AGENCY FOR INTERNATIONAL DEVELOPMENT

DEPARTMENT OF STATE

Washington, D.C.

BANGLADESH BULK FERTILIZER HANDLING AND BAGGING SITE SELECTION REPORT

May, 1977

HARRIS

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1.0 INTRODUCTION AND SUMMARY OF ACTIVITIES

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1.1 INTRODUCTION

In accordance with the provisions of Contract No. AID/otr-c 1298, between the Agency for International Development, Washington, D.C. and Planning Research Corporation, Los Angeles, California, Contractor, the services of two specialists were provided to AID in Bangladesh for the preparation of a study and recommendations in connection with planning for the construction of facilities for unloading, temporary storage, bagging and shipping of imported fertilizers. This report is the final report for the project, and contains all corrections and modifications of the draft site recommendation report submitted to USAID prior to consultants'departure from Bangladesh upon completion of the requested three weeks of study. Included in this report, as Appendix Section 8, is the recommended Scope of Work and Estimated Cost for the Design Phase of the program.

1.1.1 Objective

The objective of the study was to determine the feasibility of establishing fertilizer bulk handling and bagging capacity in Bangladesh for imported Triple Super Phosphate (TSP) and Muriate of Potash (MP). In addition, the contractor was to recommend the location or locations for any proposed facilities which would, at least cost, provide a system of fertilizer import best serving the needs of Bangladesh for the next ten years (1978-1987).

1.2 SUMMARY OF ACTIVITIES

The team consisted of a Senior Port Operations Specialist, Mr. Ernest Ball, from Frederic R. Harris, Inc., New York, and a Transportation Economist, Mr. L. Brian Browne, from the Los Angeles office of Economics Research Associates, both PRC companies. Upon arrival of Mr. Browne from California on 10 April, 1977, the team departed New York on 11 April, arriving in Bangladesh on the morning of 13 April. Working a seven day week throughout their stay, the team met with AID, UN and Bangladesh Government officials and reviewed and collected available data during the period of 13-18 April. In addition, a site visit to the river port of Narayanganj was undertaken. On 19 April, accompanied by Mr. Robert Gonsalves, of the AID staff in Dacca, the team went to the principal port of Chittagong for the evaluation of potential sites there. While there, a survey of the condition of the unloader at the cement clinker plant was carried out. The survey report is contained in Appendix Section 3. The cement plant, the TSP plant and other properties in the area were examined as potential sites for the subject facility. Evaluations of these locations are contained in Section 3, Alternatives, and completed site questionnaires will be found in Appendix Section 2. On 21 April, the team proceeded to Khulna in southwest Bangladesh, where they visited the Port Director and inspected Khulna Port facilities. On the 22nd, they traveled by water to the site of the new deepwater port of Mongla, now under construction on the Pusur River, some 30 miles south of Khulna. Returning to Dacca, the team commenced preparation of the site recommendation draft report, and met with additional BDG officials for further data. A list of persons contacted during the study is contained in Table 1.1.

The report was submitted to the AID Mission in Dacca and reviewed on 2 May. A summary of the recommendations was discussed with Bangladesh Government officials on 3 May. The team departed Bangladesh on 4 May, 1977 for Washington, D.C. where the Draft Report was submitted to AID and discussed on 9 May. Preparation of the Recommended Scope of Work and Estimated Cost for the Design Phase was carried out in contractor's New York offices thereafter.

TABLE 1.1

Bangladesh Government Officials and other Foreign Experts contacted during Team visit:

Bangladesh Officials Interviewed:

Md. Mujibur Rahman	General Manager Bangladesh Chemical Industries Corp.
Mr. A.N.M. Eusuf	Member-Director Bangladesh Agricultural Development Corp.
Mr. M.K. Kobad Hussain	Manager of Sales Bangladesh Agricultural Development Corp.
Dr. Alam Shamsul Huq	Director of Production Bangladesh Chemical Industries Corp.
Mr. Sadrul Alam	General Manager Chittagong TSP Plant
Mr. Golan Kibria	Chairman Chittagong Port Trust Authority
Mr. K.R. Zaman	Chief Financial Officer Chittagong Port Trust Authority
Capt. S.Y. Kamal	Manager of Operations Chittagong Port
Mr. Moazzem Hossain	Deputy Manager (Shipping) Bangladesh Agricultural Development Corp., Chittagong
Mr. Badrul Islan Siddiky	Regional Manager Bangladesh Agricultural Development Corp., Chittagong
Mr. Altaf Uddin Mian	Maintenance Manager Chittagong TSP Plant

TABLE 1.1 (continued)

Capt. S.M.A. Islan	Port Director Khulna/Chalna Port
Mr. M. Kibria	Port Executive Engineer Mongla Port Development
Mr. James L. Mendes	Commercial Manager Bangladesh Shipping Corp.
Mr. Lutfur Rahman	Director, Traffic, Deputy Secretary, Ministry of Communications (Ports, Railway and Inland Navigation)
Mr. M. Chisti	Section Officer, Ministry of Communication (Ports and Shipping)
Mr. A.M. Talukdar	Deputy Chief, Bangladesh Transport Survey Planning Commission
Mr. A. Shajahan	Deputy Secretary Ministry of Communication (Railways)
Mr. Zahurul Huq	Commercial Manager Bangladesh Inland Waterways Transport Corp.
Mr. Md. Azizul Hoque	Project Cirector & Deputy Chief, Program & Planning Division, Planning Commission
A.B.M. Abdul Fattah	Deputy Chief, Transport Section, Planning Commission
Dr. M. Numil Khan	Deputy Chief, Planning
Dr. A.K.M. Masood	Deputy Chief, Industries Division, Planning Commission
Roxana Ahmed	Assistant Chief, Transport Survey Section, Planning Commission

TABLE 1.1 (continued)

Foreign Experts providing information:

Mr. H. Niermans	Port Operations, Management & Shipping Expert, Netherlands Economic Institute Chittagong Port Entrance Study
Mr. Boris Rafajlovic	Project Manager and Chief Engineer Chalna Port Project - Mongla Ivan Welutinovic - PIM Yugoslav Construction Company
Mr. H.A. Dare	Project Manager Chittagong Port Construction Frederic R. Harris, Inc. US Engineering Firm
Mr. Milton Gertsch	United Nations Development Program Agricultural Expert
Mr. John R. Luthbertson	Consulting Economist Transport Study Group
Mr. Hector Davidson	First Secretary British High Commission (AID Agr)

AID Personnel assisting in the study:

Mr. D.J. Alter, Deputy Capital Development Officer

Mr. Robert Gonsalves, Transportation Section

Mr. James E. Gardner, Engineering Division

Mr. Emory M. Howard, Chief Ag. Division

Mr. Dennis Brennan, Capital Development Officer

2.0 CONCLUSIONS AND OBSERVATIONS

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2.1 CONCLUSIONS

Following observation and study of the Bangladesh fertilizer transport system and examination of alternative sites for location of bulk storage and bagging facilities, the consultants concluded that in order to provide a system of fertilizer import best serving the country's needs over the period 1978 through 1987 there is only one feasible solution. That solution is that importation of TSP and MP in bulk and the establishment of a bulk storage and bagging facility on the grounds of the TSP plant in Chittagong. The reasons for reaching this conclusion follow.

2.1.1 Bulk Imports Versus Bagged Imports

A comparison of cost of purchasing and receiving fertilizer from shipping port in bulk or bagged to onboard Bangladesh inland transport is shown on Table 2.1. As can be seen on the Table, there is a potential saving of at least $20.00/ton by switching to the purchase of imported fertilizer materials in bulk, and storage and bagging at Bangladesh port of entry. It should be noted that the figures shown on Table 2.1 represent independent estimates of the consultants, and are not taken from USAID or the estimates of others. These figures have been verified by the team upon their return to USA from shipping and bag manufacturing industry sources. It is interesting to observe that the $20.00+ saving is about the same number calculated by AID using their own source data.

TABLE 2.1

Comparison of Costs[1/]

Bulk Fertilizer Imports Versus Bagged Imports

(Costs are in US $/ton)

Cost Category	In Bulk	In Bags	Difference
Difference in Material Cost[2/]	-	-	-
Cost of Bags[3/]	-	8.40	+ 8.40
Cost of Bagging[4/]		11.54	+11.54
Export Stevedoring		10.86	+10.86
Difference in Ocean Freight[5/]	-	+5.00	+ 5.00
Import Stevedoring	2.00	5.00	+ 3.00
Port Changes	.50	1.00	+ .50
Handling to Storage	.50	1.00	+ .50
Storage at Port[6/] (2 months)	.80	1.60	+ .80
Cost of Bags[7/] [10/]	10.40	-	-10.40
Cost of Bagging	1.50		- 1.50
Loading Out Cost[8/]	1.00	1.00	-
Shrinkage[9/]	1.50	.85	- .65
Demurrage on Vessel[5/]	-	+2.00	+ 2.00
Total	$18.20/ton	$48.25/ton	$30.05/ton
Less 30% Contingency[10/]			-9.00
Advantage of Bulk over Bagged Imports			$21.05

TABLE 2.1 (continued)

1/ Based on consultants investigation of US fertilizer export market costs as of May, 1977. Costs are based on TSP at Tampa, Fla. Bangladesh costs estimated based on Bangladesh data sources and reflect relative differences in handling bulk versus bagged.

2/ Price on Bagged cargo is quoted FAS vessel, whereas Bulk price is FOB resulting in higher price for bagged cargo due to additional handling cost at port. At ports where bagging does not include unloading cars, add $5.00/ton for bagged cargo (see Note 4).

3/ 50 kilo polypropylene bag with heat sealed polyliner (42¢/bag x 20 bags = $8.40). Note: 25 kilo bags are 25¢/bag x 40 bags - $10.00/ton.

4/ Cost from cars to bagging to FAS vessel.

5/ Recent quotes indicated $5.00 differential bagged over bulk, both Foreign Flag and U.S. Flag vessels, full parcels 15-20,000 tons. Bulk 2,000 T/day, Bagged 1,000 T/day, Demurrage $4,000/day

Foreign Flag	23.00 Bulk	28.00 Bagged
U.S. Flag	55.00 Bulk	60.00 Bagged

Included in these freight rates is cost of lightening vessels at Chittagong. From the foreign flag rate above, it is indicated that the additional cost for lightening is about $5.00/ton.

6/ Assumes Bulk storage cost of own facility. Bagged storage at Port Trust.

7/ Based on quotation of 19 October 1976 to AID from Adamjee Jute Mills:
50 kilo bag - @ 8 Taka ($.52) (25 kilo bag - @ 5.75 Taka ($.38) Tk15.25 = 1.00
50 kilo bag - 20 bags/ton = $10.40/ton (25 kilo bag - 40 bags/ton = $15.20/ton)
Bags are polycoated jute. Price includes 10% Sales Tax and 30% Duty

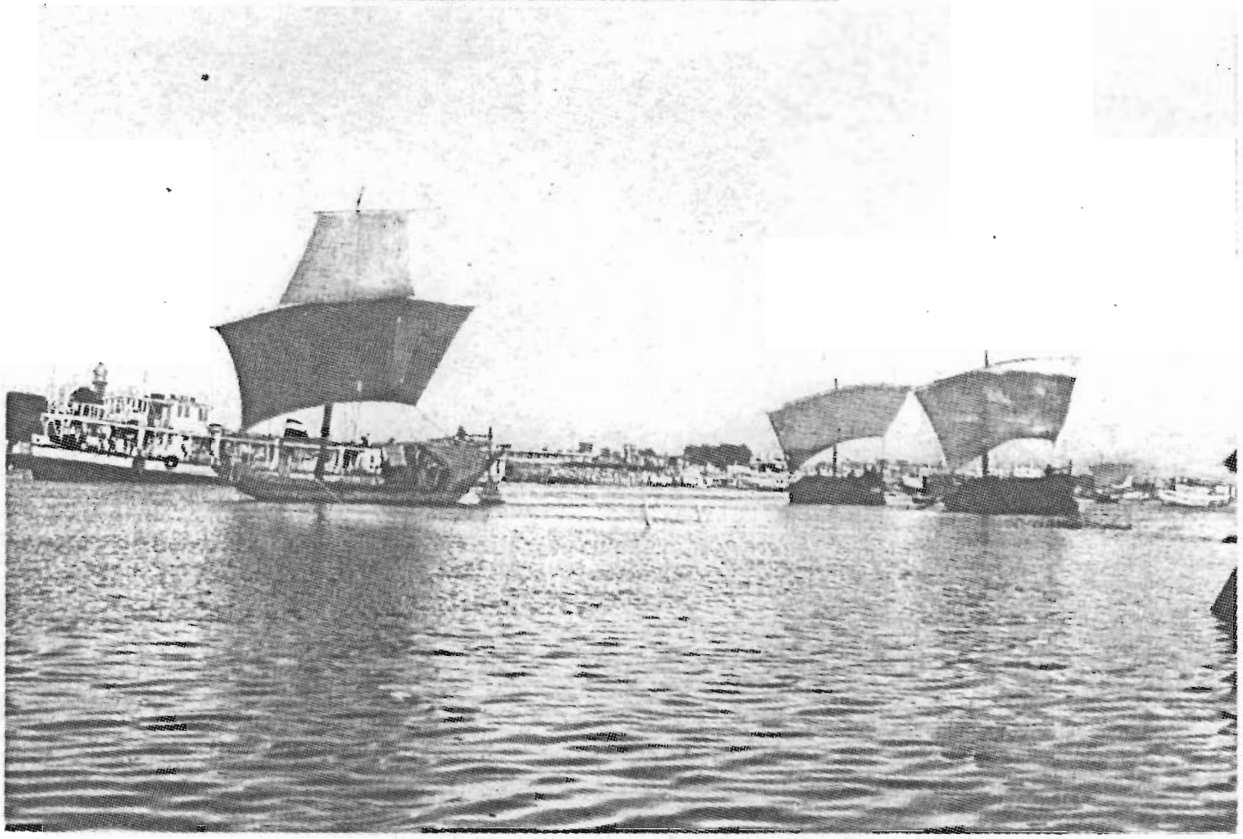
8/ Example is cost of loading to truck or rail.

9/ Bulk shrinkage 1.5%. Bagged shrinkage .75%.

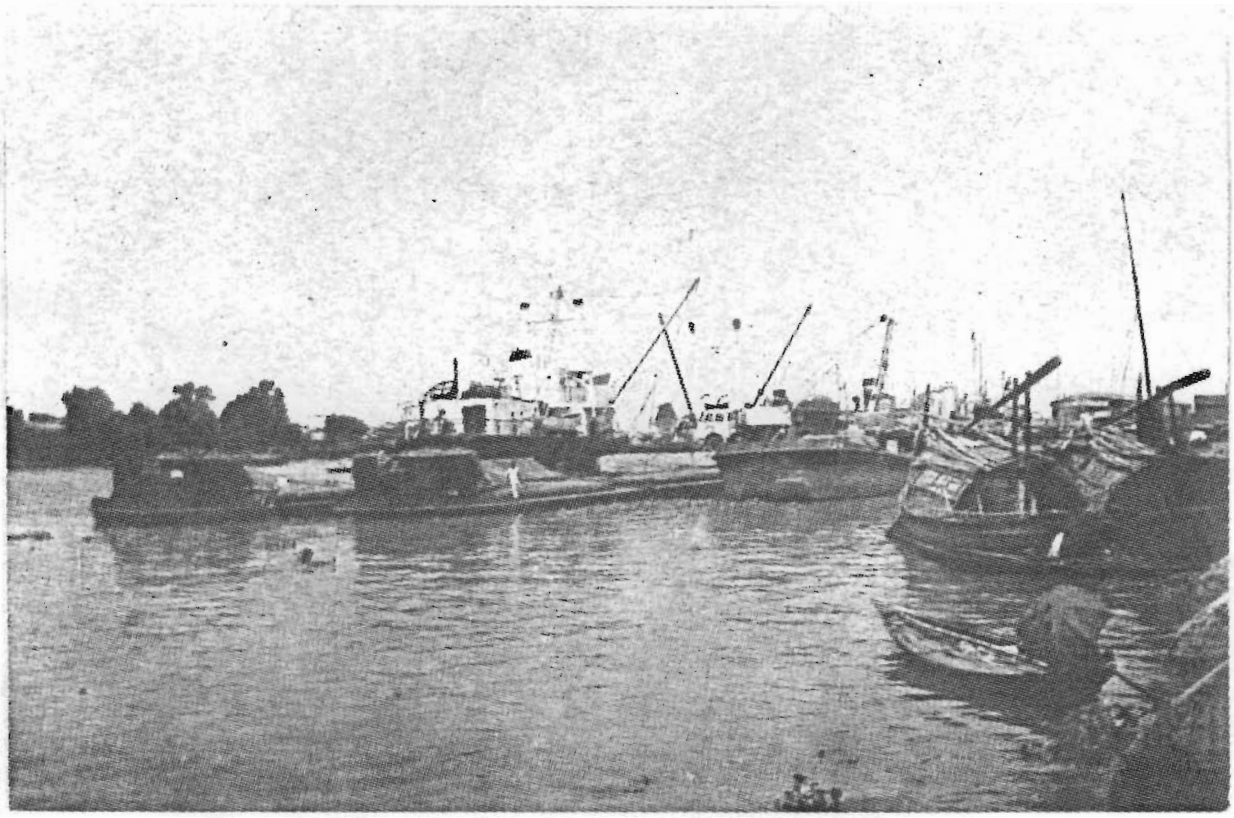
10/ Net cost to Bangladesh can be reduced by $4.16/ton to reflect the 40% tax and duty on local bags (see Note 7). Use of 25 kilo bags would result in additional savings by conversion to bulk.
(25 kilo bags cost $10.00 ton in US; cost $15.20/ton less 40% - $9.12 in Bangladesh)

FIGURE 2.1

RIVER CRAFT OF BANGALDESH



A BANGLADESH RIVER PORT



2.1.1.1 Potential Cost Saving

Table 2.2 lists the projected demand for imported TSP and MP over the study period. These projections are based on the medium demand forecast contained in the Economist Intelligence Unit (EIU) Interim Report (1977). Further details of projected domestic production and consumption of fertilizers by the Bangladesh agricultural economy are contained in Appendix 1. In Appendix 6 is contained an analysis of various forecasts of Bangladesh fertilizer demand and the consultants' reasoning for basing these projections for TSP and MP imports on the EIU medium demand forecast.

TABLE 2.2

Projected Demand for Imported TSP and MP
Bangladesh, 1978 thru 1987 1/

	Tons 2/
1977-78	121,000
1978-79	146,000
1979-80	176,000
1980-81	210,000
1981-82	250,000
1982-83	295,000
1983-84	347,000
1984-85	407,000
1985-86	477,000
1986-87	556,000
10 year Total	2,985,000
10 year average	298,500

1/ Computed from the following sources:
1) Economics Intelligence Unit, Ltd. Interim Report, Jan. 1977
Bangladesh Fertilizer Marketing and Distribution Study
2) AID Projections

2/ See Appendix Section 1, Table A1-1

According to the projected increases in demand shown above, imports of TSP and MP are forecast to rise from an estimated 121,000 tons/year in 1978 to 556,000 tons/year in 1987, and to average about 300,000 tons/year during the study period. Importing and storing this volume in bulk and bagging it in Bangladesh should generate a significant saving. Raw saving before capital cost on an average of 399,000 tons/year at $20/ton would be $6.0 million per year. A cost/benefit analysis for the recommended solution is found in Section 4.

2.1.1.2 Internal Distribution in Bags or Bulk

The team observed and studied the present transport and storage system of Bangladesh and investigated future planning for the project period. They observed a lack of internal transport equipment for and experience in the handling and control of bulk materials. Based on these observations, it was concluded that fertilizers should be bagged at the port prior to shipment, and that internal transport should be in bags. Transport in bulk to interior storage and bagging facilities should not be considered at this time for the reasons contained in the description of the internal transport system in the following sections.

2.2 OBSERVATIONS

2.2.1 Summary of Field Observations

2.2.1.1 Site Visits

The team inspected six potential sites for the proposed facility. The sites visited were the following:

- Narayanganj Port
- Chittagong TSP Plant

- Chittagong Cement Plant
- Chittagong Main Port
- Khulna/Chalna Port
- Mongla New Port Site

Site questionnaires describing conditions and observations for each site are contained in Appendix Section 2.

2.2.1.2 Fertilizer Distribution

During the field trips, the team was able to observe the condition of the existing fertilizer (godown) storage system, which has been discussed in detail in the EIU report, and can confirm that the physical condition and capacity of these facilities leaves much to be desired. Further, it was observed that delivery of fertilizer to the ultimate users in certain remote areas must be by country boat. However, it could not be confirmed that water delivery would be the major mode, as discussed below and in Section 2.2.2 Transport.

2.2.1.3 Transport Observations

During the field trip to Khulna, observation was made of the highway and rail system between Jessore and Khulna. Two way traffic was easily maintained by trucks and buses on the highway, and side roads leading to other towns and villages appeared to be in good condition, many of them paved. Much truck traffic was observed, generally heavily laden, and consisting principally of 7½-8 ton stake body trucks. The rail track appeared to be in good condition but little traffic was observed, and few rail cars were seen in Khulna. With regard to waterway traffic, which the team was

able to observe in action on the Pusur River, it was seen to consist of extremely slow wooden craft, also heavily laden to perhaps 40 tons (the largest observed) and powered by oars, by current or by sail. In the opinion of the team, regardless of the number of such units, this mode of transport should not be considered as a significant carrier for any distance. Final delivery perhaps to inaccessible locations where no alternative exists. Figure 2.1 shows photos of water crafts seen on the river. Barge traffic on the Pusur River was very light, despite the fact that there were 6 ships unloading at the Mongla anchorage. Not more than 8 barges were observed, one being about 100 DWT, traveling light down river. The remaining barges were alongside vessels and were of a variety of types, from 100 to 200 DWT. Khulna had 4 barges being unloaded during the visit to that port. It is the team's belief that a much more extensive watercrafts fleet would be required if an increase in effective water transport movement is to be attained.

2.2.2 The Internal Transport System

Movement of goods by surface transportation modes in Bangladesh is performed by an integration of the road, rail, and water systems. Table No. 2.3 delineates the extent of the inland route mileage for each system during the period 1970-71 to 1974-75.

A review of Table 2.3 indicates that in 1974-75 rail route mileage comprised 12.8% of the total route mileage; road mileage accounted for 50.9%; and river systems provided 36.3%. During the period studies, growth of rail mileage was negligible, while aggregate road mileage grew at an

annualized rate of 2.2%. During the same period river routage showed an analogous pattern to that of rail in that its annualized percentage change was only .2% (.1% for rail).

Table 2.4 presents the consultants' estimate of aggregate commodity flow by surface modes during the period 1970-71 to 1974-75. In 1974-75 it was estimated that percentage tonnage carried by rail, road, and water was respectively 20.7%, 54.1% and 25.2%. The historical evolution of the various modal tonnage performed during the period studied (1970/71 - 1974-75), indicates that rail's share of the tonnage production declined from 3.4 million tons in 1970-71 to 2.4 million tons in 1974-75. This represented an annualized percentage decline of -8%. However, during the 5 year period, road transportation increased its share of tonnage carried from 43.5% (4.6 million tons) to 54.1% (6.3 million tons). This significant increase in road uplift represented an annualized growth rate of 7.8%. In the same period, waterway traffic increased from 2.6 million tons in 1970-71 to 2.9 million tons in 1974-75. However, while annual tonnage performance increased by 2.5%, market share remained relatively stagnant, 24.9% to 25.2%.

In order to quantify the impact upon the total system of route mileage and tonnage production regarding route changes and work performed per system, the consultants computed the ratios of the relative changes. It was found that the rail system ratio was -80; the road system ration 5.6; and the river system 2.5. The efficacy of applying this statistic to the railway system must be tempered by the deterioration that has been inflicted upon the railways by external events beginning during World War II. For a discussion of the specific causes of this deterioration, see the Ministry of

TABLE 2.3

MILEAGE FOR BANGLADESH SURFACE TRANSPORTATION SYSTEM[1/]

	Railways					Road			
Year	Broad Gauge	Meter Gauge	Narrow Gauge	Total Rail	% Total	High Type 2/ (a)	Low Type 2/ (b)	Total Road	% Total
1970-71	595	1,181	(19.75)	1,776	13.6	4,481	1,874	6,335	48.3
1971-72	595	1,176	(19.75)	1,776	13.4	4,526	1,907	6,433	48.5
1972-73	610	1,176	(19.75)	1,786	13.3	4,596	2,052	6,021	49.2
1973-74	610	1,176	(19.75)	1,786	13.1	4,657	2,102	6,759	49.7
1974-75[3/]	610	1,176	(19.75)	1,786	13.0	4,718	2,184	6,902	50.2
1975-76		1,176	(19.75)	1,786	12.8	4,808	2,269	7,077	50.9
Annual % Rate of Change	.5%	-.08		.1%		1.4$	3.9%	2.2%	

1/ Bangladesh Statistical Abstract 1973-74, PP 245, 250, 256

2/ (a) High type refers to roads having concrete or bituminous surface.
(b) Low type refers to roads generally of stones, bricks, gravel or ordinary earth roads properly aligned with drainage structure provided

3/ Figures 1974-75 - 1975-76 consultants' estimate.

TABLE 2.3 (continued)

Navigable Waterways

Year	Perennial	Seasonal	Total Waterways	% Total	Total Mileage All Systems
1970-71	3,352	1,643	4,995	38.1	13,106
1971-72	3,352	1,695	5,047	38.1	13,256
1972-73	3,352	1,695	5,047	37.5	13,456
1973-74	3,352	1,695	5,047	37.1	13,592
1974-75	3,352	1,695	5,047	36.7	13,736
1975-76	3,352	1,695	5,047	36.3	13,910
Annual % Rate of Change	0%	.6%		1.2%	1.2%

TABLE 2.4

ESTIMATED ANNUAL TONNAGE CARRIED BY ALL MODES OF SURFACE TRANSPORTATION

	RAIL		ROAD		WATERWAYS		TOTAL
Year	Tonnage	% Total	Tonnage	% Total	Tonnage	Total	
1970-71	3,347,000	31.5%	4,636,695	43.5%	2,640,000	24.9%	10,623,098
1971-72	1,073,000	12.4%	4,943,648	57.1%	2,645,280	30.5%	8,661,928
1972-73	2,830,000	25.4%	5,491,020	49.4%	2,803,997	25.2%	11,125,017
1973-74	2,603,600	23.1%	5,805,188	51.5%	2,860,076	25.4%	11,268,864
1974-75	2,395,312	20.7%	6,269,603	54.1%	2,917,278	25.2%	11,582,193
Annual Percentage Change	-8%		7.8%		2.5%		2.2%
% Change Ratios	(-80)		5.6		2.0		

Source: Consultants

Communications, Government of the People's Republic of Bangladesh, "Requirements of External Assistance for the Rehabilitation and Development of Surface Transport and Communication" (August 1976, pp. 1 - 8). While acknowledging the obvious defects in this approach, it was the consultants' opinion based on statistical information and site observation that unit modal systems such as truck had significant "production" flexibility in terms of the developing Bangladesh environment. This point is discussed further in Section 2.2.2.1. This proven flexibility, coupled with the 10.1% annual growth rate in the national truck fleet for the period 1964-65 to 1973-74 was considered indicative of the particular effectiveness and reliability of the truck as a major primary transport system for Bangladesh.

