrication and installation of the navigation aids. Ten years for the vessel fabrication is assumed, since the number of vessel is increased year by year until 2010.

#### a. Lock Resumption

Three years for the fabrication, installation and construction.

#### b. Port Construction

| Type of Port | Construction Period |
|---|---|
| Type 1 | : 10 months |
| Type 2 | : 12 months |
| Type 3 | : 20 months |
| Type 4 | : 24 months |

#### c. Vessel Fabrication

Ten years for the fabrication of 53 vessels is assumed. One year is required for the fabrication of one vessel. Several factories are required.

#### d. Navigation Aids

One year is assumed for the fabrication and installation.

## 14.2 Cost Estimation

The project cost for the river navigation of the Parnaíba river basin is estimated based on the river transportation plan, the lock resumption plan, the port development plan, the navigation aids' development plan, and operation and maintenance plan described in the previous chapters, respectively.

### 14.2.1 Basic Assumption

#### (1) Unit Cost and Exchange Rate

The basic cost data obtained in January 1994 is difficult to apply for the estimation since the new Real plan was started on July 1, 1994. Therefore, the costs after the Real plan is applied for the estimation as well as the foreign currency exchange rate. Table 14.2.1 shows the unit cost of the civil works obtained by the market price in September 1994 and the exchange rate of R$ 0.86 = US$ 1.00 in September 1994 is also used.

**Table 14.2.1 Unit Cost of the Major Items of the Civil Works.**

| Items | Unit | Cost in US$ |
|---|---|---|
| Concrete foundation | m3 | 156 |
| Structural concrete | m3 | 171 |
| Reinforcing bars | kg | 1.6 |
| Excavation for the foundation | m3 | 8.2 |
| Back filling | m3 | 3.7 |
| Form for RC | m2 | 28 |
| Fine sand * | m3 | 6.7 |
| Rock * | m3 | 15.2 |

Note : The cost of fine sand and rock is of January 1994 at Teresina.

### (2) Price Escalation

No price escalation is considered in the estimation.

### (3) Assumption for the Vessel Fabrication and Operation

1) Five percent of interest is assumed for the fabrication.
2) Ten percent of tax is assumed for the fabrication.
3) Ten to fifteen years depreciation is assumed for the estimation of the operation cost.
4) Eight crews are assumed for vessel operation.

### (4) Assumption of the Lock Resumption

Cost estimation is proceeded under the following conditions (see Tables A6.1.1 to A6.1.3 in Appendix 6 for the specification of the gate equipment, weights of each equipment items for the upstream and downstream locks, respectively). :

1) Design manufacturing and installation should be made in the Brazil.
2) Brazilian Standards (NBR) should be applied for the design of the equipment.
3) Procurement of the materials and parts should be made in the Brazil.

### (5) Assumption of the Port Construction

Cost estimation is made under the following conditions.

1) Cargo handling equipment and silos are excluded in the estimation because these equipment and storing facilities are assumed to be owned by the producers.

## 14.2.2 Construction and Procurement Cost

### (1) Lock Resumption Cost

Cost calculation is made applying the unit costs as classified with the kinds of equipment, as shown hereunder :

Steel structures for the upstream lock
Steel structures for the downstream lock

Control equipment
Relevant civil works

Total amount to be available as a complete navigation system is summarized in Table 14.2.2.

**Table 14.2.2 Construction Cost of the Boa Esperança Lock**

| Item | Cost (US$) |
|---|---|
| 1. Steel Structures for the Upstream Lock | 5,196,840 |
| 2. Steel Structures for the Downstream Lock | 4,573,740 |
| 3. Control Equipments | 2,694,000 |
| 4. Relevant Civil Works | 441,800 |
| sub-total | 12,906,380 |
| 5. Other Cost(about 20% of above) | 2,573,620 |
| Total | 15,480,000 |

Detailed costs for each above item are tabulated from Tables A6.1.4 to A6.1.7 in Appendix 6.

### (2) Port Construction Cost

The port construction cost is estimated based on the river port development plan. Tables 14.2.3 to 14.2.5 show the port construction costs in each scenario (see Tables A6.2.1 to A6.2.4 in Appendix 6 for the details).

