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INTERNAL COMMUNICATIONS

STUDY 1977:

FALKLAND ISLANDS

J A PEAT - Economic Adviser ODM
V O JAMESON - Civil Engineer - Forestry Commission

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INTERNAL COMMUNICATIONS STUDY: FALKLAND ISLANDS

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TABLES IN REPORT

References in Report

1. Economic Survey of the Falkland Islands: Lord Shackleton et al : 1976.

2. Falkland Islands Transportation Study : Peat, Marwick and Mitchell and Co : 1971.

3. Falkland Islands: Report on a Study of the Operating Procedures of the Falkland Islands Government Air Service: Civil Aviation Authority : 1974.

4. Colony of the Falkland Islands : Estimates 1977-78.

5. The Potential Net Increase in Agricultural Output which Could be Attained with a Road from Port Stanley to Darwin and the Relevant Constraints : C D Kerr (GTU) : 1977.

6. Road System in Rural Areas of the Falkland Islands : M P O'Reilly; RRL : 1963.

7. Development Plan 1973/8 : The Secretariat, Stanley, 1973.

8. Preliminary Report on Stanley - Darwin Road : C D Kerr (GTU) : 1977.

9. Reports Report : SOA Sub-Committee : 1976.

10. Future of FIGAS - An Interim Report : 1977.

11. The Use of Aircraft in Agriculture : C D Kerr (GTU) 1977.

12. The Economic Analysis of Rural Roads Projects : World Bank Staff Working Paper No 24.

13. Tables for Estimating VOC's on Rural Roads in Developing Countries: Transport and Road Research Laboratory : 1976.

14. Interim Report on a Fiscal Survey : H W T Pepper : 1977.

Summary of Conclusions and Recommendations

i. We recommend that a road should be constructed from Port Stanley to Darwin/Goose Green, subject to the following general considerations:-

a. The construction methods and procedures discussed in this report should be broadly followed.

b. The Ministry of Overseas Development should provide, under OSAS, a professional Director of Public Works and a Mechanical Superintendent.

c. A Funding Scheme should be established, and a revised system for charging for use of plant should be introduced.

d. The capacity of FIGAS should not be expanded,

e. The FIG should make every effort to obtain the fullest possible increase in net agricultural output from the land to be opened up from the road.

ii. We do not believe that there is at present any justification for the purchase for FIGAS of a Brittain Norman Islander, if the construction of a Stanley-Darwin road is agreed. Unfortunately a version of the Islander suitable for agricultural purposes in the Falklands is not available. Steps should be taken to reduce the subsidy on FIGAS (taking account of depreciation) from around 50% to 25%.

iii. At present there is no case for the purchase of a vessel for use as an East-West ferry, or for any addition to coastal shipping services. Consideration might be given to the use of the M V Forrest and/or the M V Monsunen as an 'occasional' ferry. Towards the end of the construction period of the Stanley to Darwin road a further study of coastal shipping should be carried out, including consideration of the possible purchase of a bow-loading vessel to serve (inter alia) as a vehicle ferry.

iv. In the longer term further road construction should be considered taking into account the costs of the various possible roads, and the potential developmental and social benefits. Due consideration should be given to construction of feeder roads on payment by land owners, and realisation of funds for major road construction from the increased private sector income due to increased net agricultural output.

INTERNAL COMMUNICATIONS STUDY: FALKLAND ISLANDS - 1977

I. INTRODUCTION

1.1 The terms of reference for this study are at Appendix A. The study was undertaken by Mr J A Peat (Economic Adviser ODM) and Mr V O Jameson (Civil Engineer, Forestry Commission). Mr Jameson was in the islands between 10 November and 12 December: Mr Peat arrived on the 17 November, and left on the 12 December. Captain B W Woodward (Royal Engineers) was in the Falklands during the same period as Mr Peat, to provide advice on provision of a suitable mechanical engineering establishment and organisation, if certain equipment were to be purchased by or for the Falkland Islands Government (FIG) from Johnsons Construction Limited (JCL). Although not formally a member of the study team, his presence was extremely valuable to the study. Captain Woodward will be producing a separate report.