Table 2.5 presents a summary statement of the comparative historical analysis performed with respect to the inland transportation distribution system. This table draws together much of the data discussed in text and found in various tables.

A review of the Statistics presented in Tables 2.4 through 2.6 indicates that road traffic is proving an effective mode for freight haulage in Bangladesh.

2.2.2.1 The Bangladesh Road System

The main road system of Bangladesh is made up of approximately 4,808 miles of high type roads and 2,269 low type roads. High type refers to roads having concrete or bituminous surfaces. Low type refers to roads generally of stone, bricks, gravel or ordinary earth roads properly aligned and with drainage structure provided. A review of the literature indicates that of the 4,788 high type road

WHERE DID 20 KMS OF ROAD GO?

TABLE 2.5

Annualized Percentage Changes by Mode and Route for Inland Distribution of Fertilizer and Aggregate Commodity Movements

(Production/Route Ratio)

	Rail	Road	Water	Total
Fertilizer Chittagong	-20.5%	17.8%	2.0%	4.7%
All Commodities Chittagong	-4.6%	5.0%	7.2%	3.1%
Aggregate Mileage Bangladesh Transportation System	.1%	2.2%	1.2%	1.2%
Aggregate Tonnage Bangladesh Transportation System	-8.0%	7.8%	2.5%	2.2%
RATIO = $\frac{\text{\% change tonnage}}{\text{\% change route mileage}}$	(-80)	5.6	2.0	1.8

Source: Consultants

TABLE 2.6

Number of Motor Trucks Registered in 1964-65 to 1973-74

Year	Number of Trucks Registered
1964-65	7,077
1965-66	7,067
1966-67	7,241
1967-68	8,507
1968-69	8,844
1969-70	9,608
1970-71	13,387
1971-72	14,288
1972-73	15,870
1973-74	16,778

Source: Ministry of Communication

miles noted in the statistical abstract only 2,394 miles are fully bituminous and of that the Ministry of Communications considers only 1200 miles as falling into the category of a primary truck system.

The primary and secondary road systems are interdicted by numerous waterways. It has been estimated that the main road system is divided into 30 Ferry River Crossings. Additionally, it is calculated that the secondary feeder systems at the district and Thana level have roadage equal to 10,000 and 30,000-40,000 miles. While acknowledging the constraints of terrain, climate and structural deficiencies, it would appear that a usable road infrastructure is emerging in Bangladesh. A review of Table No. 2.6 "Number of Trucks Registered 1964-65 to 1974-74", indicates that the number of trucks increased from 7,077 trucks to 16,778 in 1974. This represented an annual increase of 10.1% for the nine year period. However, while acknowledging that internal conditions during 1970 caused a sudden spurt in truck registration in 1970-71, it is of interest that recorded annual rates for the following three year period remained consistently high, e.g., 1971 to 1972 = 6.73, 1972 to 1973 = 6.28, 1973 to 1974 = 5.72. A review of aggregate traffic statistics as presented in Table No. 2.4 indicates that in the years immediately following the war of liberation, most of the tonnage lost by the rail system appears to have been taken up by road transportation.

A large proportion of the trucks in Bangladesh are operated in the private sector. However, the Bangladesh Road Transport Corporation, a publicly owned entity, does operate some vehicles. Most of the trucks are assembled locally and have a capacity of approximately 7 tons. However, manufacturers stated capacity is usually exceeded by up to 50%.

Table 2.7 outlines the geographical distribution of truck registration in Bangladesh. Reference to this table indicates the concentration of trucks at Chittagong relative to other areas. There were approximately 3,812 registered trucks in the Chittagong area versus an estimated 2,197 of the larger Dacca region. This largely is attributed to the requirement for quick unloading/loading of imports/exports at the Chittagong port site. Observations at Chittagong Port indicate that trucks proved the most responsive to sudden surges in freight haulage demands.

The consultants believe that the following reasons outline some of the advantage of truck transport over other modes on parallel "competitive" traffic hauls. This has been found to be the case with primary fertilizer distribution. These reasons are:

- Trucks require relatively small initial capital outlays. Additionally, these outlays are in most cases generated from the private sector and returns on investment are internalized by this sector.

- Trucks are versatile in their mode of operation, and provide a point to point (where geographically possible) pickup and delivery system.

- Trucks, because of their speed range and variable load factor, can readily adapt their mode of operation to changes in demand for their use.

- In Bangladesh, truck maintenance costs (which are often largely labor costs) are minimized.

TABLE NUMBER 2.7

Number of trucks registered/licensed clasified by districts and by weight and by kind of fuel used as on 31st. December, 1973

District	Trucks										Truck/Tractor Units		Truck Trailor or Semi Tractor	Total	
	Up to 2 tons		Over 2 tons to 5 tons		Over 5 tons to 8 tons		Over 8 tons		Total						
	P	D	P	D	P	D	P	D	P	D	P	D	P	P	D
1. Dacca ...	271	...	204	795	...	644	...	...	475	1,439	25	186	72	572	1,625
2. Mymensingh ...	5	2	11	104	...	27	...	...	16	133	...	...	...	16	133
3. Faridpur ...	5	...	22	2	...	13	...	...	27	15	...	...	...	27	15
4. Bakergani ...	12	...	46	...	8	...	...	...	66	...	...	...	...	66	
5. Chittagong ...	243	509	537	1,618	63	168	6	37	849	2,332	10	24	...	859	2,356
6. Chittagong H.T....	147	23	183	1	144	...	8	3	482	27	88	...	...	570	27
7. Sylhet ...	...	4	12	2	405	3	1	...	418	9	6	287	321	745	296
8. Noakhali ...	12	3	100	76	...	93	...	...	112	172	...	2	...	112	174
9. Comilla ...	...	...	131	16	23	18	36	14	190	48	19	26	5	214	74
10. Khulna ...	17	1	32	16	40	20	3	44	92	81	9	...	9	110	81
11. Jessore ...	15	...	162	139	1	89	...	18	178	245	...	28	...	178	273
12. Kushtia ...	6	...	43	14	7	60	...	2	56	76	...	22	...	56	98
13. Rajshahi ...	1	6	45	44	8	4	...	...	54	54	54	...	11	119	54
14. Dinajpur ...	3	...	40	81	...	42	...	8	43	131	12	55	...	55	186
15. Rangpur ...	17	...	82	48	...	5	...	...	99	53	30	15	8	137	68
16. Bogra ...	54	1	91	45	24	9	12	38	181	93	26	29	4	211	122
17. Pabna ...	...	...	42	2	8	142	...	...	50	144	7	1	2	59	145
Total	803	549	1783	3002	731	1337	66	164	3383	5052	286	675			5,727

Notes : P—Petrol, D—Diesel.

Source : Ministry of Communication.

- Continuing development of a road infrastructure in Bangladesh appears to be achieving the highest marginal return per mile of development. See Tables 2.4 and 2.5, where percentage or road tonnage productivity is found to be the highest per percentage change in route infrastructure (% change in tonnage productiving - % change in route infrastructure).

It is not suggested in the above that the total freight transportation system be turned over to trucks. What has been indicated by this exercise of comparative analysis is that the trucking industry has shown great flexibility and adaptability in providing solutions (especially short term) to changes in demand for haulage capacity. The consultants see trucks as integral to their selection of a site for the proposed facility. However, the availability of a complimentary and integrated (rail, road and water) network has been a requirement in determining the site selection. These considerations have all been evaluated in terms of the time constraints related to the proposed facility.

2.2.2.2 The Rail System

The rail system of Bangladesh has a nominal route mileage of 1,786 miles. The Bangladesh statistical abstract reports that of this gauge, 610 miles are broad gauge and 1,176 miles are meter gauge. This statistical source shows that there are 115 steam and 34 diesel locomotives on the broad gaugs segment, and 223 steam, and 144 diesels on the meter gauge. The meter gauge is spread throughout the country in both east/west and north/south orientations. The broad gauge is located in west Bangladesh and connects the Khulna area with north Bengal crossing the narrow gauge system at 3 points.

Tables 2.8 "Route Mileage and Stations by Gauge of Bangladesh Railways - 1964-65 to 1973-74", 2.9 "Rolling Stock of Bangladesh Railways by Gauge and Type Category - 1964-65 and 1973-74", and 2.10 "Freight Carried by Bangladesh Railways Classified by Commodity - 1969-70 to 1972-73" presents a review of the freight historical handling capacity of the Bangladesh Railways. These tables indicates that the Bangladesh Railways are showing a decline in all major production indicators. This is particularly the case in the basic criterion of performance; namely, freight carried. In the years 1969-70 to 1972-73 for which statistics were available, commodity haulage fell from 4.8 million tons to 2.8 million, an annual decline of 16.2%.

The Bangladesh Government in their document "Requirements for External Assistance for the Rehabilitation and Development of Surface Transport and Communications - Railway Rehabilitation Program, (August, 1976), notes: "....the condition of the Bangladesh Government Railways has deteriorated to an extent that frequent derailments and engine failures while on the run have become almost a routine affair. Unless immediate remedial measures are taken the entire railway system may collapse in a couple of years".

The reasons outlined in the above document for this condition are summarized as follows:

- The damages sustained by the railway during World War II had not been repaired before partition of the country.

- During the period of liberation, "300 bridges and almost all the important railway stations near the

TABLE NUMBER 2.8

Route mileage and stations by gauge of Bangladesh Railway, 1964-65 to 1973-74.

Year	Broad gauge		Metre gauge		Narrow gauge		Total	
	Station	Route mileage	Station	Route mileage	Station	Route mileage	Station	Route mileage
1964-65 ...	140	546	284	1,147	10	19.75	434	1,713
1965-66 ...	141	546	289	1,147	10	19.75	440	1,713
1966-67 ...	141	554	292	1,139	10	19.75	443	1,713
1967-68 ...	141	554	299	1,178	10	19.75	450	1,752
1968-69 ...	141	554	300	1,178	10	19.75	451	1,752
1969-70 ...	156	573	310	1,202	...	...	466	1,775
1970-71 ...	156	595	311	1,181	...	...	467	1,776
1971-72 ...	156	595	311	1,181	...	...	467	1,776
1972-73 ...	159	610	312	1,176	...	...	471	1,786
1973-74 ...	161	610	314	1,176	...	...	475	1,786

Source : Bangladesh Railway.

Source Bangladesh Statistical Digest 1974 -75

TABLE NUMBER 2.9

Rolling stock of Bangladesh Railway by gauge and type or category, 1964-65 to 1973-74.

Year	Locomotives.							Coaching vehicles		Freight wagons	
	Broad gauge		Metre gauge		Narrow gauge		Total	Passenger carriages	Other coaching vehicles	Unit	Four wheelers
	Steam	Diesel	Steam	Diesel	Steam	Diesel					
1964-65	133	...	243	102	7	...	485	1,295	495	19,509	22,682
1965-66	133	...	240	102	7	...	482	1,346	485	19,303	22,481
1966-67	133	18	237	102	4	...	494	1,278	479	18,792	21,907
1967-68	131	18	235	101	4	...	489	1,240	457	18,306	21,396
1968-69	121	18	229	101	4	...	473	1,208	483	17,582	20,523
1969-70	121	18	222	125	6	...	492	1,192	479	16,835	19,628
1970-71	118	27	222	125	6	...	498	1,189	458	16,290	18,979
1971-72	118	30	222	125	6	...	501	1,179	460	16,071	18,720
1972-73	115	34	223	128	...	...	500	1,195	479	16,100	18,667
1973-74	115	34	223	144	...	...	516	1,247	453	16,081	18,573

Source : Bangladesh Railway.

Source Bangladesh Statistical Abstract 1974-75

TABLE 2.10

Freight Carried by Bangladesh Railway
1970-71 to 1972-73
(000 tons)

1969-70	1970-71 (July-June)	1971-72 (See Note 1)	1972-73 (July-June)
4,802	3,347	1,073 (6 months only)	2,830

Source: Bangladesh Statistical Abstract 1974-75. (Figures for 1973-74 not available.)

1) Figures from 16-12-71 to 30-6-72

border were completely damaged, 71 miles of railway track were destroyed, 722 units of passenger coaches, 1,484 units of freight wagons, 140 units of locomotives, and 20 marine craft were seriously damaged. Besides 12 diesel locomotives and 24 steam locomotives were damaged beyond repair."

- This period also had a serious impact upon the skill base of the system in that the above mentioned Government publication further adds "1,300 railway employees including experienced officers and skilled workers lost their lives".

- Since the war of liberation, lack of capital and scarcity of foreign exchange has constrained the railway maintenance program to "25% of maintenance work that could be carried".

The conclusion of the consultants, based on data research and site evaluation was that for the immediate near term rail transportation would not be the primary method for distribution from the proposed bulk handling facility. The consultants do not preculde the eventual greater long term utilization of rail as a primary transportation mode. In this connection, the Government of Bangladesh has outlined a planned "Railway Rehabilitation Program". The basic elements of this program are detailed in the Government document entitled: "Requirements for External Assistance for the Rehabilitation and Development of Surface Transportation and Communications; Government of the People's Republic of Bangladesh" (20th August, 1976).

This conclusion was reinforced by two other major constaints:

- The geographic cleavage of the country into a series of segmented sub-regional transportation systems, without connecting bridges to facilitate the smooth flow of freight tonnage; and

- A two gauge rail system (meter and broad). This dichotomy of the rail system imposes economic costs necessitated by freight transfers from one gauge system to the other.

The broad gauge line between Khulna and north Bengal provides the basis for a north-south corridor. This line will become more valuable with the development of Mongla Port and bridging of the Pusur River. However, in the time frame of this study, it has a limited use for a primary distribution system.

2.2.2.3 The Waterway System

Bangladesh is divided by four main rivers, The Ganges, Jamuna, Padma and Meghna.

Under favorable geographic and hydrological conditions, there are 3,352 miles of perennial and 1,695 miles of seasonal waterways in Bangladesh. In addition to the inland system, there are approximately 200 miles of coastal waterways. Table 2.11, "Water Transport Operations Under Bangladesh Inland Water Transport Authority, 1964 to 1973-74", relates the historical evolution (during the nine year period) of the waterways to: 1) Navigable waterways (miles), and 2) Volume of cargo handled. For the period for which data was available, inland water transportation performed an average of 2.75 million tons of cargo handled. During this period

TABLE NO. 2.11

Water transport operation under Bangladesh Inland Water Transport Authority, 1964-65 to 1973-74

Year	Navigable water ways (miles) (a)			Volume of cargo handled. (e) (million tons)				
	Perennial	Seasonal (b)	Total	Inland	Overseas	Foreign (d)	In transit	Total
1964-65	3,341	1,643	4,984	0.36	1.68	0.14	0.76	2.94
1965-66	3,352	1,643	4,995	...	...	...	...	...
1966-67	3,352	1,643	4,995	0.40	2.30	...	...	2.70
1967-68	3,352	1,643	4,995	0.36	2.24	(c)	...	2.60
1968-69	3,352	1,643	4,995	0.32	2.41	...	...	2.73
1969-70	3,352	1,643	4,995	0.33	2.53	...	...	2.86
1970-71	3,352	1,643	4,995	0.32	2.32	...	...	2.64
1971-72	3,352	1,695	5,047	...	...	...	...	...
1972-73	3,352	1,695	5,047	...	...	...	...	...
1973-74	3,352	1,695	5,047	...	...	...	...	...

Notes: (a) Navigable, (b) Seasonal, (c) By I.W.T. mechanised fleet. (d) Traffic suspended since 1965.
(c) The number of passenger boats is about 200,000 with capacity of about 1.5 million. The number of cargo boats is about 100,000 with capacity of about 1.2 million tons according to estimates made by district officials in 1958.

Source: Bangladesh Inland Water Transport Authority.

Source: Bangladesh Statistical Abstract 1974-75.

(1964-65 - 1970-71), variation in tonnage carried was small, indicative of this was the small standard deviation computation of 0.13 million tons. What appears relevant from these statistics is that transport flows on inland waterways are static but also stable as indicated in the 1970-71 figures.

In 1967, a system of classification of waterways was developed by NEDECO. This system is based on the concept that routes should have guaranteed channel depths, and where "economically justified" be equipped with navigational aids. The Bangladesh Inland Water Transport Authority (BIWTA) has followed this system of classification.

Waterways are classified into the following three groups:

- Class 1 Routes - waterways for which specific depths are (or should be guaranteed).

- Class II Routes - waterways for which depth estimates are given and regularly checked, and for which navigational aids are (or should be) provided.

- Class III Routes - routes of local importance, for which only approximate depths are provided.

The major inland waterways link the inland ports of Dacca, Narayanganj, Chandpur, Barisal, and Khulna together with the maritime ports of Chittagong, Chalna, and the Outer Anchorage. Also, it is envisioned that the proposed port at Mongla (Chalna Anchorage) will become a major inland river/maritime interface. These existing routes are all Class I waterways which have an estimated year round depth

of 12 feet. The Mongla-Chasiakhali Canal has recently been improved to the point where it is reported to be able to handle boats with a minimum draft of twelve feet on a year round basis.

Other routes which are significant for inland distribution by route and classification are:

- Goalundo ghat to Nagarbari ghat
  - Class I River but difficulty is encountered in maintaining it in the dry deason due to situation.

- Goalundo ghat to Chilmari - Class III Route along the Padma River with a natural minimum draft clearance of six feet as far north as Bahadurabad.

- Chatak to Fenchuganj - is the main waterway in north-east Bangladesh and is classified as a Class III system using the Surma and Kushiyara Rivers. The draft on these rivers is often 3 feet or less, constraining the use of inland water transportation from the Fenchuganj Fertilizer Factory.

A whole spectrum of vessels ply the inland waterways. These range from hand propelled country boats up on through to larger type coastal craft of 500 tons displacement. These crafts are both public and privately owned. The main public entity utilizing riverine craft is the Bangladesh Inland Water Corporation (BIWTC). In 1972, the BIWTC acquired 608 vessels with an aggregate capacity of 144,726 tons (average of 238 tons/craft) and by 1976 they had an additional 161 watercraft with a tonnage capacity of 55,000 tons (341 tons/craft). However, many of these vessels are

old and are being disposed of (200 with a tonnage of 30,000 tons).

The Ministry of Communications comments that of the total registered inland waterway fleet - "about 25% of them remain non-operational all the time due to the nonavailability of replacement engines and other major component parts. Existing repair workshop facilities in the country are very much inadequate to cater for the demands for such a cargo fleet. Moreover, the workshop machineries and equipment had become obsolete and worn out and as such are required to be replaced on an urgent basis". In the context of sustaining and development projects, the Ministry notes: "There are about 19 ongoing projects and 10 new development projects in the IWT sector involving an estimated total cost of Tk. 706.80 million including Tk. 296.3 million in foreign exchange and Tk. 544.74 million including Tk. 59.00 million in foreign exchange respectively."

In terms of use of waterways the consultants noted the following advantages:

- The natural low cost, easily accessible nature of waterways provided by the delta geography of Bangladesh.

- The existence of a large number of craft of varying sizes in both the public and private sector. These craft have considerable flexibility in regard to various volume demands.

- The low unit cost per ton of cost generated by use of river craft - especially when there was a low time constraint (cost, rate-volume effect).

However, against these advantages, the consultants observed that:

- Acquisition of new motorized craft and maintenance on existing vessels required substantial capital outlays in foreign exchange.

- Dredging for larger craft which could take advantage of the inherent cost savings in water craft, is costly and again requires the importation of foreign machinery and technical assistance.

- River craft (both motorized and non-motorized) were not found as flexible as motorized trucks in absorbing the impact of sudden changes in demand. For freight haulage, this was because of the physical constraints of time related waterway operations.

From an analysis of the Inland Water Transport system, it was determined that it would provide an excellent mode for both primary and secondary distribution of fertilizer. However, it is believed that it will have to serve in a complimentary role to rail and especially road transport. Conditions, as described above, are expected to persist for the next 5 to 10 years. It was in this context that the new facility criteria analysis vis-a-vis the role of waterways in intermodal transportation for the new site was evaluated.

2.2.2.4 The Ports

Bangladesh depends almost entirely upon her maritime ports for handling international trade. Bangladesh presently has

two deepsea ports:

- The Port of Chittagong
  Located on the River Karnafuli, and

- The Port or Anchorage of Chalna
  Located on the Pusur River near Mongla in the Khulna District

ONLY the port of Chittagong has direct access to all modal types: rail, road, and inland waterways. Ships anchored at Chalna must offload onto barges or other boats for transshipment to road and rail freight sources.

- Chittagong

  Data for the Port of Chittagong was readily available. The tables presented in Appendix 7 provided an excellent basis for complementing the onsite evaluation of the Port of Chittagong as a potential candidate for the proposed facility. The tables presented in Appendix 7 are listed below.

  - Import and Export handled - 1970/71 to 1975/76

  - Commodity-wise Imports handled - 1970/71 to 1975/76

  - Commodity-wise Export handled - 1970/71 to 1975/76

  - Principal Commodity-wise clearance of dry imports from the port - 1970/71 to 1975/76

- Principal Commodity-wise clearance of dry imports by rail - 1970/71 to 1975/76

- Principal Commodity-wise clearance by dry imports by road

- Principal Commodity-wise clearance of dry imports by river

Table 2.12, "Commodity-wise Import Tonnage Handled in the Ports of Chittagong and Chalna" present on a competitive basis an evaluation of the relative importance of each port to the Bangladesh economy. In 1972-73, Chittagong handled 4.8 million tons (15%) against .82 million tons for Chalna; in 1973-74, the figures were respectively 3.3 million tons (82.5%) to .70 million.

A review of Table 2.13 indicates that Chittagong performed the greatest share of fertilizer tonnage hauled. It is interesting to note that when aggregate tonnage dropped -46.3%, tonnage hauled at Chalna only fell by -4.2% against -55.33% for Chittagong. A review of the site conditions at both ports, and discussions with officials, indicates that Chittagong does indeed experience wider swings in export/import flows for various commodities.

Table 2.14 presents an overview of the historical trends in fertilizer distribution from Chittagong by the three systems. From this table, it is observed that road tonnage increased during the period 1970-71 to 1975-76 from 175,550 tons to 225,695 tons. This represented an average annual increase of 17.8%. Rail

TABLE 2.12

-Commodity-wise import tonnage handled in the ports of Chittagong and Chalna.

(Tons)

Commodi	1972-73		1973-74	
	Chittagong	Chalna.	Chittagong.	Chalna.
Foodgrains ...	23,36,012	5,78,883	13,25,673	5,82,167
Sugar ...	76,818	2,685	39,756	—
Chemicals ...	—	—	26	—
Coal ...	5,189	—	1,29,920	—
Cement ...	2,45,128	93,990	1,09,106	19,424
C.I. sheet ...	29,156	20,512	8,058	3,533
Cotton yarn and piece goods ...	464	—	8,689	—
Iron and Steel ...	47,227	400	49,308	—
Cotton ...	38,960	19,761	25,400	—
I.C.I. products	7,500	—	—	—
Oil in drum ...	61,707	—	16,813	—
Timber ...	—	—	787	—
Paper ...	691	38	796	—
Fertilizer ...	2,29,329	48,894	1,02,553	46,804
Pels (in bulk) ...	—	—	10,900	—
Tobacco ...	16,090	1,245	7,574	279
Oilseeds ...	85,234	4,502	56,351	1,735
Betelnuts ...	106	—	—	—
C.P. Goods ...	918	—	—	—
G/Cargo/Sundries	5,21,382	32,199	3,60,327	34,564
S. Oil ...	5,205	8,097	—	
Machinery ...	—	* 4,958	—	5,648
Bitumen ...	—	—	—	6,615
Wax ...	—	—	20	—
Pig iron ...	—	1,038	—	—
Bulk oil ...	1,143,455	—	—	—
Total	14,850,571	18,17,202	3,295,006	7,00,769

Sources : Chittagong Port Trust and Chalna Anchorage.

