ASIAN DEVELOPMENT BANK

PPA: PNG 15074

PROJECT PERFORMANCE AUDIT REPORT

ON THE

PORTS DEVELOPMENT PROJECT
(Loan No. 738-PNG)

IN

PAPUA NEW GUINEA

September 1997

CURRENCY EQUIVALENTS

Currency Unit—Kina (K)

		At Appraisal	At Project Completion	At Postevaluation
K1.00	=	$0.9936	$1.0710	$0.7400
$1.00	=	K1.0064	K0.9338	K1.3510

ABBREVIATIONS

EA	-	Executing Agency
EIRR	-	Economic Internal Rate of Return
FIRR	-	Financial Internal Rate of Return
m	-	meter
MIS	-	Management Information System
PCR	-	Project Completion Report
PNG	-	Papua New Guinea
PNGHB	-	Papua New Guinea Harbours Board
PPAR	-	Project Performance Audit Report
t	-	ton
TA	-	Technical Assistance
TEU	-	Twenty-foot Equivalent Unit

NOTES

(i) The fiscal year (FY) of the Government ends on 31 December.
(ii) In this Report, "$" refers to US dollars.

CONTENTS

BASIC PROJECT DATA
Ports Development Project - Loan No. 738-PNG

PROJECT PREPARATION/INSTITUTION BUILDING:

TA No.	TA Project Name	Type	Person-months	Amount	Approval Date
473-PNG	Ports Development Study	PP	15	$250,000	29 Jul 1982
686-PNG	Management Information Systems	A&O	-	$120,000	2 Jul 1985

KEY PROJECT DATA ($ million):	As per Bank Loan Documents	Actual
Total Project Cost	15.34	19.82
Foreign Currency Cost	11.00	11.88
Bank Loan Amount/Utilization	11.00	11.00
Bank Loan Amount/Cancellation		0.00

KEY DATES:	Expected	Actual
Appraisal		22 Jan-3 Feb 1985
Loan Negotiations		7-10 May 1985
Board Approval		2 Jul 1985
Loan Agreement		4 Apr 1986
Loan Effectiveness	3 Jul 1986	29 Dec 1986
Project Completion[1]	31 Dec 1989	30 Jun 1991
Loan Closing	31 Dec 1989	27 Dec 1989
Months (Effectiveness to Completion)	42	54

KEY PERFORMANCE INDICATORS (%):	Appraisal	PCR	PPAR
Economic Internal Rate of Return	19.5	15.0	14.0
Financial Internal Rate of Return	7.2	8.6	0.1

BORROWER: Papua New Guinea

EXECUTING AGENCY: Papua New Guinea Harbours Board

MISSION DATA:

Type of Mission	No. of Missions	Person-days
Loan Inception	1	5
Appraisal	1	50
Project Administration		
- Review	4	42
- Country Loan Disbursement	1	10
- Project Completion	1	17
Postevaluation	1	20

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[1] Including a 12-month maintenance period after physical completion of the last component.

EXECUTIVE SUMMARY

The Project improved the ports of Port Moresby, Kimbe, and Oro Bay, and provided for the construction of a new port at Bialla. The Project was fully implemented, although with several changes in the detailed design. At Port Moresby, the Project created additional container storage space adjacent to the main wharf and upgraded the existing cargo storage area. This eliminated the need to move containers long distances for storage, which had been a major problem at the main wharf. At both Kimbe and Oro Bay, berth improvements, better approach bridges to the wharf, and improvements to the cargo area were introduced, which increased cargo handling efficiency, particularly for containerized cargo, and made the berthing of large ships safer. Previously, most of the vessels collecting crude palm oil from Kimbe and Oro Bay were larger than could be safely berthed, and improved safety was important. In addition, a new wharf for small ships at Kimbe further relieved the growing congestion of the main berths, while additional passenger facilities made passenger movements within the port safer. The new jetty and berth at Bialla permitted direct export of crude palm oil from Bialla skipping the costly transshipment through Kimbe. A concurrent technical assistance provided for the establishment of an improved management information system for the Papua New Guinea Harbours Board (PNGHB), but the system could not be maintained and is now being replaced.

The Project was completed in June 1991, about 18 months behind schedule. Most of the delays were due to problems in achieving loan effectiveness and in the tendering of the contract for Port Moresby, slow construction due to unforeseen problems with piling and dredging, and inappropriate work scheduling by the contractor for Kimbe, Bialla, and Oro Bay. The project cost $19.82 million, which was about 30 percent higher than expected. All of the loan amount of $11 million was disbursed; the balance of the project cost, including the cost overrun amounting to $8.8 million, was borne by the PNGHB, the Executing Agency for the Project. The cost overrun was mainly due to changes in the detailed designs, unexpected works at Oro Bay and Bialla, and higher unit costs. All of the Bank funding for Port Moresby was withdrawn and reallocated to other components as the tendering procedures for this component did not conform with the Bank's guidelines.

Despite the delays, cost overrun, and some changes in design, the Project was generally completed to meet its intended objectives with adequate support of the consultant. Several loan covenants concerning the improvement in operational management of the ports were not complied with, however. These include the establishment of a system to monitor port performance and the maintenance of a minimum 7 percent rate of return on fixed assets in use by the PNGHB.

The main project benefits at Port Moresby, Kimbe, and Oro Bay are savings in cargo-handling costs and ship time. The avoided risk of damage to both ships and wharves is an important added benefit at both Kimbe and Oro Bay. For Bialla, the main benefit is the savings in transshipment costs. These benefits result in recalculated economic internal rates of return (EIRRs) of 14 percent for the overall Project and 8-26 percent for the individual ports. If the savings in ship times accruing to foreign-owned vessels, estimated as half the total ship time savings, do not flow back to the country as economic benefits, the EIRRs would drop to 12 percent overall and 6-18 percent for the individual ports. In contrast to the good economic returns, the financial gains accruing to the PNGHB for each port range from very small to negative. Most of the financial gains accrue to the stevedores, shipping companies, and cargo

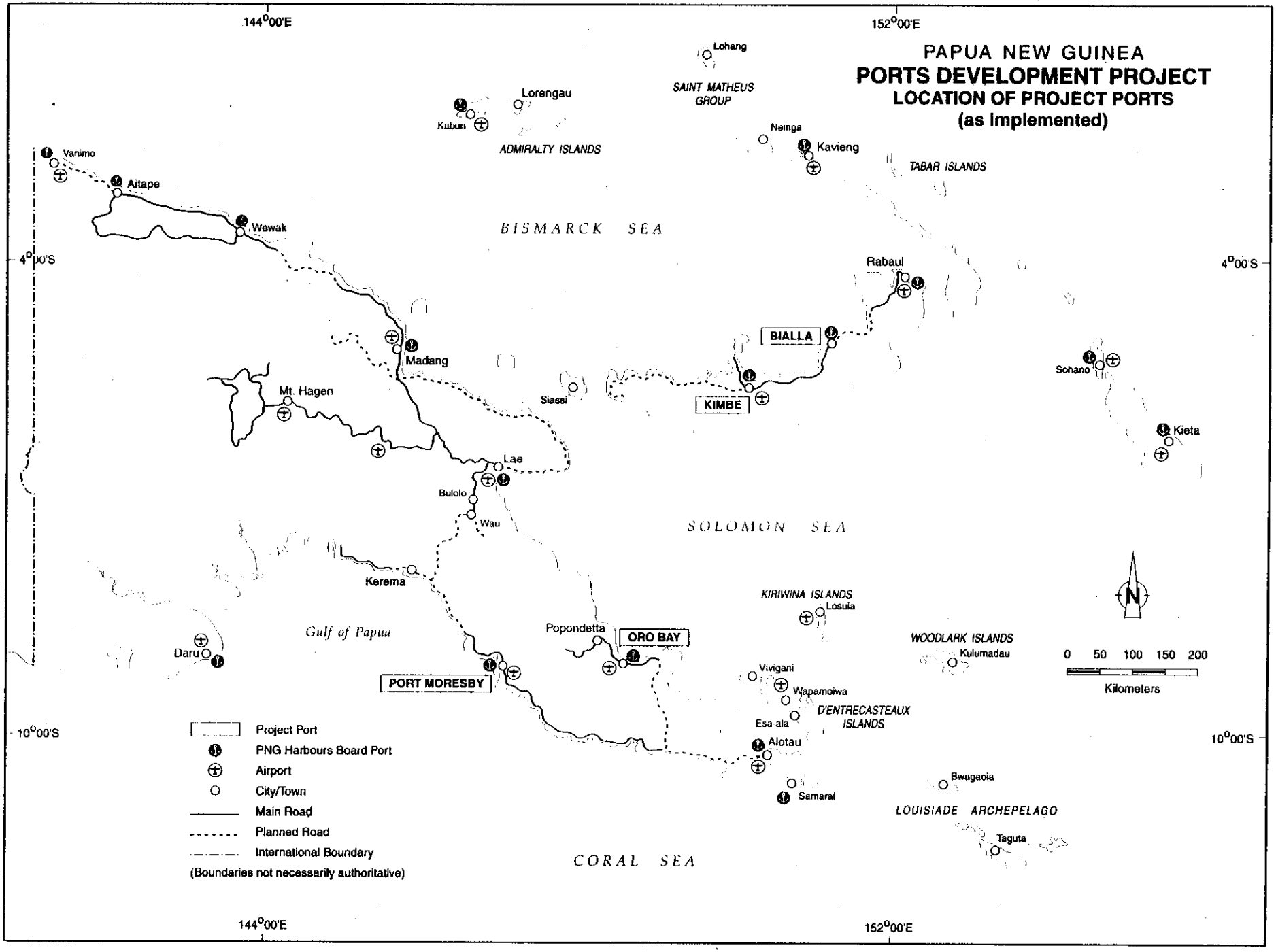
owners and not to the PNGHB, which provides the port facilities. The PNGHB's gain is small because berth congestion was not a major problem except at Kimbe, and the number of ship calls and cargo volumes from which the PNGHB derives its revenue would be similar with and without the Project. Despite the low financial contribution of the Project, the PNGHB gains significant profits from its other operations at Port Moresby and at Lae, enabling it to generate a small profit overall.

The Project is rated as generally successful. It successfully addressed the main operational constraints in each port, and, from the improvements in cargo handling efficiency, port capacity, and ship times, it is probable that the Project has achieved its overall goal of enhancing the country's export competitiveness for agricultural and forestry products, and reducing the cost of imported goods by lowering transport costs. Sea transport and ports are vital to the scattered communities in Papua New Guinea due to the absence of a road network or other practical means of moving goods and people at low cost, and the Project has a significant socioeconomic impact. There were no significant detrimental impacts on environment.

The main lessons arising from the Project concern the importance of matching yard capacity with berth capacity in ports, and the importance of having adequate management training and postdevelopment technical support when technical assistance is provided to establish computer systems. The Project also demonstrated the difficulties in cost estimation for small ports in remote areas and the problems, such as delays in one area causing delays elsewhere, that can arise from packaging several small projects into a single contract, which is done to encourage large contractors.

Follow-up action is needed by the PNGHB to complete the development of the new management information system, including the integration of the financial and operational information systems, and to resolve the problems causing delayed lease payments for the Bialla wharf. A decision also is needed on the refurbishment of the main wharf and/or development of the reclaimed area at Port Moresby.

Postevaluation also revealed several issues of importance for the ports sector of Papua New Guinea. This includes a greater awareness of the role of the PNGHB in maintaining socially important communication links for otherwise isolated communities, and the effect this has on the PNGHB's financial status. This is highlighted by the contrast between the economic and financial returns of the Project. In addition, there is a need to update the national port development plan, review tariffs at the ports, and investigate ways to improve copra loading.


PAPUA NEW GUINEA
PORTS DEVELOPMENT PROJECT
LOCATION OF PROJECT PORTS
(as Implemented)
144°00'E
152°00'E
4°00'S
10°00'S
Lohang
SAINT MATHEUS GROUP
Lorengau
Kabun
ADMIRALTY ISLANDS
Neinga
Kavieng
TABAR ISLANDS
Vanimo
Aitape
Wewak
BISMARCK SEA
Rabaul
BIALLA
KIMBE
Madang
Mt. Hagen
Siassi
Sohano
Kieta
Lae
Bulolo
Wau
SOLOMON SEA
Kerema
KIRIWINA ISLANDS
Losuia
Gulf of Papua
Popondetta
ORO BAY
WOODLARK ISLANDS
Kulumadau
Daru
PORT MORESBY
Vivigani
Wapamoiwa
D'ENTRECASTEAUX ISLANDS
Esa-ala
Alotau
Samarai
Bwagaoia
LOUISIADE ARCHEPELAGO
Taguta
CORAL SEA
N
0 50 100 150 200
Kilometers
Project Port
PNG Harbours Board Port
Airport
City/Town
Main Road
Planned Road
International Boundary
(Boundaries not necessarily authoritative)

97-1045 HR

I. BACKGROUND

A. Rationale

1. Sea transport is important to trade throughout Papua New Guinea (PNG) because of the limited development of the road network. By reducing transport costs, the Project was expected to enhance the country's export competitiveness for agricultural and forestry products, and reduce the cost of imports. To achieve this goal, the Project was to upgrade the port facilities at Port Moresby, Kimbe, and Oro Bay to efficiently serve both local and overseas trade, and to construct a new facility at Bialla. In addition, the institutional capability of the Papua New Guinea Harbours Board (PNGHB) to manage the ports under its control[1] was to be upgraded by establishing an improved management information system (MIS) under a concurrent technical assistance (TA No. 686-PNG) for $120,000.