**Table 14.2.3 Port Construction Cost in Scenario 1**

Unit : US$

| Type | Unit Cost | No. | Cost | Location |
|---|---|---|---|---|
| 1 | 1,650,000 | 3 | 4,950,000 | Luzilandia, Palmeiras, Amarante |
| 2 | 2,320,000 | 4 | 9,280,000 | Parnaíba, Porto, Miguel Alves, Uniao |
| 3 | 5,320,000 | 3 | 15,960,000 | Guadalupe, Ribeiro Goncalves, Santa Filomena |
| 4 | 8,980,000 | 3 | 26,940,000 | Teresina, Floriano, Urucui |
| Total | | 13 | 57,130,000 | |

**Table 14.2.4 Port Construction Cost in Scenarios 2 and 4**

Unit : US$

| Type | Unit Cost | No. | Cost | Location |
|---|---|---|---|---|
| 1 | 1,650,000 | 2 | 3,300,000 | Palmeiras, Amarante |
| 2 | 2,320,000 | - | - | |
| 3 | 5,320,000 | 3 | 15,960,000 | Guadalupe, Ribeiro Goncalves, Santa Filomena |
| 4 | 8,980,000 | 3 | 26,940,000 | Teresina, Floriano, Urucui |
| Total | | 8 | 46,200,000 | |

**Table 14.2.5 Port Construction Cost in Scenario 3**

Unit : US$

| Type | Unit Cost | No. | Cost | Location |
|---|---|---|---|---|
| 1 | - | - | - | - |
| 2 | - | - | - | - |
| 3 | 5,320,000 | 3 | 15,960,000 | Guadalupe, Ribeiro Goncalves, Santa Filomena |
| 4 | 8,980,000 | 2 | 17,960,000 | Floriano, Urucui |
| Total | | 5 | 33,920,000 | |

### (3) Vessel Cost

The vessel fabrication cost was estimated based on the selected vessel as presented in Chapter 7. Table 14.2.6 shows the ship price for one vessel. Table 14.2.7 shows the vessel fabrication cost in 2010 in each scenario.

**Table 14.2.6 Ship Price for One Vessel**

Unit : US$

| | Unit | Qty | Cost |
|---|---|---|---|
| 1 Ship Cost | | | 1,000,000 |
| a. Material Cost | LS | 1 | 553,000 |
| b. Labor Cost | LS | 1 | 311,000 |
| c. Miscellaneous | LS | 1 | 136,000 |
| 2 Interest | % | 5 | 25,000 |
| 3 Tax | | | 100,000 |
| 4 Others | | | 15,000 |
| Total | | | 1,140,000 |

**Table 14.2.7 Vessel Fabrication Cost in 2010 in Each Scenario**

Unit : US$

| | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| Vessel Number in 2010 | 53 | 46 | 31 | 40 |
| Ship Cost per Vessel | 1,140,000 | 1,140,000 | 1,140,000 | 1,140,000 |
| Vessel Cost in 2010 | 60,420,000 | 52,440,000 | 35,340,000 | 45,600,000 |

### (4) Navigation Aids

The fabrication and installation cost for the navigation aids are estimated based on the development plan stipulated in Chapter 12. Tables 14.2.8 to 14.2.10 show the fabrication and installation cost in each scenario.

**Table 14.2.8 Fabrication and Installation Cost in Scenario 1**

Unit : US$

| | Unit | Qty | Unit Cost | Amount |
|---|---|---|---|---|
| 1 Fabrication Cost | pcs | 475 | 1,250 | 593,750 |
| a. Material Cost | pcs | 475 | 340 | 161,500 |
| b. Labor Cost & others | pcs | 475 | 910 | 432,250 |
| 2 Installation Cost | pcs | 475 | 110 | 52,250 |
| 3 Other Cost | LS | 1 | | 184,000 |
| Total | | | | 830,000 |

**Table 14.2.9 Fabrication and Installation Cost in Scenarios 2 and 4**

Unit : US$

| | Unit | Qty | Unit Cost | Amount |
|---|---|---|---|---|
| 1 Fabrication Cost | pcs | 213 | 1,250 | 266,250 |
| a. Material Cost | pcs | 213 | 340 | 72,420 |
| b. Labor Cost & others | pcs | 213 | 910 | 193,830 |
| 2 Installation Cost | pcs | 213 | 110 | 23,430 |
| 3 Other Cost | LS | 1 | | 70,320 |
| Total | | | | 360,000 |

**Table 14.2.10 Fabrication and Installation Cost in Scenario 3**

Unit : US$

| | Unit | Qty | Unit Cost | Amount |
|---|---|---|---|---|
| 1 Fabrication Cost | pcs | 109 | 1,250 | 136,250 |
| a. Material Cost | pcs | 109 | 340 | 37,060 |
| b. Labor Cost & others | pcs | 109 | 910 | 99,190 |
| 2 Installation Cost | pcs | 109 | 110 | 11,990 |
| 3 Other Cost | LS | 1 | | 51,760 |
| Total | | | | 200,000 |

### 14.2.3 Project Cost

Tables 14.2.11 to 14.2.14 show the project cost including the costs for the engineering fee, survey cost, and construction supervision cost in each scenario, respectively.