Source Bangladesh Statistical Digest 1974-75

Table No. 2.13

Fertilizer handled in the ports of Chittagong and Chalna
1972-73 and 1973-74

(Tons)

Port	1972 - 73		1973 - 74		%
	Tons	Percent	Tons	Percent	Change
Chittagong	229,329	82.4	102,553	68.7	- 55.3
Chalna	48,894	17.6	46,804	31.3	- 4.2
Total	278,223	100.0	149,357	100.0	- 46.3

Source: Bangladesh Statistical Abstract 1974-75

Table 2.14

FERTILIZER SHIPMENTS FROM CHITTAGONG BY MODAL TYPE 1970-71 - 1975-76

(Tons)

Year	Rail		Road		Water		TOTAL	
	Tonnage	%	Tonnage	%	Tonnage	%	Tonnage	%
1975-76	28,093	10.73	197,872	75.55	35,936	13.72	261,901	100%
1974-75	10,547	4.27	202,858	82.15	33,543	13.58	246,948	100%
1973-74	16,398	16.48	66,834	67.18	16,248	16.56	99,480	100%
1972-73	25,306	11.05	143,193	62.54	60,472	26.41	228,971	100%
1971-72	7,873	11.46	50,006	72.82	10,793	15.72	68,672	100%
1970-71	88,178	42.37	87,372	41.98	32,556	15.64	208,106	100%
TOTAL	176,395	15.83	748,135	67.15%	189,548	17.01%	1114,078	100%
Average Per Year	29,399		124,689		31,591		185,680	
Annual % Change	20.5%		17.8%		2.0%		4.7%	

Source: Port of Chittagong, Bangladesh, Year Book 1975-76, Pages 72-74

tonnage during the same period declined from 176,395 tons to 28,093 tons in 1975-76; an annualized decrease of -20.5%. Water transport showed a slight increase of 2.0%. Water carried tonnage of fertilizer went from 32.556 tons in 1970-71 to 35,936 tons in 1975-76. Of significance in these statistics, as provided by the Port of Chittagong, is that road transportation's share of the fertilizer distribution tonnage went from 41.9% in 1970-71 to 75.6% in 1975-76. Water carriers share remained relatively stable; 15.6% to a lower 13.7%. However, rail transportation decreased significantly from 42.4% to 10.7%. As noted earlier, and stressed in this report, these figures demonstrate the flexibility and versatility of road transportation

- Chalna

In the interest of clarifying the use of the term "Chalna" as a port of Bangladesh, the following explanation may be useful. As previously expressed, the "Port of Chalna" or "Chalna anchorage" is strictly a lighterage port. Its activity relates both to the lighterage transfer Port of Khulna and to the new port development at Mongla. It should be understood that all three ports are located on the Pusur River in southwest Bangladesh. The port development now underway at Mongla is closest to the mouth of the river, some 50 miles from the sea, and planned for a 35 foot draft. Chalna anchorage is located in the vicinity of Mongla where cargo is presently handled between deep sea vessels and lighters. The anchorage derives its name from the village of Chalna which is located 15 miles farther up the river from Mongla.

vessels drawing in excess of 12 feet normally do not proceed beyond the Chalna anchorage. Khulna is an additional 15 miles up the Pusur. Road and rail connections to the interior terminate at Khulna. Draft restrictions in the river limit the port to barges, lighters and vessels drawing approximately 12 feet. As previously observed, road transportation was the mainstay in permitting Chittagong to accommodate traffic fluctuations (see Table 2.14). In this context, the lack of a land transportation interface caused the anchorage at Chalna to be excluded as a possible site for the proposed bulk storage facility.

- <u>The New Port Development at Mongla</u>

Presently, there is an ongoing project at Mongla to develop a 9 jetty port facility. This site is located on the east side of the river. Currently, there exist no rail or road system from this site to the hinterland. As stated above, the main focal point for road and rail (broad gauge) facilities inWest Bangladesh are found at Khulna on the west bank of the Pusur River. Although the initial five berths at Mongla are scheduled for completion in 1979, the development of raod and rail connections to the port are not expected to be completed prior to 1983. Therefore, further consideration was not given to this port as an initial site for the proposed bulk handling/storage/bagging facility.

3.0 ANALYSIS OF ALTERNATIVES

3.1 ALTERNATIVE SITES

The scope of work called for the examination of various feasible alternative plans for importing TSP and MP in bulk into Bangladesh, in order to provide a system of fertilizer import best serving the needs of the country over the period 1978 through 1987. Eight alternative sites were considered. These alternatives are shown on Table 3.1, which lists the comparative advantages, disadvantages and physical limitations of each.

In considering these alternatives, the consultants took the position that any alternative dependent upon an improvement or facility which would not be completed and available during the first five years of the 1978-1987 period could not be considered as a feasible alternative. Within this time period, only one feasible alternative can be found. This is the TSP plant site at Chittagong. All of the other alternatives fail due to physical limitations or time and cost considerations. Table 3.2 shows a preliminary estimate of capital cost for establishment of the required facilities on the various sites, and Table 3.3 summarizes the advantages and disadvantages of the five primary sites under consideration. Alternatives other than those listed are discussed in Section 3.3.

3.1.1 Micro/Macro Economic Implications

The consultants analyzed the local and national economic impact of locating the bulk storage and bagging facility at the following sites:

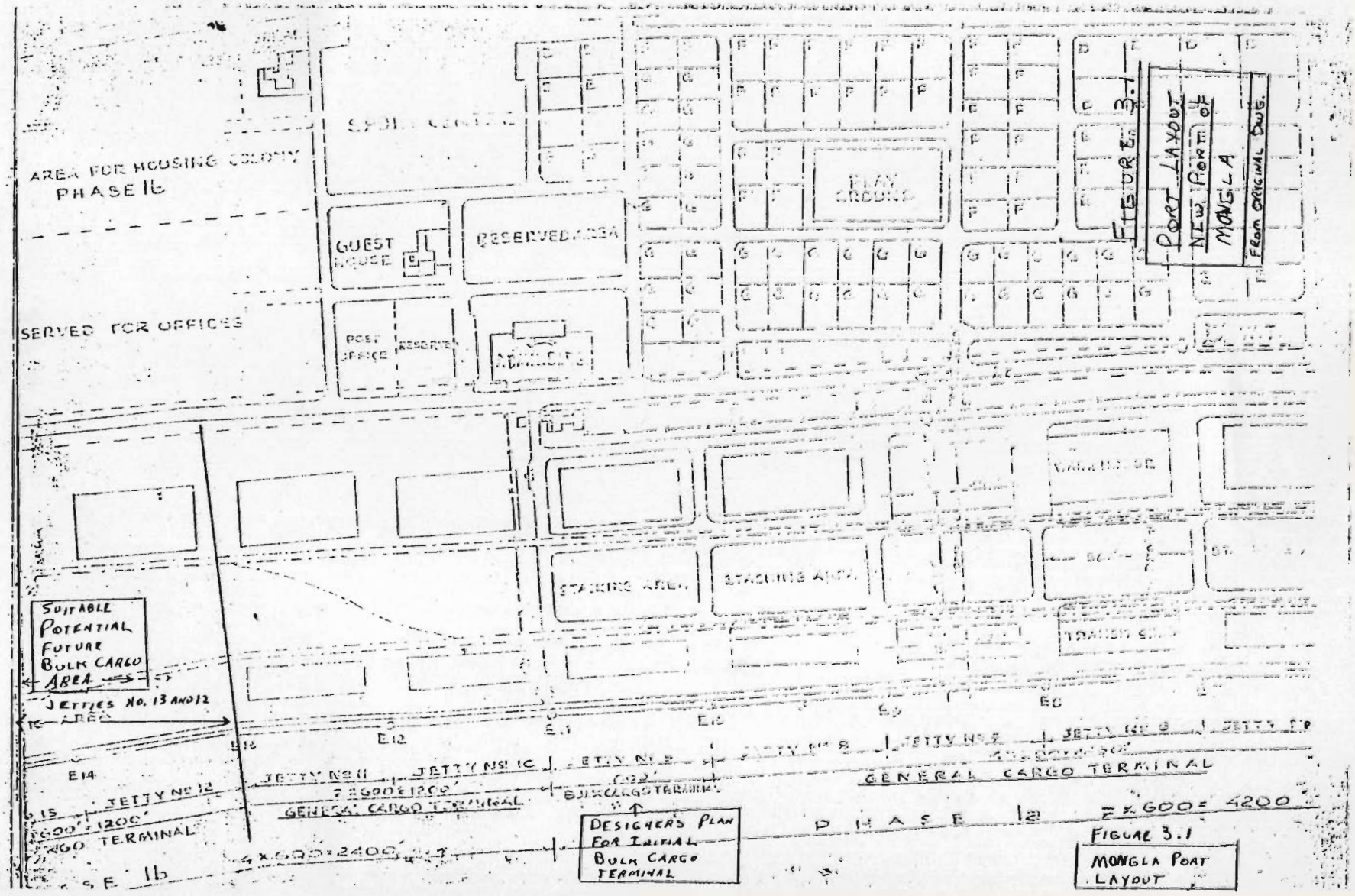


FIGURE 3.1
PORT LAYOUT
NEW PORT OF
MONGLA
From ORIGINAL DWG.
AREA FOR HOUSING COLONY
PHASE 1b
GUEST HOUSE
RESERVED AREA
PLAY GROUND
SERVED FOR OFFICES
POST OFFICE
RESERVED
STACKING AREA
STACKING AREA
SUITABLE POTENTIAL FUTURE BULK CARGO AREA
JETTIES NO. 13 AND 12
AREA
E14
E12
E10
E8
JETTY No 11
JETTY No 10
JETTY No 9
JETTY No 8
JETTY No 7
JETTY No 6
JETTY No 12
GENERAL CARGO TERMINAL
BULK CARGO TERMINAL
GENERAL CARGO TERMINAL
DESIGNER'S PLAN FOR INITIAL BULK CARGO TERMINAL
PHASE 1a
7×600=4200
PHASE 1b
4×600=2400
FIGURE 3.1
MONGLA PORT LAYOUT

TABLE NO. 3.2

BANGLADESH BULK FERTILIZER IMPORT ALTERNATIVES

Site Feasibility Comparison

Description of Alternative	Ability to berth Deepsea vessels		Availability of site		Compatibility with adjacent facilities	Available Experienced labor/mgt	Access to Hinterland		
	Draft	Yes/No	Now	Future			Road	Rail	Water
Chittagong: 1. BSP Plant	22' to 30'	Yes	Now		Yes	Yes	Yes	Yes	Yes
2. Cement Plant	22' to 30'	Yes	By conveyor across two properties		No	Yes	Yes	Yes	Yes
Port Trust Site 3. Existing Port	22' to 30'	Yes	Would consider		No	Yes	Yes	Yes	Yes
4. Proposed Port	to 40'	Yes	Indefinite future		Yes	Yes	Not known		
5. Chalna	26'	Yes	No		No	No	No	No	Yes
6. Khulna	12'	No	Now		Yes	No	Yes	Yes	Yes
7. Mongla	35'	Yes	1979 earliest		No	No	No	No	Yes
8. Narayanganj	12'	No	No. Congested Residential area		No	No	Yes	Yes	Yes

(continued.....)

TABLE 3.3

EVALUATION OF SITE CONTAINER IMPORT ALTERNATIVES

Site Feasibility Comparison (continued)

Description of Alternative	Transhipment required to reach storage	Estimated cost (Table 3.2)	Feasible Alternative now	REASON
Chittagong: 1. TSP Plant	No	8	Yes	- Completely compatible - Fits all requirements - Offers future advantages
2. Cement Plant	By long conveyor	10	No	- Not compatible with cement operation - Also conflicts with grain silo property
Port Trust Site 3. Existing Port	No	20	No	Not a compatible activity
4. Proposed Port	No	N/A	No	May never be built
5. Chalna	Yes	N/A	No	No land site No rail or road
6. Khulna	Yes	10	No	- Not on deepwater - Requires transhipment
7. Mongla	No	8	No	- Not available for indefinite time - Present layout not compatible - No rail or road access
8. Narayanganj	Yes	12	No	- Not on deepwater - No site - Requires transhipment

Table 3.2

Preliminary Estimate of Capital Cost per Site

Establishment of Bulk Fertilizer Import Handling and Bagging Facilities

Proposed Site	Estimated Capital Lost
Chittagong	
- TSP Plant	8.0 1/
- Cement Plant	10.0 2/
- Port Trust Site	20.0 3/
- Proposed Port	Project not yet confirmed 4/
Chalna	No land site 5/
Khulna	10.0 6/
Mongla	8.0 7/
Narayanganj	12.0 8/

NOTE: Costs rated on a scale of 1 to 20 for estimating purposes
Estimated costs above subject to review by consultants Cost Estimating Section on return to Home Office

1) Utilizes existing jetty, but requires facilities shown in Section 4.

2) Utilizes existing jetty but requires prox. 1/3 mile of addl. conveyor, on acquisiton of additional property.

3) Preliminary information indicates new site, new jetty and all new installation.

4) Feasibility study now in early stages. This location would require complete new development. In addition, would also require investment in coastal vessels and barges for transfer to inland ports, also requiring additional capital cost for development (See Section 3.2.1)

5) No possible development here. An anchorage only (See Appendix 2, site questionnaire).

6) Would require complete new development cost, and could be served only by barges, thus requiring additional discharge facilities and costs at deep water. This site would further require additional equipment and cost to transfer goods to eastern section. Facility would not serve entire needs of country. See Appendix 2, Site Questionnaire.

- Chittagong
- Chalna/Mongla
- Khulna
- Narayanganj

3.1.1.1 Employment and Income Effects

From a "Micro" economic analysis it was determined that there would be an employment and income effect. This would have the primary effect of creating additional jobs and income. The secondary effect would be expenditure of this income within the community. This latter effect is referred to as the income and employment multiplier. It was concluded that this impact would be nearly similar at each site. This point is noted in Table No. 3.4.

- Learning Curve Costs

A cost consideration that is implicit in any consideration of a site selection is the availability of skilled and semi-skilled labor. In Table No. 3.4, the consultants have ranked each proposed site in terms of least "learning curve costs" that would be related to developing the facility at the location. This criterion was generated by onsite visits, conferences with local officials, and reference to source documents.

- Foreign Exchange Benefits

In terms of "Macro" or national level impact, the most obvious effect would be an easing of foreign exchange requirements by using local labor and material to perform the bagging operation. This is in contrast to the present method of bringing in fertilizer in bags from overseas suppliers. See Table 2.1

in Section 2 for comparative cost of the two methods. Time lags related to operationizing a bulk handling facility at each site have been considered in establishing the present value of these foreign exchange benefits as shown on Table 3.4 which ranks the site by highest present value of exchange rates saved (foreign exchange benefits).

- Capital Development Expenditures

Another major "Macro" impact upon the foreign exchange reserves, would be the demand for foreign capital related to modifying or developing the transportation infrastructure necessary to facilitate the distribution of the bagged fertilizer. In Table 3.4, the consultants ranked each site by the least capital expenditures required to develop a complementary transportation infrastructure.

The overall ranking, as shown on the table, indicate that in all categories Chittagong has the highest economic criteria valuation. The rankings are:

(1) Chittagong, (2) Khulna, (3) Narayanganj, and
(4) Chalna/Mongla as indicated in summary form on the table

3.2 THE FEASIBLE ALTERNATIVE

A system of fertilizer import best serving the needs of Bangladesh for the next ten years (1978-87) would be one based on services, facilities, management, labor and transport to be in existence now or known to be expandable or available within the initial (at least the first 5 years) period of the 10 year time frame. It should also be a

system which will not work at cross purposes with existing or planned programs, and it should be compatible with and complementary to existing and planned programs and present and future requirements of the country. There is only one site for bulk fertilizer import which can be recommended as best serving the needs of Bangladesh for the next ten years. This site is the TSP Plant at Chittagong.

Location of bulk fertilizer storage and bagging facility at this plant best serves the needs of Bangladesh for the following reasons:

- Least Capital Cost

Table 3.2 ranked the various proposed sites in accordance with estimated capital cost for development. The ability to use existing jetty facilities, and the close proximity of the site to the jetty and to existing road and rail connections resulted in the TSP site ranking lowest in estimated capital cost.

- Existing Experienced Labor

Proximity to the TSP plant provides access to the single source of labor and supervision in Bangladesh experienced in bulk handling and bagging of TSP. In addition, Chittagong port labor represents the principal pool of labor experienced in the high volume handling of bagged materials.

- Other Significant Reasons

  - Existing bulk fertilizer handling equipment

- Existing experienced management

- Import materials supplement and complement the existing production

- Availability of MP at this location will permit the production of compound fertilizers

- Existing harbor facilities

- Improvements to the facilities (adding handling equipment, lengthening and/or deepening berth) enhance the capability of the existing facility

- Utilization of existing facility is enhanced with economic benefit of economies of scale

- Complete system of rail, road and water transport is already available in existence and is expandable (road and water)

- Electric power and local infrastructure is available

- Import fertilizer handling and bagging is completely compatible with existing operation

- Compound fertilizer production is a future requirement of the country, location here facilitates development of such products

- Additional bagging capacity supplements existing plant capacity

- Storage facilities can be complementary between the plants

- Organizational and management relationships are compatible

3.2.1 Future Expansion of the System

As the road, rail and water transport capabilities of Bangladesh increase and improve, as the use of fertilizer increases, and as familiarity with the handling of fertilizer increases, there should be further opportunities for savings by the utilization of bulk storage and handling in other ports of Bangladesh. Bulk transport and handling equipment will be required for the successful extension of bulk fertilizers into the interior of the country. Training of labor and management in the skills required for the safe and efficient storage and handling of bulk fertilizers will also be required. Three locations in particular should be considered for fertilizer bulk handling and storage facilities in the future, and at two of these, bagging facilities should be included. These locations are the following:

- Proposed Deepwater Port at Potenga (Entrance to Chittagong Harbor)

A team from the Netherlands Economic Institute has studied nine potential deepwater port sites suggested by an earlier British study to determine the most economically and technically practical site for a deepwater port for Bangladesh. Team members have indicated to these consultants that the only one of the nine sites economically feasible is the Potenga site. Technical feasibility is now being determined.

It was indicated that it should be economically feasible to berth vessels up to 50,000 DWT at Potenga, despite heavy dredging cost. Should such a port be constructed in the future, consideration should be given to constructing a bulk fertilizer storage and transfer facility there. With such a facility, vessels exceeding the draft limits of the TSP berth could be lightened at Potenga. The tonnage offloaded there could go directly to storage, for subsequent shipment by water to the TSP plant, or to other bulk facilities which may be developed. Bagging facilities should not be required at this location.

- The New Port of Mongla

Overland connections: Effective use of the port requires the development of road and rail links, probably at Khulna. Although land transport connections to the port are not expected to be available during the next five years, the provision of a land link to the port is under study by the Asian Development Bank. A ferry crossing at Khulna and an asphalt highway to Mongla is being considered by ADB. (However, these consultants believe a road and rail bridge at Khulna should be given further consideration as offering longer term cost savings, as opposed to initial capital cost savings alone. In addition, a broad gauge rail connection should be included, in order that the port may connect directly to the north-south rail line at Khulna, the primary access to north-west Bengal.) In the longer term, full development of Mongla is essential to the development of western Bengal, due to the splitting of the country by rivers into eastern and western sections. Future development beyond the 10 year term of this sutdy period should see Chittagong serving

eastern Bangladesh and Mongla serving western Bangladesh.

Port Layout: The port facilities presently under construction provide for a bulk cargo berth at berth No. 9 as can be seen on the Port layout on Figure 3.1. The layout of this berth, in the opinion of these consultants, does not lend itself to the establishment of a bulk storage and bagging facility. However, the second phase development of berths 12 and 13 would provide sufficient space for such a facility. When more information is available about the development of land links, and of sufficient open space for bulk storage and bagging facilities, this port should be considered as the logical site for establishment of the second bulk fertilizer storage and bagging facility. Its location west of the Ganges and its planned ability to receive vessels up to 35 feet draft favor the site for development of facilities to serve the future import fertilizer needs of the north and southwestern sections of Bangladesh.

- Khulna

Development of bulk storage and bagging facilities at Khulna in lieu of facilities at Mongla could be considered but depth of water at Khulna of 12 feet would not permit ocean vessels to deliver directly to the facility. Therefore, it is felt that Khulna should be served by bagged delivery from Chittagong, or by continuation of bag fertilizer purchases for that port until such time as facilities at Mongla can be developed.

- Narayanganj

Reference to the Site Questionnaire in Appendix Section 1 will show the general conditions at this river port today.

Extremely congested, with the town encroaching on the present port facilities, an adequate site for a bulk storage and bagging facility adjacent to any existing jetties within the vicinity of direct road and rail access will be difficult to find. Nevertheless, the port can be reached by light coaster vessels and barges, and its central location, with good access to road, rail and upcountry water routes suggest the general area as a potential site for additional bulk storage and bagging facilities. The area is also likely to have a more skilled labor force for manning the requirements of such a facility. However, in the future, as fertilizer consumption increases and in the event that a deep draft terminal for handling berth cargo is constructed at the entrance to Chittagong harbor, (or elsewhere), and there is available an adequate fleet of suitably designed bulk cargo coastal vessels and barges, then Narayanganj should be considered as the site of the port inland bulk fertilizer storage and transfer facility. Locating a proper site on water, with access to rail and road, in that area may require demolition of existing facilities, and relocation of roads and residential and commercial facilities.

3.3 DISCUSSION OF OTHER ALTERNATIVES

3.3.1 The Alternative of Inaction

One additional alternative which could be considered would be to do nothing now, and defer any decision on the location of the facility until such time as the following factors are determined.

(1) When it has been determined whether a new deepwater facility will be constructed at the entrance to Chittagong harbor. Should a favorable decision be forthcoming on such

a facility, to be served by adequate road, rail and water connection, then the advantages of this location's deepwater site offer the advantage of use of larger vessels. This consultant does not feel that even this advantage would be sufficient to override the advantage of integrating bulk fertilizer material imports with the existing TSP plant production.

(2) When it has been determined when road and rail connections will be provided to the new port of Mongla. For serving the area west of the Jamuna-Ganges Rivers with imported TSP, MP, (and including imported urea and compound fertilizers) this port offers the preferred location for the future. But uncertainty about its completion date, its ultimate layout, and the certainty that road and rail connections will not be provided for a good number of years causes this consultant to rule out this facility from present planning. Ultimately it is expected that a second fertilizer facility would be located here.

3.3.2 Alternatives Discarded

In addition to the alternatives indicated above, there are also a larger number of further possible solutions and combinations of solutions to the point of rendering a rational conclusion extremely complex. All of these have been discarded by the consultants as being beyond the capability of current Bangladesh present or planned infrastructure and technology during the period under consideration. The observations and analyses contained in Section 2 convinced the team that any of the following alternatives are technically impractical for the immediate future. Discussions with Bangladesh officials also confirmed a similar feeling

among those individuals knowledgeable in Bangladesh transport and operating capability today. Among the discarded alternatives were the following.

- Bulk imports to Chittagong (and Chalna) with bulk storage and bagging at Narayanganj and Khulna

  Discarded due to requirement to ship bulk by water, to unload at inland ports in bulk, to store in bulk and bag (see Table 3.1).

- Bulk imports to main ports. Bulk shipment by water and land to interior points inside Bangladesh

  Discarded because of lack of bulk transport equipment, water or land, also high risk of excessive losses in transport. Lack of know how as well. Development of interior bulk storage and bagging facilities, coupled with bulk blending would require inland river terminal facilities, bulk unloading, handling and storage capacity. Such a system has been suggested, but it is felt that the transport and distribution system would not be ready for such form of shipment within the study time frame.

- Acquire a floating bulk unloader to lie off Chittagong (or Chalna/Mongla) and discharge to barges in bulk

  Discarded due to limited capability of Bangladesh barging system. Coordination of barges with ship arrival (as in US Mississippi River and Rotterdam Rhine system) requires a very large fleet of hopper type barges in regular services. Without this, inability to coordinate ship arrival with barge

availability (where no shore storage also exists) results in excessive lost time on vessels awaiting barges. At Chittagong, it was also learned that weather conditions do not permit safe year round lying off in the Bay of Bengal.

4.0 RECOMMENDATIONS

4.0 RECOMMENDATIONS

4.1 THE RECOMMENDED SOLUTION

It is recommended that initially only one port location be established for the unloading, bulk handling, storage, bagging and shipment of imported TSP and MP fertilizers. For purposes of this report, bulk handling is defined as including handling and bagging and bulk blending and mixing, but not including granulating. A discussion of future extension of bulk fertilizer handling has been presented in Section 3.2.1, Analysis of Alternatives.

4.2 THE RECOMMENDED LOCATION

The location recommended for the construction of bulk fertilizer storage and bagging facilities is on the property of the Chittagong TSP Plant, as shown on Figure 4.1. Its geographical location in Bangladesh is shown on Figure 4.2.

4.3 THE RECOMMENDED SYSTEM

The bulk storage and bagging facility would be located on the Chittagong TSP property in the general area indicated on (Figure 4.1). Further evaluation of the exact site and configuration would be carried out in a later phase of this program. In connection with the development, a number of new installations will be required, together with improvements to existing facilities to be jointly used by the TSP plant and the Bulk/Bagging plant.

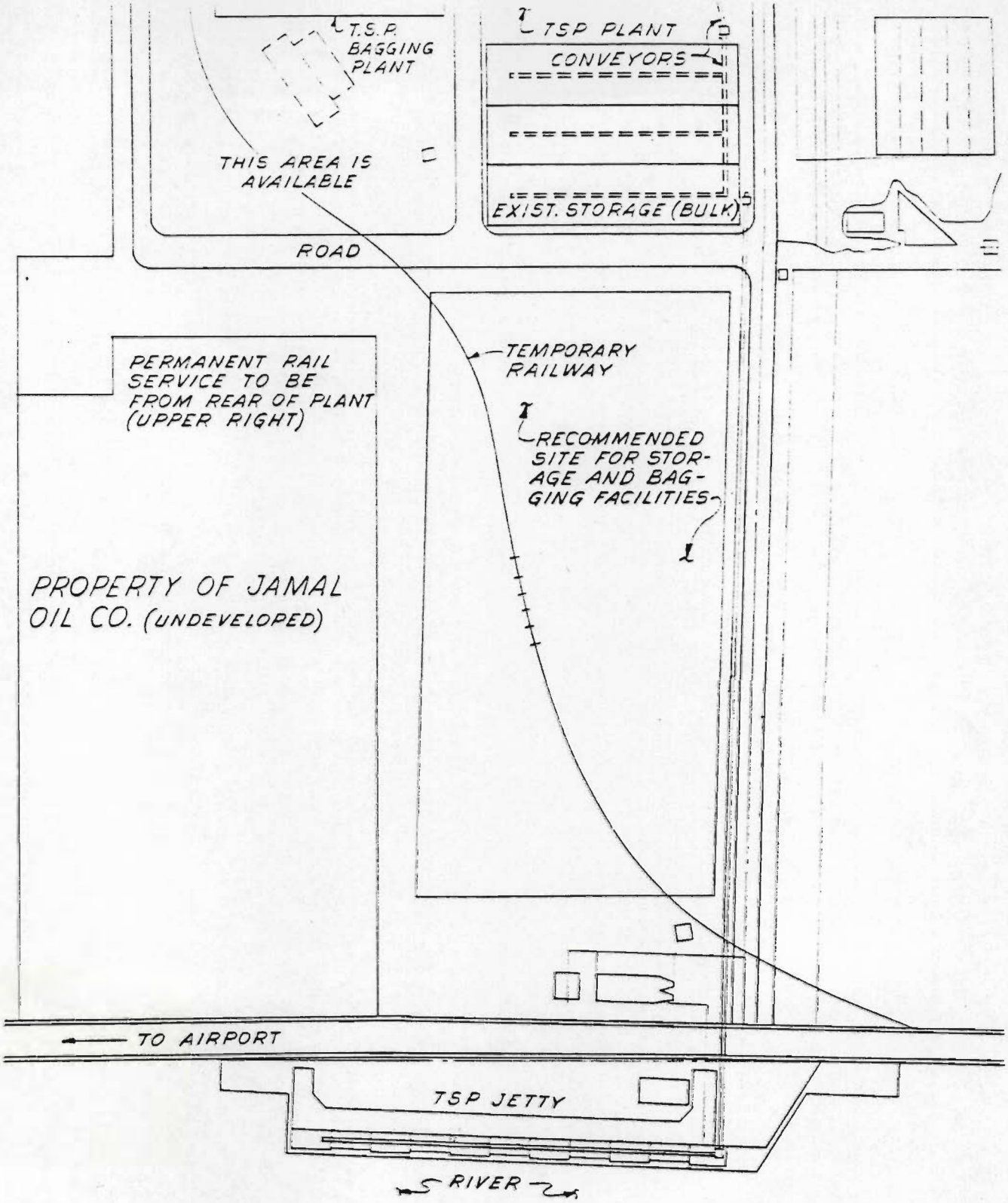


FIGURE 4.1

RECOMMENDED SITE
BULK STORAGE AND
BAGGING FACILITY

4.3.1 Design Requirements

Detailed design requirements, draft proposal documents and estimated costs are contained in Appendix 8. A general description of the required facilities is shown below.

