DEMOCRATIC REPUBLIC OF THE SUDAN

RIVER TRANSPORT AGRICULTURE MARKETING

PROJECT No. 650-0060

WHITE NILE

JUBA TO KOSTI

PREFEASIBILITY STUDY

Prepared for

USAID - MISSION

KHARTOUM

Prepared By

MOFFATT & NICHOL, ENGINEERS
OGDEN BEEMAN ASSOCIATES
BIGELOW ASSOCIATES
Contract No. OTR-1406-I-00-2251-00

MOFFATT & NICHOL, ENGINEERS

CALIFORNIA - OREGON - HAWAII - MICHIGAN

January 27, 1984

William R. Brown, Director
USAID Mission
Khartoum, Sudan

Subject: Sudan River Transport Agricultural Marketing Project No. 650-0060. White Nile (Juba to Kosti) Contract OTR-1406-I00-2251-00 Final Prefeasibility Report

Attn: Peter Kranstover, PDI Division

Gentlemen:

Enclosed herewith is the Final Prefeasibility Report for the White Nile Transport Agricultural Marketing Project.

It has been a pleasure preparing this document and working with the USAID Mission's Khartoum staff. In particular, Peter Kranstover, Thomas Eighmy, Azhari Karim and Mohamed Yahya provided guidance and assistance and their effort is greatly appreciated.

The Government of Sudan officials whom we met were most helpful as well as the management and staff of the River Transportation Corporation.

We thank you for this opportunity, and we hope that the report leads to improved river transportation on the White Nile.

Sincerely,

MOFFATT & NICHOL, ENGINEERS

Robert D. Nichol

Robert D. Nichol
President

RDN:kg

Enclosure

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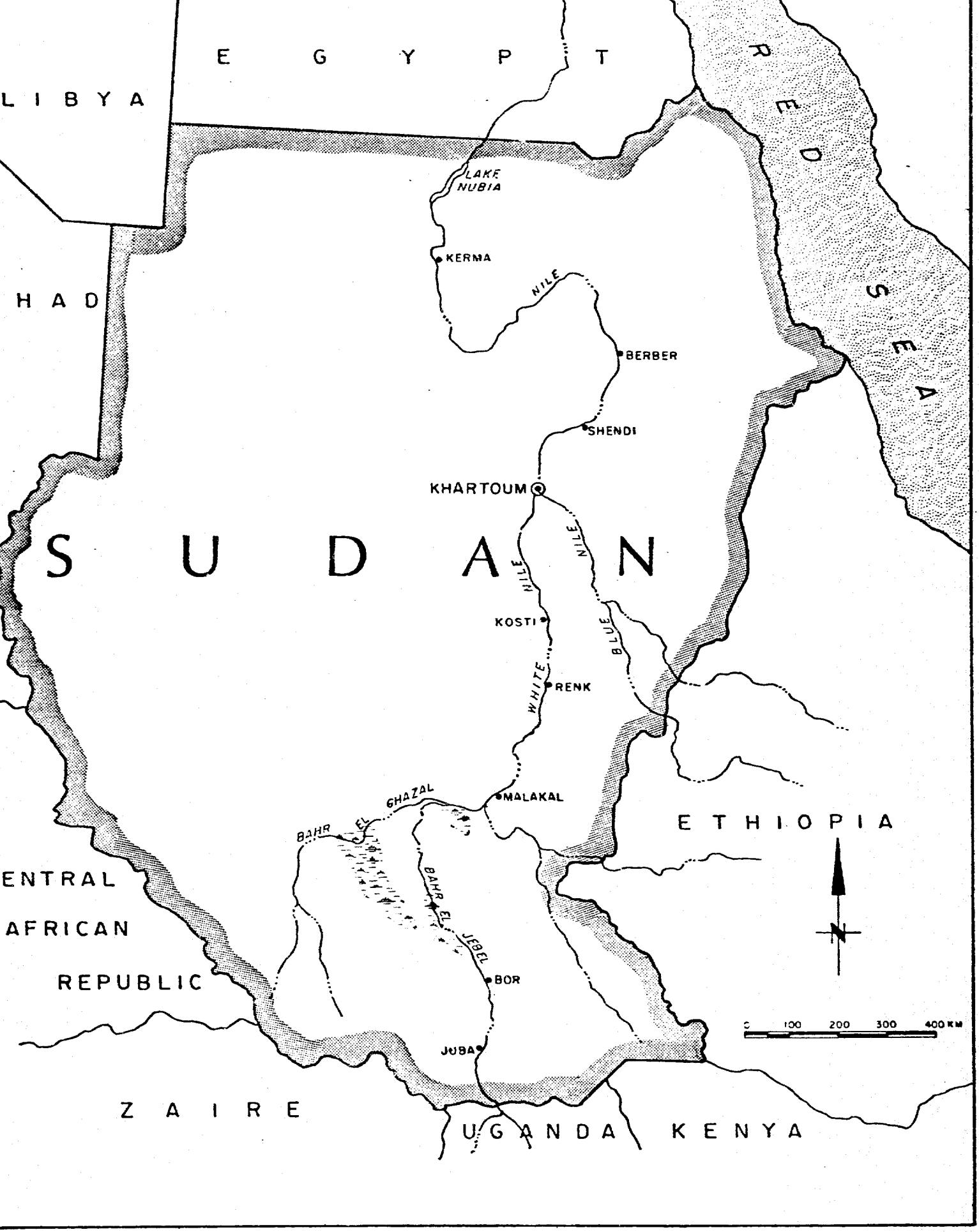

DEMOCRATIC REPUBLIC OF THE SUDAN

SUDAN RIVER TRANSPORT AGRICULTURE MARKETING

PROJECT NO. 650-0060

DECEMBER 1983

The views and recommendations contained herein are exclusively those of the contractor, Moffatt & Nichol Engineers, and are not necessarily a reflection of the policies of the United States Agency for International Development.

SUDAN RIVER TRANSPORT/AGRICULTURE MARKETING PROJECT

FINAL PREFEASIBILITY REPORT

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I. INTRODUCTION AND SUMMARY

BACKGROUND

The White Nile River is navigable from Khartoum to Juba and has historically served as a transportation artery from the railroad terminus at Kosti upriver to Juba, a distance of over 1,400 km. This system has provided transport of agricultural, petroleum and general cargo for the south and is especially important when the rainy season disrupts the only alternative mode, truck transport over semi-improved roads.

The Government of Sudan (G.O.S.) recently acquired a new fleet of tugs and barges in anticipation that there would be an improvement in river transportation. However, high costs and poor performance of the government-backed River Transport Corporation (RTC); poor conditions of the ports and some shallow river channels seem to be retarding the system's support of development potentials in the south.

The G.O.S., USAID and other funding sources are interested in achieving the economic benefits inherent in improved river transport. To that end, the G.O.S. has called for privatization of river transport activities, creation of a Department of Inland Navigation in the Ministry of Transportation and suggested improvements to the overall system.

OBJECT

In support of these goals, USAID commissioned this 8-week project to confirm, supplement and synthesize the large volume of data, information and regulations applying to improving, privatizing and administering the river system.

SCOPE OF PROJECT

The Project Team of two engineers, an economist and a river transportation specialist were assembled to examine physical, operational, financial and administrative constraints to improving the system. To accomplish this, the

team examined the river and the ports, including a site inspection trip from Juba to Kosti, reviewed previous studies and interviewed public sector and private sector responsibilities.

This report documents the findings of the Team. It contains the identification and pre-feasibility analysis of projects for physical improvement of the river and the ports. It documents the benefits of system privatization and suggests a public sector administrative structure appropriate to the present and future scale of the system.

The findings are reported in Chapter I; short-term and longer-term recommendations are presented in Chapter II; and the full report is contained in Chapters III through VIII and the Appendices. The scope of work is included as Appendix 7.

SUMMARY OF FINDINGS

The major findings of the Project Team are listed below in the order they appear in the Technical Report, Chapters III through VII. Conclusions and project recommendations appear in Chapter II.

THE RIVER

- The river is navigable by existing river craft from Kosti to Juba during high-water periods. Five shallow areas in the last 70 km prevent access to Juba during low water season.

- Steep river gradients in the 40 km Mongalla to Juba reach result in bank erosion, sediment transport and channel instability. In turn, this has created shallow areas which are likely to recur if the channel is dredged for low-water operation.

- The Jonglei Canal is unlikely to hinder navigation on the reach of the Bahr El Jebel bypassed by the canal. However, the canal is going to lead to river traffic and navigational difficulties not existing on the present system.

- An extensive navigation aids system is not economically justified at this time. A low cost but functional alternative is recommended for implementation. This includes simple range markers at any dredged areas and an aerial photograph mosaic for the river reaches from Lake No to Juba.

THE PORTS

- Existing port facilities are old, poorly maintained and inefficiently operated. Clearing the waterfront, turning warehouses into transit sheds, securing the port, restricting the public and making minor repairs should precede any further investment.

- Economic development of the river system will require facility improvements at Renk, Juba and Mongalla. Additionally some delayed maintenance work should be accomplished at the other primary classified ports.

- Existing labor-intensive cargo handling methods are appropriate for the cargo and the country. Modest investments will provide some "heavy lift" capability allowing discharge of heavier loads in the south.

- Covered storage is required to protect perishable cargo. After first investigating the availability of existing storage facilities, it may be necessary for a governmental entity to immediately build warehouses near the ports of Bor, Mongalla and Juba.

IMPROVING RIVER TRANSPORTATION

- Steep river gradients and dominant upstream cargo movements will prevent the system from achieving near-term economies associated with river transport elsewhere in the world.

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- Privatization of the presently adequate tug and barge fleet shows the greatest promise for achieving better tug-barge utilization and lower rates. This step alone could achieve annual savings of over LS 4 million.

- A method to put the present fleet into private sector operation on a competitive bid rental basis is suggested. The alternatives of fleet divestiture or privatization accompanied by extensive regulation are less likely to accomplish the goals of improved river transport service and lower rates. The fact that four or five firms have initiated recent river services reflects the financial ability of the private sector to participate productively in the system, and the proposed rental scheme minimizes the requirement for private sector financing.

- Alternatives to competitive leasing were considered:

  - Wet leasing of RTC fleet -- but Chevron experience shows this doesn't work.

  - Selling that part of the RTC fleet declared surplus -- but bidding would require major capital investments.

  - Return the RTC to early 1960's efficiency levels -- apparently not possible.

ECONOMIC AND COMMODITY FLOW FORECASTS

- The lack of reliable, frequent transport to the south is the single most serious impediment to both agricultural production and marketing in the south.

- Economic growth and commodity flow forecasts for southern ports are based on a recovery to pre-hostility highs plus moderate growth. Forecasts for the northern ports are based largely on a moderate growth in traffic to and from the southern ports.

- The largest absolute growth is forecast for Kosti, Juba, Renk and Bor in that order. Malakal, Mongalla and the smaller secondary ports show only moderate growth.

- Juba is, by far, the port with the greatest economic growth potential in its expanding hinterland. Most of the growth tonnage is for marketing agricultural commodities.

PROJECT FEASIBILITY AND RANKING

- Privatization of the existing fleet provides the greatest potential benefits versus associated costs. Initial annual benefit of LS 4,000,000 + exceed annual costs of LS 360,000 by a factor of more than 10. In fact, the largest part of the program benefits are privitization benefits. Thus, if privatization does not succeed, few of the capital improvements can be justified. The largest beneficiaries of the program will be the economy and the people in the south.

- Navigation from Mongalla to Juba at high water with overland transportation during the dry season appears to be most economic of any of the alternatives considered. Recurrent dredging of the Mongalla-Juba reach for year around access is the least attractive alternative.

- To assure the benefits of privatization, a series of investments are recommended. These include port investments at Renk, Mongalla and Juba and channel dredging at two locations downstream of Mongalla. Also, adequate warehousing near the ports is necessary. Ideally, if storage capacities are sufficient for surges in demand thereby negating the unofficial market system, there would be annual savings in excess of LS 1,000,000.

- Organizational and managerial changes will result in far more benefits than will investments in physical facilities. However, present and anticipated levels of river traffic and cargo volumes do not warrant an extensive administrative, managerial or regulatory structure. In fact, establishment of such a structure could negate most of all of the benefits of privatization.

- A small staff in the Ministry of Transportation (assisted periodically by outside experts) could guide development of the system and provide the minor regulatory requirements for vessels and operating personnel.

- Some public sector investments in ports and channels may not be directly recoverable via user fees in the early years but could be recovered over the long term if the system develops as planned. No new user fees are recommended at the outset of privatization, nor are rate increases warranted under privatization. Waterway fees should be charged only in the context of fees for all other transport modes, and when collected, should be returned to the agency responsible for modal development and maintenance.

II. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

A 20-year implementation plan of short term and long term river system improvements is specified. This program is designed to support market access requirements for current and potential agricultural activities that are dependent on improved river transport.

The recommended improvements cover a range of organizational and administrative actions as well as for facility construction. They include privatizing the RTC fleet; river administration; river dredging; navigational aids and port developments.

Present worths (at 10%) of costs and benefits and the internal rate of return for capital improvements are:

Present worth of benefits	=	LS 34,600,000
Present worth of costs	=	LS 26,600,000
Net of benefits & costs	=	LS 8,000,000
Internal rate of return	=	24.9%

Factors to which the feasibility analyses are particularly sensitive include:

- Type of privatization; implementation and transition period
- Implement improvements (privatization or other) with extreme care to avoid negating potential benefits/feasibility
- Disposition of current RTC employment
- Employ excess of those needed for recommended cargo operations in a sorely needed and vastly expanded river passenger service

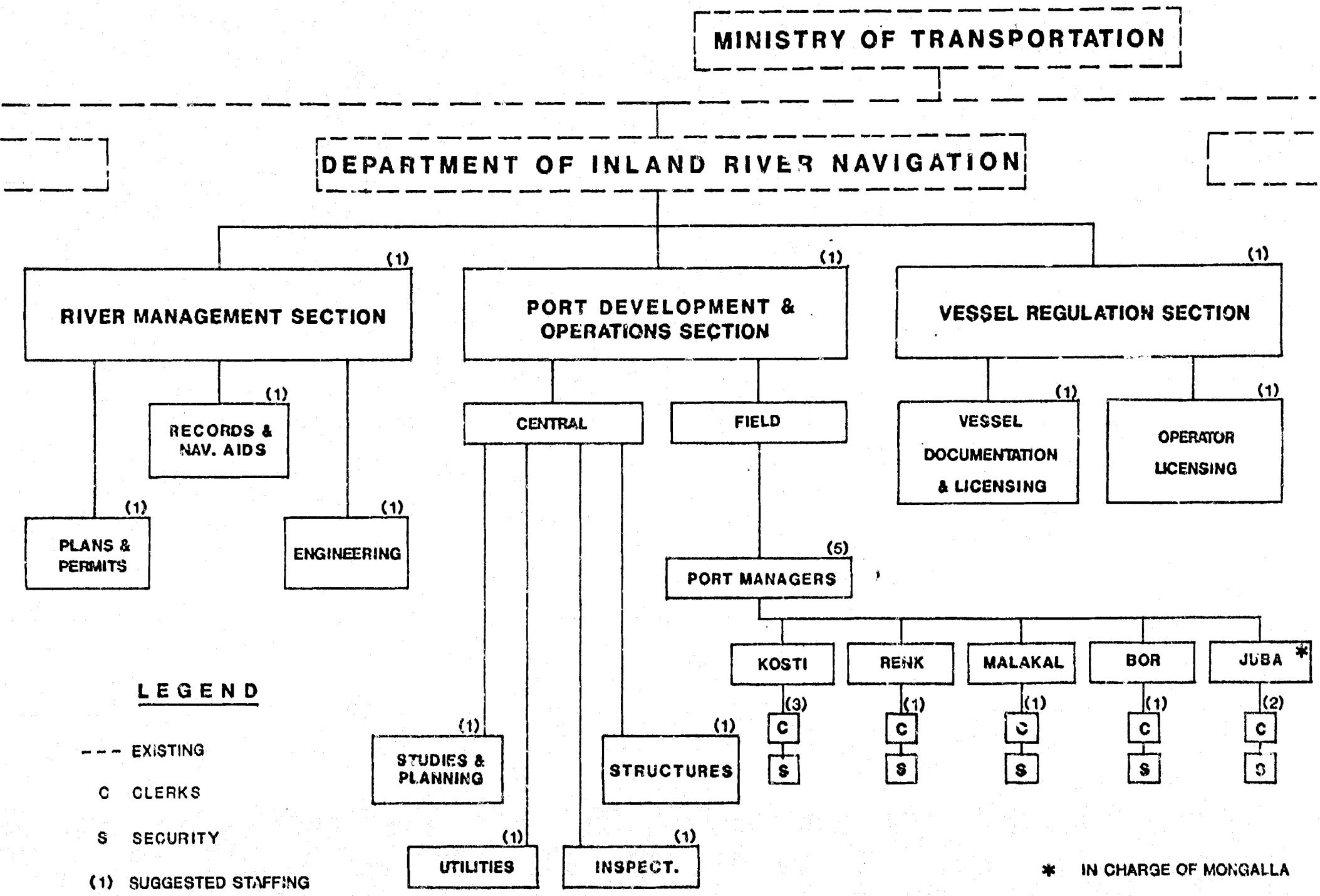
- Allocation of program costs in the form of users fees
- Over regulation
- Do not initiate a program of cost allocations from a single-mode viewpoint
- Avoid lengthy, time consuming regulations

RECOMMENDED SHORT TERM IMPROVEMENTS

All components of the river transport system were investigated on-site or through personal contacts and technical reports. Present component and system capacities were then compared with present traffic volumes plus latent (presently unsatisfied) transport needs.

The comparison of (1) present and latent needs with (2) present capacities resulted in the identification of needed short-term improvements. These improvements, which are physical, operational and organizational in nature, are presented in the following pages on a project by project basis. Included in each project are: locational/descriptive maps, descriptions and costs for improvements; project relationships; and environmental considerations. Together these projects contribute to a system capacity that can meet short-term requirements to support needed agricultural development and marketing activities through:

- Major transport cost reductions and service improvements, at current rates, that remove impediments to growth in the south
- Minimizing foreign exchange requirements and providing a mechanism for ensuring timely repayment of RTC debts for the new fleet
- Minimizing financial requirements for private sector participation in river transport
- Minimizing destructive unofficial market pricing in the south.


MINISTRY OF TRANSPORTATION
DEPARTMENT OF INLAND RIVER NAVIGATION
RIVER MANAGEMENT SECTION (1)
PORT DEVELOPMENT & OPERATIONS SECTION (1)
VESSEL REGULATION SECTION (1)
RECORDS & NAV. AIDS (1)
PLANS & PERMITS (1)
ENGINEERING (1)
CENTRAL
FIELD
VESSEL DOCUMENTATION & LICENSING (1)
OPERATOR LICENSING (1)
PORT MANAGERS (5)
KOSTI
RENK
MALAKAL
BOR
JUBA *
C (3)
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C (1)
S
C (1)
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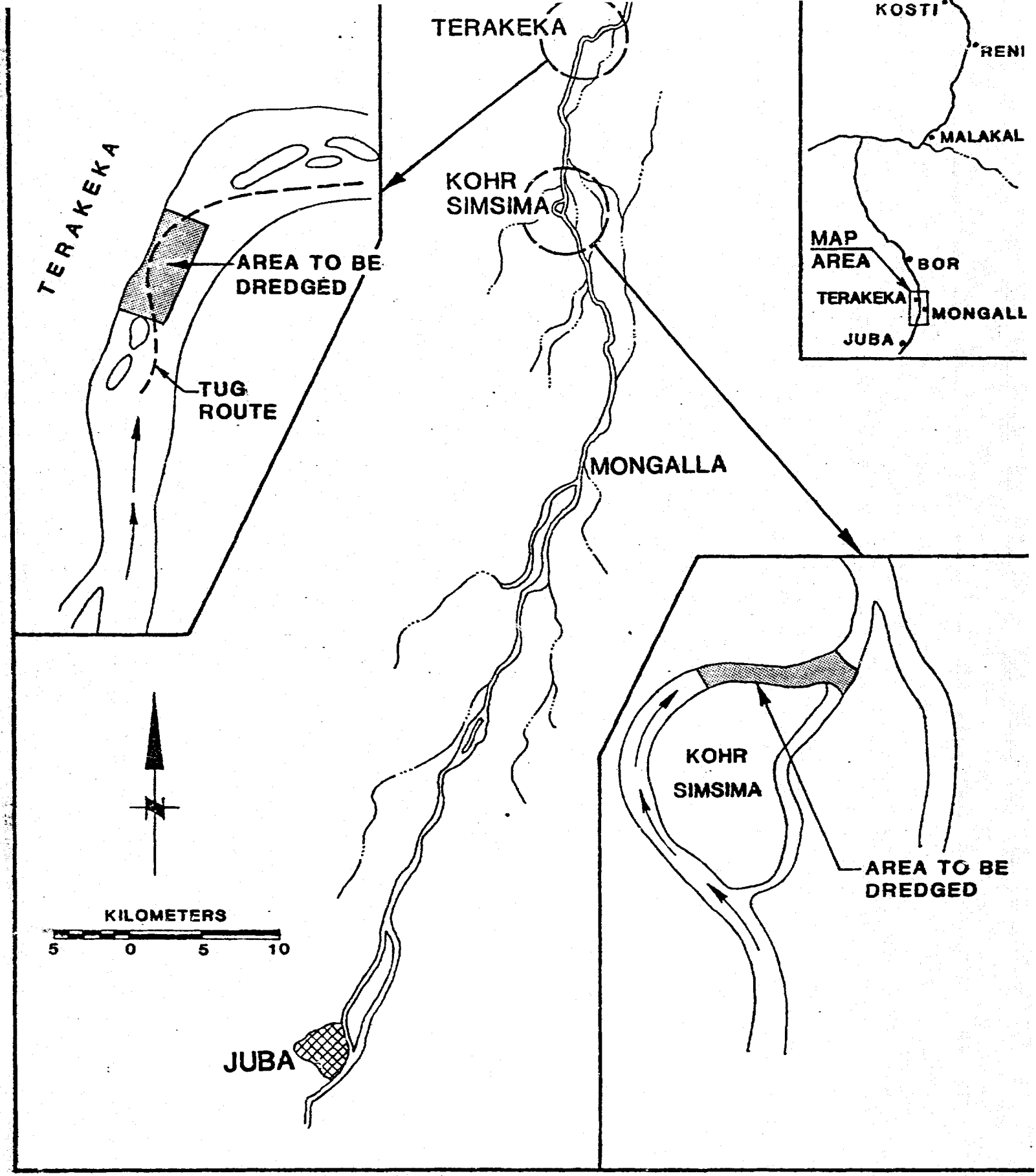
C (2)
S
STUDIES & PLANNING (1)
STRUCTURES (1)
UTILITIES (1)
INSPECT. (1)
LEGEND
EXISTING
C CLERKS
S SECURITY
(1) SUGGESTED STAFFING
* IN CHARGE OF MONGALLA

PROJECT: PRIVATIZATION

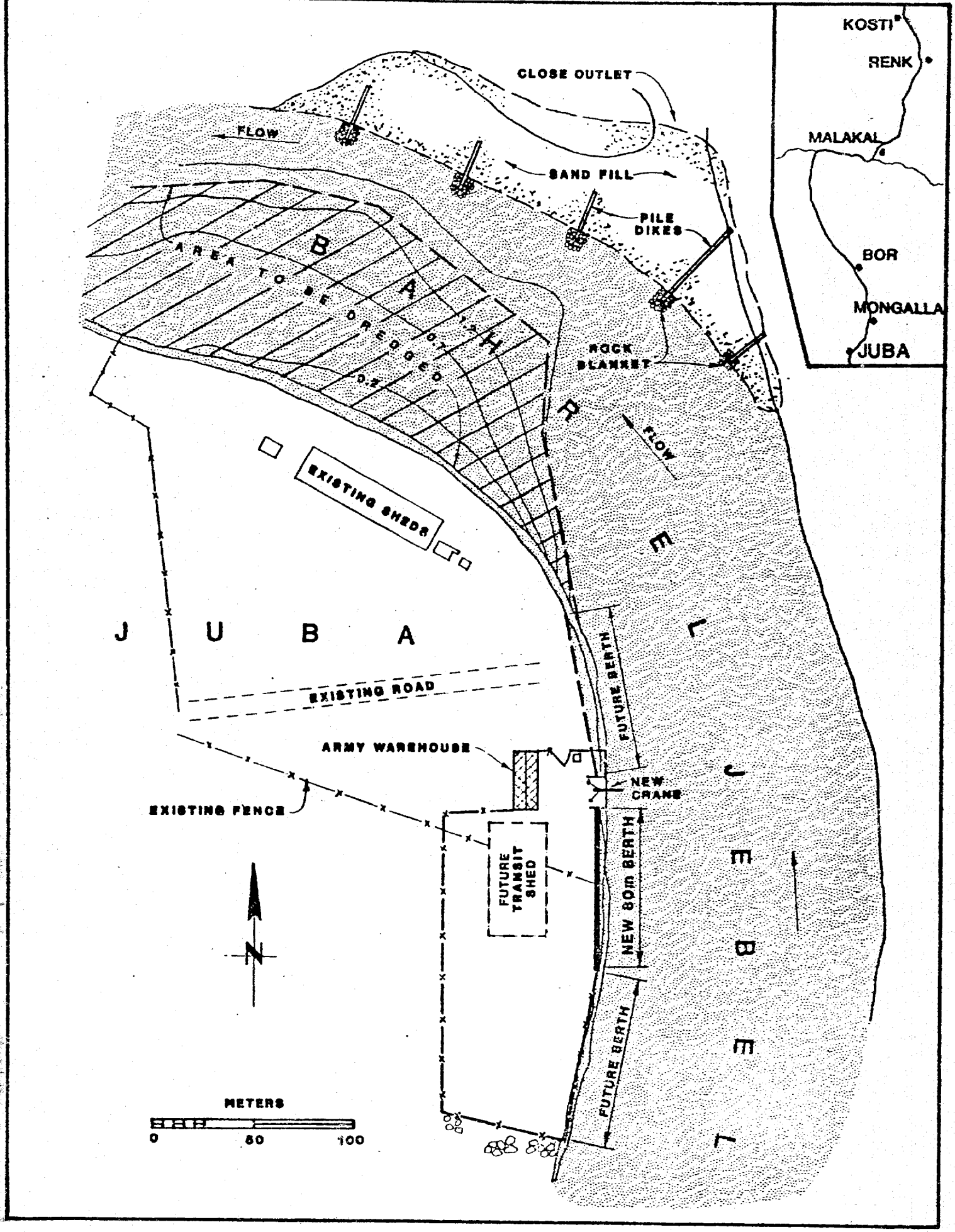
PRIORITY RANK	No. 1
DESCRIPTION OF IMPROVEMENTS	Within the MOT's Department of Inland River Navigation establish a River Management Section; Vessel Regulation Section; and Port Development Section, the latter with a Central Staff and Field Staff including Port Managers and support at the five Primary Ports (Kosti, Renk, Malakal, Bor and Mongalla/Juba).
ESTIMATED COSTS	LS 360,000 annually
TECHNICAL ASSISTANCE	Provide assistance to the MOT in organizing the Department of Inland River Navigation three new sections, establishing job descriptions, operational and management procedures and help train the selected personnel.
RELATION TO OTHER PROJECTS	Should precede all capital improvement projects.
ENVIRONMENTAL CONSIDERATIONS	Not applicable



PROJECT: DREDGING - BOR TO MONGALLA

PROJECT: DREDGING - BOR TO MONGALLA

PRIORITY RANK	No. 2
DESCRIPTION OF IMPROVEMENTS	Dredge approximately 68,000 cubic meters at two locations between Bor and Mongalla: Kohr Simsima at km 1387 and Terakeka at km 1378. Minimum depth shall be 2.2 meters at low water. Provide appropriate navigation aids at sites once work complete. Fly and prepare aerial photo book - Lake No to Juba.
ESTIMATED COSTS	LS 1,704,000 first year plus LS 852,000 every other year (dredging) LS 371,000 aerial photo book
TECHNICAL ASSISTANCE	Preparation of construction documents, pre and post dredge surveys, construction inspection, and monitoring system.
RELATION TO OTHER PROJECTS	Work is necessary to allow heavy loaded barges year around access to Mongalla.
ENVIRONMENTAL CONSIDERATIONS	Bottom sediments will be disturbed at the dredge site and land vegetation covered at the disposal site. Both will recover and new biota established.



PROJECT: PORT OF JUBA

PROJECT: PORT OF JUBA

PRIORITY RANK	No. 3		
TONNAGE	81/82	1990	2000
	54,300	105,000	160,000
UNIT BERTHS NEEDED	1	2	3-4

DESCRIPTION OF IMPROVEMENTS

Clear the waterfront; dredge the port and channel the river; construct an 80 meter quay; build a short vertical wall and erect a stiff-leg crane; and grade, place laterite, light and secure aproximately 3 feddans of backland.

ESTIMATED COSTS

LS 4,500,000 in 1985 plus LS 240,000 every ten years for replacing laterite, fencing, lighting and crane repairs. LS 1,400,000 each for 2nd and 3rd berths.

TECHNICAL ASSISTANCE

Train personnel on proper port management and operations, prepare construction documents, assist in contract administration, and initiate facility maintenance program.

RELATION TO OTHER PROJECTS

Improvements at Juba are closely related to those at Mongalla for dry weather operations. They must be planned together. Further, improvements at Juba are contingent on the following road improvements: Juba-Mongalla, Juba-Kenya, and Juba-Yambio.

ENVIRONMENTAL CONSIDERATIONS

Land vegetation disturbed at new berth but improvements compatible with adjacent facilities. Dredging and channelization will alter regime.

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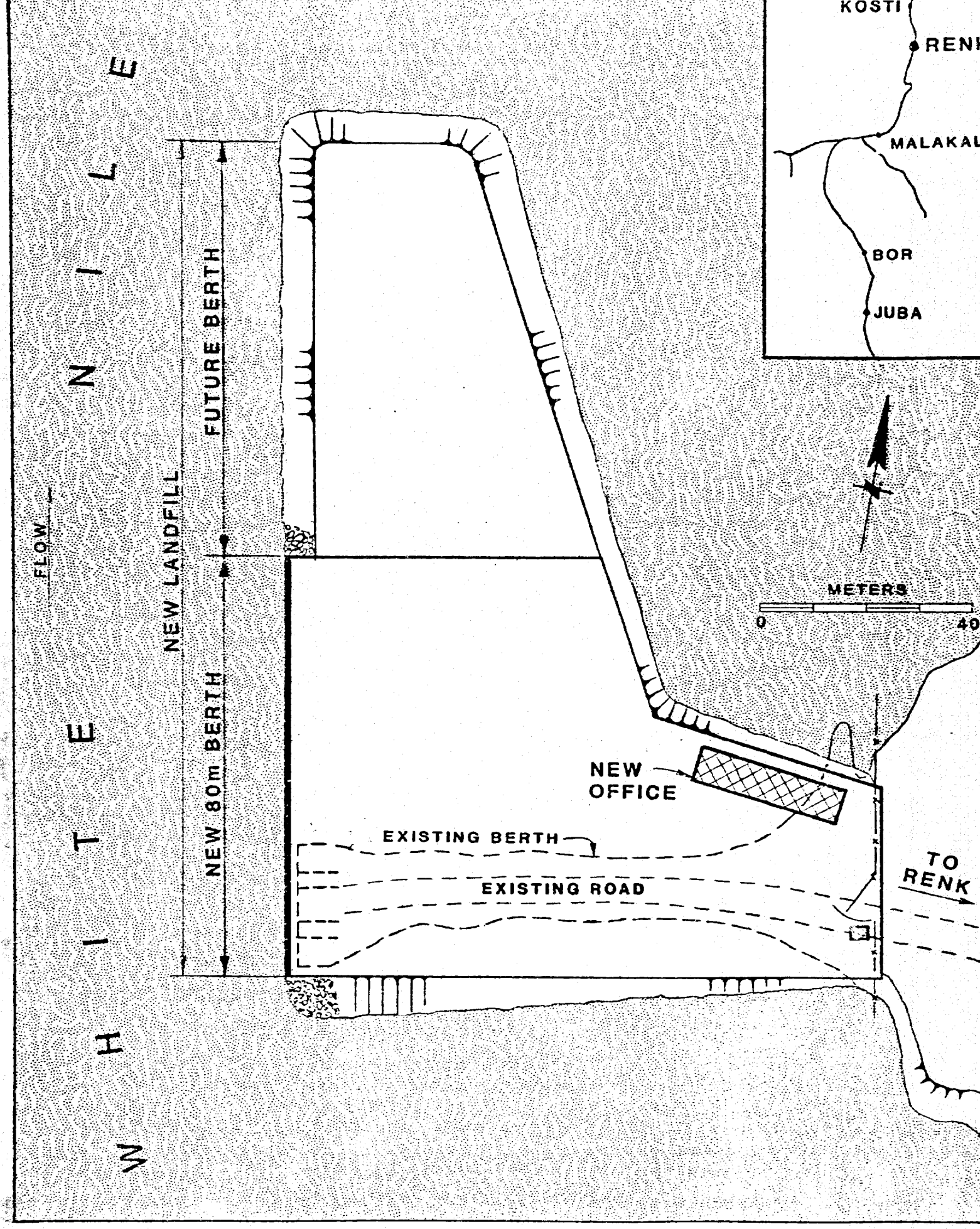


PROJECT: PORT OF RENK

PROJECT: PORT OF RENK

PRIORITY RANK	No. 4		
TONNAGE	81/82	1990	2000
	39,000	55,000	60,000
UNIT BERTHS NEEDED	1	1	1-2

DESCRIPTION OF IMPROVEMENTS

Dredge and fill approximate 63,000 cubic meters, construct an 80 meter sheet pile berth, provide laterite, lighted and secure backlands and new administrative offices within the port area.

ESTIMATED COSTS

LS 3,100,000 plus LS 240,000 every ten years to replace laterite, fencing and lighting.

TECHNICAL ASSISTANCE

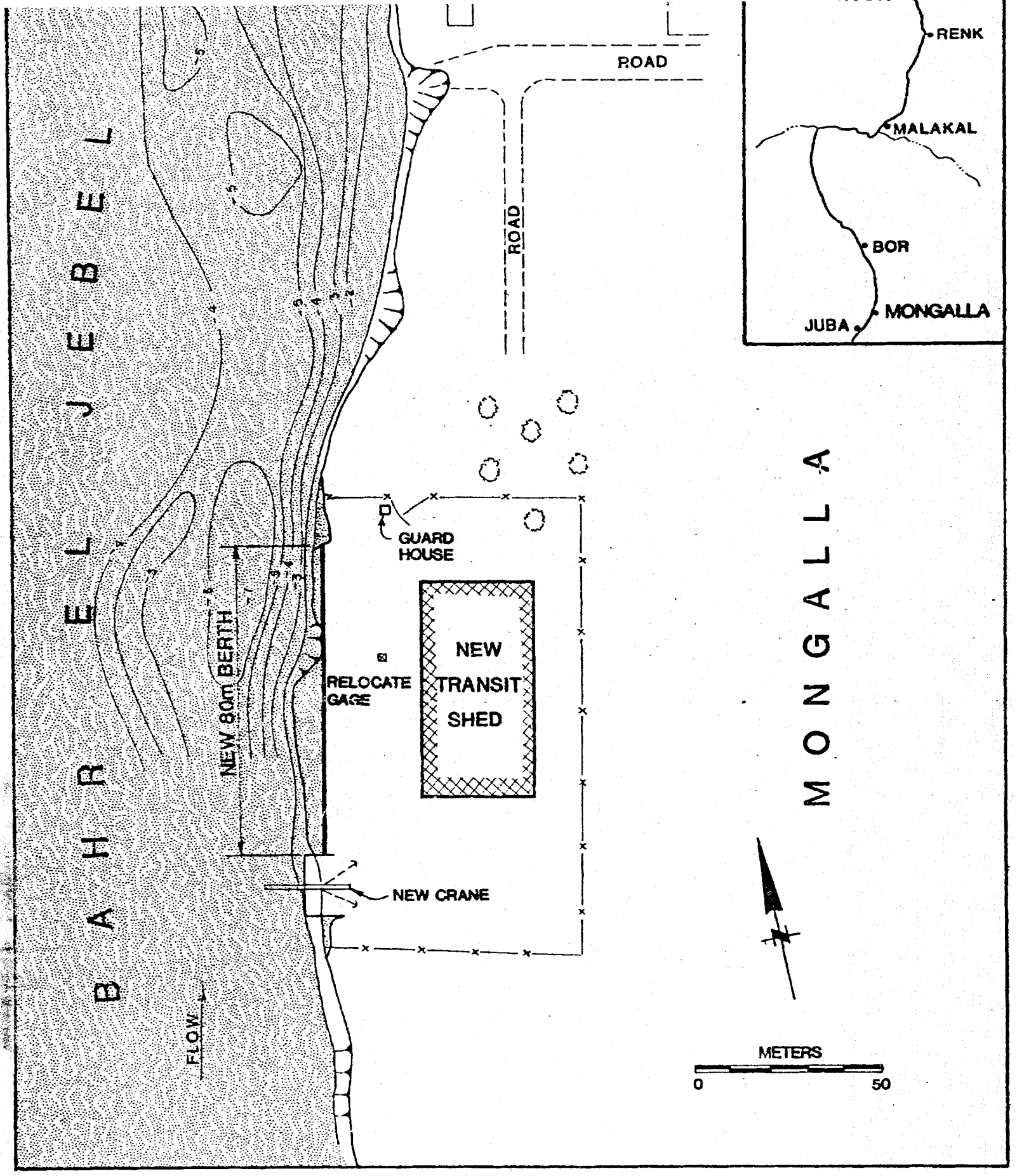
Provide construction documents and contract administration. Assist in establishing efficient port operational procedures.

RELATION TO OTHER PROJECTS

The throughput tonnage is closely linked (1) to Juba and forecasts for self-sufficiency in the south, and (2) to the capture by truck transport of north-bound exports from Renk's hinterland. If the south does not become self-sufficient or if north-bound exports do not move by truck, the Port of Renk will handle much higher tonnages than those shown above.

ENVIRONMENTAL CONSIDERATIONS

Dredging and filling will disturb the marine biota.



PROJECT: PORT OF MONGALLA

PROJECT: PORT OF MONGALLA

PRIORITY RANK	No. 5		
TONNAGE	81/82	1990	2000
	3,400	10,000	15,000
UNIT BERTHS NEEDED	1	1	1

DESCRIPTION OF IMPROVEMENTS

Unit berth needed in 1985 to support least-cost system (See Chapter VII).
If Mongalla is the dry season port for the south: clear the backland; construct a unit berth 80 meters in length and a vertical wall with associated stiff-leg crane; and add a laterite surfaced, lighted and secure backland area with port administrative office. Transit shed is needed but will be provided by others.

ESTIMATED COSTS

LS 2,350,000 plus LS 240,000 every ten years to replace laterite, fencing and lighting.

TECHNICAL ASSISTANCE

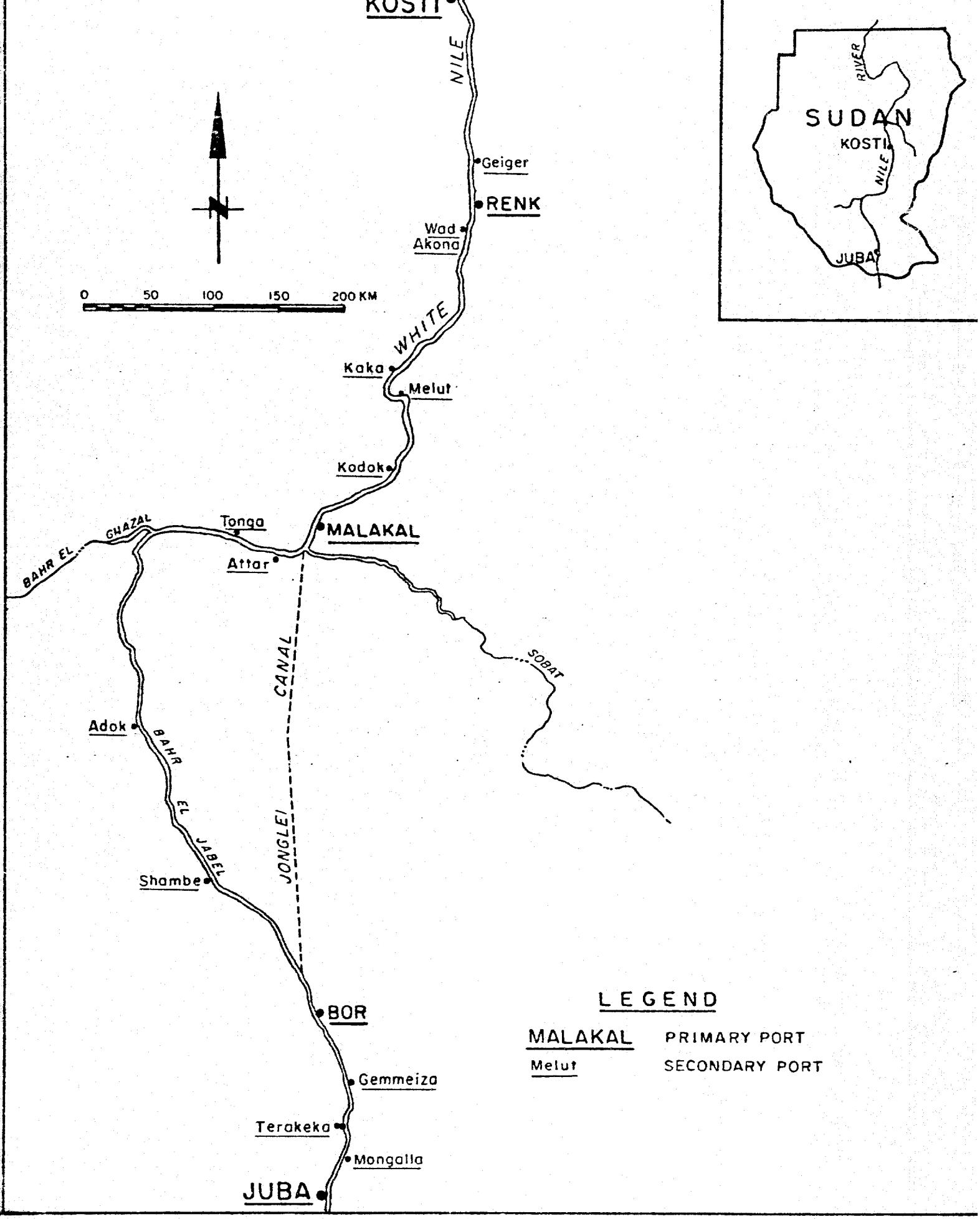
Prepare construction documents and assist in contract administration. Set up port management operations, and maintenance procedures.

RELATION TO OTHER PROJECTS

Improvements at Mongalla tightly related to those at Juba. They must be planned together. Further, improvements at Mongalla are contingent on the maintenance of a good gravel road to Juba.

ENVIRONMENTAL CONSIDERATIONS

Some trees and vegetation destroyed.



PROJECT: SYSTEM IMPROVEMENTS

PROJECT: SYSTEM IMPROVEMENTS

PRIORITY RANK	No. 6
DESCRIPTION OF IMPROVEMENTS	At Kosti clear the waterfront; at Malakal move the barge, repair the bulkhead and remove submerged obstacles; and at Bor dress the bulkhead slope, place new bollards, and remove water obstructions. Insure a workable radio communication system between the five Primary Ports and the tug fleet.
ESTIMATED COSTS	LS 500,000 plus LS 10,000 yearly communication maintenance.
TECHNICAL ASSISTANCE	Provide guidance in best use of funds including selecting and maintaining proper communication network. Set up a facilities maintenance program.
RELATION TO OTHER PROJECTS	These improvements are essential to ensure efficient system-wide operations, and to capture the full benefits of privatization.
ENVIRONMENTAL CONSIDERATIONS	Slight disturbance of water/land interface with quick return to equilibrium.

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RECOMMENDED LONG TERM IMPROVEMENTS

Mid to long term improvements are identified in the capital improvement program of Table II-1. These improvements are in support of the economic and commodity flow forecasts and coordinated with the short term improvements discussed above.

All of the mid to longer term improvements are capital improvements for facilities to replace worn out structures or to support growing port throughputs. As shown in Table II-1, ports to be further improved over the 20-year project period are:

Port	Additional 80 Meter Unit Berths
Kosti	3 to 4
Juba	2
Malakal	1
Bor	1

As with any capital improvement program, this forecast should be updated every two to four years.

IMPLEMENTATION

The implementation schedule is based on the suggested items of work and their interrelationship to design and construction scheduling, and assumes an "earliest possible" start. Actually the schedule must be tempered with donor funding programs and political consideration of the host country.

SCHEDULING OF CONSTRUCTION WORKS

Ideally from the Sudd southward the construction work should be performed in the dry season, which is from approximately November 1 through May 1 with the river stages being the lowest from mid February through mid April.

Though it is not absolutely necessary, dredging and waterfront work would be better performed during the low river stages for the purposes of quality control. The Photo book in order to be useful for the 1985 low river stages should be flown between February and April of 1984 and this is shown on the implementation schedule. The dredging plant for the Bor to Mongalla Channel should be mobilized in the last quarter of 1984 and be accomplished during the first quarter of 1985.

The port improvements to Juba and Mongalla should start in the first quarter of 1985, with an estimated 9 months construction schedule. The final laterite surfacing should be done at the beginning of the dry season. To make this schedule, the construction documents should be finished by the end of the third quarter, 1984.

Renk has a longer dry season than the southern ports, lower water stages a little bit later and therefore, construction could start in the second quarter of 1985.

System improvements to the other primary ports should be tied in with the major dredging and/or port improvement projects.

CONSTRUCTION PACKAGES

Construction work south of the Sudd could be under one general constractor which includes the dredging as well as the port improvements at Mongalla and Juba. This would allow for better utilization of the contractor's plant and personnel and although there is approximately 70 river kilometers between Terakaka and Juba he can set his forces up with the main camp at Juba and/or Mongalla with sub camps at the other port and dredging site. Assuming that he mobilizes his water equipment in the Kosti area and moves south, then maintenance work on the system at Malakal and Bor could be accomplished on the way to Equatorial Province and tied with the Kosti maintenance work.

SCHEDULING OF TECHNICAL ASSISTANCE AND CONSTRUCTION DOCUMENTS

To assist in privatization and setting up sections in the Ministry of Transportation's Department of Inland Navigation, technical assistance should commence as soon as possible in 1984 and is shown on the implementation schedule as starting in April in 1984. Additionally the preparation of the contract documents for the improvements should start soon so as to have some construction work occur during the low river stages of early 1985.

Table II-1
PROPOSED CAPITAL IMPROVEMENT PROGRAM

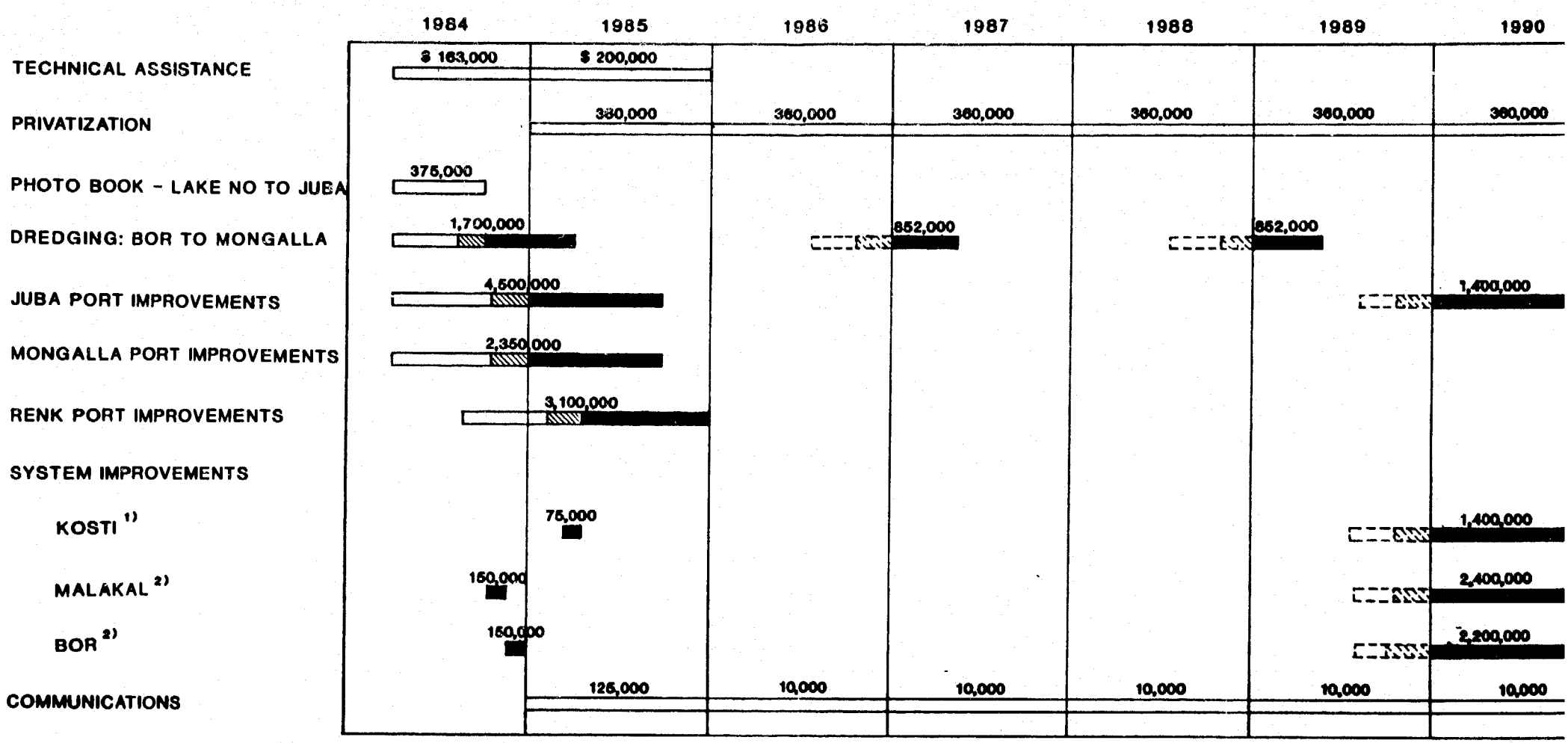
	SHORT TERM IMPROVEMENTS 1985			LONG TERM IMPROVEMENTS 1990		2000	
	Foreign Exchange	Local Currency		Foreign Exchange	Local Currency	Foreign Exchange	Local Currency
PRIVATIZATION	LS	LS 360,000/year		LS	LS	LS	LS
DREDGING PLUS PHOTO BOOK	1,800,000	275,000	plus 852,000 every other year				
JUBA PORT	1st Unit Berth & Crane 3,200,000 (plus 240,000 every 10 years)	1,300,000		2nd Unit Berth 1,000,000 (plus 240,000 every 10 years)	400,000	3rd Unit Berth 1,000,000 (plus 240,000 every 10 years)	400,000
MONGALLA PORT	Unit Berth & Crane 1,700,000 (plus 240,000 every 10 years)	650,000		-	-	-	-
RENK PORT	Unit Berth & Office 2,800,000 (plus 240,000 every 10 years)	300,000		-	-	-	-
BOR PORT	Clean up New Bollards, Dress Slope	150,000		Unit Berth 1,900,000 (plus 240,000 every 10 years)	300,000	-	-
MALAKAL PORT	Clean up New Bollards, Dress Slope	150,000		Unit Berth 2,000,000 (plus 240,000 every 10 years)	400,000	-	-
KOSTI PORT	Clean Up	75,000		Unit Berth 1,200,000 (plus 240,000 every 10 years)	200,000	Unit Berth 1,200,000 (plus 240,000 every 10 years)	200,000
SYSTEM IMPROVEMENTS	125,000	(+10,000 every year)			10,000		
	LS 9,625,000	LS 3,260,000		LS 6,100,000	LS 1,670,000		

tes - Funds are in 1983 Sudanese Pounds

Best Available Copy

IMPLEMENTATION SCHEDULE

WHITE NILE RIVER TRANSPORT AGRICULTURE MARKETING PROJECT



NOTES:

1) WITH RENK CONTRACT
2) WITH DREDGING CONTRACT

CONSTRUCTION COSTS ARE IN DECEMBER, 1983 SUDANESE POUNDS (EXCEPT TECHNICAL ASSISTANCE IS IN U. S. DOLLARS).

L E G E N D

- TA & CONSULTANT SERVICES
- BIDDING & AWARD
- CONSTRUCTION

III. THE RIVER

REVIEW OF THE RIVER SYSTEM

CHANNEL CHARACTERISTICS

The river system from Juba to Kosti has been described in several earlier reports. The more recent reports were written in regard to Jonglei Canal construction and operation. A summary of the studies for the Jonglei Canal, which consider only the river system from Bor to Malakal, is given in "Jonglei Canal Project Appraisal Study" by Sir M. MacDonald and Partners Limited (1983). Other reports that provide an information base relative to river transport are the U.S. Army Corps of Engineers Report (1980) and the "Study of River Transport in the Sudan" funded by the European Economic Community (EEC 1983).

These reports all separate the river into three separate reaches based on observed natural channel characteristics. We have found it useful to classify individual reaches of the river based on natural channel slope.

Our analysis of the slopes and typical river velocities for the Juba to Kosti suggests the river includes four distinct river reaches. Table III.I summarizes the slope and velocity conditions that exist.

We identify the river consists of the following separate reaches:

- o Juba to Mongalla
- o Mongalla to Bor
- o Bor to Lake No
- o Lake No to Kosti

Table III.1

TYPICAL CHANNEL SLOPE AND VELOCITY FOR THE WHITE NILE FROM JUBA TO KOSTI

From - To	Elevation Drop m	Distance (km)	Slope	Velocity (m/s)
Juba-Mongalla	12.32	40	0.00031	1.4
Mongalla-Bor	21.06	167	0.00013	0.9
Bor-Shambe	14.41	209	0.000068	0.8
Shambe-Lake No	19.3	414	0.000047	0.8
Lake No-Sobat River	1.66	129	0.000013	0.6
Sobat-River-Melut	3.54	171	0.000021	0.6
Melut-Kosti	6.06	358	0.000017	0.5

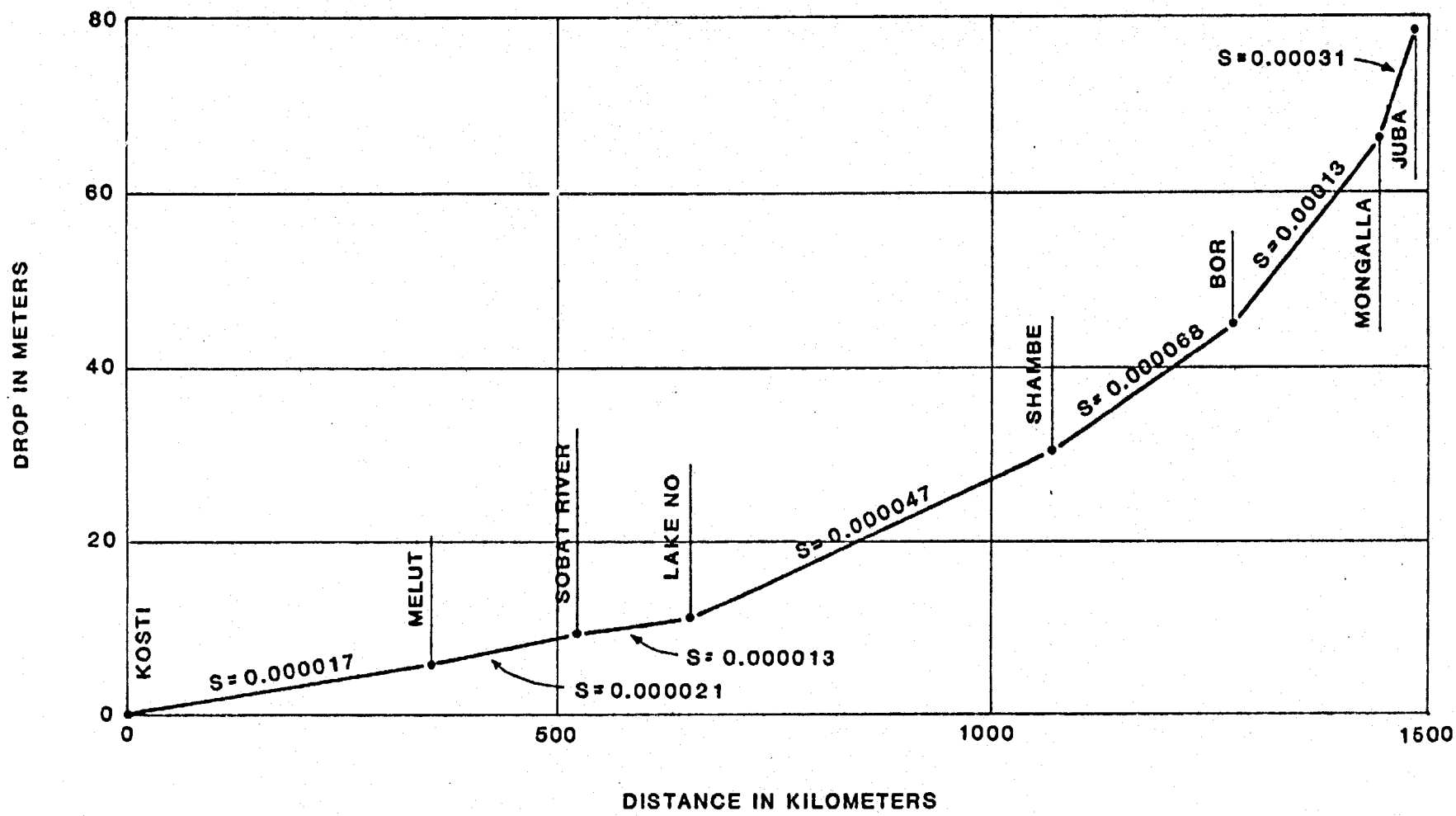
Source: Ogden Beeman and Associates

Juba to Mongalla (km 1448 to km 1408)

The waterway from Juba to Mongalla includes 9 km of the Juba Channel and 31 km of the Bahr El Jebel. Along this portion of the river valley, the channel is incised into the plain with a u-shape form that has a flat bottom and steep banks. The river meanders and frequently has two distinct channels and occasional smaller secondary channels.