**Table 14.2.11 Project Cost in Scenario 1**

Unit : US$

| Project | Unit | Qty | Unit Price | Cost |
|---|---|---|---|---|
| A. Construction and Procurement Cost | | | | |
| 1 Lock Resumption | | | | 15,480,000 |
| 2 Port Construction | LS | 1 | | 57,130,000 |
| 3 Vessel Procurement | vessel | 53 | 1,140,000 | 60,420,000 |
| 4 Navigation Aids | | | | 830,000 |
| sub-total | | | | 133,860,000 |
| B. Engineering Fee | | 10% | | 13,380,000 |
| C. Physical Contingency | | 5% | | 6,760,000 |
| Total | | | | 154,000,000 |

**Table 14.2.12 Project Cost in Scenarios 2**

Unit : US$

| Project | Unit | Qty | Unit Price | Cost |
|---|---|---|---|---|
| A. Construction and Procurement Cost | | | | |
| 1 Lock Resumption | | | | 15,480,000 |
| 2 Port Construction | LS | 1 | | 46,200,000 |
| 3 Vessel Procurement | vessel | 46 | 1,140,000 | 52,440,000 |
| 4 Navigation Aids | | | | 360,000 |
| sub-total | | | | 114,480,000 |
| B. Engineering Fee | | 10% | | 11,442,000 |
| C. Physical Contingency | | 5% | | 5,778,000 |
| Total | | | | 131,700,000 |

**Table 14.2.13 Project Cost in Scenarios 3**

Unit : US$

| Project | Unit | Qty | Unit Price | Cost |
|---|---|---|---|---|
| A. Construction and Procurement Cost | | | | |
| 1 Lock Resumption | | | | 15,480,000 |
| 2 Port Construction | LS | 1 | | 33,920,000 |
| 3 Vessel Procurement | vessel | 31 | 1,140,000 | 35,340,000 |
| 4 Navigation Aids | | | | 200,000 |
| sub-total | | | | 84,940,000 |
| B. Engineering Fee | | 10% | | 8,490,000 |
| C. Physical Contingency | | 5% | | 4,370,000 |
| Total | | | | 97,800,000 |

**Table 14.2.14 Project Cost in Scenarios 4**

Unit : US$

| Project | Unit | Qty | Unit Price | Cost |
|---|---|---|---|---|
| A. Construction and Procurement Cost | | | | |
| 1 Lock Resumption | | | | 15,480,000 |
| 2 Port Construction | LS | 1 | | 46,200,000 |
| 3 Vessel Procurement | vessel | 40 | 1,140,000 | 45,600,000 |
| 4 Navigation Aids | | | | 360,000 |
| sub-total | | | | 107,640,000 |
| B. Engineering Fee | | 10% | | 10,760,000 |
| C. Physical Contingency | | 5% | | 5,400,000 |
| Total | | | | 123,800,000 |

### 14.2.4 Operation and Maintenance Cost

#### (1) Unit Cost for the Administrative Staff

Table 14.2.15 shows the unit cost of the administrative staff in September 1994.

**Table 14.2.15 Unit Cost for the Administrative Staff**

| Administration | Unit | Cost in US$ |
|---|---|---|
| Director | month | 11,700 |
| Administrative Manager | month | 3,560 |
| Secretary | month | 1,390 |
| Driver | month | 530 |
| Office boy | month | 270 |
| Project manager | month | 4,100 |
| Mechanical Engineer | month | 1,600 |
| Designer | month | 1,000 |

#### (2) Running Cost for the Vessel Operation

Table 14.2.16 shows the running cost of vessel operations during from 2003 to 2010 in each scenario.

**Table 14.2.16 Running Cost of the Vessel Operation**

Unit : US$

| Year | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| 2003 | 7,725,200 | 5,623,200 | 3,280,200 | 3,710,700 |
| 2004 | 8,971,200 | 6,091,800 | 3,748,800 | 4,101,300 |
| 2005 | 10,217,200 | 6,797,600 | 4,217,400 | 4,687,200 |
| 2006 | 11,463,200 | 7,497,600 | 4,686,000 | 5,077,800 |
| 2007 | 13,207,600 | 8,200,500 | 5,154,600 | 5,663,700 |
| 2008 | 13,207,600 | 8,903,400 | 5,857,500 | 6,249,600 |
| 2009 | 13,207,600 | 9,840,600 | 6,560,400 | 7,030,800 |
| 2010 | 13,207,600 | 10,777,800 | 7,263,300 | 7,812,000 |

Note : Interest and depreciation cost are excluded in above running cost.

### (3) Office Administration Cost

Office administration costs for the river navigation were estimated based on the operation and maintenance plan in Chapter 13. Table 14.2.17 shows the office administration cost for vessel operation, port operation, and river maintenance offices (see Tables A6.3.1 to A6.3.3 for the details estimation).