4.3.1.1 The Storage Area

Specific requirements will include the following:

- Bulk Storage Building

Covered storage of sufficient size to accommodate some 60,000 tons of TSP and MP (two 15,000 ton vessel loads each of MP and TSP) with asphalt topped concrete floor, to be loaded by overhead conveyor with reclaim by front end loader. Building material to be resistant to corrosive nature of the fertilizer materials. Design should consider the possibility that in addition to TSP and MP, other materials such as Urea, DAP, and compound fertilizers may be stacked in the building. Ability to separate commodities by bulkheads should be considered. Consideration should also be given to the merit of incorporating dehumidification in the design.

- Bagging Facilities and Warehouse for Bagged Storage

Located adjacent to the bulk storage, the facility should provide sufficient bagging capacity (open mouth packer I & C or similar) with elevator or conveyor feed, vibrating screen, and sewing machine (Union Special or similar) and sewing line conveyors, delivery to hand truck line, for transfer to truck or rail or to bagged storage area. Size

FIGURE 4.2

TSP PLANT LOCATION
CHITTAGONG, BANGLADESH

of bagged storage to be determined. The bagging and bagged storage area should be located at rail gate/rail door height. Included in the bagging and warehouse area should be adequate space for empty bag storage.

- Bulk Blending

Ability to blend TSP and MP in measured proportions should be included in the bulk handling system.

- Maintenance and spare parts facilities for mobile equipment and general maintenance should be provided.

- Rail facilities should be integrated with the TSP trackage and adequate car storage provided. In plant switching equipment (Trackmobile) should be provided if not available from TSP plant. (A switcher was observed at the TSP plant.)

- Adequate road and truck lineup area must be provided to minimize congestion and facilitate loading and dispatch.

- Office and dispatch facilities must be provided.

4.3.1.2 Conveying Between the Jetty and the Storage Area

Evaluation of the existing conveyor system will be required to ascertain sufficient capacity to handle the new requirements, as related to improvements recommended at the Jetty. A new and separate conveying system may be required.

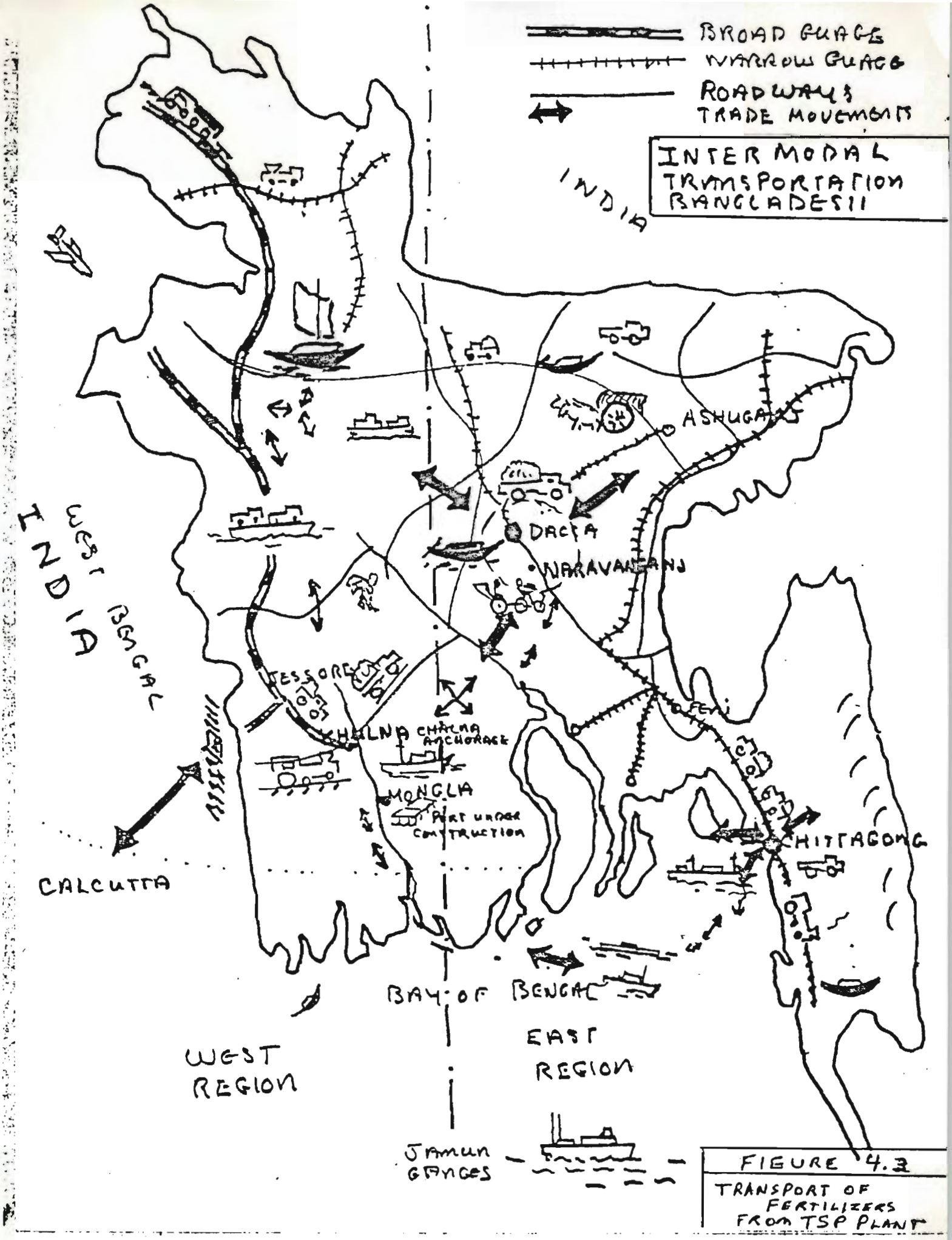


FIGURE 4.3

TRANSPORT OF FERTILIZERS FROM TSP PLANT

4.3.1.3 The Jetty Area

- Installation of a crane unloading system capable of handling at least a 4 yard clamshell bucket is most desirable. Jetty design should be investigated to determine whether rail gantry mount or crawler design is preferable. If smaller crane required, then two units should be provided.

- Hoppers to be fed by crane buckets, with gate control to feed conveyors, will be required. Conveyor improvements indicated above must be considered.

- Present jetty length of 400 feet could be improved. Consideration of adding additional mooring dolphins or increasing wharf length to accommodate longer vessels should be examined. Such installation has to be coordinated with increasing the draft capability beyond the present 21 feet. Berth length to accommodate vessels of 15,000 to 18,000 DWT.

- Berth depth can be increased to 30 feet, it is indicated by port officials. Preliminary investigation of this question elicited firm assurance that deepening can be accomplished without difficulty, but ability to dredge the berth must be verified. Dredging to 30 feet would permit berthing vessels with up to 18,000 tons of cargo onboard. Dredging depth will have to be coordinated with depth of water at the bar crossing.

- Barge and coaster loading facilities should be investigated, with truck delivery of bagged fertilizer from the bagging plant.

4.3.1.4 A Site Consideration

The TSP plant operators, BCIC, have engaged the services of Engineering Associates and Consultants, Ltd. to undertake a study to find a site for a process water reservoir (and a source). Care should be taken to avoid conflict between siting of the fertilizer storage faciliteis and process water site reservoir siting.

4.3.1.5 Management and Operation

It is recommended that the operation and management of the facilities be assigned to BCIC, with BADC taking custody of the product at point of delivery to the inland carrier, be it truck, rail or water. Since the facilities will be located on BCIC property, and BCIC already has management, supervision and labor familiar with bulk handling, storage, bagging operation and maintenance, it is felt that such an arrangement will result in maximum efficiency. Purchasing of the imported TSP and MP can be handled by either BADC or BCIC.

4.3.1.6 Berth Capacity

In the TSP site for the location of the bulk storage and handling facility, the consultants considered the effect of additional volume on the capacity of the TSP berth. Table 4.0 contains a preliminary analysis of expected volume of TSP raw materials and estimated imports of TSP and MP by the year 1987. As indicated in the table, the level of berth occupancy (and capacity) will be dependent upon the adequacy of unloading equipment. This factor should be an important consideration both in design and in working schedule. During vessel unloading, round the clock operation (at least 20 hours work per day) is recommended.

TABLE 4.0

Port Capacity 1987

TSP Jetty, Chittagong

Raw Materials for TSP Production

		Tons/Year (1987)
Phosphate Rock	200-225,000 T/yr.	
Crude Sulphur	50- 75,000 T/yr.	
Total		300,000
Estimated Imports of TSP & MP (Table 2.2)		556,000
	Total	856,000 1/

Days of work @ 10,000 T/day avg.	86 days occupancy
Days of work @ 5,000 T/day avg.	171 days occupancy
Berth Occupancy @ 10,000 T/day	24% 2/
Berth Occupancy @ 5,000 T/day	47% 2/

1/ This tonnage assumes that TSP production will continue generally at present leve 1. Also that no imported TSP would be shifted to additional facilities which may be later constructed at Mongla.

2/ Import requirements should be coordinated and ship charters scheduled to maximum extent possible in order to minimize vessel conflicts. Without coordination, allowing random arrival with a single berth, queueing of 2+ days per vessel can occur.

4.3.2 Transport Requirements

The projected volume of fertilizers through Chittagong is shown on Table 4.1 and a visual concept of their distribution is shown on Figure 4.3.

Study of the capacity of the region's transport system indicates that the increased fertilizer imports through the port of Chittagong are within the present and potential capacity of the existing and developing cargo transport system in the area. In this regard, it must be recognized that in terms of this study, the effect of the bulk storage and bagging facility is not significant. If the facility were not built, the requirement would be met by bagged imports as at present. The recommended solution calls for bagging prior to shipment to the interior. Therefore, there should not be any significant effect upon inland transport, whether imported in bags or imported in bulk and then bagged.

The capacity of the Bangladesh Rail system has been shown in Section 2.2.2.2 to be severely limited by financial and operational inability to overcome the effects of the war of liberation, and requires major financial investment. Therefore, for the next several years, it cannot be expected to bear the major burden of increased freight. However, as discussed in Section 2.2.2.1, the Bangladesh Road system has shown its ability to respond to increasing demand. Highway capacity has been particularly demonstrated in the analyses of fertilizer shipments from Chittagong shown in Table 2.14. Therefore, it is forecasted that fertilizer throughputs for the Port of Chittagong will increase from 217,000 tons in 1977-78 to approximately one million tons by 1987-88. Most of this tonnage increase will come from

TABLE 4.1

Forecast of Chittagong Fertilizer[1/] Traffic

1977-78 to 1987-88

(000 Tons)

Year	Urea Imports[2/]	Urea Exports[2/]	Required TSP & MP Imports	Domestic TSP Production[3/]	Total Tonnage
1977-78	30		121	60	211
1978-79	64		146	60	270
1979-80		241*	176	60	477
1980-81		276	210	60	546
1981-82		275	250	60	585
1982-83		502	295	60	857
1983-84		587	347	60	994
1984-85		601	407	60	1,068
1985-86		531	477	60	1,068
1986-87		458	556	60	1,074
1987-88		378	640	60	1,078

1/ Source: Appendix 1 (Based in EIU Study of Bangladesh Fertilizer Industry, 1977)

2/ Assumes 50% urea imports, 100% urea exports via Chittagong

3/ Utilized constant 60,000 tons/year domestic TSP production in order to present conservative forecast. Actual domestic production is expected to be improved. EIU projects 85,000 tons/year by 1980.

imports. It is projected that domestic production will remain relatively constant at some 60,000 tons/year (see Note 3, Table 4.1).

4.3.2.1 Lighterage and Transshipment Constraints

- Chittagong (Lighterage)

Because of the method utilized by BADC and BCIC for chartering vessels, lighterage costs currently incurred at Chittagong are not reflected directly as operating costs. Instead they are contained in the cost of materials and ocean freight.

Because of draft limitations due to the bar at harbor entrance, and subject to tide and river stage conditions, vessels are presently limited to 21 feet draft on arrival at the TSP berth. Thus, lightening is required in the outer anchorage. This can amount to half the vessel's cargo when a 15,000 ton vessel is utilized. Shippers option will determine the combination of vessel utilized for the long haul, plus lighterage at Chittagong. Shipper must determine which represents the least cost to him, either a small vessel with a high freight but little or no lighterage cost, or a larger vessel with low freight but high lighterage cost. In the end, this selection is reflected in the cost of material and freight charged the Bangladesh purchaser. Investigation of the freight market in New York indicates that the difference in cost may be in the neighborhood of $10.00/ton. Deepening of the berth to permit the berthing of deeper draft vessels in accordance with bar and river stage conditions would permit the Bangladesh purchasers (BADC and BCIC) to benefit by lower material costs (when freight is included), or by lower total costs should they resort to booking their own freight.

- Khulna (Transshipment)

Until such time as the Mongla port development has been completed and road and rail connections established, it will be necessary for BADC to analyze regularly its freight market and determine the economic advantage between bulk imports to Chittagong, bagging and coastal shipping to Chalna and lighterage to Khulna, versus the continuation of bagged imports for that region. Table 4.1a estimates a comparison based on the $20.00/ton basic advantage of bulk imports and local bagging earlier indicated in Table 2.1. In the example shown in Table 4.1a, an advantage of $11.00/ton is indicated favoring the impact of bulk with bagging at Chittagong and coastal shipment to Chalna/Khulna. If small coasters or barges capable of reaching Khulna directly (eliminating lighterage at Chalna), additional savings of up to $5.00/ton can be made. Local Bangladesh costs shown in this table are order of magnitude estimates only.

4.4 COST/BENEFIT ANALYSIS

A cost/benefit analysis of the recommended installation was undertaken using a twenty year useful life for the facilities and allowing a 5% salvage value. Annual volume was based on the projections for TSP and MP imports used in Section 2.1.1.1, Potential Cost Savings (Table 2.2). The analysis utilized the $20.00/ton saving attainable by switching from bagged imports to bulk, as shown on Table 2.1 (also calculated similarly by AID in an earlier analysis). Any further saving in freight or material cost due to future elimination of cost of lightening vessels (Section 4.3.2.1) would be in addition.

TABLE 4.1a

Comparison of Cost of Delivery of TSP & MP to Khulna

	Purchases in Bags	Bulk Purchase & Baggi at Chittagong
Excess Cost at Chalna in Bags 1/	+20.00	
Bagged cost at Chittagong 1/ Plus Estimated Cost		-0-
Lighterage Chalna/ Khulna	2.00	2.00
Unloading at Khulna	3.00	3.00
Coastal Freight Chittagong-Chalna		5.00
Loading Cost at Chittagong		4.00
Total	25.00	14.00
Favorable Balance Using Chittagong		11.00

1/ From Table 2.1

Note: Local Bangladesh costs are consultants estimates.

Cost for the installation of the facility was taken from Table 3.2 investment ratings, and for purposes of this analysis, a weighting of $1.0 million was utilized for each rating point, (i.e., 8 = $8,000,000). Further verification of actual construction costs will have to be undertaken later. The cost/benefit analysis shown on Table 4.2 indicates an undiscounted net benefit over the 10 year study period of $44,688,000, and as can be seen, is even able to generate a saving of $1,956,000 during its first year of operation. (No discount rate was applied in this first analysis, using as an assumption that AID funded projects have no alternative opportunity cost. Also no interest on indebtedness was included.)

The last column of Table 4.2 shows the discounted net benefit at 10%.

A second cost/benefit analysis was calculated, utilizing a 10% discount factor, and 10% interest on unamortized debt. This analysis is shown on Table 4.3. In this case, over the 10 year study term, a saving of $20,226,000 is attained. Again, there is a first year saving in the amount of $1,165,000. It should be recognized that all the above figures are based on an assumed 8 = $1.0 million ($8,000,000) investment cost, (which figure will require further engineering study), on an estimated $20.00/ton saving and upon present best forecast of volume.

Table 4.3

Cost Benefit Analysis

(Discounted to Present Value with Interest and Amortization)

Bulk Handling and Bagging Facility, Chittagong

1977/78 thru 1986/87

($000)

Years	Tonnage 1)	Savings per ton 2)	Gross savings per year	Amortization schedule 3)	Other Costs 4)	Total Costs	Net Benefits	Present Value 5)
1) 1977-78	-	-	-	-	-			
2) 1978-79	146,000	$ 20	2,920	927	584	1,511	1,409	1,165
3) 1979-80	176,000	20	3,520	927	704	1,631	1,889	1,419
4) 1980-81	210,000	20	4,200	927	820	1,747	2,453	1,675
5) 1981-82	250,000	20	5,000	927	900	1,827	3,173	1,970
6) 1982-83	295,000	20	5,900	927	990	1,917	3,983	2,248
7) 1983-84	347,000	20	6,940	927	1,094	2,021	4,919	2,524
8) 1984-85	407,000	20	8,140	927	1,214	2,141	5,999	2,799
9) 1985-86	477,000	20	9,540	927	1,354	2,281	7,259	3,079
10) 1986-87	556,000	20	11,120	927	1,512	2,439	8,681	3,347
Total							39,765	20,226

1) Table 2.2

2) Table 2.1 (Constant 1977 Dollars)

3) Estimated cost from Table 3.2. Factor of 8 - assumed to be equivalent to $8.0 million for this analysis. Investment amortization at 10% over 20 years.

4) Operating, administrative and overhead costs as follows:

1st 200,000 tons @ $4.00/ton (Minimum 200,000 tons)

All above 200,000 tons @ $2.00/ton

5) Discount rate 10%.

5.0 ADDITIONAL CAPITAL DEVELOPMENT PROSPECTS

5.0 ADDITIONAL CAPITAL DEVELOPMENT PROSPECTS

5.1 OTHER RELATED CAPITAL DEVELOPMENT POSSIBILITIES

In the course of study of this project, certain additional capital development prospects relating to fertilizer production, agriculture and transportation were observed. It is the consultants conclusion that the following programs should be considered for study and possible assistance in the interest of fertilizer and agricultural development and related port and transport requirements.

5.1.1 Granulation (and Ammoniation) Unit - TSP Manufacturing

Bangladesh production of TSP is presently not in granular form due to lack of a granulation unit at the Chittagong plant. Imported TSP is in granular form, which permits ease of handling and broadcasting by the farmer. Powdered TSP results in skin burn and breathing discomfort due to dust in handling powdered TSP, in addition to serious product set up problems. Thus, farmer preference is for the granular product. Bangladesh Chemical Industries Corporation (BCIC) officials report that project papers in the amount of $3.0 million have been prepared for the installation of a granulation unit at the TSP plant, but that lack of funding has prevented implementation of the program. It has been suggested by United Nations Development Program (UNDP) experts in Dacca, and by the Economics Intelligence Unit Study of the Bangladesh Fertilizer Industry that an ammoniation unit be included in conjunction with the installation of a granulator. The consultants observation of the present TSP production operation and the

difficulties observed in the handling and bagging of the present ungranulated product suggest that provision of a granulator under the bulk handling and bagging program should be beneficial and compatible with AID objectives of facilitating bulk handling in Bangladesh.

In addition to the ability to produce ammoniated phosphates, the presence of a granulator and ammoniator at the TSP plant would permit the integration of the MP source at the adjacent bulk storage plant in accordance with recommendations of the design engineers responsible for the granulator installation. This would thus provide Bangladesh with its first compound fertilizer manufacturing installation.

5.1.2 Gypsum Disposal System - TSP Manufacturing

BCIC officials also reported that project papers and plans have been prepared in the amount of $2.0 million for the installation of a gypsum disposal system at the Chittagong TSP plant. Gypsum disposal is a problem common to phosphoric acid production. Management at the Chittagong plant reported that there is available on present plant property room for only one more year's production of gypsum and that without a long term solution to the gypsum problem, the plant would be forced to close down for lack of disposal area. Efforts have been made to sell this by-product gypsum or to develop uses for it. Limited use has been made of the product at the adjacent cement plant. One long term solution described to the consultants involved the pumping of the residue gypsum to a nearby depression where the product would collect, settle out and subsequently could be reclaimed after aging. A German process for recovering the sulphur have the gypsum by the production of Ammonium

Sulphate is reported to be a part of the program under consideration by BCIC. Ammonium Sulphate would be utilized as a source of nitrogen for direct application and in the production of compound fertilizers. The recommended solution of the Japanese consultants involved in the second TSP plant called for piping the gypsum to the coast and disposing of it at sea. Further study of the gypsum disposal problem is advisable.

5.1.3 Road and Rail Connection to New Port of Mongla

Section 2.1.2 describes the development of the new deep-water port of Mongla in southwest Bangladesh. Its location is some 30 miles south of Khulna, the rail head for the broad gauge railroad to northwest Bengal and transfer point for the present lighterage traffic of Chalna. Located on the opposite side of the Pusur River, from Khulna, there is no connection by rail or road between this new port and the overland transport system west of the Ganges. The first five berths of the new port are expected to be completed by the end of 1978 or early 1979. Effective integration of this first class modern port facility will require the crossing of the Pusur River and establishment of rail and road connections. As discussed in Section 2.1.2, the Asian Development Bank is considering financing the construction of a road connection with a ferry crossing at Khulna. These consultants suggest that for effective integration of this modern port facility into the Bangladesh transport system, a rail and road bridge be considered and a broad gauge rail connection to the port be included. If a study of Mongla is undertaken, consideration should also be given to modifying the present plan, to accommodate fertilizer and grain handling in bulk early in the port's

development rather than in the second phase. Consideration should also be given to relocating the planned workers town, so that it does not occupy the space between the port and the canal.

APPENDIX

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APPENDIX SECTION 1

FORECAST OF FERTILIZER REQUIREMENTS

TABLE A1-1

BANGLADESH FERTILIZER FORECAST
1977/78 to 1987/88
(000 Tons)

	Urea			TSP			MP		
	Demand	Domestic Production	Import Req.	Demand	Domestic Production 1/	Import Req.	Demand	Domestic Production	Import Requirement
1977-78	371	310	61	144	60	84	37	-0-	37
1978-79	402	275	127	161	60	101	45	-0-	45
1979-80	437	678	(241)*	180	60	120	56	-0-	56
1980-81	475	751	(276)*	201	60	141	69	-0-	69
1981-82	525	800	(275)*	229	60	169	80	-0-	81
1982-83	578	1,080	(502)*	260	60	200	95	-0-	95
1983-84	638	1,225	(587)*	296	60	239	111	-0-	111
1984-85	704	1,305	(601)*	337	60	277	130	-0-	130
1985-86	774	1,305	(531)*	384	60	324	153	-0-	153
1986-87	847	1,305	(458)*	433	60	373	183	-0-	183
1987-88	927	1,305	(378)*	489	60	429	211	-0-	211

SOURCES: AID Project Papers
Economist Intelligence Unit, Ltd., January 1977
Bangladesh Fertilizer Marketing and Distribution Study, Interim Report

( )* EXCESS UREA FERTILIZER FOR EXPORT VIA CHITTAGONG

1/ Production forecasted to increase to 85,000 tons/year by EIU. This forecast utilized constant 60,000 tons/year in order to reflect a conservative estimate.

TABLE A1-1 (continued)

	Combined TSP and MP			Total	Total	Total Imports
	Demand	Domestic Production	Import Req.	Demand All Fertilizers	Domestic Fertilizer Production	Requirements All Fertilizers
1977-78	181	60	121	552	370	182
1978-79	206	60	146	608	335	273
1979-80	236	60	176	623	738	176
1980-81	270	60	210	745	811	210
1981-82	310	60	250	834	860	250
1982-83	355	60	295	933	1,160	295
1983-84	407	60	347	1,045	1,285	347
1984-85	467	60	407	1,171	1,365	407
1985-86	537	60	477	1,311	1,365	477
1986-87	616	60	556	1,463	1,365	556
1987-88	700	60	640	1,627	1,365	640

APPENDIX SECTION 2

Site Questionnaires

- Narayanganj Port
- Chittagong Cement Plant
- Chittagong TSP Plant
- Chittagong Main Port
- Khulna/Chalna Port
- Mongla New Port Site

Site Questionnaire

Bangladesh Bulk Fertilizer Handling and Bagging Study

Date: 16 April 1977

Name of Site: Fertilizer Wharf

Location: Narayanganj, Bangladesh

Estimated Cost or Value: Unknown (area is heavily developed)

1. Landside Requirements

- Size and availability of land: No land available within reach of main wharf. Land is low. Some vacant land across river
- Right of way: Main roads encroach on port property and city lies adjacent
- Inland Transport Capabilities: Excellent road connections, meter gauge rail, this side of river only. Water transport available by country craft - sail and poll powered
- Inland Transport Requirements: Must have access to rail, highway and water
- Apparent Soil Conditions: Bearing capability appears limited. Across river appears worse
- Compatibility with adjacent facilities: Heavily developed area with dwellings and shops all around. Fertilizer facilities for bulk would not be compatible here - would need new location
- Environmental Concerns: Definite environmental concerns here from dust of handling and run off to river.

2. General Description of the Site: Narayanganj is a crowded bustling river port area with many people wandering around, much rickshaw and vehicle traffic. Land area viewed virtually fully utilized. Would require demolition of buildings, relocation of road and major rearrangements to locate in vicinity of both rail and water.

3. Waterside Requirements:

- Ability to accomodate required vessel size: No. Cannot berth deep sea vessels. Depth of water reported to be max. 12' with additional problems during low water season. Minimum depth unclear.