Typical slope of the river downstream from Juba is 0.00031, with an average velocity of 1.4 meters/second. Samples of the bed surface reveal typically coarse sands with occasional fine gravels. Refer to the "Study of River Transport in Sudan" (From EEC, 1983).

The sediment bed load and channel slope exhibits characteristics of an alluvial river where active bed load movement occurs during moderate to high river discharge. In alluvial rivers, the thalweg (deeper thread) of river will exist along the outer bank of a bend and shallow point bars occur immediately downstream of the bend along the inner bank.



SCHEMATIC WHITE NILE CHANNEL SLOPE
JUBA TO KOSTI

Mongalla to Bor (km 1408 to 1281)

The Bahr El Jebel in this reach exhibits similar channel characteristics as was found immediately upstream. Steep cut banks are noticeably fewer downstream of a torturous dual channel area known as Kohr Simsima. According to sediment cores a clay layer exists as a subsoil throughout this region of the Sudan (MacDonald, 1983). The river has apparently scoured this bed subsoil and can now be considered to behave as an alluvial river with gradual channel migration and sediment transport.

The channel slope from Mongalla to Bor averages 0.00013, or approximately 40% of the previous reach. Typical channel velocities are 0.9 m/s. Bedload samples are analyzed to be medium to coarse sands.

Bor to Lake No (km 1281 to km 658)

The river from Bor to Lake No is called the Bahr El Jebel, but it is also known as the great swamp region, the Sudd. The Sudd comprises a flat plain with an average slope of .000054. (The Jonglei Canal will bypass the Sudd resulting in a steepening of slope to around 0.00010 along the canal proper.)

The Sudd region consists of a succession of shallow basins into which water spills from multiple low flow channels during times of high flow. These basins tend to lie below the alluvial banks of the low flow channels, but are connected back to the same low flow channels at the downstream end of the basins.

The low flow channels are multiple and extreme meandering is common. Cross sections tend to be of uniform depth and bed sediments vary from medium sands at limited locations to fine silts and clays which predominate. Upland areas in this reach are primarily covered with wetland vegetation of papyrus and hyacinth.

Lake No to Kosti (km 658 to km 0)

The river downstream of the swamp regions of the Sudd return to an alluvial river system. The river channel varies from a wide u-shaped single channel with gently meandering curves to a braided, multiple channel with several islands. The braided channel reaches are somewhat shallower than the single channel reaches. A typical channel slope of 0.000017 is present.

Bed sediments through this reach are predominantly medium sands. Some bed rock occurs at and downstream of El Jebelein, km 68. Deposits of medium gravels are also reported in the downstream portion of this reach.

RIVER HYDROLOGY

Evaluation of navigation for the White Nile requires identification of flood and water discharge and concurrent water surface elevations. These values will provide the channel depths available for navigation.

Water Surface Elevations

The criteria for water surface elevations were developed by the consultant group for the "Study of the River Transport in the Sudan" (EEC, 1983). They identified that gage records were not complete because of the Civil War, so that "some very interesting values ... were not available" for the analysis. Review of their work and other records available indicate that their low water elevations are most appropriate for the feasibility level analysis in this report.

Minimum water surface elevations for the Bahr El Jebel and White Nile between Bor and Malakal were derived from an unpublished report by Euroconsult for the Egypt-Sudan Permanent Joint Technical Commission on Nile Rivers - Jonglei Canal (PJTC). This minimum elevation criteria was derived using a mathematical model of the river-canal system.

A summary of low water elevations for selected stations is provided in Table III.2. The tabular results of the Euroconsult analysis for Bor to Malakal is included in Appendix 1.

Table III.2

MINIMUM WATER SURFACE ELEVATIONS AT SELECTED STATIONS FOR BAR EL JEBEL AND WHITE NILE, BEFORE JONGLEI CANAL

Station	KM	Elevation
Juba	1448	454.67
Mongalla	1408	442.71
Bor	1281	442.26
Shambe	1072	408.31
Lake No	658	389.01
Sobat Mouth	529	385.61
Malakal	508	385.17

Sources: Nile Basin 1973, PJTC

Notes: 1) Kilometers upstream from highway bridge at Kosti.
2) Based on Khartoum elevation of 363.08 meters.

River Discharge

Mean monthly discharges at selected sites were derived from "Nile Water Study" 1979 as reproduced by "River Transport Study in the Sudan". (EEC. 1983). This table is provided in Appendix 1.

NAVIGATION IMPROVEMENTS

The river system from Juba to Kosti is a relatively stable river system in that the channel alignment has changed very little in the past several years. Nevertheless, the river is still a dynamic system with locations of bank erosion upstream and active sand bed load movement upstream and downstream of the Sudd.

Channel shallow points do exist at several locations in the system, with a primary concentration in the river upstream of Bor to Juba Port. The draft of the floating equipment attempting to service the river ports at this time is greater than the natural depths at the shallowest locations during periods of seasonal low water. Correction of this problem can be approached in several ways. For purposes of this study, the following methods will be considered:

- o Limit navigation to existing depths by development of a river data base.
- o Provide necessary channel depths through an annual maintenance dredging program.
- o Develop deeper natural channels through a channel stabilization program.

NAVIGATION CHANNEL CRITERIA

Channels used for navigation must be wider than the width of tow to allow for lateral movement, effect of wind and current and turning around bends. In addition, the subsurface obstacles such as a shallow bed or rock pinnacles are not visible to the operator. In an attempt to allow a channel depth and width that is safe for navigation, certain criteria for channel requirements are established. These criteria must also cover inaccuracies of the hydrographic surveys in measuring water depths as well as the difficulties in vessel navigation.

Channel Depths

For channel design, a push tug formation with four standard 500 ton cargo barges will be used for the Juba to Kosti channel. Overall dimensions of a two barge wide configuration is 19.0 meters. Range of draft to cargo tonnage is provided in Table III.3. During high water conditions of full

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load of 5000 bags per barge could occur, or 500 tons. Barge draft would be 1.8 meters. During low water, we have selected a minimum depth of 1.2 meters equivalent to the pusher tug draft as the channel depth criteria. This is equivalent to 300 tons on the cargo barge as shown below.

Table III.3

DRAFT VERSUS LOAD FOR RTC CARGO BARGES

Tons	Draft
0	0.3m
100	0.6m
200	0.9m
300	1.2m
400	1.5m
500	1.8m

Source: River Transport Corporation (1983)

Minimum channel depth design should also include 0.35 meters for hull clearance over rock pinnacles or submerged debris. In channel dredging, an additional 0.35 meters is allowed for advanced maintenance and survey inaccuracy to assure minimum depths will remain until the next dredging event. This totals a minimum channel depth for pusher-tug passage at low water of 1.2 (tug draft) + 0.35 (hull clearance) + 0.35 (survey accuracy) = 1.9 meters.

When estimating actual dredging quantities, the capability of a dredge to excavate to a neat line elevation is not realistic. In shallow water dredging of less than 3 to 5 meters, allowance of 0.3 meters for operator and equipment capability is an accepted practice. This would mean a minimum total depth for the dredge cut of 2.2 meters to establish a 1.2m deep channel.

Channel Width

Width of the channel for safe navigation can typically vary from a minimum vessel side clearance of 1/4 to 1/2 the vessel width. This is dictated by the vessel size and speed, wind and current conditions and alignment of the channel. As an example, deep draft vessels with a beam width of 32 meters in the United States will often have a single direction channel bottom width from 60 meters to 90 meters wide. Our experience suggests push-tug and barges 20 meters wide require a single direction channel bottom width of 38 to 45 meters.

For the purpose of dredging estimates, it is assumed that a bottom width of 38 meters is adequate. This will allow one way traffic over the dredged shoal area. Requirements for a two way channel through the shallow areas in the short term is not justified, based on existing river traffic. Consideration for two vessel lanes, or a two-way channel, would be possible for the long term if there is increased vessel use of the river.

Dredged channel widths on curves need to be wider to allow for safe vessel maneuvering. Observation of the present operation procedure by the Reis on tight channel curves indicates the effective vessel width can approach 70% of the total tug and barge length. Overall length of the existing barge tows is 96.5 meters. A design bottom width of 70 meters will be used for severe bends in shallow channel reaches.

These widths are bed excavation widths. The non-cohesive materials of fine to coarse sand will have an angle of repose from 1 on 2 (1 vertical on 2 horizontal) to 1 on 4. For purposes of dredge quantity estimates, a 1 on 3 side slope will be applied.

Hydrographic Surveys

Completing surveys of channel depth and alignment is the first step in developing a navigable waterway. Hydrographic surveys are the data base used to establish water elevation gages, navigation aids, controlling

channel depths, channel alignment, dredging and channel stabilization measures. The importance for channel surveys cannot be overemphasized.

Development of a continuing hydrographic survey capability is necessary for future development on the river. For the purpose of planning and operations on the short term, survey of channel depth and width can help establish the actual capability of transport to the southern ports without additional control measures. Passage of the existing fleet over shallow bars may be possible for a greater time period, with less risk of damage, than is presently being realized.

As an example, criteria for movement upstream of Mongalla could be based on the river gage reading established at Mongalla. Continued movement of tug-barge tows could then take place until the gage elevation falls below an identified minimum water surface and channel depths rather than arbitrary cutoffs by calendar date. Use of shallower draft vessels or alternative transport could then be considered.

Identification of the deeper thread of the river through shoal areas may allow passage of existing fleet. With annual or seasonal hydrographic survey information, the location of navigation aids can be identified to assist the Reis in using the deepest channel available. Surveys of the river channel could be the least expensive alternative for improving the river transport operations.

Surveys of the river, particularly the Juba to Bor reach, could be accomplished by contract to establish the channel control points and elevations, as well as complete the first bankline to bankline mapping of the channel depth. This initial survey can then help identify the active channel bed locations for future annual or more frequent hydrographic surveys. A plan for continuing survey capability on the longer term, either by multi-year contract to an in-country or out of country contractor, or by the Sudanese government should be identified.

Subsequent surveying capability would require, as a minimum, the following equipment and personnel.

Equipment:

- o Survey vessel - A working vessel with living on board capabilities for 8 personnel minimum. Use of RTC equipment such as one of the 1976 vintage General Motors pusher tugs for surveys could be appropriate. Occasionally the vessel draft would prevent surveys in very shallow water. This would necessitate an additional small utility boat with its own power. This boat could be transported on board the larger vessel.

- o Electronic positioning - Horizontal position could be accomplished using state-of-the-art electronics such as the Del Norte Trisponder, Motorola Mini-Ranger or Atlas Polar-Fix. Experience has shown this equipment is relatively trouble free and dependable.

- o Electronic Sounding - Depths could obtained using a fathometer with hard-copy read out.

- o Electronic Plotting - On board computers are available that can incorporate the fathometer and horizontal positioning information and automatically plot the survey chart.

- o Manual Equipment - Realizing the difficulties in Sudan for maintenance and repair of the electronic equipment, manual survey instruments should be available on the survey boat.

A list of typical survey equipment is shown in Appendix 1.

Development of a government capability to survey and prepare charts on a suitable scale is one approach. As the river surveys will be accomplished in remote, isolated areas of Sudan, and as the government of Sudan agencies

do have apparent difficulties maintaining state-of-the-art electronic equipment, it is suggested that the manual equipment be used for the initial development of hydrographic survey capability.

Navigation Aids

Considerable discussion and review of installing navigation aids is available in previous reports. The options suggested for navigation aids include:

- o Buoys - Floating markers placed in-water to mark narrow channel reaches, small curvature radii bends, and subsurface hazards to navigation such as rock pinnacles.

- o Beacons - Fixed light structures installed on piles in the water or on land bases to indicate channel alignment, low water bankline or shoals.

- o Channel Markers - Boards fixed on posts on land to transmit information, directions, restrictions and prohibitions.

- o Channel Ranges - Two boards with light reflecting foils fixed on two piling placed so that their alignment indicates the center line of the navigation channel.

- o Kilometer Stations - Sign boards on piling along the bank that indicate kilometer position of a vessel on the river.

The installation of all these navigation aids in the short term time frame does not appear warranted. At this time Chevron has completed installation of position markers, or kilometer posts from Kosti to Bentui. They have also cleared rocks and marked the low water channel through the Jebelein rocks between Kosti and El Jebelein. The river traffic at this time does not have significant problems navigating the river from Kosti to Lake No. Short term investment for navigation aids in this 658 kilometer reach is not necessary.

The Bahr El Jebel from Lake No to Bor is torturous with numerous sharp curves and narrow channel widths. With the exception of Lake Shambe, the channel is adequately deep so that no problem exists for vessel drafts. Placement of kilometer posts in the reach of the river could help inexperienced operators to navigate through the Sudd. However, the Sudd is not the place for inexperienced operators with or without kilometer posts. Vessels moving on the Lake No to Bor reach must have a knowledgeable Reis.

During our river trip through the Sudd, it was found that the Reis and the engineer knew at what kilometer post we were passing without any markers to reference. Construction of kilometer posts to mark the channel would be of little value to an experienced pilot, and would be expensive. A January 1983 proposal to place 180 of these markers had a cost of $U.S. 1,675,000.

Another important consideration for navigation aids in the Sudd is completion of the Jonglei canal in 1986. The majority of river traffic will be diverted around the Sudd. A decision to construct navigation aids at this time in the Sudd therefore appears premature. Future conditions can obviously revise this position. One exception to this is the crossing of Lake Shambe from the navigation channel to Shambe dock. Marking the deeper water by buoys or piling should be considered. Surveys of this area by the consultants for the river transport study (EEC, 1983) indicate the water depths at low water are approximately 3 meters. Completion of the Jonglei Canal will result in the minimum low water depth of 2.5 to 3 meters (PJTC, 1983). This is a meandering channel, and should be marked to assure safe passage. The presence of fine silt sediments in the lake, calm water conditions and the small seasonal change in surface water elevations indicate use of anchored buoys as appropriate channel markers.

The reach of river from Bor to Juba does not require kilometer posts. It does require an experienced Reis and channel dredging for low water passage. Placement of navigation aids at sites where dredging is accomplished is also necessary. The presence of unconsolidated, non-cohesive sand bed, river flow conditions and potential for annual dredging prompts a recommendation

for channel ranges rather than buoys. For the purpose of the dredging cost estimate, construction of channel ranges on steel piling has been used. Such markers can be used to control dredging work and assist subsequent navigation on the channel.

A recommended short term alternative for kilometer posts and channel markers is the completion of an aerial photo book that identifies channel information. An example of this is provided in Appendix 1. The photo mosaic developed from an aerial flight need not be at exact scale. To develop an exact scale mosaic it is necessary to have completed a detailed horizontal ground control survey.

The cost for horizontal control over 1488 kilometers of river channel would be significant, while the actual error in the photography would be minor for their use as a general navigation tool. A cost estimate for development of an aerial mosaic book without the more expensive ground control survey is provided in the Appendix.

The aerial mosaic book could serve several purposes. It could serve as a base map to identify the deep water side of the channel for movement on the river. It would identify the approximate location of the vessel in the event of an emergency and it would serve as a reference to office management for discussions of shoal locations and other problem conditions. It would also identify location of future navigation aids.

Future development of waterborne commerce may justify better river marking and mapping. At the present level of operation, an aerial photo book and selected surveys of identified problem reaches appears to be of more immediate value and at a lesser cost. Cost for the aerial photo book is estimated at U.S. $206,000 based on Chevron's experience.

Channel Dredging

The short term solution for adequate channel depths on a year around basis is the annual dredging of the shallow reaches from Juba to Bor. The river

trip of 16 October to 24 October 1983, and the information obtained from previous reports has provided the basis for a qualified estimate on an initial dredging program.

Five reaches have been identified for channel dredging and are summarized in Table III.4. It is believed that the volume of sediment to be dredged as given in Table III.4 reflect an annual dredging requirement. This conclusion is somewhat conservative as no detailed experience with dredged channels in the Bor to Juba channel was identified or made available during our study. However, the river characteristics of discharge, channel slope, bed load sediment as identified for the Bahr El Jebel and the history of channel dredging requirements in other rivers of similar characteristics indicate this conclusion, while conservative, is realistic. Actual annual dredging requirements will be determined after a few years of channel maintenance and channel surveys.

TABLE III. 4

DREDGING REQUIRED TO PROVIDE A 1.2 M DEEP NAVIGATION CHANNEL FROM KOSTI TO JUBA

Location	Low Water Depth	Dredging Volume
Juba Channel, km 1442	0.9m	24,600 c.m.
Juba Channel, km 1439	0.9m	57,300 c.m.
Bahr El Jebel, km 1415	0.9m	16,800 c.m.
Kohr Simsima, km 1387	0.7m	50,400 c.m.
Terakeka, km 1378	1.1m	17,600 c.m.
	TOTAL	166,700 c.m.

Source: Ogden Beeman and Associates

Channel Stabilization

It is possible to reduce or eliminate channel dredging requirements through hydraulic design and construction of river control structures. In general

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such work attempts to impose a channel width limit at selected river reaches so as to cause natural flow to scour the bed to depths at or near the navigation requirements.

Design and construction techniques used for this include riprap along banklines, closing secondary channels, and placement of wing dikes or groins to direct channel flow.

Selection and design of the flow control structures require more hydraulic and sediment data than is presently available for the Bahr El Jebel. Additional data acquisition with study and design should be considered for two locations where conditions were identified that could lend themselves to a channel stabilization program. The specific sites for consideration include the Juba port area near kilometer 1488 and the Juba channel near kilometer 1442.

Juba Port

The Juba port site is located at a bend in the river. The upstream end of the port has a rock outcropping that is a fixed point control of the channel alignment. This fixed point causes the flow of the channel to be concentrated toward the east bank line and results in erosion on the east bank of the river. As the bank line erodes and the channel widens, the bed elevation gradually increases, thereby decreasing the natural channel depth. A point bar is forming downstream of the rock outcropping on the inside of the river bend. This is immediately in front of the port warehouses and has restricted low water use of the port waterfront.

A possible correction of this condition is placement of several short dikes perpendicular to flow on the east bank. This would concentrate flow toward the port side west bank, thereby scouring out some of the shoaled bed material. Consideration should also be given to closure of a small secondary channel opposite the Juba port area. These actions must be considered in a hydraulic design to assure they will improve channel conditions rather than create more problems.

This recommendation is most appropriate in reference to the existing Juba port developments. The Sudan government intends to remove a rock obstruction at the upstream end of Juba channel. The concept is to increase the flows through Juba channel and scour the bar to adequate channel depths. It is our understanding that no hydraulic design has been completed.

The decision therefore appears to be premature for two reasons.

- o Active erosion on the east bank is occurring during existing discharge conditions. Increased discharge would tend to increase this rate of erosion and increase movement of the deeper water away from the port.

- o Another concern, maybe the most serious, is the opening of the channel may introduce additional bed load into Juba channel from upstream.

Juba Channel, km 1442

The shallow area that has developed at this location is a reach of the river where several secondary channels divert water away from the main channel. The reduced velocities in the main channel caused by the reduced water volume could be the cause of sediment deposition in this reach. Analysis may indicate closure of the secondary channels would improve the flow regime, thereby increasing natural channel depths.

DREDGING PLAN

Dredging of the channel between Bor and Juba is necessary for improving river transport. The river upstream of Bor will be closed from January through May because vessel draft exceeds low water depths. Access to Juba and Mongalla requires a deeper channel and the short term remedy is to dredge the existing channel.

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FREQUENCY OF DREDGING

It is important to understand that one time dredging of identified shallow reaches will not create a permanent deepening of the channel. Channel shoaling is a result of active bed load transport and is most likely to take place during higher river stages and becomes a navigation problem as the river level drops.

It is probable that several, if not all five, shoal locations will tend to return to a shallow condition at the end of the next high water period. Dredging in the river must be planned for on an annual basis, at a minimum.

Efforts to monitor the shallow reaches preferably by surveys and river stage gages, should commence concurrently with the first dredging. This information will document the dredging requirements and allow for better planning of the timing and extent of dredging and the selection of the best equipment for the work.

Dredge Equipment

Two types of dredging equipment are typically used to accomplish channel maintenance. They are hydraulic dredges and mechanical dredges.

Generally speaking, the hydraulic pipeline cutterhead dredge (hydraulic dredge) is most commonly used for routine maintenance of navigation channels. A hydraulic dredge is specifically designed to remove sediment from the bed of a river or lake and transport it via pipeline to a different location. The hydraulic dredge uses a large centrifugal pump to pull sediments from the bed in a water-sediment slurry that is typically 20% solids by volume.

Typical dredging capabilities of a pipeline dredge vary with the horsepower on the pump and the diameter of the pipe. For example, typical small river dredges would have a 12" to 18" pipeline diameter with pump horsepower ranging from 700 to 1000. Such dredges could pump 250 to 600 c.m. per hour over distances of up to 300 m.

Mechanical dredges include the barge mounted cranes with clamshell and dragline buckets, and the dipper, backhoe and bucket ladder dredges. These types of dredges are normally used for work in channels that have a large amount of debris or a confined work area due to dock or other waterfront structures. They are better suited for work in sediment with debris than a hydraulic dredge because the debris will get caught in the pipeline or pump of a hydraulic dredge. The mechanical dredge tends to be less costly to operate than a pipeline dredge, but the production rates of sediment excavated per hour are much lower.

The mechanical dredge's ability to move sediment away from the channel is limited to the boom capability of the equipment, with a maximum for the larger cranes in the range of 15 to 25 m from the dredge cut. If it is necessary to transport the sediments to a location away from the channel, the use of second barge and tug is necessary.

Dredge Availability

Availability of dredge equipment is an important consideration for maintenance dredging in the Bahr El Jebel. At this time there are no operating hydraulic dredges in the Sudan.

Mechanical dredges in country include:

- Two - 100 ton American crawler cranes at Rabak owned by Arkel-Talab.

- One - model 4150 Manitowoc Crawler Crane at Rabak owned by Chevron.

- One - large crawler crane, make and model not identified, at the mouth of Sobat River owned by CCI Construction.

- Several large crawler cranes owned and operated by the Ministry of Irrigation.

All of these cranes can be used to dredge the navigation channel. With the exception of the Manitowoc, they all require a large flat top barge and tug to be able to work the problem sites identified.

Continued growth of the river transport in the Sudan would put added emphasis on timely dredging of the river. Under this scenario, the low production rates and relatively high unit cost of mechanical dredges to complete the necessary dredging would become critical. Future availability of a pipeline dredge for annual maintenance must be considered. Development of dredging data, information on channel shoaling following dredging and continued channel stage and discharge measurements are necessary to derive the optimum long term plan.

Contract Alternatives

In order to proceed immediately with river deepening, it is necessary to initiate contract dredging work. Due to the lack of survey information, soils data and contractor experience in this river reach, equipment rental with work performed under the direction of the owner would be the normal way to proceed. If the owner objects to this procedure, it may be possible to proceed with an indefinite quantity, unit price contract if a contractor can be found who is willing to work on that basis.

A unit price contract would be negotiated with the method of dredging and disposal specified. Separate pay items should be included for mobilization and demobilization, movement from location to location and for unit cost of dredging based on bucket measurement if no survey is available. Survey capability would allow measurement of units by pre- and post-dredge survey. To accomplish this work, one month should be allowed for negotiations and one month for contractor mobilization. It is estimated that 3.5 to 4.0 months would be required for the dredging work.

Conventional contracting with a unit price bid based on pre-dredge surveys would be preferable but would take several extra months in order to include the pre-dredge survey in the contract documents. Future dredging work should be initiated on a basis that will allow this procedure to be followed.

Dredge Plan - First Year

Because of the lack of equipment available in country, RTC should make a tug, a flat barge, and a fuel barge available to any qualified contractor wishing to undertake the dredging work. RTC should prepare daily rental rates for this equipment and the contractor can use these rates in preparation of his bid.

The details of the manning and the cost estimate, are included in Appendix 1. The estimate assumes that the pusher tug would be rehabilitated by contractor and made suitable for crew quarters.

The production rate for a dragline crane, assuming material is sidecast away from the channel one time and not rehandled is estimated at 1840 c.m./day. The work day consists of two-10 hour shifts, seven days a week for a 3 c.y. bucket.

It is assumed that the contract crew will live in Juba when dredging along Juba Channel at km 1442 and km 1439. Navigation aids for the completed dredging will be installed after each site is dredged.

Contract administration cost for the management and inspection of the contract is estimated at 15% of the total cost. A summary breakdown of the contract estimate is provided in Table III.5.

Table III.5

ESTIMATED COST TO DREDGE 166,700 CUBIC METERS FROM THE BAHR EL JEBEL BASED ON SEPTEMBER, 1983 U.S.$.

Item	Cost	Time
Mob/demobilize		
Preparation of Equipment to and from Kosti	$301,000	28 days
Navigation aids		
12 channel ranges	62,800	6 days
Dredging cost		
Equipment, Personnel	770,300	97 days
Sub-total	$1,134,100	131 days
Profit @ 12%	136,092	
Overhead @ 8%	95,500	
Contingencies @ 10%	136,569	
Project Total	$1,502,261	131 days

Source: Ogden Beeman and Associates

Dredge Plan - Long Term

The long term plan will depend on the growth of cargo movement and the demands for timely channel depths and widths. With increased demands for water transportation, implementation of a channel stabilization program to eliminate or reduce dredging would probably become economical.

Channel dredging continues to be required during design, construction and testing of channel stabilization works. A dredging requirement will therefore continue to exist for many years even with aggressive channel stabilization and river control measures.

The first year unit cost for dredging, as identified in the previous section, is quite high. It is not unreasonable, however, in light of the lack of dredging contractor demand and capability in Sudan. Continued dredging in the future should show a trend for decreasing unit cost.

One way to achieve a better price for river channel maintenance in the long term is to open the work for competitive bidding outside the country. To achieve this, predredge and postdredge survey capability must exist. Government capability for channel survey is one possible answer.

Another condition contributing to the high unit cost of the dredging and the length of time for accomplishing the work is the use of mechanical dredges. As an example, if the work identified in the first dredging effort was to be accomplished by a 16 or 18 inch discharge, 100 horsepower pipeline cutter head dredge, the production rate could approximate 10,000 c.m./day. This is compared to 1800/day estimated for a large drag bucket dredge. The result is the dredging of 166,000 c.m. as proposed could be accomplished within 17 dredging days, or 30 total days if you included moving from one river bar to another.

The pipeline dredge has the following advantages:

- o High production rate allowing faster completion of the work.
- o Ability to move material over distances and do land filling in conjunction with channel dredging.
- o Potential for lower unit cost.

The mechanical dredge has the following advantages:

- o The basic crane unit can be used on other projects when not dredging.
- o The equipment is simpler to operate and maintain than a pipeline dredge.

The final decision on dredge optimization and selection, and long term tradeoffs between dredge types and river training works is beyond the scope of this project. The main point to be made is that once a dredging program is initiated to deepen the channel, subsequent dredging or channel stabilization work will be required to maintain the depths.

JONGLEI CANAL

The project is located in the Jonglei province in Southern Sudan. It includes excavation of a canal from the Bahr El Jebel at Bor to the White Nile at the mouth of the Sobat River. The canal will have a total length of 360 km, and a variable canal section. Figure 1 depicts the typical canal cross sections (from MacDonald, 1983).

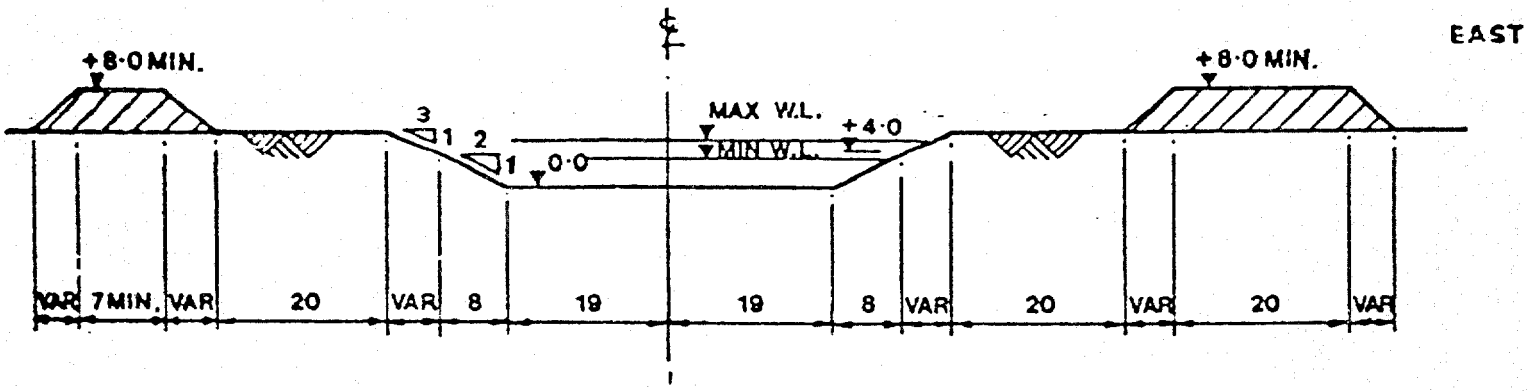
In addition to the canal the principal features of the project are a flow regulator and navigation lock structures at the head of the canal near Bor and training structures at both the head and tail of the canal.

HYDRAULIC CONSIDERATIONS

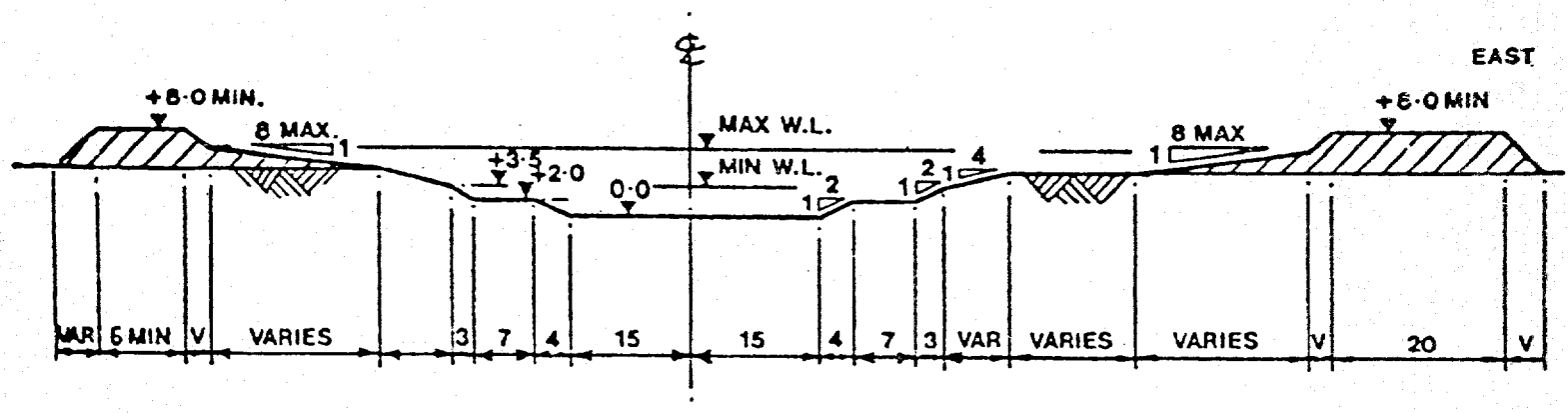
Detailed hydraulic studies by others have concluded that the proposed operation of the canal will not cause a negative impact on navigation. The primary concern of adequate channel depth for navigation in the natural channel was answered with a complex mathematical analysis by Euroconsult for the Egypt-Sudan Permanent Joint Technical Committee on Nile Waters. Results of their study are provided in Appendix 1.

We completed a limited analysis of the hydraulic conditions using records of discharge and water surface elevations available in publications by the Ministry of Public Works, Egypt, titled "Nile Basin". For purposes of this report, 10 years record from 1963 to 1972 were made available to us. Sample calculations completed are included in Appendix 1. In brief, our analysis confirmed the operating criteria identified in the other reports. That criteria is given in Table III.6.

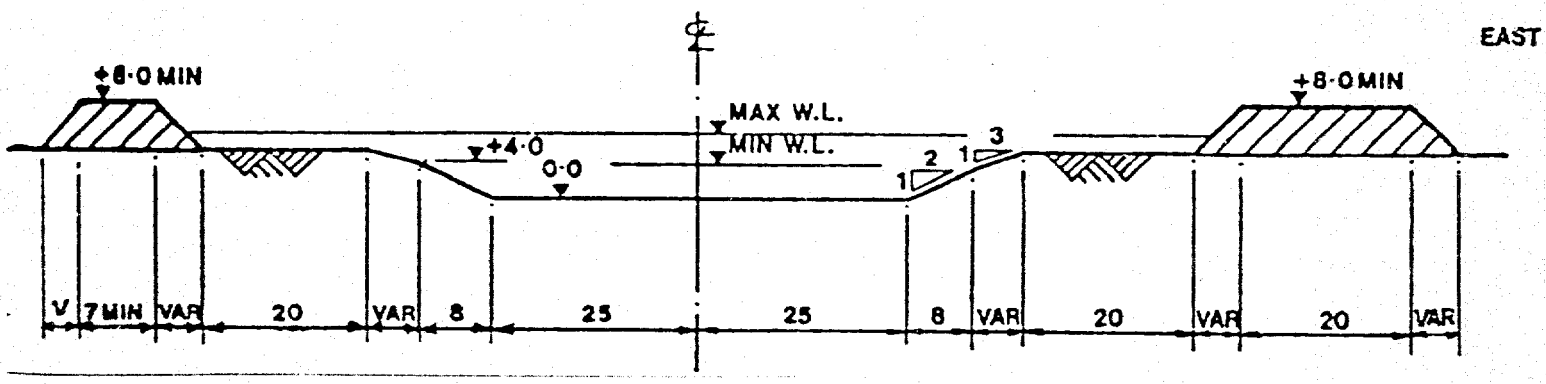
CANAL CROSS SECTIONS



Downstream Section KM 6-40



Intermediate Section KM 40-309



Upstream Section KM 309-356

Distance from Canal Tail (KM)	Longitudinal Canal Slope CM/KM
00.00 - 40.00	12.5
40.00 - 60.50	9.5
60.50 - 130.00	7.0
130.00 - 263.05	10.5
263.05 - 309.09	11.0
309.09 - 357.07	7.4

Table III.6

OPERATION CRITERIA FOR JONGLEI CANAL

Maximum Flow	35×10^6 c.m./day (phase I)
Average Flow	25×10^6 c.m./day
Minimum Flow	15×10^6 c.m./day
Maximum Depth	7 meters
Minimum Depth	4 meters

Source: Sir M. MacDonald and Partners Limited, July 1983

Typical velocities in the canal would vary from 0.7 to 1.1 meters/second. This was computed using Mannings equation with a Manning's factor of 0.0275. Energy slope was assumed to approximate channel bed slope. These velocities can be expected to erode and transport non-cohesive soils in the fine to medium sand range. We did not find references to this as a potential problem in the previous studies examined.

One impact that may pose a problem to navigation is the potential reversal of flows between the Sobat River and Bentiu on the Bahr El Ghazal. Reversal of flow will be minor in terms of depth and channel velocity, but may cause a build-up of hyacinths in the navigation channel. This build-up in turn could become a problem to passing vessels.

OPERATION CONSIDERATIONS

The project includes a navigation lock, outfall works, and 16 crossing points comprising 4 bridges and 12 ferries. In addition, berthing places are constructed in bays formed by widening the canal for loading and unloading near villages.

In the downstream part of the canal between km 2 and km 40, the straight reaches are too narrow at reduced flows for fully laden pushtows to pass each other. It was agreed to provide widening of the canal at distances of 3 kilometers for vessels to pass.

With all of these navigation complexities, it is essential to provide adequate canal control that incorporates the following responsibilities:

- o Collect and analyze hydrological and hydraulic data to assist in water flow regulation and definition of operating conditions.
- o Determine and implement criteria for water intake.
- o Control communications for canal operation as a navigable waterway.
- o Complete minor repair works and canal maintenance.
- o Manage and control ferry operations.
- o Operation of structures (lock and regulator gate).
- o Control and supervise use of the canal banks and adjacent land areas.
- o Establish licensing and background requirements for operators of vessels on the canal.

It is important to define as soon as possible the management structure and its requirements for equipment, personnel and facilities to allow their establishment before the canal project is completed. The present construction schedule calls for a project completion by mid 1986, depending on availability of project funding.

IV. THE PORTS

BACKGROUND

The Southern Regional River Transportation System services the White Nile River from Kosti to Juba, a distance of 1436 kilometers. Both the Sobat and Bahr El Ghazel rivers are major tributaries of the system but are usually serviced by the Provincial Governments and other suppliers of water transportation needs.

Most of the permanent port facilities on the White Nile were constructed before the 1950's, and after thirty years of use and neglected maintenance, are in need of major repairs. Additionally, there were changes in management in the later 1950's after the country gained its independence and again in the early 1970's when the organization charged with river operations was separated from other transportation modes, and made responsible for this sector of the economy. Also in the late 1970's and early 1980's came the realization by the Government of Sudan that the quasi-governmental agency operating the system (River Transportation Corporation) should not have a monopoly on river transportation and that the country and its citizens may be better served if private enterprise is allowed to participate in river transportation.

The RTC has had recent infusion of funds for new fleet vessels, but there is no evidence of any monies received from its operations or from outside donors that have found its way into port facilities. In fact, there is strong evidence that capital improvements of facilities have a low priority, and that available funds are used for operations, i.e. primarily labor. Consequently, the port facilities have deteriorated along with the volume of cargo handled.

EXISTING CONDITIONS

Kosti is the headquarters for the Southern Region providing a home port for its fleet and crews, offices for its administrative and operational management and facilities to service and make minor repairs for its vessels.

It is also the "boneyard" for most of the equipment that has appeared on the river since the beginning of the century. Petroleum products for the south are dispatched from here, and it is connected with an all-weather highway by bridge across the White Nile to Port Sudan and Khartoum. Also it serves as El Obeid's and El Fasher's river port. Kosti anchors the northern terminus and is the port in the system with the most facilities.

South of Kosti there are nearly two dozen river landings that have been "ports-of-call" of the RTC. Some have had improved facilities, but all are in disrepair with quays collapsed, bollards missing, banks eroding and sheds abandoned.

The usual berthing operation consists of ramming the vessel into the earthen banks, dropping a wooden gangplank, and finding a tree stump to tie to. If bollards aren't available, then the pusher holds the vessel against the current while discharging and loading passengers and for other short berthing stops. For longer periods, the berthing location is a function of the location of the mooring tie. The backland usually consists of hastily placed fill or causeway leading to shore across swamp grass at high water stage, or in the case of a defined shoreline, the vessel moors against the bank, making sure it doesn't hit portions of the collapsed quay or large rocks that were once part of an improved waterfront.

At Malakal, where historically the town recognized the importance of its waterfront, the berthing facilities are located at the center of its long levee where vessels must moor against an inactive barge which serves as a breasting camel to keep them from hitting submerged obstacles. Here the backland area is the town itself and the rest of RTC supporting facilities (except for the stationmaster's office and two old transit sheds) are located one kilometer downstream.

Between Malakal and Lake No the port facilities are again unimproved banks. In the Sudd the vegetation is cleared from the bank where a road leads to a village (Adok) or a fill is pushed out into a lake (Shambe). At Bor and

Mongalla the landings are in the center of town, while at Gemmeiza and Terakeka the villages are located a short distance away.

Juba, anchoring the southern terminus of the system, has adequate waterfront and backland areas, but the "laws" of hydraulics limits its usefulness, and because it's located at the end of the system (1436 kilometers from Kosti), it sometimes doesn't get much attention.

Unfortunately the conditions of the existing facilities mirror the economic health of the system. Capital improvements and an implemented maintenance system take a back seat to "more urgent needs".

PORT CLASSIFICATION

All active ports in the system compete for cargo. That competition is based on through-put demand which is a function of the port's service area; alternate modes and corresponding costs of transportation; cargo types; location on the system and its geo-political stature in the region it serves; its facilities, costs and services provided for its users, etc. All of these factors determine the port's relative importance to the system.

Recent RTC cargo records indicate the ports' descending order of importance based on tonnage as shown below.

Table IV.1

1981-82[1]	% of cargo turnover	1982-83[2]
Kosti	30.5	Kosti
Juba	19.8	Juba*
Renk	14.2	Renk*
Bentui	11.9	?
Jebel Aulia	7.9	?
Bor	7.1	Bor
Malakal	4.2	Malakal*
Mongalla	1.2	Mongalla*
Shambe	.8	?
Adok	.8	?
Gemmeiza	.6	?

Sources: 1. European Development Fund
2. RTC Assistant Traffic Manager - (Records not complete).
* Final 1982-83 records may show that Juba and Renk have reversed positions as well as Malakal and Mongalla.

The location of capital expenditures for facilities should have some correlation with the amount of cargo moved. But since there are no records and no observations of any recent improvements to port facilities (with the possible exception of two transit sheds at Kosti), then it is necessary to classify the ports according to the factors listed above so as to narrow the choices for capital infusion.

Based upon these considerations the ports were classified into two major categories:

Class I - PRIMARY PORTS - Determined by tonnage now handled (or near-term cargo projections) and importance to the Southern Region (e.g. "main-line" ports).

Class II - SECONDARY PORTS - Historically have/are handling cargo (and passengers) and/or have the potential for increased traffic because of their locations and service areas (e.g. "feeder" ports).

For most secondary ports located on the west bank, passenger traffic revenue generation is greater than that for general cargo. The primary ports, except for the two termini, are all located on the east bank, but Kosti and Juba have bridges serving the opposite bank. These are the only bridges in the 1436 kilometer system.

Table IV.2
CLASS I. PRIMARY PORTS
(North to South)

Port	Comment	Riverbank Location	Distance Between (km)
Kosti	Northern Terminus and Reg. Hdqrts.	West	
			174
Renk	Leading exporter of basic food comty.	East	
			327
Malakal	Reg. Cap. & North Term. of Jonglei and Sobat.	East	
			380(1)
Bor	Prov. Cap & South Term. of Jonglei and Sudd.	East	
			167
Juba	Reg. Cap. & South Term. of system	West	

Source: Moffatt & Nichol

Notes: (1) Distance upon completion of the Jonglei Canal. Present distance through the Sudd is 768 kilometers.

N.B.: USAID Khartoum has expressed an interest in investigating the need for a port on the Bahr El Ghazal to service the Wau and Rumbeck areas. Bentui on the Bahr El Ghazal ranked fourth in tonnage

(1981-82) but it is basically a one user facility (i.e. Chevron). Historically Meshra Er Req was an active port serving this area, and if this or another port could capture some cargo from Adok or Shambe then it might be considered a Primary Port.

TABLE IV.3

CLASS II. SECONDARY PORTS

(North to South)

Port	Riverbank Location	Distance (km) to: Class I Port N	Class I Port S	Class II Port N	Class II Port S
Geigar	East	146	28	-	43
Wad Akona	West	15	312	43	144
Kaka	West	159	168	144	25
Melut	East	184	143	25	76
Kodok	West	260	67	76	106
Attar	East	39	379(1)	106	43
Tonga	West	82	422(1)	43	272(2)
Adok	West	354(2)	414(2)	272(2)	205(2)
Shambe	West	477(2)	209(2)	205(2)	276(2)
Gemmeiza	East	67	148	276(2)	30
Terakeka	West	97	70	30	30
Mongalla	East	127	40	30	-

Source: Moffatt & Nichol

Notes: (1) Distance upon completion of Jonglei Canal.

(2) Distance upon Bahr El Jebel through Sudd.

FACILITY CRITERIA

All Secondary Ports should meet some of the following criteria, but all Primary Ports should aim for all of the criteria listed in order to function properly.

WATER DEPTH

The water depth at river low water stage should allow the river fleets' deepest draft vessels (when loaded) to use its berthing facilities.

BERTHS

The land-water interface should be non-eroding, improved, and protected so that the berthing perimeter of the vessels can be reached anywhere with a brow and have easy access to the backlands.

For this study, a unit berth is used consisting of 80 meters with one feddan of backland area (4200 square meters). The 80 meter berth allows simultaneous mooring of two 500 ton barges allowing both barges to be worked at one time, or one barge to be worked at once, or for one barge to be worked while the other is docked and prepared for loading or unloading. For multi-user, multi-purpose facilities, proper practice is to provide a two berth minimum because a one berth facility is subject to high queing at low occupancies. (For example, queing time to service time ratios would approach 50% for a one berth facility with less than 35% occupancy, random arrivals and first come, first serve queue discipline.) The use of a "unit berth" concept allows a "unit cost estimate" for additional "units" with appropriate modifications for different sites.

BACKLANDS

There must be a cleared, unobstructed area behind the berth for landside activities to occur, i.e. cargo transferring activities. For Primary Ports the surface areas should be able to function under all weather conditions and allow handling of heavy cargo loads. All ports should have mooring ties which are able to resist vessel line loads.

BUILDINGS

The need for structures is a function of how the cargo is handled and how the port is administered. Primary Ports should have offices for the river

agent/stationmaster, communications equipment, supporting personnel, and port security. Transit sheds are necessary to allow for cargo surges and inclement weather protection of perishable goods. These sheds are not warehouses as cargo should move through them.

Additional facilities for passenger comfort should be considered where the volume can justify the investment.

SECURITY

The port must be secured and public access restricted.

FACILITIES AND OPERATIONS INTERRELATIONSHIPS

The requirement for facility improvements is based upon both cargo demand and improved operational efficiency. This is a function of good management operating these port facilities to increase their throughput and corresponding revenues. Good management is far more important than good facilities.

Without considering major administrative, organizational and management changes that should be made in the system, facility improvements would have a better chance of obtaining functional success if certain procedures and/or actions (by the existing personnel in charge of that port, i.e. River Agent or Stationmaster) were accomplished prior to expenditure of capital improvement funds. Clearing the waterfront of derelicts and moving inactive vessels elsewhere in some ports (e.g. Kosti and Juba) will double to quadruple their capacity to move cargo across their waterfront. By operating their covered areas as transit sheds for cargo surges and not permanent warehouses eliminates the need for more storage facilities. Providing solid communication lines between the port's administration and its fleet of users allows for efficient operations of cargo movement. Clearing and securing the backlands from public access reduces operational conflicts, pilferage of goods, and will increase the shippers' confidence in using the facility.

Donors considering the infussion of funds for port capital improvements should insist on these basic operational changes before committing these funds.

JUBA

EXISTING FACILITIES

The Port of Juba occupies approximately nine feddans and is located on the inside bend of the White Nile River which flows to the north northwest. The river then makes a sixty degree bend to the west, which results in a two hundred meter radius curve near the center of the port. The accretion of material at this bend has produced a sand bar and this shallow condition continues to degenerate due to ongoing erosion of the opposite bank. The erosion along the far bank increases the channel width and as a result the channel bed continues to accrete to maintain its natural flow cross sectional area.

The river varies between 125 to 150 meters in width, flows between 1.2 to 1.7 meters per second, and its depth varies between 0.5 meter near the shoreline to 2.0 meters near the opposite bank at low water stage. Hydraulically, the port is located on the wrong side of the river.

Waterfront

The semi-enclosed "secured" waterfront perimeter is approximately 450 meters in length, but only about 150 meters can be used by RTC's new equipment (Norwegian pusher tugs and 500 T capacity barges) during low water stages.

The majority of the waterfront is not being utilized because of the existence of scrapped vessels, trailers, abandoned equipment, corroded tanks, etc. located on the perimeter prohibiting its function as a water land interface cargo transferring facility. Photos in the Appendix show examples of the misuse of this waterfront perimeter. Although there is partial evidence that at one time the perimeter had been stablized and

improved, presently the waterfront is in disrepair and the river upstream of the bend has eroded the bank, so that there is no defined, stabilized perimeter. At the extreme upstream end there is an outcropping of rock which anchors this portion and any improvements downstream should consider the effect of this natural jetty.

Backland

Although there is partial fencing of the backland perimeter, the port area is not secure, and the public has complete access and is permitted to occupy and encamp on port property, severly restricting its useful function as a cargo loading and temporary storage facility.

The port backland is unimproved, and there exists two cargo sheds, each approximately ten by thirty meters, separated by the stationmaster's office and an annex which houses four goods clerks and a booking clerk. The sheds, although old, are in fair condition and the goods in them are dry and secure. There are also two warehouses (twelve by thirty meters) that are occupied by Sudanese Army goods and a six by ten meter workshop that long ago had seen its last repair project and is now used as a fuel drum storage facility waiting for an explosion to occur. Additionally, two brick buildings, one used as an office for the twenty-one man port police force, the other for a portside restaurant, are located just east of the port's cargo sheds.

The river agent's office (the senior RTC official) is located outside but adjacent to the port area and consists of a single story brick building housing his office staff of four clerks, two traffic inspectors, two radiomen and the chief of the port police.

With unlimited access to the port's backland and associated waterfront, a shipment of a basic food commodity (e.g. dura) draws quite a crowd, particularly when in short supply, and this provides the consignee a floating "store" for the cash and carry crowd.

CARGO HANDLING

The transfer of goods between barge and shore is done by manual labor and are carried across wooden gangplanks supplied by each barge. Heavier goods are also handled manually by gangs (as witnessed by the loading of a van for a downstream destination), but very heavy equipment handling is dependent upon the availability of one of the two portable hydraulic stinger cranes. The port has a 20 ton Coles crane and a 10 ton Todano crane, the latter in partial operation, the former not in operation because of "the unavailability of spare parts". There also exists a large 10 ton stiff-leg railroad crane that long ago had seen use, but unfortunately occupies a portion of the waterfront perimeter.

The port's two sheds store the incoming goods and at the time of investigation included wheat flour, cement, medicine, spare parts for buses, bicycle tires and salt, the latter a shipment from Port Sudan that has been unclaimed and has been occupying valuable storage space for over a year and for which no demurrage charge has been collected.

The RTC River Agent has approximately 140 people working for him including 87 daily rate laborers at 93 pt/day for a six hour work day consisting of one half Sudanese and one half neighboring country refugees. These daily rate workers must be released one day every three months or they become permanent employees, which the RTC has a policy of not replacing. The Juba force of these permanent stevedores has been reduced to thirteen. For the laborer though, even being a daily rate employee of the RTC is tantamount to a permanent job, being paid when no cargo is moving and only working a few hours per day when cargo has to be transferred.

The method preferred by the local merchants is to bypass the RTC personnel and to unload cargo by their own gangs, paying the labor crews as much as 25 pt/sack (e.g. dura) and unloading directly from the barge to a lorrie to be transferred to the merchant's warehouse. There have been examples of a single laborer moving over 50 sacks per day, and the merchant puts enough labor on to unload a 300-500 ton barge in two days. For small consignments that the merchant lets the RTC handle, he is charged .0054 pt/10 kg.

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Periodically when basic food stuffs are in short supply, the Supply Officer of the Provincial Commission will confiscate the commodity, with the assistance of the State Security Police, and distribute the goods to the various tribes of the area, paying the merchant the "official" price (e.g. dura LS 33/sack wholesale and receiving LS 35/sack retail). This results in an unhappy merchant who, by trading on the "unofficial" market, can receive more than double this amount.

POL unloading facilities are provided by Shell Oil Company and are located just downstream from the port. Although RTC has some abandoned and presently corroding fuel tanks, the pusher tugs carry their own fuel. Therefore all of the region's POL products transported by water are at the Shell facilities. These consist of benzine (7 tanks at 12,000 imp. gal. each, one at 20,000 imp. gal.); gas/oil (one tank at 213,500 imp. gal.); and Jet A-1 (2 tanks at 12,000 imp. gal. each, one at 38,000 imp. gal.). The storage facilities are adequate since the region is only receiving 25% of its Jet A-1 allotment, 29% of its gas/oil allotment and 38% of its benzine allotment (1982 data supplied by Shell).

SERVICE AREA AND COMPETING MODES OF TRANSPORTATION

The Juba port serves the Equatoria Region, both western and eastern provinces, and is the most southerly navigable river port in Sudan. The only improved all-weather roads are in Juba proper and the only transportation connection with areas north of Juba is by river during the wet season (June through November). It should be noted though, that some of the southern roads (e.g. Juba, Mongalla) open a few weeks earlier than some of the more northern roads (e.g. adjacent to the Sudd) because of slightly higher elevation and more granular soil permitting better drainage. From late November through May the northern roads are passable, and because of the inefficiency and unreliability of the RTC, most merchants prefer to receive and ship their goods by lorrie, even at a higher cost, as far north as Kosti and Khartoum. Additionally, during low water, the navigation to Juba is restricted and the merchants that do ship by water must send lorries north to Mongalla or Gemmeiza to transfer their goods.

The roads south and southeast of Juba provide access to Uganda and Kenya respectfully, and are the supply lines for Juba's thirst for imports including petrol, dry foodstuffs, fruits and vegetables, miscellaneous merchandise, coffee and tea. The latter beverage ingredients, when in excess of local demand, are exported to the north.

CARGO PROJECTIONS

Presently Juba has a 4 to 1 ratio of imports over exports and handled just over 30,000 tons in the 1982-83 year with its existing facilities. A unit berth at 30% occupancy could easily handle this tonnage, leaving over 80% of the total waterfrontage for other use. Or, in other words, four more unit berths would allow Juba to handle nearly 250,000 tons annually. This tonnage is far beyond the most optimistic projections of even the EDF Report.

The waterfront perimeter and backlands areas are physically adequate to handle the projected cargo. Unit berths should only be built when the volume demands it.

PORT REQUIREMENTS

Non-mechanized cargo movement is the most cost effective method for the foreseeable future, but Juba, being the southern terminus of the system and with its tie to the road system in the south, necessitates a requirement to handle heavy loads. There is a need for a simple, fixed, non-destructive, workable piece of heavy cargo handling equipment to replace the two complex maintenance prone hydraulic cranes that now exist at the port. A simplified gin pole type of arrangement, similar to a ship's mast with boom and corresponding winches allowing for a 10 ton pickup at a reach of 8 meters, powered by a standard "donkey" engine driving a drum, with the ability to be rigged for manual operations should be investigated. This would be placed adjacent to a vertical quay allowing a barge to be pulled alongside, and then moving the barge as required. (RTC's Khartoum North has such equipment and,

although very old, is still in operation. The possibility that RTC could construct and install one at Juba should be examined before ordering from foreign sources.)

Once the waterfront is cleared there will be more perimeter for cargo transfer. An 80 meter unit berth could be constructed near the upstream end of the port where there is no shoaling problem. This berth would also be the location for the heavy lift equipment. Bollards would be provided, fendering for the vertical wall at the lift, and area lighting supplied by local power (with standby generator) for night work and double shifting of gangs when required. The backland would be cleared and stabilized with laterite and fenced for security.

The five month rainly season requires the perishable goods to be stored under cover. Normally goods would be transferred directly between the barges and the shoreside transit sheds, but there is a growing tendency for the merchant to move his goods directly from the water by truck to his own storage area.

There is perceived to be a need for warehousing facilities in the port (e.g. EDF Report Suggesting 2 - 1000 square meter sheds in Phase I) but a more prudent approach to test this market is to increase the cargo movement through the port's own shed, auctioning off the goods not claimed, shortening the allowable storage time and increasing the dumurrage charges. The port should investigate reclaiming its warehouses from the Army and the availability of other existing near-port facilities, e.g. adjacent to the POL facility. Once the demand has caught up with the supply of existing covered sheds, then a 100' X 180' transit shed should be built backland of the new berth. This should be a transit shed for throughput cargo and not a "permanent storage warehouse" on port waterfront property.

Security is only as good as its enforcement. Until management wants to secure the port, new fencing throughout its perimeter is not justified. But the new berth and backland must be secured, with only those personnel who

are directly involved in cargo handling of that cargo present. This type of enforcement under a clear and efficient working environment might be enough to convince the shipper to use this facility.

Dredging of the shoal is required. However, it should be done in coordination with channel stabilization measures. It is estimated that 31,700 cubic meters of material must be removed to provide a minimum draft for 300 ton barge loads at low water.

IMPROVEMENTS

Short Term

Management Actions:

- o Clear the waterfront of all abandoned equipment and materials.
- o Moor inactive vessels elsewhere.
- o Remove goods from the warehouses that are not in transit.
- o Secure the port by allowing only port related services and personnel on port property.
- o Negotiate with the Army for reposession of Warehouse No. 2.
- o Make an inventory of available warehouse space.
- o Establish a simplified maintenance program (e.g. pick up trash).

Facilities:

- o Dredge the shallow areas, block the side channel and establish a hydraulic monitoring program.
- o Fabricate from existing material temporary bollards and place them behind the unimproved bank.
- o Construct an 80 meter berth, provide associated fendering and mooring facilities, improve and secure backland area with lighting, and install a simplified fixed crane.
- o Secure the new berth and backland by fencing.

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Long Term

Management System:

- o A maintenance system ultimately leading to a preventive maintenance program.
- o Administrative and operation personnel in one building on port property.

Facilities:

- o Additional 80 meter berths as required.
- o Dismantling of existing buildings.
- o Construction of an Ad-Op building.
- o Erection of a 100' X 180' transit shed.
- o Provision for a passenger loading/control area.
- o Laterite "paving" of the remaining backlands.
- o Construction of a workshop for facilities maintenance.
- o Securing the complete port with a control gate.
- o Adding some cargo handling mechanization (e.g. conveyors) to increase throughput.

RENK

EXISTING FACILITIES

Renk is primarily a one commodity port supplying most of the dura for the South. It is located on the east bank of the White Nile and, although its tonnage classifies it as a Primary Port, its facilities could be generously described as a "river landing". Its quay is broken, bollards completely pulled out of the ground, there is no berthing perimeter backland, no security, and RTC offices are located away from the berth. In short, it is a very inadequate facility.