**Table 14.2.17 Office Administration Cost**

Unit : US$

| | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| 1. Vessel Operation Office | 2,802,000 | 1,809,600 | 1,148,400 | 1,589,200 |
| 2. Port Operation Office | 4,131,600 | 2,776,800 | 1,820,400 | 2,458,000 |
| 3. River Management Office | 2,961,600 | 1,736,400 | 1,574,400 | 1,682,400 |
| Total | 9,895,200 | 6,322,800 | 4,574,400 | 5,729,600 |

# 15. ECONOMIC AND FINANCIAL EVALUATION

# 15. ECONOMIC AND FINANCIAL EVALUATION

## 15.1 Economic Evaluation

The economic evaluation method applied in this study is based on the principal known as "with and without". This means to analyze and examine differences of assumed economic effectivity in the execution of projects between "changes of national economy when the project is executed (with)" and "national economy assumed when the project is not executed (without)" so as to judge appropriateness of the project by net effects being induced by the execution of the project.

To do this correctly, cost - benefit analysis is conducted by using the discounted cash - flow method on measurable effects in monetary terms (direct benefit) to obtain the internal rate of return (IRR), net present value (NPV) as well as the cost benefit ratio (B/C) to evaluate the appropriateness of the project. As for a net effect assumed which is difficult to measure, the indirect benefit is analyzed by a qualitative method to supplement evaluation of appropriateness of the project.

Cost - benefit analysis on the subject project in this study is conducted on various alternatives delineated in Scenarios 1 - 4 that are mentioned in Chapter 8. Transferable benefit items such as tax, interest, subsidies, etc., and price escalation (rate of inflation) were excluded from the calculation of costs (out-flow) and benefits (in-flow) to prepare projected cash flow. The project term applied for the above mentioned evaluation was set as 30 years from the date of commencement. The salvage value of assets is assumed to be remain for 30 years within the project term and is calculated as in-flow thereafter.

### 15.1.1 Direct Economic Benefit

#### (1) Traveling Cost Saving Benefit

The cost of navigation in the case of project execution (with case) and that of land transport by vehicles in the case of no execution (without case) are compared and the difference is adopted for economic evaluation as Traveling Cost Saving Benefit.

As transporting costs for river navigation per ton per km unit differs by scenario, the costs obtained through the analysis in Chapter 7 is used for further studies. The on-land travelling costs of vehicles determined from "INDICADORE" issued by Brazil Truck Association was used for the evaluation of the unit cost benefit for river navigation. The traveling cost saving benefit was obtained by calculating the difference of traveling costs between the case of "with" and of "without", based on the above unit cost benefit and on the predetermined transport volume by the scenarios in Chapter 8. The results are summarized in Table 15.1.1.

**Table 15.1.1 Competing Traveling Costs and Traveling Cost Saving Benefits**

| | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| Transport Cost of Ships per ton km | US$ 0.0281 | US$ 0.0249 | US$ 0.0168 | US$ 0.0182 |
| Transport Cost of Trucks per ton km | US$ 0.067 - 0.081 | US$ 0.067 - 0.081 | US$ 0.067 - 0.081 | US$ 0.067 - 0.081 |
| Traveling Cost Saving Benefit in 2010 | US$ 22,442,395 | US$ 21,870,714 | US$ 20,511,393 | US$ 23,085,300 |

Note : See Table 15.1.2 for the transport cost of truck per ton km.
See Tables A7.1.1 to A7.4.3 in Appendix 7 for the traveling cost saving benefit in 2010.

**Table 15.1.2 Transport Costs of Trucks per ton-km**

| | Paved Road | | Gravel Road | |
|---|---|---|---|---|
| | Truck 1 (Less 10 t) | Truck 2 (10 t) | Truck 1 (Less 10 t) | Truck 2 (10 t) |
| Fixed Cost per km | 443.4 | 477.0 | 443.4 | 477.0 |
| Running Cost per km | 309.0 | 353.0 | 464.0 | 530.0 |
| Total (Cr$/km) | 752.4 | 830.0 | 907.4 | 1,007.0 |
| Average Load (ton) | 5 | 8 | 5 | 8 |
| Traveling Cost per ton km | 150.5 | 103.8 | 181.1 | 126.0 |
| Average Cost (Cr$/ton km) | 127.2 | | 154.0 | |
| Average Cost (US$/ton km) | 0.067 | | 0.081 | |

Source : INDICADORE DO TRANPORUTE, May 1994

### (2) Benefit of Agricultural Production

According to production forecasting by the regional agriculture bureau, there will be considerably higher growth rate in the upper stream region comparing with the present condition. In particular, the growth rate of rice and soybean production is prominent. If this forecast is achieved, land transport alone will not be able to handle the required transport demand not only in the subject region but also in other regions and also the demand of soybean exports from the ports. In addition, the development and promotion of river navigation will contribute to the increase in agricultural productivity.

In this context, the implicit benefit of river navigation contributing to agricultural productivity can be considered in the case of "with" for the study. Unfortunately, a quantitative analysis for confirming such benefits can hardly be achieved from the available data so far collected. Under such circumstances, soybeans were focused, among the agricultural products, for they have been a typical product creating exporting revenues. Fifty percent of national net income (farm gate price - production cost) is deemed as an agricultural production benefit and accounted as a benefit (in-flow).