1.2 During the course of the study the team produced a series of short working papers, and other documentation. The intention was to provide some guidance to the FIG on methodology, and also advance warning of the team's preliminary views on more important and urgent issues. Where appropriate these papers are referred to in this report. A full list of papers passed to the FIG is at Appendix B.

1.3 This was by no means the first study of internal communications in the Falklands, and where possible this report takes into account, and follows on from earlier studies. Our intention has been to avoid duplication wherever possible, and to concentrate on examination of specific proposals and projects once a general framework has been established.

1.4 We wish to record our sincere thanks to all the Falkland Islanders who made our stay so enjoyable, and we hope valuable. The problems of the Islands are very different from those of most countries with which ODM is associated, but no less real. We have attempted to take full account of the unique nature of the Islands, and to give due weight to the social benefits which would flow from an adequate internal communication network.

II. <u>The Existing Internal Communications Network</u>

a. <u>Population and Vehicle Ownership</u>

2.1 Details of population are given in the Shackleton Report (1),[1/] and that report also includes a map showing the order of magnitude of the different settlements. This information is shown in Table 1. (below). No details were available in Stanley of actual population of the settlements, but in Table 2 (below) is a summary of information provided by the two members of the Cambridge Expedition to the Falkland Islands 1977.[2/]

2.2 No information was readily available on vehicle ownership in Stanley, or in the camp settlements. For Stanley an examination of licence fee payments for the 12 months up to October 1977, and Government and British Antarctic Survey (BAS) records yielded the following information. /For details see Working Paper No 2./:-

Table 3. Vehicle Ownership: Stanley

Vehicle Type	Private	Govt & BAS	Total
Petrol Land Rover	100		
Diesel " "	74	22	195
Motorcycles	64	-	64
Cars	49	8	57
Tractors	11	4	15
Lorries	20	7	27
Others	28	3	31
TOTAL	346	44	390

/As at end October 1977/

Source: Internal Communications Study

2.3 The pupils at Darwin School also provided some information on vehicle ownership in Darwin/Goose Green, and their home settlements. This is set out in Table 4. At Table 5 is data on vehicle ownership from the Cambridge Expedition. Overall the view, expressed in the Shackleton Report, that vehicle ownership per person is higher than in the UK is confirmed, and it would appear that per caput ownership is higher in West Falkland settlements than in the East. This could well be due to the tracks in the West being generally of a higher standard, and permitting more internal land movement.

1/. The full titles of references are given in 'References in Report' above.

2/. The report on this expedition is not yet available but Messrs Jones and Orme have kindly provided us with some advance information.

Table 1. Order of Magnitude of Settlement

35+ Persons	16-35 Persons		Under 16 Persons	
Goose Green	Douglas Station	Port Stephens	Rincon Grande	New Is
Port San Carlos	Salvador	Weddell Is	Johnsons Harbour	West Point Island
North Arm	Teal Inlet	Roy Cove	Port Louis	Carcass Is.
Port Howard	Green Patch	Pebble Is	Port William	Sedge Is.
Fox Bay East	Fitzroy	Walker Creek	Seal Point	Saunders Is.
Hill Cove	Darwin	San Carlos	Bluff Cove	Keppel Is.
	Fox Bay West		Speedwell Island	Dunnose Head.
			Beaver Is.	

Source: - Shackleton Report

Table 2. Population by Settlement

Goose Green/Darwin	109	Green Patch	14
Hill Cove	51	Weddel Is	12
Port Howard	44	Rincon Grande	11
North Arm	43	Port Louis	10
Fox Bay East	35	Dunnose Head	10
Port Stephens	35	Johnson Harbour	9
Port San Carlos	31	West Point Is	9
Fox Bay West	30	Bluff Cove	6
San Carlos	29	Saunders Is	6
Chartres	28	Golding Is	5
Keppel and Pebble Is	28	Carcass Is	4
Teal Inlet	25	Beaver Is	4
Fitzroy	23	New Is	4
Walker Creek	19		
Douglas Station	17	Sea Lion Is	4
Roy Cove	17	Sedge Is	2
Salvador	15	Speedwell Is	2