- Navigational Access:

  - Depth of Water: 12'
  - Tidal rise: No tide
  - If river, low water problems: Yes
  - Ease of Navigation & time required: Can be reached by coasters, but none observed during visit. Appears to be largely a barge port and country craft interchange

- Berth Conditions:

  - Depth of Water: 12' to less (Reliability of this number doubtful)
  - Siltation and Dredging Concerns: Unknown

  Safety of Berth:

  - Harbor Protection: Not applicable

  - Current and Wind Conditions: High winds and cyclone conditions. Also gusty winds in pre-monsoon period

  - Tide: No

4. Berth Requirements and Waiting Time:

- Discharge rate (Fertilizer): Not applicable
- Present Annual Tonnage:
- Proposed Annual Tonnage:
- Average Waiting Time (present):
- Average Waiting Time (proposed):
- Comments: This port is geographically well situated for secondary distribution facility, should adequate coaster and barging capacity be found. Preference would be to utilize this for bagged cargo transfer, not bulk.

Site Questionnaire

Bangladesh Bulk Fertilizer Handling and Bagging Study

Date: 19 April 1977

Name of Site: Cement Plant

Location: Chittagong

Estimated Cost or Value: Estimated 40,000 T/Acre (Based on TSP Plant)

1. Landside Requirements

- Size and availability of land: Yes - vicinity of cement plant is open property - up to 20 acres - partly occupied by athletic field. Would require approval of cement company.
- Right of way: For connection to TSP Plant requires crossing both cement company property and grain silo property plus highway
- Inland Transport Capabilities: Location offers direct access to highway and rail. Water delivery would require truck haul for bagged fertilizer.
- Inland Transport Requirements: Must have access to road, rail and water transport. This site has all three.
- Apparent Soil Conditions: Existing berth piling mounted. Area is supporting cement plant with adjacent grain silo - looks OK.
- Compatibility with adjacent facilities: General area is industrial. Compatibilit of cement and fertilizer dubious, but handling facilities are compatible.
- Environmental Concerns: Not significant at this time.

2. General Description of the Site: Concrete berth of 450' with open 1 meter 20° idler conveyor belt delivery to silo storage for cement clinker. Belt capacity reported as 600 T/M, but doubt it. For cement more likely 400 T/M. Large athletic field is on opposite side of road adjacent to cement plant. Distance from wharf appears to be about 1/2 mile and any transfer conveyor must go under or over grain silo conveyor. A bucket wheel unloader is on this wharf. Not used, but now under repair.

3. Waterside Requirements:

- Ability to accomodate required vessel size: Yes - Berth is about 450' - accommodates vessels to 550'

- Navigational Access:

  - Depth of Water: To 30 feet - but limited by bar crossing 15' + tide
  - Tidal rise: 8' normal (to 18' spring range)
  - If river, low water problems: No
  - Ease of Navigation & time required: River easily navigable, but berthing in high current may be difficult. Time prox. 1 hour from bar.

- Berth Conditions:

  - Depth of Water: 22' prox. (could be dredged to 30')
  - Siltation and Dredging Concerns: Some silting - Port Trust dredges

  Safety of Berth:

  - Harbor Protection: River location offers good protection for berth
  - Current and Wind Conditions: Oct & Nov - subject to cyclonic winds However, river limits fetch to about 500 yards. Current heavy at times - 3-4 kts normal - up to 8 kts or higher
  - Tide: 8 to 18 feet tides depending on season

4. Berth Requirements and Waiting Time:

- Discharge rate (Fertilizer): Bucket wheel unloader not successfully run as yet - no information
- Present Annual Tonnage: 1975 - 16,000 tons, 1976 - 7,000 tons
- Proposed Annual Tonnage: to 550,000 T plus above
- Average Waiting Time (present): None
- Average Waiting Time (proposed): 1 Berth 600,000 T/yr at 6,000 T/day = 100 days Est. waiting time prox 18 hr. avg.
- Comments: Depth of water over bar at present limits. Vessel drafts to 15' bar draft plus 8' or more (seasonal) max draft winter 21-25 ft., after May 23 - 30 ft. (if berth dredged).

Site Questionnaire

Bangladesh Bulk Fertilizer Handling and Bagging Study

Date: 20 April 1977

Name of Site: TSP Plant/BCIC

Location: Chittagong Port, Bangladesh

Estimated Cost or Value: 40,000 Taka/Acre

1. Landside Requirements

- Size and availability of land: 6-10 acres

  Could be made available - also the other parts as on drawing.

- Right of way: Yes - direct access to planned roads and to highway

- Inland Transport Capabilities: Full capacity of rail, highway and waterway system to entire Bangladesh

- Inland Transport Requirements: Must have access to road, rail and water transport. This site has all three.

- Apparent Soil Conditions: Area is same elevation as planned. Some drainage problems. Elevation about 3-4 meters. Adjacent property is able to carry heavy industrial plant and bulk commodity loads.

- Compatibility with adjacent facilities: Entirely compatible as both TSP production and fertilizer imports are compatible.

- Environmental Concerns: This is industrial area - environmental concerns of fertilizer imports same as others here. TSP Plant, Cement Plant, Grain Silo and Refinery

2. General Description of the Site: See Drawing of the site.

Facility has jetty for ocean vessels, but no shore equipment for unloading bulk cargo. Conveyor system connects jetty to plant storage.

3. Waterside Requirements:

- Ability to accomodate required vessel size: 21' draft maximum now. Jetty is 400' in length. Can moor vessels to 520'
- Navigational Access:
  - Depth of Water: To 30 feet, but limited by bar crossing - 15' + tide
  - Tidal rise: 8' normal (to 18' spring range)
  - If river, low water problems: No. Min. draft winter 21' (25' after May 23-30)
  - Ease of Navigation & time required: 1 hour from bar no restrictions except length of vessel 520'. Berthing in high current may be difficult.
- Berth Conditions:
  - Depth of Water: 21' draft (present) can be dredged to 30'
  - Siltation and Dredging Concerns: Some, but controlled by regular dredging
  - Safety of Berth:
    - Harbor Protection: Yes - river location offers good protection
    - Current and Wind Conditions: Oct. & Nov. - subject to cyclonic winds River limits fetch from opposite jetty to about 500 yards. Severe river currents to 8 knots during monsoon
    - Tide: 8 to 18 feet (as above)

4. Berth Requirements and Waiting Time:

- Discharge rate (Fertilizer): Normal average is 1800 tons/day. Bulk Phos Rock
- Present Annual Tonnage: 250,000 tons (125 days work at current rate) to
- Proposed Annual Tonnage: 850,000 tons (170 days work at increased rate)
- Average Waiting Time (present): No waiting reported
- Average Waiting Time (proposed): to 2 days
- Comments: Berth should probably be dredged to 30' as part of project. Also should consider providing a crane and hopper system for increased discharge rate.

Site Questionnaire

Bangladesh Bulk Fertilizer Handling and Bagging Study

Date: 4/21/77

Name of Site: Chittagong Port Trust Main Port

Location: Chittagong, Bangladesh

Estimated Cost or Value: Not indicated

- -

1. **Landside Requirements**

- **Size and availability of land:** No site specified or found Available. Port officials would agree to consider a site.
- **Right of way:** Would require passage through main port gate
- **Inland Transport Capabilities:** Complete access to road Rail and Water. Rail limited to meter gauge system - East Bangladesh
- **Inland Transport Requirements:** Require access to water rail and road.
- **Apparent Soil Conditions:** Port property already supporting heavy warehouse loads. Soil conditions appear acceptable
- **Compatibility with adjacent facilities:** Property is major General cargo facility. Bulk fertilizer dust would be a hazard.
- **Environmental Concerns:** Fertilizer dust could encroach on nearby housing across road from port.

2. **General Description of the Site:** No site specified. If selected, would require discussion with port officials. Indications are that entirely new site with new berth and full water port construction would be required

3. Waterside Requirements:

- Ability to accomodate required vessel size: Maximum length without notice 585', with notice 605'

- Navigational Access:

  - Depth of Water: 30 to 40', but bar crossing 15', tide of 8 to 18 feet

  - Tidal rise: 8 to 18'

  - If river, low water problems: No low water problems

  - Ease of Navigation & time required: River easily navigable, requires 1 hour from bar, but bar crossing requires height of tide

- Berth Conditions:

  - Depth of Water: 30' (subject to special tide conditions)

  - Siltation and Dredging Concerns: River is self cleaning. Some siltation at the Jetty heads. Maintained by port dredger

  - Safety of Berth:

    - Harbor Protection: No breakwaters at harbor entrance, but port location in river is protected

    - Current and Wind Conditions: Oct. & Nov. subject to cyclonic winds. April NW winds to 30 -40 kt gusts. Current heavy at times. Normal 3 - 4 kts up to 8 to 14 kts maximum

    - Tide: 8 to 18 ft. tides depending on season

4. Berth Requirements and Waiting Time:

- Discharge rate (Fertilizer): Not available, only handled in bags

- Present Annual Tonnage: See port statistics

- Proposed Annual Tonnage:

- Average Waiting Time (present):

- Average Waiting Time (proposed):

- Comments: This location not recommended unless no alternative exists

Site Questionnaire

Bangladesh Bulk Fertilizer Handling and Bagging Study

Date: 4/22/77

Name of Site: Khulna Port via Chalna Anchorage

Location: Southwest Bangladesh on Pusur River

Estimated Cost or Value: Reportedly not expensive per Port Director

- -

1. Landside Requirements

- **Size and availability of land:** There are river sites available for new facilities. Present port not suitable.
- **Right of way:** New site would require investigation
- **Inland Transport Capabilities:** Khulna offers access to road and broad gauge rail to Northwest Bengal and by protected inland water to Dacca and Narayanganj.
- **Inland Transport Requirements:** Suitable as above
- **Apparent Soil Conditions:** Observation indicates acceptable conditions - piling probably required in any case
- **Compatibility with adjacent facilities:** No site specified. Open land available thus compatibility would be acceptable
- **Environmental Concerns:** If new site, no particular concern

2. **General Description of the Site:** Khulna port has two facilities. One operated by the port, with wide apron and serving modern transit sheds. But suitable only for barges and lighters. BIWTC operates an antiqualed facility near town where lighters handled.

3. Waterside Requirements:

- Ability to accomodate required vessel size: No. River location of Khulna does not permit ocean vessels
- Navigational Access:
  - Depth of Water: Khulna 12' feet maximum
  - Tidal rise: Reportedly 8 - 12 feet
  - If river, low water problems: No
  - Ease of Navigation & time required: Easily navigable 65 miles from mouth.
- Berth Conditions:
  - Depth of Water: Khulna Maximum 12 feet
  - Siltation and Dredging Concerns: Northern part of river is subject to siltation.
  - Safety of Berth:
    - Harbor Protection: Yes, by river banks
    - Current and Wind Conditions: Up to 5 knots current, normal 3 - 3-1/2 kt. Winds unknown.
    - Tide: 8 - 12 feet

4. Berth Requirements and Waiting Time:

- Discharge rate (Fertilizer): Not applicable at Khulna
- Present Annual Tonnage: _____
- Proposed Annual Tonnage: _____
- Average Waiting Time (present): _____
- Average Waiting Time (proposed): _____
- Comments: Chalna anchorage has about 450 ships per year and 1.5 million tons of cargo/year. Neither Chalna nor Khulna are suitable. Chalna - no berths. Khulna - no water depth.

Site Questionnaire

Bangladesh Bulk Fertilizer Handling and Bagging Study

Date: 4/23/77

Name of Site: New port site of Mongla

Location: Port 8 miles south of Chalna on East bank of Pusur River Bangladesh

Estimated Cost or Value: Not available

- -

1. **Landside Requirements**

- **Size and availability of land:** See drawing for details
  Port now under construction
- **Right of way:** Would be within port boundaries
- **Inland Transport Capabilities:** No connection with rail or road, and
  well require bridging of Pusur river to connect
- **Inland Transport Requirements:** Should have access to rail water and road, particularly access to broad gauge rail system at Khulna for shipment to north west Bengal.
- **Apparent Soil Conditions:** Sandy soil at about 3 - 4 meters elevation -
  created by fill from dredging canal
- **Compatibility with adjacent facilities:** Layout of port shows bulk terminal
  between two general cargo berths - not compatible
- **Environmental Concerns:** Layout shows town constructed just behind port.
  Fertilizer dust would be a concern

2. **General Description of the Site:** A very fine looking construction job with concrete filled steel piling construction, concrete deck-wide 30 meter apron (prox). Transit sheds open storage and warehouses to be constructed. Will be a major general cargo port, but lack of land connection not resolved.

3. Waterside Requirements:

- Ability to accomodate required vessel size: Pusur river reported plan to be maintained to 35'. Would accommodate vessels to 25 - 30,000 DWT
- Navigational Access:
  - Depth of Water: 35' draft alongside
  - Tidal rise: Estimated to be about 8 feet (Port Director says 8 - 12 feet)
  - If river, low water problems: 12' change during monsoon
  - Ease of Navigation & time required: Port is about 20 miles from river-mouth. Access reported good.
- Berth Conditions:
  - Depth of Water: 35' alongside MLW
  - Siltation and Dredging Concerns: River moderately silt laden. Port Director indicated they plan to have two dredgers to maintain channel
  - Safety of Berth:
    - Harbor Protection: Westerly fetch of about 1/2 mile. A river location.
    - Current and Wind Conditions: Current to 5 knots, normally reported to be 3 - 3-1/2. Wind conditions unknown.
    - Tide: Reported as 8 to 12 feet

4. Berth Requirements and Waiting Time:

- Discharge rate (Fertilizer): New Port not yet completed
- Present Annual Tonnage:
- Proposed Annual Tonnage:
- Average Waiting Time (present):
- Average Waiting Time (proposed):
- Comments: Lack of connection to land plus the planned layout limits suitability. Berths 11 and 12 would be considered in the future for bulk cargo site.

APPENDIX SECTION 3

SURVEY REPORT: BUCKET WHEEL UNLOADER

CHITTAGONG CEMENT PLANT

SURVEY REPORT

BUCKET WHEEL UNLOADER

CHITTAGONG CEMENT PLANT

CHITTAGONG, BANGLADESH

DATE 19 APRIL 1977

Survey Team:

E. Ball, Frederic R. Harris, Inc., New York
H. Dare, Frederic R. Harris, Inc., Chittagong

Requested by:

USAID Mission, Dacca, Bangladesh

Authorized by:

Mr. Atiqur Rahman, Manager, Chittagong Cement Plant

Summary of Findings:

No repair assistance required. Necessary parts for repair are now on hand. Electrical controls are now completing test. Mechanical parts being installed and unit scheduled for activation on or before 1 May 1977. Repairs being performed by cement plant staff.

SURVEY REPORT: BUCKET WHEEL UNLOADER

CEMENT PLANT, CHITTAGONG

1. The survey of the bucket sheel unloader at the Chittagong Cement Plant was requested by the USAID Mission to Bangladesh in the interest of determining the scope of repairs required to place the unit in operation, in order that it might be considered for handling imported fertilizer materials in bulk.

2. The survey team inspected the machine during the afternoon of 19 April 1977. The findings are as follows:

3. On arrival at the site, the team found cement plant maintenance personnel working on the unloader. Covers were off the electrical control boxes and breaker panels. Electricians there reported they were megger testing (insulation and continuity test) the electrical system and drying out the controls, preparatory to placing the unit in operation. The maintenance supervisor arrived and advised that the unloader had operated only once during its initial use in 1975. The unit had run for approximately 60 hours during discharge of cement clinker, when the main shaft coupling on the bucket elevator failed. No spare was available and a dispute arose with the French supplier over repair and replacement parts. As a result, the plant was enjoined from using the unit.

4. During the 60 hours of performance by the unloader, approximately 30 hours were devoted to cargo handling. (The remainder being used for testing.) Performance

was reported as averaging about 300 T/hour, although rated at 600 T/hour. The maintenance manager advised that the unit never performed at full rate and was operating at limited load when it broke down. When operating the bucket wheel and elevator feeds to a 1 meter 20° idler conveyor belt system rated at 600 T/hr. but judged by the survey team to have a more likely rating of approximately 400 T/hr.

5. Manufacturer of the unloader is as follows:

Present Name of Company: Fives-Coil-Babock (FCB), France France

Previous Name: Fives-Lillie-Coil (FLC), France

6. Repair parts and other services required to place the unit in operation:

None

Within the past month, the dispute between the parties has been resolved and a replacement main shaft coupler for the bucket elevator has been received. The part was in the process of being installed at the time of the survey, and, as reported, the electrical system being checked. It was indicated that during the time of inactivity, the electrical system was tested regularly and was in good order.

7. The maintenance supervisor stated that the unit was scheduled for operation on or about May 1, and that no assistance was required.

Respectfully submitted
E.E. Ball

APPENDIX SECTION 4

CONSIDERATIONS REGARDING DISCONTINUING TSP PRODUCTION

CONSIDERATIONS REGARDING THE DISCONTINUING OF TSP PRODUCTION

The project scope of work called for considering, in light of cost and other factors, the alternative of using the TSP factory entirely for bulk handling (bagging plus granulating and/or mixing) and discontinuing use of the factory for manufacturing.

After the various factors presented, it is the consideration of these consultants that at this time there is merit to continuing the local production of TSP. Should the establishment of a bulk fertilizer handling and bagging facility be undertaken in conjunction with the TSP operation, the facility as a whole will benefit from greater utilization of assets. In addition, the combination of facilities there will constitute the nucleus for a compound fertilizer plant, as discussed in the body of the report heretofore.

THE TSP PLANT'S OPERATING HISTORY

It should be realized that the Chittagong TSP Plant actually is only operating in its third year of production, and to write off this investment of capital and knowhow after such a short term seems hasty. The plant experienced startup difficulties with the French Unit and, in addition, is reported to have suffered one shutdown due to lack of sulphur caused by governmental ordering difficulties. In addition to the above startup problems, the plant started operating during a particularly precipitous pricing period for fertilizers and raw materials.

OPERATING IMPROVEMENTS STUDIES

- BCIC has negotiated a contract with the consulting firm, Bresler & Associates, Inc. for the study of and recommendation of the TSP plant operations. (Urea production would also be studied.) As of the time of these consultants departure (May 1977), the contract had not been approved by the BDG, but approval was expected. The study was expected to commence in July 1977. The TSP portion of the study reportedly was to be undertaken by Jacob Engineering, an experienced TSP consulting firm.

- TVA undertook a study of Bangladesh TSP production in 1974. However, raw material and product prices have changed substantially since that time, and the recommendations may no longer be valid.

- Economist Intelligence Unit (EIU), in their 1977 Fertilizer Marketing Study for Bangladesh, presented some analyses and comparisons of local production versus international price with estimates of future prospects. The cost of raw materials used by EIU as Bangladesh costs results in an analysis indicating very unfavorable results, as shown in Table A4-1.

COST COMPARISON, LOCAL PRODUCTION VERSUS IMPORT (1977)

According to EIU figures, Table A4-1 shows the present disadvantage suffered by local production as compared with today's import price. According to the EIU numbers, local product can be expected to be produced at from $100/ton to $150/ton higher than present import prices. A primary

Table A4-1

Chittagong TSP Cost versus Imported TSP
(1975-76 cost)

Plant operating rate 60,000 Tons/Year (EIU Medium Cost Level)

Raw Material Cost	Taka (Per ton of TSP)	$ US	Estimated Foreign Exchange Cost/ Ton	CIF Cost per ton of Raw Materials
Phosphate Rock	1992	132.80	133 -	82.00
Sulphur	333	22.20	22 -	55.00
Bags	200	13.33	-	
Other Variables	367	24.47	-	
Total Variable Cost	2892	192.80	155 -	
Labor	169	11.27	-	
Maintenance	194	12.93	6 -	
Admin, O/H and Ins.	232	15.46	5 -	
Interest	345	23.00	23 -	
Depreciation	564	37.60	-	
Total Fixed Cost	1504	100.26	34 -	
Total Cost	4396	$ 293.07/ton	189 -	
Estimated C&F Price Imported TSP (average of below costs)		155.00	155 -	
Difference		$ 138.07/ton	34 -	

"While there is no doubt scope for cost reductions at the TSP plant through economies in administration, staff and overhead costs, it is clear that its product cost will remain high, probably in the region of $200-300 per ton ($ = Tk 15). Although fob prices exceeded this level during the exceptional market conditions of 1974-75, Bangladesh should be able to obtain imported TSP much of the time at a normal c & f price of $130 - $180/tonns (see Section 3.4)".

Source: Economist Intelligence Unit, Ltd.
1977 Fertilizer Marketing Study (Preliminary Report)
Costs in Table are from EIU Table 67
Above quotation is from page 157 of that Report.

cause of unprofitable operation according to EIU is high raw material cost.

REVIEW OF ESTIMATED LOCAL PRODUCTION COST

The projected study by Bresler & Associates should review the EIU calculations and prices to determine their current validity in light of worldwide historical present and projected future cost of TSP and TSP raw materials.

CONSULTANTS CONSIDERATIONS AND CONCLUSIONS

- Considerations

The picture is unclear to the consultants regarding the actual Bangladesh cost of raw materials and production at the present plants. At the same time, it is difficult to predict the future prices of imported TSP or phosphate rock and sulphur. Therefore, the consultant considers this unclear picture as a further advantage for the establishment of the bulk fertilizer handling and bagging facility at the TSP plant in Chittagong. Should it eventually be decided to discontinue use of the factory for manufacturing TSP, the fact that the fertilizer bagging and handling facility is located at the plant permits the conversion of a significant proportion of the investment in the TSP plant to continued use. Facilities for the berthing of vessels containing imported fertilizers, for the storage and bagging of these products, all remain of value. In addition, there is the potential utilization of plant machinery and buildings for compound fertilizer blending, granulating and manufacture.

- Some Advantages of Continuing Production

Table A4-2 compares some of the advantages of continuing production against the limited number of disadvantages (primarily cost).

- Conclusions

With recognition of the above considerations, it is the consultants' conclusion that the TSP plant should continue in operation and await the recommendations and results of the TSP Operational Improvements Study expected to be undertaken by Bresler (and Jacob Engineering). When the results of such an in depth study of the operation are available (including comparison with and forecasts of world prices), an intelligent decision can be made. If the decision clearly dictates discontinuing production of TSP at the Chittagong site, the alternative of using the TSP factory entirely for bulk handling is considered as a viable alternative.

TABLE A4-2

Advantages and Disadvantages of Continuing TSP Production

Advantages	Disadvantages
Local employment stimulus	Higher Cost
Training in technical skills	Foreign Exchange Loss
Payroll and purchase of benefit to local economy	(See Table A4-1)
Avoids total dependence on import sources (ration between raw material cost and finished product may change). Continuing operation permits the option of buying raw material and continuing to produce, or to buy finished product.	
Maintains skills and permits development of compound fertilizer industry	
Continues to make contribution to interest on debt	
Utilizes the existing investment	
Dependence on exports may not be permanent • Raw material discoveries in Bangladesh could alter the picture - Oil could bring about sulphur recovery - Drilling or other exploration could uncover phosphate sands	

APPENDIX SECTION 5

LIST OF DATA SOURCES

APPENDIX SECTION 5

List of Data Sources Provided by AID and BDG

AID PRP for Bulk Fertilizer Handling and Bagging Project

AID Exhibits for Project Paper, April 1977

AID Subject Files; Fertilizer Handling, Fertilizer Forecasts, etc.

Economist Intelligence Unit Reports:

- Bangladesh Transport Survey, 1974
- Bangladesh Fertilizer Industry Study, 1977 Interim Report

Bangladesh Statistical Abstract, 1975

Ministry of Communications:

- Requirements for Rehabilitation of Surface Transport, 1976

List of Reported Data Sources Not Located

L. Buerger Study of Chittagong Port, 1976

World Bank Study of Transport System of Bangladesh

Transport Map of Bangladesh (Source Unknown)

APPENDIX SECTION 6

CONSULTANTS REVIEW OF HISTORICAL DEVELOPMENT OF FERTILIZER DEMAND AND AVAILABLE DEMAND FORECASTS

FERTILIZER DEMAND, PRODUCTION AND IMPORT REQUIREMENTS

Table No. A1-1, "Bangladesh Fertilizer Forecasts - 1977/78 to 1987/88" (Appendix Section 1) illustrates the demand and production of fertilizer in Bangladesh during the ten year period 1977-78 to 1987/88. Demand for all fertilizer is calculated to increase at 11.2% per annum, while production will remain static at 360,000 MT per annum. This will cause a widening in the import requirements of 192,000 in 1977/78 to 1,267,000 tons in 1987/88 if all forecast demand requirements are to be met. Of a special interest to this study is the fact that both TSP and MP import requirements increase significantly as shown on the Table.

EIU Table 1, "Fertilizer Consumption in Bangladesh by Volume, 1962/63 to 1975/76", traces the historical evolution of fertilizer demand, production and importation during the thirteen year period specified. Aggregate demand for fertilizer of all types grew at an annual rate of 15.2% from 73,000 tons in 1962/63 to 458,000 tons in 1975/76. In this period, TSP use increased from 3,000 tons to 111,000 tons, growing from 4% of the total fertilizer use to 24% in 1975/76. It grew at a high demand factor of 32% per annum. MP also showed a healthy growth in demand from 2,000 tons to 27,000 or 5% of the total demand. This represented an annual growth factor of 20%.

Table 2 of the EIU Study (Appendix Section 6) "Index of Growth in Fertilizer Consumption - 1962/63 to 1975/76", highlights the increase in use of fertilizers in Bangladesh over this period. With a base year of 1962/63 = 100; TSP had the most significant growth, from 100 to 3,667, followed by MP; 100 to 1,100; and urea 100 to 778. Important to this

report, as noted above is the growth in demand for TSP and MP and concommitant impact upon domestic (TSP) supply and imports; the latter element having negative implications regarding foreign exchange.

The Table "Projection of Fertilizer Demand - EIU Study", and as well as "The Projection of Local Fertilizer Production" as contained in Annex B6 of the project paper (Source: Bangladesh Chemical Industries Corporation (BCIC), and AID Mission 1977) were used to determine the forecasts presented in Table No. A7-1. The medium demand forecast by EIU was the basic criterion used in the demand projections for this study.