CARGO HANDLING

The dura arrives at the port in sacks on lorries directly from warehouses generally located within one kilometer of the quay. The sacks are loaded onto the barge by porters and the shipper usually pays 25 pt/sack for loading and 20 pt/sack for warehouse to port transfer, and one barge can be loaded in two days.

Dura harvest occurs in early spring and is the time when the grower gets the lowest price, but by selling it off season he can obtain twenty to thirty percent more. The large modern warehouses (owned by the banks) and the large number of individual small brick warehouses provide the grower with this opportunity. In Renk the entrepeneur is either growing, storing, or shipping dura and the RTC has a virtual monopoly on providing this last function when the only access to the South is by river.

SERVICE AREA AND COMPETING MODES OF TRANSPORTATION

Renk, because of its warehouses, has a virtual monopoly on exporting dura from the east bank of the Upper Nile Province. But once the roads are passable, the merchant has an alternate means of shipping.

Upon completion of the all weather road from Rabak there will be year around access to the North. During the dry season most merchants prefer to ship south by highway, at least to Malakal, as they can control the shipment and don't have to play the RTC game of "who's first on the shipping priority list in Kosti". Also the government allows the merchant to recover this additional shipping cost in calculating the selling price and he can market the dura in a few days, instead of a few months if he lets the RTC handle it.

PORT REQUIREMENTS

Berths supported by secured backlands are needed. As many as thirty vessels (barges and power plants) have been scattered along the bank. RTC has stationed a shuttle tug at the port which assists in moving the vessels.

A new 80 meter unit berth is proposed with improved backland for lorrie to barge loading. The berth would be constructed on the upstream end of a new fill with additional fill placed downstream for mooring of inactive barges waiting to be loaded. This fill could allow for the mooring of twenty vessels double berthed, so that the vertical wall unit berth should be active at all times and its lighting will allow for night loading.

IMPROVEMENTS

Short Term

Management Actions:

- o Put in some temporary bollards and moor the inactive vessels elsewhere.
- o Secure the berth by posting a guard at the causeway throat.
- o Insure that there is always a communications link with the fleet and Kosti.

Facilities:

- o Dredge and fill 63,000 cubic meters of material.
- o Construct an 80 meter sheet pile berth and improved backlands.
- o Secure the area and provide new port offices inside.

Long Term

Management Actions:

- o Simplify and expedite the shipping procedures.
- o Market the advantage of using the port.

Facilities:

- o Construct more unit berths as required.
- o If financially justified, construct a transit shed.

OTHER PRIMARY PORTS

KOSTI

The waterfront and backland facilities are all there and can easily handle the anticipated cargo. Proper management can increase the throughput capacity without need for capital improvements.

MALAKAL

The existing landing in the center of town is limited. We suggest cargo operations downstream be phased in where open area exists near the RTC workshop and POL tanks. As cargo increases, secure the area, construct a unit berth, acquire more backland, and move the RTC administrative offices here. Clean up the present facility and let it eventually become only a passenger facility.

BOR

Stabilize the shoreline and remove obstacles for berthing. Reestablish a manned port office, clear and fence the backland and provide bollards for mooring. As cargo volume increases consider in the long term relocating the port from the center of town. (NB RTC in recent conversations with USAID have discussed the possible purchase of G.O.S. Army surplus warehouses to be placed at Bor and Mongalla.)

SECONDARY PORTS

The dozen ports comprising this classification are divided equally between west and east bank location. Discounting Adok and Shambe, which are located in the middle of the Sudd, the secondary ports average 62 kilometers apart and 118 kilometers from a primary port approximately one-half to one full day average travel time.

Adok and Shambe pose a special problem because of their isolation, and upon opening of the Jonglei Canal, through traffic will bypass them completely. How they operate and what improvements are needed will be a function of the cargo they capture.

Kodok needs to stabilize its causeway's banks and remove some submerged rocks that are restricting the berthing perimeter and most of the other secondary ports need similar maintenance work.

Future considerations should be given to identifying detailed facility problems in these twelve ports and the possibility of providing one-time funds for a mobile floating contractor's plant. This would consist of a main barge having at least a 100 ton crane with drag and clam buckets and side barges with repair materials. If done properly, the repairs should last at least as long as the lack of maintenance which occurred during the last twenty-five years.

ESTIMATED COSTS FOR FACILITY IMPROVEMENTS

Estimates of port improvements were made after preliminary designs were prepared for the purpose of quantity takeoffs. Construction costs were provided by contractors in the area who have equipment and personnel capable of doing the work. Obviously unit costs as well as mobilization, demobilization and subsistence costs increase with up river distances from Kosti and Khartoum.

Site conditions, e.g. foundation material, river stages and the availability of construction materials, e.g. laterite and rock, also have a profound effect on costs. Discussion and estimated details appear in Appendix 2.

The following estimate summaries include contractors' mobilization, demobilization, subsistance, overhead, profit and a 15% contingency.

JUBA

Per discussion in this chapter, Juba Port administration should clear and secure its remaining waterfront and backland area. If this item is added to port improvements, costs and credit taken for salvage, then allow LS 100,000 for this work. See Table IV - 4 for a breakdown of improvements at the Port of Juba.

Donors, prior to commitment of funds for capital improvements, should consider requiring RTC expenditures of funds or forces to complete the delayed maintenance items.

RENK

For the purpose of this estimate, the fill would be from land excavation, dry hauled and placed from the shoreline. Because its a high volume port, a vertical sheet pile bulkhead would retain a laterite surface backland behind the improved berth and the area would be secured. Approximately LS 350,000 could be credited to the future berth area which would function as barge storage and overflow facility. A detailed estimate and sketch is shown in Appendix 2 and the approximate construction time is 180 days. Fill, Improved Berth and Backlands, Buildings & Overflow Area would cost LS 3,100,000.

OTHER PRIMARY PORT IMPROVEMENT COSTS*

Minor improvements at Kosti, Malakal and Bor are essentially delayed maintenance costs as follows:

Kosti

Clear the waterfront of all inoperative vessels to allow additional "natural" berthing perimeter.	LS 75,000

*Work can be accomplished with contractor's mobilized forces on way to work in Equatorial Region. Construction administration, management and field services included.

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Table IV.4

JUBA[5]

Navigation Improvements[1]	Unit	Cost(LS)[2]	Const. Tim
Dredging	31,700m^3	1,131,750	120 days
Channelization	200m	661,021	120 days

Berthing Wall	Unit	Cost (LS)[3]	Const. Tim
Steel Soldier Piles and Lagging	80m	453,182	12 weeks
Mass Cyclopean	80m	340,256	11 weeks
Short Wall & Improv. Slope[4]	80m	245,660	10 weeks

Stiffleg Crane & Vertical Wall	Unit	Cost(LS)[3]	Const. Tim
Crane & Wall	Lump Sum	500,816	12 weeks

Backlands			
Stabilize, Fence, Light	12,150m^2	306,780	12 weeks

Mobilization, Demobilization, Subsistence for Landside work

If Independent of Navigation Improvements LS	894,312
If Concurrent with Navigation Improvements	792,637
Savings if Total Project Under One Contract	101,675

Transit Shed (optional)	Unit	Cost(LS)
Galv. Steel, (100' X 180')	1,672m^2	LS 736,200

(Credit approx. LS 125,000 of mob/demob if shed part of total contract)

Summary (Juba)

Assume all work under one general contractor:

Navigation Improvements	LS 1,792,771
Berthing Wall	245,660
Crane and Wall	500,816
Backlands	306,780
Mob/Demob Subsistence	792,637
	LS 3,638,664

Source: Moffatt & Nichol

Notes:
1. Discussion in Chapter III.
2. Including mob. and demob. and both dredging and channelization under one contract but not lead time for foreign material or equipment.
3. Excluding mob. and demob. which is a separate item.
4. Selected because of lower cost and higher local currency components.
5. All costs in this table exclude construction administration, managemen field surveys and professional fees.

Malakal

Move the camel barge, clamshell submerged obstructions, repair & stabilize bulkhead.	150,000

Bor

Remove submerged obstructions, place new bollards and dress slope	150,000

SECONDARY PORT IMPROVEMENTS COST

Delayed maintenance at Mongalla is the only proposed secondary port improvement.

Mongalla

Dress the shoreline, place new bollards.	150,000

SUMMARY OF PORT IMPROVEMENT COSTS

A summary of the above improvements and costs is presented in Table IV - 5. This table presents short-term cost summaries, longer-term improvements and the useful life cycles for various port components.

MAINTENANCE COSTS AND PROCEDURES

Each port should have personnel as a part of its staff who are responsible for establishing and implementing a facilities maintenance program. The proposed improvements have relatively low maintenance requirements. Procedures such as checking the security fence, examining the rock slope at low water, making sure the laterite drains by raking and compacting very low areas, and then having the hand tools and material bins to accomplish this work should be a first order of priority for the port management.

Costs for this are a minor part of the port's overhead but should be a line item in its annual budget. These costs are not considered large enough to be listed in this report. The simplest crane proposed for the southern terminus should have some basic spare parts, but proof exists that Khartoum North has operated a similar one for forty years without major problems.

ENVIRONMENTAL CONSIDERATIONS

Environmental Effects: The proposed port improvements are adjacent to similar facilities and are compatible. The river navigation and channel stabilization improvements will disturb the biota when approximately 200,000 cubic meters are excavated. The fill at Renk will occupy approximately two feddans of river bottom.

Mitigation Measures: Non anticipated.

Table IV - 5[1]

A. SHORT-TERM IMPROVEMENT COST SUMMARY

Juba, inc. port cleanup	LS	4,500,000
Renk		3,100,000
Other Primary Ports		375,000
Secondary Port (Mongalla)[2]		2,350,000
	LS	10,325,000

B. LONGER-TERM PORT IMPROVEMENT COST SUMMARY

1990-2000	Malakal Unit Berth w/crane, w/o T.S.	LS	2,400,000
	Bor Unit Berth w/crane, w/o T.S.		2,200,000
	Renk Additional Berth w/crane		2,000,000
	Additional Unit Berths w/o crane		1,400,000
	Additional Transit Shed		900,000

C. LIFE CYCLE COSTS OF SHORT-TERM INVESTMENTS

Wall and Crane	40 year life	Juba	LS	49,000/year
Wall, bldgs., fill	40 year life	Renk		70,000/year
Paving & Fencing	10 year life	Juba		24,000/year
Paving, Fencing & Brows	10 year life	Renk		24,000/year
Transit Shed	40 year life			22,500/year

Source: Moffatt & Nichol

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(1) Table includes costs of contract administration and management, field investigation and surveys, and engineering design and const. services of 20%

(2) Funded immediately if Mongalla is southern terminus. (NB - Transit Shed needed but may be furnished independently)

V. IMPROVEMENT OF RIVER OPERATIONS

INTRODUCTION

The economies of river transportation are dependent upon both nature and man. Nature provides the river and man stimulates the commodity movements and operates the transport system. In Sudan, both nature and man-controlled features are retarding the achievement of benefits which river transport has brought to other river basins of the world. Nature controlled elements of the river are analyzed in Chapter III. This chapter presents analyses of man-controlled aspects ranging from basic river transport costs to monopolistic versus free market operations; to public sector administrative guidelines.

Thus, in the following interrelated sections:

Comparison of Transport Systems deals with the basic competitiveness of river versus road or rail transport and river transport efficiencies around the world.

Costs of Water Transportation in Sudan and Unit Cost of Moving Commodities by Water develop lower cost alternatives to the current system.

Practical and Economic Units to Water Transportation relates the operating cost factors to physical conditions on the White Nile, and

Planning for and Implementing System Privatization suggests a simple, competitive mechanism for privatization which avoids the creation of a ponderous regulatory procedure more likely to retard than to promote privatization.

COMPARISON OF TRANSPORT SYSTEMS

The use of inland waters for transport of goods and people started early in recorded history. The stimulus for its early development was that waterways provided "highways" over which goods and people could be moved by sail power or by human or animal power from the shore.

Today one normally associates the development of inland waterway systems with their inherent fuel efficiencies rather than their "highway" characteristics. Stated another way, the development of a water transport system is most likely to provide long-term operating economies rather than (or in addition to) first cost construction economies as compared, for example with rail or highway development. Nevertheless, there are still locations where the waterway provides opportunities both for its inherent fuel efficiencies and the opportunity to provide a "highway" for commerce which might not otherwise be available. Due to the topography and difficulty of developing all-weather highway or rail systems, the White Nile from Kosti to Juba appears to fall in this category where the "highway" benefits may be of equal or greater interest than the fuel efficiency benefits.

It is obvious either from observation or analysis that the waterway under consideration, and the waterborne transport system on it, is unique. The best insight to both the opportunities and problems inherent in this waterway is provided in Table V.1.

The relatively low fuel efficiency for waterway transport in Sudan can probably be explained as follows:

- The gradient of the river is steep compared to most U.S. waterways where locks and dams have reduced river gradients and substituted time (in locking through) for energy (to push upstream).

- The predominant commodity movement in Sudan is upstream (food and fuel) while in the United States it is downstream (grain and coal).

- The channel is poorly developed leading to light loading, navigation problems and delays which decrease the fuel efficiency of the system.

- The transport system is reported to be poorly managed which can result in excess running and fleeting time, poor distribution of loads, and failure to capture downstream movements.

As compared with the United States example, the first two factors have a larger impact on fuel efficiency than the second two factors. As proof of this point, Table V.2 shows the fuel efficiency potential on this reach of the White Nile under two load scenarios.

Table V.1
FUEL CONSUMPTION IN FREIGHT TRANSPORT
(TON KM PER KILOGRAM)

Mode	Sudan (1)	United States (2)
Waterway	24	234
Pipeline	111	223
Rail	100	92
Highway		27
Heavy Truck	45	
Medium Truck	30-17	

Sources: (1) Sudan National Energy Assessment, Transport Sector, Ann 2 National Energy Administration, April 1983.
(2) U.S. Department of Transportation, Freight Transport Energy Use. DOT-TSC-OST 79-1, July 1979

Table V.2

FUEL EFFICIENCY ON SEVERAL WATERWAY SYSTEMS

Waterway	Load	Fuel Efficiency (Ton-km/kg)
Sudan (national average)	n.a.	24
White Nile	1200t up 200t down	50
White Nile	1600t up 400t down	65
U.S. (national average)	n.a.	234

Source: Ogden Beeman and Associates.

The effect of river gradient on fuel efficiency cannot be too strongly emphasized. It is this factor that basically establishes the horsepower (and fuel consumption) required to operate on the river. Table V.3 compares the ratio of horsepower to tonnage for several rivers of various gradients throughout the world.

Table V.3

THE INFLUENCE OF RIVER GRADIENT ON TUG POWER

Waterway	Gradient	Horsepower/ton
White Nile (1)	10-30 (X 10^{-5})	0.50
Niger/Benue	8-30	0.25-0.50
Lower Rhine	5-15	0.15-0.20
Mississippi	5-15	0.10-0.25

Source: River Studies, Niger and Benue Rivers
Nedeco, 1959, with additions by Ogden Beeman and Associates.

Notes: (1) Gradients included are Jonglei Canal to Juba

Thus, as one embarks on plans to improve the navigability of the White Nile it should be realized that there are inherent limitations on the economies of fuel consumption to be realized. Nevertheless, it is clear an efficient operation with a maintained channel should achieve fuel efficiencies, on the average, better than truck transport.

It should be realized that the final 40km reach from Mongalla to Juba has a gradient of 30×10^{-5}. This is steep enough to be considered questionable for efficient water transport and quite possibly resulting in fuel consumption greater than highway modes when considered on a ton-kilometer basis. Interestingly, it is also this excessive gradient which results in three out of the five shallow areas requiring dredging occuring in this reach and five occuring where the slope is 23×10^{-5} or more.

It is probable that the incentive to improve navigation in this reach arises more from the riverine "highway" aspect rather than any inherent economic benefits of water transport. This point will be further discussed later in this chapter.

COSTS OF WATER TRANSPORTATION IN SUDAN

In order to evaluate the economic and financial aspects of projects for physical or administrative improvements, or privatization of the river transport system, it is necessary to analyze the cost of tug-barge operation in Sudan.

The financial costs of existing and privatized tug-barge operations were compared to establish a base point for further evaluation. These financial costs are shown in Table V.4. The first column shows a pro-forma analysis prepared by RTC for rate setting purposes. After discussing this analysis with RTC staff and evaluating the rationale behind it, we have adopted it for a starting point. RTC used the following criteria:

- The cost figures are for one tug and four barges making a 28 day round trip - Kosti-Juba-Kosti.

- Depreciation and interest charges are based on the new 940 H.P. tugs, four - five hundred ton barges and utilization of six - 28 day trips per year. Depreciation and interest are at 5% per year based on first cost of equipment.

- Repair costs are theoretical and based on 7% of first cost for tugs and 2% of first cost for barges.

- The overhead account apparently includes all RTC staff including the boatyard employees.

- The fuel cost is based on experience for several trips and maybe somewhat understated due to the problem of extra maneuvering and delays.

Plan 1 and 2 represent proforma cost figures for two cases under privatization. Plan 1 assumes that the depreciation and interest charges of the RTC would be passed directly onto the private operator but would be reduced by one-third because the private operator would get nine trips per year instead of six. Overhead was calculated at 15% of expenses and a 10% profit was added. Plan 2 assumes that depreciation charges would be increased to 12% of the capital cost. Again, nine trips per year were assumed. An allowance of 20% for overhead was established and a 10% profit margin allowed on fixed and variable costs. Crew expenses were left the same for the private operation although it is assumed a private operator would probably have a smaller but higher paid crew.

Table V.4

FINANCIAL COSTS OF RIVER TRANSPORTATION EXPRESSED IN L.S./MONTH FOR A TUG AND FOUR BARGES

Fixed Cost	RTC(1)	Private Sector	
		Plan 1(2)	Plan 2(3)
Depreciation	15,910	10,607	10,607
Interest	15,910	10,607	25,457
Repairs	13,279	13,279	13,279
Overhead	62,981	11,745	20,351
Variable Cost			
Crew Salaries	10,103	10,103	10,103
Fuel	21,957	21,957	21,957
Total Costs	140,140	78,298	101,754
Profit @ 10% of Costs	0	7,830	10,175
Total Costs, L.S.	140,140	76,128	111,929

Sources: (1) RTC Traffic Department Study; Unpublished (1982)

(2) Consultant: Assume barges work 9 mos/yr instead of 6 mos/yr RTC. Assume barge and Tug at 5% Depn and 5% Interest same as RTC. Assume overhead at 15% total expenses.

(3) Consultant: Same as Plan 1, except assume barges and Tug at 12% Interest. Assume overhead at 20% total expenses.

It seems that a private operator should be able to meet the assumptions for Plan 1 and 2 if the RTC would lease or joint-venture the tugs and barges at their existing fixed costs (Plan 1) or a higher interest rate (Plan 2). Nine trips per year is a conservative approach allowing three months for repairs if trips can be concluded in under one month each. This implies 9 months with actual tug running time per month of 316 hours at 10 km/hour plus a 10% allowance for maneuvering and positioning barges. United States practice would probably be more like eighteen hours running per day for 350 days/year availability. Note that this results in a comparison of 6300 hours running time/year in the USA versus 2844 hours in the private sector Sudan example.

Table V.5 demonstrates the distribution of costs for several river transport operations. Column 1 is typical Mississippi River operations in the USA while Column 2 is the RTC examined on an aggregated, actual basis rather than a pro-forma, individual trip basis. The RTC-2 distribution is from Table V.4.

TABLE V.5

DISTRIBUTION OF COSTS FOR RIVER TRANSPORT EXPRESSED AS PERCENT OF TOTAL COSTS

Column	1	2	3	4	5
Fixed Cost	USA(1)	RTC-1(2)	RTC-2(3)	Private(4)	
				Plan 1	Plan 2
Depreciation	5.3%	14.9	11.3	13.5	10.4
Interest	6.1	15.3	11.4	13.5	25.0
Repairs	6.8	23.8	9.5	17.0	13.0
Overhead	20.8	16.1	44.9	15.0	20.0
%	39.0	70.1	77.1	59.0	68.4
Variable Cost					
Salaries (crew)	20.6	17.2	7.2	13.0	9.9
Fuel	40.4	12.7	15.7	28.0	21.7
%	61.0	29.9	22.9	41.0	31.6
Total Costs	100.0%	100.0	100.0	100.0	100.0

Sources:
1. U.S. Army Corps of Engineers (1983) for the Mississippi River - Small Tug and four barges.
2. Study of River Transport in the Sudan; RRI Report 2a (1983) Allocating the costs of RTC from Table 5.2.1, p. 5.7 Workshop wages included in repair cost.
3. RTC Traffic Department Rate Study - Unpublished (1983) Repair Costs estimated by RTC Workshop costs included as overhead
4. Ogden Beeman and Associates.

Tables V.4 and V.5 demonstrate several points of interest.

- o The major cost problem at TRC is overhead and it appears to be centered at the boat yards and repair facilities. This is ironic because lack of equipment availability is a major problem for the operation. Note that boatyard personnel are shown under repairs in Table V.5, Column 2 and under overhead in Column 3, thus grossly distorting the distribution of costs.

- o The USA fleet has low fixed cost and high operating cost, expressed as a percentage, compared to any of the Sudanese examples, public or private (Ref. Table V.5). This relates to the very high utilization factor for U.S. equipment which tends to keep interest and depreciation charges low as a percent of overall cost.

- o Fuel costs as a percentage of total cost in the U.S. is higher compared to Sudan. This relates again to the very high utilization of tugs meaning that running time and fuel consumption are very high compared to other costs.

- o Privatization with 12% interest rates results in 25% of cost going to interest. This is a result of the low utilization factor of the equipment and could only be reduced by utilization exceeding the nine trips per year assumed in Plans 1 and 2.

Tables V.4 and V.5 make it clear that the staffing at RTC is too high and results in high costs compared to private sector alternatives even if rates of interest approach market rates. If cost is used to set freight tariffs, one must conclude that the person buying goods in Juba is subsidizing the redundant RTC work force. If Table V.4 is correctly conceived, one could conclude that the costs of river tug-barge systems could be reduced under privatization by a combination of reduced work force <u>and</u> higher equipment utilization.

The nine trips per year used on the pro-forma privatization analysis is still substantially below USA standards. This could be raised by having a sequential scheduling of tugs and barges where, for example, a tug would drop off a barge at each port up-bound and pick one up down-bound. Tugs moving at one week (or less) sequential schedules could interchange equipment as necessary. This would keep the capital intensive tug moving and possibly (but not necessarily) decrease usage of the less capital and labor intensive barge. While the long term goal of the system should be to increase utilization and availability of the tugs, it is believed that to predict more than nine trips per year is speculative at this point. Note that a doubling of utilization of the tugs would bring the distribution of costs much closer to the USA example in Table V.5. For example, under Plan 1, depreciation and interest charges would drop 50% and fuel costs would increase 100% while labor costs, as a percent of total cost, would stay the same.

With the cost of operation defined on a per trip basis, we can now define unit costs of commodity movements by looking at several different load factor assumptions.

UNIT COST OF MOVING COMMODITIES BY WATER

In the previous section we have defined and compared the monthly cost of operating one transportation unit of 940 HP tug and four - 500 ton barges. The unit costs of moving commodities will be a function of how many trips can be made in one month and how many tons are carried per trip.

Table V.6 shows the unit transportation cost, per ton-km, under three different cost and four different load scenarios. While Load Programs A and D probably somewhat understate and overstate fuel costs, respectively, the unit costs are valid for comparison purposes. Informal discussions with RTC indicate they have under consideration an increase in the tariff rate. While the tariff covers 10 categories, a typical example is the rate class for dura which they propose to raise from its present rate of L.S. 0.048 to around L.S. 0.080

because of cost figures demonstrated in Table V.6. Interestingly the cost basis of L.S. 0.028/ton km translates to around U.S. $0.015/short ton mile which is in the range we would expect to see for the transport (exclusive of loading, unloading and user fees) cost in the United States.

Table V.6

UNIT COST OF TRANSPORTING COMMODITIES (in L.S./ton km)

Operator	Trip Cost L.S./trip	Load Program(1) A 1600u/s 300d/s	B 1200u/s 300d/s	C 1000u/s 200d/s	D 800u/s 200d/s
RTC	140 140	0.052	0.065	0.082	0.098
Private P1.1	76,128	0.028	0.035	0.045	0.053
Private P1.2	111,929	0.042	0.052	0.065	0.078

Source: Ogden Beeman and Associates

Notes: 1. Load Programs defined as tonnage shown times an average travel distance of 1427 km as per RTC practice.

If the private sector can achieve nine trips per year at the costs shown, they can make a profit under the present RTC tariff for all the combinations double underlined and would essentially break even under the combinations with the single underline. Conversely, the RTC is considering an increase to the L.S. 0.080 range to get onto a breakeven status. The potential financial benefit to the nation should thus be obvious and can be derived by the number of ton-kilometers expected to move on the waterway system. Any improvement in tug use better than availability of nine months/year and turnaround time of 28 days will improve the cost figures shown.

Based on the RTC plan to make six trips per year per transportation unit, and the suggested level of nine trips per year for privatized operators, the productivity of one transportation unit per year is shown in Table V.7.

Table V.7

ANNUAL PRODUCTIVITY OF A TRANSPORT UNIT IN TONS

Operator	Trips/yr	Load Program			
		A	B	C	D
		1600u/s	1200u/s	1000u/s	800u/s
		300d/s	300d/s	200d/s	200d/s
RTC	6	11,400	9,000	7,200	6,000
Private Pl. 1 or 2	9	17,100	13,500	10,800	9,000

Source: Ogden Beeman and Associates

To get an idea of fleet requirements, at Load Plan B (1200 u/s, 300 d/s), 7.5 transportation units (tugs plus four barges) would be required to transport 100,000 tons/year which is in excess of today's tonnage. This represents less than half the fleet of new 940 HP tugs.

It is believed that the cost and utilization figures shown are achievable under privatization. Another potential benefit of privatization exists but has not been quantified. Evidence suggests that there are downstream (backhaul) movements from Juba that are presently moving by truck but would move by barge if service was improved and a marketing program instituted. Since it is a downstream backhaul, any such cargo captured would provide revenue with no offsetting costs except the day or so required to load the barge. Thus it would convert almost directly to profit to the operator.

PRACTICAL AND ECONOMIC LIMITS TO WATER TRANSPORTATION

Previous investigations have considered Juba as the upstream limit of navigation and have tended to look at Juba-Bor as a segment for hydraulic and hydrologic analysis. In our examination of the river it became apparent (See Chapter III - "The River") that actually this reach should be subdivided into two segments - Juba to Mongalla and Mongalla to Bor. While previous investigations considered improving navigation to Juba for the obvious reasons of the intersecting highway system and its historic accessibility by water, we believe this premise must be examined.

A tug-barge tow moving upstream is expending energy on three items: overcoming drag or friction with the water, "lifting" the entire weight of tug-barge and cargo up the stream gradient and moving through a medium with an opposing velocity component. We are accustomed to a truck overcoming friction (air and tires on the road) and "lifting" the weight of truck and cargo as it goes uphill. Imagine if the roadway was also moving at a downhill velocity equal to half the speed of the truck!

The drag factor can usually be defined by the still water speed of tug and barge. The drag factor increases with load and draft and is obviously greater for loaded than unloaded barges. The energy needed to "lift" the load increases directly with stream slope (i.e. gradient). The velocity of the water (i.e. opposing motion) increases with the square root of the slope. Thus, gradient is the best indicator of horsepower requirements, barge size and loads and overall economies of water transport.

In highly developed water systems slope (or gradient) is reduced or eliminated by lock and dam systems. In many systems downbound loads predominate, meaning the effect of slope becomes a positive contribution to efficiency. Unfortunately, as one moves upstream on the White Nile the gradient and load direction are both working against the economies of water transport. The gradient of 30×10^{-5} or 0.3 m/km does not seem high but it seriously effects the economies of water transport.

Utilizing the previously derived cost figures and compensating for the additional fuel costs, we have examined the cost of transporting commodities from Mongalla to Juba. The results are shown below.

- RTC Rate - Based on 800 ton u/s and 200 ton d/s. Eighteen hours running time Mongalla-Juba-Mongalla plus maneuvering at both ends.

- Tug-Barge Cost	3166
- Fuel Cost	1100
L.S.	4266

This translates to a ton-km rate of L.S. 0.106.

o Privatized Rates on a similar basis would be 0.064 and 0.088 per ton km for Privatization Plans 1 and 2 respectively.

These costs for the final 40 km are 30% to 42% higher than the average cost of transportation of the remainder of the river.* It would appear that under R.T.C. operation, transport on this segment is probably about equal cost between tug-barge and truck. (Eighmy, 1983, quotes the RRI study results of L.S. 0.092/ton km financial costs for the road transport alternative.) Before payment for river improvements, it appears private sector tug-barge operation may have some cost advantage over trucks for this segment.

The impact of river gradient on barge transport costs have been discussed earlier. It is not coincidental that three out of the five shallow spots (less than 1.2 m depth at low water) in the 1435 km reach from Kosti to Juba occur in the 40 km reach from Mongalla to Juba and all five shallow spots are in the last 70 km from Terakeka to Juba. The steeper gradient which makes water transport marginal also results in braided channels, eroding banks, sediment transport and irregular river widths resulting in shallow bars and ill defined channels. Thus, the majority of the dredging required to restore minimum depths at low water must be allocated against the 40 km segment Mongalla-Juba rather than the remainder of the system. At the present volume of river traffic, it is apparent that even modest annual dredging efforts, if paid for through user charges, would drive up

*A factor of 1.45 is used in Appendix 4 to reflect the higher cost of operating on this 40 km reach.

the cost of transport over alternative highway modes. For example, dredging costs of L.S. 1.0 million would add L.S. 20 per ton or L.S. 0.50 per ton km to 50,000 tons moving from Mongalla to Juba. In fact, if the dredging only had to be performed every ten years (which is completely unrealistic) it would still add L.S. 0.05/ton km driving all cost scenarious over the apparent cost of highway transport.

It would appear that the more likely alternatives for transport from Mongalla to Juba are the following:

- o Use of water transport during high water and trucks during the dry season.
- o Develop an all-weather road and tranship all goods at Mongalla.
- o Develop a very shallow draft system with the required power and run a water transport shuttle system from Mongalla to Juba as required by channel depth restrictions without dredging.

Further examination of these alternatives is included in the economic analysis.

PLANNING FOR SYSTEM PRIVATIZATION

The Government of Sudan (G.O.S.) has declared a national policy to privatize the water transportation sector. With the RTC considering the increase in tariff levels by a substantial amount, it appears that both a plan and a schedule for privatization should be implemented. The G.O.S. and private sector actions and responsibilities for privatization are discussed in this section. The overall issue of public sector responsibilities for the navigable waterway system will be discussed in a later chapter.

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GOVERNMENT ACTIONS AND RESPONSIBILITIES

Given the fact that policy favors privatization (and clearly the figures presented earlier indicate its potential benefits) the Government must get on with its implementation. While the responsibility has been assigned to the Ministry of Transportation (MOT), Department of Inland River Navigation, this department is concurrently trying to assume numerous other responsibilities for waterway development. In order to proceed with privatization, we see the following steps in order of priority.

Policy Determinations: Obligations of the Government.

All steps in privatization must be derived from some underlying policies.

Based on our review of the situation, we believe these policies (or alternatives to them) should be made before proceeding further.

1. The RTC tariff shall be on a break-even basis based on a proforma analysis of costs and revenues. If the RTC has the ability to subsidize transport, the private sector will have trouble entering the market.

2. Privatization must be initiated by use of the existing RTC fleet. Previous studies (RRI, 1983), experience and our analysis indicate the fleet is wholly adequate for present and future needs. It would be uneconomic and financially questionable to allow hard currency reserves to be spent for additional equipment.

3. Proclaim that private operators will have the following privileges:

   - Importation of spare parts and technical assistance, within stated limits, required to keep equipment in service.

- o Fuel allocation at prices similar to that charged to the RTC.

- o Equal access to port facilities on a first come, first served queue discipline with maximum labor and hours mandated when barges are in the queue.

- o Use of RTC drydocks or lifting devices subject to scheduling ahead and paying for the use on a published tariff basis. Repairs can be provided by the operator or by direct contract with RTC.

4. Proclaim that Government policy will aim at the following:

   - o Free access to markets and commodities.

   - o Freedom from arbitrary regulation not justified by safety or national welfare.

   - o Freedom from ruinous competition. (Necessary because the available fleet is so far in excess of present demand.)

5. Proclaim that, in order to promote privatization while assuring the Government interests are protected, the following system will be used:

   - o All firms will be given the opportunity to provide pre-qualification statements including financial responsibility, personnel available, experience and a pro-forma description of operations and financial performance.

   - o The G.O.S. will "license" all firms having minimum qualifications. All licensed firms then are qualified to enter the business with their own equipment or to bid on the lease of RTC vessels as described below.

Policy Determinations: Obligations of the Operator

The following policies will enunciate the obligations of the operator:

1. The annual rental rates on all government equipment will be not less than 10% of acquisition value plus a fee of 10% of rental rate to cover administration.

2. Vessels and equipment will be rented subject to on-hire and off-hire survey of hull, machinery and equipment by an independent ship surveyor. Operator will restore all equipment to on-hire condition, less effects of age, at off-hire.

3. Operator will provide to the Bureau of Investment proof of financial responsibility and proof of insurance or bonding to protect the Government (against loss of vessels) and shippers (against loss of cargo). Amounts will relate to coverage of all RTC equipment rented plus value of cargo.

4. Operator must charge according to a published tariff which can differentiate between commodities, upbound/downbound, and provide reduced rates for volume shipments or guaranteed minimums. Tariff must be published and cannot be changed more than every 90 days except in response to changing cost factors, such as fuel price. Rebating, surcharging or price fixing between operators are to be forbidden and will result in loss of license and any privilege to rent RTC equipment.

5. Operators using RTC equipment must specify and provide a minimum level* of service over a given route. Failure to provide this service over a period exceeding four months will result in loss of equipment.

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*In terms of frequency of service and available tonnage capacity

IMPLEMENTING PRIVATIZATION

With the above described policies in place, implementation is rather a simple matter because it is put in terms of competitive rates for equipment rental rather than exclusive "licenses" or "franchies" for providing service. We would see the sequence like this:

- o Draw up policy document, coordinate with appropriate agencies and publish.

- o Call for prequalification statements based on a prescribed format.

- o All applicants meeting minimum qualifications will be licensed. Any licensed operator is qualified to participate in the bidding process to use RTC equipment. (Foreign experts could assist in the qualification and selection process.)

- o Perform a pro-forma analysis of number of tugs and barges required for the trade in the next year and select the number of transportation units (940 HP tug plus four barges) required to provide 125% (plus or minus) of that requirement based on the performance levels and utilization described by the operators in their prequalification statements.

- o Give the licensed operators 60 days to submit a bid form which will simply agree to the conditions and bid an amount <u>over</u> the minimum for a period of two or three years (decision by bidder).

- o Select successful bidders on basis of highest bid gets one transportation unit etc. until enough units have been allocated to equal 125% of demand as specified. Irrespective of bid amounts, a minimum of two operators will be chosen and no single operator can exceed three RTC units.

- o Give the successful bidders 120 days to get operational. As each one enters service, one RTC transportation unit is dropped from service in a predetermined sequence to allow the private operator to recruit RTC personnel.

- o When all private sector vessels are operational, close down remainder of RTC fleet, if any remains.*

ADMINISTRATION OF PRIVATIZED OPERATIONS

The administration of the privatized operations will be simple. Since the aspect of licensing or franchising has been subordinated to the concept of equipment rental or leasing, the administrative aspect converts from a regulatory to a commercial undertaking. Assuming that RTC is the equipment lessor, they will wish to have an administrative staff of several people to do the following tasks:

- o Handle paperwork and files in relationship to the leased fleet.

- o Arrange for on-hire and off-hire surveys to be performed by a neutral party.

- o Arrange for any repairs or upgrading required by the off-hire survey.

- o Prepare bid forms and lease contracts for renewal of leases and new leases.

- o Deposit the rental payments and assure necessary deposits are made.

- o Keep a basic log of equipment utilization including trips, times and engine hours, based on reports from the lessee.

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*Exclusive of non-Norwegian passenger vessels and equipment.

It would appear that this work could be accomplished with a staff of five to ten people supplemented as necessary by skilled personnel to perform surveys and direct any repairs or modifications resulting from off-hire surveys.

As equipment leases expire after two or three years, they will have to be renegotiated or rebid. This will take some further policy-making which can best be done after the system is operational for a year. The simplest alternative is to reopen the bidding on equipment with expired leases. At that time it will probably be better to make leases for longer periods allowing operators to make further capital investments and efforts to upgrade service and marketing of the service.

INCENTIVES REQUIRED FOR PRIVATIZATION

The Encouragement of Investment Act of 1980 provides certain privileges and concessions for investments made in areas of specific priority for national development. The Act seems to be broad enough that river transport privatization could be covered.

Since the competitive rental system previously described drastically reduces the need for hard currency investment, many of the concessions suggested in the Act are not necessary or appropriate if this scheme is adopted. In addition to the policy recommendations already suggested for privatization, two concessions from the Act would assist and encourage privatization:

- Partial waiver of profits tax and permission to repatriate profits could be allowed to the extent that foreign currency was introduced to assist in privatization. Note that this amount should be modest in that the vessels would be made available for rentals payable in Sudanese currency.

- Allotment of land at reduced prices with payment in installments could be an appropriate assistance area since waterfront land parcels will be most appropriate for river operations headquarters.

Available information, including the "Survey of Private Sector Investors in River Transport" (MOF and P., undated) suggests that the privatization concept described herein will require little other assistance from the government. Should initial steps fail to generate operator interest, this position could be reevaluated and changed as appropriate.

VI. ECONOMIC FORECASTS

ECONOMIC GROWTH FORECASTS

Normally, economic growth forecasts are used with historical data to analyze the basic "demand" functions for transportation services. For developing countries, these growth forecasts are frequently based on micro-economic analyses for specific projects in each sector of the economy that require improved transport services. Once the transport-dependent growth has been identified by origin, destination, tonnage, seasonality, etc., materials handling the mode-split analysis can be used to identify specific transportation service requirements by mode and link.

This traditional approach to transport investment planning was not possible for the synthesis of this project because:

- Primary data on current economic activities are simply not compiled at the subregional levels by origin, tonnage and market destination.

- Various Ministries (Agriculture, Industry, etc.) are only beginning to assemble such data as are their Southern Region counterparts.

- Recent reports (except for the 1978 Kenya-Sudan Road Study) have dealt with economic and commodity flow forecasting on a macro basis, and then applied those forecasts to route or link analysis.

As a result of the above factors, the forecasts for this project are derived as follows.

First, historical commodity flows data are compiled for the river and the ports from Kosti to Juba. To the extent possible, economic activities related to these historical flows are described.

Second, limited detailed data on existing and potential economic development projects requiring river transport are compiled by individual port. These detailed data include commodity types by origin, destination, tonnage, materials handling technique and value. They are then supplemented with more subjective information and forecasts from reports such as the Southern Region Six-Year Plan of Economic and Social Development, the River Transport Investment Policy Study, the Yambio Feeder Road study, and the 1983 Study of River Transport in the Sudan. Importantly, these data reveal the "recovery" of the ports and river handling volumes from previous high levels, and analysis of economic recoveries can add to the reliability of such forecasts.

Finally, the transport "demand" forecasts are compared to forecasts in recent reports and differences described where possible. Thus, the economic and commodity forecasts are fully adequate to support the objectives of this report.

Table VI.1 shows, by port, recent commodity flows as available, historical highs, and forecasts for 1990 and 2000. The record of total traffic between Kosti and Juba is shown in Table VI.2.

Table VI.1 partially reveals the role these ports have historically played in supporting economic activities in their hinterland including:

- The more or less steady growth of Kosti and Renk and the early 1970's maximum imports at Bor and Juba following the close of hostilities in the south.

- The basically one way nature of commodity flows through Renk, Malakal, Bor and Mongalla. (This is also true of Shambe and Adok which are not shown in Table VI.1.)

- The fact that most upriver ports are net importers with few exports.

TABLE VI - 1

COMMODITY FLOWS

	HISTORICAL					FORECAST(2)	
	78/79	79/80	80/81	81/82(1)	Highest Year	1990	2000
KOSTI							
Imports	24,700	900	2,300	24,500		50,000	100,000
Exports	32,500	49,800	44,400	59,200	(81/82)	90,000	170,000
Total	57,200	50,700	46,700	83,700	83,700	140,000	270,000
RENK							
Imports	200	600		400		5,000	10,000
Exports	17,900	15,600		38,600	(81/82	50,000	50,000
Total	18,100	16,200	27,500	39,000	39,000	55,000	60,000
MALAKAL							
Imports	7,300	5,300	6,100	9,600		15,000	24,000
Exports	1,800	1,300	700	2,000	(75/76)	3,000	4,000
Total	9,100	6,600	6,800	11,600	24,400	18,000	28,000
BOR							
Imports	5,400	6,800		18,700		24,000	34,000
Exports	-	100		700	(75/76)	3,000	4,000
Total	5,400	6,900	8,900	19,400	23,000(3)	27,000	38,000
MONGALLA							
Imports				2,400		4,000	5,000
Exports	N.A.	N.A.	N.A.	1,000	N.A.	3,000	10,000
Total				3,400		7,000	15,000
JUBA							
Imports	28,900	17,000	19,000	42,100		75,000	115,000
Exports	8,700	2,300	5,100	12,200	(71)	30,000	45,000
Total	37,600	19,300	24,100	54,300	94,000(4)	105,000	160,000

Source: Unpublished RTC data unless noted
1. 1983 EDF Report, Vol. III, Tables 1.1.2-12 & -13
2. Bigelow Associates
3. 1980 Transport Policy Report
4. Southern Region Gross Plan 1977

Table VI.2

HISTORICAL TRAFFIC IN THE SOUTHERN REGION

Southern Region -
River Freight Traffic Volume (Actual Tons)

Year	Total Cargo	Liquid Cargo Petrol. Prod. tons	%	Dry Cargo tons	%
70/71	90,953	16,248	17.9	74,705	82.1
71/72	94,294	16,471	17.5	77,823	82.5
72/73	80,141	14,070	17.6	66,071	82.4
73/74	71,407	4,956	6.9	66,451	93.1
74/75	87,451	5,662	6.5	81,789	93.5
75/76	74,344	12,304	16.6	62,040	83.4
76/77	69,750	10,252	14.7	59,498	85.7
77/78	65,594	8,777	13.4	56,817	86.6
78/79	70,904	17,468	24.6	53,436	75.4
79/80		17,671			
80/81		18,934			

Southern Region - Passenger Transport Volume by Classes
Between Kosti and Juba (Actual Passengers)

Year	1st Class		2nd Class		3rd Class		TOTAL
	Number	%	Number	%	Number	%	
1970/72	2,492	1.51	9,064	5.48	153,717	93.01	165,273
1971/72	2,937	1.78	9,726	5.83	152,733	92.34	165,396
1972/73	3,221	1.61	12,475	6.23	184,688	92.17	200,384
1973/74	2,071	2.02	6,878	6.71	93,588	91.27	102,537
1974/75	2,558	1.63	10,134	6.45	144,327	91.92	157,019
1975/76	3,083	1.43	11,781	5.45	201,400	93.13	216,264
1976/77	2,906	2.04	10,695	7.52	128,610	90.44	142,211
1977/78	2,089	1.22	5,984	3.49	163,370	95.29	171,443
1978/79	1,617	1.70	4,872	5.11	88,846	93.19	95,335
1979/80	733	1.84	2,410	6.04	36,766	92.12	39,909
1980/81	739	2.93	2,640	10.45	21,879	86.62	25,258

Source: 1983 EDF Interim Report, Tables A.4.3. - 18 and - 1

Other implications of the data in Table VI.1 are first, that river cargoes are moved long distances as shown by the larger tonnages that are handled by Kosti, Renk and Juba. Second, the smaller tonnage through Malakal, Bor and Mongalla indicate a restricted hinterland due to small populations, low levels of economic activity or a lack of good road or rail connections to population or activity centers. In fact, the very small scale of commodity flows on the entire river (less than 100,000 tons in 1982 as shown in Table VI.2) indicates that significant capital investments will be difficult to justify, solely on an economic basis. This same statement also applies to ports such as Mongalla, Malakal, Lake No, Adok, El Jebelein, etc., particularly since unloading at these ports can be accomplished over the river bank and without constructed facilities on a small-tonnage basis.

The above comments on scales and character of economic activities are intended to provide a basis for the forecasts for 1990 and 2000. These forecasts are discussed below on a port by port basis.

A final perspective on the past and possible future of the White Nile can be gained from the type of commodities or traffic historically transported on the river. Table VI.3 reveals:

- o A very small number of different types of commodities.
- o A dominance in terms of tonnage, of dura, flour and petroleum.

For the most part, Table VI.3 shows commodities moving upstream. Primary downstream movements are coffee, tea, and tobacco from Juba to Kosti and dura from Renk to Kosti. The remaining discussion in this chapter is focussed on the individual port handling forecasts shown earlier in Table VI.1. Then in Chapter VII, these forecasts are used to identify needed port improvements; costs for the feasibility analyses and capital improvement programming; and benefits for the feasibility analyses.

Table VI.3

COMMODITIES MOVED ON THE SOUTHERN SECTION

COMMODITIES MOVED	1970-71	1975-76	1980-81*
BEANS AND PEAS	1,563	857	NA
CEMENT	1,736	3,572	1,339
DURA, DUKHN & MAIZE	24,584	23,657	23,205
HOUSEHOLD EFFECTS	4,213	429	NA
ONION	1,826	1,785	NA
SALT	1,304	4,795	1,746
SUGAR	3,227	4,347	2,358
FLOUR	8,542	6,169	7,666
BENZINE & FUEL OIL	16,248	12,304	18,934
MISCELLANEOUS	27,710	28,168	NA
TOTAL	90,953	86,083	NA

Source:

Freight Traffic Estimation Study (Second Print)

Ministry of National Planning, Khartoum Nov. 1978 p. 42

*1983 EDF Interim Report, Tables A.4.3. - 24 and - 29

COMMODITY FORECASTS BY PORT

JUBA

Juba has historically served as a regional capital and the uppermost port of the southern reach of the river. It is also the focus of collection-distribution activities in support of about 4,000,000 in population in 1982 and the export of coffee, tea, tobacco and cattle produced in the Southern Region. Consequently, Juba is served by an extensive, though lightly developed, road system to its hinterland which includes parts of the Zaire, Uganda and Kenya as well as the Southern Region.

Prior to the outbreak of hostilities in the 1950's the Southern Region was much more self sufficient than it is today. The underutilized and deteriorated port, factories and 15 saw mills reflect the earlier activites and future potentials. These potentials are listed in Table VI.4.

Table VI.4

FORECASTS BY COMMODITY

Commodity	Earlier Tonnage	Forecast Tonnage
Coffee and tea	1,700 tons in 1977-78	8,000 tons by 2000
Tobacco	1,000 tons in 1974-75	1,500 tons by 1990
Forest products		
from Imatong	12,000 tons in early '60s	34,000 tons by 2000
from Acholi	?	3,700 tons by 2000
Cotton	?	1,500 tons by 1995
Cattle (holding facilities planned at Mongalla)		
Hides and skins	627 tons average 1951-1961	3,700 tons by 1990
Cereals (dura, etc.) for export.	-15,000 tons in 1981-82	+10,000 tons by 1990

Source: Kenya-Sudan Road Link, Norconsult A.S. Aug. 1978

These forecasts depend on some changes taking place in the Southern Region:

- o Replacement of hand cultivation with animal-drawn and possibly some tractor-drawn implements.
- o Intensification of agricultural activities through the use of improved seeds, fertilization, etc..
- o The extension of cash crops to small holder operations.

Given these conditions and the potential listed above, export forecasts for the Port of Juba are:

1990	2000
20,000 tons	45,000 tons

Import forecasts are based on an immediate relief of current dura, petroleum, etc. shortages; population growth percentages for urban (8%) and rural (3%) areas; and the extension of Juba's hinterland by the Yambio feeder road and Kenya-Sudan Road links. At a rate of 5% per year until self sufficiency is reached in 1990 and 3% thereafter, import forecasts are:

1990	2000
70,000 tons	115,000 tons

MONGALLA

The Port of Mongalla has the smallest throughput tonnage of the ports listed in Table VI.1. Given its location between and being the only dry weather access to Juba and Gemmeiza, Mongalla has a very small hinterland. Even so, it is the southern terminus for heavy loads in the dry season, it has a textile factory, and both a sugar and cattle holding facility have been scheduled by the G.O.S. for Mongalla. Presently it is a 100% importer of food stuffs - mostly dura, sugar, salt, etc..

Given its proximity to Juba (55 km by road; 40 km by river), other than economic justifications will be needed if the port is to be improved before the year 2000. Thus, imports to Mongalla are estimated to grow at about 3% with the rural population and the maximum likely exports are forecast to be related to textiles and to the proposed a) sugar plant, and b) marketing of Southern Region live cattle in the north.

Thus, tonnage for the Port of Mongalla are:

1990	2000
7,000 tons	15,000 tons

These forecasts are not used as the basis for improvements to Mongalla as suggested in the next chapter.

BOR

As early as 1975, the Provincial Capital of Bor had a higher traffic volume (23,000 tons) than the 1981-82 tonnage of about 20,000 tons. The 1975-76 high was followed by 18,000 in 76/77; 16,000 in 77/78; and 5,000 in 78/79 when tonnages started rising again. These are 96% import volumes.

Bor is also the location of the future headrace facilities for the Jonglei Canal - a factor that may or may not significantly affect the port's future throughput tonnage. If loading-unloading facilities are spaced along the length of the canal as planned, Bor is unlikely to be a focus for commodity flows or economic developments stimulated by the Jonglei Canal. At minimum, Bor will be headquarters for operating and administrative personnel "locking" vessels into and out of the canal and regulating water flows into the canal. Consequently, it will probably develop as a local mini-transport hub for unloading and loading a few tows using the canal, but continue to be a regional import/ distribution port. At maximum, Bor could develop into a major transshipment hub in

the region, particularly if loading-unloading facilities are not built along the canal. Thus, forecasts for the partially urbanized area are for 4% population and import growth and for a minimal 3% growth in exports. The totals are:

1990	2000
27,000 tons	38,000 tons

MALAKAL

Given its history as a distribution center, its role as an RTC repair facility location close to the terminus of the Jonglei Canal, Malakal is likely to develop into a subregional transportation hub. Both the existing and soon-to-be completed roads to Malakal support this likelihood, as they help form a hinterland population of between 4 and 5 million. Consequently, commodity flows through the (probably relocated) Port of Malakal will increase at a rate of 5% for imports to an expanding urban and rural population and 3% for exports. Total tonnages are expected to be:

1990	2000
18,000 tons	28,000 tons

RENK

Renk is also a "one way" port like Bor, Mongalla, Shambe, Adok, etc. However, unlike the others, Renk is an exporting rather than importing facility. With a part of its hinterland in the highly productive Blue Nile province, it has grown steadily from the early 70's as the source of dura exported to the south to Melut, Malakal, Adok, Shambe, Bor, Mongalla, and Juba. A large tonnage also moves north to Kosti in competition with road transport. Presently about 7% of the total tonnage is comprised of imports. Considerations related to forecasts for Renk include:

- The Southern Region is striving for self-sufficiency which could mean a large drop in exports to the south from Renk. These exports would then be directed north to Kosti or Khartoum via water or an up-graded road. However, growth in exports to Malakal and Bor will offset diminishing exports to Juba.

- Improved road and water transport costs might be:

River - 175 km @ 0.035 LS/ton km[1]	=	6.1 LS/ton
Extra on- and off-loading @ LS 0.5/bag	=	5.5 LS/ton
Total costs via the river[2]	=	11.6 LS/ton
Road - 175 km @ 0.04 LS/ton km	=	7.0 LS/ton

indicating that truck would be the preferred mode.

- The future growth in Renk's hinterland is of no consequence to the port if related commodity flows move by truck.

Thus, forecasts for the Port of Renk include small imports grow-in at 3% and an immediate increase in exports of about 15,000 tons to meet currently unsatisfied requirements in upriver areas.

1990	2000
55,000 tons	60,000 tons

KOSTI

Kosti's future as the country's intermodal cargo exchange center seems assured. Major rail, road and water links converge at Kosti with the petroleum products pipeline terminating close by at Jebel Aulia. International exports are assembled from around the country for rail or truck shipment to Port Sudan and international imports are railed or trucked from Port Sudan to Kosti for distribution around the country. However, this project is concerned primarily with the ability of the Port of Kosti to handle traffic to and from the upriver ports.

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1. See Table V - 6, P.I.1, Load Program B
2. See Appendix 4, Truck Transport Costs

Given the forecasts of imports and exports for upriver ports, the forecasts for Kosti are derived as the sum of properly accounted for cargo types, tonnages and direction of flows to and from the upriver ports. For example, total upbound commodities originate in Kosti (consumer goods and misc.), Renk (dura) and Jebel Aulia (petroleum) products. These exports are accounted for in the total imports of the upriver ports. Using this approach, the project-related forecasts for Kosti are:

1990	2000
140,000 tons	270,000 tons

COMMENTS ABOUT THE PORT FORECASTS

A number of factors have been taken into account in each of the port forecasts above. They include:

- o A 5% growth in petroleum shipments; Jebel Aulia to upriver ports (both on the channels to Juba and on tributaries).
- o A completion of road improvements from Renk to Kosti by 1985, from Juba to Lodwar by 1985, and the Jonglei Canal by 1990.
- o A major increase in services to Juba (as well as river rates no higher that at present) by 1985, either through privatization or some other means.
- o No major change in G.O.S. or Southern Region policies regarding economic recovery throughout the south.

FORECAST COMPARISONS

Ideally, for a prefeasibility analysis such as this, several data sources and port forecasts would have been available for comparative purposes. One of those forecasts would have been available from RTC, another from the Ministry of Transportation, and possibly a third either from the

Ministry of National Planning or the Ministry of Finance and Economic Planning. We were unable to find such forecasts. Thus, those in Table VI.5 are by consultants alone.

The differences in forecasts for the various ports appear to have resulted from the following considerations.

Renk and Juba

These differences are handled together because Renk is exporting so much dura to Juba. Apparent differences in Table VI.5 forecasts are due to the following:

- The Bigelow Associates forecast a) self sufficiency in the Southern Region by 1990 and an export of surplus to ports as far north as Shambe by 2000, b) continuing exports from Renk to ports as far south as Adok and c) the capture by truck transport of surplus in Renk's hinerland that is destined to Kosti, Khartoum or Port Sudan.

- The RRI forecast appears to include growing exports to Juba and other southern ports through the year 2000.

Malakal and Bor

Differences at these ports appear to be basic differences in the rates of growth in agricultural inputs and production. Whereas the Bigelow Associates forecast is based partly on a recovery (by the southern ports) of pre-hostility levels plus a modest 4% growh, the RRI report appears to be based on recovery plus strong growth.

Table VI.5

FORECAST COMPARISONS

FOR TOTAL TONNAGE BY PORT

(000's tons)

Port	Historical Tonnage[1] 75/76	80/81	Forecast to 2000 This Project[2]	RRI[3]
Kosti	23	84	270	210
Renk	11	39	60	307
Malakal	25	12	28	61
Adok	5	1	-	10
Shambe	5	2	-	15
Bor	23	20	38	125
Mongalla	5	3	15	15
Juba	14	54	160	290

Sources:
1. See Table VI.1 and 1980 G.O.S. Policy Study
2. Bigelow Associates
3. 1983 EDF Report - Summary

VII. PROJECT FEASIBILITY AND RANKING

It is in this chapter that all costs and benefits are assembled to test the economic feasibility of the proposed river improvement program. Thus, this chapter presents:

1. A summary of least-cost alternatives from Chapter III, IV and V to meet "demands" identified in VI.

2. A summary of "benefits" comprised of lower transport costs from V; and from VI, lower commodity prices plus profits and wages from new economic activities stimulated by the river system improvements.

3. Analyses and comparisons of benefits versus costs from 1 and 2 above, and

4. Discussions and analyses of the sensitivity of the economic feasibility analysis to central factors such as:
   -- the disposition of RTC employment
   -- user fees on the overall system, and
   -- economic issues related to the transition of operations from RTC to the private sector.

The products of this chapter are a prefeasibility analysis for short-term and long-term improvements, a 20-year capital improvement program, and a "flagging" of key issues upon which the feasibility of the program depends.

PROGRAM COSTS

The cargo forecasts shown earlier in Table VI-1 will require the system improvements shown in Table VII-1. Included in this capital improvement program are both short-term and long-term capital investments; periodic reinvestments in repaving, fencing, lighting etc; and bi-annual (every two years) maintenance dredging costs. Life-cycle costs (40 years maximum for berth walls, fixed cranes, etc.) are reflected in the schedule which also emphasizes the minimization of annual maintenance expenses.

A key aspect of the costs in Table II-1 is that they are designed to support the present type of operations between Mongalla and Juba. That is, the program reflects costs for continuing present high water operations into Juba with the Norwegian class tugs and barges and, during low-water periods, off-loading at Mongalla for trucking to Juba or beyond. These operations were based on financial analyses of several alternatives as follows.

Alternative	Annual Cost for 30,000 T/yr
1. Continue high-water barging to Juba and low-water off-loading at Mongalla for trucking to Juba	LS 802,000
2. Make Mongalla the southern terminus, pave a road from Mongalla to Juba, and truck 55km	LS 1,192,000
3. Make Mongalla the southern terminus for Norwegian craft, tranship to shallow draft craft for 40km trip to Juba	LS 950,000
4. Dredge the Mongalla-Juba reach with annual redredging and operate Norwegian craft into Juba on a year-round basis	LS 2,779,000

(See Appendix 4 for details of these analyses)

As shown by these cost comparisons, continuing present offloading at Mongalla during low-water periods is significantly less costly than the next lowest cost alternative. It is less than one-third the cost of dredging all the way to Juba for year-round operations into Juba.