B. Formulation

2. The Project was based on preparatory work done under the 1982/83 Bank-funded Ports Development Study[2] for Port Moresby, Kimbe, and Oro Bay, and the feasibility studies for Bialla prepared by the PNGHB in 1980 and 1984. Appraisal of the Project was completed in 1985.

C. Objectives and Scope at Appraisal

3. The scope of the Project scope comprised (i) construction of a fender dolphin, additional cargo-stacking areas, and ancillary facilities for the existing main wharf at Port Moresby; (ii) extension and strengthening of the existing wharf, relocation of the mooring dolphins, construction of a new small ships wharf, and provision of additional cargo storage, port buildings, and ancillary facilities at Kimbe; (iii) construction of two breasting and two mooring dolphins, and rehabilitation of the existing wharf and ancillary facilities at Oro Bay; (iv) construction of an offshore loading jetty for palm oil and the provision of ancillary facilities at Bialla; and (v) consulting services for design and construction supervision.

4. Without the additional cargo-stacking areas and ancillary facilities at Port Moresby, containerized cargo and empty containers passing over the main wharf would have to be stacked at the container yard behind the container berth. This area is significantly farther away from the main wharf than the stacking area provided under the Project, and savings in cargo handling equipment, containers, and cargo handling expenses were expected from the Project. The fender dolphin at Port Moresby was expected to save ship time in berthing. At Kimbe and Oro Bay, a major consideration in the design of the Project was the improvement of safety for both large ships and the wharves since the berths were only 30 meters (m) long while vessels reached up to 170 m in length. The improved safety was expected to encourage more of the larger vessels to call at these ports, and result in lower freight rates. At Kimbe, the wharf extension, the small ships wharf, and the cargo area improvements also were expected to improve cargo handling rates and reduce ship service and wait times. Modest savings in ship

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1 The PNGHB owned 17 ports including Bialla.

2 TA No. 473-PNG, for $250,000, approved on 29 July 1982. This study also recommended the upgrading of five other PNGHB ports. Of these five, Lae Port was funded by the Bank under Loan Nos. 468-PNG, for $8 million, and 469-PNG(SF), for $12 million, approved on 25 September 1980. The others were funded by the PNGHB.

times were also expected at Oro Bay. The new facility at Bialla was expected to eliminate the expensive transshipment of bulk liquid palm oil products through Kimbe, and the associated extra handling costs.

D. Financing Arrangements

5. The total cost of the Project was estimated to be $15.34 million, inclusive of $11.0 million in foreign exchange costs. On 2 July 1985, the Bank approved a loan of $11 million out of the ordinary capital resources for the foreign exchange portion. The Borrower was Papua New Guinea, and the proceeds of the loan were relent by the Borrower to the PNGHB under a subsidiary agreement. The entire local cost portion of the Project was to be provided by the PNGHB from its own funds. At the same time as the loan, $120,000 was approved for TA No. 686-PNG to establish an improved MIS for the PNGHB. The PNGHB was the Executing Agency (EA) for the Project. The PNGHB also was the EA for the Lae Port Project (Loan Nos. 468-PNG and 469-PNG[SF]) completed in 1989, and is an EA for the ongoing Transport Infrastructure Development Project (Loan Nos. 1153-PNG and 1154-PNG[SF]).

E. Project Completion

6. The Project was substantially completed in June 1990, although several components were completed earlier, and the project loan was closed in February 1990. The Project Completion Report (PCR) Mission was fielded in October 1990 and the PCR was circulated to the Board in July 1991.

7. The PCR provides a detailed evaluation of project implementation, including the variations in cost and schedule compared with the appraisal expectations. Postevaluation found the PCR's assessment did not adequately deal with the economic and financial benefits, and the compliance with those loan covenants that concerned the operational aspects of the Project. The PCR concludes that the Project is generally successful and provides useful recommendations for further development in the Project ports.

F. Postevaluation

8. The Project Performance Audit Report (PPAR) is based on a review of the PCR, the Appraisal Report, material in the Bank's files, and records of the EA; and discussions with staff members of the Bank, the EA, other concerned Government agencies of the Borrower, and port users including stevedores, shipping lines, and cargo owners. The PPAR focuses on pertinent aspects of the Project and presents the findings of the Postevaluation Mission that visited the project area from 26 January to 6 February 1997.

II. IMPLEMENTATION PERFORMANCE

A. Design

9. The Project aimed to address the inadequate cargo handling and container storage capacity at Port Moresby's main wharf, the inadequate safety for berthing large vessels at Oro Bay, the inadequate ship safety and congestion at Kimbe, and the high cost of transshipping bulk liquids originating from Bialla. These were major problems at the time of

appraisal, but have been overcome by the Project (see paras. 24 to 30). The operational problems at each port at the time of postevaluation were comparatively minor. The results indicate that the Project components were appropriate to the needs.

10. During implementation, several changes were made in the detailed design, but these changes did not alter the Project's objectives or the ability of the Project to achieve its purpose. At Port Moresby, the berthing dolphin was deleted; instead, the PNGHB is to provide tugboats when berthing assistance is required. The other works at Port Moresby were reduced slightly in scale and financed completely by the PNGHB rather than partly from the Bank loan. At Oro Bay, the surveys for detailed design indicated that the proposed renovation of the existing wharf deck was insufficient to prolong the useful life of the wharf. Instead, the wharf was reconstructed using the existing supporting piles after they were strengthened. In addition, a second connecting bridge between the wharf and the cargo yard was constructed to allow circular flow of cargo. At Bialla, the jetty head was enlarged to enable the new facility to handle general cargo, instead of just bulk liquids as originally proposed.

11. With the exception of the enlarged jetty head at Bialla, the changes in the detailed design were appropriate. Deletion of the berthing dolphin at Port Moresby was reasonable, as not all vessels have difficulty in berthing, and even for those that do, the difficulty is experienced only during the southeast monsoon period. At Oro Bay, there was no practical alternative other than increasing the works to the level of reconstruction. The second bridge at Oro Bay greatly facilitates the movement of containers at the port and is beneficial as the containerization of cargo has increased significantly. Inclusion of the second bridge also enabled the wharf to be reconstructed with minimal disruption to cargo and ship operations. At Bialla, the small volume of nonbulk liquid cargo currently passing over the new wharf does not justify the large jetty head. However, the alternative provincial wharf can handle only small vessels, and the change does provide flexibility for accommodating large coastal and overseas vessels in the future or in the case of emergencies. Given the relatively high cost of mobilizing equipment to construct a large jetty head at a later stage, and the small added cost of enlarging the head as part of the Project, the change was practical.

12. The need for changes in the detailed design and the appropriateness of the changes suggest weakness at the project preparation and appraisal stages. Certainly, further evaluation at appraisal of the impact and costs of the berthing dolphin at Port Moresby was possible and could have prevented the inclusion of this unnecessary subcomponent under the Project. Earlier detection of the weakness of the old piles at Oro Bay would have required a detailed engineering survey. The other changes at Oro Bay are of a very practical nature, much appreciated by the port users, and some of these changes may have been included earlier if there was more involvement of the port users at the conceptual design stage.

B. Contracting, Construction, and Commissioning

13. The issues related to contracting and construction were the delay at Kimbe, Bialla, and Oro Bay, and the award of contract number one for the Port Moresby works. The delays can be traced to inappropriate selection of floating piling and dredging equipment and poor work planning by the contractor (see para. 18). Contract number one was retendered by the PNGHB without the Bank's prior approval and in contravention of the Bank's *Guidelines for Procurement*. This led to the PNGHB funding all of this component from its own sources. The facilities provided under the Project have the capacity expected of them.

C. Organization and Management

14. The arrangements for implementing the Project, which involved the establishment of a Project Management Office and the use of a consultant for engineering design and supervision, were appropriate. Except for its handling of the tendering of contract number one, the PNGHB as the EA, performed adequately. The consultant engaged for the feasibility study was retained for engineering design and supervision. This consultant was able to provide needed backup from its head office to overcome the many minor construction problems, such as wrongly positioned piles, and design weaknesses on the part of the contractor under contract package number two. The Borrower's support for the Project would have been better if it had released funds under the subsidiary loan agreement and had addressed the need for tariff increases or other compensatory measures to improve the PNGHB's financial position in a more timely manner.

D. Actual Cost and Financing

15. The cost of the Project was $19.82 million, about 30 percent higher than expected. All of the loan amount of $11 million was disbursed and the cost overrun was borne by the PNGHB. The civil works at Oro Bay and Bialla substantially exceeded the expected costs (by nearly 500 and 250 percent, respectively) due to changes in detailed design (see para. 10), longer than expected pile lengths, particularly for Bialla, which required 128 piles, and high mobilization and unit construction costs. The cost for the Kimbe works was close to the appraisal expectation despite extra pile requirements and high mobilization costs. At Port Moresby, the reduction of the area of paving saved about $0.8 million, but these savings were partly offset by higher unit costs for other works. The net result for Port Moresby was a 10 percent lower cost than expected (see Appendix 1).

16. The Project highlights two difficulties in estimating costs for small construction works in isolated locations. The first concerns the difference between the actual and expected project costs after adjustments are made for the change in the detailed designs, and the variation in this difference between project components. A major reason for both the difference and the variation in the difference is the small and isolated nature of the civil works, which makes the estimation of unit costs and quantities difficult and prone to inaccuracy. Under the Project, the contingency allowances provided to cope with these estimation problems were not adequate for Oro Bay and Bialla, but were sufficient for Port Moresby and Kimbe. Secondly, specialized items of equipment such as floating pile drivers and dredges are not readily available in PNG. Particularly for small isolated ports, such as Kimbe, Bialla, and Oro Bay, this can lead to high mobilization costs and limits flexibility for changing equipment. Under the Project, the mobilization costs were relatively high, estimated to be 15-25 percent of the construction costs.

E. Implementation Schedule

17. The Project was expected to be physically complete by December 1988. Full completion was expected to be a year later, that is, the end of 1989 when the 12-month maintenance period was finished. Actual construction took until June 1990 and the Project was deemed complete at that time, before the end of the maintenance period. If the maintenance period is included, the Project was 18 months behind schedule. This total delay can be attributed to a 6-month delay in achieving loan effectiveness and a 12-month increase in the

length of the construction period. The delay in achieving loan effectiveness was due to the protracted negotiations between the Borrower and the PNGHB in finalizing the subsidiary loan agreement and delay in having the agreement ratified by the National Executive Council. The works at Port Moresby were finished in early 1988, about 13 months later than planned mainly because of delays in achieving loan effectiveness and the problems associated with the tendering of contract number one (see para. 13). The works at Kimbe were completed in mid-1989, those at Oro Bay at the end of 1989, and those at Bialla in mid-1990, representing delays of 12-24 months in the construction schedules for the individual ports. For the three ports, the main cause of delay, apart from the problems in achieving loan effectiveness, was slow construction due to problems with piling, dredging, and inappropriate scheduling of work (see para. 18). The loan was closed in December 1989, ahead of physical completion.

18. Under the contract package for Kimbe, Bialla, and Oro Bay, the dredge initially mobilized by the contractor proved inappropriate when coral was encountered at Kimbe, while the increase in pile depths by as much as 50 percent over that expected meant the selected piling equipment was slow and could not operate in rough sea conditions. Another major cause of delay was the contractor's scheduling of critical works for completion during the wet season. Many tasks had to be delayed when heavy rains occurred and the schedule could not be achieved. Because the works at Kimbe, Bialla, and Oro Bay were done under a single contract, delays in one port affected work progress in the other ports. Better work planning at Oro Bay, the last of the three ports started under this contract, helped reduce the overall delay. Wet season flooding in the Bialla area disrupted the delivery of rock and piles and also affected the work schedule.

F. Technical Assistance

19. The project preparatory TA provided a rational overall plan for improvement of the PNGHB's ports. This plan was largely implemented through the Project, the revised Lae Port Project, and PNGHB self-funded projects for ports such as Vanimo and Alotau.[1] For Port Moresby, Kimbe, and Oro Bay, the study accurately predicted what was required and the scale of benefits to be achieved. The study for Bialla, done separately by the PNGHB, also proved to be generally reliable, although the projected cargo throughputs were overestimated.