The consultants reviewed available forecasts as presented in Table 21, "Bangladesh Fertilizer Demands". Additionally, they performed their own preliminary quantitative analysis. The forecast resulting from the consultants' historical "least squared time series" analysis is shown on line 18. USAID least squares regression estimation considered the additional impact of exogenous effects such as "...the war of liberation...acute price rises in international prices for fertilizer associated with oil price hike, and finally in 1974 (by) the explosion at the Chorasal Plant". They performed this analysis by dropping out these "off" years. A review of the statistical inference methods indicates that more sophisticated multivariate analysis is required in which exogenous impacts and variations in price etc., are studied in order to generate a more determinate method for forecasting. After consideration of the available forecasts, the consultants concluded the EIU, medium demand projections most closely approximated likely future trends. This conclusion was based on: 1) Analysis of existing forecasts,

2) Site observations, 3) Discussions with local officials, and 4) Initial statistical analysis.

TABLE 21

BANGLADESH FERTILIZER DEMAND FORECASTS [1)]

	Tons (000) Base Year Actual 1975-76	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86
1. IEED (1974)	458	401(-6.4)	438(-1.5)	478(1.1)	521(2.6)	569(3.6)	620(4.2)			
2. IEED (1972)	458						852(9.3)			
3. Energy (1976) Low *2	438			491(2.9)					765(6.4)	
4. Energy (1976) High *2	438			601(8.2)					1221(12.1)	
5. Energy (1976) Medium *2	438			561(6.4)					1113(10.9)	
6. FAO (1974)	458			373(-5.0)						
7. Five Year Plan (1973)	458	548(9.4)								
8. Revised Five Year Plan (1976)	458	327(-15.5)			(539)*(3.3)			(942)*		
9. TUA (1974) Conservative	458		395(-4.8)					532(1.9)		
10. TUA (1974) Liberal	458		437(-1.6)					794(7.1)		
*11. USAID (1976)	458	288(-20.7)			433(-1.1)	492(1.2)	561(2.9)	640(4.3)		
12. FAO (1971)- 'Requirements' (a)	458			1462(33.7)					1724(15.9)	
13. FAO (1971) - 'Requirements' (b)	458			1094(24.3)						
14. USAID PP (1976) *2	438	282(-15.8)			425(-.6)			639(4.8)		
15. ACPP 'Requirements" for Foodgrain only	458			488(1.6)						
16. EIU Medium	458				363(-4.5)					644(3.5)
High	458				428(-1.2)					869(6.6)
Low	458				295(-8.3)					448(-.2)
17. EIU No. 2 (JAN.1977) High	458	591(13.6)	673(13.7)	769(13.8)	879(13.9)	1015(14.2)	1173(14.4)	1357(14.5)	1570(14.7)	1817(14.8)
Medium	458	552(9.8)	608(9.9)	633(8.0)	745(10.2)	834(10.5)	933(10.7)	1045(10.9)	1171(11.0)	1307(11.1)
Low	458	309(5.4)	547(6.1)	582(6.3)	621(6.3)	674(6.7)	731(6.9)	794(7.1)	862(7.3)	938(7.4)
18 Regression Line Forecast (Low)	458	464(.7)	490(2.3)	516(3.0)	542(3.4)	568(3.7)	594(3.8)	620(3.9)	645(3.9)	672(3.9)
19 Regression Line Forecast *3		533(7.9)	567(7.4)	600(7.0)	635(6.6)				768(5.9)	802(5.7)

1) Figures shown in brackets ( ) represent annualized growth rates for the stated period.

*2 Excludes Potash

*3 AID high regression forecast

APPENDIX SECTION 7

Pertinent Extracts from the following:

1. Economist Intelligence Unit Fertilizer Industry Study, 1977

2. Port of Chittagong Year Book, 1975-76

3. Bangladesh Transport Survey 1974

4. Bangladesh Requirements for Rehabilitation of Surface Transport, 1976

5. USAID Project Papers

APPENDIX SECTION 7

PART 1

Extracts from Economist Intelligence Unit, Ltd.
Fertilizer Industry Study, 1977

THE ECONOMIST INTELLIGENCE UNIT LIMITED
SPENCER HOUSE
27 ST JAMES'S PLACE
LONDON
SW1A 1NT
Registered Office
TELEPHONE 01-493 6711
TELEX 266353
CABLES
ECONUNIT LONDON SW1
Registered No.563972 England

ARA/PD

27th April 1977

Mr Dennis J Brennan
Chief
Capital Development Division
USAID
Dacca, Bangladesh

Dear Mr Brennan

I write to confirm the understanding reached during our discussions in Dacca earlier this month.

Subject of course to agreement from BADC, we have no objection to USAID using the data and analyses contained in our Interim Report. I must emphasise however that a number of significant findings and recommendations contained in this report are of a provisional nature and may be subject to amendment or alteration in our Draft Final Report, following further research in Phase Two.

May I also take this opportunity of expressing our appreciation for the kind assistance provided by USAID to members of our study team during their work in Bangladesh.

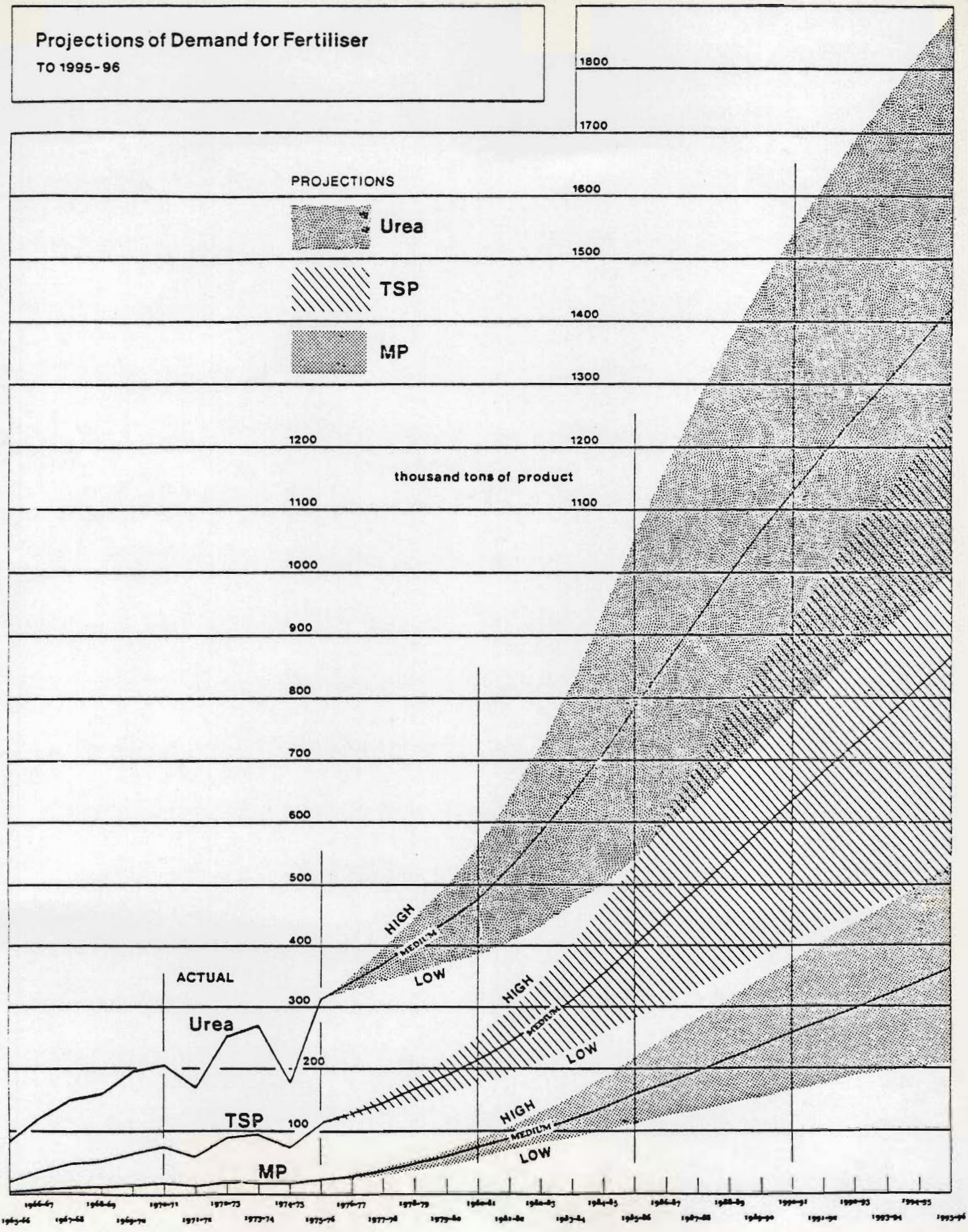
I look forward to meeting you and your colleagues again when I visit Dacca later this year.

Yours sincerely

Anthony R Alibert
Management Studies Division

cc. Mr Abdus Samad

FIGURE 1.


Projections of Demand for Fertiliser
TO 1995-96
PROJECTIONS
Urea
TSP
MP
thousand tons of product
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
ACTUAL
Urea
TSP
MP
HIGH
MEDIUM
LOW
HIGH
MEDIUM
LOW
HIGH
MEDIUM
LOW
1965-66
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1990-91
1991-92
1992-93
1993-94
1994-95
1995-96

FIGURE 2.

Fertiliser "Demand" Projections

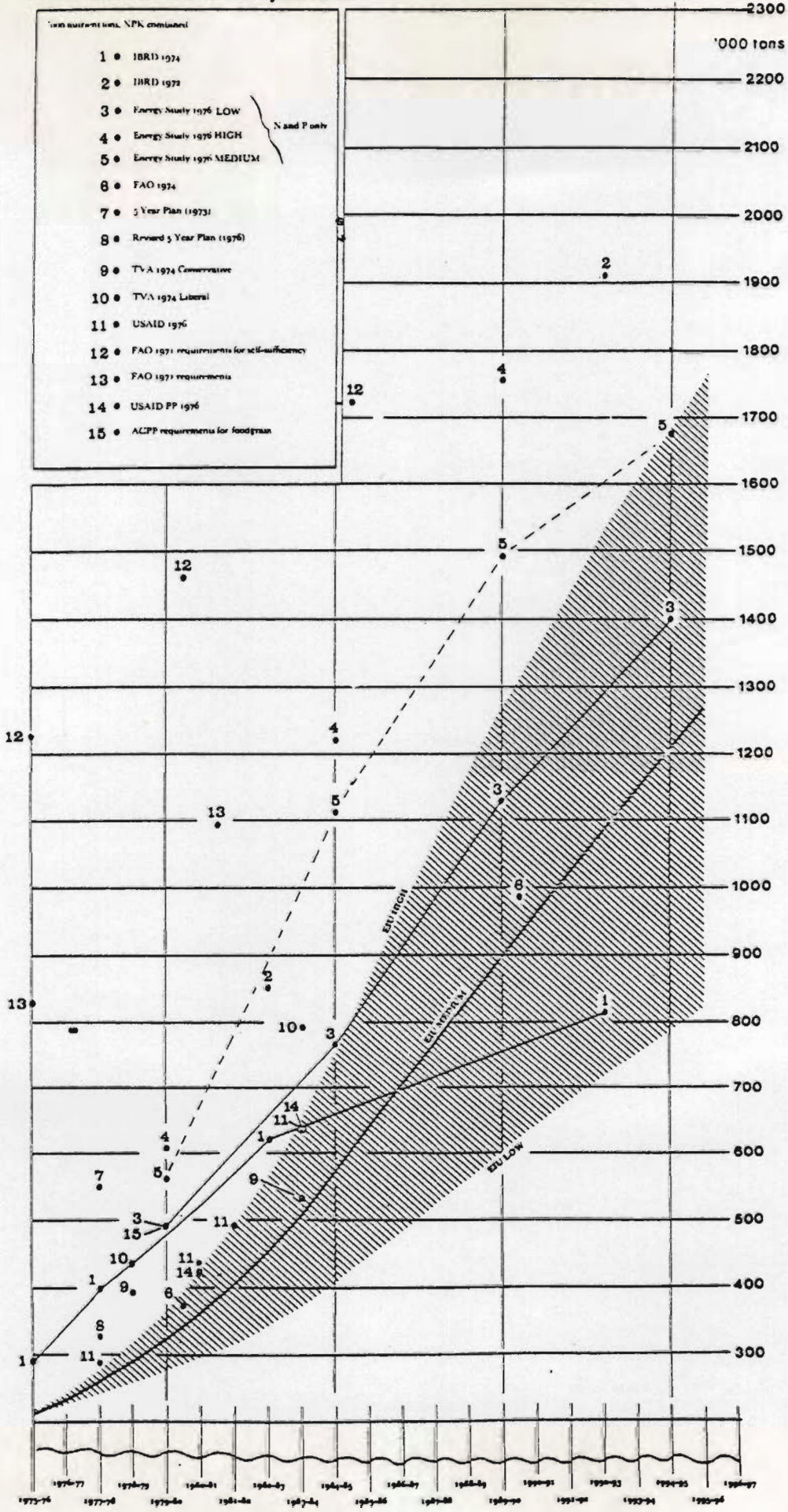

Table 1. Fertiliser Consumption in Bangladesh by Volume, 1962/63 to 1975/76

	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76
Thousands of Product Tons														
Urea	40	75	71	83	121	152	160	196	212	170	277	268	176	312
Ammonium Sulphate (AS)	25	8	7	21	6	15	12	14	-	-	-	-	-	-
Triple Super Phosphate (TSP)	3	23	19	20	35	48	53	66	76	60	89	94	76	111
Single Super Phosphate (SP)	3	2	-	-	-	-	-	-	-	-	-	-	-	2
Muriate of Potash (MP)	2	4	4	4	8	11	12	15	18	14	18	18	18	22
Hyperphosphate (HP)	-	-	-	-	-	-	-	-	-	-	-	-	11	4
NPK	-	-	-	-	-	-	-	-	-	-	-	-	1	7
Total	73	112	101	128	170	226	237	291	306	244	384	380	282	458
Percentages														
Urea	55	66	70	65	70	67	68	67	69	69	72	70	63	68
Ammonium Sulphate (AS)	34	7	7	16	4	7	5	5	-	-	-	-	-	-
Triple Super Phosphate (TSP)	4	21	19	16	21	21	22	23	25	25	23	25	27	24
Muriate of Potash (MP)	3	4	4	3	5	5	5	5	6	6	5	5	6	5
Hyperphosphate (HP)	-	-	-	-	-	-	-	-	-	-	-	-	4	1
NPK	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: BADC.

Table 2. Index of Growth in Fertiliser Consumption, 1962/63 to 1975/76
(1962/63=100)

	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76
Urea	100	188	178	208	303	380	400	490	530	425	693	670	440	778
Ammonium Sulphate	100	32	28	84	24	60	48	56	-	-	-	-	-	-
Triple Superphosphate	100	767	633	667	1,167	1,600	1,766	2,200	2,533	2,000	2,967	3,133	2,533	3,667
Single Superphosphate	100	67	-	-	-	-	-	-	-	-	-	-	-	67
Muriate of Potash	100	200	200	200	400	550	600	750	900	700	900	900	900	1,100
Total	100	153	138	175	233	310	325	399	419	334	526	529	386	627

Source: Table 1.

Table 4. Sources of Supply of Fertiliser from 1962/63 to 1975/76
(Thousands of Tons)

	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76
Imports														
Urea	26	7	-	6	59	63	88	113	105	108	124	-	62	71
AS	21	-	7	21	6	15	-	13	-	-	-	-	-	-
TSP	-	20	-	49	46	57	84	16	149	3	116	96	47	219
MP	-	-	-	7	12	10	24	34	2	-	-	41	-	37
SP	-	-	-	-	-	-	-	-	-	-	-	-	5	-
HP	-	-	-	-	-	-	-	-	-	-	-	11	13	-
NPK	-	-	-	-	-	-	-	-	-	-	-	-	17	-
Sub-Total	47	27	7	83	123	145	196	176	256	111	240	148	144	327
Domestic Supply*														
Fenchuganj:														
Urea/AS	64	53	68	99	81	122	81	97	43	56	36	62	59	47
Ghorasal:														
Urea	-	-	-	-	-	-	-	-	43	-	151	207	22	234
Chittagong:														
TSP	-	-	-	-	-	-	-	-	-	-	-	-	24	39
Sub-Total	64	53	68	99	81	122	81	97	86	56	187	269	106	320
Total	111	80	75	182	204	267	277	273	342	167	427	417	250	647
% Imported	42	34	9	46	60	54	71	64	75	66	56	36	58	51
% Domestic Production	58	66	91	54	40	46	29	36	25	34	44	64	42	49

* Ammonium Sulphate is not included in this table after 1969/70.

Source: BADC.

Table 19. Summary of National Fertiliser Demand Projections*

(thousand tons, product)

	High				Medium				Low			
	Urea	TSP	MP	Total	Urea	TSP	MP	Total	Urea	TSP	MP	Total
1975-76 (actual)*2	314	116	24	454	314	116	24	454	314	116	24	454
1980-81	561	252	91	904	477	214	76	767	386	175	63	624
1985-86	1,059	543	220	1,822	784	402	159	1,345	544	282	114	940
1990-91	1,546	912	373	2,831	1,130	633	256	2,019	781	404	164	1,349
1995-96	1,893	1,262	528	3,683	1,424	864	361	2,649	998	516	210	1,724

* Fertiliser demand for tea is excluded. *2 Includes sales of NPK, HP and SP expressed, in terms of their nutrient equivalent as urea, TSP and MP products.

N.B. The demand projections differ slightly from the preliminary figures presented in Progress Report 2, produced by the Consultants, primarily as a result of further work on the minor crop sector. No significant changes have been made in the assumptions underlying the projections, however.

Source: Estimates by the Consultants.

Table 21. Comparative Fertiliser Demand Projections
('000 tons nutrient, NPK combined)

		77-78	78-79	79-80	80-81	81-82	82-83	83-84	84-85	85-86	89-90	90-91	92-93	94-95	95-96
1	IBRD (1974)	401	438	478	521	569	620						814		
2	IBRD (1972)						852						1,911		
3	Energy (1976) low*2			491					765		1,128			1,399	
4	Energy (1976) high*2			607					1,221		1,755			2,275	
5	Energy (1976) medium*2			561					1,113		1,492			1,675	
6	FAO (1974)			373							985				
7	Five Year Plan (1973)	548													
8	Revised Five Year Plan (1976)	327			(539)*			(942)*							
9	TVA (1974) Conservative		395					532							
10	TVA (1974) Liberal		437					794							
11	USAID (1976)	288			433	492	561	640							
12	FAO (1971) 'requirements'(a)			1,462					1,724						
13	FAO (1971) 'requirements'(b)			1,094											
14	USAID PP (1976)*2	282			425			639							
15	ACPP 'requirements' for food-grain only			488											
16	ETU MEDIUM				363					644		965			1,270
	HIGH				428					869		1,354			1,768
	LOW				295					448		643			822

* Extrapolation by USAID. *2 Excludes potash.

Source: compiled by the Consultants.

Table 63. Trends in Fertiliser Production
('000 long tons, product)

	Fenchuganj		Ghorasal	Total	Chittagong
	Urea	AS	Urea	Urea	TSP
1962-63	71.5	-	-	71.5	-
1963-64	99.5	-	-	99.5	-
1964-65	76.2	-	-	76.2	-
1965-66	91.4	-	-	91.4	-
1966-67	93.6	-	-	93.6	-
1967-68	109.3	-	-	109.3	-
1968-69	86.6	-	-	86.6	-
1969-70	94.4	4.6	-	94.4	-
1970-71	55.2	6.1	44.3	99.5	-
1971-72	46.3	3.1	-	46.3	-
1972-73	38.6	5.9	172.4	211.0	-
1973-74	59.7	10.0	217.5	277.2	-
1974-75	57.5	4.8	10.5	68.0	29.5
1975-76	52.4	6.1	225.3	277.7	47.9
Capacity (330 days operation)	107	11	335	442	150
Average operating rate (%)	62	52	40	-	26

Source: Bangladesh Chemical Industries Corporation.

Table 64. Future Production Assumptions
('000 long tons, product)

	Fenchuganj Urea	Ghorasal Urea	Ashuganj Urea	Chittagong Urea	Total Urea	Chittagong TSP
1975-76 (actual)	52	225	-	-	278	48
1976-77	60	250	-	-	310	60
1977-78	60	250	-	-	310	70
1978-79	25	250	-	-	275	80
1979-80	64	250	364	-	678	85
1980-81	85	250	416	-	751	85
1981-82	85	250	465	-	800	85
1982-83	85	250	465	280	1,080	85
1983-84	85	250	465	425	1,225	85
1984-85	85	250	465	505	1,305	85
1985-86	85	250	465	505	1,305	85

Source: The Consultants' Estimates.

Table 67. TSP Plant Production Cost Estimates
(TK/long ton)

Plant Operating Rate (tons)	60,000			85,000*		
Raw material cost	High	Medium*4	Low	High	Medium*4	Low
Phosphate rock*2	2,439	1,992	1,097	2,439	1,992	1,097
Sulphur*3	536	333	268	536	333	268
Bags	200	200	200	200	200	200
Other variable costs	367	367	367	367	367	367
Total variable costs	3,542	2,892	1,932	3,542	2,892	1,932
Labour		169			119	
Spares & maintenance		194			136	
Administration, overhead & insurance		232			164	
Interest		345			244	
Depreciation*5 TSP II		564			398	
TSP I		–			287	
Total fixed costs		1,504			1,348	
TOTAL*6	5,046	4,396	3,436	4,890	4,240	3,280

* Assumes operation of TSP I. *2 Rock prices of $45, 82, 100 per tonne cif assumed for low, medium and high, respectively. *3 Sulphur prices of $55, 68, 110 per tonne cif assumed for low, medium and high, respectively. *4 Based on actual 1975-76 cost estimates. *5 Depreciation based on replacement value at current costs. *6 Excludes provision for loss offset allowance, repayment of principal, or return on investment.

Source: Estimated by the Consultants from BCIC data.

Table 89. Comparative Costs of TSP

	Granular TSP plant based on imported phosphate rock and sulphur 288,000 tpa; 90% op. rate		Granular TSP plant based on imported phosphoric acid 288,000 tpa; 90% op. rate	
Assumed plant investment*				
Cost ($ mn)	97.4		24.4	
Assumed raw material cost*2				
($ tonne cif)				
- Sulphur	55	110	-	-
- Phosphate rock	45	100	45	100
- Phosphoric acid (54% H_3PO_4)	-	-	162	304
Ex-factory TSP cost*3 ($/tonne)				
- 0% return on investment	201	309	177	296
- 10% return on investment	239	347	189	308
- 20% return on investment	276	384	201	319
Cost of imported TSP ($/tonne cif)				
- projected short-term (to 1980-81)	$150			
- projected medium-term equilibrium price	$200			
- historical peak, 1973-76	$380-468			
- historical low, 1973-76	$130-150			
- historical average, 1973-76	$200-250			

* 1.25 x 1974 estimates. *2 Based on analysis in Section 3. *3 Includes depreciation over 15 years and interest on capital at 8 per cent.

Source: Based on Tennessee Valley Authority, "Bangladesh Fertiliser Situation, 1974", and Consultants' estimates.

TSP. Raw materials - phosphate rock and sulphur - are the main item in TSP production costs, accounting for half or more of the total. The effects of varying the unit costs of raw materials, adopting BCIC's 1975-76 cost estimates for all other items, are shown in Table 67. At the peak levels of raw material costs reached in 1974-75 they could have accounted for almost 60 per cent of production costs, while at the lowest levels now likely they would represent about 40 per cent of total costs (see Section 3.2). At an operating rate of 60,000 tons a year total costs per ton would range between TK3,436 and TK5,046, while at 85,000 tons per annum, assuming operation of TSP I (and including provision for its depreciation), costs would fall by about TK150/ton. These costs allow for deprecation at current replacement costs, but exclude provisions to offset past losses or for debt repayment. Even if, by some means, it should be possible to push output up to 90 per cent of the combined plant capacity, costs per ton would still lie between TK2,750 and TK4,360, equivalent to $180-285 per metric tonne (at $=TK15), whereas bulk TSP is on offer at present at about $100 fob US Gulf.

Assuming no allowance for a return on the investment, a new local plant, operating at 90 per cent of capacity, could apparently produce TSP at an ex-factory cost of not more than $200-300/tonne (depending on raw material price levels). This compares with the Consultants' earlier estimate for existing plants (Section 1.1) of between $180 and $285/tonne, assuming a similar cost and operating basis. A 20 per cent return on investment would raise ex-factory costs for a new plant to an upper level of between $275 and $385/tonne, depending on rock/sulphur costs.

Historical and projected cif costs of imported finished TSP were analysed in Sections 2.1 and 3.4. A comparative summary is included in Table 89. The Consultants' projected short-term (1980-81) price of $150/tonne and medium-term (1985-86) price of $200/tonne of TSP both fall below the estimated cost of local production in a new plant, allowing for some return on investment, even assuming low raw material costs. Average actual TSP import prices over the 1973-76 period are at about an equivalent level.

Only the historical peak import price level of $400 or more (which the TVA study adopted) would be above the local production cost level. The hazardous nature of projecting fertiliser prices is underlined by their extraordinary volatility over the last three years. However, the Consultants consider it most unlikely that the landed cost (in constant price terms) of TSP imports would stabilise at a level as high as this, for an extended period, in the foreseeable future (see Section 3.4).

The experience with the existing TSP plant at Chittagong has been discouraging and it is likely to remain a high-cost producer. The above analysis, although only approximate, suggests strongly that a postponement of the decision to invest in new phosphate facilities for at least five years (which is implicit in the supply projections in this study) is justifiable on cost, as well as technical, grounds. The foreign exchange component of continued imports of TSP will be higher (though not markedly so) than a local product, but its incidence can be reduced by substituting bulk for bagged imports (which this report recommends).

secondly, on the possible use of compound fertilisers, combining a physical or chemical mix of two or more fertiliser nutrients. These two issues are discussed in the following sections.

4.2 Choice of phosphate sources

In their study, "The Bangladesh Fertiliser Situation (1974)", the Tennessee Valley Authority set out concisely the alternatives for future additional phosphate supplies, as follows:

i. build new facilities to produce soluble fertilisers (TSP or DAP), either at Chittagong or another location, using imported raw materials;

ii. build new facilities to produce soluble fertilisers from imported intermediates (phosphoric acid or MAP);

iii. import finished soluble fertilisers;

iv. use ground phosphate rock for direct application where soils are suitable.

TVA concluded that local production of TSP would be cheaper than importing TSP, but the preferred solution was to use ground rock for direct application, combined with TSP from the existing local plants. Although a detailed analysis of the relative merits of different methods of phosphate production is not within the scope of this study, it clearly could have an important bearing on future procurement needs. In the absence of any official long-term policy with regard to phosphates, the Consultants have recalculated TVA's estimates, in approximate terms, using up-dated costs and a range of raw material prices.