Source:- The Cambridge Expedition to the Falkland Islands 1977

Table 4. Vehicle Ownership December 1977

<table>
<tr><th>E Falkland</th><th>Total (Vehicles)</th><th>Diesel Rover</th><th>Petrol Rover</th><th>Motor Cycle</th><th>Car</th><th>Tractor</th><th>Other</th></tr>
<tr><td>Goose Green</td><td>66</td><td>5</td><td>23</td><td>25</td><td>2</td><td>11</td><td>–</td></tr>
<tr><td>Darwin</td><td>9</td><td colspan="2">7</td><td>2</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>Port Louis</td><td>7</td><td colspan="2">4</td><td>–</td><td>–</td><td>1</td><td>2</td></tr>
<tr><td>Douglas Station</td><td>4</td><td>1</td><td>–</td><td>1</td><td>–</td><td>2</td><td>–</td></tr>
<tr><td>Fitzroy</td><td>14</td><td>1</td><td>6</td><td>4</td><td>–</td><td>3</td><td>–</td></tr>
<tr><td>Bluff Cove</td><td>4</td><td>1</td><td>1</td><td>1</td><td>–</td><td>1</td><td>–</td></tr>
<tr><td>Johnson's Hbr</td><td>8</td><td colspan="2">4</td><td>1</td><td>–</td><td>–</td><td>3</td></tr>
<tr><td>Port San Carlos</td><td>14</td><td>5</td><td>–</td><td>3</td><td>–</td><td>4</td><td>2</td></tr>
<tr><td>W Falkland</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Hill Cove</td><td>32</td><td>4</td><td>7</td><td>10</td><td>–</td><td>7</td><td>4</td></tr>
<tr><td>Roy Cove</td><td>9</td><td>1</td><td>2</td><td>–</td><td>–</td><td>6</td><td>–</td></tr>
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<tr><td>Fox Bay West</td><td>10</td><td colspan="2">3</td><td>3</td><td>–</td><td>4</td><td>–</td></tr>
<tr><td>Beaver Island</td><td>2</td><td>–</td><td>1</td><td>–</td><td>–</td><td>1</td><td>–</td></tr>
<tr><td>Weddell Island</td><td>9</td><td colspan="2">3</td><td>3</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>New Island</td><td>1</td><td>1</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>Pebble Island</td><td>12</td><td>3</td><td>4</td><td>2</td><td>–</td><td>3</td><td>–</td></tr>
</table>

Source:- Darwin School Project

Table 5.

Vehicle Ownership

East Falkland	Total	Rovers	Motor Cycles	Tractors	Others
Goose Green/Darwin	57	21	16	11	9
Port Louis	8	3	2	2	1
Douglas Station	12	5	4	3	-
Fitzroy	16	8	4	4	-
Bluff Cove	n.a.				
Johnson's Hbr	8	2	2	1	3
Port San Carlos	9	4	2	3	-
Green Patch	13	4	3	3	3
North Arm	31	7	15	6	3
Rincon Grande	22	7	9	3	3
Salvador	12	4	6	2	-
San Carlos	24	8	9	4	3
Teal Inlet	16	5	6	4	1
West Falkland					
Hill Cove	22	12	2	6	2
Roy Cove	8	1	1	5	1
Port Howard	37	14	16	6	1
Port Stephen	n.a.	8	n.a.	n.a.	n.a.
Fox Bay West	18	3	8	4	3
Beaver Is	n.a.				
Weddell Is	n.a.				
New Is	n.a.				
Keppel & Pebble Is	13	4	4	3	2
Chartres	23	8	7	6	2
Fox Bay East	24	8	8	6	2
Saunders Is	10	2	5	2	1

Source:- The Cambridge Expedition to the Falkland Islands 1977.

b. Roads and Vehicle Operating Costs

2.4 There are two sections of stoned track leading out of Stanley, one in the direction of Bluff Cove and one in the direction of Estancia. Both are about 8km long, badly drained, sunken, unculverted and too rough to be used by cars. The track in the direction of Bluff Cove is reasonably well aligned and could form the base for a road. The track in the direction of Estancia is less well aligned and parts only could be used as a base for a road.

2.5 The road between Stanley and the new airport has recently been completed. The surface is waterbound macadam with a bitumen seal coat. This road will require regular surface dressing if it is not to become a maintenance problem.