Tables 15.1.3 and 15.1.4 show the estimated agricultural production benefit and net profit of soybeans per ton, respectively.

**Table 15.1.3 Agricultural Production Benefit**

Unit : 1000 US$

| | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| Transport Section | To Parnaíba | To Teresina | To Floriano | To Teresina (Rainy season) |
| Agricultural Production Benefits (until year 2003) | 1,477 | 1,477 | - | 1,477 |
| Agricultural Production Benefit (until year 2010) | 4,350 | 4,350 | - | 4,350 |

**Table 15.1.4 Net Profit of Soybeans per ton**

| Output per ha | Farm-gate Price per ha | Rough Profit per ha | Production Cost per ha | Net Profit per ton (R$/ton) |
|---|---|---|---|---|
| 2.7 ton | 168.20 | 454.14 | 390.16 | 24 |

Source : Regional Agricultural Bureau

As described above, the benefits of traveling cost saving and of agricultural production are calculated as in-flow items for cost benefit analysis on an annual basis from the year 2003 when river navigation is expected to commence.

### 15.1.2 Project Cost and Cost for Maintenance, Management and Shipping Operation

The Project cost (initial investment cost) is composed of that for the resumption of Boa Esperança Lock, construction of river ports, installation of navigation aids and ship building as well as for maintenance, management and shipping operations associated with these major items as estimated in Chapter 14.

However, it is to be noted that the relevant costs in Chapter 14 are based on the present market price. These figures were used for the financial evaluation in this study, but the economic price, which was converted from these figures by the application of shadow rates taking into account the present national economic situation of Brazil and the socio-economic environment of Piauí region, was used for the economic evaluation.

Conversion parameters applied to this study were pre-determined by sectors as follows :

Accounting Rate of Interest : 0.10 (see note 1, below)
Conversion Rate by Sectors
- Direct Construction Cost : 0.80
- Cost of Material and Equipment : 1.00
- Cost of Ship building : 0.75
- Engineering Cost : 0.90
- Labor Cost in Ship Operation : 0.80
- Office Administration Cost : 0.80

The annual project costs and operation and maintenance, abbreviated as O&M hereafter, cost converted by the above mentioned rates, are used to prepare a projected cash flow for the cost benefit analysis based on the proposed construction schedule and navigation operation plan. Table 15.1.5 shows the results of the project costs and O&M costs for the

economic analysis (see Tables A7.5.1 to A7.5.4 in Appendix 7 for details of the projected economic cost).

Note 1 : In Brazil, an accounting rate of interest (ARI) used as a national parameter is normally 0.12. However 0.10 is adopted here, considering the present social and economic condition of Piauí region.

**Table 15.1.5 Economical Project Cost and O/&M Cost in 2010**

| | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| Economical Project Cost | US$ 119,700,000 | US$ 102,500,000 | US$ 77,400,000 | US$ 96,700,000 |
| O&M Costs in 2010 | US$ 20,714,960 | US$ 15,419,000 | US$ 10,609,700 | US$ 12,034,600 |

### 15.1.3 Cost Benefit Analysis

The economic internal rate of return (EIRR) in each scenario was estimated based on the cash-flow of benefit and cost stream. Table 15.3.6 shows the results of the estimation (see Tables A7.6.1 to A7.6.4 in Appendix 7 for the projected cash-flow in each scenario).

**Table 15.1.6 Estimated EIRR in Each Scenario**

| | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 |
|---|---|---|---|---|
| EIRR (%) | Minus | 6.56 | 8.54 | 11.02 |

Judging from the above mentioned results, only Scenario 4 is considered to be feasible assuming a parameter on opportunity cost of initial investment as 0.10.

The net present value (NPV) for Scenario 4 is estimated as US$ 7,807,152 and the cost benefit ratio (B/C) is calculated as 1.05. The NPV is thought to be low in comparison with the amount of the initial investment and it can be judged that the superiority of this project scenario is not identified among the others.

However, it is difficult to clearly define a distinct difference between the case of project execution, "with", and of no execution, "without", concerning the explicit benefit to agricultural production only from the prescribed examination. The increased soybeans' production could be transported on-land through the railway system, via Imperatriz or Teresina. As a consequence, the benefit will not be counted as concerned to the project, but the traveling cost saving benefit alone will be in the analysis. In this case the benefit is deemed to be an item for the project evaluation. The results of the analysis are given below. As shown, its EIRR does not reach to the national parameter of 0.10.

The EIRR, without including agricultural benefits into the evaluation, is 7.86 %.

### 15.1.4 Sensitivity Analysis

Since the EIRR of Scenario 4 shows 11.02 %, the sensitive analysis is conducted only for the out-flow (cost) of Scenario 4.