TSP production versus imports. Estimated costs of TSP produced in a new, local 288,000 tpd plant, using the alternatives of imported rock/sulphur and imported acid, are shown in Table 89. Costs are based on TVA's methodology. However, the capital element has been inflated by 25 per

Assuming no allowance for a return on the investment, a new local plant, operating at 90 per cent of capacity, could apparently produce TSP at an ex-factory cost of not more than $200-300/tonne (depending on raw material price levels). This compares with the Consultants' earlier estimate for existing plants (Section 1.1) of between $180 and $285/tonne, assuming a similar cost and operating basis. A 20 per cent return on investment would raise ex-factory costs for a new plant to an upper level of between $275 and $385/tonne, depending on rock/sulphur costs.

cent, compared with TVA's 1974 estimates, on the basis of the comparative change in the estimated cost of the Ashuganj project. Likely upper and lower levels of landed prices of raw materials have been used (see Section 3). The higher phosphoric acid price was adopted by TVA; this is high in relation to today's prices, when delivered prices as low as $200 per tonne (100% H_3PO_4) of acid have been reported; however, for Bangladesh, it has been assumed that the lowest cif price for acid would be about $300/tonne ($162/tonne of 54 per cent H_3PO_4), given the relatively high freight costs, uncertainties about handling and the relatively small unit demand.

The higher raw material costs for the acid plant are offset by the much lower capital costs and, given the acid/rock price ratios indicated, an acid plant would apparently produce TSP at slightly lower cost than a rock/sulphur plant. However, the import and handling of bulk acid might create serious technical problems in the Bangladesh context. The original plan for a TSP plant at Mongla (see Section 1.1) envisaged import of acid along these lines.

APPENDIX SECTION 7

PART 2

Extracts from Port of Chittagong Year Book
1975-76

PORT OF CHITTAGONG
STATISTICS

Port of Chittagong
Year Book 1975-76

IMPORT AND EXPORT HANDLED

(Figures in Tons)

YEAR	IMPORTS	EXPORTS	TOTAL
1970-71	37,55,100	4,11,844	41,66,944
1971-72	23,05,868	2,500,59	25,55,927
1972-73	48,50,571	2,82,870	51,33,441
1973-74	32,95,066	2,87,606	35,82,672
1974-75	42,40,616	2,57,924	44,98,540
1975-76	41,44,481	3,65,046	44,79,527

COMMODITY - WISE · IMPORTS HANDLED

(Figures in Tons)

Sl. No.	Commodity	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76
1.	Foodgrain	1132422	953371	2336012	1325673	1563936	1512152
2.	Sugar	31391	18145	76818	39756	—	—
3.	Salt	109	6979	—	—	55799	—
4.	Oil in drums	42629	23596	61707	16813	37431	50677
5	Oil Seeds	3688	2742	85234	56351	14398	101305
6.	Cement	286470	40146	245128	109106	256923	123115
7.	Fertilizer	199100	68703	229329	102553	249777	267459
8.	Cotton	1121	2891	39794	25409	53823	41677

-Contd.

(Contd. from Pre-Page)

Sl. No.	Commodity	1970 71	1971-72	1972-73	1973-74	1974-75	1975 76
9.	Cotton Yarn	—	51	4273	6528	1620	—
10.	Cotton Piece goods	104	81	4948	2161	2550	5169
11.	Iron & Steel	44938	24227	47227	49308	32090	61903
12.	C.I. Sheets	5243	44871	29156	8058	4480	3133
13.	Chemicals	1680	—	--	26	22147	20540
14.	Tea	1287	1678	—	—	—	--
15.	Cement Clinker	--	—	—	--	--	51611
16.	Tobacco	3588	3411	22427	7574	1653	8439
17.	Betal-nuts	410	—	50	--	—	1102
18.	Timber	2352	--	--	787	1650	3019
19.	Paper	3573	100	3056	796	3333	966
20.	Wax	268	--	—	20	--	--
[illegible]	[illegible]	--	—	—	--	72077	74794
22.	Sundries	700530	320418	516768	380327	415967	366407
23.	Coal	158138	50158	5189	129920	216468	116084
24.	Pols (in bulk)	1135000	735500	1150455	1053900	1232494	1304839
	Total :	3755049	2297068	4850471	3295066	4240616	4144481

PRINCIPAL COMMODITY - WISE CLEARANCE OF DRY IMPORTS FROM THE PORT

(Figures in Tons)

COMMODITY	YEAR					
	1970-71	1971-72	1972-73	73-74	1974-75	1975-76
Foodgrain	1112661	951309	2304411	1296264	1417299	1504517
Cement	284683	43040	243036	104812	249662	131334
Fertilizer	208106	68672	228971	99480	248948	261901
Other cargo	758270	495651	822215	668018	732037	610915
Coal	117046	24471	96643	99857	172158	187221
Total :	2480086	1583143	3695276	2288431	2518104	2895888

PRINCIPAL COMMODITY-WISE CLEARANCE OF DRY IMPORTS BY RAIL

(Figures in Tons)

COMMODITY	YEAR					
	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76
Foodgrain	360829	152929	313019	228806	512095	390562
Cement	71110	5942	27016	13273	16448	6898
Fertilizer	88178	7873	25306	16398	10547	28093
Other cargo	221206	59892	104798	110645	128577	126803
Coal	20924	5289	9972	33693	42702	49971
Total :	762247	231925	481011	402815	710369	602328

PRINCIPAL COMMODITY-WISE CLEARANCE OF DRY IMPORTS BY ROAD

(Figures in Tons)

COMMODITY	YEAR					
	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76
Foodgrain	245394	225825	485504	361008	325029	375368
Cement	151047	25602	157568	77255	158033	83892
Fertilizer	87372	50006	143193	66834	202858	197872
Other cargo	448506	308726	459079	400237	464977	521960
Coal	42834	14021	32717	44741	91433	65673
Total :	975153	624180	1278061	950075	1242330	1244765

PRINCIPAL COMMODITY-WISE CLEARANCE OF DRY IMPORTS BY RIVER

(Figures in Tons)

COMMODITY	YEAR					
	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76
Foodgrain	506438	572555	1505888	706450	580175	738587
Cement	61846	11496	57552	14284	75181	40543
Fertilizer	32556	10793	60472	16248	33543	35936
Other cargo	88558	127033	258338	157136	138483	162152
Coal	53288	5161	53954	21423	38023	71577
Total :	742686	727038	1938204	915541	865405	1048795

APPENDIX SECTION 7

PART 3

Extracts from Bangladesh Transport Survey 1974
Economist Intelligence Unit, Ltd.

The existing inland water cargo-carrying fleet (see Section A of Part 4.4) consists of the following:

BIWTC

37 cargo coasters and tankers

45 dumb bay crossing flats and barges

400 dumb inland flats and barges

6 self-propelled barges

Non-BIWTC

31 cargo coasters and tankers

377 dumb inland flats and barges

146 self-propelled barges

The BIWTC bay crossing barges fall into two groups, the Batty barges (17) that were built in 1972; and the remainder, which are all 20-25 years old. The inland flats vary from 7 to 90 years in age and the majority are about 35 years old. The inland barges are generally much younger with about 40 per cent less than ten years old, 40 per cent 10-15 years old and 20 per cent over 20 years old. The jute boats are old. The non-BIWTC fleet is generally younger and smaller, with only limited series of vessels, usually within a single fleet.

BIWTC has an on-going vessel purchase programme which at present consists primarily of 250 dwt, 350 dwt and 650 dwt barges. There are a number of design features of these vessels which appear to be of questionable cost effectiveness. The use of ship shape hulls with curved plate, for example, raises production costs significantly while giving only marginal reductions in towing resistance, particularly at the low towing speeds for which the hulls are intended. The structural design of all three barges includes rolled equal-leg angles as stiffeners. These angles must be either imported or produced by Chittagong Steel Mill, whose high production costs for widely used steels are even greater for the small quantities of rolled angles demanded by the BIWTC building programme. The question arises as to whether it would be more economical to use flanged plate stiffeners, which should be cheaper to produce in the yards and which are structurally more efficient than equal angles.

Table 1.44. Summary of the Main Freight Movements by Principal Mechanised Vessels, 1972-73 Estimated Actual and Allocated Movements for Commodities Considered in Allocation Exercise

(quantities in '000 tons)

a. Movement & vessel type	Allocated quantity	Corresponding actual
Lighterage from OA to Maritime Ports by liberty type lighter[a]	1,069	1,280
Lighterage from OA to Maritime Ports by other vessel type[a]	9	85
Lighterage from OA to inland destinations by Minibulker	736	657
Other movements from OA to inland destinations	153	5
Sub-total	1,967	2,027
Movements of dry cargo from Chittagong to inland destinations by Minibulker and other bay-crossing vessels	2	833
Movements of dry cargo from Chalna anchorage to inland destinations	1,128	767
Sub-total	3,097	3,627
Movement of dry cargo to Chalna anchorage from inland destinations	572	697
Other movements[ab]	307	401
	3,976	4,725
Movements of petroleum products by coastal oil tanker	577	568
	4,553	5,293

/continued ...

Table 1.44. Summary of the Main Freight Movements by Principal Mechanised Vessels, 1972-73 Estimated Actual and Allocated Movements for Commodities Considered in Allocation Exercise (contd)
(quantities in '000 tons)

b. For principal origins and destinations (dry cargo only)

Port A	Port B	Direction 1 (A to B) Allocated	Direction 1 (A to B) Actual	Direction 2 (B to A) Allocated	Direction 2 (B to A) Actual
Outer Anchorage	Chittagong	703	997	-	-
	Chalna	375	368	-	-
	Dacca/Narayanganj	814	494	-	-
	Khulna	-	102	-	-
	Ashuganj	30	65		
	Barisal	26	1	-	-
	Chandpur	19	-	-	-
Chittagong	Khulna	2	138	-	75
	Chandpur	-	10	-	3
	Dacca/Narayanganj	-	599	-	28
	Ashuganj	-	50	-	-
	Barisal	-	13	-	-
Chalna	Khulna	688	617	295	297
	Dacca/Narayanganj	251	60	268	376
	Barisal	176	44	-	-
	Chandpur	10	-	-	15
Khulna	Chandpur	-	-	-	8
	Barisal	4	2	-	-
	Dacca/Narayanganj	-	75	-	-
Ghorasal	Chandpur	-	8	-	-
	Narayanganj	-	72	-	-
	Barisal	-	14	-	-
	Khulna	-	30	-	-
Chhatak (& nearby)	Dacca/Narayanganj	-	67	-	-
	Chandpur	-	21	-	-
India	Dacca	92	42	-	-

a Not including movements of bulk oil. b Including those to Chittagong Port and imports from India by inland water vessels to Dacca.

10.2.A. RAIL

INTRODUCTION

Initially the Railway recovered rapidly from its severely disrupted state at the end of the War of Liberation, but from the second half of 1972 progress was disappointingly small. Table A.1 summarises the position (figures for 1969-70 to 1972-73 are taken from Tables A.8 and A.9 of Part 2.3; the position in July 1973, the only subsequent month available at the time of writing, is shown to indicate the lack of improvement during 1972-73)[1].

Table A.1. Indicators of Efficiency, 1969 to 1973

a. Locomotive miles per day per locomotive on line[a]

	Broad gauge			Metre gauge		
	Steam	Diesel	All	Steam	Diesel	All
1969-70	56	235	81	61	135	85
1970-71	42	159	62	41	101	64
1971-72[b]	23	52	30	11	61	30
1972-73	34	111	57	29	88	53
July 1973	28	139	60	24	90	52

b. Freight wagon miles per day[a]

	Broad gauge	Metre gauge
1969-70	15.2	18.2
1970-71	12.6	13.0
1971-72[b]	5.7	3.3
1972-73	10.3	8.0
July 1973	10.3	7.3

a In relation to total stock of locomotives/wagons (excluding only those condemned); b From December 17, 1971 to June 30, 1972.

Source: Bangladesh Railway.

1 In the discussions on our Draft Final Report, Railway officials questioned whether these indicators gave a fair measure of the Railway's performance post-liberation. Since the figures are calculated in terms of locomotives and wagons on line (which excludes only these condemned) they hide what is claimed as an improved performance in terms of the utilisation of locomotives actually in service. To demonstrate this the Railway has constructed an alternative index, unit-miles per engine day. This index is obtained by adding passenger-miles and freight ton-miles and dividing by the number of engines in use plus a notional 15 per cent for those under repair. By means of this peculiar calculation the Railway is able to show an apparent 30 per cent improvement in performance in 1973-74 compared with 1972-73. This is quite unrepresentative of the freight carrying capacity, which if measured by the ton miles performed, is shown to have increased by a bare 2 per cent.

PLANT AND EQUIPMENT OF THE ROADS AND HIGHWAYS DIRECTORATE

The R and H Directorate has a substantial amount of road plant, machinery and veh but a large proportion is currently unserviceable. The plant and equipment falls int two broad categories, that obtained since 1966 from the USSR, Poland and Rumania and that obtained from non-communist countries prior to mid-1966. The trucks fall into three groups, the above two and a group consisting of 181 (mainly French, some British) supplied under aid in 1972. A notable feature within each main type of equip ment is the large number of suppliers; the lack of standardisation is apparent.

R and H's Superintending Engineer, Equipment Control, undertook an inventory and assessment of the whole of the Directorate's fleet in the second to third quarters of 1973. The results are summarised below:

Table B.2. R and H Main Plant and Equipment, Numbers and Condition, 1973

Type	Capacity	Running	Repairable	Condemned	Tota
Asphalt mixing	5 t/hr	-	8	-	8
plant	20-30 t/hr	5	1	2	8
		5	9	2	16
Bitumen sprayer		-	20	13	33
Bulldozer		2	44	3	49
Concrete mixer		22	19	157	198
Crane		8	6	5	19
Earth transporter		1	30	31	62
Endloader		4	13	-	17
Excavator		2	-	-	2
Grader		10	58	2	70
Mobile workshop		4	-	3	7
Pile hammer		-	3	-	3
Plough		15	-	-	15
Pump		-	-	59	59
Road sweeper		5	-	-	5
Roller, self-	4½-6 t	3	21	23	47
propelled	8-10 t	125	154	44	323
	above 10 t	3	1	-	4
	unknown	2	11	7	20
		133	187	74	394

/continued

Table C.3. Port Detention Time of BDRS Bay Crossing Flats in 1970 (hours)

Port	From arrival to start of cargo operations	Loading Unloading	From completion of cargo operations to departure	Total
Chittagong	41	108	95	244
Dacca/Narayangaj	76	160	42	278

Sources: BDRS Position Reports and vessel logbooks, 1970.

The difference between the ports in loading and unloading time is partly due to the inclusion in Dacca/Narayanganj time of some vessels unloaded at Dacca and reloaded at Narayanganj. In 1970 towing capacity was in theory just adequate, but excessive time on harbour duty generated a lack of effective towing capacity. We assume a future handling rate of 18 tons per vessel working hour on average, giving loading/unloading time of 4.5 days for an average round trip load of around 680 tons. For operations between Dacca and Narayanganj we add a further day.

Berth allotment delays are assumed to be reduced by 25 per cent, giving a saving of 1.2 days on a round trip. Following increased availability of tugs (see below) delays between completion of cargo operations and the start of a voyage are assumed to be reduced by 50 per cent. Overall port detention times would be reduced to 7.5 days at Chittagong and 8.5 days at Dacca/Narayanganj.

Out of commission time. Following implementation of recommendations on vessel maintenance and repair, out of commission time for tugs is assumed to be as for powered vessels - one month a year. The improvement for the dumb craft should be as dramatic, from the present (1973) two months to about two weeks.

Revised voyage times. On the above basis, a Chittagong-Dacca/Narayanganj round trip would take 19.3 days, against the previous (1970) 25.3 days, an improvement of 24 per cent. The number of round trips in a year for the flats would rise to around 18.

Inland tugs and associated dumb craft

In 1973 the main feature for tugs was the high out of commission time - 41 per cent in our sample of BDRS operations. For dumb craft, again to take BDRS experience, 25 per cent of total time was spent waiting to discharge at Chalna and 20 per cent out of commission.

Transit times. Our sample of BDRS Voyage Reports and Position Reports for 1970 showed steaming and delay times for the main routes as follows:

Narayanganj-Chalna:	steaming 35 hours, delay 5 hours
Narayanganj-Khulna:	steaming 36 hours, delay 12 hours
Chalna-Khulna:	steaming 5.5 hours, delay nil.

Our interviews with public and private operators suggest that about 40 per cent of delay times were caused by stoppage overnight through lack of navigational aids, 25 per cent by cargo handling operations en route, 20 per cent by waiting for pilots and 15 per cent by bad weather. Again working on the basis of 70 per cent control of controllable factors, voyage times would be reduced by 2.1 hours (5 per cent) on the Narayanganj-Chalna run and by 5 hours (10 per cent) on the Narayanganj-Khulna run. This is unduly generous to the latter (the minor route); we assume an actual reduction in voyage time of only 5 per cent.

Port operations. The tugs spend substantially more of their time in the ports than in transit. Between voyages at Narayanganj they spent, in 1970, 9 hours steaming and 19 hours idle; for Khulna the steaming time rose to 53 hours and delay time to 32 hours and for Khulna to 70 hours and 40 hours respectively. Comparable figures for dumb craft are given in Table C.4.

Table A.5. Examples of Comparative Route Lengths for Rail and Water (miles)

Origin and Destination	Rail	Water
Chittagong-Dacca	198	197
Mongla-Dacca	n.a.	234[a]
Chittagong-Narayanganj	209	187
Chittagong-Chandpur	112	155
Ghorasal-Dacca	53	47
Chhatak-Narayanganj	219	214
Khulna-Sirajganj	176	360
Khulna-Dacca	359	267[a]

a Kocha route; there is a shorter seasonal route via the Madhumati and since late 1973 an all season short-cut via the Mongla-Ghasiakhali canal, which saves 42 miles compared with the Kocha route.

With the future development of important industrial facilities outside the three main centres of Khulna, Chittagong and Dacca/Narayanganj, new areas of potential competition between rail and inland water will be opened. The development of new internal transport demands will lessen the importance of the most expensive (in economic terms) bay crossing movements in the competition between rail and water transport. The existing manufacturing facilities at Ghorasal (fertiliser) and Chhatak (cement) provide examples of the potential new competition (see Table A. 5 above).

Another pointer to the potential for competition to rail from inland water is provided by the example of coastal oil tankers. These specialised vessels, loading and unloading in bulk, and concentrating on what is virtually a single traffic, demonstrate how cheap water transport can be. Figure A. 5 shows that the ton-mile costs for the movement of oil by coastal tanker are below the minimum rail transport costs in the relevant range of 200-300 miles.

Reductions in water transport costs through short term improvements

The implications of recommended short term operational, managerial and technical improvements for rail transport costs have been discussed above. We consider here the corresponding implications for inland water transport costs of the recommended short term improvements. The relevant short term improvements are those put forward in Part 10. 2, Section C and implied in the corresponding sections of Part 9. Within the context of short-term improvements, fundamental changes in vessel design

able C.1. Parameters of Major Commodity Flow Links

ink o	Between		Distance (miles)	River	Depth (ft) Wet[a]	Depth (ft) Dry[b]	Width (ft) Dry[b]	Tide (ft) Wet[c]	Tide (ft) Dry	Velocity (mph) Wet[d]	Velocity (mph) Dry[e]
	Chhatak	Sunamganj	27	Surma	9.5	5.5	200	-	-	0.7	-
2	Sunamganj	Ashuganj	130	Surma, Baulia, Meghna	8	4	160-240	0.5	1.0	0.9	0.3
3	Ashuganj	Narayanganj	57	Meghna, Lakhya	11	8	>300	1.0	2.0	1.6	0.6
4	Dacca	Narayanganj	22	Buriganga, Dhaleswari and Lakhya	17	11	300	1.0	2.0	2.0	0.9
5	Narayanganj	Chandpur	42	Buriganga, Dhaleswari and Meghna	17	11	300	1.0	2.0	2.0	1.0
6	Narayanganj	Chandpur	32	Dhaleswari, Lakhya and Meghna	17	11	300	1.0	2.0	2.0	1.0
7	Chittagong	Chandpur	155	Meghna-Bay	7	7	>300	16.0	13.0	2.5	2.2
8	Barisal	Chandpur	63	Meghna, Jayanti, Arial Khan	9	8	100	1.5	3.0	2.4	1.2
9	Barisal	Chittagong	158	Meghna-Bay	7	7	100	2.5	5.0	2.4	2.0
10	Barisal	Chalna	87.5	Baishkhali, Gabkhan, Kocha and Ghasiakhali	14	13	160	-	-	2.4	1.0
11	Khulna	Chalna	33	Pusur	15	14	>300	3.5	7.0	2.4	1.0

Source: Water Level: Depth Relationships, Part 4.1.

Source: NEDECO Surveys 1966.

Source: NEDECO + IWTA data on observed and predicted tides.

Source: Extrapolated from WAPDA river station data.

Wet season defined to be May-October, Dry season November-April.

Table B.33. Tentative Allocation of Primary Fertiliser Movements 1982-83
(000 tons)

Source of supply	Product	Mode of despatch	Total quantity	Destination districts
Chittagong (plant 120 + direct imports 80)	TSP	Rail	170	Mymensingh 45, Sylhet 25, Comilla,25, Noakhali 15, Tangail (via Dacca) 5, North Bengal 55.
		Road	30	Chittagong and Hill Tracts 30.
Imports discharged at Outer Anchorage	TSP	Water	25	Dacca 25,
Mongla (plant 100 + direct imports 25)	TSP	Rail	75	Rajshahi 20, Pabna 10, Jessore 15, Kushtia 15, Faridpur 15.
		Water	40	Pabna 10, Khulna 5, Barisal 15, Patuakhali 10.
		Road	10	Khulna 10.
Imports through Chittagong	MP	Rail	95	Mymensingh 25, Sylhet 15, Comilla 15, Noakhali 5, Tangail (via Dacca) 5, North Bengal 30.
		Road	15	Chittagong and Hill Tracts 15.
Imports through Mongla	MP	Rail	40	Rayshahi 10, Pabna 10, SW Districts 20.
Imports discharged at Outer Anchorage	MP	Water	40	Dacca 15, Khulna 10, Barisal 10, Patuakhali 5.
Ghorasal	Urea	Rail	215	Mymensingh 100, North Bengal (metre gauge) 116).
		Road	35	Tangail 10, Dacca 25.
Fenchuganj	Urea	Mainly Rail some cb	100	Sylhet 50, Noakhali 35, Comilla 15.
Satnal	Urea	Road	50	Chittagong 15, Comilla 35,
		Water	310	Dacca 25, Barisal 35, Patuakhali 20, Faridpur 35, Khulna (including for re-distribution)105, Pabna (including for redistribution) 90.
Imports through Chittagong	Urea	Road	50	Chittagong and Hill Tracts 50.

increase in traffic than rail. The demand for baycrossing water transport is expected to remain dominated by the distribution of petroleum products. Road is shown with a relatively modest expansion of traffic but interdistrict traffic is less important to the road transport industry than to the other main modes and the overall demand for road transport services would be expected to rise by rather more than the 15 per cent shown for interdistrict movements.

Table B.38. Summary Projections of Volumes of Main Commodities to be Carried by Alternative Modes, 1982-83
(interdistrict movements 000 tons)

			Water[a]			
	Road	Rail	BX	IB	CB/CL	Total
Fertiliser	50	645	65	350	-	1,110
Cement	25	700	255	350	-	1,330
Clinker	-	300	-	-	-	300
Foodgrain	650	900	375	225	500	2,650
Coal (internal)	50	85	-	-	30	165
Jute & Jute Manufactures						
raw jute to mills	290	115	-	-	210	615
raw jute exports	-	125	-	90	-	215
jute manufactures	5	80	-	100	-	185
Iron and steel	50	190	-	210	-	450
Refined sugar	60	120	-	10	-	190
Tea	30	5	-	-	-	35
Fruit & vegetables	240	5	-	-	225	470
Vegetable oil	25	50	40	25	-	140
Oil seeds	40	25	-	30	30	125
Refined salt	50	90	-	50	120	310
Stones and boulders	-	475	-	200	50	725
Subtotal	1,565	3,910	735	1,640	1,165	9,015
Petroleum products	345	425	1,375	-	100	2,245
	1,910	4,335	2,110	1,640	1,265	11,260
Comparative 1977-78 Figures						
Total	1,667	3,035	1,674	1,124	1,155	8,655
Dry cargo	1,396	2,701	606	1,124	1,070	6,897

a BX = baycrossing; IB = inland tug and barge; CB/CL = country boat/cargo launch.

Source: For 1977-78 figures, Table B.30 of Part 10.3.

APPENDIX SECTION 7

PART 4

Extracts from "Bangladesh Requirements for Rehabilitation of Surface Transport, 1976"

Annexure-I

SUMMARY OF THE POSITION OF LOCOMOTIVES, CARRIAGES AND WAGONS.

Sl. No.	Descriptions		Locomotives		Passenger carriages (PCVs in unit)		Wagons In terms of (4-wheelers)	
			MG	BG	MG	BG	MG	BG
1	2		3	4	5	6	7	8
1.	(i) As on 30-6-1970	Steam	222	118	890	275	14,984	4,632
		Diesel	125	18	667 (Steel) 223 (Wooden)	93 (Steel) 182 (Wooden)		
2.	Damaged during war of liberation.	Steam	51	44	112	225	609	875
		Diesel	27	18				
3.	Abandonments during 1970-75.	Steam	22	6	112	57	(ii) 3,774	(iii) 3,637
		Diesel	10	2				
4.	Additions during 1970-75.	Steam	3(iv)	Nil	106	106	(v) 2,218	(vi) 3,319
		Diesel	26	16				
5.	(vii) Position as on 30-6-1975.	Steam	203	115	884	324	13,428	4,314
		Diesel	141	32				
6.	Likely to be abandoned during 1975-78.	Steam	110	72	100(viii) (Wooden)	100(ix) (Wooden)	1,500	1,000
		Diesel	22	Nil				

1	2	3	4	5	6	7	8
7.	Prospect of addition during 1975-78	Steam	..	49		994	500
		Diesel 12	...				
8.	Likely position on 30-6-78 if availability of external assistance does not improve.	(x) Steam-93	43	833	224	12,922	3,814
		Diesel-131	32	700 (Steel) 133 (Wooden)	142 (Steel) 82 (Wooden)		

Notes :—(i) 14% MG Steam locomotives, 10% BG Steam locomotives, 21% Diesel MG locos., 6% Diesel BG locos., 13% passenger carriage, 8% MG goods wagons & 6% BG goods wagons were out of service for repairs.