20. The main thrust of the accompanying TA for strengthening the institutional capacity of the PNGHB was to establish an MIS that linked operational and financial performance. This was to provide comprehensive information for port management and longer-term planning. Although a computerized MIS was established, the TA did not achieve its overall goal. The TA was concluded following satisfactory operation of the system for a four-week reporting period in 1988. Backup support was arranged through a local computer services company. However, problems occurred in the adaptation of the system and could not be solved through the backup support. As a result, financial reporting continued to be done separately. Although the financial and operational data have the same source, discrepancies between the financial and operational reports arise because the entry of data is done separately, and there is lack of confidence in the quality of the operational reports. These doubts have not been examined in detail, but a random audit done as part of the Second Ports Development Study in 1990 found the generated operational information to be generally reliable. At the end of 1994,

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[1] This was updated under TA No. 1077:*Second Ports Development Study*, for $350,000, approved on 2 December 1988.

the PNGHB introduced a new system using different software, and is currently trying to make the new system operational. This does not mean that the original software chosen by the TA consultants was inadequate. However, the new software is compatible with that in use for generating financial reports and change to this new software should be expedited.

21. Failure of the TA can be related to (i) the scope of the TA because, as defined in the terms of reference, the TA did not provide PNGHB with sufficient training in operating the MIS, nor with adequate backup services subsequent to the completion of the TA; (ii) the high turnover of management staff of the PNGHB, particularly in the Electronic Data Processing section; and (iii) a lack of coordination between the MIS unit within the PNGHB and the computer department serving the financial management function.

G. Compliance With Loan Covenants

22. While the loan covenants designed to ensure efficient implementation of the Project were reasonably complied with, several covenants concerning subsequent operations were not complied with. The PNGHB was to establish productivity standards for each of the ports and these were to be used to gradually improve operations, as well as to monitor project benefits. This was not done. While failure to make the MIS operational posed some difficulties in generating data by which the productivity standards can be monitored, a system still could have been created and operated. There is no evidence to indicate that this was attempted. Many of the stevedore companies also objected to providing data on the utilization of their equipment, arguing that this was confidential information. However, given that the cargo operations in most of the PNGHB's ports, including those under the Project, are licensed to single operators, the inclusion of stevedores in such a productivity monitoring system is necessary to ensure against abuse under monopoly arrangements. A stronger effort to obtain information from the stevedores ought to have been made.

23. The PNGHB also has not maintained at least 7 percent rate of return on net fixed assets in use as covenanted (see para. 33). This is due, in part, to failure of the Borrower to regularly review and increase tariffs as required. However, tariff increases should not be considered as the sole solution. The financial data for the PNGHB show that the decline in the rate of return is also due to a faster increase in the PNGHB's assets compared with its income. Not all of the PNGHB's assets are profitable since it owns and operates some ports in accordance with the social objective of maintaining access for small communities, and an increase in the proportion of nonprofitable to profitable assets could cause a drop in the rate of return. This aspect of the PNGHB's operations and the effect of expansion of nonprofitable assets on its financial position does not appear to have been sufficiently understood when the loan covenant was prepared.

III. PROJECT RESULTS

A. Operational Performance

1. Port Moresby

24. The Project was to improve operations at the main wharf. This wharf handles both coastal and overseas cargo in containerized and break-bulk forms. Its operations are

linked to berth 4, the dedicated container berth. Up to 1995, total cargo throughputs for the main wharf and berth 4 were close to appraisal expectations, growing at around 4-5 percent a year (see Appendix 2). Within this overall trend, the volume of coastal dry cargo was lower than expected, but this was compensated for by a higher volume of overseas dry cargo. An important change was in the proportion of dry cargo that was containerized. At the time of appraisal, 28 percent of the dry cargo was containerized, but by 1994 the proportion had reached 68 percent. The 1994 container throughput was 42,000 twenty-foot equivalent units (TEUs), 35 percent higher than expected.

25. As envisaged at appraisal, the additional open storage area and improvements within the cargo area behind the main wharf allowed containerized cargo to be stored close by. This avoided the movement of containers to other areas, such as the cargo area behind berth 4, a distance of about 700 m and requiring the use of a busy public road. As a result, cargo handling rates have increased, congestion in the cargo area behind the container berth has been avoided, and secondarily, the capacity of the main wharf has been effectively increased by over 100,000 revenue tons per year. Cargo handling costs and ship service and waiting times are lower than they would otherwise have been without the Project. Although the useful life of the main wharf is affected by the physical condition of the structure and decisions about the overall layout of the port (see para. 47), because of the Project, the capacity of the main wharf and its backup cargo area should be adequate until 2010.

2. Kimbe

26. At Kimbe, the Project benefited overseas and coastal cargo operations as well as passenger movements (see Appendix 2, Table 2). The throughput of total cargo at this port grew at around 4 percent per year since project completion, faster than the 2 percent growth per year expected at appraisal. The growth in bulk liquid palm oil products has been particularly strong. Moreover, the planned loss of transshipped bulk liquid from Bialla coincided with a compensatory lift in local bulk liquid cargo. Total cargo throughput in 1995 exceeded the appraisal forecast by about 26 percent. The containerization of cargo, which at appraisal was about 13 percent of the dry cargo, reached 30 percent in 1994, involving 2,400 TEUs, twice the forecast volume. Ship sizes, which were expected to increase as a result of the Project, have not changed appreciably, although without the Project it is possible that ship sizes would have decreased in response to deteriorating safety for berthing large vessels.

27. The cargo area improvements, the wider access bridge, and longer berth enable the port to more efficiently handle containers and avoid the need to warp[1] long vessels to access all hatches. As a result, dry cargo handling rates have improved and ship service and waiting times have decreased. Construction of the small ships wharf also relieved pressure on the main wharf, leading to savings in ship time as well as general efficiency gains in the coastal operations involving small vessels. Further reductions in berth occupancy came from the Bialla component, which lessened the volume of cargo handled at the port, and the concurrent, although not part of the Project, increase in bulk liquid pumping rates. As a result of these changes, the berth occupancy rate at the main wharf has remained less than 35 percent and is expected to remain at a satisfactory level until 2009. The separate passenger waiting area constructed under the Project also has contributed to port safety and general efficiency by

[1] A procedure used where if a vessel is longer than the berth, the vessel is progressively moved in stages to bring all of its length alongside the berth.

regulating the movement of passengers within the port area, as well as providing waiting passengers with better amenities.

28. An important benefit from the berth improvements, including the berthing dolphins, is the reduced risk of damage for both ships and berth. For a port with only one berth capable of handling the larger coastal and overseas vessels, and without all-weather road access from alternative ports, serious damage to the berth would disrupt cargo movements and lead to a reduction in trade volumes.

3. Bialla

29. The cargo handled at the new Bialla facility is almost exclusively bulk liquid palm oil products and fuel for Hargy Oil Palms Pty. Limited. Cargo for the local settlements continues to be handled at the old provincial wharf. Throughput at the new wharf is growing at about 5 percent per year, but is well below the appraisal forecast (see Appendix 2, Table 3). For example, the 1995 throughput of 32,000 ton (t) is 40 percent of the forecast volume. This is due to unfulfilled appraisal expectations about the planting of additional areas for oil palm and crop yield increases. Because of the Project, palm oil products from Bialla are now directly exported and the high transshipment and extra handling costs that were incurred before the Project have been saved. Exports are in tankers in the range of 11,000 to 20,000 deadweight t and with a frequency of call of one or two vessels per month, berth occupancy is around 5 percent and congestion is not an issue.

4. Oro Bay

30. At Oro Bay, overseas and coastal dry cargo and bulk liquids, primarily palm oil products, are handled at the single wharf. Total cargo throughput is similar to that forecast at appraisal, although coastal cargo is greater, and overseas cargo less, than forecast (see Appendix 2, Table 4). The average growth rate in cargo up to 1995 was 2 percent per year. At the time of appraisal, 18 percent of dry cargo was containerized, and by 1994 this proportion had increased to 39 percent, comprising 1,300 TEUs, about half the appraisal forecast. Construction of a second approach bridge under the Project facilitates container handling between the wharf and the storage area and has increased cargo handling rates. Although congestion was not a serious problem in Oro Bay, ship service and waiting times have been reduced. Berth occupancy since project completion has been in the range of 25-30 percent with a wait time/service time ratio of about 0.1. Importantly, the lengthening of the berth, the construction of a strong point at the eastern end and a dolphin at the western end, and reconstruction of the wharf have improved berth security and reduced the risk of damage in the same way as in Kimbe. This has contributed to the continued use of the port by vessels of up to 170 m in length.

B. Institutional Development

31. The PNGHB's capability to control the operational and financial performance of its facilities and generate planning data was expected to be strengthened by the development of an MIS. However, the MIS is not yet operational (see para. 20), and the expected institutional improvement did not occur.

32. The PNGHB's national engineers were seconded to the consultant teams during the design and construction phases of the Project and gained useful technical and project

management experience. Several of these staff are now in senior positions within the PNGHB, and this secondment has provided a low-cost method for strengthening the organization's capability.

C. Financial Performance

33. Over the past decade, the PNGHB's profitability has decreased as indicated by the return on average net fixed assets in use, which typically ranged from 6-10 percent during the 1980s, but decreased to around 1-4 percent during the period 1991-1995 (see Appendix 3). A return of at least 7 percent was covenanted under the Project. The reduced profitability results from a deterioration in operating income, as indicated by its high operating ratio[1] over recent years and a faster increase, since 1985, in the average value of the net fixed assets in use compared with operating income. Since 1990 the operating ratio has often been about 0.9, which indicates a low profit margin, while between 1985 and 1995 the average net fixed assets increased at around 11 percent per year, much higher than the 4-5 percent increase in operating income. Despite its weakening financial position, the PNGHB has produced a positive operating income each year, has serviced its debts and paid taxes, and in most years has paid a dividend to the National Government. An increase in operating margin and return on average net fixed assets in use, however, would improve the robustness of the PNGHB's cash flow and provide for eventual asset replacement.

34. The impact of the Project on the PNGHB's financial position is not clear, being confounded by changes in non-project variables, such as cargo volumes. However, the gain in revenue due to the increased capacity is modest and it is probable that the Project, except for Bialla, contributed to a more rapid rise in the PNGHB's assets compared with its income, and a resultant weakening of its financial position. The PNGHB's gain is modest because, without the Project, berth capacities would have been adequate until 2000 in the case of Port Moresby and 2005 for Oro Bay.[2] Only at Kimbe where the berths would have reached capacity in 1992 without the Project would significant revenue losses have occurred over the short to medium term.[3] At Bialla, the investment reduced PNGHB's income at Kimbe through the loss of transshipped cargo. However, this was partly compensated for by the lease of the Bialla facility to Hargy Oil Palms Pty. Limited at a rate that was to enable the PNGHB to recoup the capital expense at Bialla, plus interest.

35. At Bialla, the sole user that leases the facility from the PNGHB pays to the PNGHB, either directly or indirectly,[4] berthage and wharfage charges as well as a lease payment. Compared with a single fixed annual charge that would recoup the cost of the wharf, this mixture of fixed and variable charges seems to place an unnecessary administrative burden on the PNGHB to monitor and collect all the fees, and reduces the incentive for the lessee to maximize use of the berth. The lease payments have not been regularly remitted to the PNGHB by the lessee, which was in default at the time of postevaluation.

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1 Ratio of operating expenditure to operating revenue. The lower the ratio, the better the operating profit.

2 Berth capacity was not the main constraint at these ports.

3 It is also probable that, if the Project had not been implemented, part of the theoretically lost cargo might have been diverted to other PNGHB ports where the lost income would have been regained.

4 Wharfage is paid directly, while berthage is first paid by the shipping company and charged back to the port user in the form of shipping expenses.

D. Economic and Financial Reevaluation

36. The main economic benefits from the Project at Port Moresby, Kimbe, and Oro Bay are savings in cargo handling costs, ship service, and waiting time, and the avoided costs of diverting cargo to other forms of shipping and/or wharves. This is a result of improvements in cargo handling rates and other changes, which effectively increased capacity at each of the ports. Another important benefit at Kimbe and Oro Bay is the avoided risk of damage following the improvement in safety. A significant benefit at Kimbe, but one that could not be quantified for lack of data, is the savings in ship time for small vessels using the new small vessels wharf. At Bialla, the major benefit is the saving of transshipment and extra handling costs for bulk liquids. Based on the quantified benefits, the economic internal rates of return (EIRRs) were reestimated to be 26 percent for Port Moresby, 8 percent for Kimbe, and 11 percent for Bialla, or 8 percent for both Kimbe and Bialla if the investments are considered together, 10 percent for Oro Bay, and 14 percent overall for the Project (see Appendix 4). The quantified economic impact at Kimbe is less than it should be since the benefits from the small vessel wharf were not quantifiable and were not included in the analysis. Compared with the calculations at both appraisal and project completion, these returns are higher for Port Moresby, but the same or slightly lower for the other ports and overall. The differences reflect variations in methodology as well as in the assumptions about the types of benefits that occurred and cost savings. The postevaluation methodology and assumptions are considered more appropriate and realistic (see Appendix 4, Section D). As it is not certain that benefits in ship times accruing to foreign-owned vessels will flow back to the country in the form of economic benefits, the effect on the economic impact of a reduction in ship time benefits was also assessed. The recalculated EIRRs with a reduction of 50 percent in the ship time benefits were 12 percent for the overall Project and 6-18 percent for the individual ports.