As for analysis of the cost aspect, sensitivity analysis is conducted, assuming a 5 % reduction in the construction and associated costs with invariable costs of maintenance, management and operation.

The results of this analysis are tabulated in Table 15.1.7. As shown therein, a considerable increase in feasibility is hardly recognized.

**Table 15.1.7 EIRR, NPV, and B/C in Scenario 4**

| | Original Case in Scenario 4 | 5 % Reduction in Construction cost of Scenario 4 |
|---|---|---|
| EIRR | 11.02% | 11.59% |
| NPV | US$ 7,807,152 | US$ 11,725,641 |
| B/C Ratio | 1.05 | 1.08 |

Note : See Table A7.6.5 in Appendix 7 for the projected cash flow

### 15.1.5 Indirect Benefit

The following positive effects associated with the project can be expected from the foreseeable indirect benefits through the execution of the development plan in the Parnaíba river.

**(1) Regional Development Effect**

The urbanization phenomena will appear especially near the river ports in the coastal zone of the Parnaíba river in the south-western area. This will benefit the distribution of the population and settlement of inhabitants, which will alleviate the regional economic imbalance.

**(2) Increased Employment Opportunities**

Not only during the construction period, but also in the successive period of urbanization in the cities, the creation of additional commercial businesses along the river ports will be achieved through such regional development. These effects are expected to increase the opportunities of employment. Needless to say, settlements of workers in the ports can also be expected.

**(3) Consolidation of Administrative Functions**

The new transport system opening up the upper stream region of the Parnaíba river by the resumption of the Boa Esperança Locks will contribute not only to increased cargo transport but to close and frequent interchanges of personnel that may lead to an appropriate consolidation of administrative functions on the local governments concerned.

## 15.2 Financial Evaluation

In the actual implementation of the project, it is quite important to examine whether the project is manageable or not, in both terms of regional and national financial management.

Scenario 4, which is previously considered economically feasible, will have further detailed evaluations carried out.

Tariffs of transport for river navigation expressed in a unit of per ton-km are estimated in comparison with the present transporting costs of competing systems, such as by vehicles, or by trucks, based on the transporting costs in Scenario 4 including its capital investment. Having obtained the corresponding annual income by multiplying these charges by the estimated cargo volume, it is checked whether this would cover the project cost including maintenance and management by discounted cash-flow method. If the financial internal rate of return (FIRR) delineated from such process exceeds the national parameter (NP), it can be refereed to as long term banking interest prevailing in Brazil. In such case, the project can be considered financially feasible.

### 15.2.1 Determination of River Transport Charge

As discussed in Chapter 7, the transporting cost of river navigation including the capital costs applicable to Scenario 4 is 0.0272 US$/ton/km.

On the other hand, the transporting charges by trucks in the Piauí region, which were studied through the cargo volume analysis in Chapter 4, ranges from 0.02 to 0.04 US$/ton-km at present.

From the above, an advantage of river navigation compared with transport by trucks will possibly be lost, if the charge in the navigation is set more than 0,0272 US$/ton-km. This limiting value is adopted for the project implementation without loss of its superiority over the on-land transport measures.

### 15.2.2 Financial Evaluation

The possibility of repayment is examined, based on the total estimated project cost and maintenance and management costs as well as applicable charges mentioned in the above, and the expected revenue from river navigation in Scenario 4. As FIRR shows a minus figure, the project is considered not feasible. Additional examination was conducted to find an applicable solution by setting the following 4 questions.

Case 1 : How high does the unit transport charge (per ton-km) have to be so as to repay the total project cost including its operation?

Case 2 : What will be the FIRR, if the transporting revenue from the competitive charges against by trucks can cover the cost of ship building and O&M?

Case 3 : How much is an appropriate charge just to cover the cost of ship building and associated O&M costs?

Case 4 : If the competitive charge against transport by trucks, i.e., 0.0272 US$/ton-km, is applied, what subsidies for ship building would be needed?

Table 15.2.1 shows the results of the examination reflecting the above questions.

**Table 15.2.1 FIRR in Scenario 4 in Each Case**

| Case | FIRR | Possible Solution |
|---|---|---|
| Original Case in Scenario 4 | Minus | |
| Case 1 | 11.26 % | Charge per ton km is to be US$ 0.0816 |
| Case 2 | 2.91 % | Impossible to repay |
| Case 3 | 11.89 % | Charge per ton km is to be US$ 0.0354 |
| Case 4 | 11.78 % | 50 % of the cost for ship building is to be subsidized |

Note : see Tables A7.7.1 to A7.7.5 in Appendix 7 for the project cash-flow

In accordance with the above mentioned results, it shows that unless the cost by trucks is increased to 0.10 US$/ton-km or more, the feasibility of the project cannot be achieved. Consequently, if it is decided to execute the project under the present conditions, all the costs for resumption of Boa Esperança Lock, construction of the river ports and cost for the installation of navigation aids are to be borne by public expenditure that does not require repayment. In addition, 50 % of the cost for ship building is to be provided as a subsidy of the government. Only such action can make this project viable.