Sensitivity analyses reveal no change in the attractiveness of Alternative No. 1 even if:

a) trucking costs from Mongalla to Juba are reduced to zero;
b) channel maintenance costs were reduced by one half; or
c) tonnage figures are doubled to 60,000 tons/yr.

It is anticipated, however, that the Dutch will have improved the Juba-Mongalla road to a good gravel condition by 1985 and that the road is maintained in that condition for a 4-month, low-water period. Further, it is expected that the private sector will transship petroleum products at Mongalla during low-water periods by off-loading directly from barges into delivery trucks or constructing new storage tanks at Mongalla.

PROGRAM BENEFITS

Benefits of the proposed capital investment program are calculated as follows.

A. Transport cost savings are calculated that would accrue to

1. present and normal growth* traffic, and
2. traffic using another route or mode that would be diverted to the improved system due to its lower costs or rates.

B. Benefits are estimated for economic activities stimulated by the proposed system improvements. These benefits (in terms of new profits and wages available for re-expenditure in the regional economy) are expected to result from

1. the provision of more reliable or less costly access to markets that cannot be reached by other modes

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*Normal growth in traffic that could be expected to take place without improvements to the transport system.

2. the reduction of costs for inputs (petroleum, fertilizers, etc.) such that new production occurs, or

3. consumer savings, in excess of lower transport costs, that result from more reliable supplies or the reduction of black market pricing.

Each of these categories and subcategories is discussed below. In each instance, a base-case or no-project forecast is included that: 1) precludes self-sufficiency in the south even with completion of the Sudan-Kenya road, 2) postulates insignificant service improvements by RTC, and 3) anticipates a doubling of present river rates.

A. TRANSPORT COST SAVINGS

Present and "normal growth" traffic and related savings from an improved river transport system are based on:

-- savings to the major long distance traffic between Kosti and Juba and between Renk and Juba

-- the evaluation that normal growth <u>into</u> Juba can reach 50,000 tons if no improvements are made (higher tonnages would require major improvements): exports are estimated to be 8,000 tons

-- lower unit costs for improved services as shown in Table V-6 from

RTC's Load Factor C	=	0.082 LS/t km
to PI.1 Load Factor B	=	0.035 LS/t km
Savings	=	0.047 LS/t km

Thus, for inbound and outbound movements,

for 20,000 tons Kosti-Juba @ 1,436 km
plus 30,000 tons Renk -Juba @ 1,262 km
for 8,000 tons Juba -Kosti @ 1,436 km

savings can be calculated to be:

(20,000t)	(1,436 km)	(0.047 LS/tkm)	=	1,350,000 LS
(30,000t)	(1,262 km)	(0.047 LS/tkm)	=	1,780,000
(8,000t)	(1,436 km)	(0.047 LS/tkm)	=	540,000
				3,670,000 LS/yr

Diverted traffic is estimated to be 2,000 t/yr of coffee, tea, etc. now moving by truck between Juba and Kosti or Khartoum. The differences in cost per delivered ton are:

via truck	(1,600 km)	(0.2 LS/t km)	=	320 LS/t
via improved river	(1,436 km)	(.035LS/t km)	=	50 LS/t
+ an additional transhipment			=	15 LS/t
				65 LS/t

Thus, savings due to diverted traffic are calculated to be

(2,000 t/yr) (320 - 65 LS/t) = 510,000 LS/yr

Savings due to transport cost reductions total 3.67 + .51 or LS 4.18 million/yr. over the 20 year analysis period with two modifications. The modifications are due first to diminishing southbound traffic (dura) as the south regains its self sufficincy in cereals, and second to diminished savings on the shorter route through the Jonglei Canal.

Diminished savings due to self sufficiency are calculated to be (30,000 tons) (1,436 km) (0.047 LS/t km) or LS 2.02 million/year. The loss of these savings would increase from zero in 1985 to LS 2.02 million by 1995, and remain at that level through the year 2050.

Diminished savings due to the Jonglei canal opening in 1990 are (50,000 tons) (357 km - the proposed length reduction) (0.047 LS/t km) = LS 0.84 million/year. This reduction would apply from 1990 to 2050.

B. ECONOMIC BENEFITS

Economic growth stimulated by, and directly attributable to, river transport improvements will occur primarily in the hinterland for Juba, Mongalla and Bor. This growth, however, will be directly and strongly influenced by government policies, severe budget constraints, the level of political unrest in the south, etc. Only the severe budget constraints are taken into account in identifying activities attributable to river transport improvements.

Recognized projects and proposed developments in the south that will <u>not</u> be considered further include the following:

a.	Industrial projects	All temporarily delayed by severe budget constraints. This affects forecasts at Juba, Mongalla and Bor.
b.	Coffee and tea	Not considered constrained soley by the lack of reliable, inexpensive river transport -- currently goes by road if necessary.
c.	Tobacco and cotton	Ditto
d.	Hides and skins	Not likely to be stimulated significantly by improved river transport -- these are low value, relatively non-perishable commodities that wait for the present erratic service.

Thus, the economic growth, part of which can be directly attributable to improved market access, lower cost inputs or lower transport costs include those shown in Table VII-1 below.*

Table VII-1

ECONOMIC ACTIVITIES AND BENEFITS

Activity	Benefits ('000s LS) 1995	2050
Cattle (Kapoeta Dist.)	26	76
Subsistance Cereals (Kapoeta & Lafon Dists.)	500	750
Cash Crops	81	341
Mechanized Cultivation	44	148
Timber	85*	340*

*Estimates by Bigelow Associates of LS 10 per ton for benefits

Source: Kenya-Sudan Road Study
1980 Transport Policy Report
Unpublished data by the Ministry of Industry (see App. 3)

These benefits are assumed to start at zero in 1985 and grow to the combined values shown above. Notes to the above include the following.

- The Kenya-Sudan Road Study recognized that the road would be only partly responsible for stimulating the marketing of cattle and timber products through Juba and that an improved river system would be required.

- Inputs to the production of cereals, cash crops, and the mechanized cultivation would flow through Port Sudan rather than Mombassa where the cost of inputs is based on high trucking rates all the way from Mombassa. An improved river system and rail or trucking to Port Sudan would be more cost competitive.

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Thus, the analysis above is based partly on the assignment of benefits to an improved river system that had previously been attributed to the Kenya-Sudan road.

The introduction of significantly improved transport services to the south will have a major effect on unofficial market prices for dura, petroleum etc. Assuming that only one half of the dura and petroleum supplies are subject to unofficial market pricing and that such pricing only doubled their cost, savings could run on the order of LS 2 million per year for dura and LS 4 million per year for petroleum. Since the unofficial price for petroleum in Juba is over three times the price in Khartoum (Project Team trip notes, Oct. 1983) these estimates are considered conservative. See calculations in Appendix 4.

One-half of these savings are considered attributable to increasing supplies over the improved Juba-Lodwar (Kenya) road and one-half attributable to significantly increased river services at present transport rates. Those savings start at zero in 1985, peak at 3.0 million per year in 1995 and remain at that peak through the year 2050.

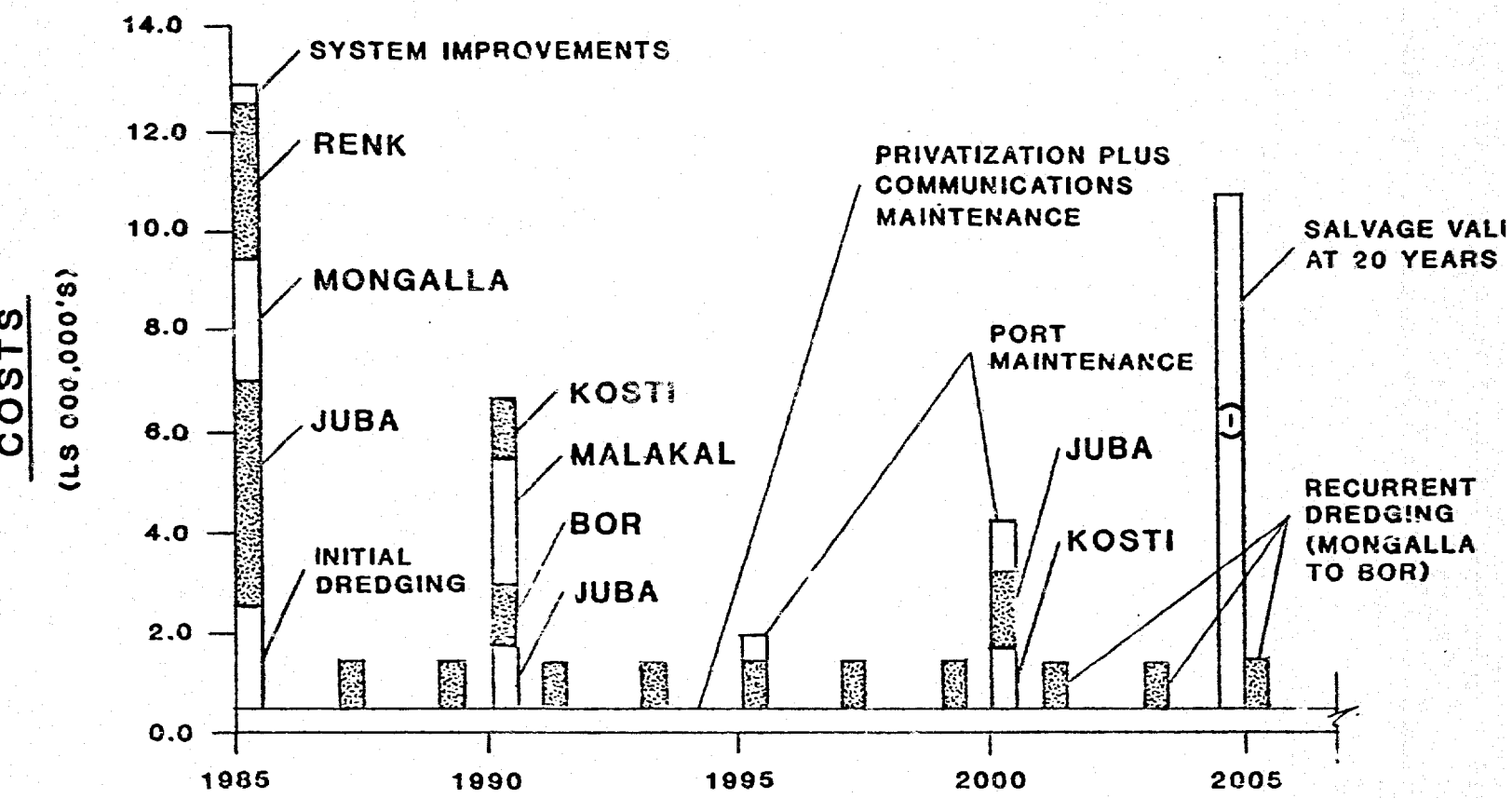
FEASIBILITY ANALYSIS

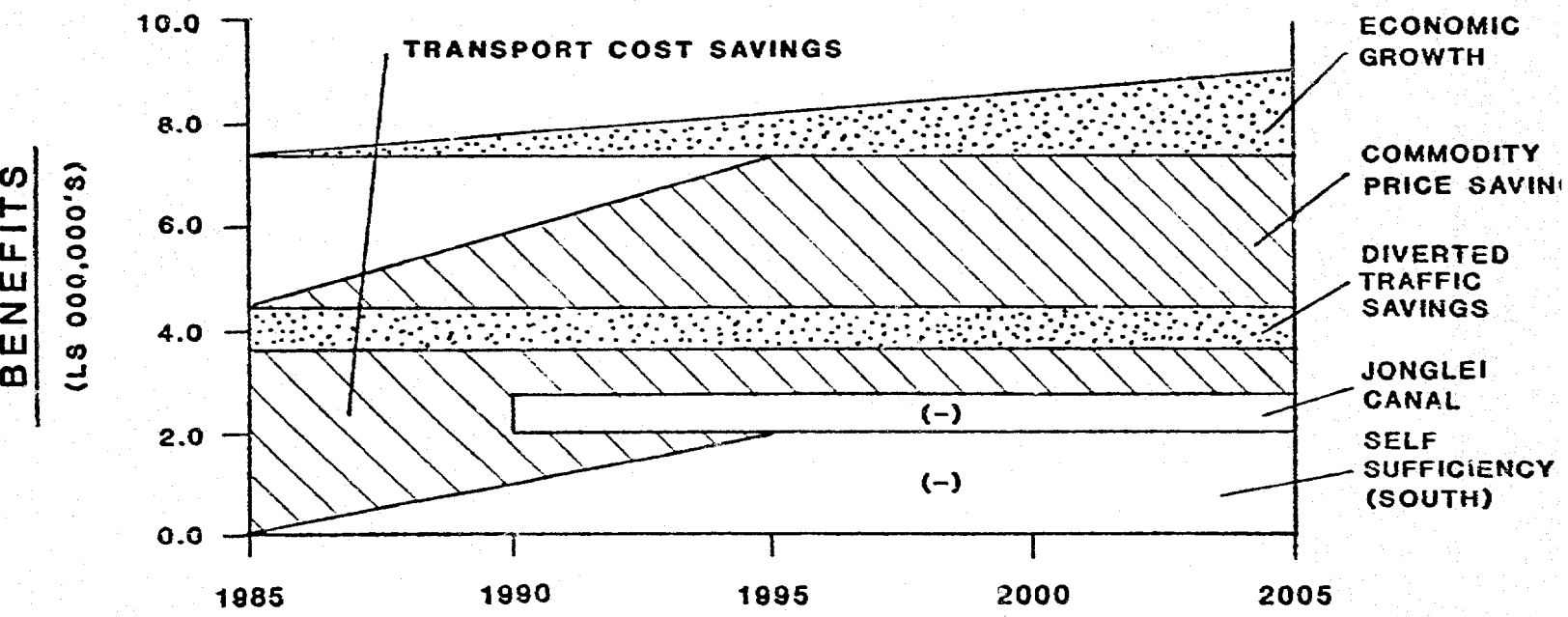
The costs from Table II-1 and benefits from the previous discussion are displayed graphically in Figure VII-A. These costs and benefits are used to calculate the present worths and the internal rate of return for the program.

The basis for these calculations include the following:

- -- No inflation was taken into account as no differential rate of inflation is foreseen for costs versus benefits
- -- A 20-year period is used with salvage values prorated according to total facility life
- -- A 10% interest rate is used

PROGRAM COSTS AND BENEFITS OVER TIME





The results of these calculations, for the overall program of system improvements, are:

Present Worth of	Benefits	= LS 36.6 mill.
	Costs	= LS 26.6 mill.
	Benefits - Costs	= LS 8.0 mill.
	Internal Rate of Return	= 24.9%

Key aspects of the data in Figure VII - A are that:

- o Relatively minor administrative/organizational costs can generate major transport cost savings at present rates. However, if rates are doubled, as proposed by RTC, the potential savings will be reduced by 50%.

- o The levels of transport cost savings plus unofficial market price savings are so great that they must be seriously impeding growth in the south. Economic growth rates in VII - A might double if they were removed.

SENSITIVITY ANALYSIS

The feasibility analysis above is sensitive to a number of analytical estimates as well as to issues such as

-- the potential loss of employment by RTC which, if it occurred, could be taken as a disbenefit to the project

-- the potential imposition of user fees which could seriously impact or negate the financial feasibility of the project, and

-- alternative privatization schemes which could negate most or all of the benefits and as a consequence, negate the economic feasibility analysis above.

They are discussed below starting with analytical estimates.

Generally, both costs and benefits have been estimated in such a way as to result in a conservative feasibility analysis. For example, a 15% contingency was added to the first year costs which lowered the IRR from 23.5 to the 21.0% shown earlier. In addition, only a few major types of benefits were included in the calculations, and some benefits partly attributable to river system improvements were left out. Examples of potential partial benefits not included were listed in Program Benefits above and others excluded are: minor benefits from the future export of other than dura from the Juba area to down river ports; benefits from increased trade between Juba and Kenya, Uganda or Zaire; the benefits from a well-run river passenger service; and inventory time savings.

Given these cautiously compiled costs and benefits, the feasibility of the improvement program is only sensitive to major assumptions such as the removal of all transport cost savings or the doubling of initial capital costs. The program feasibility is not particularly sensitive to items such as the addition of another unit port, the reduction of tonnage forecasts by 10,000 tons or the loss of benefits from Juba exports. The program feasibility is, however, sensitive to the following central issue.

DISPOSITION OF RTC EMPLOYMENT

Under any scheme for improving RTC cargo operations or for privatization of cargo operations, a significant percentage of the current RTC staff will be essential. These employees are the river pilots, tug and barge crews, maintenance facility staff, and administrative personnel necessary for efficient operations. However, the proposed transport operating models in Chapter V, Table V-5, are based on a significantly reduced staff, and, theoretically speaking, the feasibility analysis for the proposed program of improvements would have to include lost cargo-related jobs as a dis-benefit to the program.

The question is, "Should the reduction in redundant* employment be included in the feasibility analysis?" If the answer is no, the feasibility remains as calculated earlier. If yes, the reduction in benefits is estimated to be 5,000 employees at an average salary of LS 2,000 per year totalling LS 10,000,000 per year. With this disbenefit added to the proposed program, the costs will exceed benefits and the IRR, while not calculated, would be negative.

In any event, another alternative must be considered. That is the disposition of the rest of the RTC fleet and, in particular, the disposition of the passenger fleet. The basic considerations are:

1. Passenger travel, reflected earlier in Table VI-2 for Juba to Kosti, has been about ten times as high as it is now -- that is, there is a very large latent demand for passenger services.

2. RTC has a fleet of Belgian and traditional craft, which if repaired could meet at least part of the current and latent demand.

3. Passenger serives by an improved RTC or by a private organization could probably be highly profitable** and would be much more labor intensive than the cargo service improvements dealth with in this project.

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*If efficient, productively employed staff were displaced by the proposed program, there would be no question about those losses being included as disbenefits.

**The scope of this project deals with agricultural marketing and cargo considerations, not with passenger transport. Thus the profitability of improved passenger service has not been analyzed.

As a consequence of these considerations, the question of the disposition of RTC employment is dealth with in the following manner:

The lost employment related to cargo operations is not counted as a disbenefit to the feasibility analysis because:

-- it is a redundant, not productively employed labor pool, and

-- it could be assigned to a massively improved passenger operation by RTC* or by private operators.

USER FEES

The financial feasibility of the proposed system improvement program is sensitive to the type and extent of user fees assigned to the proposed privatized operations. (See also the discussions in the following Chapter VIII regarding user fess) Also, this financial feasibility will have significant economic implications in that both current and newly developing activities in the south could be severely affected by high user fees. For example, if the present worth of program costs (LS 26.6 million from "Feasibility Analysis" above) were recovered over a 20 year period at 10%, LS 3.13 million per year would be allocated to users, carriers, port operators or tonnages. If allocated to the almost 100,000 tons carried in 1981/82, about LS 30/ton would be required. This level of user charge could have an intolerable effect on the market price of all low value commodities such as sugar, dura, salt, timber products or cattle. In fact it would add 50% to the cost of one head of cattle or LS 10 to the cost of a cubic meter of timber. Such charges could make the delivered price of some commodities simply non-competitive.

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*It is the consultant's understanding that RTC does not want to operate this service.

Further, this size of charge could also result in mode shifts (from water to truck) for some shorter distance movements, a highly undesirable effect from the standpoints of potential energy efficiency and foreign exchange losses. Thus, user fees should be set only after a consideration of:

- o indirect as well as direct beneficiaries
- o user charges on competing modes of transport, and
- o government policy regarding supports (or lack thereof) to developing economic activities.

PRIVATIZATION ALTERNATIVES AND IMPLEMENTATION

The economic feasibility of the proposed river transport improvement program can be very sensitive to the type of or approach to privatization. For example, if a single, government controlled monopoly is selected to replace the RTC monopoly, it is unlikely that rates charged by the new monopoly would support 1) the generation of user savings calculated earlier, or 2) provide low cost transport support to expanded or new economic activities in the south. Similarly, the lack of reliable and frequently scheduled service to the south could have serious effects on the marketing of live cattle from the south; dura and petroleum prices in the south, etc. Thus, the means of and techniques for implementing the competitive leasing scheme should be made with constant attention to the effects of privatization methods on existing services throughout the transition period.

On a preliminary basis, privatization directions that are <u>most</u> likely to support the above feasibility calculations are:

- o A return to former (1960's) service and efficiency levels by the RTC -- based on recent experience this does not appear promising.

- o Rental of the new fleet to prospective carriers on a wet-lease* basis -- recent experience with Chevron and others does not appear promising.

- o Competitive sale or leasing of new fleet where merchants in the south or in Renk are major participants either on their own or as joint ventures with logistics firms -- an untried solution.

Privatization directions that are least likely to support the feasibility analyses are:

- o Continuing monopolistic RTC policies and operations

- o Setting up a private monopoly under MOT control (judged to be no better than RTC).

The issue is discussed in more detail in Chapter VIII.

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*With RTC operating personnel

VIII. ADMINISTERING THE INLAND WATERWAY SYSTEM

OVERVIEW

Seeing the Nile River bisecting and running the entire length of Sudan naturally encourages visions of a water transport system of locks, dams, canals, dredging, navaids, ports, push tows and all those signs of vitality one sees on the great river systems of the world such as the Mississippi, the Rhine or the Yangtze. However, one should keep in mind that these systems serve highly developed hinterlands with an abundance of raw materials which are seeking markets at urban centers on the waterway or at connecting seaports.

This situation does not exist in Sudan and thus the administrative structure for developing the Nile as a navigable waterway should not exceed the inherent need or demand for water transport. One fully laden push tow making one round trip, St. Louis, MO - New Orleans, LA (in fourteen days), handles more ton-kilometers of freight than the entire White Nile fleet presently handles in one year. Obviously the administrative structures required are substantially different. An over-sized or over enthusiastic regulatory and administrative structure for the Nile runs the risk of stifling development as well as wasting resources. Thus, the structure must be broad enough to cover the essential items but thin enough to not cause mischief and waste resources. Overregulation can kill privatization just as redundancy and inefficiency have apparently caused a loss of confidence in the RTC.

ESSENTIAL PUBLIC SECTOR FUNCTIONS

The best starting point for organizational structure is to define the main public sector functions required to manage a navigable waterway system. Table VIII.1 provides this along with a description of who performs these functions in the United States. Further explanation of these functions and the applicability to the White Nile are described below.

Table VIII.1

PUBLIC SECTOR RESPONSIBILITIES FOR WATERWAY MANAGEMENT BY FUNCTION WITH UNITED STATES EXAMPLE

Functional Area Function Performed	Responsible Agency in United States	Remarks
THE RIVER		
Hydrologic Monitoring	U.S. Geological Survey	Also Corps of Engineers
Surveys, Depths, Charts	U.S.Corps of Engineers	
Channel Study & Design	U.S.Corps of Engineers	
Channel Dredging Supervision	U.S.Corps of Engineers	Dredging by private contractor
Bank & Channel Stabil.	U.S.Corps of Engineers	
Locks & Structures	U.S.Corps of Engineers	
NavAids	U.S.Coast Guard	
Permit functions	U.S. Corps of Engineers	Coast Guard has bridges
THE PORTS		
Wharf Structures	Public Port Agencies	Single Product Ports are private
Backland and Buildings	Public Port Agencies	Single Product Ports are private
Cargo Handling	_	Normally Private Sector
THE FLEET		
Vessel Operations	_	Private Sector
Documentation/Licensing Vessels	U.S. Coast Guard	
Vessel Safety Rules	U.S. Coast Guard	
Personnel Licensing	U.S. Coast Guard	
Trade Route Approval	_	Generally Unregulated
Ship Repair Facilities	_	Private

Source: Ogden Beeman and Associates

THE RIVER

The river provides the "highway" for water transport. Thus, the development and exploitation of river navigation is a public sector transport function similar to, and competitive with, highways or other transport modes. The public responsibility for this function in the United States is generally done by the U.S. Army, Corps of Engineers (Corps). (Historically, this function was assigned to the Army because the main source of engineering talent was the U.S. Military Academy. Present staffing of this function is nearly 100% civilian.) For inland waterway development, the Corps works by geographic district offices which might oversee, for example, 1000 kilometers of navigable waterways. For a navigable waterway, the annual series of events might be such:

- After high water, surveying to define channel condition in the shallow areas.
- Preparation of contract documents and supervision of dredging work.
- Ongoing channel design and engineering effort to deepen channels, alter alignment, provide bank or channel stabilization or other efforts to improve navigation or reduce costs.
- Design, construct and operate locks for use of inland navigation.
- Issue permits for structures, pipelines, fills, etc., which might affect or interfere with navigation.

Other agency participation is limited to the following:

- Hydrologic and hydraulic gaging and monitoring by the U.S. Geological Survey for use by navigation and other interests including hydro power, irrigation, etc.
- Navigation Aids are provided by the U.S. Coast Guard after coordination with Corps of Engineers and river operators.

At the present level of river transport in Sudan, it is hard to justify much of a management structure to look after the above items. In fact, unless significant growth in traffic and activity is anticipated, the function could essentially be ignored unless the Mongalla to Juba channel was to be dredged on a recurrent basis. Based on a steady growth in river usage and a desire by the G.O.S. to improve the transport infrastructure, the organization shown in Table VIII.2 could be formed. This group could be started with as few as three people and expanded to the number shown as the waterway traffic increased and channel improvement was warranted. This group, for example, would be able to undertake the work generally described in Chapter 3 for the improvement of the reach from Terakeka to Juba as well as begin planning for the Jonglei Canal opening, getting a base set of aerial maps and otherwise assisting private sector river operators.

Table VIII.2
RIVER MANAGEMENT SECTION
PERSONNEL REQUIREMENTS

Function	No.	Skills
Chief	1*	Civil Engineer
Studies, Planning and Permits	1*	Civil Engineer
Surveys, Records and Navaids	2*	Surveyor or Civil Engineer Reis or Tug Engineer
Design, Plans and Specifications	2	Hydraulic Engineer Draftsman
Contracting	1	Contract/Finance Specialist

Source: Ogden Beeman and Associates

*Three people for minimum staffing.

THE PORTS

In the United States the port agencies are independent or quasi-independent agencies authorized and formed under either state or municipal law. Since ports serve a local area, and their development should be responsive to

local needs and aspirations, the justification for national development and control is questionable. In some remote areas of the United States (i.e. Alaska) port facilities are subsidized to provide "minimum" service levels relating to health, safety and human needs. However, most port agencies attempt to break even or make a return on investment from charges generally levied against the vessel and the cargo. Single user or single commodity ports on inland waterways (e.g. coal, grain in bulk, petroleum, chemicals in bulk) are normally privately owned and are considered one link in the commodity transport chain and are not seen as public sector responsibilities.

The decision of how to handle port development and administration in Sudan is more a matter of political preference than selection of the "correct" method. Since privatization will bring about multiple operators (potentially on medium term leases), it is not realistic to think of operator-provided port facilities other than nature's own river bank. G.O.S. responsibility might be warranted if one considers the port an extension of the river "highway". Facility development by merchants or truckers could lead to redundency and overdevelopment. Where local administrative structure has the capability, encouragement of local control (perhaps backed by G.O.S. financing) provides a nice blend of national development and local control with the pressures to serve the local region. All things being equal, we would advocate local control if the locals can do it and it fits with G.O.S. political philosophy.

In any event, all cargo handling should be done by the private sector. Theat leaves the development and operation of perhaps a wharf, backland and warehouse or two as the issues to be dealt with. Table VIII.3 shows an organization structure suitable for either G.O.S. development and operation or shared with local government. The central staff would provide development services for all ports including design, construction supervision and supervision of maintenance. At each port with more than, for example, 20,000 tons per year, and a developed infrastructure, there would be a manager who would assign berths and space, keep records and prepare invoices for user fee payments. As noted, this person could be an agent of local government or the G.O.S. depending on political or social factors beyond the scope of this study.

Table VIII.3

PORT DEVELOPMENT SECTION

Function	No.	Skills
Central Staff		
Chief	1	Civil Engineer
Studies and Planning	1	Engineer or Planner
Structures	1	Structural Engineer
Utilities	1	Electrical/Mechanical Egr.
Inspector	1	Construction Specialist
Field Staff		
Port Manager	1	Management or Administrative
Port Clerk	1	Administrative
Security Staff	-	As required

Source: Ogden Beeman and Associates

THE FLEET

Privatization as described in Chapter 5 will eliminate many administrative and regulating requirements because the emphasis will be shifted from the regulatory arena to competitive equipment rental contracts. Nevertheless, there is a minimum amount of regulatory work to be done to protect the useability of the waterway and the safety of structures and vessels on the waterway. (This becomes of greater interest with the opening of the Jonglei canal, as noted in Chapter 3.) Based on the assumption that the total private sector fleets will be in the range of 6 to 12 tugs and up to around 50 barges, the organization shown in Table III.4 should be adequate for regulatory and administrative functions.

Table VIII.4

VESSEL REGULATION SECTION

Function	No.	Skills
Chief	1	Naval Architect or Marine Engineer
Vessel Documentation/Licensing	1	Naval Architect of Marine Engineer
Operator Licensing	1	Inland Waterway Vessel Operations

Source: Ogden Beeman and Associates

The main function of the section will be to document the ownership of the fleet so the G.O.S. knows what is operating in-country and can expedite such matters as fuel and currency allocations under the privatization scheme presented in Chapter 5. Documentation is also useful as proof of ownership and for use in financing and insuring vessels.

There is no need for a separate set of rules regarding vessel construction or safety. A simpler and more efficient method would be for on and off hire surveys by an independent surveyor with recommendations on required safety features. Insurance carriers will normally require this anyway.

The operator licensing will become more important with the Jonglei canal and increased traffic. Initially the main criteria for licensing will be related experience plus some oral testing on rules of the road from the Nile Steamer Manual. U.S. Coast Guard forms 1258 (Documentation) and 866 (License Application) with requirement for one type of license are shown in Appendix 5. Given the situation in Sudan and the present volume of waterway traffic, it is hard to justify higher levels of regulation and administration which might threaten the benefits of privatization.

Clearly the experience at RTC mandates that the public sector not be in the repair or building business except on a competitive basis. However, no single operator could afford to build a lift or keep it occupied up to capacity. The solution is for the RTC (or other G.O.S. agency) to make an

appropriate number of drydocks or lifts available to the operators, on a scheduled basis. It is suggested that the system be modeled after the Swan Island Ship Yard of the Port of Portland, Oregon. In that case the Port (public sector agency) owns the drydocks and cranes. The vessel operator books the use of the required equipment and supplies his own forces or contractor forces to accomplish needed repairs. The most appropriate way for this to take place would be for the RTC to publish a tariff for usage including certain penalties for prolonged usage. The number of drydocks or lifts required could be estimated based on the fleet size. For example, if eight tugs were on dock (or lift) two weeks per year and sixteen (one half of the fleet) barges were on one week per year, it would amount to 32 weeks or about 62% occupancy per year. This would suggest that one tug/barge lift would provide suitable capacity in the early years of privatization.

IMPLEMENTING ADMINISTRATIVE PROCEDURES

The functions, responsibilities and assignments described above have already been assigned to the Department of Inland River Navigtion in the Ministry of Transport. Assignment of these public sector functions to this Ministry is appropriate as it places navigation development in its rightful place along with other modes of transportation. The new department is now being staffed and the general approach to staffing (as described to this consultant) was to keep it at a minimal level which is consistent with consultant recommendations as stated above. It is timely to form this department at this time so it can take on the river and port improvements described herein, as well as institute certain vessel and personnel licensing proceedures which will be appropriate under privatization as described in Chapter 5.

Most of the skills required for the new department exist in country although it is reported that the Universities do not offer naval architecture/ marine engineering studies. These areas can be filled by mechanical engineers or ship/tug engineers supplemented by foreign experts (if needed) as the department gets underway in the next year. We would suggest a six months to one year time period to form the Department, write out proceedures, establish forms and become fully operational.

Opportunities for foreign technical assistance and training are shown in Appendix 5.

CHARGING FOR SERVICES

The river system and its development will result in several different services being developed and performed by the public and private sectors. These services can be divided into several categories as described below.

SERVICES FULLY COMPENSATED BY CHARGES

There are two areas where charges should fully cover the cost of services and provide a profit to the provider. These are river transportation (under privatization) and cargo handling service. In both cases the service (transport and handling) are easy to define and measure, the user or beneficiary is specific and the basis for charges easy to measure. We would expect the free market system to set rates for these services under privatization of river transport and cargo handling activities.

SERVICES AND FACILITIES PARTLY SUBSIDIZED

The area of port facility development presents a somewhat more complex issue since required facilities cannot be brought on in small enough units to exactly match demand and often the national or local interest will encourage development of excess capacity to stimulate or be prepared for future growth. There are many approaches to charging the customer in such a situation. The charges should be simple enough to administer with minimum paperwork but thoughtful enough to encourage the correct response from the user. For example, complex tariffs with numerous commodity classes lead to arbitrary decisions and may cost more to administer than they earn in revenue. High charges for berth usage may result in barges being unloaded along the riverbank and facilities standing idle.

We would advocate a port tariff system structured as follows:

- For all ports with a developed wharf structure, each barge tying up at the wharf shall pay a fee per day of use. The basis of the fee could be the total annual cost of all wharf structures in the system divided by the total number of barge-days occupancy expected at full development. This would allow cost recovery but would not penalize the barges if overcapacity is provided as a matter of policy. This charge should be standard at all ports with wharf structures. If barge occupancy gets too high and it becomes desireable to speed turnaround, the second day rate could be made higher than the first day rate.

- For all ports with other facilities or staffing including those with a wharf, there should be a per ton charge on all cargo moving through the port. The charge could be derived by adding together the annual cost of facilities and management at all of the ports and dividing by an amount equal to the total tonnage expected to be moving at full development of the port system.

- For all vessels requiring documentation there should be a documentation fee based on the cost of the personnel time involved in concluding the documentation. For example, if there were LS 12,000/ year in salaries for a documentation officer and clerk, and 120 vessels (estimated) were to be documented, the documentation charge would be LS 100 per vessel.

FEES FOR THE USE OF THE RIVER

Fees for use of the river are much more complex to derive, levy or administer for two reasons. The users of the river are many and varied and the extent to which they take advantage of dredging, surveying, navaids or other management functions is hard to define. Secondly, other competing transportation modes are possibly subsidized in unknown ways so charging

fees for use of the river potentially establishes a modal penalty. Also, one could argue that improvement in the river will lead to higher bid prices for the lease of RTC equipment through providing a return to the G.O.S. for its investment in improving the river.

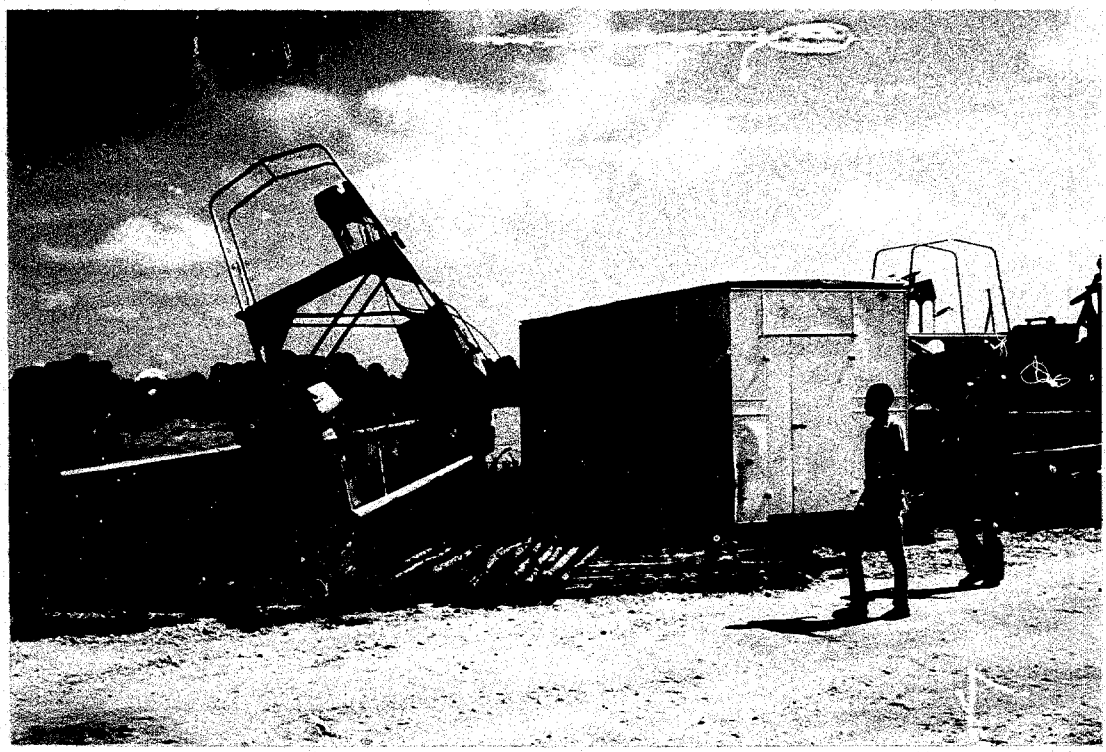
While we would not advocate user fees for the immediate future, such a fee could be calculated by taking the cost of improvements and management and dividing it by the number of tons of cargo expected to move on the river at full development. It should appear as a charge against the cargo, as moved, instead of against the tug or barge whose annual productivity is unknown and subject to market fluctuations. Such a fee, if levied, could be collected by the Ministry of Finance from the owner of the commodity, based on records of the privatized transport company. It could also be collected by the Department of Inland River Navigation in M.O.T.

The above discussion outlines a general approach to fee setting for the various services involved in river transportation. Further detail or derivation of fee levels is not appropriate at this time but should be performed after the civil works program and administrative charges are adopted and a more exact cost figure can be attached to the various components discussed. The use of technical advice or training may be appropriate and is briefly discussed in the appendix.

IX PHOTOGRAPHS

Juba Passenger Barges

Juba Port Warehouses

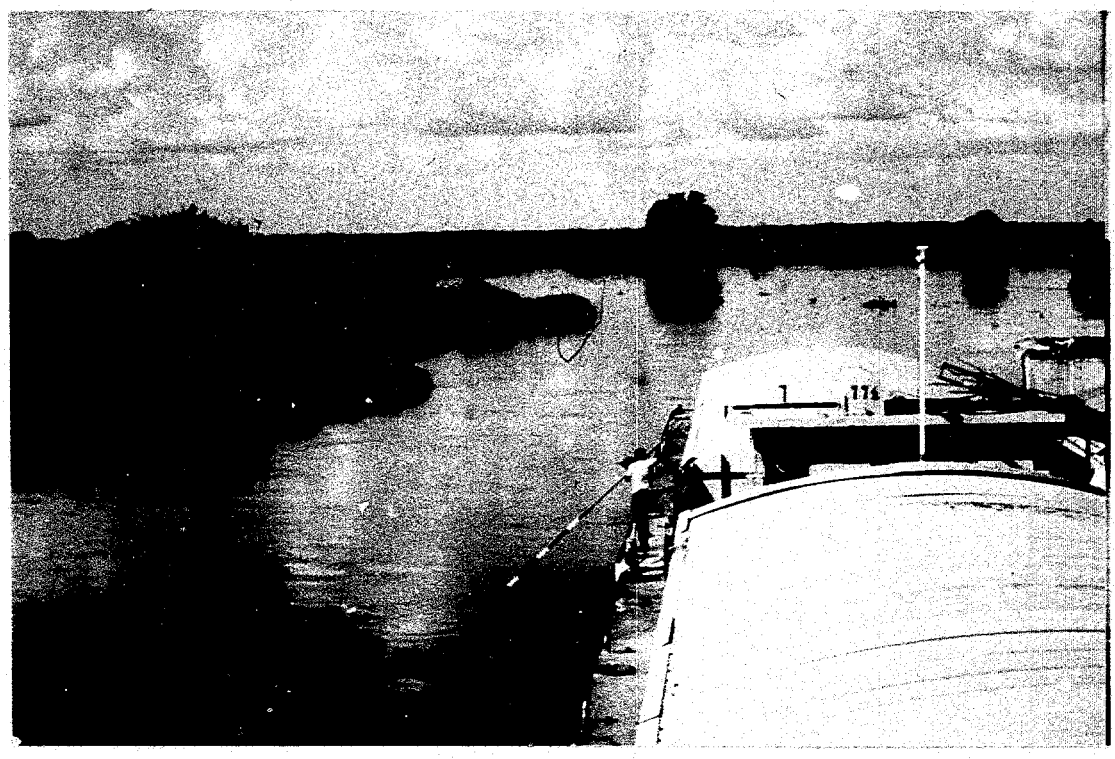


Juba Abandoned Derelicts on Waterfront

Juba Boat Yard and Ferro-cement Boats

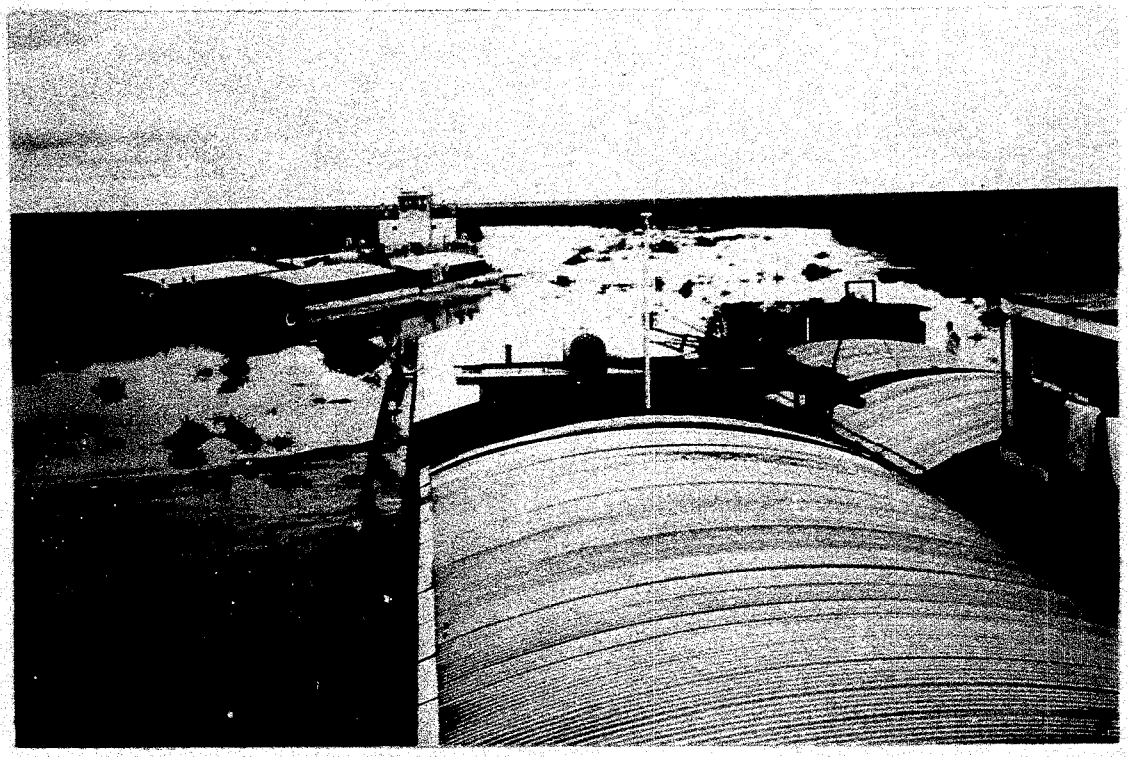
Mongalla Waterfront

Mongalla Unloading Flour from Barge

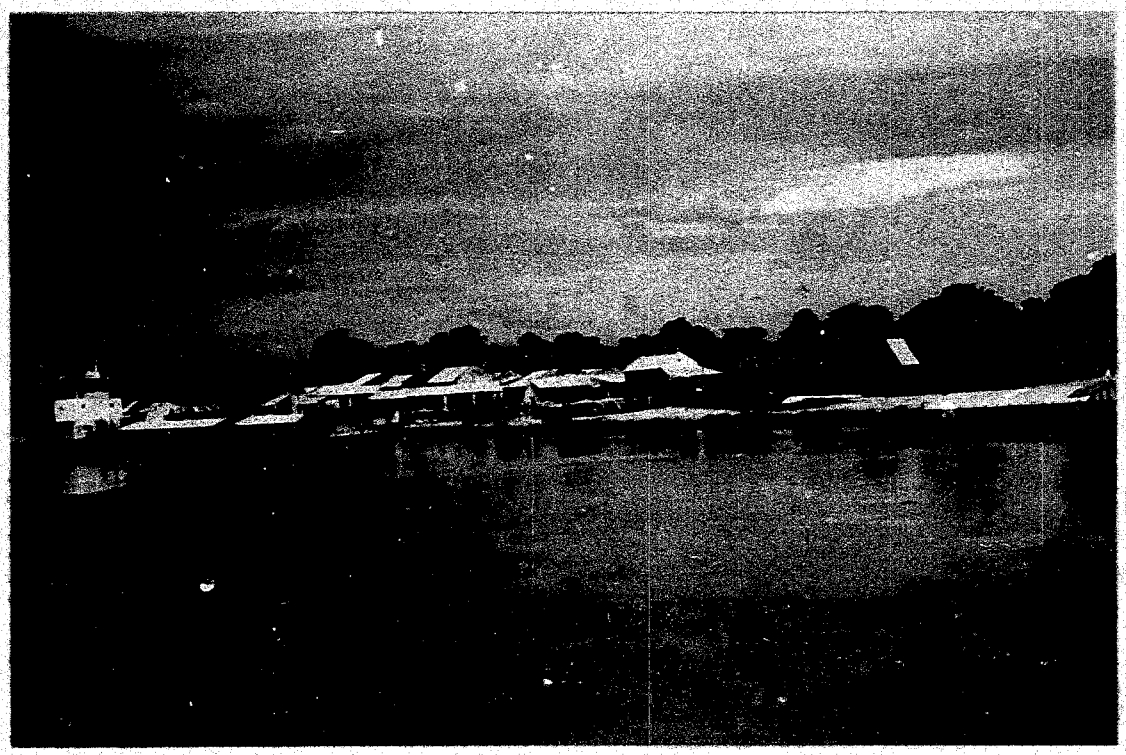


Mongalla/Terekaka River Gaging

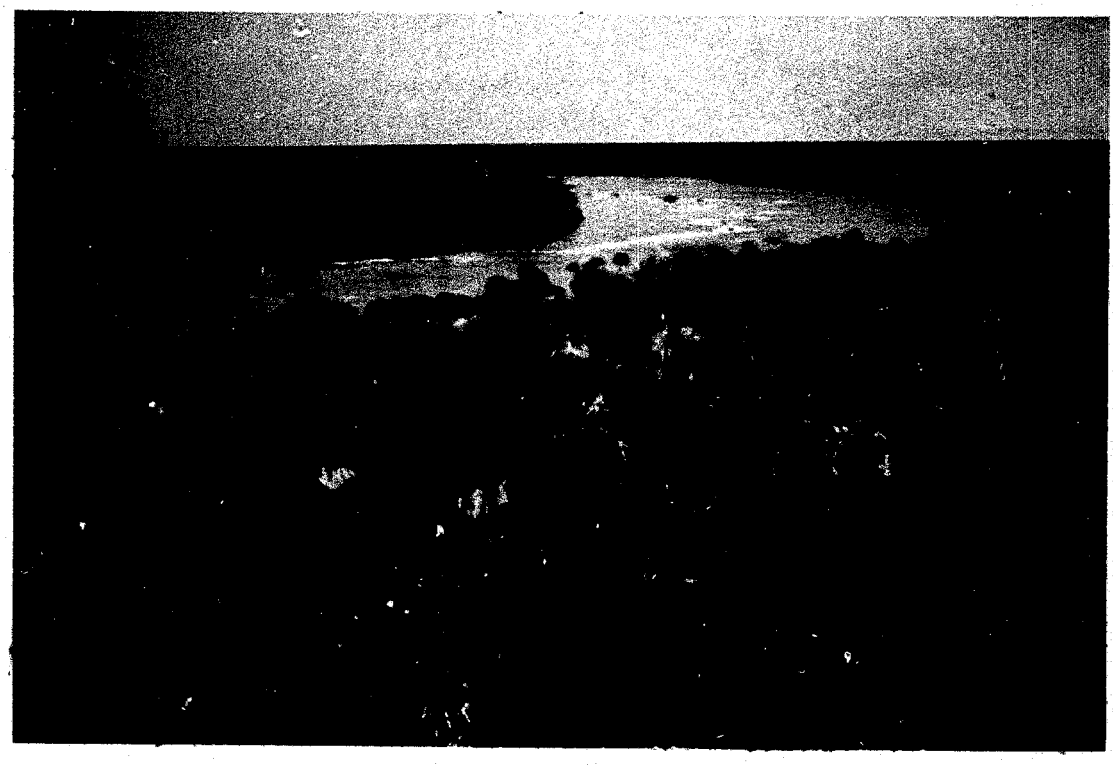
Terekaka Landing



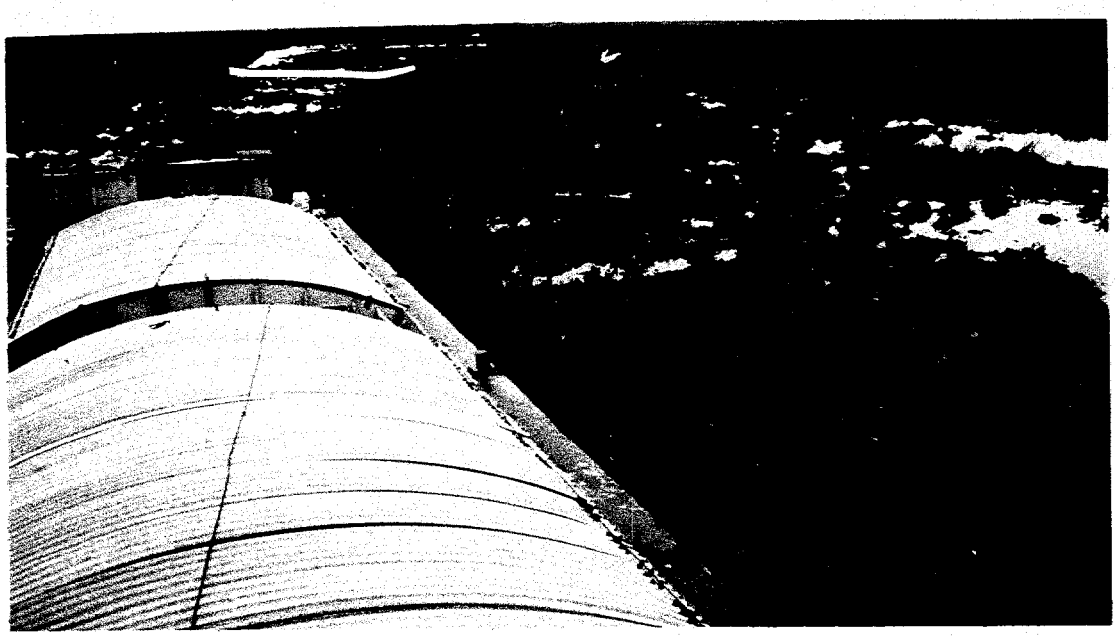
Tug Talbaldia and Four Barges South of Bor



Bor

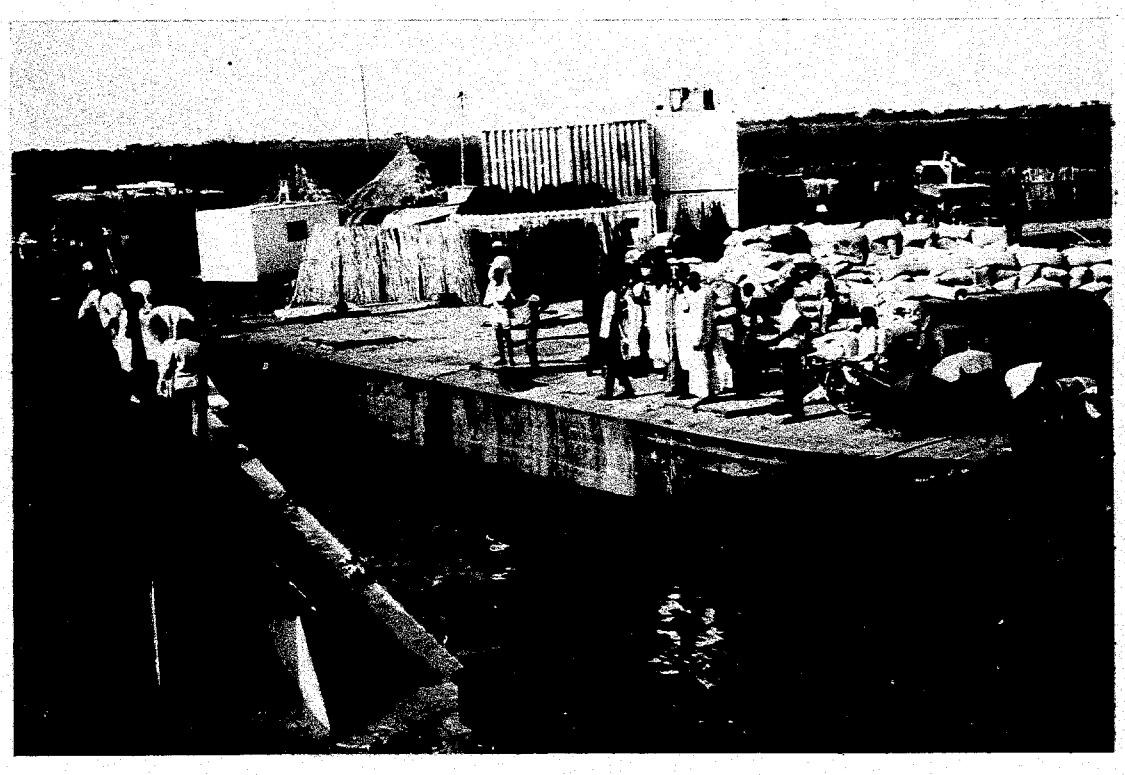


River Meander in the Sudd



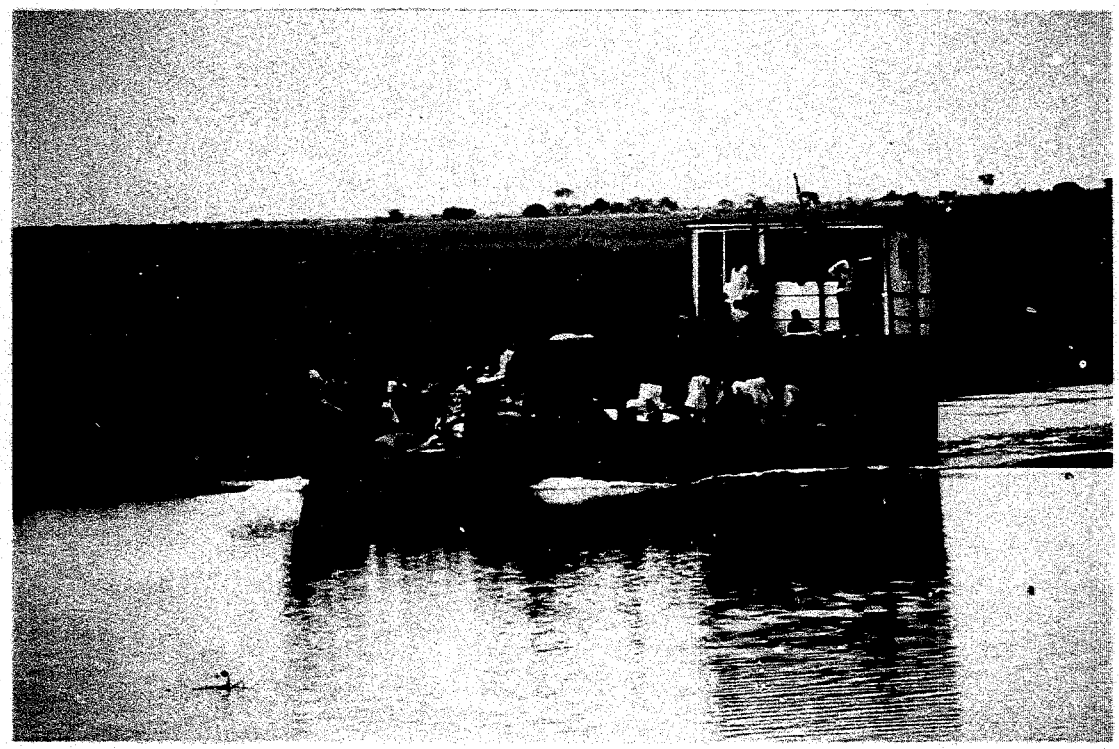
Water Hyacinths near Shambe

Shambe

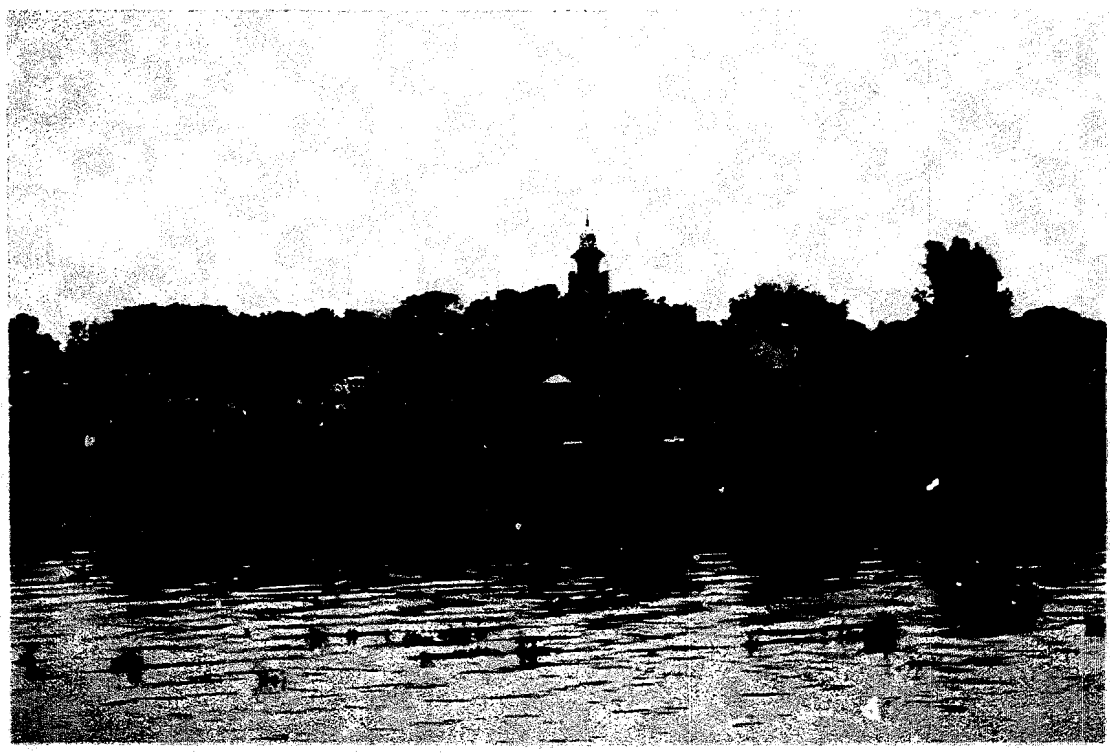


Adok with Chevron Equipment

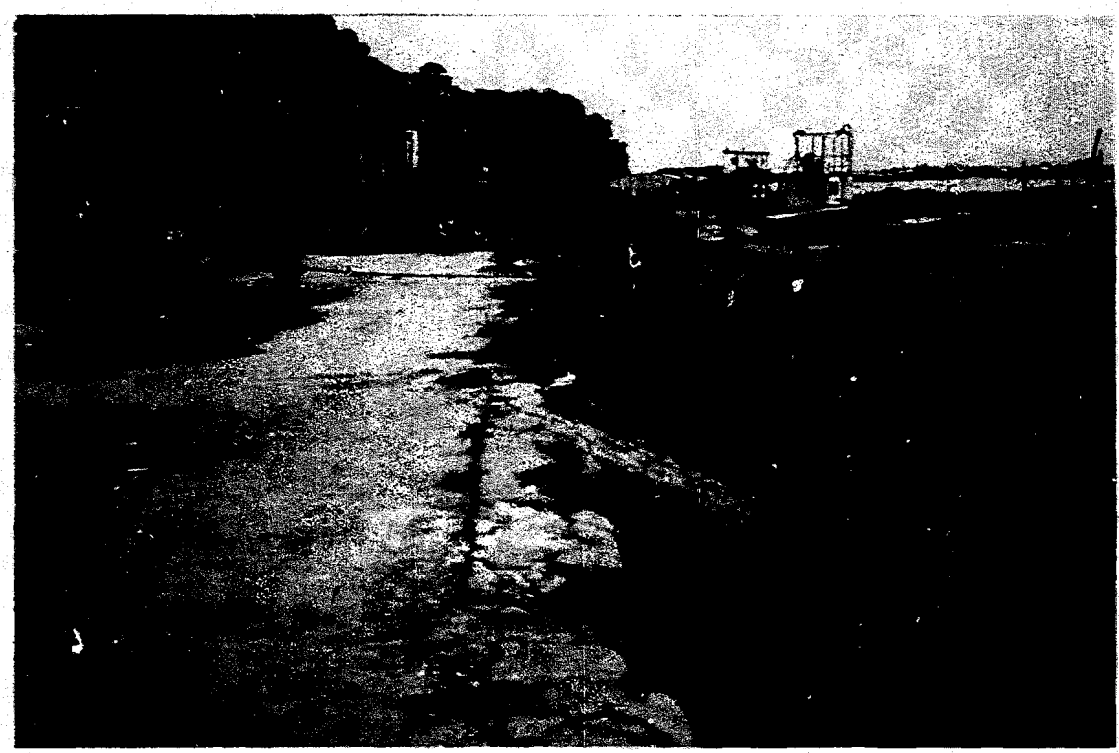
Tonga



Regional Government's Vessel (Converted LCM)