37. The recomputed financial rate of return (FIRR) was less than 2 percent for Port Moresby, Kimbe, and Bialla together, and the overall Project, and negative for Oro Bay. All these results are much lower than calculated at appraisal and project completion. The low FIRRs reflect the small increments in revenues compared with the investment costs.

38. The large difference between the economic and financial returns reflects differences in the nature of the economic and financial benefits and where the benefits accrue. The majority of the economic benefits come from cargo handling cost savings, which lead to financial gains for the stevedores; from savings in ship time, which are reflected in financial gains for the shipowners; and from risk minimization, which does not generate a tangible income. These gains were significant. The financial benefits as measured for the FIRR analysis, on the other hand, are those gained by the PNGHB through increases in berthage, wharfage, and storage income over the without-Project situation. As indicated in para. 34, the gains for the PNGHB are small. Most of the financial gains at the ports flow to the stevedores and cargo owners through reduced handling costs and freight charges. While the increased port efficiency reflected by the high EIRRs would justify an increase in tariffs, which would improve the financial returns, the tariff rates would have to more than double to produce satisfactory FIRRs due to the small cargo throughputs. Such large increases, which are likely to be passed on directly to cargo owners and consumers, pose political problems and may be difficult to implement. Most of the small ports in PNG are simply financially nonprofitable and are maintained more for the socioeconomic benefit of the otherwise isolated communities that they serve (see also para. 44).

E. Socioeconomic and Sociocultural Results

39. Each of the Project ports plays a key role in facilitating the inward and outward flow of items for the people in the hinterlands. In each case, there is little alternative for trade other than the Project ports as the road network is not well developed. Maintaining adequate and efficient ports, therefore, is important. In addition, specific benefits also have accrued to passengers at the port of Kimbe and to smallholder oil palm producers. Passengers at the port of Kimbe have benefited from the improved waiting facilities and the safety given by the separation of the passenger area from the cargo area. By replacing the expensive transshipment of palm oil from Bialla with direct export shipment, and avoiding the introduction of transshipment at Oro Bay and Kimbe, which may have occurred in view of deteriorating port safety, the Project has enhanced palm oil profitability and thereby benefited oil palm producers, including the many smallholders around Kimbe, Bialla, and Oro Bay. The benefit for oil palm producers is indicated by the significant increases over the past decade in bulk liquid trade at those ports (see Appendix 2, Tables 2-4). The major portion of the bulk liquid trade comprises crude palm oil, a significant proportion of which is derived from smallholder produce. Adverse socioeconomic impacts are not apparent.

F. Women in Development

40. Because of its nature, the Project was not designed to include special provisions for women.

G. Environmental Impacts and Control

41. The new facilities at Port Moresby, Kimbe, and Oro Bay are small and significant environmental impacts are not apparent. Although of a larger scale, the new pier and wharf at Bialla have not caused erosion, accretion, or other noticeable changes in the area. The forklifts used at Oro Bay leak oil, which has destroyed the paving in the area, and the potential runoff of contaminated rainwater from the area into the sea poses an environmental threat. This matter is being attended to by the PNGHB, and the stevedore operating the forklifts replaced some of the leaking equipment at the beginning of 1997. Spillage during the loading of liquid palm oil products at Kimbe, Bialla, and Oro Bay is a potential environmental threat. While no problems have occurred so far, there is no adequate provision yet at the field level to contain a major spill should it occur. An ongoing Bank Project, the Transport Infrastructure Development Project, does provide for the procurement of equipment to combat oil pollution and the development of a national oil spill contingency plan.

H. Gestation and Sustainability

42. Benefits from development of each of the four ports commenced as soon as the facilities were completed, and will increase in size as cargo volumes steadily increase over time. The sustainability of the benefits will be dependent upon the PNGHB continuing to operate profitably so that it will be able to maintain the facilities (see para. 43 for further discussion). The sustainability of benefits is also of concern at Port Moresby where the main wharf has deteriorated and is approaching the end of its useful life. A decision about what to do with this wharf is required (see also para. 47). At Kimbe, congestion will soon occur and further improvement of port operations, including possibly by berth expansion, will be required to avoid the dissipation of future benefits. There is also a problem with the maintenance of the pavement

at Oro Bay, and maintenance of the Bialla facility has not yet commenced. However, the PNGHB is aware of the need for maintenance and has addressed the problem at Oro Bay.

IV. KEY ISSUES FOR THE FUTURE

A. The Role of Papua New Guinea Harbours Board

43. PNGHB is currently responsible for 17 declared ports, few of which are profitable.[1] Maintaining these ports enables the Government, through the PNGHB, to provide significant socioeconomic benefits to many communities that would otherwise be isolated. At present, the profitable ports sufficiently subsidize the nonprofitable ones and enable the PNGHB to generate a net profit, although not enough to provide an adequate return on assets. The PNGHB's profitability is declining, however, and its ability to maintain its facilities and sustain the benefits under this and other projects is under threat. Moreover, the extension of the PNGHB's responsibility to cover more ports is being considered, initially at three locations. These three new sites as well as other sites under consideration are small and unlikely to be profitable. The effect of such expansion will be to increase the demand on the PNGHB's limited capital resources and further erode its profitability. There is growing pressure also from private sector operators to be allowed to compete with the PNGHB for general cargo business at ports that are profitable. As the PNGHB continues to operate nonprofitablle ports as a community service obligation, it will not be able to compete with the private sector on an equitable basis should this occur. In view of these pressures on the PNGHB, there is a need to set clear directions for the future of the PNGHB in the transport sector as a whole and the maritime subsector in particular. Most importantly, its development plans and operations should clearly distinguish between the social and profit objectives, and appropriate sources of funds need to be identified to enable it to fulfill the social obligations. Direct financial compensation to the PNGHB for operation of the nonprofitable but socially necessary ports may be warranted.

B. Port Tariffs and Papua New Guinea Harbours Board Income

44. Port tariffs were increased by 30 percent in 1985, 15 percent in 1986, and 6 percent in 1992. Since then, there have been only minor upward adjustments in miscellaneous charges. Given the long time since the last significant increase and the PNGHB's deteriorating financial position, a review of the tariffs would be appropriate. However, tariffs are not the only way to improve the PNGHB's financial position. Compensation to the PNGHB for maintaining unprofitable ports that provide vital communication links with otherwise isolated communities could also be considered. Any review of the tariffs should also consider changing from the existing single ad valorem tariff schedule to a cost-based one. The existing schedule is applicable to all ports and has charges based on vessel type, i.e., coastal or overseas, and cargo according to whether it is part of foreign trade or local trade. A cost-based tariff schedule has the advantage of enabling charges to reflect the cost of providing the service, avoiding the cross-subsidization among services that currently occurs, and the difficulty of ensuring adequate cost recovery when there is a change in the services. However, any change in either

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1 Private wharves also operate within PNGHB's declared ports, particularly the profitable ones. However, many profitable wharves are developed and operated outside of declared PNGHB ports by other entities; an example is the new port serving the Lihir Island Gold Mine.

the type of schedule used or the magnitude of the charges must recognize that some of the PNGHB's ports have low throughputs and full cost recovery may not be possible in all ports.

C. Port Planning

45. A period of six years has elapsed since completion of the last national ports development plan under TA No. 1077, and there is a need to update the traffic forecasts and development plans. The capability of the PNGHB for undertaking such planning is still underdeveloped, and assistance from external agencies will be required. Such a plan would need to recognize the problems faced by the PNGHB in expanding its area of coverage as discussed in para. 43, and the opportunities for private sector involvement.

D. Port Capacity

46. The size of vessels operating between major PNG ports as part of the coastal trade may give rise to a problem when these small coastal vessels have to share the same berth used by large overseas vessels. Where a port has only one berth as is the case at Kimbe and Oro Bay, the fixed day schedules of the coastal vessels are adversely affected by overseas vessels with long berth times. For example, large multipurpose vessels may take several days when loading copra and during these times coastal vessels may bypass the port, resulting in the transshipment or reshipment of the cargo on a subsequent voyage. There is a need to address this problem. The introduction of ways to increase cargo handling rates may provide a lower cost alternative for increasing port capacity than additional berth length.

E. Port Moresby

47. The main wharf at Port Moresby, which benefited from the Project, is near the end of its useful life and the PNGHB has undertaken a study to assess options for its refurbishment. These options depend on the future purpose of the wharf, which may be used either as a combined overseas/coastal facility or as a dedicated coastal terminal. The PNGHB recently reclaimed an area adjacent to container berth 4, taking advantage of the availability of low-cost fill material from the Poroporina Highway Project. Although congestion is not a problem for the port of Port Moresby over the short term, and simple refurbishment of the main wharf may be a low-cost solution to the immediate problem of berth safety, including the use of the reclaimed area for development of a new berth in the options to be considered is warranted. This is because the use of the reclaimed area presents an opportunity to address longer term issues affecting the spatial layout of the port, the division of coastal and overseas operations, and container handling.

F. Stevedore Arrangements

48. Currently, cargo handling at each of the small ports such as Kimbe, Bialla, and Oro Bay is done by a single stevedore operating under a three-year license issued by the PNGHB. The small cargo throughputs in these ports could not support more than one stevedore and the single-operator arrangement is appropriate to the needs. However, the monopoly situation created does raise the risk of low cargo handling productivity or other aspects of poor stevedore performance such as what happened at Oro Bay where the stevedore refused to repair the oil leaks in his equipment, which led to the deterioration of the asphalt pavement. The licensing procedure provides scope for ensuring certain minimum levels of efficiency and service, in that licenses are valid for only three years and are open to tender at

the time of renewal. The selection criteria require the winning bidder to have minimum quantities of appropriate types of equipment and to be able to demonstrate that they can achieve minimum levels of productivity. However, these conditions do not appear to be applied, as there is no evidence that productivity indicators are requested or used in the bidding process, and generally old equipment is provided by the winning bidder. Two factors contribute to this situation. First, performance data on cargo handling is not collected and consequently, productivity indicators are not produced. The MIS which was established under the Project was an attempt to address this issue, but did not succeed partly because of the reluctance of the existing stevedores to provide information. Secondly, in respect to the condition of the equipment, the three-year term of the license does not encourage the stevedores to invest in new and improved equipment that would have to be written off over a much longer time period. A longer license term would encourage investment in better equipment, but is not practical at the present time in view of the absence of productivity indicators or the mechanism for monitoring them. The result is an absence of pressure on stevedores to improve, or even maintain, cargo handling productivity, and this may increase costs for cargo owners, and the reduced efficiency of the PNGHB's wharves and other port facilities.

V. CONCLUSIONS

A. Overall Assessment

49. The project facilities were developed generally as planned, and the immediate objectives of improved cargo handling, safety, and ship times were met. On the negative side, the associated TA did not succeed in strengthening the institutional capability of the PNGHB. The project-induced operational improvements have resulted in significant economic benefits as measured by recalculated EIRRs. Although difficult to prove, the Project's achievements in cargo handling efficiency, port capacity, and ship times are likely to have kept transport costs lower than they would otherwise have been, and it is probable that the Project has achieved its overall goal of enhancing the country's export competitiveness for agricultural and forestry products and reducing the cost of imported goods. In view of the importance of ports as communication links for the otherwise isolated communities that they serve, such improvements in the costs of trading can have significant socioeconomic impacts. The financial returns of the Project are low, however, as most of the financial benefits do not accrue to the PNGHB. Significantly, the difference between the economic and financial returns highlights the difficulty of recouping port investment costs through port-related charges in PNG and underlies the need for continuing public support for the sector. There were no significant adverse environmental or social impacts and, provided development continues and addresses the future needs at the ports, the benefits are sustainable. Viewed overall, the Project is rated as generally successful.

B. Lessons Learned

50. The requirement for the PNGHB to provide unprofitable facilities to achieve nationally important social objectives, such as maintaining communication points for small communities in remote areas, will adversely affect its financial position unless appropriate compensation is provided.

51. The success of the Port Moresby component of the Project demonstrates the importance of matching yard capacity to berth capacity and the significant increases in capacity

that can be achieved through a relatively modest investment in yard facilities when there is a shortfall in these.