## 15.3 Comprehensive Evaluation

A comprehensive examination on the preceding evaluations is summarized as follows :

The project may be considered as one of the national inputs for opportunity cost, although the results of the quantitative analysis on direct benefit of the project indicate relatively low EIRR values of 11.02 % or 7.86 %. Even if there is no sign of significant superiority in the project, it can be judged that the project is still feasible and economically viable when considering various positive effects counted as indirect benefits in the qualitative examination.

It should be considered that inherent difficulties of the project still exists in the financial and operative aspects. The substantial reason for this is a limitation imposed on the shape and type of vessels able to manoeuvre in the Parnaíba river because of its natural conditions. Resulting river navigation is obliged to transport limited cargoes and so reflects the incapability of offering a lower transporting cost.

To conclude the above, a policy formulation based on careful consideration of financial matters is imperative in determining whether to execute this project or not.

# 16. ENVIRONMENTAL STUDY

## 16. ENVIRONMENTAL STUDY

Data collection, bibliographic research, study on the existing reports, and a field reconnaissance survey for the environmental survey were carried out from September to October, 1993 on a local contract basis in order to evaluate the possible impacts caused by the development of river transportation of the Parnaíba river basin, and to establish the countermeasures for future developments.

The impact analysis and evaluations are made by the "matrix-step" method ; a cause-effect relationship. The relationship between fifteen (15) relevant environmental attributes and seven (7) impact generating actions were utilized for the "matrix-step" method.

Environmental survey and assessment shows that no serious damage will be imposed to fauna or flora representatives, and that there are no endangered species subject to the direct consequences of the Navigation Plan. Besides these aspects, it was noted that the fisheries of the basin will not be affected by navigation activities due to the present low significance of fishing activities. The following is a summary of the studies (see Appendix 9 for the detailed results).

### 16.1 Environmental Problems

The environmental study pointed out several problems correlated to bad land and soil usage and agricultural and livestock practices, which could impose future problems for the region, even if they are not directly linked to the navigation development, but could be worsened as a consequence of disorganized development.

In view of the navigation development plan for the Parnaíba river basin, the impact survey clearly showed that the impacts and problems that will arise directly from the waterway implementation and eventually its operation, will be — *in general* — temporary, of small magnitude and spatially very small in coverage, mainly those resulting from specific construction actions since large scale dredging works on the channel is not planned.

From the discussions and analyses for the study, a general scenario can be outlined for the Parnaíba river basin, as stated below:

- The biggest effects of waterway operation, especially those that will result from the probable intensification of economic exploitation of extensive areas along the main riverbanks, will be of great magnitude and coverage, basically due to the extremely out of date socioeconomic, political and cultural patterns that still predominant all the region.

- The navigation development will be able to extend human occupation along the marginal areas of Parnaíba and Balsas River valleys, as well as in the plateaus of Southwest Piauí and Southeast Maranhão, with acceleration and amplification of the deforestation processes and consequent deterioration and environmental weakening of marginal areas along river valleys, borders and steep areas.

- Construction of new roads for production flow may affect hydraulic conditions of minor drainage systems due to obstructions, landslides along river banks, etc., with increasing erosion processes, which will be intensified by burning practices, thus affecting greater areas than at present. As a consequence, obstruction of river beds will be intensified, thus bringing problems for the future waterway traffic.

## 16.2 Matrix Examination and General Consideration

From the matrix examination, it may be observed that most impacts will affect surface water quality, but in general temporary effects, which will last as long as the causing actions last. However, other environmental factors are also important, as the matrix shows, which are likely to be changed and cannot be disregarded.

On the other hand, the study also points out the presence of significant impacts over socioeconomic factors. This shows that the navigation plan could originate important changes to the region in general, not only affecting the natural resources. Moreover, the study also shows that the future consequences of the Navigation Development Plan will be closely related to the type of occupation and economic activities that may be developed in the region, which in turn could be conditioned to a higher or lower degree by the development of navigation.

The present practices of intensive agriculture become highly questionable, considering that:

a. The bad use of soil making them prone to intensive erosive processes;

b. An increase of water pollution is observed, due to excessive use of pesticides and fertilizers;

c. The incorrect use of irrigation in the plateau area together with swamp drainage, associated to the destruction of riparian forests can, in the long run, jeopardize the regional water balance;

d. The uncontrolled deforestation, linked to the excessive use of pesticides and monoculture implantation provokes ecological imbalances, with consequent increase of plague incidence;

e. Land use along river banks for agriculture, especially in areas with quartz sands, together with the increasing occurrence of ravines, has made these areas inappropriate for productive use;

f. The intensification of burning frequency, mainly at the end of drought periods, leads to loss of soil protection, which is highly susceptible to erosion, thus diminishing its potential for production.