2.6 Over the rest of the islands there is a network of generally ill-defined tracks which can be used by four wheel drive vehicles and motor-cycles with difficulty. Some of the rivers and streams have been bridged, but many of the bridges are in an unsafe condition and few of them are capable of carrying anything larger than a Land Rover or small tractor.

2.7 In our calculation of vehicle operating costs (VOC's) if a Stanley-Darwin road were to be built [see Appendix H. paragraph 8.] we have made use of a TRRL publication (13). For a landrover VOC's with a road should be about 22P per mile. It is not possible to use this same source to estimate existing VOC's over camp tracks, as it does not include data for the (virtually non-existant) type of tracks involved. For this reason we attempted to build up our own estimates.

2.8 The Shackleton Report (1) includes a rough estimate of VOC for a petrol land rover of 33p per mile, excluding cost of labour in maintenance and repairs. This is built up as follows:-

TABLE 6. Shackleton Estimates of VOC's

	Average Annual Cost
Depreciation on 1970 landrover	200
Petrol @ 85p/gallon for 1,000 miles	78
Oil	6
Spare Parts	45
	329

NB Cost per mile (based on 1,000 miles average annual travel) = 33 pence.

Source :- Shackleton Report Table 51.

2.9 To supplement this estimate we included questions on VOC's in the questionnaire [Working Paper No 4] and arranged for similar data to be collected by the students at Darwin School [Working Paper No 3]. The figures for mpg, spare parts cost and hours spent on repair and maintenance varied widely, but the best estimates that we could arrive at are set out in Table 7.

TABLE 7. Estimates of VOC's

	@1,000 miles pa	@ 1,500 miles pa
Depreciation	£400	£400
Petrol @ £0.68 per gallon	48	72
Oil	10	15
Spares and Repair and Maintenance	150	200
Total	£608	£687
ie Cost per mile	£0.61	£0.46

Source:- Internal Communication Study estimates.

These estimates include an allowance for the value of time spent on repair and maintenance. Even though most of this work is carried out by the owner, the time still has an opportunity cost. Mileage over camp tracks is nearer 1,000 than 1,500 on average. The figures of £0.61 - £0.46 per mile are only rough estimates from the data we collected. In some specific cases actual VOC's have been very much higher, but we hope that these estimates can be taken as indicative of orders of magnitude.

c. FIGAS

2.10 At present the Falkland Islands Government Air Service (FIGAS) is operated by three pilots, using two reconditioned D H Beaver float planes, which arrived in Stanley in 1976, as replacements for two other Beavers. FIGAS is operated as an unscheduled service, with priority given to medical and government flights. The fare structure was revised in the 1977 budget, and is set out below.

Table 8 FIGAS Fare Structure

Mileage Rate	15 per mile	
Resident Rebate	10 per mile	
Boarding Fees	Adults	£6.00
	Children 7 - School leaving	£3.00
	Children 1-7 Age	£1.50
	Children under 1	Free
Medical Patients	Adults	£2.00
	Children 7 - School leaving Age	£1.50
	Children 1-7	£0.75
	Children under 1	Free

Source: Gazette No 11 19 August 1977

2.11 Even with these recent increases in fares FIGAS is still run at a loss, before making any allowance for depreciation. Some past and projected revenue and expenditure figures are given in Table 9. When an appropriate allowance for depreciation is made (for details see Working Paper No 6), the subsidy in 1975/76 was around 68.7%, and the projected subsidy in 1977/8 (after the fare increase) is still 48.1%

Table 9

FIGAS Revenue and Expenditure

	1975/6 (Actual)	1976/7 (Revised Estimate)	1977/8 (Estimate)
Expenditure	£103,775	£90,439	£79,967
Revenue	£39,219	£16,600	£52,000
Loss	£64,556	£73,839	£27,967

Source: Colony of the Falkland Islands Estimates (4)

2.12 No detailed breakdown was available of FIGAS traffic, but an origin-destination survey was carried out during the course of this study. As traffic was disrupted during parts of 1976 and 1977 due to major problems with planes and pilots, this survey was based on 1975 data. Time did not permit examination of the logs for a full year, but data for four months was analysed, and the results are summarized in Table 10. /Further details are available if required/. Given the population of the Falklands FIGAS carries passengers to and from an amazingly wide variety of locations. However, it can be seen from Table 10 that flights into and out of Stanley accounted for 78.4% of passengers carried during the survey period, and that over one-third of passengers flew between points either directly on the line of the proposed Stanley-Darwin road, or potentially to be linked to such a road. This point is of considerable importance to the recommendations made later in the report. Of the traffic into and out of Stanley the majority is from or to other points in East Falkland. Internal W Falkland traffic accounted for only 7.6% of passengers flown.