52. The difficulties encountered with the Port MIS illustrate the importance of having adequate management training and postdevelopment technical support in TAs involving computer systems.

53. The need to mobilize construction equipment, labor, and materials to remote ports makes project cost estimation difficult. It is suggested that higher than usual contingency amounts be allowed in such circumstances.

54. The benefits of packaging comparatively small projects at a number of different ports into a contract size that will attract international bidders need to be considered in the context of the potential delays that can result in the construction program at one port due to delays at another. For example, where a contractor mobilizes one floating piling rig for a project requiring piling at two or more ports, delays in piling at one port will cause delays in the construction program at the others.

C. Follow-up Actions

1. For the PNGHB and the Government

55. There is an urgent need for the PNGHB to complete the development of the MIS, including the integration of the financial and operational information systems so that they share the same data entry.

56. The problems causing delayed lease payments for the Bialla facility need to be resolved by the PNGHB. The PNGHB's financial viability is being weakened by these delays.

57. A firm plan for the refurbishment of the main wharf and/or development of the reclaimed area at Port Moresby as discussed in para. 47 should be finalized by the Government.

2. For the Bank

58. In view of its historical role of assisting the ports sector in PNG, the Bank may consider assisting the Government to undertake any necessary studies required for making an informed decision about the refurbishment of the main wharf and/or development of the reclaimed area at the port of Port Moresby.

APPENDIXES

Appendix 1

PROJECT COST BREAKDOWN BY COMPONENT
(in $ '000)

Component	Appraisal	Actual
A. Port Moresby [a]		
1. Civil Works	1,075	1,454
2. Consulting Services	225	190
3. Physical Contingencies	165	-
4. Price Contingency	385	-
Subtotal	**1,850**	**1,644**
B. Kimbe		
1. Civil Works	4,700	7,382
2. Consulting Services	870	550
3. Physical Contingencies	700	-
4. Price Contingency	1,600	-
Subtotal	**7,870**	**7,932**
C. Oro Bay		
1. Civil Works	480	2,870
2. Consulting Services	55	170
3. Physical Contingencies	65	-
4. Price Contingency	170	-
Subtotal	**770**	**3,040**
D. Bialla		
1. Civil Works	1,600	5,670
2. Consulting Services	200	220
3. Physical Contingencies	250	-
4. Price Contingency	600	-
Subtotal	**2,650**	**5,890**
E. Project Preparatory Technical Assistance	100	99
F. Interest During Construction	2,100	1,218
Total	**15,340**	**19,823**

[a] Port Moresby works were intended to be funded jointly by the Bank and the Papua New Guinea Harbours Board (PNGHB), but were funded entirely by the PNGHB.

Source: Project Completion Report.

CARGO PROJECTIONS

Table 1: Port Moresby ('000 revenue tons)

	Postevaluation Estimates				Appraisal Estimates			
Year	Overseas Dry	Coastal Dry	All Liquid	Total Cargo	Overseas Dry	Coastal Dry	All Liquid	Total Cargo
1981	n.a.	n.a.	n.a.	n.a.	347.6	76.6	0.0	424.2
1982	n.a.	n.a.	n.a.	n.a.	457.1	191.9	35.4	684.4
1983	n.a.	n.a.	n.a.	n.a.	467.1	244.6	97.0	808.7
1984	n.a.	n.a.	n.a.	n.a.	379.0	395.0	0.0	774.0
1985	n.a.	n.a.	n.a.	n.a.	387.7	371.0	0.0	758.7
1986	n.a.	n.a.	n.a.	n.a.	396.6	333.7	0.0	730.3
1987	n.a.	n.a.	n.a.	n.a.	405.8	307.1	0.0	712.9
1988	492.7	266.6	8.1	767.4	415.1	309.5	0.0	724.6
1989	521.6	258.7	15.9	796.2	424.6	313.1	0.0	737.7
1990	479.4	237.6	104.7	821.7	434.4	349.7	0.0	784.1
1991	560.6	256.9	106.9	924.4	444.3	359.1	0.0	803.4
1992	495.2	249.3	123.0	867.5	454.5	368.7	0.0	823.2
1993	528.0	254.7	117.6	900.3	464.9	378.6	0.0	843.5
1994	550.1	316.2	129.0	995.3	475.5	388.8	0.0	864.3
1995	557.0	300.0	132.9	989.8	486.4	399.2	0.0	885.6
1996	563.9	304.5	136.9	1,005.3	497.6	410.1	0.0	907.8
1997	571.0	309.1	141.0	1,021.0	509.2	421.3	0.0	930.5
1998	578.1	313.7	145.2	1,037.0	520.9	432.9	0.0	953.8
1999	585.4	318.4	149.5	1,053.3	533.0	444.7	0.0	977.7
2000	592.7	323.2	154.0	1,069.9	545.3	456.9	0.0	1,002.2
2001	600.1	328.0	158.7	1,086.8	557.8	467.3	0.0	1,025.2
2002	607.6	333.0	163.4	1,103.9	570.7	478.0	0.0	1,048.7
2003	615.2	337.9	168.3	1,121.4	583.8	488.9	0.0	1,072.7
2004	622.9	343.0	173.4	1,139.2	597.3	500.1	0.0	1,097.3
2005	630.6	348.2	178.6	1,157.4	611.0	511.5	0.0	1,122.5
2006	638.5	353.4	183.9	1,175.8	n.a.	n.a.	n.a.	n.a.
2007	646.5	358.7	189.4	1,194.6	n.a.	n.a.	n.a.	n.a.
2008	654.6	364.1	195.1	1,213.8	n.a.	n.a.	n.a.	n.a.
2009	662.8	369.5	201.0	1,233.3	n.a.	n.a.	n.a.	n.a.
2010	671.1	375.1	207.0	1,253.1	n.a.	n.a.	n.a.	n.a.

n.a. = not available.

Note: Data is for all PNGHB berths in Port Moresby.

Source: For postevaluation estimates, PNGHB for 1988 to 1994 and Mission estimates for 1995 to 2010; for the appraisal estimates, the Appraisal Report.

Table 2: Kimbe ('000 revenue tons)

	Postevaluation Estimates				Appraisal Estimates			
Year	Overseas Dry	Coastal Dry	All Liquid	Total Cargo	Overseas Dry	Coastal Dry	Total Liquid	Total All
1981	n.a.	n.a.	n.a.	n.a.	48.1	50.5	61.3	159.9
1982	n.a.	n.a.	n.a.	n.a.	49.8	36.4	65.3	151.5
1983	n.a.	n.a.	n.a.	n.a.	51.3	25.4	88.9	165.6
1984	n.a.	n.a.	n.a.	n.a.	51.5	31.5	119.0	202.0
1985	n.a.	n.a.	n.a.	n.a.	52.7	32.2	130.8	215.7
1986	n.a.	n.a.	n.a.	n.a.	53.9	33.0	139.0	225.9
1987	n.a.	n.a.	n.a.	n.a.	55.1	33.8	148.0	236.9
1988	62.8	99.8	89.6	252.2	56.4	34.5	156.2	247.1
1989	60.6	58.0	134.0	252.6	57.7	35.3	66.0	159.0
1990	52.2	57.8	124.4	234.4	59.0	37.4	98.0	194.4
1991	41.8	47.0	111.5	200.3	60.7	38.1	99.6	198.3
1992	46.5	58.4	135.5	240.4	62.4	38.7	101.1	202.2
1993	49.8	66.1	149.2	265.1	64.1	39.4	102.7	206.3
1994	59.6	72.0	131.7	263.3	65.9	40.1	104.3	210.4
1995	60.6	73.4	137.0	271.0	67.8	40.8	106.0	214.6
1996	60.6	74.9	142.4	278.0	69.2	41.3	106.2	216.7
1997	61.2	76.4	148.1	285.8	70.7	41.8	106.4	218.9
1998	61.8	77.9	154.1	293.8	72.2	42.3	106.6	221.1
1999	62.4	79.5	160.2	302.2	73.7	42.8	106.8	223.3
2000	63.1	81.1	166.6	310.8	75.3	43.3	107.0	225.6
2001	63.7	82.7	173.3	319.7	75.3	43.7	107.0	226.0
2002	64.3	84.4	180.2	328.9	75.2	44.2	107.0	226.4
2003	65.0	86.0	187.5	338.5	75.2	44.6	107.0	226.8
2004	65.6	87.8	194.9	348.3	75.1	45.1	107.0	227.2
2005	66.3	89.5	202.7	358.5	75.1	45.5	107.0	227.6
2006	66.9	91.3	210.9	369.1	n.a.	n.a.	n.a.	n.a.
2007	67.6	93.1	219.3	380.0	n.a.	n.a.	n.a.	n.a.
2008	68.3	95.0	228.1	391.3	n.a.	n.a.	n.a.	n.a.
2009	69.0	96.9	237.2	403.1	n.a.	n.a.	n.a.	n.a.
2010	69.7	98.8	246.7	415.2	n.a.	n.a.	n.a.	n.a.

n.a. = not available.

Source: For the postevaluation estimates, PNGHB for 1988 to 1994 and Mission estimates for 1995 to 2010; for the appraisal estimates, the Appraisal Report.

Table 3: Bialla ('000 revenue tons)[a]

Year	Postevaluation Estimates			Appraisal Estimates		
	Bulk Liquid	Dry Cargo	Total	Bulk Liquid	Dry Cargo	Total
1984	n.a.	n.a.	n.a.	31.7	4.0	35.7
1985	n.a.	n.a.	n.a.	36.0	5.0	41.0
1986	n.a.	n.a.	n.a.	39.0	5.4	44.4
1987	n.a.	n.a.	n.a.	42.5	5.7	48.2
1988	n.a.	n.a.	n.a.	46.0	6.0	52.0
1989	n.a.	n.a.	n.a.	50.0	6.5	56.5
1990	11.5	1.0	12.5	54.5	7.0	61.5
1991	26.1	0.0	26.1	58.8	7.4	66.3
1992	35.4	0.0	35.4	63.5	7.9	71.5
1993	36.5	0.0	36.5	68.6	8.4	77.0
1994	31.3	0.0	31.3	74.1	8.9	83.0
1995	32.0	0.0	32.0	80.0	9.5	89.5
1996	34.0	0.0	34.0	80.0	9.5	89.5
1997	35.3	0.0	35.3	80.0	9.5	89.5
1998	36.4	0.0	36.4	80.0	9.5	89.5
1999	37.4	0.0	37.4	80.0	9.5	89.5
2000	38.5	0.0	38.5	80.0	9.5	89.5
2001	39.6	0.0	39.6	80.0	9.5	89.5
2002	40.4	0.0	40.4	80.0	9.5	89.5
2003	41.2	0.0	41.2	80.0	9.5	89.5
2004	42.0	0.0	42.0	80.0	9.5	89.5
2005	42.8	0.0	42.8	80.0	9.5	89.5
2006	43.2	0.0	43.2	n.a.	n.a.	n.a.
2007	43.7	0.0	43.7	n.a.	n.a.	n.a.
2008	44.1	0.0	44.1	n.a.	n.a.	n.a.
2009	44.5	0.0	44.5	n.a.	n.a.	n.a.
2010	45.0	0.0	45.0	n.a.	n.a.	n.a.

[a] Includes only those types of cargo passing over the new wharf, i.e. bulk liquid crude palm oil, palm kernel oil, and fuel, and dry cargo of Hargy Oil Palms Pty. Limited. Before the Project, these items passed over the old provincial wharf. Small amounts of dry and nonbulk liquid cargo continue to pass over the provincial wharf after the Project.

Source: For the postevaluation estimates, Hargy Oil Palms Pty. Limited for 1990 to 1995 and Mission estimates; for the appraisal estimates, the Appraisal Report.