Consequently, it is important to consider that new management practices in the savanna areas should be established, but, prior to this, it is necessary to know in detail the peculiarities of the environment so that it can be provided to the society, without destroying its natural inheritance.

## 16.3. Conclusion and Recommendations

Thus, the analysis of the environmental study, in the present stage of knowledge and information about the waterway shows that certain precautions are necessary as regards a region *with a high degree of environmental fragility*.

Also, the development actions which will bring new inhabitants and new economic activities to Piauí, could be responsible for making worse the present conditions of environmental deterioration, which may jeopardize the integrity of the waterway itself.

However, these considerations have in mind a longer period than a more immediate planning view, being only a warning for the future. The study does not reveal more serious problems other than the ones that can be predicted in the light of current socio-environmental conditions of Piauí today.

Studies show that there are no animal or plant endangered species that *could* be affected by the necessary actions for implementation of the plan. Thus, one can conclude that the plan will not jeopardize the natural environment. However, the proponent must be acquainted of the fact that, at least for the regional vegetation, it is not secure to make any conclusions about rare or endangered species due to the small amount of available studies and information.

As for legal aspects, attention must be given to Brazilian laws concerning the environment , in order that any project or action that may affect the environment must be submitted for the scrutiny of the State authorities as for licensing purposes, as well as to some other institutions in specific cases, such as wood procurement, hunting, fishing, etc.

## 16.4 Study Team's Comments

The environmental study did not show any significant problems related to the navigation activities and navigation by itself will not generate any significant impact to fauna, flora or fishing activities along the Parnaíba river basin.

However, the consequences of the navigation development plan must be taken into account, in order that the present environment will not be affected due to the socioeconomic changes that will be brought to the whole Parnaíba river basin by the river transportation.

# 17. CONCLUSION AND RECOMMENDATIONS

# 17. CONCLUSIONS AND RECOMMENDATIONS

## 17.1 Conclusions

Throughout the course of the studies so far conducted, the applicability, the feasibility and the possibility of river navigation in the Parnaíba river have been investigated as a transporting method for agricultural products promoting the sectorial development in the South-west region of the State. The main conclusions derived from the study are summarised below.

1 River navigation along the whole of the Parnaíba river is at present very difficult because of the following reasons:

- The cargo volume transported downstream of Teresina will decrease greatly during the dry season, because only smaller vessels of 0.9 m or less in draft can safely manoeuvre in the channel. The outcomes of such a limitation are lower efficiency in the transport and the resulting higher transporting cost expressed in a unit per ton-km. The possible solution would be regular dredging work or construction of effective spur dikes to provide sufficient water depth in the channel, though the required investment would be great, and thus it could no longer be pdayable only from the transporting revenues.

- The particulars of vessels traveling in the channel will be affected by the existing locks at Boa Esperança particularly in their size. In terms of safe manoeuvring, self-propelled vessels shall be assigned rather than barges without propellers. Subsequent transporting costs per ton-km for such vessels will be comparatively higher and less competitive than for transport by barges, typically practised in the river Tiete.

2. The development of a port at Luiz Correia located at the mouth of the Parnaíba river has a potential prospects for its future, though the necessity of its urgent implementation has not been yet confirmed for the project period until 2010. For the time being, the ports of Fortaleza and Itaqui will preferably be utilised as a substitution.

3. A feasible scenario can possibly be proposed in view of the socio-economic situation around the Parnaíba river, where river navigation is limited to the upstream region of Floriano in dry season and to that of Teresina in the rainy season. Despite such conditions, the project still requires a great deal of investment. The feasibility from a financial aspect for a prolonged period will still be discouraging.

4. The essential implications stated above serve as a significant warning about the project implementation. Deliberate and obstinate determination shall be required in the implementation program covering aspects on the possible funding resources, the commencement schedules, etc.

## 17.2 Recommendations

To extend the above conclusions, some recommendations shall be stressed as below :

1. As a life-line of transporting agricultural products from the south-west region of the State, a state-wide study on the facilities supporting the State infrastructure will be a possible room for the development plan. It is worth studying overall transport activities, perhaps constituting a linking network in the state.

2. Despite relatively low feasibility for river navigation, any countermeasures shall be adopted sooner or later in order to offer an effective transport service for the future demand of agricultural products, because no such transporting system is available in the southwest region of the State. If the program is implemented, backed up by an adequate financial policy, a pilot program on a smaller scale, using much smaller vessels, shall firstly be planned and examined. Based on such trials, the actual project will be continued by solving the problems experienced in the prototype.

For example,

1) Establishment of a project implementation office.
2) Engineering studies for the rehabilitation of the Boa Esperança Locks, such as surveys for basic and detailed design, preparation of tender documents.
3) Financial arrangements for the project implementation.
4) Operation and management of pilot river navigation in the upstream area.