2.13 In addition to the Beavers there are two privately owned Cessna aircraft, and the regular weekly F27 link with Commodoro Rivadorio. The possibility of one or more additional private aircraft being purchased in the near future cannot be excluded.

2.14 Servicing of the Beavers is carried out by two RAF Flight Sergeants - an air frames technician and a powerplant technician. The operating procedures of FIGAS were the subject of a report by the Civil Aviation Authority in 1974 (3).

d. Inter Island Shipping

2.15 The major inter-island shipping vessel is the MV Monsunen, which carries cargo - including the wool-clip - to and from the settlements. A summary of the operating accounts for the Monsunen for 1973-1976, and estimates for 1976 and 1977 is at Table 11. From these accounts it will be seen that a small profit was made in 1974, 1975 and 1976, but that a significant loss is projected for 1977, and a smaller loss for 1978.

2.16 An analysis of the Monsunen cargo in 1976 was carried out, and the results are summarized in Tables 12 and 13. These show that

Table 10

FIGAS TRAFFIC SURVEY 1975

No's of Passengers	Jan'75 No.	Jan'75 %	April'75 No.	April'75 %	July'75 No.	July'75 %	Oct'75 No.	Oct'75 %	Total (4 months) No.	Total (4 months) %
Inward to Stanley (East)	77	17.2	92	25.5	133	25.9	98	25.0	400	23.3
Inward to Stanley (West)	67	15.0	51	14.2	84	16.3	60	15.2	262	15.3
INWARD TO STANLEY TOTAL	144	32.1	143	39.6	217	42.2	158	40.2	662	38.6
Outward from Stanley (East)	110	24.6	72	19.9	131	25.5	102	26.1	415	24.2
Outward from Stanley (West)	91	20.3	55	15.2	66	12.9	55	14.2	267	15.6
OUTWARD FROM STANLEY TOTAL	201	44.9	127	35.2	197	38.4	157	40.3	682	39.8
W. Falkland to other East Falkland	12	2.7	9	2.5	25	4.8	18	4.7	64	3.7
Other East Falkland to West Falkland	14	3.1	22	6.1	12	2.3	15	3.8	63	3.7
Other Internal East Falkland	30	6.7	27	7.5	34	6.7	22	5.5	113	6.6
Internal West Falkland	47	10.5	33	9.1	29	5.6	22	5.5	131	7.6
TOTAL	448	100	361	100	514	100	392	100	1715	100

	Jan '75	April'75	July'75	Oct '75	Total (4 months)
(a) Stanley/Darwin and Darwin/Stanley as % of total Passengers carried	9.6%	15.0%	14.2%	13.5%	13.0%
(b) Passengers carried between: Stanley, Darwin, Fitzroy Bluff Cove, San Carlos, Port San Carlos North Arm and Walker Creek as % of total passengers carried	27.7%	32.1%	38.5%	40.3%	34.8%

30.1% of general cargo out of Stanley, and 36.3% of the wool, skins and hides into Stanley was due to settlements either on the line of the proposed Stanley-Darwin road, or potentially to be linked to such a road, Table 14 provides a further breakdown of the inward cargo from such points.

2.17 Further details of the Monsunen and its operations are included in the Shackleton report and will not be repeated here. The 144 tons M V Forrest is owned by FIG. but is chartered to the Ministry of Defence for the use of the Royal Marines Naval Party 8901. It has recently been agreed that, subject to other commitments, the Forrest will be used to deliver fuel to Darwin School. In addition to the Monsunen and Forrest there are a large number of smaller vessels in the Falklands, and the Royal Marines have recently produced a list of these with details of owners, location, serviceability and capacity.