Table 4: Oro Bay ('000 revenue tons)

	Postevaluation Estimates				Appraisal Estimates			
Year	Overseas Dry	Coastal Dry	All Liquid	Total Cargo	Overseas Dry	Coastal Dry	Total Liquid	Total All
1981	n.a	n.a	n.a	n.a	10.2	19.7	1.0	30.9
1982	n.a	n.a	n.a	n.a	14.3	16.5	15.7	46.5
1983	n.a	n.a	n.a	n.a	16.5	18.3	25.7	60.5
1984	n.a	n.a	n.a	n.a	16.5	23.0	36.0	75.5
1985	n.a	n.a	n.a	n.a	18.2	23.5	41.0	82.7
1986	n.a	n.a	n.a	n.a	19.0	23.9	48.0	90.9
1987	n.a	n.a	n.a	n.a	20.2	24.4	53.0	97.6
1988	21.6	36.3	45.6	103.5	20.9	24.8	55.0	100.7
1989	21.0	37.9	49.3	108.2	22.1	25.3	57.0	104.4
1990	18.6	37.8	59.8	116.2	23.3	25.9	60.0	109.2
1991	19.9	33.9	56.0	109.8	24.2	26.4	61.9	112.5
1992	21.5	32.4	54.3	108.2	25.1	26.9	63.8	115.9
1993	17.7	32.3	55.5	105.5	26.1	27.4	65.8	119.4
1994	20.1	33.2	61.9	115.2	27.1	28.0	67.9	123.0
1995	20.3	33.5	63.8	117.6	28.2	28.5	70.0	126.7
1996	20.5	33.9	66.0	120.4	28.8	29.1	70.0	127.9
1997	20.7	34.2	68.3	123.2	29.4	29.7	70.0	129.0
1998	20.9	34.5	71.0	126.5	30.0	30.3	70.0	130.2
1999	21.1	34.9	73.9	129.9	30.6	30.9	70.0	131.5
2000	21.3	35.2	77.2	133.8	31.2	31.5	70.0	132.7
2001	21.5	35.6	81.1	138.2	31.9	32.1	70.0	134.0
2002	21.8	36.0	84.7	142.4	32.6	32.7	70.0	135.3
2003	22.0	36.3	88.1	146.4	33.3	33.4	70.0	136.7
2004	22.2	36.7	91.6	150.5	34.0	34.0	70.0	138.1
2005	22.4	37.0	94.8	154.3	34.8	34.7	70.0	139.5
2006	22.6	37.4	98.1	158.2	n.a.	n.a.	n.a.	n.a.
2007	22.9	37.8	101.6	162.2	n.a.	n.a.	n.a.	n.a.
2008	23.1	38.2	104.6	165.9	n.a.	n.a.	n.a.	n.a.
2009	23.3	38.5	107.8	169.6	n.a.	n.a.	n.a.	n.a.
2010	23.6	38.9	110.5	173.0	n.a.	n.a.	n.a.	n.a.

n.a. = not available.

Source: For the postevaluation estimates, PNGHB for 1981 to 1994 and Mission estimates for 1996 to 2010; for the appraisal estimates, the Appraisal Report.

PAPUA NEW GUINEA HARBOURS BOARD FINANCIAL STATEMENTS

Table 1: Income Statements (K'000)

Item	Fiscal Year ending 31 December										
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Operating Revenue											
Wharfage	7,241	8,387	9,272	10,066	12,089	10,079	10,597	11,542	12,020	12,882	12,258
Berthage	2,914	3,086	3,263	3,051	3,426	2,925	3,040	3,102	3,156	3,149	3,032
Storage	1,686	1,620	1,865	2,068	2,725	2,399	1,791	1,361	1,612	2,747	2,870
Others	2,674	2,896	2,690	2,844	3,091	2,827	2,783	2,954	3,638	5,516	4,753
Total	**14,515**	**15,989**	**17,090**	**18,029**	**21,331**	**18,230**	**18,211**	**18,959**	**20,426**	**24,294**	**22,913**
Operating Expenditures											
Staff Costs	4,752	4,604	4,621	5,406	5,930	6,820	7,730	7,661	8,165	8,678	9,980
Maintenance	3,351	1,204	1,283	1,089	1,392	2,013	1,725	1,301	1,637	2,249	2,249
Depreciation	2,848	3,434	3,995	4,326	5,716	6,922	4,164	4,237	4,214	4,087	4,462
Other	2,115	1,548	2,556	2,143	3,206	3,282	3,627	3,451	3,625	3,987	3,862
Total	**13,066**	**10,790**	**12,455**	**12,964**	**16,244**	**19,037**	**17,246**	**16,650**	**17,641**	**19,001**	**20,553**
Operating Income	1,449	5,199	4,635	5,065	5,087	-807	965	2,309	2,785	5,293	2,360
Other Income	1,777	2,288	1,382	1,616	1,917	111	1,460	1,047	577	434	1,144
Earnings Before Interest and Tax	3,226	7,487	6,017	6,681	7,004	-696	2,425	3,356	3,362	5,727	3,504
Interest	1,232	1,677	1,390	2,096	2,357	2,573	2,509	2,584	2,490	2,796	1,725
Tax	1,201	1,980	2,888	1,828	83	-881	0	509	482	1,349	738
Net Income	**793**	**3,830**	**1,739**	**2,757**	**4,564**	**-2,388**	**-84**	**263**	**390**	**1,582**	**1,041**
Dividends	100	2,226	870	1,378	2,036	0	0	132	195	791	520
Other	-7,365	117	0	670	675	0	6,159	0	0	0	0
Retained Earnings	-6,672	1,721	869	2,049	3,203	-2,388	6,075	132	195	791	521
Ave. Net Fixed Assets	48,513	49,161	51,948	62,054	79,188	91,306	90,358	105,542	121,854	121,500	145,456
Return on Average Net Fixed Assets	3.0%	10.6%	8.9%	8.2%	6.4%	-0.9%	1.1%	2.2%	2.3%	4.4%	1.6%
Debt-service Ratio	-	3.97	2.45	3.29	6.31	2.87	0.98	1.44	1.82	1.85	2.00
Operating Ratio	0.90	0.67	0.73	0.72	0.76	1.04	0.95	0.88	0.86	0.78	0.90

Sources: PNG Harbours Board Annual Reports for 1985 to 1993; PNG Harbours Board Unaudited Financial Statements for 1994 and 1995.

Table 2: Balance Sheets (K'000)

Item	Fiscal Year ending 31 December										
	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
ASSETS											
Net Fixed Assets in Operation	49,442	48,880	55,015	69,092	89,283	93,328	87,387	123,696	120,011	122,988	167,924
Capital Work in Progress	856	1,413	7,490	5,774	116	125	157	228	1,174	3,361	3,853
Investments	3,971	3,854	3,807	3,226	2,043	2,661	3,661	3,661	3,937	3,425	3,425
Current Assets											
Cash and Short-term Investments	11,106	14,604	15,777	10,189	12,087	10,871	10,398	9,786	13,852	14,711	13,646
Accounts Receivable	1,572	2,009	694	763	1,059	1,330	1,180	1,503	1,358	4,129	4,829
Other Current Assets	318	118	0	0	0	104	639	825	834	1,125	1,370
Total Assets	**67,265**	**70,878**	**82,783**	**89,044**	**104,588**	**108,419**	**103,422**	**139,699**	**141,166**	**149,739**	**195,047**
EQUITY AND LIABILITIES											
Equity Capital	7,830	7,830	7,830	7,830	7,830	7,830	7,830	7,830	7,830	7,830	7,830
Asset Revaluation Reserve	32,849	32,849	40,814	45,222	54,263	64,687	54,149	93,683	93,543	98,139	145,484
Other Reserves	2,675	2,558	2,558	1,888	1,213	1,213	1,213	1,213	1,213	1,213	1,213
Retained Earnings	-410	1,312	2,181	4,230	7,432	5,043	11,118	11,249	11,445	12,236	12,756
Long-term Liabilities and Loans	18,378	14,718	19,519	22,314	23,597	25,566	23,575	20,567	17,547	16,449	14,935
Current Liabilities											
Accounts Payable	795	1,723	2,027	716	5,550	2,623	904	1,309	1,348	1,821	1,112
Other	5,148	9,888	7,854	6,844	4,703	1,457	4,633	3,848	8,240	12,051	11,717
Total Equity and Long-term Liabilities	**67,265**	**70,878**	**82,783**	**89,044**	**104,588**	**108,419**	**103,422**	**139,699**	**141,166**	**149,739**	**195,047**

Sources: PNG Harbours Board Annual Reports for 1985 to 1993; PNG Harbours Board Unaudited Financial Statements for 1994 and 1995.

Table 3: Income Statements for Selected Ports and Years (K'000)

Item	1990	1991	1993	1994	1995
PORT MORESBY					
Operating Revenue	5,506	5,617	6,081	6,890	6,576
Operating Expenditure excluding Depreciation	1,618	1,799	2,020	1,959	2,079
Operating Income excluding Depreciation	3,888	3,818	4,061	4,931	4,497
Depreciation	1,253	1,574	756	0	928
Operating Income	2,635	2,244	3,305	4,931	3,569
Operating Ratio	0.52	0.60	0.46	0.28	0.46
KIMBE					
Operating Revenue	1,021	984	1,480	1,576	1,521
Operating Expenditure excluding Depreciation	434	501	601	711	707
Operating Income excluding Depreciation	587	483	880	865	814
Depreciation	398	445	352	0	398
Operating Income	189	38	528	865	416
Operating Ratio	0.81	0.96	0.64	0.45	0.73
BIALLA					
Operating Revenue	5	53	111	2,020	530
Operating Expenditure excluding Depreciation	32	2	1	0	0
Operating Income excluding Depreciation	-27	51	111	2,020	530
Depreciation	143	206	183	0	181
Operating Income	-170	-155	-73	2,020	349
Operating Ratio	35.00	3.94	1.65	0.00	0.34
ORO BAY					
Operating Revenue	392	368	394	423	378
Operating Expenditure excluding Depreciation	154	226	246	276	304
Operating Income excluding Depreciation	238	143	148	148	74
Depreciation	199	200	117	0	151
Operating Income	39	-57	31	148	-77
Operating Ratio	0.90	1.15	0.92	0.65	1.20

Source: PNG Harbours Board.

ECONOMIC AND FINANCIAL REASSESSMENT

A. General Methodology

1. The economic and financial impacts were evaluated by calculating, respectively, the economic internal rate of return (EIRR) and the financial internal rate of return (FIRR) (see Tables 1-10). This was done for each port component, the Kimbe and Bialla components together, and the whole project. In each case, with- and without-Project situations were compared to estimate incremental benefits (see Sections B and C) and costs (see para. 3). At Port Moresby, Kimbe, and Oro Bay, the main economic and financial benefits arise from increases in cargo handling rates and wharf capacity. For Bialla, the benefits arise from eliminating the transshipment of bulk liquids through Kimbe. Additional economic benefits from improved safety occur for Kimbe and Oro Bay. At Kimbe, the small vessels wharf constructed under the Project also generates significant benefits, but these could not be estimated due to lack of data. The recomputed EIRR for Kimbe will be lower than actual as a result.

2. Although wharf capacity was a constraint only in Kimbe, the determination of wharf capacity is necessary to calculate ship time benefits. In each port, the capacity of the wharves affected by the Project was assumed to be reached when the ship-service-to-waiting-time ratio reached 0.2. For the normal range of service times, this means a maximum wait time of 3-5 hours. At this point, ship and cargo owners would seek alternative arrangements, such as using landing craft and/or the provincial and private wharves. This limiting ship-service-to-waiting-time factor was assumed to apply both with and without the Project. On the basis of the above parameters, wharf capacities are reached (see Table 11).

3. The economic and financial costs are the investment and incremental maintenance expenses. Maintenance costs were assumed to be 2 percent of the investment cost for Port Moresby and Kimbe, 1.5 percent for Oro Bay, and 1 percent for Bialla. The costs (and benefits) accruing to the private stevedores and cargo owners such as the fuel and palm oil processing companies, and associated with cargo handling equipment and bulk liquid storage and handling were not included.

4. All costs and benefits were adjusted to 1996 values by use of the World Bank published G5-manufacturer's unit value index in the case of foreign exchange costs and the gross domestic product deflator for Papua New Guinea for local costs. The exchange rate used for 1996 was $1.00=K0.74. For the economic analyses, the nontraded investment costs and benefits were adjusted by use of a standard conversion factor of 0.9. The traded benefits comprise those accruing to foreign-owned ships. Residual values for the investments were based on 50-year lives.

B. Economic Benefits

1. Port Moresby

5. The reclamation and paving works at Port Moresby allowed containerized cargo to be stacked closer to the main wharf than would otherwise have been possible, and an easier and more efficient movement of equipment and cargo through the yard. Without the Project, it is assumed that containers would have been moved to the container yard behind berth 4 (the

dedicated container berth). Compared with the without-Project situation, the handling of all cargo, but particularly containerized cargo, with the project improvements is considered faster, resulting in less need for cargo handling equipment, fewer total working hours for all cargo handling equipment, and savings in ship time. Cargo throughputs and diverted cargo benefits, which also occur due to the increased wharf capacity, are detailed in para. 14. The ship time savings comprise both service time as a result of higher cargo handling rates and ship waiting time as a result of lower berth occupancy rates with faster ship servicing.

6. Benefits in the form of reduced investment in containers due to a longer dwell time of containers in the port as assumed at appraisal and reduced loss and damage of cargo as assumed in the Project Completion Report are not considered significant. Reductions in cargo damage are attributable to containerization, which would have occurred without the Project. The fender dolphin proposed at appraisal was not constructed and the ship time benefits due to easier berthing, assumed at appraisal, were not included.