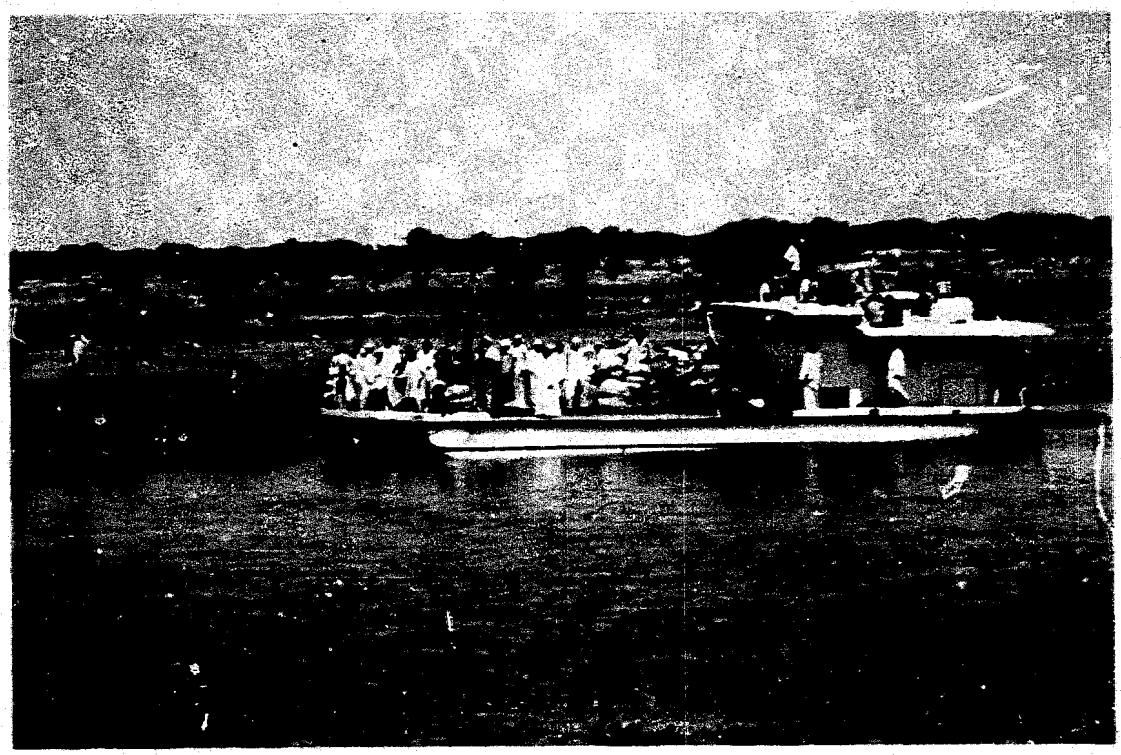


Malakal

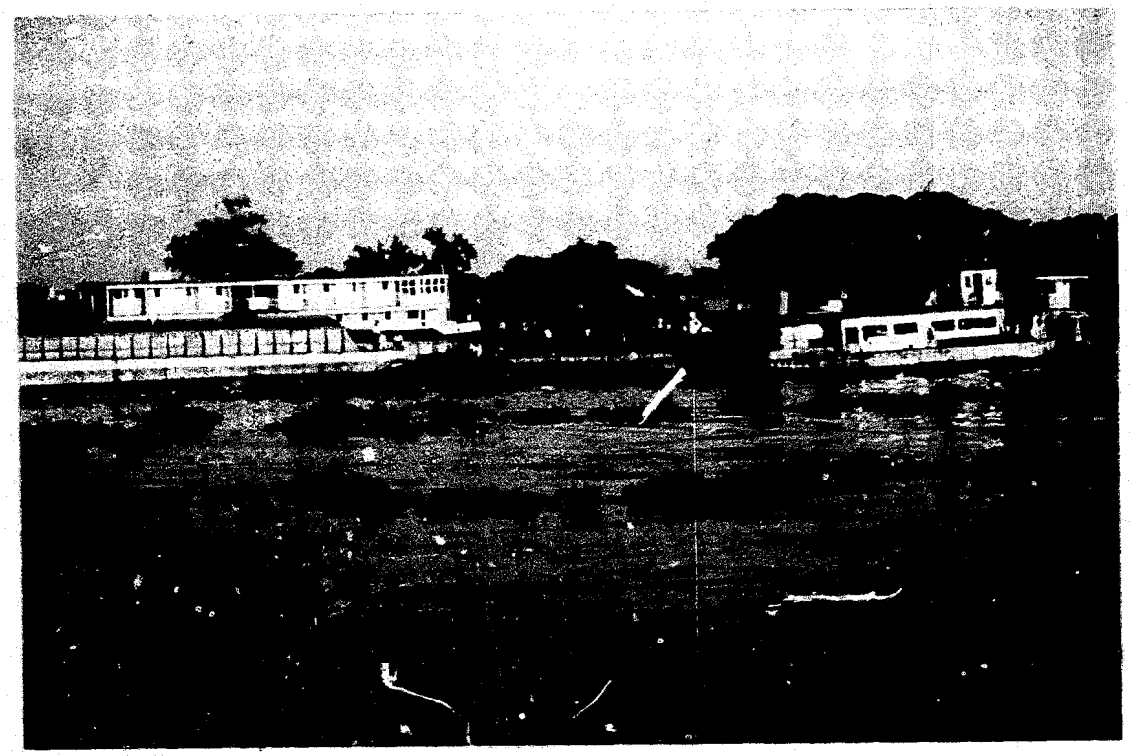


Warehouse and Mooring Barge at Malakal

Flour Stored on Ground at Wad Akona



Regional Government Vessel (Juba Boatyard Type)

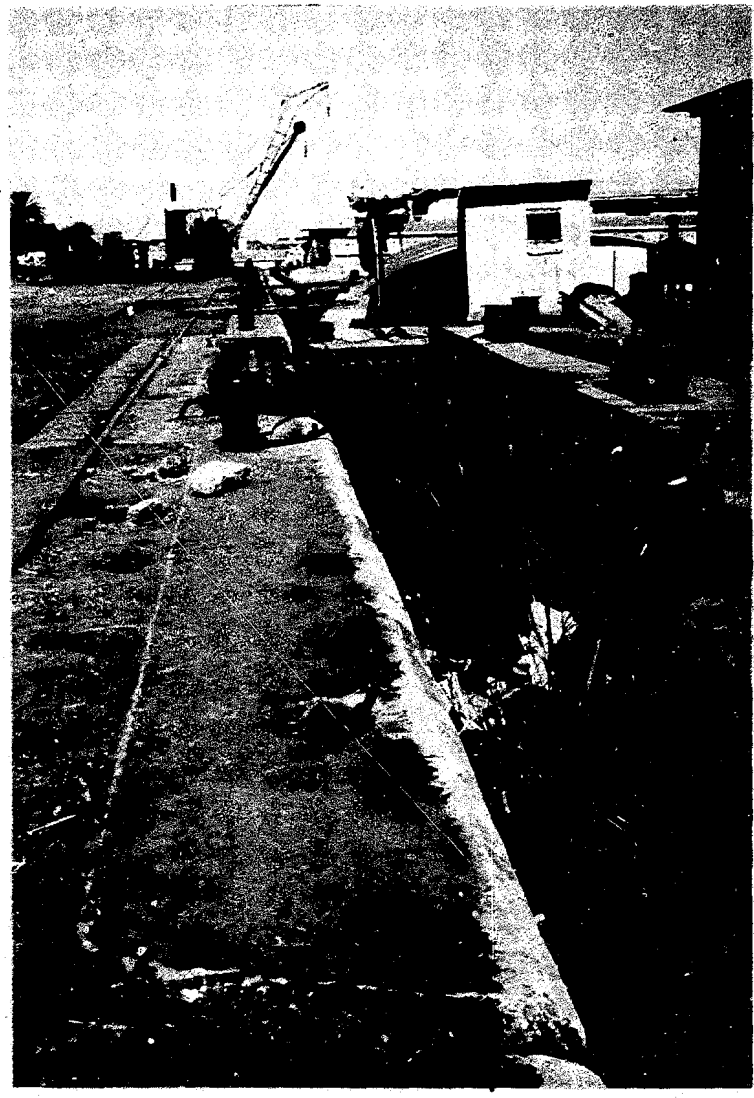


Renk

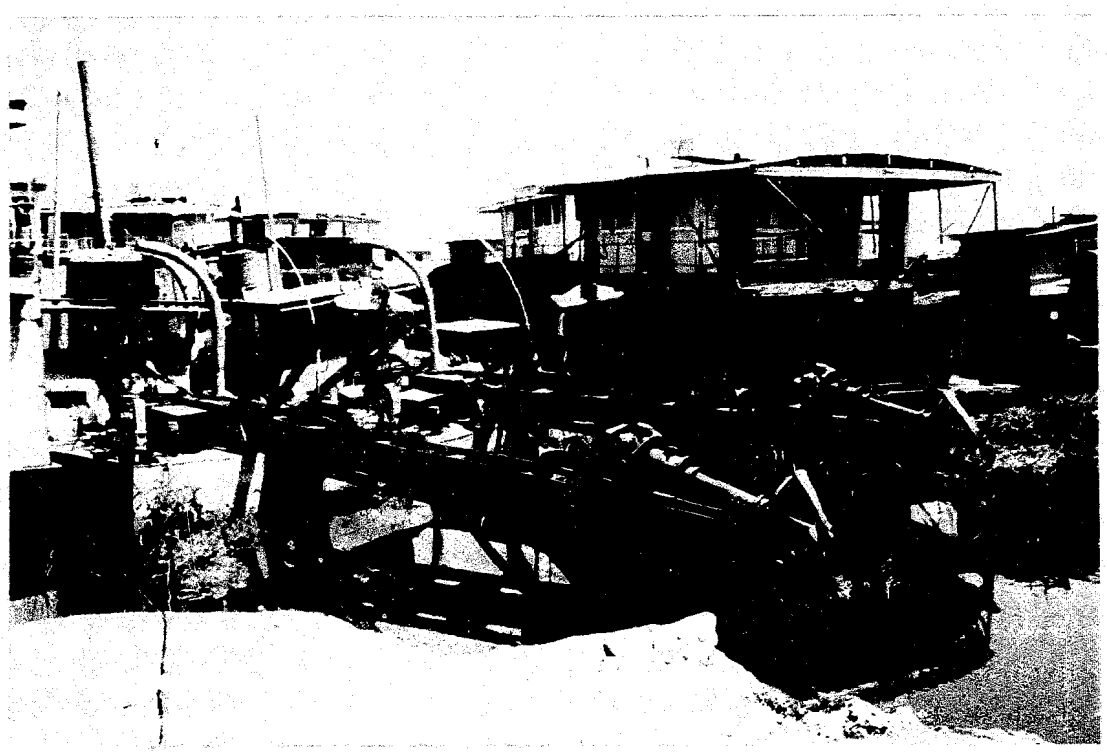
Renk with Displaced Bollard

Renk Waterfront Environment

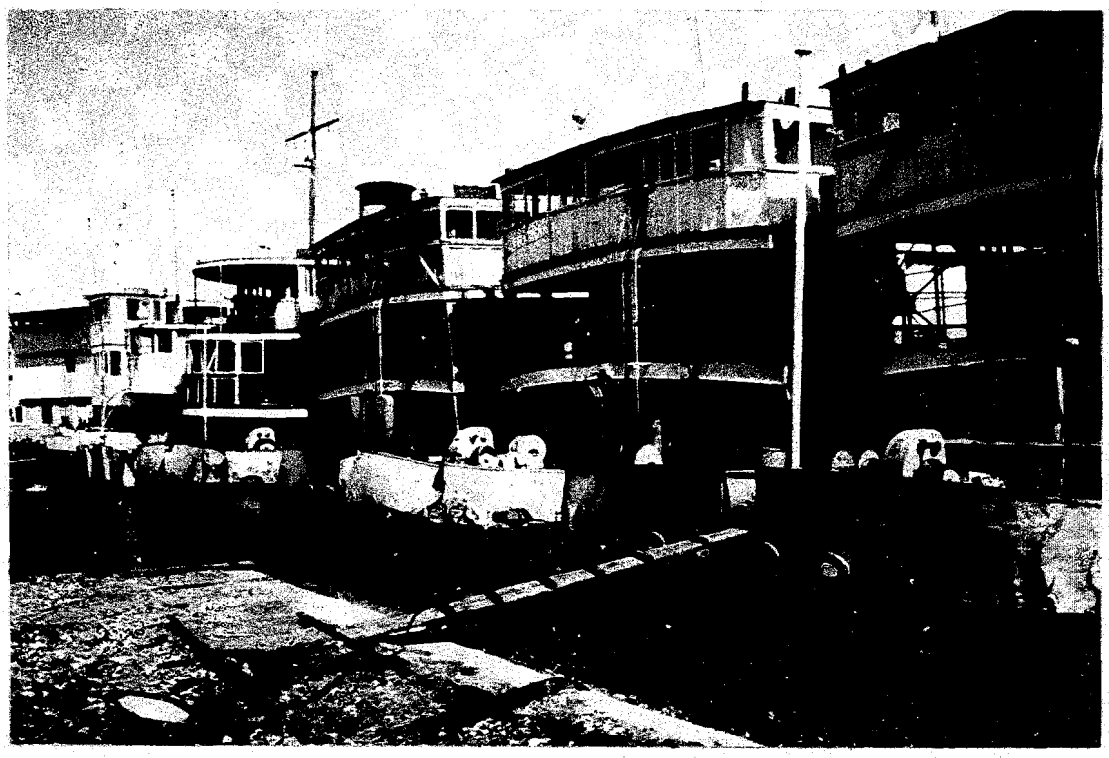
Kosti - New Transit Shed



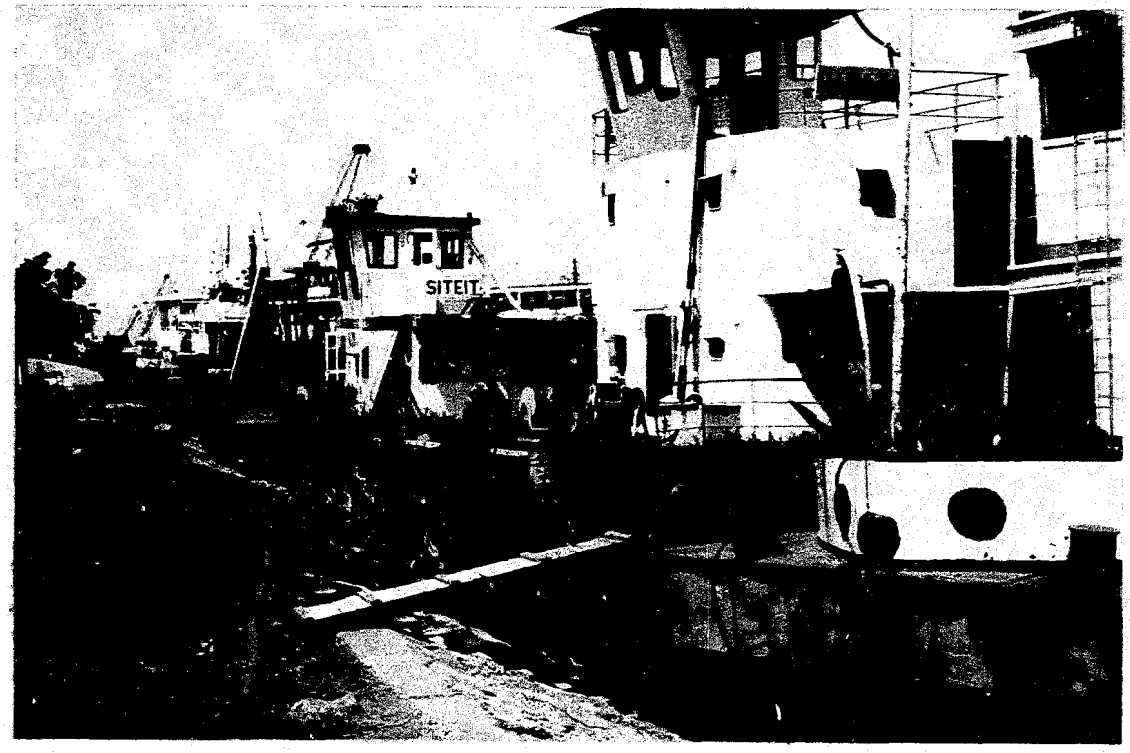
Kosti Waterfront



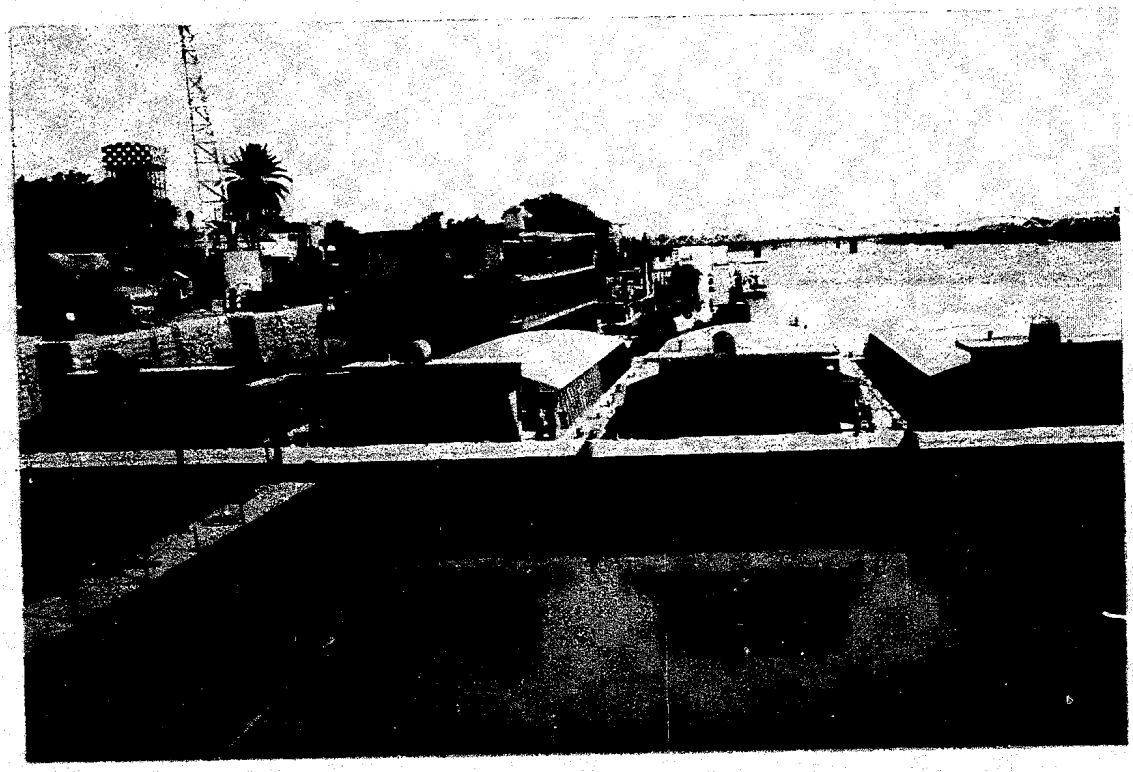
Kosti - Inoperative Hydraulic Dredges



Kosti - Inoperative Passenger Barges



Kosti - Inoperative Tugs



Khartoum North - New Barge Outfitting

Khartoum North - Drydock and Repair Yard

APPENDIX No. 1

THE RIVER

OGDEN BEEMAN & ASSOCIATES, INC.
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PORTLAND, OR 97204
(503) 223-8254

SHEET NO. ____ OF ____
CALCULATED BY GLH DATE 11/9/83
CHECKED BY ____ DATE ____
SCALE SOURCE - PERMANENT JOINT TECHNICAL

BAHR EL JEBEL

KILOMETERS FROM LAKE NO	SITE	WATER LEVEL AT 85% DRY YR	W. LEVEL AFTER JONGLEI OFFTAKE	MEAN BED LEVELS
132	SOBAT MOUTH	385.61	385.04	321.56
77	ZARAF MOUTH			380.90
64	TONGA	387.29	386.70	381.40
000	LAKE NO			
51	BUFFALO CAPE	390.76	389.91	385.92
222	HELET HEWER	397.18	396.28	392.70
298	ZARAF - CUT 2	400.01	399.61	395.03
421	SHAMBE	408.13	406.73	304.00
465	POLE 93	410.80	409.30	406.78
504	KENESA	411.38	409.45	406.00
534	POLE 104	412.50	410.40	410.00

THIS REACH IS NOT NAVIGABLE - NAVIGATION USES ATEM RIVER
— SEE ATEM RIVER BELOW —

584	POLE 114	420.00	419.20	415.84
628	BOR	422.90	421.75	417.40
648	MALEK	424.38	423.88	419.90

ATEM RIVER:

0	ATEM TAIL	404	409	410.40
38	WEST ATEM TAIL		413.25	414.00
45	JONGLEI 3	411.20	414.30	415.05
50	JONGLEI 4	410.00	414.65	415.40
119	ATEM BIFURCATION	414.00	419.20	420.00

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SHEET NO 1 OF 1
CALCULATED BY _____ DATE _____
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SCALE _____

Mean Monthly Discharges at Selected Sites in Million cubic Meters/Month

Loc.	Month												
	J	F	M	A	M	J	J	A	S	O	N	D	T
1	2150	1850	1970	2010	2480	2370	2610	3000	2960	2930	2600	2370	29300
2	45	47	43	38	35	28	37	62	95	113	56	34	634
3	1020	454	289	251	431	862	1290	1590	1770	1990	1980	1760	13700
4	2390	1680	1590	1490	1610	1980	2470	2890	3050	3370	3270	3120	28800

Source: White Nile Study, 1979

Note: Locations

1. Bahr El Jebel @ Mongalla 1912-1967
2. Bahr El Ghazal @ Ex. 7 1923-1940
3. Sobat @ Hillet Doleib 1912-1967
4. White Nile @ Malakal 1912-1967

Conversion: $10^6 \frac{\text{Cubic Meters}}{\text{Month}} \times \frac{35.3\ ft^3}{C.M.} \times \frac{1}{\frac{30\ \text{days}}{\text{Month}} \times \frac{24\ \text{hours}}{\text{Day}} \times 3600\ \frac{\text{sec}}{\text{hour}}}$

or $13.62 \times \frac{CM}{M}$ - cubic ft/sec

HYDROGRAPHIC SURVEY CAPABILITY — TYPICAL EQUIPMENT & MANNING

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Consulting in the development of ports waterways and marine facilities
DATE | SCALE | JOB NO.

EQUIPMENT LIST

- Vessels
  - 1 Large vessel, power & equipped for 3 man crew to live on board
  - 2 small craft (3 man) with 2-25 HP outboards
- Survey Instruments
  - 3 Fathometers with continuous analogue trace.
  - 1 micro-wave position fixing system (Ex. Del Norte Trisponder, Decca Trisponder, Motorola Mini-Ranger)
  - 1 Tellurometer distance measurement system
  - 3 Sextants
  - 1 Range finder
  - 2 Theodolite transits
  - 2 Stadia Rods
  - 2 Plane tables
  - 2 Three arm protractors
  - Sounding poles
  - lead line
  - Tag line on winch
  - Survey tapes of various lengths
  - Accessory drafting equipment

MANNING LIST

- Boat Crew
  - 1 Vessel Operator
  - 1 Assistant vessel Operator/deckhand
  - 1 Deckhand/Cook
- Survey Crew
  - 1 Party Chief
  - 2 Hydrographic Surveyors
  - 2 Survey Technicians

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SCALE

COST ESTIMATE - AERIAL PHOTO BOOK

This estimate is based on cost of Aerial Photography completed for Chevron - 1993.

Contractor: Air Surveys & Design
305 Spring Street
Herndon, Va. 22070

PHOTOGRAPHY: 5 sets contact prints @ 1"=1,000 scale
3 km min width

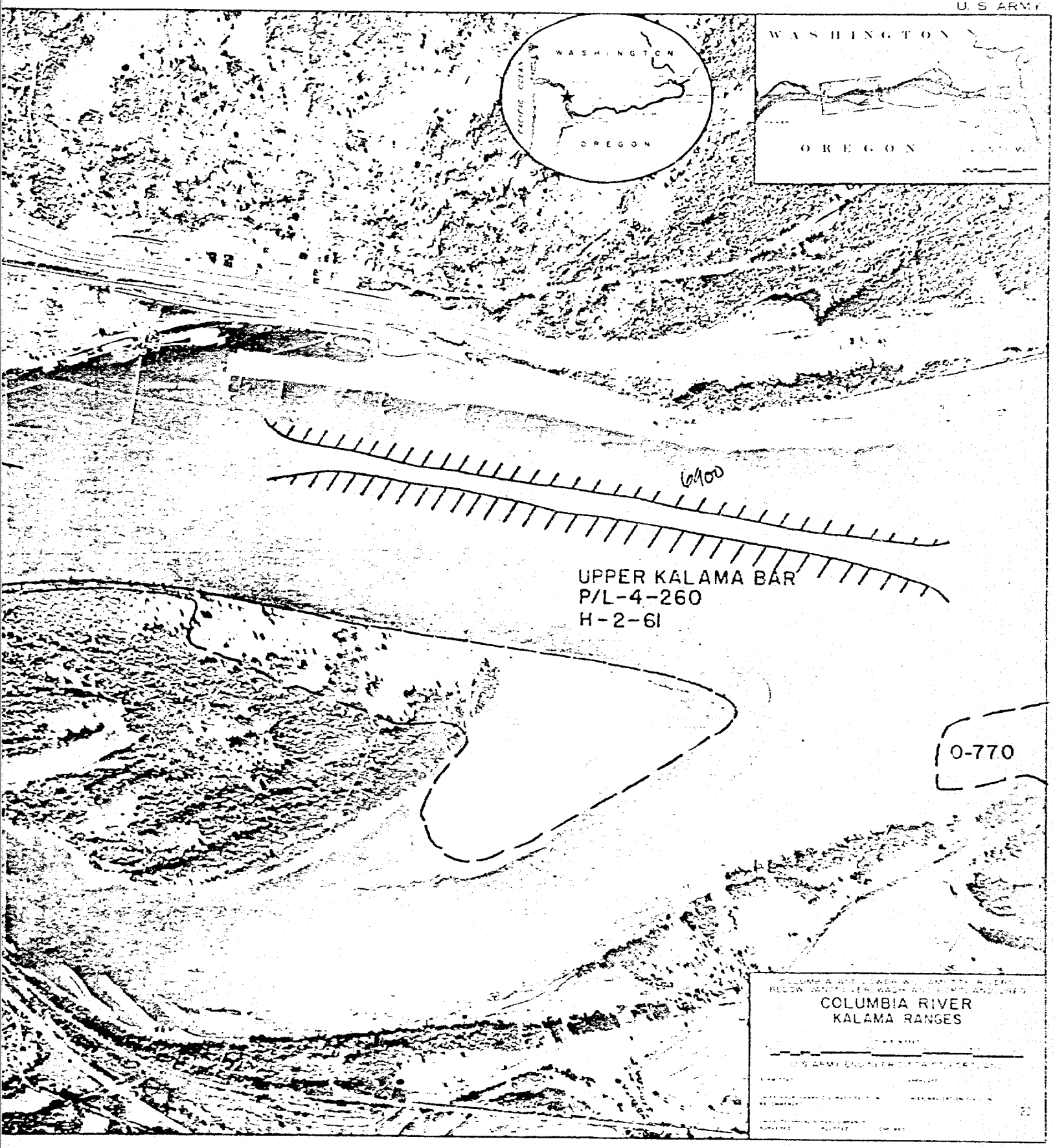
mob + demob	=	$10,000	
set up base	=	$20,000	
1450 km @ $80/km	=	$116,000	
		$146,000	$146,000

MAP BOOKS

Develop base information	=	$25000	
Prepare mosaics, reduce, print	=	35,000	
		60,000	$60,000

TOTAL = $206,000

U. S. ARMY


WASHINGTON
OREGON
PACIFIC OCEAN
WASHINGTON
OREGON
6400
UPPER KALAMA BAR
P/L-4-260
H-2-61
0-77.0
COLUMBIA RIVER
KALAMA RANGES

PORTLAND, OR 97204
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CALCULATED BY SGT DATE 10/20/83
CHECKED BY _____ DATE _____
SCALE _____

DREDGING VOLUME ESTIMATE - JUBA TO BOR

References: Study of River Transport in the Sudan
Final Report
July 1983

Channel water elevations: Juba = 12.68 m (454.67 m)
(Channel depth) Mongalla = 11.80 m (442.71 m)
Bor = 11.06 m (422.26 m)

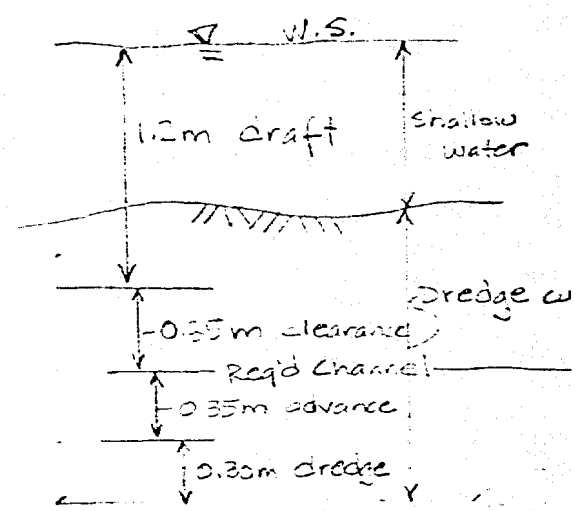
This is based on 15 yrs low water less 30 cm at Juba and 40 cm at Mongalla and Bor.

Use 0.35 m for advance maintenance, survey accuracy
use 0.35 m for vessel safety
use 0.30 m for capability of dredging equipment
1.00 m total beyond vessel draft

The dry season has shallow reaches < 1.2 m (draft of pusher tug)
Consider light load during dry season:

Cargo Barge	tons	draft	
	0	0.3 m	
	300	1.2 m	← use 300 tons @ 1.2 m
	500	1.8 m	

Total depth = 0.3 + 0.35 + 0.35 + 1.2
= 2.2 meters



Channel widths

Requirement for 2 way traffic not present. Establish one way channel at all shoal locations.

Overall tow width = 19 meters

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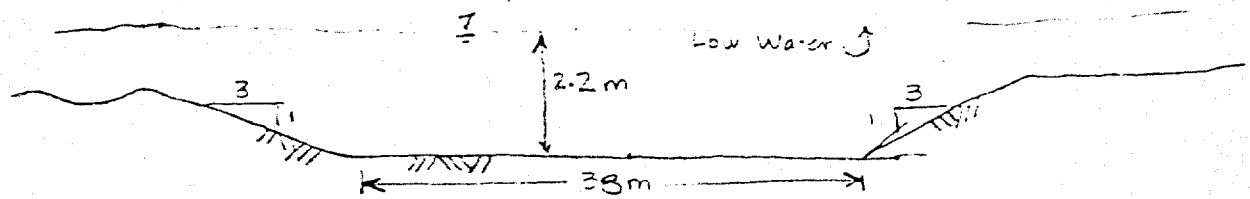
Allow ½ tow width on each side:

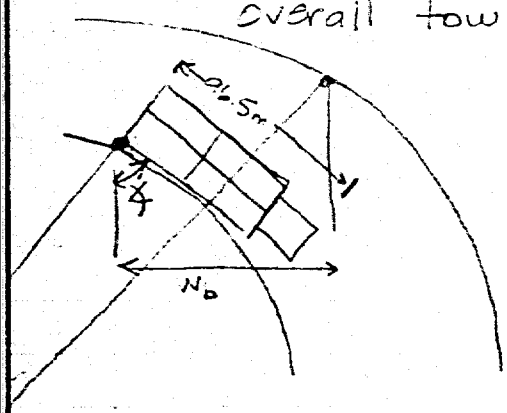
Total width (bottom) = 2 x 19 = 38 meters

Assume 1 on 3 side slopes in sand sediments



Wider channel requirements are necessary for turns. Present operation of pusher tug suggests the following:

overall tow length = 96.5 meters



∡ of turn ~ 90° in tight turn

Cos 45° (100m) ≅ 70m width

SHOAL #1 @ KP 157

Relatively straight → 38 meters wide
Min. Low water:
~8' sounding = 1.2m dredge cut
= 1.0 m depth at lower water

From 1983 report → cut = 1.3 meters
(450 meters long)(38m wide)(1.3 meters) = 22,300 m^3

1 on 3 side slopes
$\frac{(.3)(3)(1.3)}{2}$ (450)(2 sides) = 2300 m^3

TOTAL = 24,600 m^3

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SHOAL # 2 u/s KP 156

Straight → $W_b = 38$ meters

From 1983 report: cut ≅ 1.3 meters

(1050 m long)(38m wide)(1.3m) ≅ 51,900 m^3

Side slopes

(1.3)(3)(1.3)(1050) = 5,400

TOTAL = 57300 m^3

SHOAL #3 D/s KP 152

Straight → $W_b = 38$ meters

cut = 1.3 meters

(270 m)(38m)(1.5m) = 15,400 m^3

(1.3)(3)(1.3)(270) = 1,400 m^3

TOTAL = 16,800 m^3

SHOAL #4 @ Kohr Sim Sima, KP 146

slight curve → $W_b = 70$ meters

cut ≅ 1.5 meters

(450 m)(1.5)(70 m) = 47,300 m^3

(1.5)(1.5)(3)(450) = 3,100 m^3

TOTAL = 50,400 m^3

SHOAL #5 @ Terakeka, u/s KP 144

x-over → W_b ≅ 85 meters

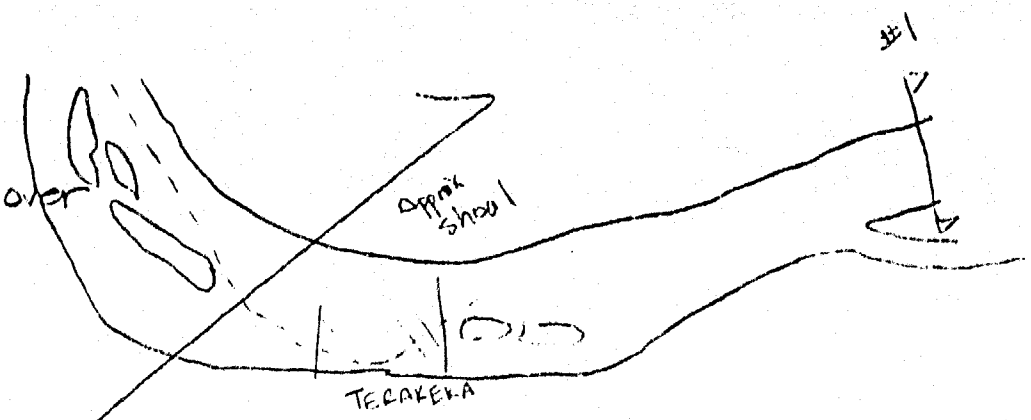
cut ≅ 1.1 meters

(50m)(85)(1.1) = 16900

(60)(1.1)(1.1)(3) = 700

TOTAL = 17,600 m^3

#5 Terakeka X-over

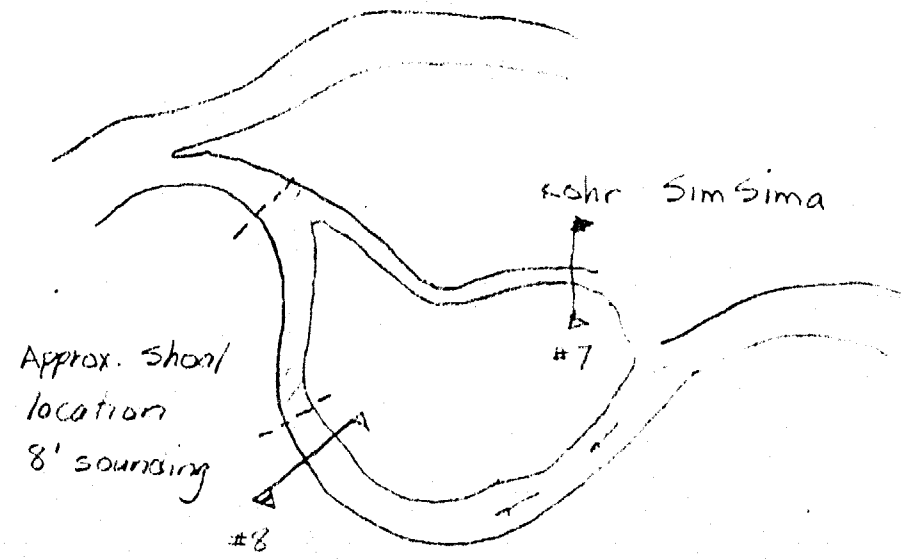


(200 m)(2.5 m)(40 m) = 20,000 m^3
= 26,000 cyds

may be longer to straighten out channel!

• SEE SHEET ATTACHED

#4



(450 m)(1 m)(40 m) = 18000 m^3
= 23,400 yd^3

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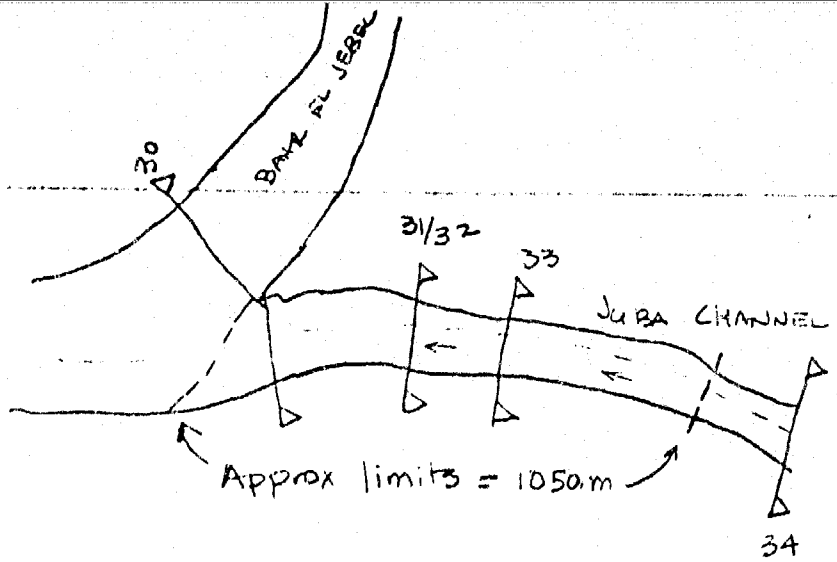
DATE	SCALE	JOB NO.

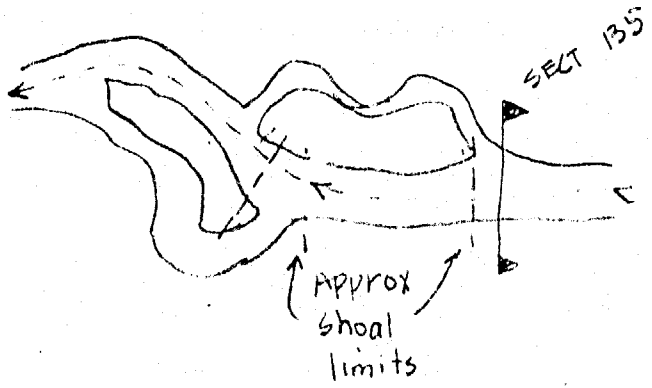
2nd



U/s from KP 156

(1050m)(1.5m)(40m) = 63,000 m³
≅ 82,000 cyds

1st shoal d/s from Juba

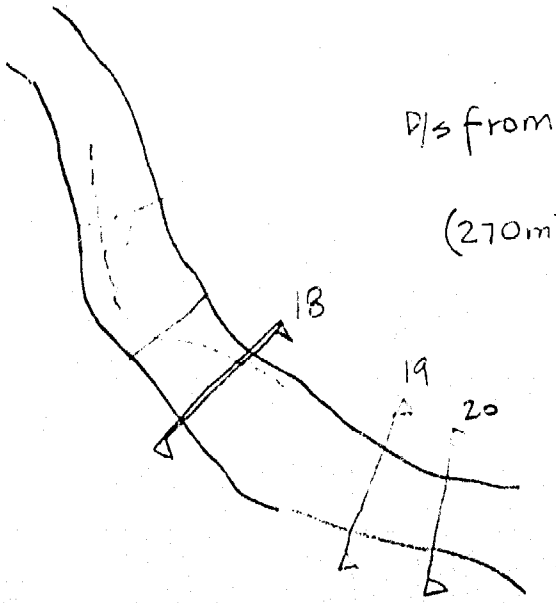


400m - 500m (432m)

At KP 157

(450 m)(1.0m)(40m. wide) = 18000 m³
= 23,400 cyds

3



D/s from 1405 km (152)

(270m)(10)(40m) = 10,800 m³
= 14,040 cyds

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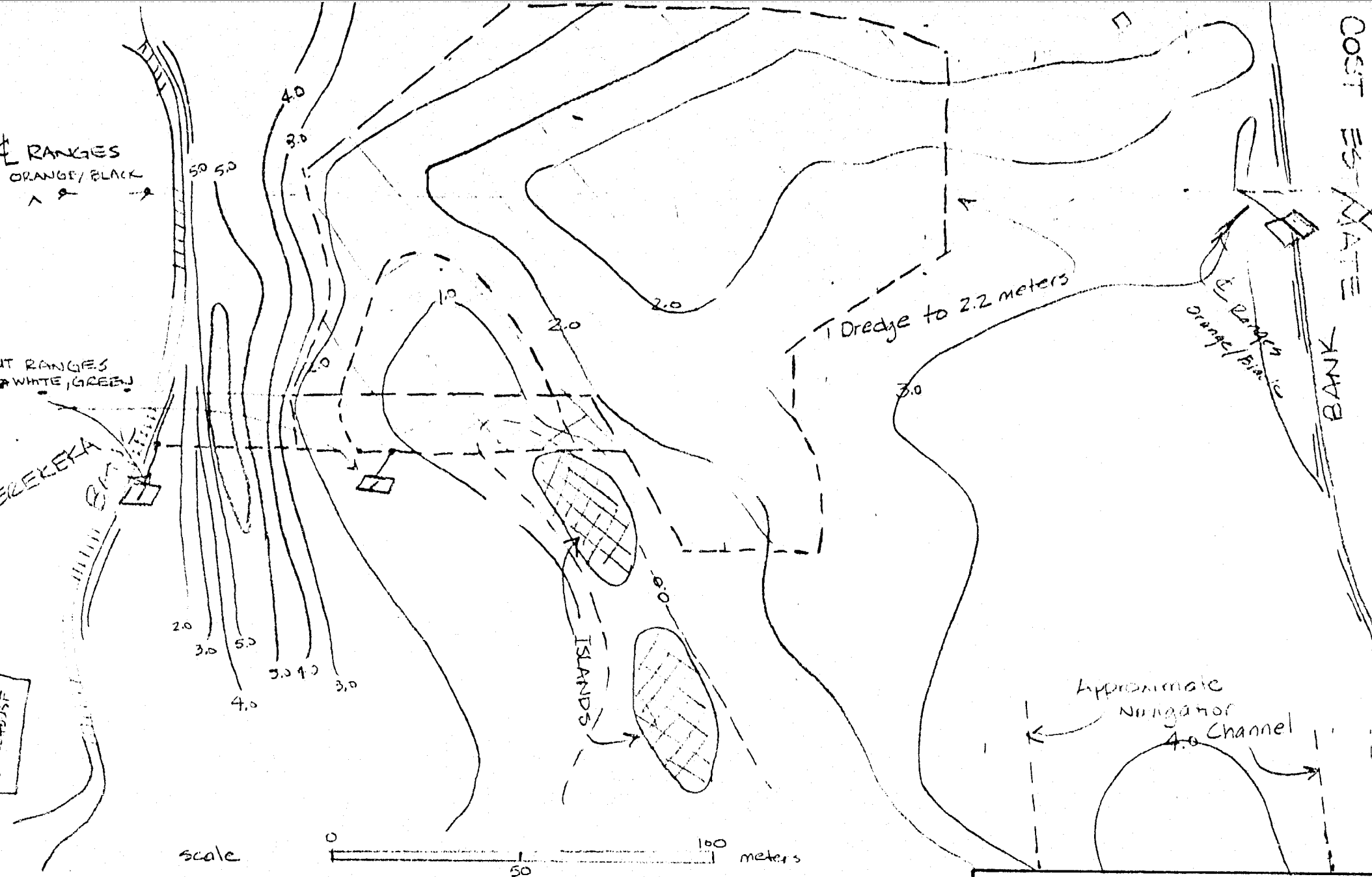

edge to 2.2m ⇒ (194.00 m^2)(0.7m) ≅ 10,000 m^3

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TERAKEKA RIVER PORT

DREDGING PLAN

DATE	SCALE	JOB NO.

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SHEET NO. ____ OF ____
CALCULATED BY GLH DATE 11/7/93
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CHANNEL STABILIZATION – PRELIMINARY DESIGN

Determine stable x-section area

X-section 35, EEC Report @ km , Juba Channel

Area = 280 m^2

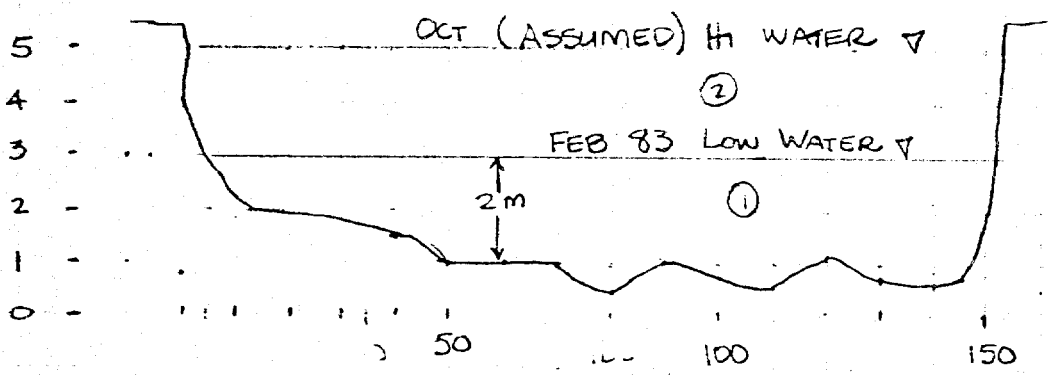
S_e = .00031 $\quad$ $R = 280/202.8 = 1.40$

wp = 202.8 m $\quad$ $n = 0.03$

$$\text{Discharge} = Q = \frac{AR^{2/3}S^{1/2}}{.03} = \frac{(280)(1.40)^{2/3}(.00031)^{1/2}}{.03} \cong 205 \ m^3/s$$

$$\cong 17.7 \times 10^6 \ m^3/d$$

X-Section 1, (Juba survey February 1983) (see sketch attached)

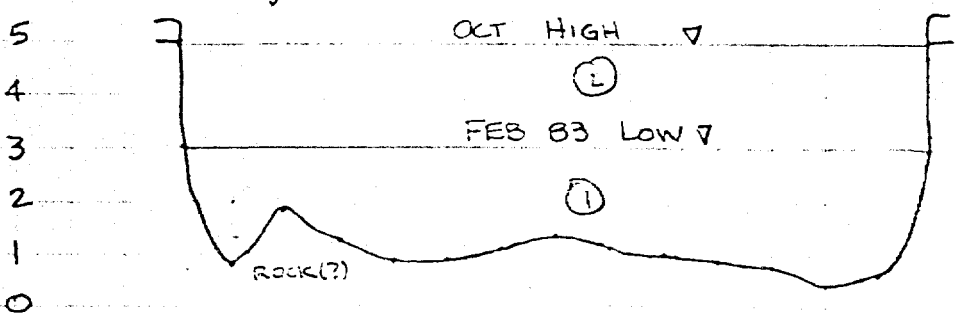


① Area = 277.5 m^2 @ low

② Area = 577.5 m^2 @ high

Site is too shoal on port side.

X-Section 2,



① Area = 271 m^2 @ Low

② Area = 540 m^2 @ High

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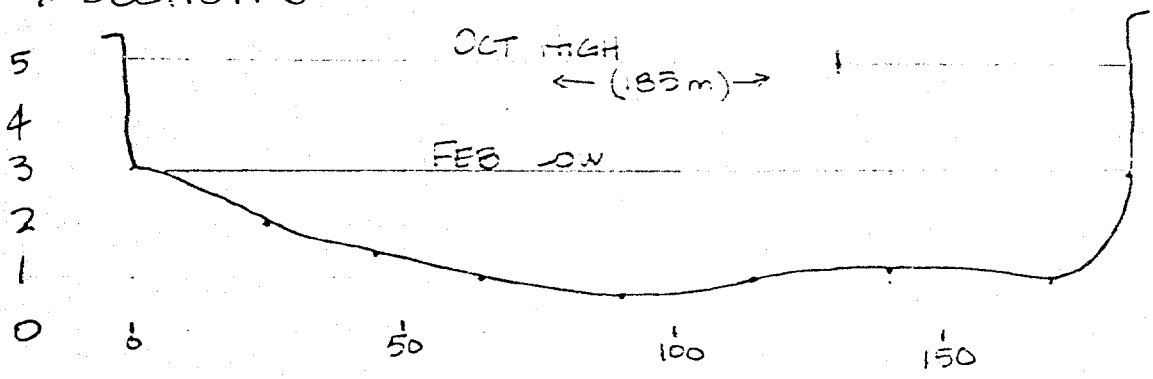
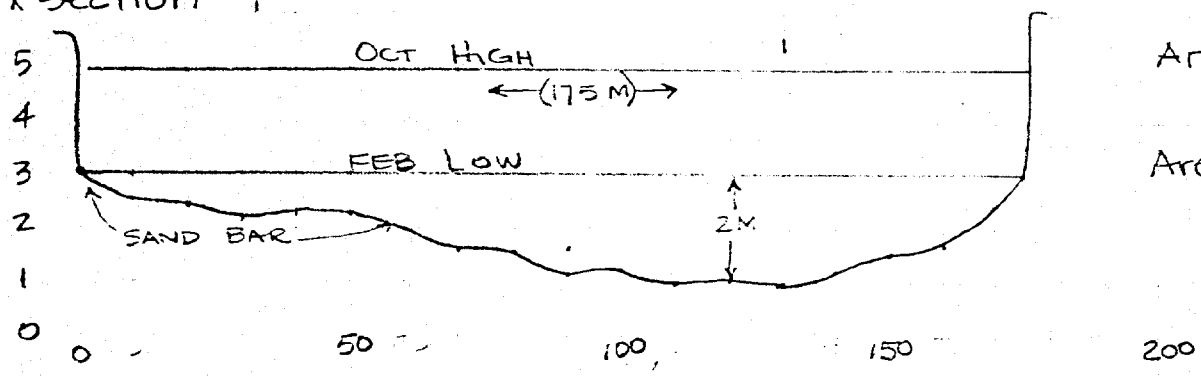
X-section 3



Area = 299.5 m² @ Low

Area = 069 m² @ Hi

X-section 4



Area = 229.3 m² @ Low

Area = 580 m² @ High

Low flow:

Discharge @ X-section 2

$$Q = \frac{(271)(2.01)^{0.67}(.0003)^{1/2}}{.030} = 250 \text{ m}^3/\text{s}$$ ok

@ X-section 4

$$Q = \frac{230(1.29)^{0.67}(.0003)^{1/2}}{.030} = 158 \text{ m}^3/\text{s}$$

@ X-section 1

$$Q = \frac{(278)(1.81)^{.67}(.0003)^{1/2}}{.030} = 238 \text{ m}^3/\text{s}$$

@ X-section 3

$$Q = \frac{(299)(1.58)^{.67}(.0003)^{1/2}}{.030} = 234 \text{ m}^3/\text{s}$$

High flow discharge:

X-section 1 $Q = \frac{(578)(3.67)^{.67}(.0003)^{1/2}}{.030} = 797 \text{ m}^3/\text{s}$

2 $Q = \frac{(520)(2.89)^{.67}(.0003)^{1/2}}{.030} = 775 \text{ m}^3/\text{s}$

3 $Q = \frac{(629)(3.46)^{.67}(.0003)^{1/2}}{.030} = 887 \text{ m}^3/\text{s}$

4 $Q = \frac{(580)(3.18)^{.67}(.0003)^{1/2}}{.030} = 727 \text{ m}^3/\text{s}$

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Check n value at Mongaila

5yr low $Q = 1190\ m^3/s$, $A = 1060$, $T_w = 280$

$$n = \frac{AR^{2/3}S^{1/2}}{Q} \cong \frac{(1060)\left(\frac{1060}{280+T_w}\right)^{2/3}\left(\frac{.00030 + .00013}{2}\right)^{1/2}}{1190}$$

$$\cong 0.032 \longrightarrow \underline{\underline{.030 \text{ to } .035 \quad OK}}$$

5yr high $Q = 2580$ $A = 1650$, $T_w = 280$

$$n = \frac{(1650)\left(\frac{1650}{280+118}\right)^{2/3}\left(\frac{.0003 + .00013}{2}\right)^{1/2}}{2580} = 0.030 \longrightarrow \underline{\underline{\text{use } .030}}$$

High stage u/s of secondary channel:

Ave $Q = (797 + 775)/2 = 786\ m^3/s$

Req'd Depth $\cong$ 42 meters

for Top width @ 135' meters

$$Q = \frac{(567)\left(\frac{567}{1434}\right)^{.67}(.0003)^{1/2}}{.030}$$

$$= 822\ m^3/s$$

@ 130 meters

$$Q = \frac{546\left(\frac{546}{1384}\right)^{.67}(.0003)^{1/2}}{.03}$$

$$= 790\ m^3/s \sim 786$$

Low stage u/s of secondary channel:

Ave $Q = 240\ m^3/s$ u/s,

Req'd depth = 2.0 meters

for top width = 130 meters

$$Q = \frac{(260)\left(\frac{260}{1344}\right)^{.67}(.0003)^{1/2}}{.030} = 233\ m^3/s$$

[illegible] use top width @ $\underline{\underline{125\text{-}130 \text{ meters}}}$

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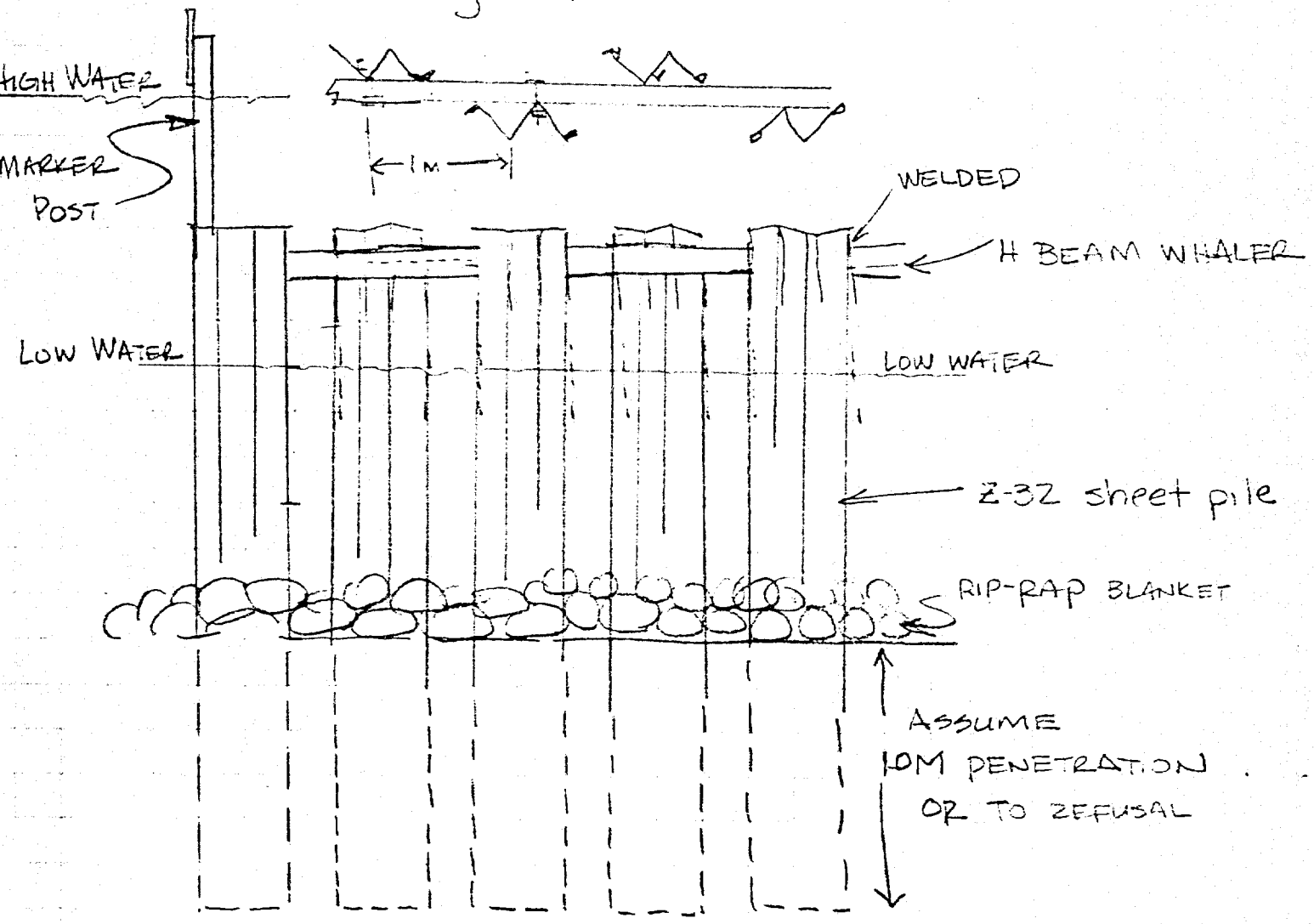
Pile dike design:

use 1 Z-32 sheet @ meter spacing, with h beam whaler welded together.