(ii) Includes 437 MG B. Rly. wagons held up in India since 1965 war but abandoned in the year 1972-73. 23 MG B. Rly. wagons held up in Pakistan since 1965 war but abandoned in the year 1972-73.

(iii) Includes 3331 BG B. Rly. wagons held up in India since 1965 war but abandoned in the year 1972-73. 80 BG B. Rly. wagons held up in Pakistan since 1965 war but abandoned in the year 1972-73.

(iv) Includes 3 MG Indian Rly. steam locomotives held up in Bangladesh Railway since 1965 war and accounted for Bangladesh Railway in 1972-73.

(v) Includes 919 MG Indian Rly. wagons held up since 1965 war & accounted for B. Rly. in the year 1972-73, 1298 Nos. Romanian MG wagons placed in service & 1 MG wagon manufactured locally and placed in service.

(vi) Includes 3194 BG Indian Rly. wagons held up in Bangladesh since 1965 war but accounted for in the year 1972-73. 123 Pakistani BG wagons held up in Bangladesh since 1965 war but accounted for B. Railway in the year 1972-73.

(vii) 65% MG & 77% BG Steam Locos., 36% MG & 28% BG Diesel Locos., 34% MG & 50% BG passenger carriages and 40% & 50% BG Goods wagons were out of service for want of repairs.

(viii) & (ix) It is proposed to abandon 100 wooden MG Coaches out of 223 Nos. wooden MG coaches and 100 BG wooden out of 182 Nos. during 1975-78. The balance wooden coaches are also very old and their continuation in service is unsatisfactory. But unless replacement is made these will have to continue in service.

(x) 46% MG & 54% BG Steam Locos., 35% MG & 38% BG Diesel Locos., 40% MG & 43% BG Passenger carriages and 40% MG & 50% BG goods wagons are likely to remain out of service for over due periodical overhaul (POH) for want of spares and facilities.

(xi) Age chart of the rolling stock may be seen at Annexure II.

Annexure II

AGE CHART OF LOCOMOTIVES AND OTHER ROLLING-STOCK AS ON 30-6-75

A. LOCOMOTIVES.

Age Groups	Steam B.G.	Steam M.G.	Diesel B.G.	Diesel M.G.
Age over 60 years	46	57	..	..
Age between 55-60 years	13	18	..	..
Age between 50-55 years	21	14	..	..
Age between 45-50 years	8	17	..	..
Age between 40-45 years	6	4	..	..
Age between 35-40 years	..	..	..	..
Age between 30-35 years	19	75	..	..
Age between 25-30 years	2	1	..	..
Age between 20-25 years	..	7	..	25
Age between 15-20 years	..	..	..	26
Age below 15-00 years	..	..	34	100
	115	203	34(*a*)	151(*b*)

(*a*) Includes 2 awaiting condemnation.
(*b*) Includes 10 awaiting condemnation.

B. CARRIAGES :

	over age Wooden	over age Steel	under age Wooden	under age Steel	No. on line on line
B. G.	131=253*	Nil	18=33*	174=348*	323=634*
M. G.	132=241*	Nil	7=14*	745=1889*	884=1745

C. WAGONS :

B. G.	288=320*	3864=3994*	4152=4314*
M. G.	710=889*	10764=12539*	11474=13428*

CONDEMNING AGE :

Locomotive	Steam	45 years
	Diesel	20 years
Carriages		35 years
Wagons		45 years

*Indicates number of vehicles in equivalent units in 4-wheelers.

APPENDIX SECTION 7

PART 5

Extracts from USAID Project Papers

OPTIONAL FORM NO. 10
JULY 1973 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

TO : Mr. Dinsmore J. Alter, CDD

DATE: October 19, 1976

FROM : Md. Kobbad, CDD

SUBJECT: Pricing of Polycoated Jute Bags

According to your instructions, I have collected and attached herewith the names of Jute Mills and Plastic/Polythine Factories which are now existing in Bangladesh.

Further, I have visited Adamjee Jute Mills at Narayangonj on October 18 to obtain ex-mill price of 25 Kg and 50 Kg polycoated Jute Bags. Separate price of each bag is as follows:

Size	Ex-Mill Price	Cost Ratio
33" x 19" 25 Kg	Tk. 5.75 each *	Jute : Polythine 3.60: 2.15
36" x 22" 50 kg	Tk. 8.00 each *	Jute : Polythine 5.00: 3.00

* This price includes 10% Sales tax & 30% duty tax. These taxes are precluded from exported bages i.e. 40% less.

PROJECTION OF FERTILIZER DEMAND CONTAINED IN THE INTERIM REPORT OF THE ASHUGANJ STUDY

	UREA			TSP			MP		
	High Demand	Medium Demand	Low Demand	High Demand	Medium Demand	Low Demand	High Demand	Medium Demand	Low Demand
77-78	396	371	341	153	144	133	42	37	35
78-79	443	02	361	176	161	144	54	45	42
79-80	497	437	377	203	180	155	69	56	50
80-81	557	475	395	233	201	167	89	69	59
81-82	634	524	422	274	229	184	107	81	68
82-83	721	578	450	323	260	204	129	95	77
83-84	821	638	481	380	296	225	156	111	88
84-85	935	704	513	447	337	248	188	130	101
85-86	1064	77[illegible]	548	526	384	274	227	153	116

SOURCE: Bangladesh Fertilizer Marketing and Distribution Study, Interim Report. The Economist Intelligence Unit, Ltd, January 1977

Projection of Local Fertilizer Production

In thousand of Metric Tons

	Urea	TSP	MP
1977	282	55	None
1978	300	60	None
1979	300	60	None
1980	300	60	None

Source: Bangladesh Chemical Industries Corporation (BCIC) and AID Mission 1977.

APPENDIX SECTION 8

TECHNICAL SCOPE OF WORK
FOR
DESIGN PHASE
BANGLADESH BULK FERTILIZER
HANDLING AND BAGGING PROJECT

1.0 DESCRIPTION OF PROJECT

1.1 OBJECTIVE

To prepare designs, specifications and requirements for the construction of a facility for the unloading from ocean vessels of bulk Triple Super Phosphate (TSP) and Muriate of Potash (MP), and the handling, storage, bagging and shipping of these materials at a selected site in Chittagong, Bangladesh.

1.2 BACKGROUND

The Government of the Peoples Republic of Bangladesh, (BDG) through its established fertilizer distribution organization, Bangladesh Agricultural Development Corporation (BADC) has been receiving its import requirements for TSP and MP in bags. Studies by AID and by consultants to BDG and AID indicate a substantial saving can be obtained through the purchase of these materials in bulk, with bagging to be accomplished in Bangladesh. A study was undertaken during April and May of 1977 to verify the merit of bulk handling and to select a site for such a facility if justifiable. The conclusions and recommendations of the study follow.

1.2.1 Summary of Conclusions of the Site Selection Report

Following observation and study of the Bangladesh fertilizer transport system and examination of alternative sites for location of bulk storage and bagging facilities, the consultants concluded that in order to provide a system of fertilizer import best serving the country's needs over the period 1978 through 1987, there is only one feasible solution. That

solution is the importation of TSP and MP in bulk and the establishment of a bulk storage and bagging facility on the grounds of the TSP plant in Chittagong.

- Internal Distribution in Bags or Bulk

  The team observed and studied the present transport and storage system of Bangladesh and investigated future planning for the project period. The observed a lack of internal transport equipment for experience in handling and control of bulk materials. Based on these observations, it was concluded that fertilizers should be bagged at the port prior to shipment, and that internal transport should be in bags. Transport in bulk to interior storage and bagging facilities should not be considered at this time.

- The Feasible Alternative

  The scope of work called for the examination of various feasible alternative plans for importing TSP and MP in bulk into Bangladesh. Eight alternative sites were considered.

  A system of fertilizer import best serving the needs of Bangladesh for the next ten years (1978-87) would be one based on services, facilities, management, labor and transport to be in existance now and known to be expandable or available within the initial (at least the first five year) period of the 10 year time frame. It should also be a system which will not work at cross purposes with existing or planned programs, and it should be compatible with the complementary to existing and planned programs and present and future requirements of the country. There is only one site for bulk fertilizer import which can be recommended as best serving

these needs of Bangladesh for the next ten years. This site is the TSP plant at Chittagong. The background of the site selection is contained in the "Bangladesh Bulk Fertilizer Handling and Bagging Site Selection Report" of May 1977.

1.2.2 The Recommended Site

The bulk storage and bagging facility should be located on the Chittagong TSP property, in the general location shown on Figure 1.1. In connection with the development, a number of new installations will be required, together with improvements to existing facilities to be jointly used by the TSP plant and the Bulk/Bagging plant.

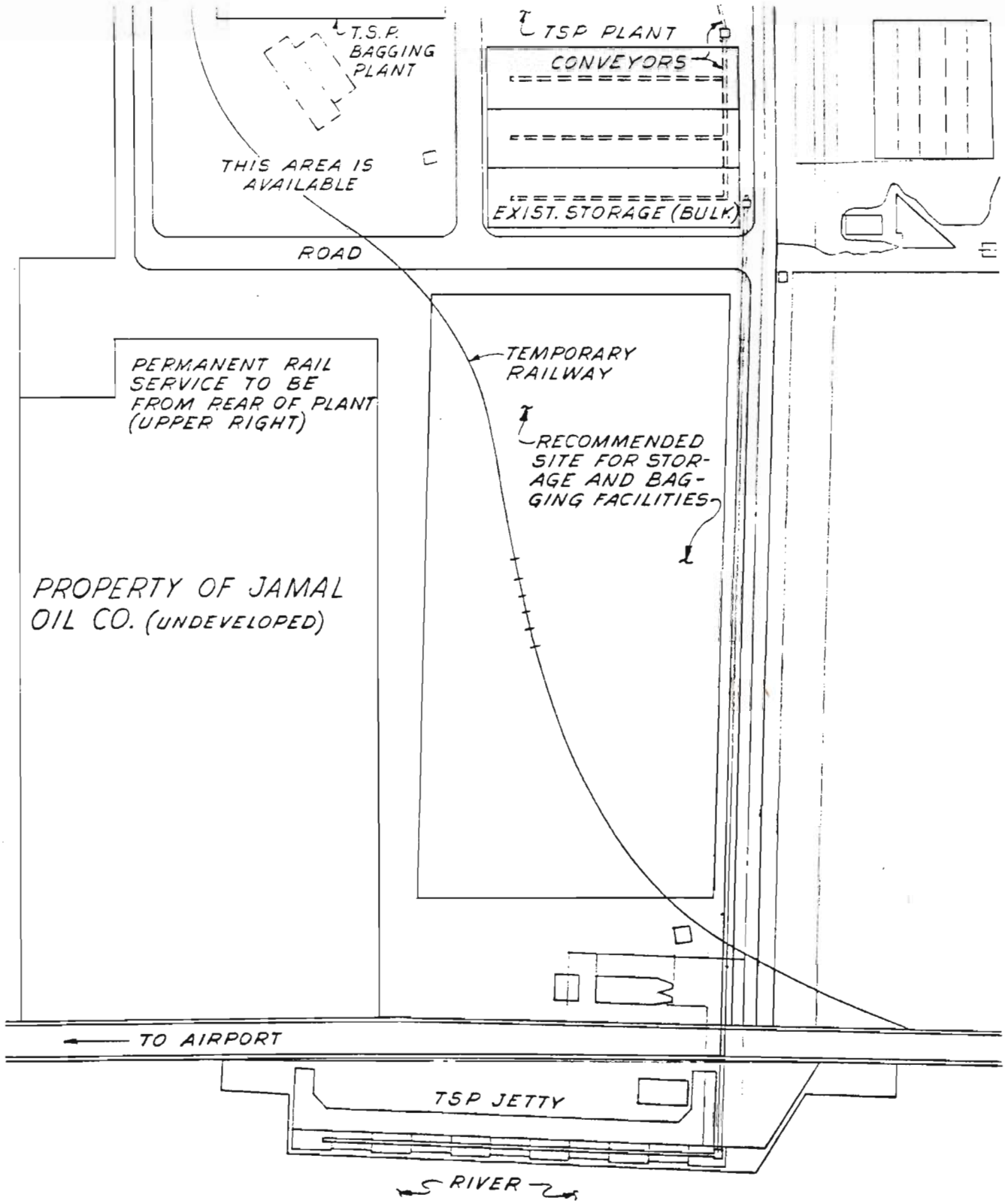

FIGURE 1.1

RECOMMENDED SITE
BULK STORAGE AND
BAGGING FACILITY

2.0 SCOPE OF WORK

2.1 OVERVIEW

The Scope of Work calls for the preparation of design requirements for completion of the subject facilities. Incorporated in the requirements is included the necessary verification and justification for the design specifications selected, the preparation of an estimate of completed cost and the preparation of contract documents including bidding and contractual requirements, plans and technical specifications. Five categories of service are contemplated as follows:

- Soils and Site Conditions
- Buildings and Marine Structures
- Material Handling and Mechanical Requirements
- Electrical Requirements
- Cost Estimates

The design requirements of each of these categories are described in the following subsections.

2.2 DESIGN REQUIREMENTS

Care should be taken in the design stage that the design of the storage and bagging facility not interfere in a significant way with the operation of the TSP plant. The operation of the TSP plant should be examined in detail in order to be certain that the requirements of both the plant and the storage and bagging facility are met. Accordingly, engineering staff specified by the consultant should include personnel familiar with design and operation of such plants. Consultant should be aware that the TSP plant operators, BCIC, have engaged the services of Engineering Associates and Consultants,

Ltd. to undertake a study to find a site for a process water reservoir (and a source). Care should be taken to avoid conflict between siting of the fertilizer storage facilities and process water site reservoir siting. In addition, BCIC may contract with Bresslu & Associates, Inc., for a study of operational improvements at the TSP plant. The study would begin in July 1977.

It should also be understood that although it will be necessary that field investigation of the various considerations be undertaken in Bangladesh, the design work may be accomplished in consultants home office. Offerer's proposal should describe his intentions in this regard.

2.2.1 Site Data

Site investigations in connection with design of this facility should consist of:

- Geology and Seismic Activity Study to establish the seismic risk zone and to recommend the ground accelerations to be used in the evaluation of the liquefaction potential of the site and design of the facility.

- Meteorologic and Oceanographic Study to establish design requirements as controlled by tidal waves, cyclones, etc.

- Review of all available hydrographic survey data including work by other consultants working in the general area. If necessary, perform hydrographic survey in the immediate vicinity of the existing jetty to establish the potential for future dredging and berthing of larger vessels.

- Geotechnical Investigations of the Plant site and the existing Jetty. The investigation should consist of borings, probes, test pits and appropriate laboratory tests to establish the subsoil stratigraphy and necessary design parameters. The data should permit the evaluation of the existing condition of the Jetty and its capability to service the proposed plant in terms of projected load, berthing of larger vessels, etc. The scope of the site investigations and laboratory testing should conform to the generally accepted design practice in U.S.A.

- Any right of way or height limitations potentially restricting the site should be investigated and documented, and a complete survey and topographic drawing of the site prepared.

A report presenting the details and the findings of all the above cited investigations including recommendations for the foundation design of the entire proposed facility should be prepared.

2.2.2 Building and Marine Structures

2.2.2.1 Marine Structures

- Preliminary Design

  In order to arrive at an optimum final design of the wharf and related facilities, a preliminary conceptual study should be prepared, which will include the following:

  1. Field survey of the existing wharf.
  2. Determine the functional capacity of the wharf (size of vessel that can be berthed, utilities available).

3. Determine depth of channel at the wharf and approaches and possible dredging requirements.

4. Investigate the effect of increased bulk storage surcharge, as well as the possible deepening of the channel - on the stability of the inshore area. Develop a slope protection or retaining system to assure positive stability for the above.

5. Investigate possible undermining of existing wharf supporting piles by dredging.

6. Determine the capacity of the existing fender system to absorb the impact of berthing vessels.

7. Determine the structural status of the wharf (load sustaining capacity, degree of deterioration and corrosion of structural components, etc.

8. Establish maximum and minimum sizes of vessels as well as mooring and berthing forces and arrangements of mooring lines and fittings.

9. Determine the optimum method of expansion, either lengthening of wharf or construction of mooring dolphins. In any case, the arrangement shall permit future expansion, and should include consideration of facilities for loading of barge and coastal vessels.

10. Selection of the type of unloading crane to be used should be with due consideration of the functional requirements, as well as the supporting capacity of the structural components.

11. Select a fender system which will be compatible with the existing fenders and will increase the capacity to absorb the impact of larger vessels.

- Final Design

  The final design of the marine facility shall include drawings showing plans, sections and details of all the structural components of the wharf, mooring dolphins and crane girders, if such are used.

  Material and construction specifications shall be spelled out in great detail. There should also be included a construction cost estimate, as well as a construction time schedule and bar chart.

  All structural components of the marine facility shall be analyzed and calculated with due consideration given to all possible combinations of forces acting on the structures (vertical loads, as well as horizontal forces, moorings, berthings, wind waves and earthquake, etc.)

  The final design shall also reflect results of laboratory soil test, as well as pile driving and pile load tests.

2.2.2.2 Buildings

Detailed plans and specifications should be prepared for the following buildings:

a. Bulk Storage Shed - an enclosed storage area shall be provided with a maximum capacity of about 60,000 metric tons of granular TSP and MP. Bulk storage shall be

flat (on the floor) with an ability to separate products. Design consultant shall verify the adequacy of the storage capacity to accommodate the projected requirements.

b. Bagging Facilities and Warehouse for Bagged Material

c. Maintenance and Spare Parts Building

d. Office and Dispatch Facilities

e. Shelter for personnel including locker rooms, showers and sanitary facilities

The buildings should be designed to meet all the functional requirements specified in Section 4.3.1.

Due to the corrosive nature of the materials to be handled, it is recommended that concrete should be used as the basic material for all buildings.

The usage of concrete will also minimize the expenditures of hard currency on building materials.

It is also recommended that consideration should be given to the use of precast prestressed components where possible to reduce cost, increase speed of construction and to provide flexibility in the arrangement of partitions in buildings to separate various materials or types of activities.

The design should make provisions for building expansion to keep in step with future requirements and to incorporate added facilities with as little disruption of existing operations as possible.

The material handling equipment in the storage and bagging areas shall be arranged to facilitate the transfer of bulk, the bagging equipment, as well as the transfer of bags to trucks, railroad cars or to bag storage.

2.2.3 Material Handling and Mechanical Requirements

The design shall provide for the unloading of Phosphate Rock, Crude Sulphur, TSP and MP from moored vessels, placing the product into storage, reclaiming from storage and feeding to the bagging plant, designing of the bagging plant and providing storage and loading facilities for the bagged product.

The design shall include provisions for all utilities required such as fire protection, sanitary service and plant air.

Vessel unloading shall be by one or more swing crane and clam shell bucket or other means and shall be designed for an average sustained unloading rate of at least 300 tons per hour. Adequate capacity to accommodate the projected volumes without excessive vessel waiting time, must be verified and equipment specified accordingly.

There is an existing conveyor between the jetty and the storage area. The contractor shall evaluate and advise whether this existing system should be upgraded or whether the optimum design should be a new and separate conveying system.

Ability to store the necessary clamshell buckets and to move them to repair facilities shall be considered in the design. In addition, provision must be made for the placing of mobile

equipment in vessel holds as required, for their access to the jetty within reach of lifting equipment.

Unloaded product shall report to a surge bin or hopper which will feed a belt conveyor. The belt conveyor, utilizing a tripper or shuttle conveyor shall deliver the product to storage.

Reclaim from bulk storage shall be by front end loader, number and type of which shall be specified. Bucket wheel reclaim may be considered

Feed to the bagging plant shall be by belt conveyor designed for a continuous bagging operation.

The bagging plant shall be semi-automatic and should include vibrating screens, open mouth packers and sewing machine. Transfer of bagged product to storage shall be by hand truck, with provisions for future change to mechanical conveyance. Each bagging unit shall have a capacity of approximately 20 bags perminute. Number of units required shall be determined by the designer. Alternate bagging plant concepts should be considered and the most cost-effective and efficient design selected. Design of the bagging system should include consideration and study with recognition of conditions in Bangladesh, of the relative merit of use of 25 kilo bags versus 50 kilo bags, considering both the effect on physical handling and the effect on cost. Equipment requirements should be specified accordingsly, and should be capable of bagging either size. Adequate covered storage shall be provided for bagged products and empty bags. Bulk blending of TSP and MP in measured proportions shall be provided for. Provision shall be provided for conveyance of bulk material to the existing TSP plant and to railroad and truck loading.

Belt conveyors shall be designed in accordance with CEMA (Conveyor Equipment Manufacturers Assn.) standards and recommendations.

Plant utilities shall be provided as required by the facility and in accordance with the requirements of local and national codes. Fire protection requirements shall be provided in accordance with the U.S. National Fire Protection Association standards.

- Maintenance and spare parts facilities for mobile equipment, and general maintenance should be provided.

- Rail facilities should be integrated with the TSP trackage and adequate car storage provided. In plant switching equipment (Trackmobile) should be provided if not available from TSP plant.

- Adequate road and truck lineup area must be provided to minimize congestion and facilitate loading and dispatch.

- Office and dispatch facilities must be provided.

2.2.4 Electrical Requirements

- Determine whether the electrical power is available in adequate quantity and ascertain whether the available power supply network provides the level of continuity and reliability desires.

- Develop and design of the electrical system aimed to achieve the lowest cost of efficient plant operations with the lowest capital investment.

- Develop a design of the electrical system that provides an adequate degree of protection of life and property.

- Determine whether the environment inside of the Bulk Storage Building is hazardous and therefore may require a design of an explosion proof electrical distribution system.

2.2.5 Cost Estimates

Preliminary and Final Engineering Cost Estimates will be required for the purposes of financing the work and for checking bids made by contractors. These estimates would include the following:

- Materials and Equipment - Estimated quantities and Costs.

  Prepare list of materials and equipment from Plans and Specifications. Cost of materials and equipment should be figured as at the site, and should include purchase cost, freight, unloading, cartage, storage, inspection, testing and insurance.

- Labor - Estimated labor-hours and costs

  In preparing labor estimates, allowances should be made for variations in wages, for variations in length of time required, for variations in working conditions, and for variations in the classes (skilled and unskilled) of labor required for different kinds of work. Allowance should also be made in regard to the probable local labor supply and demand and to local customs and union regulations.

- Plant - Estimated amount and kind of construction equipment needed and costs.

  Should consider temporary buildings and structures, machinery and tools necessary for the work. Renting or purchasing of plant and equipment should be considered. Consideration should also be given to the estimated life of any particular machine, the length of time it will be used on the job, and the amount of work to be done. Plant costs should include transportation, installation, maintenance, fuel, lube and repair, operation, removal, interest on investment and depreciation. These costs often include labor costs of machine operators.

- Overhead - Determine items included and estimated costs.

  Overhead costs usually include such general office and other labor costs as are not considered as direct productive labor on the job. Overhead costs include rents, general insurance, workmen's compensation insurance, social security tax, finance charges, office equipment and stationary, telephone and telegraph, interest, taxes, legal expenses, expenses of plans and specifications, traveling expenses and sundries. Overhead costs also include the salaries of managers, superintendents, estimators, engineers, inspectors, clerks, timekeepers, stenographers, draftsmen and watchmen chargeable to the particular job. Total overhead expenses can vary from 10 to 30 percent of the total cost, or from 15 to 50 percent of the labor cost.

- Profit - Estimated percentage for time, place and job

  The amount of profit is usually expressed as a percentage of the total estimated cost of the job. This percentage can vary from 8 to 18 percent, depending on the contractor's desire for work, what he thinks is fair, and what he thinks he can get. The percentage of profit also depends, to some extent, on risks and unforeseen difficulties of the job, and on how often payments are to be made and in what amounts.

3.0 COSTS

3.1 ESTIMATED COST OF DESIGN PROJECT

Cost of the Design Phase of the project is estimated to be $500,000 (1977 Prices) as shown on Table 3.1

3.2 ESTIMATED COST OF THE FACILITY

A preliminary estimate of the cost of providing the facility is shown on Table 3.2, and indicates that the facility can be installed for about $8 million (1977 prices), including a 25% contingency factor.

TABLE 3.1

BANGLADESH BULK FERTILIZER HANDLING AND BAGGING FACILITY

ESTIMATED COST OF DESIGN PROJECT

A. Manpower Requirements

1.	Project Management	17 MW
2.	Civil	20 MW
3.	Soils & Foundations	25 MW
4.	Mechanical	50 MW
5.	Electrical	35 MW
6.	Marine Structures	75 MW
7.	Buildings & Miscellaneous Structures	65 MW
8.	Quantity Take-off & Cost Estimates	5 MW
9.	Specifications	18 MW
	Total Manweeks	310 MW

B. Costs

1.	Bangladesh - 60 MW x $2,500/MW =	$150,000
2.	U.S.A. - 250 MW x $1,200/MW =	300,000
3.	Subcontracts (Surveys, Borings, Etc.) =	50,000
	Total Estimated Cost of Design	$500,000

TABLE 3.2

BANGLADESH BULK FERTILIZER HANDLING AND BAGGING FACILITY

ESTIMATED COST OF FACILITY

a.	Dredging	$ 200,000
b.	Modifications to Existing Pier	500,000
c.	Buildings	2,300,000
d.	Material Handling Equipment	700,000
e.	Bagging Equipment	400,000
f.	Cranes & Vehicles	1,500,000
g.	Civil	300,000
h.	Utilities	100,000
		$6,000,000
	Contingencies (25%)	1,500,000
		$7,500,000
	Engineering	500,000
	Total	$8,000,000

ADDENDUM TO THE SCOPE OF WORK

The AID Mission to Bangladesh has requested the services of a Chemical Engineer as a member of the design team to examine and verify the feasibility of adding a granulation (and ammoniation if practical) unit to the existing TSP plant, and to provide design specifications, if found feasible and approved. Offerers should include in their proposal such a provision, including the individual's qualifications. The individual should have the capability of undertaking a study of the operations and needs of the TSP plant. He should also be knowledgeable in world cost and pricing of TSP and raw materials, in order to examine and recommend, if made a part of the study, either the continuation of or the phasing out of TSP production at the site.