7. In calculating the ship time benefits, berths 1, 2, 3B, and 4 were grouped together and a semischeduled E2/E2/n Erlang queuing model was applied. Ship time was valued at $10,000 per day for both overseas dry cargo and tanker vessels, $4,000 per day for coastal dry cargo vessels, and $3,000 per day for coastal tankers. The cargo handling benefits were calculated on the basis that, without the Project, additional cargo handling capacity equivalent to the extra hours of ship service time for dry cargo vessels would be required. This equipment comprising tractors with trailers and forklifts was assumed to cost an aggregate of K90 per working hour, based on current rates at the port.

2. Kimbe and Bialla

8. Kimbe handles dry overseas and coastal cargo and bulk liquid cargo. Following the Project, the latter comprises mainly the outward movement of crude palm oil and palm kernel oil from New Britain Palm Oil Limited. Prior to the Project, bulk liquid palm oil from Bialla was transshipped to Kimbe by coastal tanker for loading into overseas tankers, and this cargo was loaded at the preexisting provincial wharf at Bialla. With the Project, transshipment of the Bialla bulk liquid was replaced by direct export from the new Bialla wharf. Almost all dry cargo and nonbulk liquid cargo at Bialla continues to be handled over the provincial wharf as it was before the Project. Although the investments at Kimbe and Bialla are interrelated, each investment was modeled separately as well as together.

9. At Kimbe, the extended main wharf and widened approach bridge allow faster handling of dry cargo for the overseas and large coastal ships. This leads to reduced berth time for the dry cargo ships, which in turn also reduces ship waiting time for all ships using the main wharf, that is, both the dry overseas and coastal ships and the tankers. The increased wharf capacity also generates diverted cargo benefits as defined in para. 14. Cargo throughputs are also defined in para. 14. In calculating the ship time benefits, a semischeduled E2/E2/n Erlang queuing model was applied. Ship time values were the same as those assumed for Port Moresby. For the Kimbe investment alone, i.e., without the investment at Bialla, the cargo included the inward and outward movement of Bialla crude palm oil and palm kernel oil as well as all the inward and outward Kimbe cargo passing over the main wharf. Savings in cargo handling were assessed as being equivalent to the cost of two gangs of workers together with forklifts and arbilift, i.e., an aggregate of K70 per hour, for the difference in berth time of dry

cargo ships between the with- and without-Project cases. The Kimbe investment also included a small ships wharf. However, because of the manual style of loading and berthing arrangements, and the relatively low value of the vessels using this wharf, the savings in ship times and cargo handling are small in relation to the gains at the main wharf and were not quantified. Safety for both ships and the main berth was improved by the lengthening of the main wharf and construction of breasting and mooring dolphins. Discussions with ship agents and port engineers indicate that the avoided risk of damage to ships and berth could have an annual equivalent value of about K200,000.

10. The investment in a new wharf at Bialla facilitated the transshipment of bulk liquid palm oil products from Bialla to Kimbe by coastal tanker and the handling and storage costs for this cargo at Kimbe to be saved. In addition, the reduced throughput of cargo at Kimbe causes a reduction in berth occupancy and ship waiting times at that port. The transshipment cost was determined to be K20 per ton (t) of bulk liquid transshipped based on a two-day turnaround trip, a vessel cost, inclusive of operating expenses, of K5,000 per day for a tanker of 500 revenue ton capacity. The storage and handling costs at Kimbe were estimated by New Britain Palm Oil Limited to be K2.50 per t.

11. The benefits and costs for the combined investments at Kimbe and Bialla are the sum of the separate investments. However, when the Kimbe and Bialla investments are considered together, the ship times at Kimbe are lowered by both the Kimbe port improvements and the removal of the Bialla cargo as they were when the investments were considered separately, but the combined effect is less than the sum of the individual investments. This is due to the nonlinear relationship between berth occupancy and ship wait times in the Erlang queuing model.

3. Oro Bay

12. At Oro Bay, the breasting and mooring dolphins, coupled with the reconstruction of the wharf, improved safety for the berthing of large vessels, particularly the overseas tankers loading bulk liquid palm oil products. As at Kimbe, the annualized value of the avoided damage to ships and berths was assumed to be K200,000 per year. In addition, the construction of a second bridge linking the wharf and the cargo area has allowed faster cargo handling of containerized cargo. Break-bulk cargo handling was not a problem as this cargo was moved with small forklifts that could readily pass each other on the preexisting single bridge. Cargo handling savings are equivalent to K70 per revenue ton of cargo in containers. The faster cargo handling also contributed to savings in ship service and wait times, the latter being estimated by use of a semischeduled E2/E2/n Erlang queuing model, and the increased wharf capacity leads to diverted cargo savings as defined in para. 14.

13. The avoidance of ship diversion was not taken as a benefit for Oro Bay although it was included in the evaluation done at project completion. Congestion is not a problem at this port which is shown by the berth occupancy ratio which, without the Project, is projected to reach less than 40 percent with a wait-to-service ratio of about 0.22 by the year 2010. Coastal ships do sail past, which results in cargo being transshipped through Lae. However, this is not due to congestion, but rather, to scheduling problems within the shipping company involved and other issues not related to the port.

4. Diverted Cargo

14. The same wharf capacities and cargo throughputs as assumed for the financial analyses were used in the economic analyses. Cargo in excess of the with-Project wharf capacities was not included. Cargo in excess of the without-Project wharf capacities up to the with-Project wharf capacities was assumed to be handled at other wharves, such as the provincial wharves, or by other means. Therefore, with the Project there were savings derived from the transfer of cargo from these "other" arrangements to the Project-benefited wharves. In the tables, this benefit is designated as "diverted cargo." For each port, the unit value of this transfer was assumed equivalent to the average cost of ship service and waiting time at the point where the ship service-to-waiting-time ratio reached 0.2. This is the point where ship and cargo owners are assumed to seek lower cost alternatives. Diverted cargo benefits accrue to Port Moresby, Kimbe, and Oro Bay. At Kimbe and Oro Bay, it was further assumed that the overseas bulk liquid tankers would be given priority and would not have to wait longer than 20 percent of their service times. The average cost per revenue ton of ship time at each port at the 0.2 ship-service-to-waiting-time cutoff point was K20 at Port Moresby, K30 for dry cargo, and K8.4 for coastal bulk liquid at Kimbe, and K42 for dry cargo at Oro Bay. Other benefits are detailed in paras. 7 to 10.

5. Sensitivity Analysis and Results

15. A sensitivity analysis was completed to assess the impact on the EIRR of reducing the ship time benefits. Lower ship time benefits may occur if the benefits accruing to foreign-owned vessels are not passed back to the country through lower freight rates. The recalculated EIRRs for the base case and a reduction of 50 percent in the ship time benefits are in Table 12.

C. Financial Benefits

16. The financial benefits are those accruing to the Papua New Guinea Harbours Board, which owns the port assets. At Port Moresby, Kimbe, and Oro Bay, the benefits derived from additional berthage, wharfage, and storage charges as a result of increased cargo handled due to increased capacity as defined in para. 2. Average aggregate rates for all these charges were derived from the 1995 income statements for each port. These average rates, per revenue ton and in 1996 prices, were K6.64 for Port Moresby, K5.6 for Kimbe, and K3.21 for Oro Bay. For Bialla, there is a reduction in Papua New Guinea Harbours Board income due to the loss of berthage and wharfage charges on transshipment of Bialla cargo into Kimbe, equivalent to K1.09 per revenue ton of bulk liquid, but there is added income equivalent to K421,000 per year from the lease of the Bialla facility to the oil palm producer. Cargo in excess of the with-Project wharf capacities was not included.

D. Comparison with Appraisal and Project Completion Methodologies

17. The methodology used for the postevaluation economic analyses differs from that used for appraisal and at project completion in the treatment of cargo throughputs at each port and the types of benefits included. The postevaluation analyses assume that the without-Project capacities of the wharves affected by the Project are less than the capacities with the Project. Therefore, the with- and without-Project cargo throughputs differ. Although full details

are not available, the appraisal and project completion analyses appear to assume the same cargo throughputs in the with- and without-Project situations for the economic analyses. For the financial analyses, however, the assumption is that all increases in cargo volumes after completion of the Project are incremental, implying different throughputs with and without the Project.

18. The other major differences, compared with the appraisal analyses, are that the postevaluation assessment (i) did not include as benefits at Port Moresby and Kimbe the reduction in the number of containers needed by shippers, since other factors were considered more important in determining the turnaround time of containers than the faster container handling provided by the Project; (ii) did not include as benefits for Kimbe the reduction in charter freight rates as the size of vessels calling at Kimbe has not changed appreciably from that before the Project; (iii) did not include as benefits for Oro Bay the reduction in charter freight rates as a result of a change in vessel size as that did not occur; but (iv) did include as a benefit at both Kimbe and Oro Bay amounts for avoided damage due to improved port safety.

19. Compared with the project completion analyses, the postevaluation assessment (i) did not include as benefits the savings from avoided loss and damage to cargo at Port Moresby and Kimbe as these savings were attributable more to the containerization of cargo than to the Project, and it is assumed that the containerization of cargo would have occurred in the without-Project situation even with the slower handling rates; (ii) did not include as a benefit for Bialla any ship time savings occurring as ships do not yet have to wait; (iii) did not include as a benefit for Oro Bay ship diversion savings as ship diversions are a result of scheduling problems within the shipping companies rather than a fault of the port; but (iv) did include as a benefit at both Kimbe and Oro Bay amounts for avoided damage due to improved port safety.

Table 1: Economic Analysis - Port Moresby (K'000)

Year	Costs			Benefits				Net Benefits
	Investment	Maintenance	Total	Ship Time	Cargo Handling	Cargo Diversion	Total	
1985	0	0	0	0	0	0	0	0
1986	1,132	0	1,132	0	0	0	0	-1,132
1987	1,926	0	1,926	0	0	0	0	-1,926
1988	748	0	748	833	91	0	924	176
1989		76	76	684	55	0	739	663
1990		76	76	262	14	0	276	200
1991		76	76	627	0	0	627	551
1992		76	76	1,126	344	0	1,470	1,394
1993		76	76	640	78	0	718	642
1994		76	76	1,563	275	0	1,838	1,762
1995		76	76	1,720	268	0	1,988	1,912
1996		76	76	1,802	271	0	2,073	1,997
1997		76	76	1,826	275	0	2,101	2,025
1998		76	76	1,911	279	0	2,190	2,114
1999		76	76	1,949	283	0	2,232	2,156
2000		76	76	2,037	287	0	2,324	2,248
2001		76	76	1,963	272	247	2,482	2,406
2002		76	76	1,836	257	500	2,593	2,517
2003		76	76	1,707	242	756	2,705	2,629
2004		76	76	1,629	227	1,015	2,871	2,795
2005		76	76	1,496	212	1,279	2,987	2,911
2006		76	76	1,360	196	1,547	3,103	3,027
Residual Value								2,512
EIRR								26%

Table 2: Economic Analysis - Kimbe and Bialla Combined (K'000)

	Costs			Benefits							Net
Year	Investment	Maintenance	Total	Ship Time	Kimbe Cargo Handling	Diverted Cargo Kimbe	Avoided Damage Kimbe	Bialla Trans-shipment	Bialla Cargo Handling	Total	Benefits
1985	0	0	0	0	0	0	0	0	0	0	0
1986	801	0	801	0	0	0	0	0	0	0	-801
1987	5,191	0	5,191	0	0	0	0	0	0	0	-5,191
1988	4,532	0	4,532	142	5	0	0	0	0	147	-4,385
1989	2,629	134	2,763	613	35	0	180	0	0	828	-1,935
1990	1,275	134	1,409	157	14	0	180	207	22	580	-829
1991		134	134	90	10	1	180	471	51	803	669
1992		134	134	335	11	0	180	619	67	1,212	1,078
1993		134	134	573	20	113	180	642	69	1,597	1,463
1994		134	134	627	10	133	180	544	58	1,552	1,418
1995		134	134	698	16	140	180	557	60	1,651	1,517
1996		134	134	692	15	219	180	593	64	1,763	1,629
1997		359	359	676	14	301	180	617	66	1,854	1,495
1998		359	359	673	12	380	180	636	68	1,949	1,590
1999		359	359	657	11	456	180	655	70	2,029	1,670
2000		209	209	639	9	538	180	674	72	2,112	1,903
2001		209	209	628	7	612	180	695	75	2,197	1,988
2002		209	209	597	6	676	180	708	76	2,243	2,034
2003		209	209	564	6	742	180	723	78	2,293	2,084
2004		209	209	529	5	811	180	737	79	2,341	2,132
2005		209	209	493	5	882	180	752	81	2,393	2,184
Residual Value											9,522
EIRR											8%

Table 3: Economic Analysis - Kimbe (K'000)