Provide rip-rap blanket 0.6 m deep x 6 m wide at base of piling for scour protection.

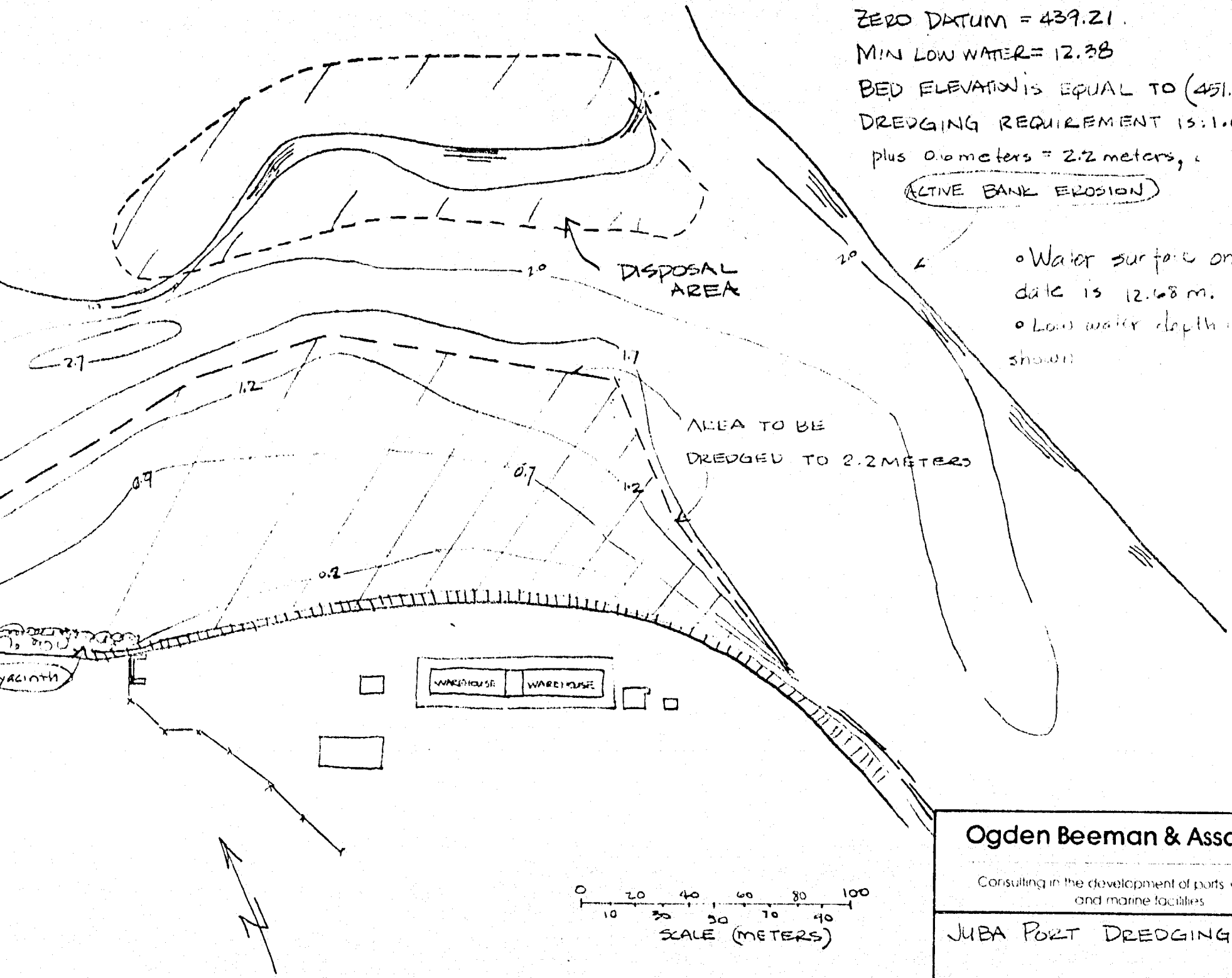
$m^3/m = (0.6)(6) = 3.6\ m^3/m$

$(3.6\ m^3/m)(2\ Tons/m^3) = 7.2\ tons/m$

ZERO DATUM = 439.21.
MIN LOW WATER = 12.38
BED ELEVATION is EQUAL TO (451.81 - depth)
DREDGING REQUIREMENT IS: 1.6 meters
plus 0.6 meters = 2.2 meters,

ACTIVE BANK EROSION

- Water surface on survey date is 12.68 m.
- Low water depth is depth shown



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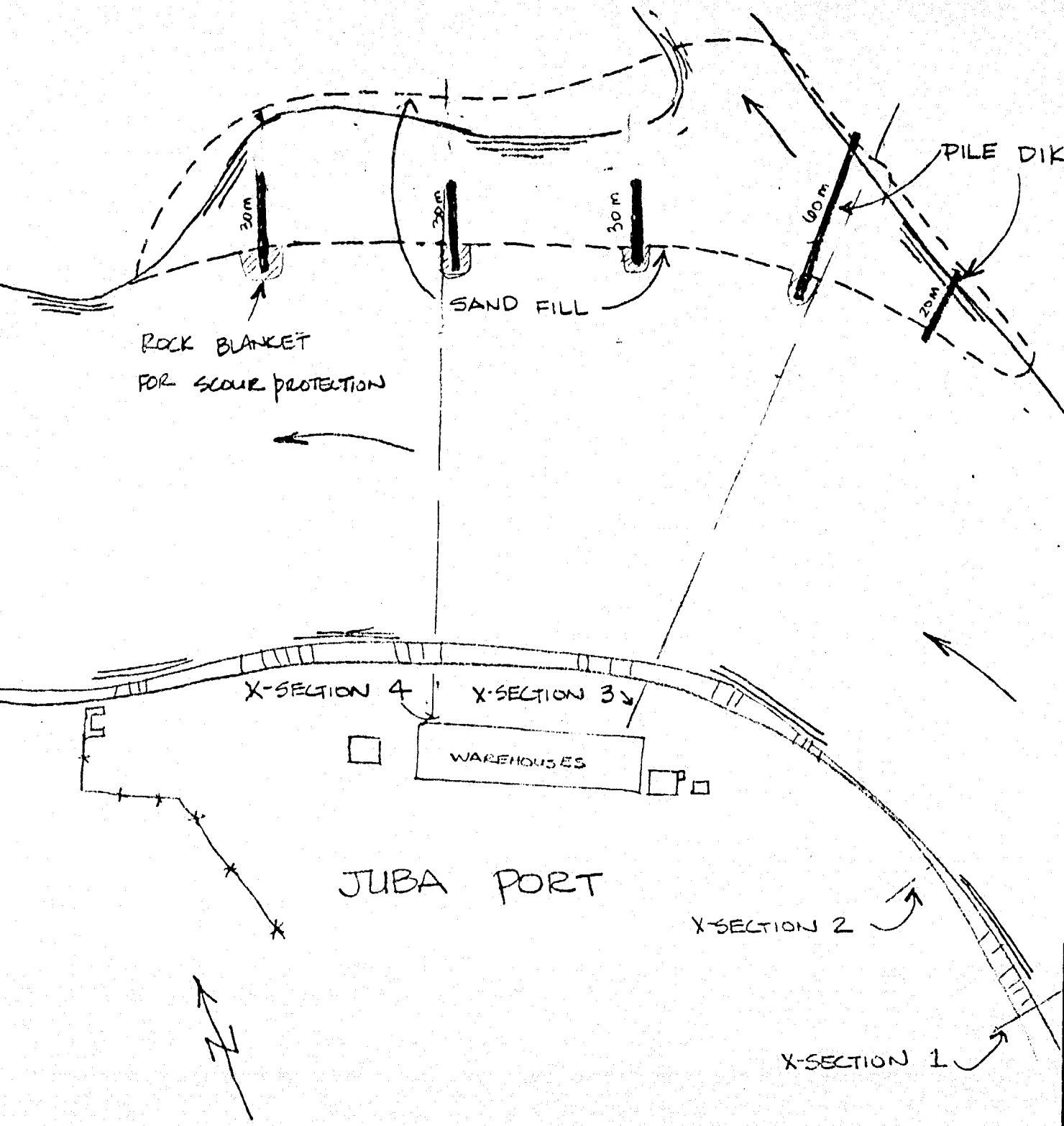
JUBA PORT DREDGING

DATE	SCALE	JOB NO.



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JUBA PORT CHANNEL PRELIM STABILIZATION PLAN

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COST ESTIMATE FOR JUBA PORT
JUBA PORT MAINTENANCE DREDGING / CHANNEL STABILIZATION

QUANTITY ESTIMATE

Req'd depth for navigation at low water = 1.2m + 0.35m = 1.55m

use 1.0 meters

This is based on 1.2m draft for tug + 0.35m for hull clearance

Depth to be dredged = 1.6 + 0.35 + 0.3 = 2.25

use 2.2 meters

This is based on 0.35m for survey and advanced maintenance + 0.3m for capability of dredging equipment to cut a neat line.

Low water depth	cut depth	x	Area (m^2)	=	volume (m^3)
0.2	2.0 m		6250 m^2		12500 m^3
0.7	1.5 m		7970 m^2		12000 m^3
1.2	1.0 m		7190 m^2		7200 m^3

total = 31,700 m^3

COST ESTIMATE

DREDGING COSTS

It is assumed the dredging would be done separately from channel dredging. If work is completed in conjunction with channel dredging, exclude Juba port mob/demob and port dredging cost will be added to channel dredging cost.

Disposal along NE shore line d/s of secondary channel (see sketch)

Channel stabilization assumed to be same as identified

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Equipment:

1 RTC pusher tug @	1500/day	
2 flat top barges @	600/day	
1 Crawler Crane w/ bucket @	$120/hr	($2400/day)
1 D-6 Dozer @	$50/hr	($450/day)

Equipment total = $4950/day

Fuel Cost:

Pusher Tug, steaming	$350/day
on site	$100/day
Crane @ 20 hr day	$300/day
D-6 Dozer @ 9 hr day	$120/day
	$870/day

Personnel cost:

Pusher Tug	1 Reiss	see dredging estimate - channels
	1 Engineer/Pilot	
	1 Master mechanic	
	3 oilers	
	1 cook	
	2 A/B	
Crane & Dozer	2 operators	
	2 oilers	
	1 welder	

Ex Pats =	$870/day
Sudanese =	$95/day
TCN =	$300/day
	$1265/day
Food & subsistence = 15 (40) =	600/day
	1865/day

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Time to complete work:

- Dredging is limited to availability of flat barge for transporting material.

sand @ 120#/ft³ = 3240#/yd³
= 1.91 tons (metric)/m³

1-50 ton barge = 262 m³ → use 260 m³
1-D6 Dozer will unload barge in 3 hrs.
1 clamshell (3 cy bucket) will load at 90 m³/hr

Barge load:
260 m³/90 m³/hr + 3 hrs = 5.9 → say 6 hrs
20 hr day/6 = 3.3 barges/day

(3.3)(260 m³/barge) ≅ 860 m³/day

31700 m³/860/d = 37 days to dredge

Cost to Dredge:

Mobilize from Kosti:

Equipment preparation =	$150,000
Travel from Kosti:	
Pusher tug: (6 days)(350+1500) =	11,100
barges : (6 days)(600) =	3600
Personnel: (Tug only)(6 x 310/d) =	1900
Ex-pat transport	12,000
	178,600

Dredging Cost:

Equipment: (37 days)(4950/+ 520/d) =	$202,400
Personnel: (37 days) (1265/+ 600/d) =	69,000
	$271,400

Demobilize @ Juba (1 day)(1845) = 2000

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COST for channel stabilization

PILE DIKE CONSTRUCTION.

Drive sheet pile for dikes & weld.

Rate = (5 meters/hr)(1 pile/5 meter penetration) = 1 pile/hr

Total dike length = 200 meters

(200 m)(2 pile/m)(1 hr/pile)(1 day/16 hrs) = 25 days

Rock Blanket:

(1 hr/5m)(200 meters)(1 day/8 hrs) = 5 days < 25 days

∴ Do concurrent with pile driving

(200 meters)(7.2 tons/m) = 1440 tons

Equipment cost:

1 crane with pile driver @ 170/hr (16 hr day)	$2700/d
1 barge (for crane) @	300/d
1 flat top barge for rock	300/d
1 pusher tug	1500/d
1 D-6 Dozer @ 8 hrs/day	400/d
	$5200/d

Personnel cost:

Personnel	1265/d
Food & Subsistence	600/d
	1900/d

Construction cost: (25 days)(5200 + 1900) = $177,500

MATERIALS COST

Steel purchase: (200 m)(1 pile/m)(8 m/pile)(56.6 kg/m) = 91 tons

whalers (200 m)(47.5 kg/m) = 5 tons

96 tons

Steel - Cost, including shipment = (96 tons)(675/ton) = $64,800

Rock - Cost at Juca Port = (1440/tons)(15/ton) = 21,600

Material cost = $86,400

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DEEPEN COST ESTIMATE - CHANNEL DREDGING

ALTERNATIVE 1: [illegible] equipment.

Equipment: Crane [illegible], [illegible] draline bucket, [illegible]
1 Crew [illegible]
1 Pusher Tug
1 Crew launch
1 Small work boat

Equipment procurement:

1-Flexi-float barge: 40' x 100'	FOB / Houston	430,000
	Freight / Port Susan	28,000
	Port Susan / Kodiak	51,000
		509,000
(2 units →		$1218,000)
Preparation of workshop		$80,000
Crew launch (Mon Ark)	FOB Arkansas	45000
	Freight / Port Susan	10000
	Port Susan / Kodiak	2000
		57,000
Work boat (Mon Ark)	FOB / Arkansas	10,000
	Freight / Port Susan	3000
	Port Susan / Kodiak	1000
		14,000
Pusher Tug - RTC 1000 HP		
	rehab, clean-up, prep	$100,000

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TOTAL @ Kodiak $860,000

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Equipment Rental Rate:

100 ton Crane w/ bucket		$20/hr
20 hr/day	=	$400/day
RTC pusher rental rate	=	$500/day
Crew launch - work boat	=	$1000/day
3 barges @ $200/day each	=	$600/day
		$5100/day

Equipment Fuel Cost:

Pusher Tug - steaming	$350/day
- on site	$100/day
Generator small boat/launch	$150/day
Crane - 100 gal. @ 20 hr/day	$300/day

Rental & fuel mobilization cost:

4 days - Kosti to Juneau:

RTC pusher = 1500 + 350 = 1850/day
Barges = = 200/day
2050/day

4 x 2050/day = $8200

between bars = 2 days = set up at first bar
2 x 2050/day = $4100

TOTAL = $12,300

Rental & fuel operation cost:

100 ton crane =	$2400 + 300 =	$2700/day
RTC pusher = 1500 + 100		= 1600/day
Crew launch - work boat		= 1150/day
Barges		= 200/day
		$5650/day

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CALCULATED BY [illegible] DATE [illegible]
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Personnel:

Pusher Tug	1 Captain	(Suparese)
	1 Engineer/Pilot	(Suparese)
	1 Master Mechanic	(Ex-Pat)
	3 Oiler/Deckhands	(Suparese)
	1 Cook	(Suparese)
	2 AB	(Suparese)
Crane	2 Operators	(Ex-Pat)
	2 Oilers	(TCN)
	1 Welder	(TCN)
Project Supervisor	1 Supervisor	(Ex-Pat)

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Personnel Cost:

Non-Operational: 4 ex-pats mo. trip @ 3000 = $12,000

Operating costs:

Ex Pats

1 Supervisor ($40000/yr)	=	$130/day
1 Master mech	=	$130/day
2 operators ea $110/day	=	$220/day
		$530/day
30% vacation pay	=	$160/day
25% fringe benefits	=	$130/day
10% location differential	=	$50/day
total	=	$870/day

Suparese

1 Engineer/Pilot	=	25 LS/day
1 Captain	=	15 LS/day
3 Oiler/Deckhands @ 10 LS	=	30 LS/day
2 AB @ 10 LS	=	30 LS/day
1 Cook @ 11 LS	=	11 LS/day
		111 LS/day
50% Termination gratuity		55 LS/day

$25[illegible]

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Tom 2 divers @ 60/day = $120/day
1 welder @ 60/day = 60/day
$180/day
30% motor pay
25% fringe
[illegible] overhead
total = $300/day

Food & subsistence
15 people x $35/day = $525/day

Housing @ Juba:
15 people x $40/day = $600/day

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Project Duration:

Daily production rate, 100 ton dragline with 3 cy bucket
1 swing/minute @ 2.5 cu.yds
20 hrs. day operation (2@10hrs)
0.80 effective time due to move, operator efficiency

(20 hrs/d)(2.5 cyds/min)(60m/hr)(0.80 effective) = 2400 cy/day
= 1840 m³/day

Work Sequence:

① Start at KP 157, 785 km from Lake No, 3 km from Juba:
Mobilize from Kosti = 6 days
set up at KP157 = 2 days

24,600 m³/1840/day = 13.4 ≅ 14 days

② Set up at KP 156, 780 km from Lake No, 10 km from Juba
set up at KP156 = 1 day

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57,300 / 340 = 31 days

③ Set up at KP 152, 700 km from Lake Vo, 400 km from Juba
Set up = 1 day
16,300 m³/340 = 9.1 ≅ 9 days

④ Set up at Korr SimSima, km from Juba
Set up = 2 days
50,400 / 340 = 28 days

⑤ Set up at Terekeka, km from Juba
set up = 1 day
17,600 / 340 = 9.6 ≅ 10 days

⑥ Return to Kosti
1320 km / 12 km/hr = 110 hrs
= 4.6 days = 5 days

Summary of time on project:
Mobilization = 11 days → 11 days
Operation time:
① KP 157 = 14
156 = 31
152 = 9
Korr Sim. = 28
Terekeka = 10
92 / total = 92 days
Bar to Bar = 5 days 5 days

→ total = 97 days

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COST ESTIMATE (surface equipment preparation)

Mobilization/demobilization:

Equipment + fuel (11 days) (2050/day) = 22600

Manpower (11 days) (1790/day) = 19,700

$42,300

+ travel (4 equipment @ $3000) 12,000

total = $54,300

Operation:

Equipment Rental

① 4 @ (5650) = $79,100

② 31 @ (") = 175,200

③ 9 @ 5650 = 50,900

④ 28 " = 158,200

⑤ 10 " = 56,500

total = $519,900 — 519,900

Personnel Cost:

① 1790 (14) = 25100

650 (14) = 8400 (housing @ 600)

② 1790 (31) = 55500

600 (31) = 18600 (housing @ 600)

③-⑤ (47)(1790) = 84200

total $191,800 — 191,800

Bar to Bar = Personnel

①-② (1)(600 + 1790) = 2390

③-⑤ (4)(1790) = 7200

total $9,600 — 9,600

Bar to Bar - Equipment Rental

①-③ (5)(2050) = 10,300 — $10,300

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Cost Summary:

A. Mob/Demob

Preparation of equipment	$ 360,000
Transportation costs	$ 54,300

B. Operation cost

	519,900
	191,800
	9600
	10 300
SUB-TOTAL	$ 1,645,900

C. Profit @ 12%	197,500
D. Contingencies @ 10%	164,600
E. Overhead @ 8%	131,700
TOTAL	$ 2,139,700

Equivalent LS @ 1.80 exchange: LS 3,851,500

ALTERNATIVE 2 RTC FURNISHED EQUIPMENT

RTC provides following equipment:

1-2-C Pusher Tug @ 1000 HP @	$ 1500/day
1-Flat top 500 Ton barge @	$ 300/day
1-300 ton fuel barge @	$ 300/day
	$ 2100/day

Prepare flat top barge; Anchors spuds (2), $ 50,000

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OST Estimate (without equipment preparation)

A Mob-Demob = Eq. Barge (11 days)(2450/day) = $27,000
Work Barge (11 days)(1730/day) = $19,700
$46,700

+ Tow (ex-Cost) = $58,700

3 Operation

Equip rental = .00 tow @ 2400/d
RTC Pusher @ 500/d
Launch-work boat @ 500/d
RTC Barges @ 600/d
Fuel @ $550/d
total 6050/d x 92 days = $556,600

Personnel Cost: (some) $191,800

Bar to Bar: $9,600
(5)(2155) = 12,300 $21,900

OPERATION TOTAL 770,300

OST SUMMARY

MOB/Demob	Equip Preparation	$301,000
	To & From Kosti	58,700
Op'n Cost		$770,300
	SUB-TOTAL	1,130,000
Profit @ 12%		135,600
Contingencies @ 10%		113,000
Overhead @ 8%		90,400
	US $ =	$1,469,000

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COST ESTIMATE - NAVIGATION AIDS FOR DREDGING

It is assumed the navigation aids will be placed with the dredging plant + 1 pile driver unit at $25/hr

Nav aids will be signs + target boards.

Nav Aids

2 pile w/ targets at 4 locations = 8
4 pile w/ targets at Terrekeka = 4
total = 12

steel pipe 80' length, 6.5" diam @ 80.00/ft
(12)(80.00)(80) = $7700

Square targets: 1/4" steel x 4' x 4' @ $175 each
(12)(175) = 2100

Reflective backing: @ $100 each
(12)(100) = 1200

Welding Mtls: 1 can rods @ $400 $400
Oxygen, Acetylene @ 500 500

total = $11,900

Equipment Cost

Alt #1 (5150/day) + $200/day for pile driver = 5350/day
5350 x 6 days = $32,100

Alt #2 (6550 + 200)(6 days) = $36,300

Crew Cost

D/S: (6 days)(1790) = 10800
Juba: (2 days)(600) = 1200
$12,000 $12,000

Apply 1.3 for profit, OH, contingency

ALT #1 TOTAL = $57,300
ALT #2 TOTAL = 62,900

GIVEN: Discharge and elevation records for the White Nile and its tributaries, 1963-1972. Data from the PJTC on the Jongelei Canal Bor to River Sobat.

REQ'D: Evaluate the impact of the Jongelei Project on the navigation of the river from Bor to Sobat.

SOL'N:

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I. Use the discharge records to determine average annual volume that could be saved by avoiding flows into the Sudd.

Mongalla is the closest upstream station from Bor that discharge was measured.

The swamps (Bahr El Zaraf + Abu Tonga) represent the downstream station where discharge leaves the Sudd.

YR	MONGALLA ($10^6 m^3$)	- SWAMP ($10^6 m^3$)	= TOTAL VOLUME LOST
1963	60,500	21,500	39,000
1964	64,000	32,700	31,300
1965	56,900	32,500	24,400
1966	52,000	20,200	31,800
1967	50,500	21,100	29,400
1968	50,400	21,600	28,800
1969	53,700	21,900	31,800
1970	56,300	22,500	33,800
1971	50,000	18,100	31,900
1972	43,300	21,800	21,500
AVE-10 YRS	53,760	23,390	30,370

		VOL LOST	>	DESIGN CRITERIA	
Low yr	= 1972	$21,500 \times 10^6 m^3$	>	$5475 \times 10^6 m^3$	OK
Ave yr	= 1969	$31,800 \times 10^6 m^3$		$9125 \times 10^6 m^3$	OK
Hi yr	= 1963	$39000 \times 10^6 m^3$		$15695 \times 10^6 m^3$	OK

Reported average discharge capacity: phase I = $25 \times 10^6 m^3$/day
maximum discharge capacity: phase II = $43 \times 10^6 m^3$/day

$(25 \times 10^6)(365) = 9125 \times 10^6\ m^3/yr$ < 21,500 min (1972)

$(43 \times 10^6)(365) = 15,695 \times 10^6\ m^3/yr$ < 21,500 min (1972)

This suggests that the canal will not draw the Bahr El Jebel flows down below the minimum of the 10 yr record. It is a realistic volume.

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DATE

II The minimum month discharge for the 10 yrs. was $102\ m^3/day$, at Malakal. Assume this is minimum that must pass Bor into old channel to maintain natural minimum channel depths.

$$(102\ m^3/day)(365d) = 37230 \times 10^6\ m^3/yr$$

Hi yr.	= 60,500 − 37230	= 23,270 $\times 10^6$	m^3/yr	> 15695
Ave yr	= 53,700 − "	= 16,470	m^3/yr	> 15695
Low yr.	= 43,300 − "	= 6,070	m^3/yr	< 15695
		6,070	m^3/yr	> 5475

A low year, such as 1972, will limit available volume of water for discharge, based on criteria of maintaining minimum navigation depths in natural channel. The volume available will still be greater than minimum proposed flow at $15 \times 10^6\ m^3/d$ ($5475 \times 10^6\ m^3/yr$).

III Consider volume to be discharged in channel based on minimum depths of 4m to 7m.

2 x-sections

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Upstream section @ 4 m depth

$$\text{Area} = (50)(4) + (2)(4)(4) = 232\ m^2$$

$$WP = 50 + 2\sqrt{4^2 + 8^2} = 67.89$$

$$R = 232/67.89 = 3.42$$

Typical section @ 4m depth,

$$\text{Area} = (30)(2) + \tfrac{1}{2}(2)(2) + (52)(2) + (1.5)(\tfrac{1}{2})(1.5) + \tfrac{1}{2}(.5)(.5)$$

$$= 177.25\ m^2$$

$$WP = 44 + 2\sqrt{2^2+4^2} + 2\sqrt{1.5^2+3^2} + 2\sqrt{.5^2+.5^2} = 62.81$$

Jan 1969	419.99	334.33m	.0000991
Feb	419.96	333.46m	.0001000
Mar	419.96	333.34	1003
Apr	420.00	333.74	1007
May	420.02	333.63	.0001007
Jun	420.0[illegible]	334.[illegible]0	.0000998
Jul	420.02	334.77	979
Aug	420.07	335.03	974
Sep	420.14	335.29	968
Oct	420.13	335.54	961
Nov	420.02	335.65	955
Dec	419.99	335.44	.000096
Jan 1972	419.64	335.29	954
Feb	419.53	334.59	972
Mar	419.52	334.02	986
Apr	419.49	333.53	999
May	419.56	333.47	.0001003
Jun	419.61	333.90	992
Jul	419.61	334.46	976
Aug	419.68	334.93	965
Sep	419.67	385.19	.0000958
Oct	419.75	385.27	.0000958
Nov	419.99	385.16	.0000968
Dec	419.96	334.57	.000098

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Monthly allowable volume, using 102 m³/day as min. at Morgalla

1969

Jan	4310 − 3162 = 1148	Jul	4610 − 3162 = 1448
Feb	3800 − 2856 = 944	Aug	5370 − 3162 = 2208
Mar	4320 − 3162 = 1158	Sep	5030 − 3060 = 1970
Apr	4030 − 3060 = 1260	Oct	4530 − 3162 = 1368
May	4640 − 3162 = 1478	Nov	4410 − 3060 = 1350
Jun	4330 − 3060 = 1270	Dec	4350 − 3162 = 1188

1972

Jan	3610 − 3162 = 448	Jul	3500 − 3162 = 338
Feb	3340 − 2856 = 484	Aug	3700 − [illegible] = 538
Mar	3280 − 3162 = 118	Sep	3580 − 3060 = 520
Apr	3040 − 3060 = (−20)	Oct	3960 − 3162 = 798
May	3330 − 3162 = 168	Nov	4320 − 3060 = 1260
Jun	3400 − 3060 = 340	Dec	4260 − 3162 = 1098

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Sobat elevation taken at Hillet Doleib. Difference in Hillet Doleib and mouth

Depth @ 4 meters:

2	MO	$Q=\frac{(177.3)(2.52)^{2/3}S^{1/2}}{.0275}$	(=days)(86400)	check < AVAIL M^3	check > ($15\times10^6 m^3/d$) DESIGN MIN M^3
1	Jan		344×10^6	< 1148×10^6	> 465×10^6
	Feb		312.4	< 944	> 420
	Mar		346.3	< 1158	> 465
	Apr		335.9	< 1260	> 450
	May		347.5	< 1478	> 465
	Jun		334.5	< 1270	> 450
	Jul		342.4	< 1448	> 465
	Aug		341.6	< 2208	> 465
	Sep		329.4	< 1970	> 450
	Oct		340.7	< 1368	> 465
	Nov		327.1	< 1350	> 450
	Dec		339.0	< 1188	> 465

2					
	Jan	337.9	< 448×10^6	< 465×10^6	falls below min
	Feb		< 484	> 435	
	Mar	343.5	> 118	< 465	falls below min less than 4m.
	Apr	334.5	> −21	< 450	" " "
	May	346.3	> 168	< 465	falls below min
	Jun	319.2	< 340	< 450	" " "
	Jul	344.7	> 338	< 465	" " "
	Aug	341.8	< 538	> 465	
	Sep	327.7	< 520	> 450	
	Oct	338.7	< 798	> 465	
	Nov	329.4	< 1260	> 450	
	Dec	=	< 1098	> 465	

Try 3 m. depth: $Q=\frac{(122.25)(2.124)^{2/3}S^{1/2}}{n}$

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972				
	Mar	196 > 118	NG	2m will work
	Apr	190.8 >	NG	Requires add'l discharge
	May	197.5 > 168	NG	2.5m will work
	July	194.9 < 338	ok	

2.5 meters minimum depth will work for average slopes. This is greater than 2.2 meters necessary for navigation depth

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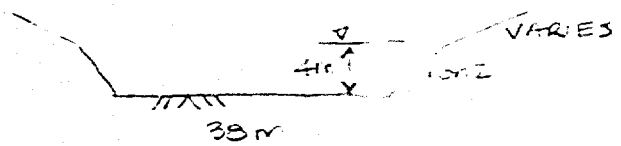
SCALE
DATE

[Typical velocities in canal, using bed slope and x-sectional areas given by Jonglei Canal project appraisal study.

X-section 1



slope = .000125
A = 184 m² @ 4 meters
wp = 55.67
n = 0.0275

$$V = \frac{R^{2/3} S^{1/2}}{n}$$

$$= \frac{(3.31)^{.67}(.000125)^{.5}}{.0275}$$

$$= 0.90 \text{ m/s} \cong 15.00 \times 10^6 \text{ m}^3/\text{day}$$

A = 373 m² @ 7 meters
wp = 74.64 m
HR = 5.00

$$V = \frac{(5.00)^{.67}(.00025)^{.5}}{.0275}$$

$$V = 1.19 \text{ m/s} \cong 38.4 \times 10^6 \text{ m}^3/\text{day}$$

X-section 2

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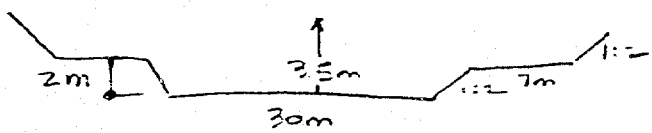

A = 138 m² @ 3.5'
wp = 58.56
HR = 2.36
n = .0275

$$V = \frac{(2.36)^{.67}(.000125)^{.5}}{.0275}$$

$$= 0.73 \text{ m/s} \cong 8.7 \times 10^6 \text{ m}^3/\text{d}$$

A = 190 @ 4 m
wp = 62.56
HR = 3.04
n = .0275
S = .00011

$$V = \frac{(3.04)^{.67}(.00011)^{.5}}{.0275}$$

$$= 0.8 \text{ m/s} \cong 13.2 \times 10^6 \text{ m}^3/\text{d}$$

Velocity range for project criteria is <u>0.8 m/s to 1.2 m/s</u>.

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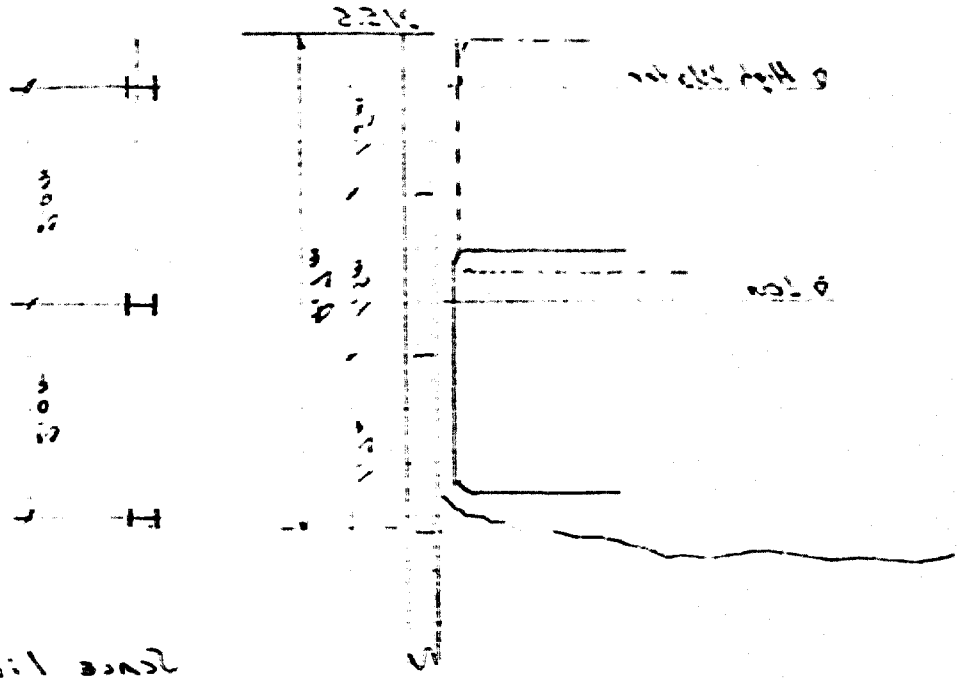
MOTT HAY & ANDERSON CONSULTING ENGINEERS	PROJECT	SHEET	OF
	DESIGN FOR	DESIGNER	DATE
		CHECKER	DATE

Tees Barrier Piers & Abutments

Pier Data

Wid. a = 2.0m
Fdd = .5m
Draft = 1.2m
Liner = .4m
Dia dwlr = .6m
4.7m



ITEM	Q (Bom wks)	Unit price fc	Unit price Ic	ES fc	ES Ic
Excavation Piers existing	2400m³	18.5	–	44,400	–
Buy & Hp 12-72 (32' long)	53 ton	1350	100	71,550	5,300
~~Hdg - Dewatering (one time)~~	~~L.S.~~				
Drive Piers driving	4160	775	–	32,240	–
Rock/Water Lasting-Make	1632m	585	165	95,472	27,024
" " " - Place	1204	60	2	7,200	240
Excavation - one separation	1500m³	9	2	3,500	3,000
Forms (use 12" pre cast)	564	900	120	4,500	600
Crows	564	5000	1500	[illegible]	5,000
				241,944	

MEAN MONTHLY DISCHARGES

RIVER	STATION	PERIOD	J	F	M	A	M	J	J	A	S	O	N	D	TOT
BAHR EL JEBEL	MONGALLA	1912-1967	2150	1850	1970	2040	2480	2370	2610	3000	2960	2930	2600	2390	293
BAHR EL GHAZAL	EXIT	1923-1940	45.2	46.9	42.9	37.9	35.4	28.1	37.5	62.0	95.4	113	56.4	33.6	63
SOBAT	HILLET DOLEIB	1912-1967	1020	454	289	251	431	862	1290	1590	1770	1990	1980	1760	137
WHITE NILE	MALAKAL	1912-1967	2390	1680	1590	1440	1610	1980	2470	2840	3050	3370	3270	3120	28

From: "NILE WATER STUDY" 1979

TABLE: 2.4.3-2, RIVER TRANSPORT STUDY IN THE SUDAN
FINAL REPORT
VOLUME III, ANNEXES
EUROPEAN DEVELOPMENT FUND
JULY, 1983

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Consulting in the development of ports, waterways and marine facilities

DATE	SCALE	JOB NO.

KILHAM STATIONERY & PRINTING CO.

APPENDIX No. 2

THE PORTS

NOTE

The data used for the estimates were generated from observations and conversations with various individuals and contractors located in the Sudan and whose construction experience included similar type work.

In order to develop the estimated quantities preliminary designs had to be made. Additionally because of the isolation of some of the southern ports considerations had to be made for mobilization, demobilization, labor subsistence, etc. Also, a number of contractors prefer to use ex-pat employees and these costs had to be included.

It was important to be consistant in applying costs for feasibility comparison. Also, since it is necessary for the estimates to be used for budget and fund allocation purposes, a contingency was applied and the costs shown are the funds the donor would have to pay the contractor to perform the work in December 1983.

Finally, once the projects are identified and more detailed designs are performed, then they should be re-estimated with new unit cost data reflecting current information.

MOFFATT & NICHOL, ENGINEERS	CLIENT	JOB NO.	
	PROJECT	SHEET OF	
	DESIGN FOR	DESIGNER	DATE
		CHECKER	DATE

COST ESTIMATES SUMMARY

W/ 20% ADDED FOR CONST. ADM, MAN., FIELD, PROF. SERVICES

A. SHORT TERM

JUBA - 3,638,664 × 1.2 = 4,366,396 ~ 4,500,000

RENK - 2,549,397 × 1.2 = 3,059,276 ~ 3,100,000

DELAYED MAINTENANCE - (CONT. AD, MAN + FIELD, PROF FEES)

KOSTI	75,000	375,000
MALAKAL	150,000	
BOR	150,000	
MONGALLA		150,000
		£S 8,125,000

B. LONG TERM

UNIT BERTH W/ CRANE + WALL + BACKLAND

(245,660 + 500,816 + 306,780 + 792,637) 1.20 ~ £S 2,200,000

(WALL + CRANE + BACKLAND + MOB/DEMOB)

TRANSIT SHED 736,200 × 1.20 ~ £S 900,000

TRANSIT SHED + CRANE + WALL*

(736,200 + 800,816) × 1.20 ~ £S 1,800,000

MALAKAL UNIT BERTH - ADD 200,000 FOR FILL (NEW AREA)

RENK " - - SUBT " (FILL ALREADY THERE)

UNIT BERTH + BACKLAND W/o CRANE + WALL

(245,660 + 306,780 + 600,000) 1.20 ~ £S 1,400,000

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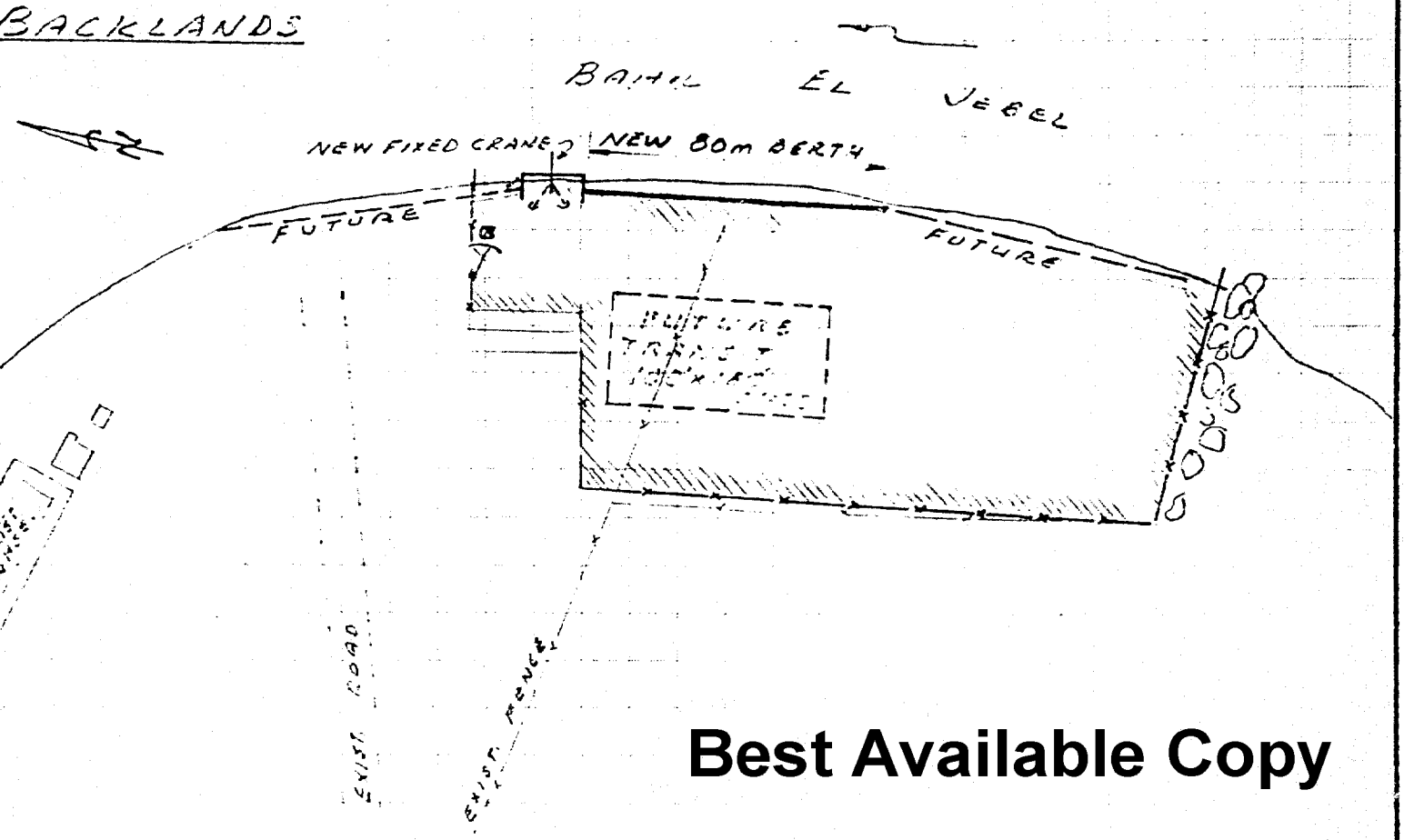
* MOB + DEMOB - PROVIDED (894,212) - (IF INDEPENDENT W/ THE STEEL UNIT)

Batching plant - 23.3%	= 208,375	BUT USE	500,000
Crane + Wall - 47.5%	= 424,777	"	300,000
Backlands - 29.2%	= 261,139	"	200,000

MOFFATT & NICHOL, ENGINEERS	CLIENT USAID - KHARTOUM	JOB NO. PROJ. 650-0060	
	PROJECT RIVER TRANSPORT AG MGTG	SHEET	OF
	DESIGN FOR JUBA PORT	DESIGNER	DATE
		CHECKER	DATE

BACKLANDS



SCALE 1:20

ITEM	Q	UNIT PRICE fc	UNIT PRICE lc	£S fc	£S lc
REMOVE TREES & CLEAR SITE	L.S.	11520	750	11,520	750
CLEAR & GRUBB BACKLAND	12,150m²	1.95	.02	23,693	243
ROUGH GRADING "	12,150m²	.98	.02	11,907	243
MATERIAL PLACEMENT "	3,952Ton	10.91	.09	43,116	356
FINE GRADING	12,150m²	0.46	.05	5,589	608
FENCING w/ 1 VEH GATE	250m	94.0	1.50	21,020	475
GUARD HOUSE	1 EA	—	1000	—	1000
LIGHTING - [illegible]	5 EA	15000	5000	75,000	5000
				201,845	17,695
Heavy Lift Area					
STAPLED [illegible] SURFACE	1 EA	270,000	—	270,000	
[illegible] WALL - [illegible] (GALVANIZED)	30M	2055	946	61,650	28,350
				331,650	28,350

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REMOVE WRECKS, FENCE, CLEAR WF

DIM
- D-8 - 3da x 8 x $100 = 2400
- TRUCKS - 1 6da x 8 x $40 = 1920
- LOADER 4da x 8 x $65 = 2080

$6400 x1.8 = 11520

Submine labor - 15 x 5da x $10 = 750

CLEAR & GRUB

75 x 150m = 11250
50 x 80m = 900
12,150 $m

GRADER 65 ⌀
LOADER 85 ⌀
D-8 100 ⌀
TRUCKS - 2 80 ⌀

329 ⌀ x 5da x 8' = $13200 x1.8 = 23760 ÷ 12150 = 1.95

Submine labor - 5 x 5da x $10 = 250 ÷ 12150 = .02

ROUGH GRADING

GRADER - 65 x 5da x 8h
D-8 100 x 5 x 8h
165 x 5 x 8 = 6600 x 1.8 = 11880 / 12,150 = .98

Submine labor - 250

LATERITE PLACEMENT - 12,150m x .15m = 1823 m³ (2.17mT/m³) = 3952 mT

Find pit - L.S. = $1000
Loader 85 ⌀ x 7 x 8 = 4760
Truck 4 x 7 x 40 ⌀ x 8 = 8960
Grader 8 x 7 x 65 = 3640
D-8 7 x 8 x 100 ⌀ = 5600
23,960 x 1.8 = 43,128 ÷ 3952 = 10.91

Truck = 3952 t / 20 t/load ≈ 200 loads

Sec. pit - 20 km away.
8 loads/day
4 trucks x 8 = 32 loads/day
Say 7 days for haul/place

Submine - 7 x 5p x 10 = 350 ÷ [illegible] = .09

FINE GRADING

GRADER 6da x 65 x 8 = 3120 x 1.8 = 12100 = 0.46
Submine - 6da x 10p x 10 = 600 ÷ 12150 = .05

FENCING

per Chevron $40/m - 6' 3 strand barb (or Rebate) (installed)
Ship to Juba & haul - 4 25%

1.30 x 40 x 1.5 = 94/m L.

Submine 5 x 10da x 10 = 500

GUARDHOUSE -

Supplied by RTC - L.S. 1000

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MOB + DEMOB - 8 days down
6 days back

Barge $200/da
100T crane 120/da
Tug $1500/da
Fuel 350/da

Crew Subsistence: $40/da
Ex Pats: 30% vac.
25% fringe
10% dislocation
$3000 RT U.S.
Local labor - 15% Grat.

EQUIPMENT

	(A) Sloped face	(B) Soldier Piles	(C) Mass Excavation
40	Backhoe		
120	100 T American		
40	Grader		
50	D-8		
40	2 Generators	"	"
30	Rock Drill		
40	2 Air Compressors		
75	5 Pickup Trucks		
20	Drag Bucket		
20	Clam "	Pile Hammer	
50	Roller		
100	4-16 meter Trucks	2-16 meter Trucks	
60	1-988 Loader	D Loader	Truck Crane
100	Office Trailer (Sim)	Truck crane	
785			
Say w/ Misc. tools	= $900/hr/da	∴ Dec. by 3%	∴ Inc. by 3%
		$875	$925

Ex-Pat Crew

* 1. P.M.	25.00	25
* 1. P.E.	20.-	20
* 1. Super	23 -	23
4. Operators	20 -	80
* 2. O.K. + Clerk	15 -	30
2. Foreman	20 -	40.
6. Laborers	18 -	108
17		326
		100 vac.
		85
		25
		546 × 8 × 7 days = 20570 + 17300 = $37,870

Labor Mob + Demob for Entire Job

* [illegible]
[illegible] = $945/da

Cost [illegible] Work 34 (Trim + Pile)

14 da [(785 equip) - (40 drag × 200) + 1850 (Lab)] + 14 da × 60 × 75 (Crew Lab)

$48070 + 5400 = $56,470

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MOB & DEMOB + OH COSTS

TIME FOR PROJECT

WALL + BACK LAND (time for ea wall)

WALL - Critical Time - (Backland Work Concurrently)

(A) Sloped - 10 weeks - 6 da weeks = 60 da

(B) Soldier - 12 " = 72 "

(C) Mass - 11 weeks = 66 "

+ 12 da. (On Job Mob & Demob)

EX-PAT - LABOR + Subsist.