Year	Costs			Benefits					Net Benefits
	Investment	Maintenance	Total	Ship Time	Cargo Handling	Diverted Cargo	Avoided	Total Damage	
1985	0	0	0	0	0	0	0	0	0
1986	801	0	801	0	0	0	0	0	-801
1987	3,601	0	3,601	0	0	0	0	0	-3,601
1988	2,315	0	2,315	142	5	0	0	147	-2,168
1989		134	134	613	35	0	180	828	694
1990		134	134	147	14	0	180	341	207
1991		134	134	23	10	0	180	213	79
1992		134	134	250	11	0	180	441	307
1993		134	134	315	20	259	180	774	640
1994		134	134	231	10	473	180	894	760
1995		134	134	215	16	508	180	919	785
1996		134	134	213	15	521	180	929	795
1997		134	134	207	14	547	180	948	814
1998		134	134	195	12	586	180	973	839
1999		134	134	163	11	631	180	985	851
2000		134	134	148	9	675	180	1,012	878
2001		134	134	98	7	720	180	1,005	871
2002		134	134	96	6	731	180	1,013	879
2003		134	134	102	6	724	180	1,012	878
2004		134	134	104	5	728	180	1,017	883
2005		134	134	79	5	786	180	1,050	916
2006		134	134	77	5	795	180	1,057	923
Residual Value									4,433
EIRR									8%

Table 4: Economic Analysis - Bialla (K'000)[a]

Year	Costs			Benefits					Net Benefits
	Investment	Maintenance	Total	Transshipment Savings	Cargo Handling	Ship Time at Kimbe	Diverted Cargo	Total	
1985	0	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0	0
1987	1,590	0	1,590	0	0	0	0	0	-1,590
1988	2,217	0	2,217	0	0	0	0	0	-2,217
1989	2,629	0	2,629	0	0	0	0	0	-2,629
1990	1,275	0	1,275	207	22	101	0	330	-945
1991		0	0	471	51	64	1	587	587
1992		0	0	619	67	219	0	905	905
1993		0	0	642	69	280	280	1,271	1,271
1994		0	0	544	58	275	206	1,083	1,083
1995		0	0	557	60	126	281	1,024	1,024
1996		0	0	593	64	99	359	1,115	1,115
1997		225	225	617	66	52	441	1,176	951
1998		225	225	636	68	2	523	1,229	1,004
1999		225	225	655	70	0	550	1,275	1,050
2000		75	75	674	72	0	566	1,312	1,237
2001		75	75	695	75	0	583	1,353	1,278
2002		75	75	708	76	0	595	1,379	1,304
2003		75	75	723	78	0	607	1,408	1,333
2004		75	75	737	79	0	619	1,435	1,360
2005		75	75	752	81	0	632	1,465	1,390
2006		75	75	759	82	0	638	1,479	1,404
Residual Value									5,089
EIRR									11%

[a] Excludes benefits and costs associated with concurrent increases in crude palm oil storage and pumping.

Table 5: Economic Analysis - Oro Bay (K'000)

	Costs			Benefits					Net
Year	Investment	Maintenance	Total	Ship Time	Cargo Handling	Diverted Cargo	Avoided Damage	Total	Benefits
1985	0	0	0	0	0	0	0	0	0
1986	531	0	531	0	0	0	0	0	-531
1987	687	0	687	0	0	0	0	0	-687
1988	1,880	0	1,880	0	0	0	0	0	-1,880
1989	536	0	536	0	0	0	0	0	-536
1990	395	0	395	106	15	0	180	301	-94
1991		62	62	285	44	0	180	509	447
1992		62	62	260	47	0	180	487	425
1993		62	62	280	60	0	180	520	458
1994		62	62	203	41	0	180	424	362
1995		62	62	371	59	0	180	610	548
1996		62	62	378	60	0	180	618	556
1997		62	62	382	60	0	180	622	560
1998		62	62	386	61	0	180	627	565
1999		62	62	400	62	0	180	642	580
2000		62	62	405	62	0	180	647	585
2001		62	62	420	63	0	180	663	601
2002		62	62	417	64	0	180	661	599
2003		62	62	443	64	0	180	687	625
2004		62	62	448	65	0	180	693	631
2005		62	62	465	66	0	180	711	649
Residual Value									2,659
EIRR									10%

Table 6: Economic Analysis - Project (K'000)

Year	Port Moresby	Kimbe and Bialla	Oro Bay	Total
1985	0	0	0	0
1986	-1,132	-801	-531	-2,464
1987	-1,926	-5,191	-687	-7,804
1988	176	-4,385	-1,880	-6,089
1989	663	-1,935	-536	-1,808
1990	200	-829	-94	-723
1991	551	669	447	1,667
1992	1,394	1,078	425	2,897
1993	642	1,463	458	2,563
1994	1,762	1,418	362	3,542
1995	1,912	1,517	548	3,977
1996	1,997	1,629	556	4,182
1997	2,025	1,495	560	4,080
1998	2,114	1,590	565	4,269
1999	2,156	1,670	580	4,406
2000	2,248	1,903	585	4,736
2001	2,406	1,988	601	4,995
2002	2,517	2,034	599	5,150
2003	2,629	2,084	625	5,338
2004	2,795	2,132	631	5,558
2005	2,911	2,184	649	5,744
2006	3,027	9,522	2,659	15,208
Residual Value	2,512	8,080	1,735	12,327
EIRR				14%

Table 7: Financial Analysis - Port Moresby

Year	Incremental Cargo ('000 revenue ton)	Incremental Income (K'000)	Investment (K'000)	Incremental Maintenance (K'000)	Net Financial Benefit (K'000)
1986	0.0	0.0	1,245.2	0.0	-1,245.2
1987	0.0	0.0	2,118.6	0.0	-2,118.6
1988	0.0	0.0	822.8	0.0	-822.8
1989	0.0	0.0		83.7	-83.7
1990	0.0	0.0		83.7	-83.7
1991	0.0	0.0		83.7	-83.7
1992	0.0	0.0		83.7	-83.7
1993	0.0	0.0		83.7	-83.7
1994	0.0	0.0		83.7	-83.7
1995	0.0	0.0		83.7	-83.7
1996	0.0	0.0		83.7	-83.7
1997	0.0	0.0		83.7	-83.7
1998	0.0	0.0		83.7	-83.7
1999	0.0	0.0		83.7	-83.7
2000	0.0	0.0		83.7	-83.7
2001	13.7	91.0		83.7	7.3
2002	27.8	184.6		83.7	100.9
2003	42.0	278.9		83.7	195.2
2004	56.4	374.5		83.7	290.8
2005	71.0	471.4		83.7	387.7
2006	85.9	570.4		83.7	486.7
2007	101.1	671.3		83.7	587.6
2008	116.6	774.2		83.7	690.5
2009	132.2	877.8		83.7	794.1
2010	148.1	983.4		83.7	899.7
Residual value					2,344.5
FIRR					1.3%

Table 8: Financial Analysis - Kimbe and Bialla

Year	Incremental Cargo ('000 revenue ton)	Incremental Income (K'000)		Loss of Bialla Transshipment Income (K'000)[b]	Investment (K'000)	Incremental Maintenance (K'000)	Net Financial Benefit (K'000)
		Kimbe Cargo	Bialla Lease[a]				
1986	0.0	0.0	0.0	0	881.1	0.0	-881.1
1987	0.0	0.0	0.0	0	5,710.1	0.0	-5,710.1
1988	0.0	0.0	0.0	0	4,985.2	0.0	-4,985.2
1989	0.0	0.0	0.0	0	2,891.9	147.4	-3,039.3
1990	0.0	0.0	0.0	13.6	1,402.5	147.4	-1,563.5
1991	0.0	0.0	0.0	28.4		147.4	-175.8
1992	0.0	0.0	0.0	37.5		147.4	-184.9
1993	25.0	140.3	0.0	30.7		147.4	-37.8
1994	5.3	29.7	0.0	23.3		147.4	-141.0
1995	13.6	76.3	1,000.0	23.7		147.4	905.2
1996	23.3	130.7	100.0	20.2		147.4	63.1
1997	32.6	182.9	2,056.0	15.7		394.9	1,828.3
1998	41.6	233.4	420.8	11.1		394.9	248.2
1999	50.9	285.5	420.8	6.8		394.9	304.6
2000	60.6	340.0	420.8	2.1		229.9	528.8
2001	70.5	395.5	420.8	0		229.9	586.4
2002	70.5	395.5	420.8	0		229.9	586.4
2003	70.5	395.5	420.8	0		229.9	586.4
2004	70.5	395.5	420.8	0		229.9	586.4
2005	70.5	395.5	420.8	0		229.9	586.4
2006	70.5	395.5	420.8	0		229.9	586.4
2007	70.5	395.5	420.8	0		229.9	586.4
2008	70.5	395.5	420.8	0		229.9	586.4
2009	70.5	395.5	420.8	0		229.9	586.4
2010	70.5	395.5	420.8	0		229.9	586.4
Residual value							8,887.6
FIRR							1%

[a] Assumes lease payments are brought up to date by the end of 1997 and then continue on time.

[b] Assumes that Bialla bulk liquids in excess of Kimbe capacity are not handled at other PNGHB ports.

Table 9: Financial Analysis - Oro Bay

Year	Incremental Cargo ('000 revenue ton)	Incremental Income (K'000)	Investment (K'000)	Incremental Maintenance (K'000)	Net Financial Benefit (K'000)
1986	0.0	0.0	584.1	0.0	-584.1
1987	0.0	0.0	755.7	0.0	-755.7
1988	0.0	0.0	2,068.0	0.0	-2,068.0
1989	0.0	0.0	589.6	0.0	-589.6
1990	0.0	0.0	434.5	0.0	-434.5
1991	0.0	0.0		66.5	-66.5
1992	0.0	0.0		66.5	-66.5
1993	0.0	0.0		66.5	-66.5
1994	0.0	0.0		66.5	-66.5
1995	0.0	0.0		66.5	-66.5
1996	0.0	0.0		66.5	-66.5
1997	0.0	0.0		66.5	-66.5
1998	0.0	0.0		66.5	-66.5
1999	0.0	0.0		66.5	-66.5
2000	0.0	0.0		66.5	-66.5
2001	0.0	0.0		66.5	-66.5
2002	0.0	0.0		66.5	-66.5
2003	0.0	0.0		66.5	-66.5
2004	0.0	0.0		66.5	-66.5
2005	0.0	0.0		66.5	-66.5
2006	3.9	12.5		66.5	-54.0
2007	7.9	25.4		66.5	-41.1
2008	11.6	37.2		66.5	-29.3
2009	15.4	49.4		66.5	-17.1
2010	18.7	60.0		66.5	-6.5
Residual value					2,481.9
FIRR					negative

Table 10: Financial Analysis - Project (K'000)

Year	Net Financial Benefit ('000 revenue ton)			Project
	Port Moresby	Kimbe and Bialla	Oro Bay	
1986	-1,245.2	-881.1	-584.1	-2710.4
1987	-2,118.6	-5,710.1	-755.7	-8,584.4
1988	-822.8	-4,985.2	-2,068.0	-7,876.0
1989	-83.7	-3,039.3	-589.6	-3,712.6
1990	-83.7	-1,563.5	-434.5	-2,081.7
1991	-83.7	-175.8	-66.5	-326.0
1992	-83.7	-184.9	-66.5	-335.1
1993	-83.7	-37.8	-66.5	-188.0
1994	-83.7	-141.0	-66.5	-291.2
1995	-83.7	905.2	-66.5	755.0
1996	-83.7	63.1	-66.5	-87.1
1997	-83.7	1,828.3	-66.5	1,678.1
1998	-83.7	248.2	-66.4785	98.0
1999	-83.7	304.6	-66.4785	154.4
2000	-83.7	528.8	-66.4785	378.6
2001	7.3	586.4	-66.4785	527.2
2002	100.9	586.4	-66.4785	620.8
2003	195.2	586.4	-66.4785	715.1
2004	290.8	586.4	-66.4785	810.7
2005	387.7	586.4	-66.4785	907.6
2006	486.7	586.4	-53.9785	1,019.1
2007	587.6	586.4	-41.0785	1,132.9
2008	690.5	586.4	-29.2785	1,247.6
2009	794.1	586.4	-17.0785	1,363.4
2010	899.7	586.4	-6.4785	1,479.6
Residual value	2,344.5	8,887.648	2,481.9	13,714.0
FIRR				0.1%

Table 11: Wharf Capacities in Four Ports

Item	Port Moresby	Kimbe	Bialla	Oro Bay
Volume ('000 revenue tons)				
Without Project	950	265	n.a.	155
With Project	>1,100	330	>45	>173
Year capacity reached				
Without Project	2000	1992	n.a.	2005
With Project	>2010	2009	>2010	>2010

Note: ">" denotes in excess of the volume or year given.

Table 12: Results of Sensitivity Analysis

Port	EIRR (%)	
	Base Case	With Only 50% of Ship Time Benefits
Port Moresby	26	18
Kimbe	8	7
Bialla	11	10
Kimbe and Bialla together	8	7
Oro Bay	10	6
Project	14	12