(A) 944 × (60+12) + (72da × 17hr × 40^{hr}) = $116,928 + 21,600 = 138,
67,968 + 48,960

(B) 944 × 84 + (84 × 17 × 40^{hr}) = $136,419 + 25,200 = 161,6
79,296 + 57,120

(C) 944 × 78 + (78 × 17 × 40^{hr}) + 23,400 = 150,07
73632 + 53040 = $126,672

Office Trailer + (1) Barge Rent @

ALL EQUIP in O.M Unit Costs except Office Trailer & Barge (in OH

∴ MOB/DEMOB PRORATED TO ITEMS $56,490

EX PAT LABOR OH + Subsist. - PRORATED TO ITEMS

Depending on Wall type

(A	138,528
(B)	161,619
(C	150,072

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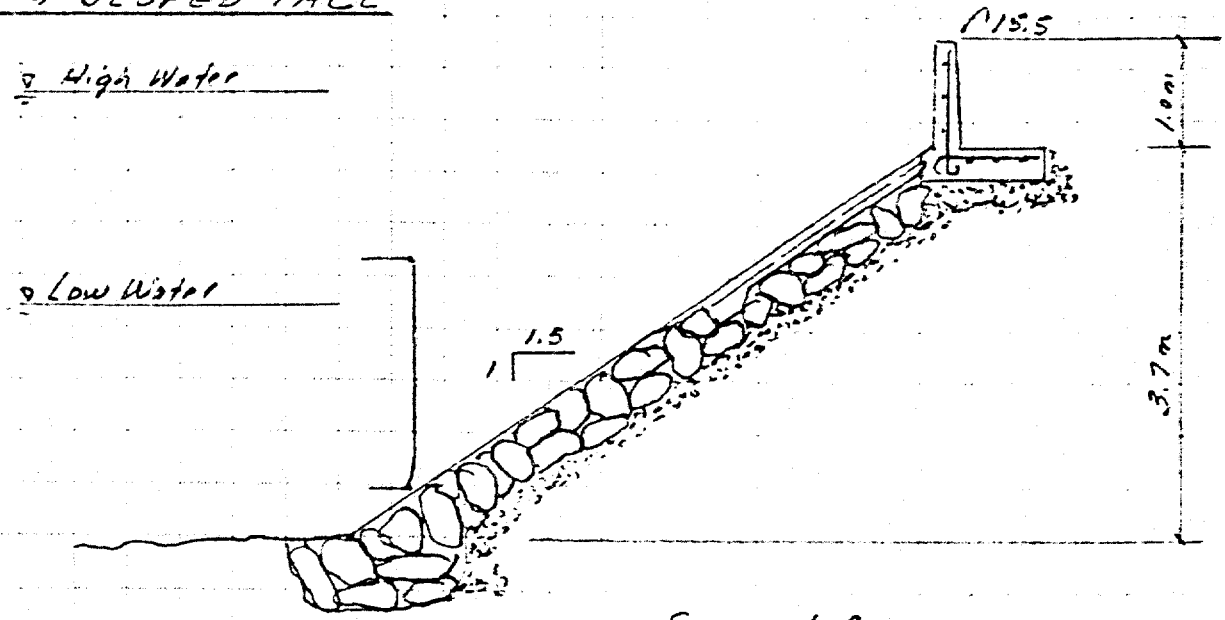
MOFFATT & NICHOL, ENGINEERS	CLIENT USAID - KHARTOUM	JOB NO. PROJ. 650-0060
	PROJECT RIVER TRANSPORT AG MRTG	SHEET OF
	DESIGN FOR JUBA PORT	DESIGNER / DATE
		CHECKER / DATE

WALL & SLOPED FACE



SCALE 1:80

ITEM	Q (80m WALL)	UNIT PRICE fc	UNIT PRICE lc	£S fc	£S lc
EXCAVATION W/SOME BLASTING	800 m³	18.5	-	14,800	-
BEDDING	240 tons	30	3	7,200	720
ROCK (200-300 kg)	840 tons	14.5	5	12,180	4,200
CONC. SLOPE -	100 m³	247	168	24,700	16,800
REBAR -					
Smooth - slope-in place	1300 lbs	-	1.3	-	1,690
Deformed - wall in place	15000 lbs	2	.3	30,000	4,500
WALL FORM	240 m²	30	8	7,200	1,920
CONCRETE	64 m³	325	168	20,800	10,752
FINISH	320 m²	-	4	-	1,280
STAIRS	4 EA	750	2000	3,000	8,000
BACKFILL	160 m³	9	2	1,440	320
BOLLARDS	5 EA	900	120	4,500	600
				125,820	50,782

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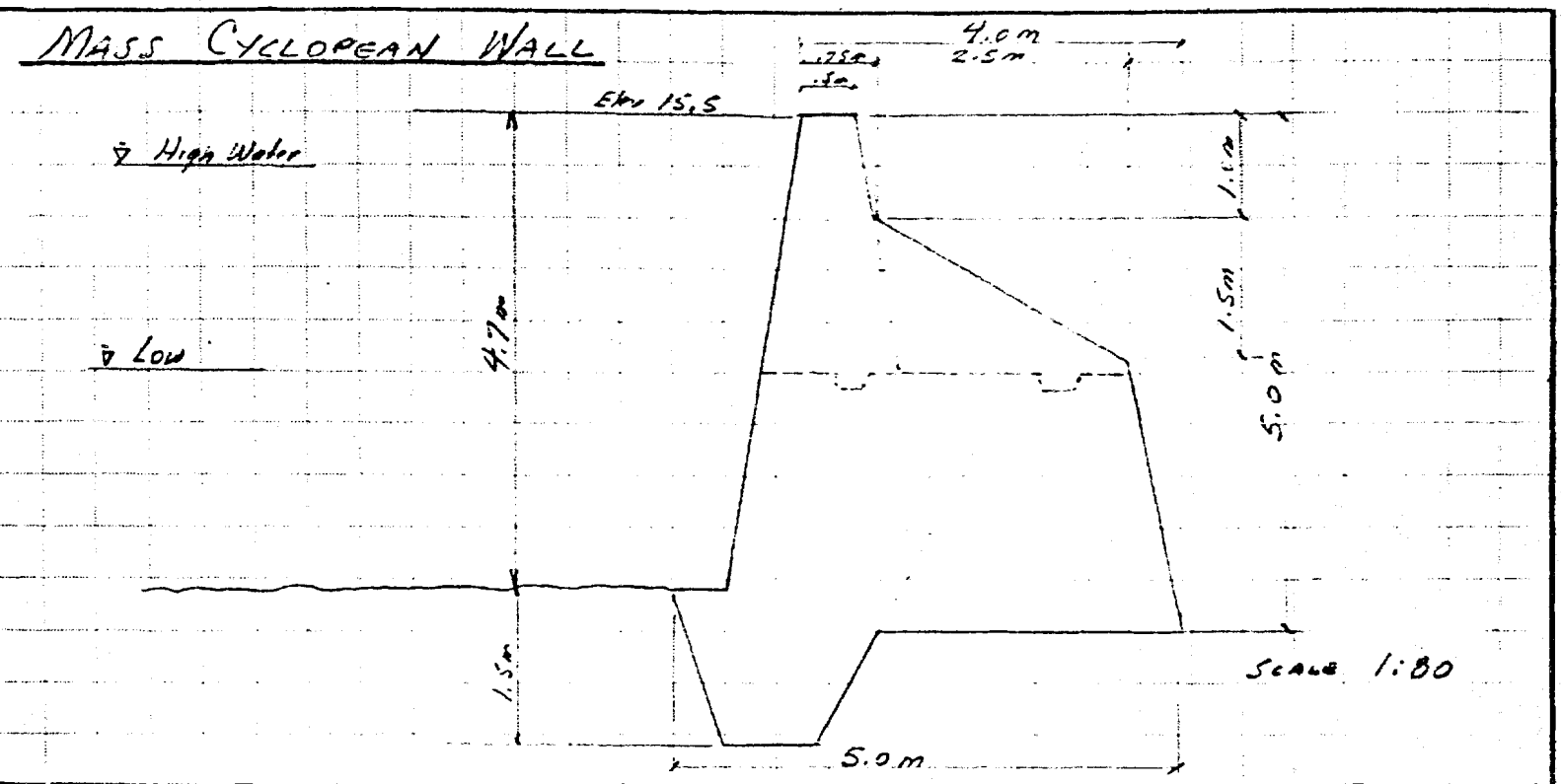
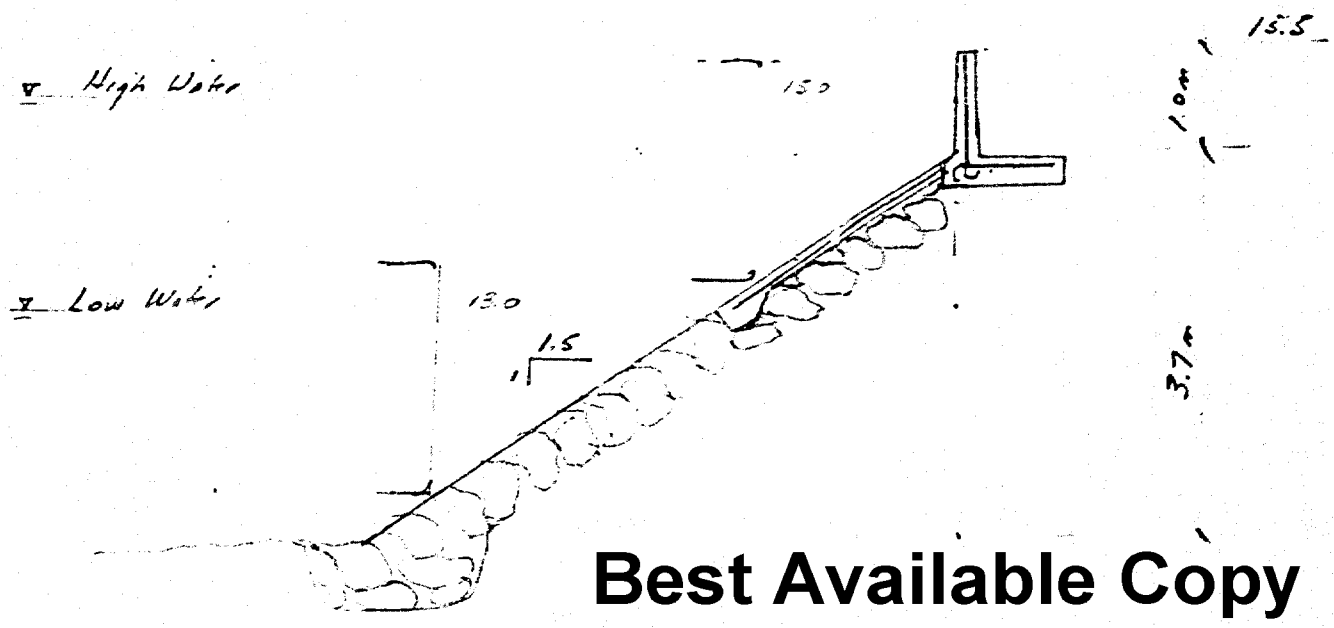
MOFFATT & NICHOL, ENGINEERS	CLIENT USAID - KHARTOUM	JOB NO. PROJ. 650-0060	
	PROJECT RIVER TRANSPORT AG MKTG	SHEET OF	
	DESIGN FOR JUBA PORT	DESIGNER	DATE
		CHECKER	DATE

MASS CYCLOPEAN WALL



ITEM	Q (80m HWM)	UNIT PRICE f.c.	UNIT PRICE l.c.	£S f.c.	£S l.c.
EXCAVATION W/SOME BLASTING	2800 m³	18.5	—	51,800	—
MASS WALL TYPE A & B					
ROCK - (200-300 kg)	1680 tons	14.5	1	24,360	1,680
CEMENT - (Robat) } FOR BATCHING	2378 sacks	8	20	19,024	47,560
SAND - (River) } FOR BATCHING	508 tons	10	3	5,080	1,524
AGGREGATE (QUARRY) } FOR BATCHING	573 tons	30	3	17,190	1,719
FORMING - WET	240 ¢m	40	10	9,600	2,400
" - DRY	280 ¢m	30	8	8,400	2,240
FINISH - (FRONT to WL)	200 ¢m	-	4	—	800
STAIRS (@ 20°-45°-2m)	2 EA	-	7500	-	15,000
BACKFILL inc. Compaction	1400 m³	9	2	12,600	2,800
CONCRETE PLACEMENT	816 m³	20	5	16,320	4,080
BOLLARDS	5 EA	900	120	4500	600
Concrete Placement	816 m³	20	5	16,320	4,080
BOLLARDS	5 EA	900	120	4,500	600
				168,874	75,723

(3) Vertical and Slope Wall



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Scale 1:80

PREL. QUANTITIES - 80mm berth

Excavation (maybe some blasting) 10m x 80m = 800 m³

Bedding 2m x 80m x 1.5 t/m³ = 240 tons

Rock 3m x 3½m x 80m = 420m³ x 2 t/m³ = 840 tons - Armor (200-300 kilos)
(300-500 kilos ~ 2-300 kg) 300 tons - Filter - (5 kilos)

Conc. Slope 80 x .20 x 3 = 48m³ x 2.4 t/m³ = 100 m³ (2.4 t/m³)

Rebar

Smooth - 15 #/LF x 11 LF/m² x 3 x 80 = 1300 #

Deformed - ~175 #/LF . 175 x 1.047 x 80 = ~ 15000 #

Wall Form - 1.5 x 2 x 80 = 240 m²

Concrete .8m³ x 80m = 64 m³ (8 cu/m³)

Finish (inc. slope) = 4m x 80m = 320 m²

Stairs - 4 (270mm o.c.) = 4 ea

Backfill 2 x 80 (good material) = 160 m³

Potholes = 5 ea

All const. from land - no water rigs

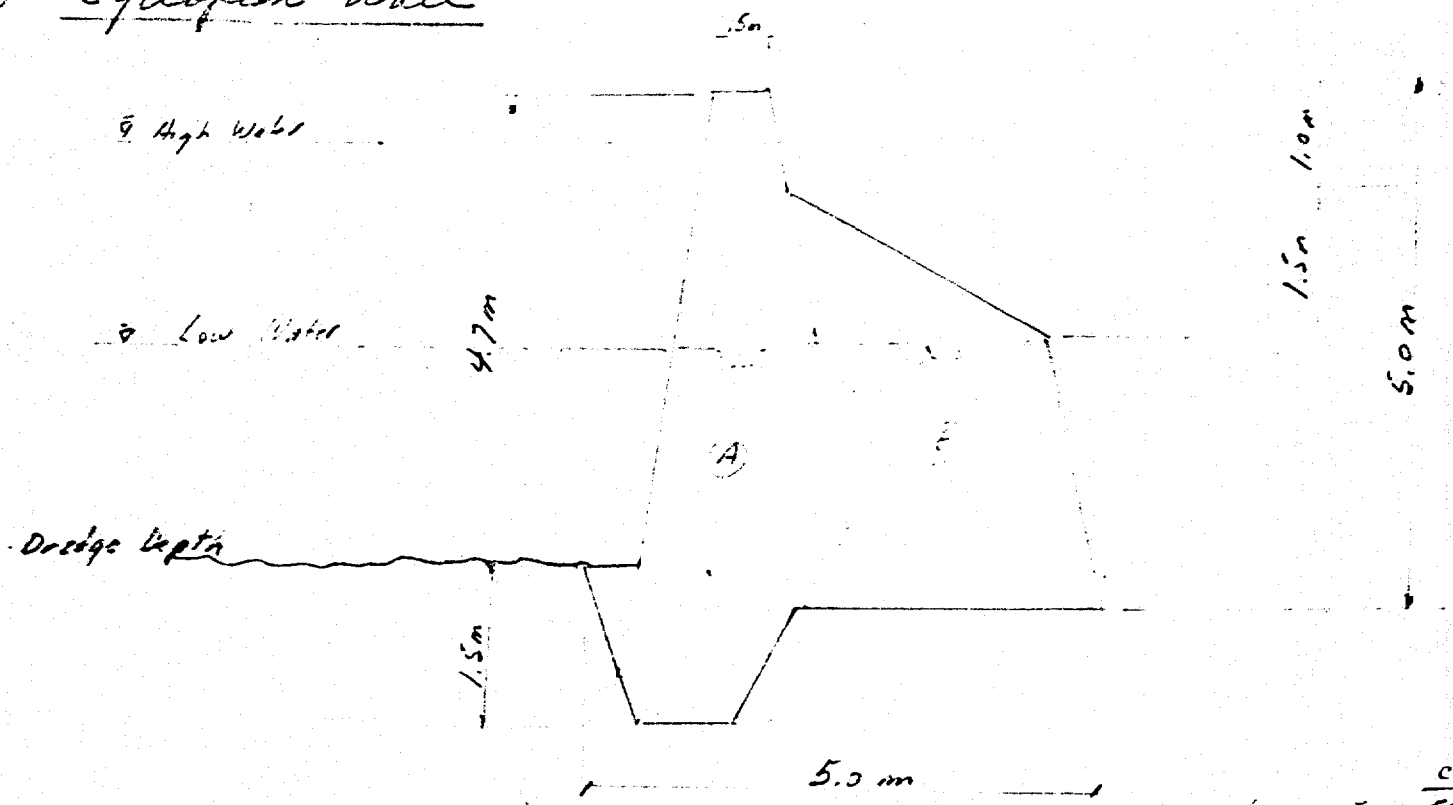
Equipment

Hydraulic Gradall - reach - 5 meters
D-?
Grader
Rock Drill (?)

Misc. Mat'l (not finished)

Timber Forms
Wire - Conc. Spacers (chairs)
Saws for cutting
Bond breaker spray
Blasting mat'l (matting)

(C) Cyclopean Wall



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CY
Cement - 528# - 60
40% sand - 2112#
50% agg - 2640#

Prelim Quantities (80 mm Depth)

Excavation (some blasting?) 35 m³ × 80 = 2800 m³

Mass Wall - 2 types (Type A - 2500 ft², Type B - 1750 ft²)

Type A:

25 m × 6.5 m + .3 m ~ 9.3 m/lm

9.3 + 6.5 = 15.8 × .3 = 4.74 m² = 380 m

* 50% Voids ~ 4.7 cm/concrete

Cement × 4.7 =	25.2 sacs Cement	× 80 m	= 2256 sacs
Sand × 4.7 × 2112#	9926# = 4.5 Tons	× 80 m	= 360 Tons
Aggregate 4.7 × 2640#	= 5.6 Tons	× 80 m	= 448 Tons

Cement 2378 sacs
Sand 508 T
Aggregate 573 T

Type B:

5.0 m × .3 m ~ 6.5 m/lm

* 30% Voids ~ 3.2 cm/cone.

Cement × 3.2 =	12.8 sacs Cement	× 80 m	= 1024 sacs
Sand × 3.2 × 2112#	= 3.1	× 80 m	= 248 Tons
Aggregate 3.2 × 2640	= 3.8	× 80 m	= 304 Tons

Forming - (Front Only - Walkway + Back Only - top 1.0 m)

Wet - 3.0 m × 50 m = 240 sm

Dry (2.5 m + 1.0 m) × 50 m = 280 sm
front back

* Note: A
Use Rock - Occupies 70%
Voids 30%

Backfill - 17.5 m² × 80 = 1400 m³

Finish - 2.5 m × 80 m = 200 m²

2352

Plant - Ts 12 /sak 12.-

Transport 1435 Km x .072 = 103.32/20 = 5.17

Ts 17.17 ~ 18 /sak Jobe

Sand - Ts30/meter @ Rabat. = 3200# = 1.5 tons = Ts20/ton

Transport 1435 Km x .072 = 103.32/ton

20.32

Ts 123.64 /ton

Note - Take Sand out of River - See G.H Estimate

Aggregate

✓ Cost of Crushing @ Quarry - ~

See Rock Cost = 14.5 + 15 (crush) = 30

Excavation -

Blasting - ~ $10,000 x 1.8 = 18,000

Time - 12 da x 8 x 250# = 24000 x 1.8 = 43,200

@ American @ OSM

51,200 ÷ 2800 = 18.5

Backfill - inc compaction

Time - 3 da x 8 x 250# = 6000

@ American

3 da x 8 x 50# = 1200

@ D.C

(7200 ÷ 1400) x 1.8 = $9/m³

Local Sol. 10 x 8 x 3000 = 2400 ÷ 1400 ~ 2.

Conc. Mixing . Placement

Bedlock 21 . Rate 50 m³/da 816/50 = say 15 da -

Buy for job = $10,000 - 2000 cap ~ $13,000 + $3000 sal = $17,000/816 = 20 x 15 = 36$

10.2 m³/m x 80 = 816 m³ = 16.5 say 20/m to place

50 m³/da - Crew - Sustained 20 x 2.5 = 100/da ≈ 5 /m³

Balances

12" Pipe Already on site - Weld Bars, Drive, = Lay Coal

	fc	Lc
Drive - (see HP.)		
875 x 5	4375	
Weld (equip)		
1 da.	200	
Loose		100
Conc. 1 yd x 5		500
	4575	600

Rock

Haul $40 x 2 hr = $80 ÷ 30T = $2.67 /T

Blast - Load $200/hr . 30 T/hr = 1.33

Place - Drag - $200/hr ÷ 5 x 20 = 4.00

8.00 x 1.5 = 14.5

Local labor - 5 x 5 x 10 = 40 x 7h x 1

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MOFFATT & NICHOL, ENGINEERS	CLIENT USAID - KHARTOUM	JOB NO. PROJ. 650-0060	
	PROJECT RIVER TRANSPORT AG MKTG	SHEET	OF
	DESIGN FOR JUBA PORT	DESIGNER	DATE
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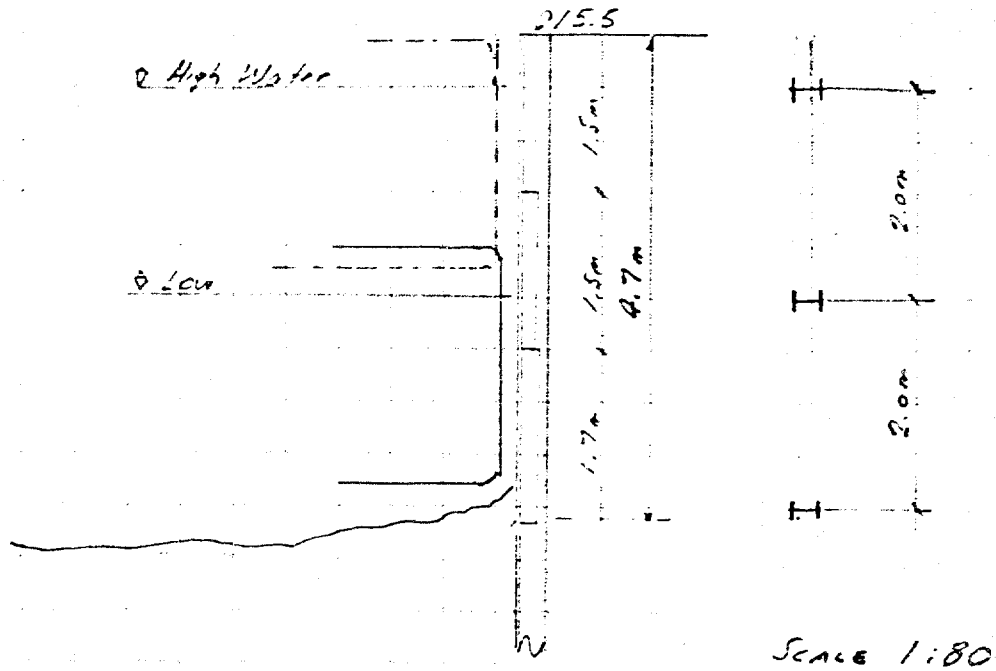
STEEL SOLDIER PILES & LAGGING

FOR JUBA

W.L. Δ = 2.0 m
Frbd = .5m
Draft = 1.2m
Clear = [illegible]
Over dredge = .6m
4.7 m



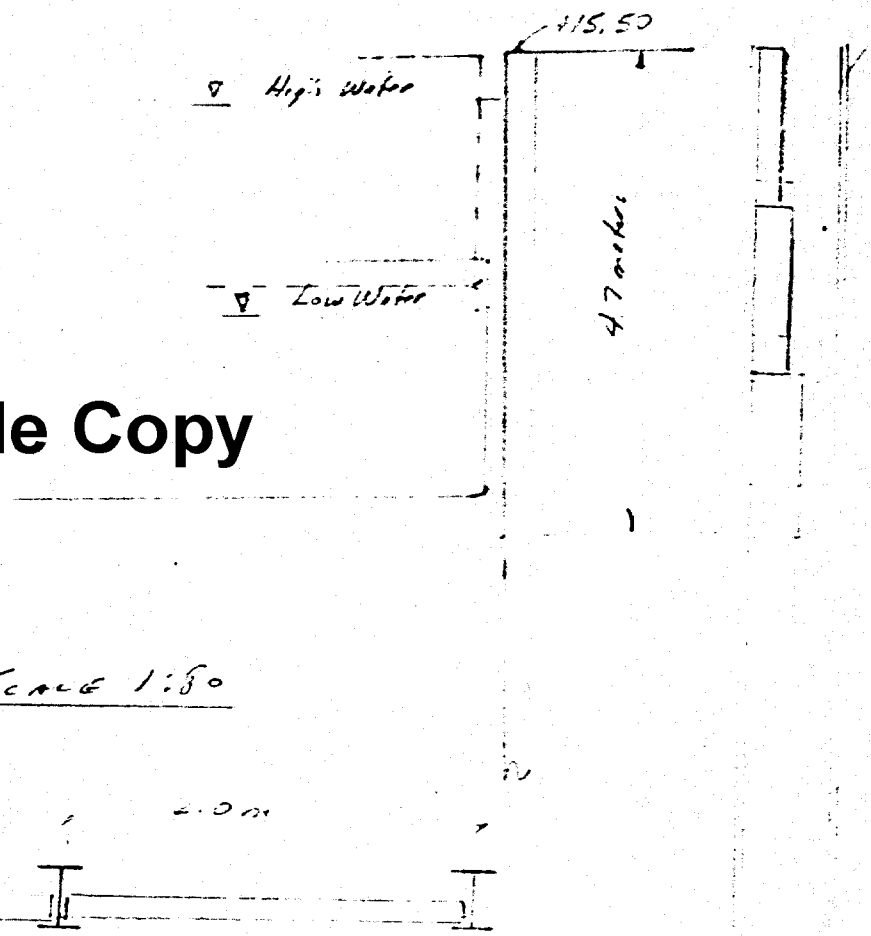
SCALE 1:80

ITEM	Q (80m WALL)	UNIT PRICE fc	UNIT PRICE lc	ES fc	ES lc
EXCAVATION w/some blasting	2400 m³	18.5	–	44,400	–
BUY 41- HP12-74 × 35' FOB JUBA	53 tons	1350	100	71,550	5,300
~~MOB + DEMOB COST (FAC TIME)~~	~~L.S.~~				
DRIVE w/some drilling	41 ea	875	–	35,875	–
R.CONC PANEL LAGGING - MAKE	165.5 m²	585	168	96,817	27,804
" " " - PLACE	120 EA	60	2	7,200	240
BACKFILL - inc compaction	1500 m³	9	2	3,500	3,000
BOLLARDS (USE 12"φ PIPE ON SITE)	5 EA	900	120	4,500	600
BROWS	2 EA	5000	2500	10,000	5,000
				273,242	41,944

Water Level Variation - 13.00 – 15.00 gage (m)
Freeboard .50 meters
Barge Loaded Draft 1.8 meters
Clearance - .4 meters

2.7 meters + water elev changes

Type of Wells -
(A) Vertical - @ low water = 2.7 + 2.0 = 4.7 meters (15.4')



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Prel. Quantities - (80 m long) - | Steel Soldier Piles & Lagging |

41 H Piles x ' x # = =

Cap 260' (80 m) x WF x # = #

Drill & Drive 41 piles 41 ea NOT TO SCALE

Lagging - Timber

Bracing 5 ea

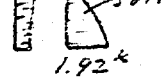
Excavation 30 m x 80 m = 2400 m³

~~Backfill [illegible] 600 [illegible]~~

Backfill [illegible] m³

$\gamma_s = 120$ pcf (combined) $M_{max} = .1283\ WL$

$W_{LF} = \frac{16' \times 120}{2} = .96\ k/LF \sim 1\ k/LF$



$M_{soil} = 1.92 \times \frac{16}{3} = 10.2$

$M_{misc} = 200 \times 16 \times 8 = 25.6^{'k}$

$M_{max} = 35.8$

$f_s = 36$ ksi

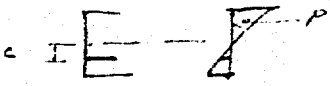
$S = \frac{35.8 \times 12}{36} = 12\ in^3/'$

HP12-74 $S = 93.4$

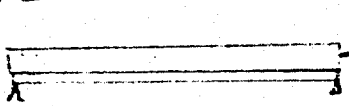
$934/12 = 7' \sim 2$ metres spacing

Conc. Logging

$f_c' = 1345$ psi $f_c = 3000$ conc.



12 x 4 =



$M_{max} = 3.5 \times 3.5 = 12.3^{'k}$

$A_{comp} = \frac{12.3}{1.345} = 9.14^{in}$

For Qs

Say. 11.5" thick - 1st - 1.7m bottom
2" thick - 2nd 1.5m
6" " - 3rd 1.5m top

∴ Conc Logging = 1.7m x 2.0 x .3 = 1.02 m³ x 40 ea panels
1.5m x 2.0 x .12 = .16 " x 40 ea "
1.5m x 2.0 x .15 = .45 " x 40 ea "
2.07 m³/m

Rebar - say 175#/cy = 225#/m³ 465#/m

Piles

53 tons x 600/ton = 31,800
Ship to Rosti 6,000
Unload. 1,000
38,800 ÷ 53 = 750 x 1.8 = 1350

Ship - RTC Tolan
53 tons x 1456 x .075 = 5708 ~ 100

Drive

Say. 1/hour. 41 hrs x 250 = 10250

Drill - say - 20% x 55' x 41 = 287' Say - 5'/hr = 40'/day = 7 days

Equip - 175 x 7 da x 8 hr = 9800
20,000 x 1.8 = 36000 ÷ 41 = 875

Conc. Panels

[illegible] 2.07 m³ x 20 = 207.50 = 24870
Sink = 1.5 T/em 3 x 165.5 = 500
Rigging 1.5 T/em x 165.5 x 5 827
Forms - [illegible] x [illegible] tm.
550
1.8 = 1632 = 6100
69001
Rebar - 465# x 165.5 x 20 =
27500 + 78804 = 15000 (Rebar)
27500 96804
= 165.5 · 169 = 585

Site - Site
Sod Labor - 5 · 4p x 10 = 200
Stripping - 5 x 8 x 100 = 4000 x 1.8 =

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MOFFATT & NICHOL, ENGINEERS	CLIENT USAID - KHARTOUM	JOB NO. PRN. 650-0060	
	PROJECT RIVER TRANSPORT AG MRTG	SHEET	OF
	DESIGN FOR JUBA PORT	DESIGNER	DATE
		CHECKER	DATE

MOB & DEMOB ESTIMATE - ALL LANDSIDE WORK

		$US
A. IF WORK INDEPENDENT OF PORT DREDGING		
1. Mobilize from Kosti - Transport to Juba (GH)		178,600
2. Demobilize Juba - Transport to Kosti		
Equip Bare - 7da x 1500		10,500
Mobile Crew w/ Equip (GH)		28,600
3. LABOR MOB & DEMOB (RON)		81,576
4. VARIABLE COST / DAY - LABOR, EQUIP, SUBSIST		
Note: Unit prices have direct labor charges		
OH - $944/da (RON)	944	
Equip - $700 x 8 = $5600/da	5600	
Subsist - 17 x 40 = $680/da	680	
	7224	
Ave wait + backlog time = 12 weeks		
12 x 6da x (944 + 680)		116,928
12 x 6da x (5600 x .C)		20,640
		$496,544
B. IF WORK CONCURRENT w/ PORT DREDGING		
CREDIT 56,490 (RON)		$(56,490)
		440,354
		x 1.8
		792,637

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MOFFATT & NICHOL, ENGINEERS	CLIENT USAID - KHARTOUM	JOB NO. PROJ 650-0060	
	PROJECT RIVER TRANSPORT AG MKTG	SHEET	OF
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SUMMARY - cont.

F. ALTERNATES - W/ OH, P, Cont. (for Juba use 15%)

a. Short Term W/o Transit Shed (A)

2,513,349 x 1.08 = 2,714,441
Profit (12%) = 325730
Cont. (15%) = 456026

£S 3,496,197

b. Short Term W/ Transit Shed (B)

3,042,613 x 1.08 = 3,286,022
Profit (12%) = 394,323
Cont. (15%) = 552,052

£S 4,232,397

c. Minimum Short Term (c)

22,270 x 1.08 = 24,052
Profit (12%) = 2,886
Cont. (15%) = 4,041

£S 30,979

D. Minimum Short Term W/ Dredging (D)

645,870 x 1.08 = 697,540
Profit (12%) = 83,704
Cont. (15%) = 117,187

£S 898,431

E. Min. Short Term + Dredg + Channel Imp.

1,120,870 x 1.08 = 1,210,561
Profit (12%) 145,267
Cont. (15%) 203,374

£S 1,559,202

MOFFATT & NICHOL, ENGINEERS	CLIENT USAID - KHARTOUM	JOB NO. PROJ. 650-0060	
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		CHECKER	DATE

SUMMARY - BARE W/O OH, P, Cont.	£S fc	lc
A. SHORT TERM - W/O TRANSIT SHED		
BACKLAND IMPROVEMENTS	201,845	18,695
SHORT WALL & IMPROVED SLOPE	155,820	50,782
STIFFLEG CRANE + VERT MASS WALL	331,650	28,380
DREDGING & CHANNEL WORKS	963,540	-
MOB & DEMOB + SUBSIST.	792,637	-
	2,415,492	97,857
	2513,349	
B. SHORT TERM - W/ TRANSIT SHED (A+)		
ADD'L MOB & DEMOB + SUBSIST. (10%)	79,264	-
TRANSIT SHED - 100' x 180' (per Chinese £250,000 Rebid)	450,000	-
	529,264	
+ A.	3,042,613	
C. MINIMUM SHORT TERM		
CLEAR WATERFRONT	11,520	750
MOB & DEMOB - (W/ fc)	10,000	
	21,520	750
	22,270	
D. MINIMUM SHORT TERM W/ DREDGING		
C. (less MOB & DEMOB in dredging)	11,520	750
DREDGING + MOB & DEMOB	633,600	-
	645,120	750
	645,870	
E. (D) + CHANNEL IMPROVEMENTS		
CHANNEL IMPROVEMENTS = 283,900 x 1.5	475,020	
	1,120,890	

MOFFATT & NICHOL, ENGINEERS	CLIENT	JOB NO.	
	PROJECT	SHEET OF	
	DESIGN FOR	DESIGNER	DATE
		CHECKER	DATE

PORT OF JUBA

NAV IMPROVEMENTS:

DREDGING (*452,000 + 176,750*) x 1.8 = £S 1,131,750

CHANNELIZATION (*264,000 + 103,234*) x 1.8 = 661,021

BERTH IMPROVEMENTS - INC. BACKLAND

WALL

STEEL SOLDIER PILE + LAGGING (325,786 + 127,396*) = £S 453,182

MASS CYCLOPEAN (244,597 + 95,659) = 340,256

SHORT WALL + IMPROVED SLOPE (176,602 + 69,058) = 245,660

CRANE + 30m Vertical Wall

STIFFLEG + MASS CYCLOP. (360,030 + 140,786*) = 500,816

BACKLANDS

STABIL., FENCE, LIGHT (220,540 + 86,240*) = 306,780

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* Contractors GH, P, Cont.

MOFFATT & NICHOL, ENGINEERS	CLIENT USAID - KHARTOUM	JOB NO. PROJ 650-0060	
	PROJECT RIVER TRANS AG MKTG	SHEET	OF
	DESIGN FOR RENK PORT	DESIGNER	DATE
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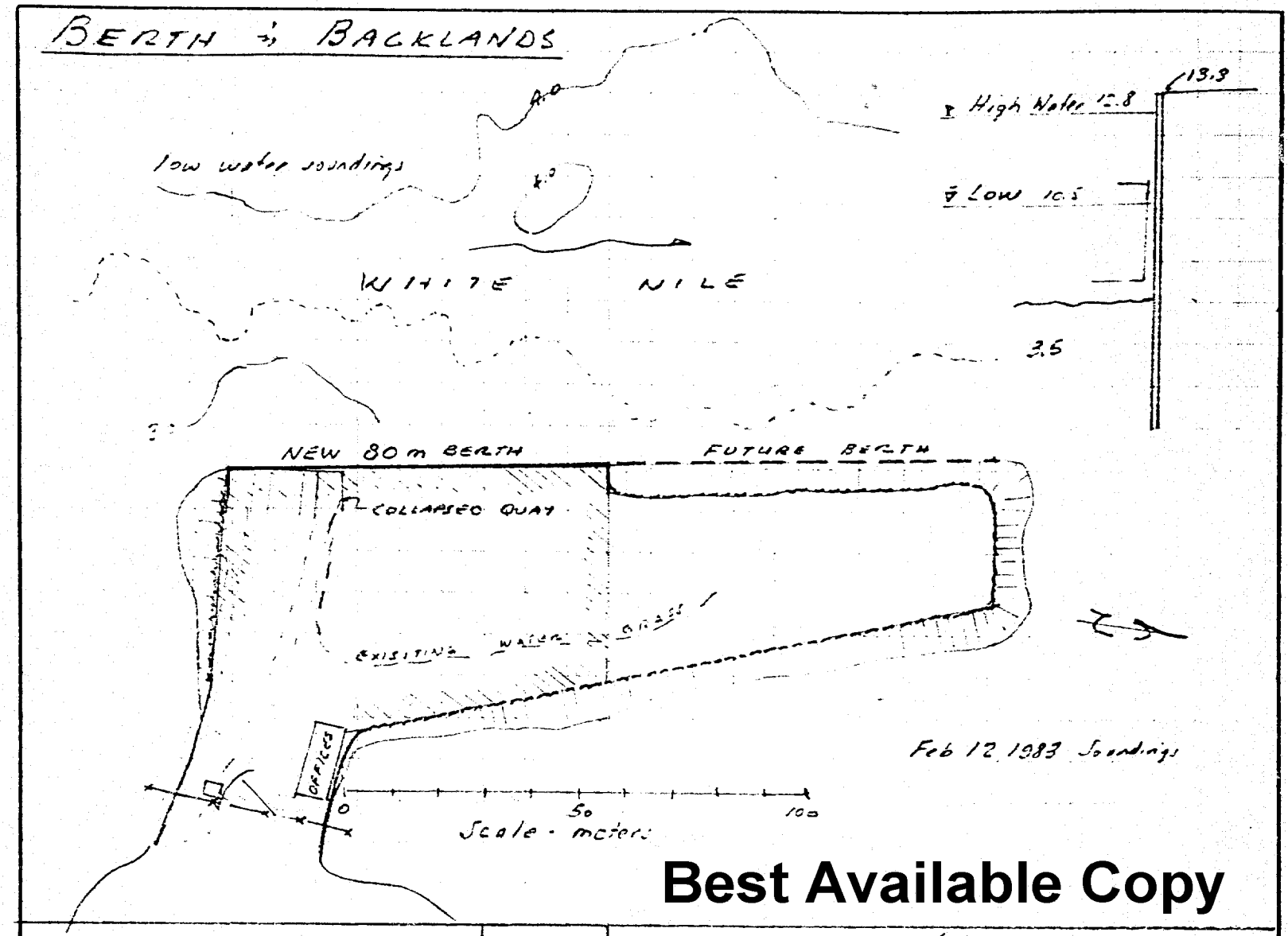
BERTH & BACKLANDS



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ITEM	Q	UNIT PRICE £S fc	UNIT PRICE £S lc	£S fc	£S lc
REMOVE OLD QUAY & BOLLARDS	L.S.	5000	500	5,000	500
EXCAV., HAUL & FILL	63,800 m³	13.81	–	881,078	–
SLOPE PROTECTION SURFACE TREAT	270 tons	25	5	6,750	1350
2 PSC SHEET PILE FD. & Jacklc	331 tons	1223	13	405,153	4303
DRIVE SHEET PILES	150 EA	675	8	[illegible]	1200
[illegible] CONCRETE PAVEMENT - INC BASE	1710 tons	20.4	41.2	[illegible]	70,452
FINE GRADING	5700 m²	149	.70	[illegible]	3,990
BOLLARDS	5 EA	1075	–	5,375	–
LIGHTING - STREET ENG.	3 EA	20000	2000	[illegible]	1,000
FENCING & 1 VEHICLE GATE	45 m	125	20	5,625	35
GUARD HOUSE	1 EA	–	1000	–	1,000
OFFICE BUILDING	120 m²	500	100	[illegible]	12,000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

MOFFATT & NICHOL, ENGINEERS	CLIENT USAID - KHARTOUM	JOB NO. PRN. 650-0060	
	PROJECT RIVER TRANS AG MRTG	SHEET OF	
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BERTH & BACKLANDS - cont.

	£S	
	fc	lc
	1,583,878	108,930
MOB + DEMOB + SUBSISTANCE	115,920	24,000
	1,699,798	132,930
TOTA £S	1,832,728	
O.H (8%)	146,618	
	1,979,346	
PROFIT (12%)	237,521	
	2,216,867	
CONTINGENCY (15%)	332,530	
	£S 2,549,397	

Use Vertical Wall - Sheetpile -

Water - 12.8 high
10.5 low
2.3 Δ

Barge 1.8
Clearance .4
Freeboard .5

5.0 meters = 16.4' clear face

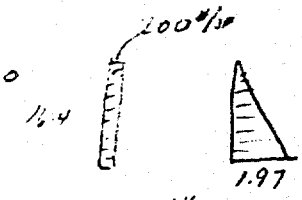
P232, S = 670 ok to use

For 80 meter berth = 263'

No of P232 = $\frac{263 \times 12}{21}$ = 150 piles

Tonnage = $\frac{45 \times 56 \times 263'}{2000}$ = 331.3 Tons

$\gamma = 120$



M = 26.24'k M = 88.3'k

M_{TOT} = 114.44 'k

$S = \frac{114.44 \times 12}{36} = 38.15 in^3$

penetration ~ 29'
∴ length = 45'

PILE FOB Jobsite

Buy @ Port Sudan = 600 /ton
Deliver to Rabak = 75 /ton
Load on Barge = 10
685 × 1.8 × 331.3 = £ 408492 = fc
170 × .072 × 331.3 £ 4055 = lc

FILL

170m × $\left(\frac{30+66}{2}\right)$ × (3+2.8) = 47528

30 × 20 × (2.5+2.8) = 3180

5 ⅀ 500 m perim × 25 m³ = 7500

58008 ~ 58000 m³ × 1.1 shrinkage = 63,800 m³

SLOPE PROTECTION - South face only

5 ⅀ 1m × 50m = 450m² × .3m × 2 t/m³ = 270 tons

fc = 25 £ 6750
fl = 5 = 1350

FILL

	Rate	0.14 DAY
D-8	100	800
950 Loader	85	680
Water Wagon		150
8-10m³ trucks (avg 12 miles)	480	3840
		3 £ 4520 /day
		= 1250 da
		560 Subsidiary 45 da
		100 Maintenance
		7360 da

Wages
Eng. 1 PM 40
Super 25
Clerk 25
& Survey 60
160 × 5 = 120 £/da

Production: Haul 3.6 mile
20 truck miles 10 trips/day
8 × 10 × 12 = 960 m³/day

7360 / 960 = 7.67 × 1.8 = 13.81 /m³

* Note: Mobilization for Fill - (1 da equipment time from Kosti) × 24 × 7360 × 1.8 = 26,496

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Drive Sheetpile

Driving Rate - 2½ sheets/hr - say 1 meter/hour = 8/day

Water Rig -

250/hr D.H. - 100 T Crane w/ Hammer - = 250

Pile Boats - 3 @ 33 ea = 100

Barge - = 25

375 × 1.8 = 675

Subsence 4 @ 2

# of days = 150/8 = 19 days × 8 × 675

+ Mob & Demob + Subsist.

[150/8 days × 4 × 40] + 4 [120 crane, 1530 Tug, 250]

100 × 4

3400 + 7880 = 11,280 × 1.8 = 20304

Soil Cement Placement

85 × (50+70)/2 = 5100 6" = .15 cm

30 × 20 = 600

5700 m² × .15 = 855 m³ × 2.00 m/m³ = 1710 tons

Barge Sand & Cement From Rabak

Sand 2530/m³ × 855 @ Rabak = lb = 25650 lb

Cement 27 × 40 sacks/m³ × 855 = lb = 23940 lb

Barge = 1710 tons × 170 × .272 = 80,930 lb

41.23

Grader - 18 165 × 8 = 9360

Drag - 3 ea × 8 × 250 = 6000

D-8 - 5 ea × 8 × 100 = 4000

19360 × 1.8 = 34848 lb = 20.37

Fine Grading

Grader - 3 × 65 × 8 × 1.8 = 2808

Subsence 5 × 8 × 10 × 10% = 4000

Bollards

Drill 12" hole & fill w/ concrete

Bag & weld & Drive to Rock - 500 × 1.8 = 900

Drive - 1 ea item = 675

Conc. = 100

1675

Fencing -

Chain - 40 m @ Rabak

say 70 m × 1.8 = 126

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Lighting

Pole, Fixture, transformer, - say 20,000 ea.

Moor Subsistence

8 ea × 40 × 120 da = 38,400 × 1.8 = 69120

TOTAL MOB, DEMOB, SUBSIST. = 115,930 fc

APPENDIX No. 3

1983 POPULATION, LOCATION OF AGRICULTURAL AND INDUSTRIAL PRODUCTION

Contents

- Preliminary Population Figures by Region and Mode of Living
- Table 5 and Figure 2 Sudan Transport Study Master Plan, Assoc. for Development of Arab Resources, 1973
- Unpublished data from the Ministry of Industry, 1983

PRELIMINARY POPULATION FIGURES BY REGION AND MODE OF LIVING

REGION	MODE OF LIVING (000's of individuals-rounded)			
	Urban	Rural Sedentary	Nomads	Totals*
Northern	230	802	50	1 083
Eastern	639	1011	559	2 208
Central	825	2943	244	4 013
Kordofan	389	1924	781	3093
Darfur	316	2 308	470	3094
Khartoum	1344	371	88	1802
Equatoria	177	1 230		1406
Bahr El Ghazal	182	2084		2 266
Upper Nile	53	1547		1600
Sudan totals*	4 154	14 219	2 192	20564

* May not add due to rounding

Source: 1983 Census Min. of Finance and Economic Planning
Unpublished Data

TABLE 5

PROJECTED AREA AND PRODUCTION OF
MAJOR AGRICULTURAL EXPORT-ORIENTED COMMODITIES
BY PROVINCE, LOCATION AND TYPE, 1985
(Area in 000 Feddans and Production in 000 Metric Tons)

COMMODITY	PROVINCE	LOCATION NO.	LOCATION	TYPE	AREA	PRODUCTIO
Cotton	Northern	1	Dongola (Semeih Valley)	M	20	15
		2	Ez Zeidab	M	7	5
	Kassala	3	Tokar and Gash	M	50	35
		4	Kashm El Girba	M	110	75
		5	Gedarif	S	30	10
	Blue Nile	6	El Gunied	M	15	10
		7	Gezira Scheme	L	590	470
		8	Ed Duiem	L	50	40
		9	Singa and Sennar	L	93	74
		10	Kosti	L	93	74
		11	Private Pump Schemes	L	15	12
			Private Pump Schemes	M	80	55
		12	Es Suki Scheme	M	70	50
		13	Rahad Scheme (Phase I & II)	M	280	195
	Kordofan	14	Habila	S	20	5
		15	Nuba Mountains	S	510	155
	Equatoria	16	Zandi Scheme	S	40	10
Groundnuts	Northern	1	Shendi, Merowe	I	5	5
	Kassala	2	Khashm El Girba	I	65	40
	Blue Nile	3	Gezira Scheme	I	220	198
		4	Land Reform	I	20	18
		5	Es Suki Scheme	I	40	36
		6	Rahad Scheme	I	70	63
		7	Southeast area	R	200	60
	Kordofan	8	Habila and Tozi	R	10	51
		9	Nuba Mountains	R	70	20
		10	Kordofan Sands (El Goze)	R	1350	405
	Darfur	11	Nyala and El Fasher	R	350	105
	Bahr El Ghazal	12	Scattered areas	R	50	15
	Equatoria	13	Equatoria Scheme	R	100	30

Source: ADAR

Notes: L = Long Stable (Egyptian) cotton
M = Medium Stable (Acala) cotton
S = Short Stable (American) cotton

I = Irrigated Area
R = Rainfed Area

T = Traditional
C = Mechanized

TABLE 5 (Cont'd)

PROJECTED AREA AND PRODUCTION OF
MAJOR AGRICULTURAL EXPORT-ORIENTED COMMODITIES
BY PROVINCE, LOCATION AND TYPE, 1985

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COMMODITY	PROVINCE	LOCATION NO.	LOCATION	TYPE	AREA	PRODUCTION
Sesame	Kassala	1	Gadaref	R	500	85
	Blue Nile	2	Ed Damazine	R	400	68
		3	Megunis	R	10	2
		4	Mazmoum	R	10	2
		5	Dinder	R	20	4
		6	Agadi El Grobine	R	20	4
		7	Southeast (Traditional)	R	300	52
	Kordofan	8	Habila and Im Lobia	R	20	4
		9	Nuba Mountains	R	200	34
		10	Kordofan Sands (El Goze)	R	1800	305
	Darfur	11	El Fashir and Nyala	R	100	15
	Upper Nile	12	Er Renk	R	60	10
	Bahr El Ghazel	13	Scattered areas	R	50	9
	Equatoria	14	Scattered areas	R	40	6
Sorghum	Northern	1	Merowe, Barber, Shendi	I	35	42
	Kassala	2	Gash, Tokar	I	65	78
		3	Gadaref	C	2000	1100
	Blue Nile	4	Gezira Scheme	I	150	180
		5	Land Reform	I	150	180
		6	Ed Damazine	T	490	137
			Meganus (Damazine area)	C	1000	550
		7	Southeast	T	675	190
	Kordofan	8	Nuba Mountains	T	490	137
		9	Kordofan Sands (El Goze)	T	980	274
		10	Habila and Tozi	C	460	260
	Darfur	11	El Fashir and Nyala	T	160	45
	Upper Nile	12	Er Renk	C	80	22
		13	Scattered areas	T	280	150
	Bahr El Ghazel	14	Scattered areas	T	80	22
	Equatoria	15	Scattered areas	T	115	32
Gum Arabic	Kassala	1	Gedaref	R		[illegible]
		2	Hawata	R		5
		3	Gala El Nahl	R		2
	Blue Nile	4	Tendelti	R		2
		5	Singa and Kosti	R		1
	Kordofan	6	El Obeid	R		26
		7	Om Ruwaba	R		6
		8	En Nuhad	R		13
		9	El Rahad	R		3
	Darfur	10	El Fashir	R		4
		11	Nyala	R		5

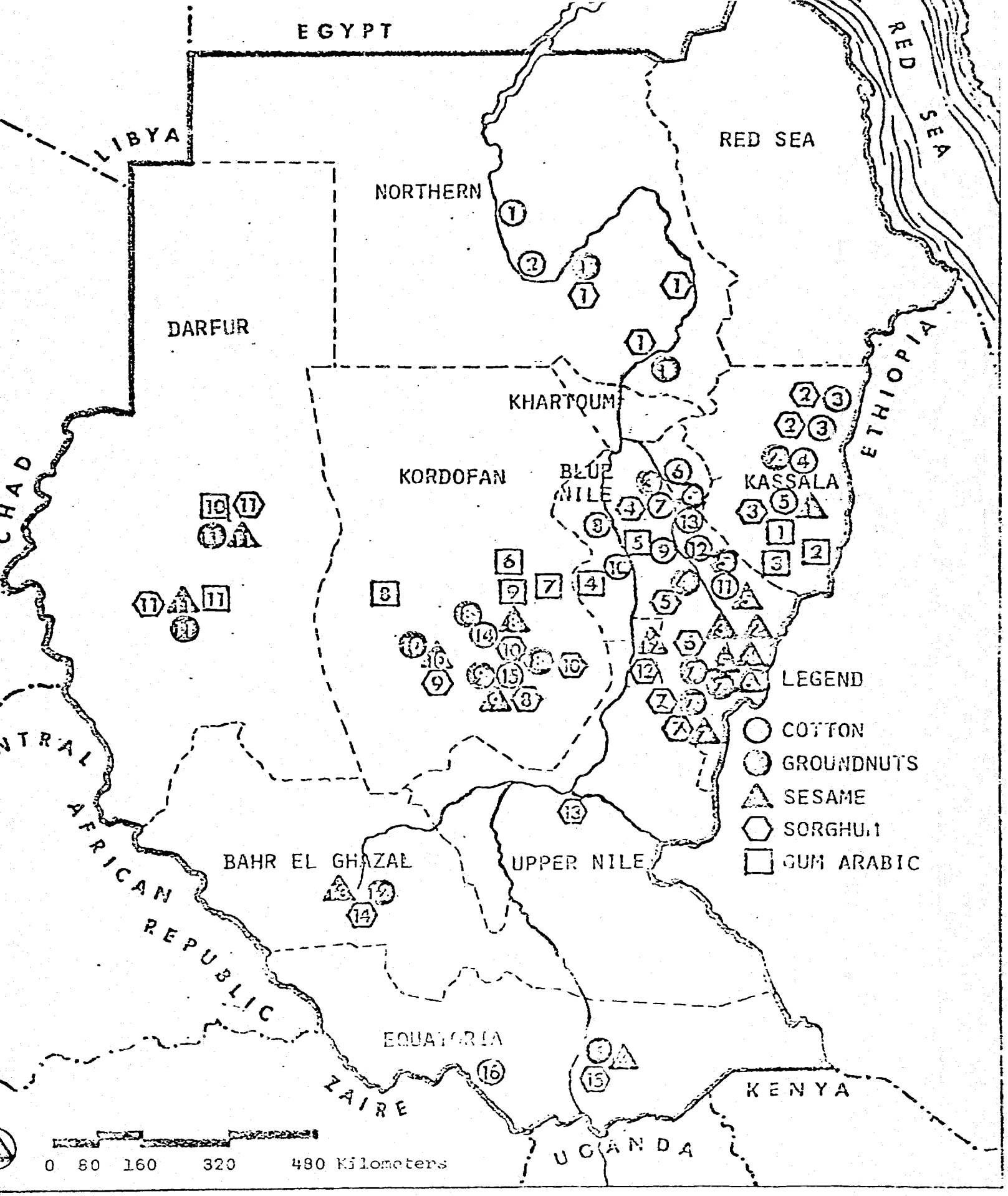

FIGURE 2

PRODUCTION OF EXPORT ORIENTED COMMODITIES

Manufacturing Firms in the Southern Region

Type of Plant	Location				
	Juba	Wau	Malakal	Mongalla	Total
Bag	1	3	2	-	6
Fishery	-	-	-	1	1
Textile	1	-	-	1	2
Tobacco	1	-	-	-	1
Canning (food)	-	1	-	-	1

Source: Ministry of Industry, 1983
Unpublished Data

APPENDIX 4

CALCULATIONS FOR CHAPTER VII

Contents

1. Alternative Operations/Costs:Mongalla to Juba

2. Shallow Draft Technology Costs

3. Truck Transport Costs

4. Savings with Removal of Unofficial Market Pricing

ALTERNATIVE OPERATIONS/COSTS: MONGALLA TO JUBA

° BASE CASE	Annualized Costs
High-water operations into Juba	
Build 1st Unit Berth at Juba	LS 460,000
Barge 2/3 tonnage to Juba	
(20,000 t) (0.05 LS/t km) (1.45)[1] (40 km)	58,000
Low-water operations into Mongalla	
Build 1st Unit Berth at Mongalla	240,000
Truck 1/3 tonnage to Juba	
(10,000 t) (0.08)[2] (55 km)	44,000
	802,000

° ALTERNATIVE No. 1 - OFFLOAD AT MONGALLA FOR YEAR ROUND TRUCKING

Year round operations into Mongalla		
Build 1st Unit Berth at Mongalla		250,000
Build & maintain new gravel road[3]		
Road const. LS 84,000/km x 55 km =	4,620,000	
Regravel @ 5, 10 & 15 yrs		
LS 9,000/km x 55 km =	500,000	
PW 5 yrs = 310,000)		
10 yrs = 193,000) =	623,000	
15 yrs = 120,000)		
Annual maint (LS 900/km) x 55 km =	50,000	
Total equivalent annual road		876,000
Trucking costs		
(30,000 t) (0.04 LS/t km)[4] (55 km)		66,000
		1,192,000

1. Cost factor for barge operations on steep Mongalla-Juba gradient.
2. Trucking cost over un-maintained gravel road during dry season.
3. From Kenya-Sudan Road Study + 15% per year inflation.
4. Trucking cost over well maintained good gravel road.

° ALTERNATIVE No. 2 - OFF-LOAD AT MONGALLA FOR TRANSSHIPMENT TO SHALLOW DRAFT CRAFT

	Annualized Costs
Year round operations to Mongalla	
Build Unit Berth at Mongalla	250,000
Build Unit Berth at Juba (no dredging) (LS 2,400,000)	250,000
Shallow draft operations year round	
(30,000 tons) (40 km) (0.107 LS/t km)[1] (1.45)	186,000
Extra transshipment of total cargo	
(11 bags/ton) (30,000 tons) (0.8 LS/bag)[2]	264,000
	950,000

° ALTERNATIVE No. 3 - DREDGE TO JUBA FOR YEAR ROUND OPERATIONS

Year round operations to Juba	
Build & dredge at Juba (@ 4,500,000)	460,000
Barge full tonnage	
(30,000 t) (0.05 LS/t km) (1.45) (40 km)	87,000
Annual dredging	2,232,000
	2.779,000

1. See following page
2. 0.4 LS/bag for either off-loading or loading (see trip notes in Appendix 6 for 1983 costs)

Shallow Draft Technology Costs

- The Hoffman Scheme -

(1983 LS)

Capital Costs

250 hp tug	=	LS 1,000,000 delivered
100 ton barge	=	LS 325,000 assembled
4 barges	=	LS 1,300,000

Operating Costs per Trip (Kosti-Juba; one trip/mo.)

Fixed Costs			
Depreciation	2,300,000 @ 5% ÷ 12 mos.	=	9,580
Interest	2,300,000 @ 12% ÷ 12 mos.	=	23,000
Repair: Tug	1,000,000 @ 7% ÷ 12 mos.	=	5,830
Barges	1,300,000 @ 5% ÷ 12 mos.	=	5,420
Overhead @ 20% of total cost		=	15,387
Variable costs			
Crew salaries		=	10,103
Fuel	2.5 LS/km x 3,000 km	=	7,500
			76,810

Cost/Ton-Km = LS 76,810 ÷ 500[1] t ÷ 1,436 km = 0.107

1. 400 tons upstream; 100 tons downstream.

TRUCK TRANSPORT COSTS

• From Kenya - Sudan Road Study, 1978 Norconsult

ROAD

Construction	1978 Costs	1983 costs (at 15% inflation)
Main report, p150		
Construction	42,000 LS/km	84,000 LS/km
Maintenance p167		
LS 410/km + 0.8 ADT (ADT = 50)	450 LS/km	900 LS/km
Periodic Regravel	4500 LS/km	9000 LS/km

Total Annualized Costs

Construction (84,000)(.12): CRF @ 10% and 20 yr. life		13,000 LS/km/yr
Maintenance		900 LS/km/yr
Regravel	(9000)(.62)-5yr	5600
	(9000)(.38)-10yr	3400
	(9000)(.24)-15yr	2 200
		25,100 LS/km/yr

TRUCK	1978 Costs	1983 cost (@ 15% infl.)
5-ton lorry	0.10 LS/t km	0.02 LS/t km
25-ton lorry	0.13 LS/t km	0.26 LS/t km
on good gravel roads		

• From Yambio Feeder Road Study 1982

	1982	1983 (@ 15% inflation)
5-ton lorry on existing earth roads	0.246 LS/t km	0.283 LS/t km

• From Truck Operating Characteristics in the Sudan 1982/83

7-ton lorry	0.24 LS/t/km	0.28 LS/t km

SAVINGS WITH REMOVAL OF UNOFFICIAL MARKET PRICING

SAVINGS IN DURA: UNOFFICIAL PRICING IN JUBA

Current official rates: in Bor LS 30/bag
in Juba LS 40/bag [1]

Unofficial market price in Juba LS 60-80/bag

Average tonnage over recent years : 10,000 t/yr.

Using 10,000 t/yr and savings of LS 20/bag (60-40) and estimating that 1/2 the annual tonnage is subject to unofficial market pricing, the potential savings are:

$$\frac{1}{2}(10\,000\ t/yr)(10\ bags/t)(LS\ 20/bag) = LS\ 1{,}000{,}000/yr.$$

SAVINGS IN PETROL: UNOFFICIAL PRICING IN JUBA

Current uninflated rates in Juba [2] 4-5 LS / Imp gal.

Unofficial market price in Juba 14-18 LS/Imp gal

Average tonnage over recent years
gasoline only : 2000 t/yr

Using 2000 t/yr and savings LS 10/gal and estimating that 1/2 of the savings are due to the Kenya-Sudan road improvements, potential savings are:

$$\frac{1}{2}(2000\ t/yr)(200\ Imp\ gal/t)(LS\ 10/Imp\ gal) = LS\ 2{,}000{,}000/y$$

1. See trip notes 14 Oct. 1983
2. See trip notes 14 Oct. 1983

APPENDIX No. 5

ADMINISTERING THE INLAND WATERWAY SYSTEM

TECHNICAL ASSISTANCE AND TRAINING

Privatization and an increased emphasis on waterway transport will present opportunities for technical assistance and training. As a general rule we would favor an emphasis on technical assistance and training in Sudan with minor use of train-in the United States. The modern technology and scale of river operations in the U.S. will make it difficult for the visiting Sudanese to visualize the applicability to the Sudanese situation. Conversely, experienced U.S. personnel should be able to grasp the situation and apply those aspects of technology and management which are appropriate to Sudan. Opportunities for this type of assistance are noted below.

THE RIVER

The new river management activities of the M.O.T. will call for the establishment of proceedures and the execution of surveys. It could also involve administering dredging contracts. Technical assistance could be provided in these areas.

- Hydrographic Surveys
  - Selection of survey techniques and equipment.
  - Training in survey methods.
  - Establishment of annual survey program.
- River Engineering
  - Selection of problem areas for study.
  - Establish study approach.
  - Assist in study and recommendations.
- Dredging
  - Producing plans and specifications and supervise bidding.

- Establish monitoring and acceptance proceedures.
- Assist in supervising the work.

THE PORTS

Construction of new port facilities will require plans and specifications for local or international tenders. Technical assistance opportunities are as follows:

° Sudanese staff participation in design, plans and specification writing.

° Technical assistance and assistance in construction administration of the projects.

° Technical assistance in ongoing port management with an emphasis on physical maintenance work.

THE FLEET

Since the fleet was provided by others and is soon to be privatized, it is recommended the U.S. assistance be withheld from this area of development. Donor countries or others, however, should be encouraged to assist in fleet maintenance to assure that privatization is successful.

LICENSING

Caution should be exercised in this area to assure that any procedures proposed by the Sudanese <u>or</u> foreign experts is appropriate to the situation and not based on some much larger model. Technical assistance should be aimed at keeping it simple rather than inventing new forms.

Possible areas of assistance are:

° Vessel Documentation: Setting up a simple, renewable

form for tug and barge documentation.

- Personnel Licensing: Setting up simple and direct procedures (based largely on demonstrated experience) to become licensed as a pilot or tug engineer. This work could be expanded to assist in establishing on the job apprenticeship programs supplemented by some course work on subjects relating to navigation.

TARIFFS AND CHARGES

Under privatization, charges for transport and cargo handling should be set by market mechanisms. We have suggested an approach to setting port tariffs and user fees if they are to be established. Technical assistance could be applied to assist the Sudanese in establishing the format and deriving the initial charges as described in Chapter 8.

SUMMARY

There are well trained and knowledgeable Sudanese able to carry out the tasks of the new M.O.T. department and other issues associated with river development. Technical assistance, as visualized, would bring in outside experts for limited periods of time to size up the Sudanese situation and assist their local counterparts in implementing needed procedures. Personnel selected to provide assistance and training should be practical and realistic with "hands on" experience. The system in Sudan is small in scale. Personnel accustomed to large scale port or federal bureaucratic systems in the U.S. may have problems identifying and implementing small scale programs and proceedures

appropriate for Sudan.

Timing, scale and implementation of this program can best be ascertained after the role of USAID in the emerging river transport development has been determined and the G.O.S. has responded to the recommendations contained in this report.

However, for budget purposes tentative manpower requirements are listed below:

1. The River

   ° Hydrographic Surveys -

   Source: Corps of Engineers

   Ch. Hydro Surveys from District with river surveys

   or

   Consultant.

   Time - 60-90 days

   ° River Engineering & Dredging

   Source: Consultant

   Time - 90 days in several trips

2. The Ports

   ° Port Design and const. management

   Source: Consultant

   Time - 60 days during prep. of plans/specs.

   30 days during construction

   ° Port Management

   Source: Consultants or Port Agencies

   Time - 60-90 days

3. Licensing

- Vessel Documentation

  Source: US Coast Guard

  Time - 30 days

- Personnel Licensing

  Source: US Coast Guard

  Time - 60 days

4. Tariffs and Charges

- Port Tariffs and user fees

  Source: Consultant

  Time - 30 days

<u>Summary</u>

Total	Min	Max	
1.	60	90	
	90	90	
2.	90	90	
	60	90	
3.	30	30	
	60	60	
4.	30	30	
	420	480	Man days

COAST GUARD
1258 (REV. 5-82)

REPLACEMENT, OR REDOCUMENTATION

I. Complete For All Applications

NAME OF VESSEL

B. Propulsion

☐ Self-propelled ☐ Non-self-propelled

Home port of Vessel

D. Present location of vessel

Name(s) of owner(s)

F. Address of owner

Citizenship

1. For vessel owned by one or more individuals

☐ I (we) certify that all owners of this vessel are citizens of the U.S.

2. For vessel owned by joint venture or association

☐ I (we) certify that all members of this (joint venture) (association) are citizens of the U.S.

3. For vessel owned in a trust arrangement

☐ I (we) certify that all trustees and all beneficiaries in this arrangement are citizens of the U.S.

4. For vessel owned by partnership

a. General Partnership

☐ I (we) certify that all partners in this partnership are citizens of the U.S.

b. Limited Partnership

☐ I (we) certify that all general partners in this partnership are citizens of the U.S. and that at least the controlling interest in the partnership is owned by citizens of the U.S.

c. ☐ I (we) certify that all general partners in this partnership are citizens of the U.S. and that at least 75% of the partnership is owned by citizens of the U.S.

5. For vessel owned by a corporation

a. State of incorporation _____

b. Citizenship of Chief Executive officer _____

c. Citizenship Chairman of the board _____

d. Number of directors necessary to constitute a quorum _____

e. Number of alien directors _____

f. Percentage of stock owned by U.S. citizens:

☐ 0-50%

☐ 51-74%

☐ 75% or more

6. For corporations qualified and applying under 46 C.F.R. Subpart 68.01

☐ Current certificate of compliance attached. I (we) certify that the corporate structure has not changed since issuance of that certificate, and that the vessel, if self-propelled, is less than 500 gross tons.

Intended use(s) of vessel

II. Complete For Initial Documentation Only

Build of vessel

1. Vessel was built at _____ in _____

2. Vessel is under construction at _____

and is scheduled for completion in _____.

Hull material

☐ Wood ☐ Steel ☐ Aluminum ☐ Fibrous reinforced plastic

☐ Other

Hull number/Hull identification number

D. Approximate overall length of vessel

Previous names/numbers of vessel

Name of person signing

G. Capacity

I (we) certify that the above facts are true, and that I am (we are) a citizen(s) of the United States and legally authorized to execute this application in the capacity shown. I (we) further certify that this vessel has never been awarded an official number.

Signature _____ Date _____

Official number of vessel	B. Intervening Names or Numbers

Reason(s) for application

Name of person signing	E. Capacity

I (we) certify that the above facts are true, and that I am (we are) a citizen(s) of the United States legally authorized to execute this application in the capacity shown.

Signature _____ Date _____

IV. For Official Use Only

Approval
Approval of this application, including any designation of home port contained therein, is approved.

Name of Documentation Officer	C. Signature of Documentation Officer
Date	E. Port

TE: THIS IS AN INITIAL APPLICATION AND DOES NOT OF ITSELF ENTITLE THE VESSEL TO DOCUMENTATION NOR TO ANY CHANGES SOUGHT. OFFICIAL NUMBERS DESIGNATED ON THE BASIS OF THIS APPLICATION ARE NOT TRANSFERRABLE.

INSTRUCTIONS FOR COMPLETION OF FORM CG-1258

A. Insert present name of vessel. If application is to change the name of a vessel, insert new name, and last documented name in parentheses.
B. Check appropriate block. If a sailing vessel with an auxiliary engine or a vessel with an outboard engine, check self-propelled.
C. See 46 C.F.R. 67.13-3.
D. Self-explanatory. Leave blank if vessel is under construction. (See II.A.2.)
E. Insert the name of all owners, the proportion in the vessel owned by each, and the manner in which owned.
If the vessel is owned by a partnership, the names of all general partners must be recited.
If the vessel is owned by a joint venture, the names of all the venturers must be recited.
If the vessel is owned in a trust arrangement, the names of all trustees and all beneficiaries must be recited.
Attach extra sheets if necessary.
F. Insert the address which was used to determine the home port. In cases of multiple ownership, specify the owner whose address was used to determine the home port. If the home port was determined by using the address of the vessel's charterer, so specify.
G. Check appropriate block. For a corporation, provide requested information. If G.6. is checked, attach copy of certificate of compliance. If vessel is owned by a governmental entity, leave G blank.
H. Insert registry, coastwise trade, Great Lakes trade, fishery, and/or pleasure. Multiple uses are permitted for eligible vessels. (See 46 CFR Subpart 67.17.)

A. 1. Insert place and year of build. The year to be shown is the year in which the vessel was completed for its intended purpose.
If the place of build is not known at the time of application, or if application is made only for registry or for a pleasure license under the simplified procedures of 46 CFR 67.05-7(b)(3), leave this section blank.
A. 2. Self-explanatory. Also complete II.C.
B. Check appropriate block. If vessel is a composite of wood and fibrous reinforced plastic, check fibrous reinforced plastic.
C. Insert builder's hull number of hull identification number, if known.
If application is made to document a vessel which has resulted from the severance of another vessel, insert the name and official number of the original vessel.
This block must be completed if II.A.2. is completed.
D. Self-explanatory
E. Insert all known names used for and numbers assigned to the vessel, including numbers assigned under state or foreign registration systems.
F. Self-explanatory
G. Insert legal capacity which entitles you to make this application. Examples of legal capacity include (but are not limited to) owner, trustee, general partner, corporate officer, or authorized agent.
H. Self-explanatory

A. See 46 CFR 67.13-1.
B. Complete only for vessel being returned to documentation after having been deleted. Insert all names used for and numbers assigned to vessel during the period it was out of documentation.
C. Insert reason(s) you are making this application. Select among: record of surrenders filled; trade endorsements filled; document (lost) (mutilated) (wrongfully withheld); ownership change; change in general partners of partnership; home port change; vessel name change; tonnage change; change in dimension(s); change in restrictions; change in legal name of owner; removal of alien master; and/or return of vessel to documentation.
D. Self-explanatory
E. See II.G.
F. Self-explanatory

Form Approved Budget Bureau No. 48-R332.3

DEPARTMENT OF TRANSPORTATION
U. S. COAST GUARD
CG-866 (Rev. 3-67)

LICENSE AND RENEWAL APPLICATION

(Print or Type Application)

FOR OCMI ONLY

DATE RECEIVED

FILE

L-

FCC LICENSE NO.

PHS FIRST AID CERTIFICATE

PROFESSIONAL EXAM

COLOR SENSE

RULES OF THE ROAD

APPEAL PROVISIONS EXPLAINED

To: Officer in Charge, Marine Inspection

PHOTOGRAPH *(Radio Officer)*

INSTRUCTIONS

Applicants for Original License or Certificate of Registry must present documentary evidence of U. S. citizenship, except for Inland Operator and Motorboat Operator applicants, who need not be U. S. citizens.

Applicants for an Original Deck, Engineer or Radio Officer's License must present a certificate from the U. S. Public Health Service duly attesting that they have passed a satisfactory examination based upon the contents of "The Ship's Medicine Chest and First Aid at Sea".

Section V. Character References — Where evidence of sea service is required of applicants, this application must be endorsed by certain licensed officers under whom the applicant has served. Where no sea service is required, the applicant must have the endorsement of three reputable persons.

Section VI. Sea Service — should include all service in support of this application. This will vary according to the nature of the request.

Section VIII. Oath — is to be completed only by successful applicants when license is received.

NATURE OF REQUEST

☐ ORIGINAL LICENSE ☐ RENEWAL OF LICENSE ☐ RAISE OF GRADE ☐ CERTIFICATE OF REGISTRY AS STAFF OFFICER ☐ EXTENSION OF ROUTE/INCREASE IN SCOPE

FOR *(State fully class, grade, type of license desired)*

I. APPLICANT'S IDENTIFICATION

NAME IN FULL		4. MAILING ADDRESS	
Z/BK NUMBER	6. SOCIAL SECURITY NO.	7. DATE OF BIRTH	8. PLACE OF BIRTH *(City, state, country)*

II. LICENSE RECORD *(Radio officers must present current FCC license with application)*

YES	NO		
☐	☐	Has any License, Certificate, or Merchant Marine Document held by you ever been suspended, revoked, or suspended with probation granted? *(If 'yes', complete item 9A)*	9A. DATE *(approximate)* AND PLACE

LICENSE NUMBER	11. DATE OF ISSUE	12. PORT OF ISSUE

GRADE, CLASS, LIMITATIONS OF PRESENT LICENSE *(CG, FCC, or Foreign)*

III. U. S. CITIZENSHIP AND MILITARY RECORD *(For Original Licenses and Certificates of Registry ONLY)*

Naturalized U. S. Citizens complete Items 14 and 15	14. COURT NATURALIZED *(State location)*	15. DATE NATURALIZED

PROOF OF U. S. CITIZENSHIP SUBMITTED *(To be completed by Inspector)*

YES	NO			
☐	☐	Have you ever served in the U. S. Armed Forces? *(If 'yes', complete items 17A through 17F)*	17A. DATE ENLISTED	17B. DATE DISCHARGED

17C. SERVICE NUMBER	17D. FULL NAME APPLICANT SERVED UNDER	17E. BRANCH OF SERVICE	17F. TYPE DISCHARGE

IV. CHARACTER REFERENCES *(For Original Licenses and Certificates of Registry ONLY)*

We, the undersigned, Certify from personal knowledge of the above named applicant that he is a person of temperate habits and of good character, and recommend him as a suitable person to be intrusted with the duties of the station for which he makes application.

SIGNATURE	NAME AND ADDRESS	OCCUPATION

V. SERVICE RECORD *(Documentary evidence of service listed below must be presented)*

a. Radio operators must have letter of commitment or evidence of sea service.
b. Staff officers must have letter of commitment.
c. License renewal applicants need list last vessel only.

NAME OF VESSEL	CLASS OF VESSEL[1]	TONNAGE OR HP[2]	STEAM OR MOTOR[3]	WATERS NAV.[4]	SERVED AS	DATE SHIPPED	DATE DISCHARGED	SERVICE YRS	SERVICE MOS	SERVICE DAYS
							TOTAL LENGTH OF SERVICE			

[1] *Passenger, freight, towing, pleasure, fishing, yachts, uninspected, etc.*
[2] *If applying for deck officer's license, give gross tonnage; if applying for engineer's license, give horsepower.*
[3] *Engineer's ONLY — State whether S—Steam or M—Motor.*
[4] *O—Ocean; C—Coastwise; GL—Great Lakes; BSL—Bays, Sounds and Lakes other than Great Lakes; R—Rivers.*

VI. EMPLOYMENT RECORD *(List only employment other than sea duty for the past 5 years)*

NAME OF EMPLOYER	ADDRESS	POSITION HELD	FROM	TO

VII. CHARACTER RECORD *(If other than original, since issuance of present license)*

LEFT THUMB PRINT

19. YES ☐ NO ☐ Have you been convicted by any court—including military court—for other than a minor traffic violation? *(If 'yes' complete item 21 below)*

20. YES ☐ NO ☐ Have you used or been addicted to the use of narcotics? *(If 'yes', complete item 21 below)*

21. PARTICULARS OF CONVICTION/USE OR ADDICTION *(State place, date, and particulars)*

VIII. CERTIFICATION – IMPORTANT, READ BEFORE SIGNING

Whoever, in any matter within the jurisdiction of any department or agency of the U. S. knowingly and willfully falsifies, conceals or covers up by any trick, scheme, or device a material fact, or makes any false, fictitious or fraudulent statements or representation, or makes or uses any false writing or document knowing the same to contain any false, fictitious or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than 5 years, or both *(18 U.S.C. 1001)*.

I CERTIFY that the information on this application is true, and that I have not made application for a license of any type to the Officer in Charge, Marine Inspection in any other port and been rejected within 12 months of this application.

22. SIGNATURE OF APPLICANT

Certificate of Seaman's Service and/or Discharges sighted and serial verified, then returned to licensee. Other supporting data attached. *(46 CFR 10.02-5 (g)(2))*

23. DATE

24. SIGNATURE OF VERIFYING OFFICIAL

25. PORT OF

IX. OATH *(To be completed by applicant when license is received in place of oath presently on license stub)*

I do solemnly swear or affirm that I am a citizen of the United States and that I will faithfully and honestly, according to my best skill and judgment, and without concealment or reservation, perform all the duties required of me by the laws of the United States.

26. DATE

27. SIGNATURE OF LICENSEE

28. SIGNATURE AND TITLE OF WITNESSING OFFICIAL

OPERATOR

The Operator's License entitles the holder to operate a small passenger vessel of less than 100 gross tons. These licenses are limited to routes other than ocean or coastwise.

Basic requirements for original license:

1. Minimum age - 18 years of age.
2. Citizenship - Need not be a citizen of the United States to obtain the license, however you must be a U.S. citizen to operate any vessel other than those bearing State or Coast Guard numbers.
3. Physical:
   a. Physical examination by a reputable physician.
   b. Must submit certificate attesting to:
      1) Acuity of vision;
      2) Color sense;
      3) General physical condition.
4. Service:
   a. Time required:
      1) Mechanically propelled, sailing, or non-self propelled vessels: 12 months experience in operation of type of vessel specified in application. (360 days of actual operating time).
      2) Auxiliary sailing vessels: 18 months experience in operation of mechanically propelled, sailing and auxiliary sailing vessels, including at least 12 months on sailing and/or auxiliary sailing vessels.
   b. Recency for original license:
      1) Ninety (90) days of the required service must be obtained within three (3) years immediately preceding date of application. Time in Armed Forces is excluded.
5. Inland Routes:
   a. Unless an applicant's experience warrants lesser route limitations, an applicant for an operator's license will receive a license authorizing service on waters other than ocean or coastwise.
   b. If an applicant's experience was on waters where he did not encounter commercial traffic, aids to navigation, or possible adverse weather conditions such as small inland lakes or white water rivers, his license will be limited to the waters upon which he shows his experience.
   c. See Operator of White Water Rafts or Motorboats fact sheets for special requirements regarding White Water licenses.
6. Tonnage Limitations:
   a. 100 gross tons limit will be established when 50% of the qualifying experience was gained on vessels of 26 gross tons or more.
   b. All other operators will be limited to 50 gross tons.
7. Original application - the applicant shall:
   a. Submit a completed "Application for License as Officer, Operator or Staff Officer (CG-866)".
   b. Show evidence of age.
   c. Submit satisfactory evidence of service and experience:
      1) Small boat experience forms (attached to CG-866)
      2) A letter from an employer, verifying the service containing the following information:
         a) Name of vessel upon which experience was acquired;
         b) Inclusive dates of service on vessel;
         c) Number of actual operating days;
         d) Waters where vessel was operated; and
         e) Capacity served on vessel
   d. Submit certificate of physical condition from physician.

8. Professional examination:

a. An applicant must pass the following examination:

SUBJECT	PASSING GRADE
Rules of the Road (closed book)	90%
Operator - Part I (closed book)	
Navigation General	70%
General	
Operator - Part II (open book)	
Safety	70%
Rules and Regulations	

9. Applicants who fail any of the above sections may be re-examined on those subjects failed as scheduling permits. If ALL subjects are not satisfactorily completed within 90 days of the date the test began, then ALL subjects (both those passed and those failed) must be retaken.

EXAMINATION INFORMATION

1. Available study material: (This is not necessarily a complete list.)

Rules of the Road:
- Navigation Rules (COMDTINST M16672.2)

General Knowledge:
- Marine Aids to Navigation
- Piloting, Seamanship and Small Boat Handling by Charles F. Chapman
- Mariner's Notebook by William P. Crawford
- Dutton's Navigation and Piloting by United States Naval Institute
- American Practical Navigator by Nathaniel Bowditch
- American Merchant Seaman's Manual edited by Felix M. Cornell and Allan C. Hoffman
- Knight's Modern Seamanship by Captain John V. Noel, USN (Retired)

Safety:
- CG-329 Firefighting Manual for Tank Vessels
- Marine Fire Prevention, Firefighting and Fire Safety by U.S. Department of Commerce, Maritime Administration
- First Aid Manual by American Red Cross
- Ship's Medicine Chest and First Aid at Sea by Public Health Service
- CG-480 Oil Pollution Control for Tankerman

Chart Problem:
- American Practical Navigator by Nathaniel Bowditch
- Dutton's Navigation and Piloting by United States Naval Institute

Local Knowledge:
- U.S. Coast Guard Light List, Volume III, Effective Edition
- U.S. Coast Pilot Number 7, by U.S. Department of Commerce, National Ocean Survey
- Nautical charts of the appropriate area(s).

All examination questions are multiple choice.

OFFICE HOURS:

Office hours are 8:00 to 11:30 a.m. and 12:30 to 3:30 p.m. daily, except legal holidays, Saturdays and Sundays. APPLICANTS FOR LICENSES SHOULD BE IN THIS OFFICE PRIOR TO 11:00 A.M. OR 3:00 P.M.

(Revised 7/83)

MOFFATT & NICHOL, ENGINEERS	CLIENT USAID - KHARTOUM	JOB NO. PROJ. 650-0060	
	PROJECT RIVER TRANSP AG MKTG	SHEET	OF
	DESIGN FOR PRIVATIZATION - ANNEX 5	DESIGNER	DATE
		CHECKER	DATE

PRIVATIZATION - CHAPTER VIII

A. RIVER MANAGEMENT SECTION

PERSONNEL	YEARLY SALARY (LS)
CHIEF	10,000
SECTION CHIEF - PLANS & PERMITS	6 000
SECTION CHIEF - RECORDS & NAVAIDS	6 000
SECTION CHIEF, ENGINEERING	6,000
OFFICE STAFF 6 EA	26,000
	54,000

B. PORT DEVELOPMENT SECTION (5 PRIMARY PORTS)

CENTRAL STAFF		
CHIEF		10,000
STUDIES & PLANNING		5,000
STRUCTURES		5,000
UTILITIES		5,000
INSPECTOR		4,000
FIELD STAFF		
PORT MANAGER	5	40,000
PORT CLERKS	8 (2 port, 2 [illegible], 3 [illegible])	32,000
PORT SECURITY	20	50,000
		131,000

C. VESSEL REGULATION SECTION

CHIEF	10,000
VESSEL DOCUMENTATION/LICENSING	5,000
SEAMEN LICENSING	8,000
	23,000

TOTAL A+B+C	[illegible]	
OVERHEAD - 70%	[illegible]	
	[illegible]	say [illegible]

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APPENDIX No. 6

OBSERVATIONS FROM RIVER TRIP

RIVER TRIP

(Brief Notes)

Bahr El Jebel - White Nile

JUBA to KOSTI

1,436 Km

16 October 1983 - 23 October 1983

Sponsors: RTC/USAID

Passengers: Thomas H. Eighmy, PhD, USAID

Mohamed Yahia Babiker, USAID

Yousif Abdulla, RTC

Steve Jefferson, Arkel-Talab

Greg Hartman, Ogden Beeman & Associates

Robert Nichol, Moffatt & Nichol Engineers

14 October '83

ETD Khartoum 0700 hours

ETA Juba 1130 hours by Nile Safari Airlines

JUBA

Toured port with RTC River Agent Abdu Zahir and saw at dockside 16 cargo barges, 7 passenger barges. Also on waterfront a lot of derelicts restricting its use. Port not secure as public has complete access.

RTC has over 140 workers, about 80% are on daily rate. Merchants prefer to use their own forces.

Dura is largest import tonnage. Because of water depth restrictions 500 T barge unloaded partly at Bor then makes trip to Juba with 3,000 to 2,500 sacks.

Dura official price around LS 35 at Juba but secondary market approaches LS 80. When supply short Regional Government takes dura

from merchant and provides own distribution system.

Fuel in short supply. Juba needs 900 T/mo. Gets less than 300 T/mo.

Estimate of 10-12 cargo barges per month from North and most barges return empty. RTC tonnage reduces drastically in dry season because of truck competition.

Warehouse facilities old, but dry. Need clearing and removal of old goods. Army has two warehouses.

Loading/unloading charges LS 0.0054/10 kg each operation and demurrage varies from LS 0.004 to 0.008/10 kg/10 days which is seldom collected.

Met with Mr Chan Malawal of Equatorial Trading Corporation. He has noticed a change in that maize getting more popular and can be grown in region.

<u>15 October '83</u>

JUBA

Met with Fayad Elias private tug/barge operator who was unloading downstream from Port. He operates Khartoum (12 days) and has leased tug and 2 barges. Merchants like to use him as no transfer in Kosti, quicker, no advanced funds required, and less loss. Charges vary between LS 180-300 per ton upstream and much less downstream (in order to fill up barge). Uses only 14 people for tug and 2 barges.

Elias estimated Khartoum-Juba RT about LS 25,000 and fuel costs LS 15-17,000. All crew former RTC employees.

RTC Tariffs supplied by Jackob Daril of RTC.

* Sugar, wheat flour	LS	0.048/ton/km
* Dura		0.045
Luggage, furnishings		0.057
* Wheat flour		0.045
* POL		0.045
Dates		0.059
Cement		0.072
Beans, veg.		0.059
Edible Oil		0.072
Coffee		0.065
Soap		0.072
Tea		0.088

(New tariffs of April 1983)

* Subsidised tariffs per GOS.

Juba Boatyard tour by Peter Angok who said they were sponsored by UK church group but now on their own. Have constructed 28 ferro-cement barges. Boatyard clean, has ways and shop. Juba Boatyard leases boats at LS 600/day O&M - (NB. Doesn't appear correct as Regional Governments and others put own operators on and ownership under question).

<u>16 October '83</u>

Tug "Germaza"

3 cargo barges

1 1st class Passenger Barge

Depart <u>Juba</u> 0905 hours

Arrive Mongalla 1230 hours

Distance 40 km

Sounded sections of river between Juba and Mongalla. Met officials of Mongalla Textile Mill who claim can't get thread to meet demand in Southern Region.

Port has no storage facilities, all loaded directly on trucks. Trees are bollards and vessel moors against earth banks. RTC Tug and four barges unloading wheat flour and dura.

Depart Mongalla 1330 hours

Sounded and made notes of more shallow reaches of the river. Channel winding and narrow.

Arrive Terakeka 1600 hours

Distance of 30 km

Bargesmoor against bank and ground storage, tug and barge had to move downstream and then reversed back upstream because of island bar in front.

Depart Terakeka 1615 hours

Channels narrow and winding

Arrive Gemmeiza 1800 hours

Distance of 30 km

Moor for the night.

17 October '83

Depart Gemmeiza 0500 hours

Slowed about 12 km downstream because of narrow winding channel.

Conversation with "Germaza" Engineer, Awad Mohamed Hassan.

Tug - 2 Diesel Engines - 1000 HP ea @ 1500 RPM

Water hyacinth slow to 1300 RPM

16 German Tugs - but only 6 on the River

(No spare parts) Reis in charge of navigation, Engineer in overall charge. Crew is 20-21 total on tug and 2 each on

4 barges equals 28-29 total. Awad says he could run operation with only 9 people.

Met Tug "TALBALDIA" at 0925 hours with 3 dura barges and 1 barge of miscellaneous goods. Port engine heating up and using too much fuel (although tug only 1 year old). One barge had a leak because of rock hit at Bor

Depart Tug "TABALDIA" @ 0940 hours.

Arrive Bor 1100 hours.

Distance of 67 km.

Met Tug "ARIABA" at Bor.

ARIABA left before TALBALDIA but was behind because took 2 days to unload 120 sacks of dura at Shambe and took 7 days to offload at Malakal (5500 bags of dura) because no wharfage available. Bor's stone face quay has been undercut and dropping pieces along waterfront, one of which damaged one of TABALDIA's barges. Erosion bad. No mooring facilities. RTC river agent withdrawn during May army uprising.

Depart Bor 1210 hours.

Moored in side channel in Sudd @ 1805 hours.

18 October '83

Depart RP 107 at 0505 hours.

Narrow wandering channels. Rain squalls.

Met Tug "ANDARABA" @ 1100 hours at RP 97.

In tow four barges and will leave dura and flour at Bor, Gemmeiza, Mongalla and Juba. Took 3 days to unload 500 bags of dura, 400 bags of flour at Adok because lack of porters,had to use own crew.

Tug's engineer rating of ports:

Best -	Malakal	Worst -	Shambe
	Bor		Adok
	Mongalla	Very worst -	Gemmeiza

Depart Tug "ANDARABA" @ 1140 hours.

Arrive Shambe at 1630 hours.

Over one hundred people waiting to board - hostile environment. Across lake before landing tug hit bottom. Reis didn't follow suggested route of EDF report. Shambe rock face fill disintergrating.

Depart Shambe at 1635 hours.

Travelled at night through the SUDD.

19 October '83

No settlements between Shambe and Adok 205 km.

Arrive Adok at 0815 hours.

Chevron had camp and "Bentiu Twin" tug made up of flexi-floats, a flexible, multi-use assembly. Village 2 kilometers from landing.

Depart Adok 0915 hours.

No villages, travelled all night.

20 October '83

Arrive Tonga 0645 hours

Distance 272 km from Adok.

Average speed from 17 Oct (1330 hours) to 20 Oct. (0630 hours) equals 11.9 km/hour.

Many cattle from here driven north to Kosti. Cattle barge should be considered.

Arrive Atara 1045 hours

Arrive Mouth of Sobat 1120 hours.

See lot more river activity.

Arrive Malakal 1255 hours.

Regional government barges observed. Heavy engines on GERMAZA barge had to be unloaded at private dock where equipment available. RTC office headed by Alfred Mohamed and out of radio service for 15 days. Private merchant porters handle all cargo movement, but RTC employs 10 people at stationmaster's office. The quay is short and narrow and barge holds off boats because of shallowness. Two old small transit sheds but loads go directly to truck. No private operators are allowed to use RTC facilities.

Meeting with Sr. Inspector of Reg. Minister of Comm. & Transp. Pio Akolong. Only 3 Regional steamers operating out of 5. No records of cargo types but boats serve Bentiu, Kodok, Shambe, Tonga, Sobat River, etc. Steamers not permitted to carry passengers but they do. Also there is no maintenance program and lack of spare parts.

Went on self propelled barge "BARO" before it left for the Sobat and Nasir.

RTC Malakal Workshop

Used for minor repairs only with 45 people plus 5 supervisors. Last repair 3 months ago. Consider moving cargo facilities downstream near workshop where more frontage and backland available. Recent incident involving Malakal government hijacking a dura barge headed for Juba got local RTC man in jail for 2 days because he protested.

21 October '83

Depart Malakal 1150 hours after picking up 2 more barges

Arrive Kodok 1550 hours.

Kodok has had approach from south and river current is eroding quay. Also collapsed wall has reduced barge berthing. Distance Malakal to Kodok is 77 kilometers.Traveled at night.

22 October '83

Observed well placed river markers established by Chevron, e.g. RP marker 438 at 0835 hours.

Average speed since Malakal 13.0 km/hour.

Arrive Wad Akona at 1115 hours.

Picked up empty fertilizer barge. Saw very well maintained Juba Boat (who's operating?)

Leave Wad Akona at 1132 hours.

Arrive Renk at 1255 hours.

Very crowded, small and broken quay with bollard completely pulled out. Observed "BARAKA" only 1 of 6 GM Motor Shuttle Tugs working.

Also moored at the quay were 9 cargo barges, 1 regional ferry boat and a 90 T self-propelled barge. There were 4 barges filled with dura and had been there average of 27 days, waiting for a pusher tug. (Note: all 6 active tugs many days south of Renk, most heading in wrong direction.)

Met at RTC station where station master informed us that all barges loaded by hand and 1 barge loaded in two days paying 20 pt/sack for trucking and 25 pt/sack for loading onto barge. There is no security, crowd control and the radio is not working. No storage on RTC property.

Meeting with Depty Commisioner of Regional Government of Upper Nile Region, Mr. Dennis Aywok Yor.

Everybody has a hand in movement of goods from Renk. RTC

must approve who is on the priority list at Kosti, and government through collection of taxes - up to LS 1.50/sack of dura (1.00 to Rural Council, .50 to Area Council).

Met with manager of Mechanized Farming Corp, Osman Hassen, who said that bulk of dura is by private sector. Government has 15,000 feddans, private sector 203,000 feddans. All hand harvest to stationery combine. Government gets 1.1 sacks/feddan and private farmer production of 3 sacks/feddan. There are about 5 large traders.

Renk merchant - An Fadi (ex-farmer)

Ships only by RTC in rainy season, dry season by lorry south. Lorry carries 60 sacks at cost of LS 10/sack (10 hour trip to Malakal) (RTC is LS 1.40/sack). If he trucked to Juba, truck cost would be LS 30/sack.

Warehouses:

Ag Bank - 4 @ 50,000 sacks ea	=	200,000	sacks
Mech Farm 2 @ 50,000 " ea	=	100,000	
		300,000	
About same around town		300,000	
One year's production		600,000	

RTC too many delays, no tug, no fuel

Merchant gets cost plus from government for dura

Buys @ Renk	LS	22
Gabona, Usher, Truck to storage		3
RTC ship to Juba		5
Merchants 10% profit		3
wholesale		33 to 35 retail

Ag bank supplies sacks, storage.

Been as many as 22-500 T barges at once in Renk.

Depart Renk at 1645 hours.

Arrived at El Jebelein at 0100 hours - moored for night.

23 October 83

Depart El Jebelein at 0500 hours.

Arrive Zuilet Rocks at 0625 hours

Had conversation with Reis El Khier Bakhiet Drar. In Sudd have to stay south of Shambe at night because of so many turns. Also must traverse Zuilet Rocks in daytime. Discussion on shallow areas south of Bor, March-May worst months for navigation. Problems with hyacynths. Kosti bridge delay, another problem. Can still travel at night without moon in clear stretches of river.

Arrive Kosti bridge 1000 hours

TRIP COMPLETE

Summary of Tug Germaza

Left Kosti	9.29.83
Distance	1436 Km with 6 barges to Juba
Arrive Juba	10.11.83
Running hours upstream	222.5
Upstream ave river speed	6.5 km/hour
Leave Juba	10.16.83
Arrive Kosti	10.23.83
Running hours downstream	117.5
Downstream ave river speed	12.22 km/hour

Total distance	2872 km
Total hours	340
Ave total speed	8.45 km/hour
Fuel consumed	43.75 tons

Kosti RTC

Met with regional mgr Bagir Ahmed Daliel and regional traffic mgr Tahir Omar.

Reviewed RTC fleet in Southern Region, location of vessels, active vs inactive etc.

RTC has 2351 people not including RTC police and fire in Southern Region, includes 1806 in technical section, 399 in traffic, 31 in manager's office, 35 in accounting, 75 in construction works (mostly on workers houses.) They are represented by 2 unions where everyone is a member, salary range in 18 classifications from 386 to 5650 LS per year.

Facilities

Warehouses, 4 ea, 2 new @ 50' x 200'

Waterfront 2000' last improvement in 1947

Houses - 151 each

Cranes - 6 ea - (mobile) - only 1 working

Floating 300 T dry dock - waiting for new pumps

Fork lifts - 3 not working

Belt Conveyors - 2 not working

Dredge - 2-12" - Both not working

Received information on status of German tugs

Crew training - all on the job.

Merchants do own cargo handling in Kosti.

Review of status of passenger boats; trouble with Belgian vessels.

RTC reviewed the plans of converting some passenger vessels and some changes in POL vessels.

All technical manuals are in English only.

According to RTC Kosti staff list of priorities:

- Adequate dry docks
- Spare parts
- River navigation (Bor to Juba)
- Training, maintenance, management
- Storage facilities (Bor, Malakal, Renk, Juba)
- Waterfront Facilities
- Cargo handling equipment
- R.R. bridge at Kosti

Fueling pier operated by Shell.

Received list of 82-83 vessel type fuel request which amounted to over 10,000 tons or about 840 tons/month. Last few months they only received total of 900 tons.

APPENDIX No. 7

Terms of Reference

(Contract Scope)

Project Area

The project area is located on the White Nile River in the Democratic Republic of Sudan between Juba and Kosti in Sudan and includes its environs and commercial zones of influence

ARTICLE I - TITLE

Sudan River Transport Agriculture Marketing Project No. 650-0060. White Nile (Juba to Kosti)

ARTICLE II - OBJECTIVE

The objective of this work order is for the consultant to furnish the technical services needed to provide a prefeasibility study outlining on a priority ranked basis the physical, financial, marketing, administrative and operational problems which inhibit the development of the White Nile River between Juba and Kosti for River Transport activities.

ARTICLE III - SCOPE OF WORK

The consultant shall perform the following tasks:

A. General

The study shall outline the investigative work needed to establish a detailed program for the staged expansion of both the public and private sector for a river conveyance system to meet the country's current and future transportation needs beyond the year 2000.

The Consultant shall develop, evaluate and compare alternative solutions and programs for the immediate and long term development of a river transport system including all facilities and administrative structures needed to establish a viable operating system within the Project Area.

The Consultant shall prepare and submit a prefeasibility study for the project area, which shall establish a program for developing river transport activities, both private and public sectors to meet immediate and short-term needs of Sudan. The program shall include special provisions for the participation of the private sector in future river transport development. The short-term needs of the program shall mean the services and facilities imporvements capable of meeting the needs within the next three to five years.

8

The results of the survey, investigation, analysis and findings shall be embodied into a comprehensive prefeasibility study report. This report shall consist of two parts: Part I, Immediate Phase of Development and Part II, Future Staged Development. In preparation of the Report, special attention should be given to having the two parts complement each other. However, each part of the Report shall be in itself, as complete as possible to minimize reference to the other.

B. Specific

The tasks to be performed for the completion of the prefeasibility study including conceptual designs are described below. The description of the tasks are not intended to limit or restrict the consultant to the items herein and the consultant shall perform these and such other tasks as may become apparent during progress of the work.

1. Review all relevant studies regarding and related to river transportaion activities on the White Nile with particular relevance to the transportation of agricultural and non-agricultural commodities in the Southern half of Sudan. The consultant shall notify USAID in writing, if sufficient data and information is not available and shall summarize the effects of this deficiency on the satisfactory completion of the prefeasibility study.

2. Evaluate Existing Facilities and Equipment. The consultant shall throughly familiarize himself with the location, size, capacity, adequacy, efficiency, dependability and functioning of the existing river transport facilities and systems within the project area.

3. Review the financial viability of the private sector to engage in river transport enterprises.

4. Review the current GOS policies and charges related to transport of commodities on the river including current warehousing and demurrage charges and the extent to which these costs can be reduced by improved river transport.

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5. Determine on a priority basis, the package of civil works needed for physical improvement of ports, goods handling and storage facilities, access roads, river navigational aids, channel dredging (if required), etc. and the administrative structures to operate and maintain the facilities along the White Nile from Juba to Kosti. In determining the necessity of these items, consideration shall be given to the proposed completion of the jonglei Canal and the effect it will have on the water level and river transport activities on the White Nile between the towns of Boi and Malakal.

6. Determine the quantities of agricultural and non-agricultural commodities transported on the river; identify constraints impeding efficient transport services and determine the extent that improved transport services could help increase the marketing and supply of tradable agricultural commodities produced within the area served by river transport services.

7. Determine net present values and economic rates of return for all proposed civil works and determine within budget levels the most cost effective level of capital investment, taking into account necessary levels of recurrent maintenance costs for efficient river transport operations.

8. Determine the GOS entities which will be responsible for improvements on and maintenance of the river channel, management and administration of ports and port handling and storage facilities.

9. Develop preliminary cost estimates, bills of quantity, commodity procurement lists and level of effort necessary to carry out the civil works effort.

10. Develop a detailed implementation plan and schedule for execution of the civil works improvement.

11. Develop a detailed implementation plan and schedule for the recommended administrative and operational improvements.

12. Assess and calculate the expected benefits and costs associated with privatization of river transport operations.

13. Recommend appropriate river user charges for potential private river transport enterprises.

14. Recommend a maintenance program to protect and preserve the proposal physical infrastructure.

15. Recommend the administrative arrangements needed to carryout the proposal cival works program.

16. Recommend the setting of user charges and the entities responsible for administering these charges.

17. Design a program for promoting private sector entry into river operations by defining constraints, developing cost effective interventions and recommending assistance to overcome these constraints. Develop costs for this program and recommend administrative arrangements for execution of this program.

18. Environmental Considerations. The consultant shall give due consideration to possible environmental effects of any proposed activities resulting from the recommendations developed in the prefeasibility study

19. Suggest a means of possible divestiture by the River Transport Corporation of part or all of its fleet to the private sector and determine a means of assisting the private sector with the financing of this divestiture.

ARTICLE IV - REPORTS

Before departure from Sudan, the consultant shall submit to USAID a draft final report outlining the findings and recommendations of his study and which shall include, but not necessarily be limited to, the items identified in the scope of work. The final report shall be due within two weeks after receipt of written comments from USAID/Sudan. The report shall be in the English language and submitted in ten (10) copies to USAID/Sudan.

ARTICLE V - RELATIONSHIPS AND RESPONSIBILITIES

1. The consultant shall report directly to the USAID Project Development and Implementation (PDI) and Engineering Division and maintain liaison with:

a. Peter Kranstover, PDI Division, USAID/Khartoum
b. Lynn Sheldon, Engineering Division, USAID/Khartoum

2. The consultant shall maintain liaison with the following Cooperating Country officials:

a. River Transport Corporation

1. Ibrahim Hassan Babikir, Chief Engineer
2. Adam Moniem, General Manager
3. Mohamed Osman, Director Planning Unit

b. Ministry of Finance and Economic Planning

1. Abdel Rahim, Chief Transport Planning

3. The consultant shall be responsible for performing the work outlined in this scope of work.

4. The consultant shall maintain close contact, through periodic meetings or briefings, with designated representatives of the Government of Sudan (GOS) and the USAID/Sudan project manager on all matters related to the work. It is expected that frequent interchange of ideas and informal discussions with USAID/Sudan shall result in agreement on all project activities so that the services will be performed smoothly and quickly. It is currently our understanding that a Host Country engineer and economist will be provided to the Contractor for consultation purposes.

APPENDIX No. 8

PERSONS CONTACTED

APPENDIX No. 8

PERSONS CONTACTED

1. USAID Mission, Khartoum

BROWN, William R. (DIR)
Sherper, Keith (D/DIR)
A/KARIM, Azhari Fadl (PO)
ARMSTRONG, George (AGR)
EIGHMY, Thomas (EPP)
GHOBRIAL, George (AGR)
HARDT, Terry (SMO)
KRANSTOVER, Peter (PO)
MINTZ, Steve (PO)
MORRIS, Eugene (PO)
SCOVILL, Meredith (EPP)
SHELDON, Lynn (PO)
TURK, Joyce (AGR)
WINCH, Fred (AGR)
WITT, Eric (AGR PO)
YAHYA, Mohamed (PO)

2. Government of Sudan

Ministry of Finance & Economic Planning
- Abdel Rahman Elsheikh (Asst. Undersecretary)
- Dr Syd Ali Zaki (Depty Undersecretary)
- Abdel Rahim (Chief Transport Planning)
- Ivagwa Elgadi (Senior Inspector)
- Lyla Elsheikh (Agricultural Section)
- Sittara Elzein Elshafic (Statistics Department)

Ministry of Agriculture
- Dr Abdel Moneum El Sheikh (Director of Planning)

Ministry of Industry

Mohamed Waatala (Planning Director)

Ministry of Communications & Transportation

El Sanosi El Rayah El Admin (Director, Inland Water Navigation Dept.)

Regional Governmental Officials

Pio Akolong (Sr Inspector of Transportation, Upper Nile, Malakal)

Denis Aywok Yor (Depty Commissioner - Renk District)

3. River Transportation Corporation (RTC)

Adam Moniem (General Manager)
Ibrahim Hassan Babiker (Chief Engineer)
Mohamed Osman El Khider (Director of Planning, Research & Statistics)
Zaki Eisa El Hassan (Traffic Manager)
Yousif Abdulla (Asst. Traffic Manager)
Mohamed Abdel Rahman Abdel Aziz (Operations Mgr)
El Bagir Ahmed Daliel (Kosti Regional Manager)
El Tahir Omar (Kosti Regional Traffic Manager)
Moutasir Ahmed (Kosti Asst. Technical Manager)
Jackob Danil (Juba Traffic Inspector)
Alfred Mohamed (Malakal River Agent)
Asad Mohamed (Traffic Commissioner, Juba, tdy)
Hashem Abduskeem (Renk Station Agent)

Tug "GERMAZA"

Awad Mohamed Hassan (Engineer)
El Khier Balshiet Drar (Reis)

Tug "ANDRABA"

Babiker Mohamed (Engineer)

4. Private Companies

Taho El Sayed El Roubi & Co.

Taho El Sayed El Roubi; President of 9 Sudenese Companies

CHEVRON

Thomas L. Steigner (Mgr Design & Construct. Engineering)
Carter Gordon (Asst. Mgr Design & Constr. Eng.)
Gary H. Hagstrom (Staff Engr, Design & Constr. Eng.)
H. "Mac" MacArthur (Camp Logistics)
Dave Connor (Mgr of Field Transportation)
Andy Bain (River Transportation Mgr, Rabak)
Peter Marshal (Barge Operator, Rabak)
Tom Urban (Drafting Service)
John Harrison (Construction Rep, Rabak)
Mark Buetzow (Naval Architect, S.F.)

Arkel-Talab

B.K. Anderson (General Manager)
Bob Chesney (Finance, Operations Mgr)
Earl Carpenter (Sales Manager)
Steve Jefferson (Port Sudan Representative)

Reading & Bates

Pat Landree (General Manager)

Gray McKenzie

Richard Burrell (Manager)
Larry Taylor (Consultant)

C.C.I.

G. Schreiber (Engineering Manager, Khartoum)
J. Quartier (Office Manager, Khartoum)

Petty-Ray Geophysical Inc.

Willard Welburn

Nile River Transport

Konrad Hoffman (Principal)

Juba Boatyard

Peter Angok (Manager)

Mongalla Textile Mills

Mr. Atta (Acting Manager)
Mr. Abraham Khalid (Administrative Manager)

Shell Oil

Mr. Albari (Kosti Manager)
Mohamed Shafir (Khartoum Mgr)

5. University of Illinois (Telephone contact only)

Dr. John Due (consultant to USAID Khartoum)
Dr. Jean Due (consultant to USAID Khartoum)

6. World Bank (IBRD)

H. Borghout (Agricultural Economist, W.D.C.)
Jan de Weille (Sr. Transportation Officer, W.D.C.)
Yoshizki Abe (Manager, Transportation Project, W.D.C.)
Clell Harrell (Former Director of Research, W.D.C.)
Ernst Frznkle (Port Specialist, W.D.C.)
KVSK Nathan (Roads Specialist, W.D.C.)
J. Masthegan (Railway Specialist, W.D.C.)

7. <u>European Development Fund</u>

Collin J. Cracknell (Civil Engineering Advisor Khartoum)
Jan de Kok (Agricultural Advisor, Khartoum)

APPENDIX No. 9

REFERENCE REPORTS

APPENDIX No. 9
REFERENCE REPORTS

TOPIC -- NILE ENGINEERING

1. Study of River Transport in the Sudan, RRI - Gopa - L & P, EEC Proj. No. 4505.043.48.49

blue cover	a.	Volume I;	1st Interim Report
	b.	Volume II;	1st Interim Report Annexes; Oct. 1982
brown cover	c.	Volume I;	Short-term Measures
	d.	Volume II;	Short-term Measures - Drawings; May 1983
red cover	e.	Volume I;	Final Report - Summary; July 1983
	f.	Volume IIa;	Final Report - Main Report; July 1983
	g.	Volume IIb;	Final Report, Main Report; July 1983
	h.	Volume III;	Final Report, Annexes; July 1983
	i.	Volume IV;	Drawings; July 1983

2. Improving Navigation on the White Nile River, U.S. Army Engineer Div., Middle East; Trade Development Programs; Sept. 1980.

3. Maps in manila folder; misc. long & transverse sections of the White Nile; some with and without dates.

4. Southern Regional Agricultural Development Project - Transportation System Assessment, L. Bergen Int., Inc. for US/AID, Feb., 1983

5. Transport Statistical Bulletin 81/82, Min. of Transp. & Comm., Oct. 82.

6. 6-yr Plan - Transp. & Comm. Sector 77/83, Min. of Natl. Plan. Dec. 78.

7. Freight Traffic Estimation Study - 2nd Print, Min. of Natl. Plan. & Transp. & Comm. Nov. 78.

TOPIC -- NILE RIVERS

1. Nile Waters Study; Coyne et Bellier, Sir Alexander Gibbs & Partners, Hunting Techn. Serv. Ltd., and Sir M. Macdonald & Partners for the DRS Ministry of Irrigation, 1979.

   a. Volume I; Main Report
   b. Volume II; Supporting Reports I, II & III (all in Vol. II)

TOPIC -- US/AID PROJECT PAPERS

1. Azheri critique of 1st Interim Report by RRI-GOPA-L & P

2. A Prelim. Estimate of the Financial IRR for River Transp. Investment in the Southern Region, Sudan, T.H. Eighmy, PhD. USAID/Khartoum, Apr. 1983

3. Short and Intermediate Measures for USAID Assis. to Alleviate River Transport Bottlenecks; P. Kranstover, USAID/Khartoum, May 5, 1982?

4. Country Development Strategy Statement - Sudan - Fy 1984; USAID/Wash, Jan., 1982

5. Southern Reg. Ag. Devel. - I (SRAD-I); Gene Morris, USAID Proj. 650-0046, 1982

6. Port Sudan; L.A. Nelsen, Dept. of State Airgram No. A-08, Mar. 17, 1980

7. Navigation Aids, T. Hardt, USAID/Khartoum, 19?

TOPIC -- POLICY OF DRS & MACRO ECONOMICS

1. River Transport Investment Policy Study; DRS Ministries of National Planning and Transport (River Transport Corp.), 1980

2. Third Three Year Public Investment Programs 1982/1983 - 1984/1985; DRS Ministry of Fin. & Eco. Planning, June 1982

3. Investing for Eco. Stabilization and Change, Hansen, IBRD Feb. 16, 1982 (Return to Meredith)

4. Request for Stand-by Arrangement - Sudan, IMF, Jan. 83.

5. River Transport - The Challenge for Development River Transport Corp., Dec. 1982

TOPIC -- PRIVATIZATION

1. Results of the Survey of Private Sector Investors in River Transport; DRS Ministry of Fin. and Eco. Planning (Transp. & Comm. Sector), Mar. - Apr., 1983.
   Survey forms and unpublished summary & findings.

TOPIC -- AGRICULTURE - TIMBER, FISHING

1. Sudan Agricultural Strategy Assessment - Summary Rept.; Devel. Alter. Inc. and Research Triangle Inst., for USAID Jan 1982.

2. Duria Storage and Bulk Transport Project; Oil Industries Services AG, for DRS Ministry of Transp. Feb. 1982.

3. Kenya - Sudan Road Link; Norconsult A.G., Aug. 1978

   a. Test Volume
   b. Appendix Vol. 1 + Harry Rook's summary for EEC funding
   c. Appendix Vol. 2 Where is AID's summary by L. Berger?

TOPIC -- USER CHARGES

1. "Taxation - Tward Social Justice" SUDANOW, Sept. 15, 1983, p. 16.

2. Strengthening the Revenue Systems of the Central Govt and Kordofan Region of the Sudan, John Due, USAID, Dec. 1982.

3. Report on Financial Aspects of Decentralization in the D.R.S., John Due, USAID, JUne 30, 1981.

TOPIC -- JONGLEI CANAL

1. Jonglei Project - Projet Evaluation, Permanent Joint Tech. Comm. for Nile Waters

2. The Impact of the Extension of Jonglei Canal on the Area from Kongor to Bor by Sayed Mohamed Osman Elsammani and Dr. Farouk Mohamed Elamin

3. Jonglei Canal Project - First Phase, Permanent Joint Tech. Comm. for Nile Waters, 1983

4. Comparative Socio-Economic Benefits of the Eastern Alignment and the Direct Jonglei Canal Line; DRS Jonglei Exec. Organ.

5. An Outline of the Proposed Socio-Econ. Survey of the Jonglei Scheme, DRS Jonglei Exec. Organ, Khartoum, 1975.

6. Interim Report on the Eastern Realignment of the Jonglei Canal; P.L. Deng, B. Van den Hock, S. Zanen, Netherlands Min. of Foreign Affairs, DRS Jonglei Exec. Organ, Bor, Feb. 78.

7. Proposals for a Mid-Term Prog. and a Crash Prog. for the Devel. of Ag. Livestock & Socio-Econ. Serv. in the Jonglei Canal Area DRS Jonglei Exec. Organ. Doc. No. 11, Sept. 1979.

8. A Prelim. Report on the Livestock Industry in the Jonglei Area, W. J. A. Payne, DRS Jonglei Exec. Organ. & UNDP, 2nd Ed. Nov. 1977.

9. Sudd Fisheries Devel. Programme - Phase I, DRS Jonglei Exec. Organ. and UNDP, Khartoum, Oct., 1978

10. Integrated Rural Devel. in the Kongor Dist. DRS Jonglei Exec. Organ. and UNDP, Khartoum, Apr. 1979.

11. Jonglei Canal Project Appraisal Study, Sir M. MacDonald and Partners Ltd, 1983.

APPENDIX No. 10

TELEX CORRESPONDENCE RE DRAFT REPORT

LBA043 (1452) (4-009579M357) PD 12/13/83 1449
ICS IFLDOSA WSHZ
958 STATE DEPT WASHINGTON DC 14:44 EST 12-23
PMS
MOFFATT AND NICHOL ENGINEERS
250 WEST WARDLOW ROAD
LONG BEACH, CA 90807

SUBJECT: PREFEASIBILITY STUDY, RIVER TRANSPORT AGRICULTURE MARKETING PROJECT (650-0060)

1. USAID has reviewed subject study. General concensus is that report is comprehensive and reflects energetic and professional manner in which assignment was undertaken.

2. USAID does, however, have some observations/comments which need to be addressed in final report. Specifically,

(A) The report should include a clear budget for short-term technical assistance, as described in Appendix 5, and for construction and dredging activities. Both dollar component and necessary local currency amount for in country support services should be listed. Inflation costs should be added over life of project to obtain a financial cost for this program.

(B) It appears somewhat unclear as to whether there is a recommendation regarding need for hydrographic surveys before any dredging takes place. Are hydrographic surveys included and costed in the priority listing of short-term measures? If not, please provide.

(C) Request, as stated in contract scope of work, an implementation plan and schedule regarding all of the civil works, construction, commodity procurement and dredging activities. USAID needs to know if one firm or many should undertake construction activities or whether discrete elements should be separated out. If so, which ones? Also how much time would

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design and construction activities take? Do you believe there are Sudanese and third country firms capable of undertaking project? A summary sheet of overall civil works construction estimate is needed and should relate to the implementation plan. Implementation plan can be based upon your preferred alterations for short and long term measures.

(D) On page IV-29, appears improvement costs for Mongalla Port have been omitted.

(E) Are contingency factors considered sufficient particularly as they relate to the degree of accuracy of the cost estimates?

(F) Re Table V-4, is a 10 profit a reasonable rate to entice private entry into river operations in the Sudan?

(G) Chapter VIII gives more general guidelines re users fees, but estimated ranges or levels would be useful. Does Moffatt and Nichol suggest fees be collected and placed under control of administrative bodies or returned to GOS treasury?

(H) Does Moffatt and Nichol recommend purchase of a dredge for long term RTC use? If so, what type?

(I) Must aerial photobook for navigation be updated? If so. how often?

(J) Report appears to support GOS "Laws" which place port channel development/operation/maintenance under control of M. Transport/ communications as opposed to present practice which lies with RTC. However, even with existing RTC inefficiencies, at least RTC has group engineers/ technicians while dept. inland waterways is virtually without any staff at all. Does Moffatt and Nichol believe USAID should insist on transfer of these responsibilities to MOTC or can we accept RTC continuance of their present functions over life of project?

(K) Would appreciate assessment of privatization of passenger service, also. Do you believe this to be.

(L) Finally, please provide map of area in report.

3. Would appreciate responses to above remarks as soon as possible. Believe report will provide very reputable source from which to begin implementation of policy changes and concomittant marketing efficiencies under subject project.

REGARDS
AMERICAN EMBASSY
KHARTOUM, SUDAN

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TO: AMERICAN EMBASSY IN KHARTOUM, SUDAN
C/O USAID PETER KRANSTOVER

SUBJECT: PRE-FEASIBILITY STUDY, RIVER TRANSPORT AGRICULTURE MARKETING PROJECT (650-0060)

1. The following is answer to your telegram.

2A. Budget for technical assistance: (See Appendix 5). The following budget is for work covered in items 1-4 of the technical assistance plan. Funds for design, plans and specifications are not included.

Item	Person Days		Trips	Days Per Diem
	Rate 1	Rate 2		
1.A.	90			90
B.		90		90
2.A.	50	40		90
B.		90		90
3.A.	30			30
B.	60			60
4.A.		30		30
	230	250		480

Rate 1: Dlrs, 400/day x 230	Dlrs 92,000
Rate 2: Dlrs, 550/day x 250	137,500
Trips: Dlrs, 2750 each x 16	44,000
Per Diem: Dlrs, 160 incl/exps x 560	89,600
	Dlrs 363,100

079

2B. Hydrographic surveys must be executed before and after dredging takes place. The estimate of LS 1,704,000 (Ch. II) for dredging includes 15 percent for engineering, design and inspection. It is anticipated that the surveying will be done by the dredge inspector on the project and thus cost is included in the 15 percent.

The technical assistance budget provides for assistance in establishing minimum hydrosurvey capability in country. This capability would be useful as part of the river management section described in Chapter VIII. However, this capability is intended for monitoring and studies, not supervision of contract dredging.

2C. Suggest overall U.S. consultant on entire project supplemented by Sudanese subcontractor. Construction activities will likely be international competitive procurement. Alternatively, dredging could be separated and performed under single contract. Implementation plan and schedule will be in final report.

2D. Final report will have Mongalla costs on page IV-29.

2E. Contingencies of 10 percent are reasonable since we were working on quoted equipment rates in country. Suggest an additional 20 percent be added to overall project budget to account for uncertainties in design and program implementation.

2F. The privatization scheme suggested requires little if any capital investment by the operator. The only capital required is that for operating purposes including spare parts acquisition. We believe 10 percent of costs is a reasonable profit figure for purposes of analysis. Note that profits of 80 percent (Plan 1) and 40 percent (Plan 2) could be added and costs would still be comparable to existing R.T.C. operating results. (See Table V.4). The actual profit margin will be established by the private operators based on competitive conditions after privatization.

2G. The five year costs of dredging and the photobook totals LS 3,779,000. By 1990, approximately 176,000 tons will be moving on the waterway.

Assuming that the LS 3,779,000 cost would be paid for by a per ton user fee, the cost per ton would be LS 4.29/ton or LS .003/ton kilometer. This would add about 6 percent to the LS 0.052/ton KM transport costs shown in Table V.6.

We do not recommend user fees until similar fees or penalties are extracted from other transportation modes. Should user fees be levied on a basis relating to costs, we recommend they be returned to the responsible agency for reinvestment in waterway development.

2H. Based on the seasonality of dredging, the uncertainty of shoaling rates and the overall scale of the anticipated dredging program, acquisition of a dredge is not recommended. Additionally, government ability to operate and maintain such equipment is severely limited. Since appropriate equipment is available from the private sector, acquisition is not warranted.

2I. New aerial photography would not be required for a number of years. However, the users of the photos will constantly be noting channel locations and other features on the prints provided. The (River Management Section) would keep the originals and could provide updating on an annual basis, as appropriate. This will be an area to be covered by technical assistance as described in App. 5.

2J. It was our understanding that the G.O.S. intent was to transfer river management functions to ministry of transport. Since the activities support the use of the river by R.T.C. and others, we believe they are public sector activities most logically placed in the appropriate public agency which appears to be M.O.T. We found little involvement of R.T.C. in channel development and therefore question what is meant by "Present Practice". If it means continuing to do nothing, A.I.D. should insist on a change. If R.T.C. shows the will and the capability to do something with channel improvement, the decision on transfer becomes a political rather than a management question.

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2K. Passenger service question was beyond our scope of work so it did not receive the same analysis given to the cargo service question. However, we are able to provide the following observations.

There is justification for leaving passenger service in the public sector. It seems to us to be more inherently a public sector function than the cargo service. Should it be privatized we would see the need for very strong regulation as to frequency of service, rates and equipment safety. This level of regulation would detract from, or negate, the benefits of privatization.

We can envision some advantages in leaving the passenger service in the public sector for the time being. First, it would not be necessary to privatize both functions concurrently which we see as confusing. Secondly, by having both systems operating it could spur some level of competition -- not for traffic but for demonstrations of competence. This could lead to privatization of passenger service at some point in future if R.T.C. could not achieve the level of competence we hope to see in privatized cargo operations.

3. Final report to be sent soon.

BEST REGARDS
ROBERT D. NICHOL
MOFFATT & NICHOL, ENGINEERS