Table 12 M V Monsunen; Cargo out of Stanley 1976

General Cargo (shipping tons)	Total	To Darwin/ Goose Green	Other road 1/ possibilities
	2,836.6	503.9 (17.8%)	348.4 12.3%

Source: Coastal Shipping

1/ ie North Arm, Bluff Cove, Fitzroy, San Carlos, Port San Carlos

Table 13 M V Monsunen: Cargo into Stanley 1976

Wools, Skins and Hides (lbs)	Total	From Darwin/Goose Green et al 1/
	4,835,585	1,754,070 (36.3%)

Source: Coastal Shipping

1/. ie as per note 1/ above.

Table 14 MV Monsunen Wool, Hides and Skins into Stanley 1976

From	lbs	As % of Total wool etc.
Darwin/Goose Green	479,246	9.9%
North Arm	700,035	14.5%
Fitzroy	209,454	4.3%
Bluff Cove	11,831	0.2%
San Carlos	160,993	3.3%
Port San Carlos	192,511	4.0%
TOTAL	1,754,070	36.3%

Source: Coastal Shipping

COASTAL SHIPPING LTD
OPERATING ACCOUNT - MV MONSUNEN

TABLE 11

DEBITS

	1973	1974	1975	1976	Estimated 1977	Budget 1978
Charter-Monsunen	8,430	8,400	8,400	9,030	9,240	9,240
- Sea Truck	848	900	900	900	900	900
Insurance - Ship	2,814	3,353	3,318	3,333	3,500	3,750
- SMUA	165	278	471	678	700	700
Stores Consumed -Ship	3,903	3,701	5,059	4,036	11,000	7,200
- Catering	796	805	1,231	1,320	2,000	2,000
Fuel	2,335	5,002	6,782	6,259	8,500	9,000
Crew's Wages	7,830	9,949	12,757	16,873	23,000	23,750
Old Age Pension Subs	96	141	214	230	300	393
Provident Fund	232	290	322	508	670	650
Passage & Travel Expenses	1,320	-	15	1,121	1,800	1,500
Repairs - Dry Dock	3,960	5,272	5,713	11,377	12,000	15,000
- Local	609	1,735	703	730	850	950
Laundry	121	90	53	142	150	150
Water	19	23	35	161	200	200
Master's Entertaining	52	68	63	-	150	150
Stanley Office Management	1,800	1,800	1,800	1,800	1,800	1,800
Stevedores Stanley	4,567	5,676	8,820	6,861	7,000	8,500
Crane & Tractor Hire	1,726	2,409	3,331	2,703	3,000	3,750
Electricity	54	52	61	60	50	50
Government Fees	120	92	116	163	160	160
Printing & Stationery	30	67	29	62	60	75
Postages, Cables, Etc.	108	124	145	127	140	200
Educational Insurance	60	20	40	40	-	-
Rent, Rates & Maintenance	343	516	743	365	500	500
Overseas Port Charges	3,124	1,250	2,731	2,659	2,600	3,000
Consular Fees	41	22	64	-	-	-
Audit, Directors & Secretary	70	195	220	220	220	220
Interest on Overdraft	174	19	9	142	150	350
Passage Reserve	500	500	500	-	-	-
Formation Expenses	57	-	-	-	-	-
Sundries	57	35	24	64	400	250
Launch Hire			12	-	-	-
Propn. Pension P F Thain				60	70	70
TOTAL	46,411	52,784	64,681	72,024	91,110	94,458
PROFIT	-	535	121	532		
£	46,411	53,319	64,002	72,556	91,110	94,458

CREDITS

	1973	1974	1975	1976	Estimated 1977	Budget 1978
Freight - Coastal	37,533	47,447	51,214	53,557	63,500	80,000
- Overseas	7,766	4,781	10,988	8,261	9,900	12,200
Bar Profit	14	30	33	72	50	50
Work Done for Other Vessels						
- M V Monsunen	730	1,025	400	420	450	-
- Sea Truck	-	16	-	25	144	150
Coastal Passages	-	20	-			-
Charter PA	-	-	2,167			-
Levy on Freights				9,100		
Passage Reserve T/F				1,121	379	-
TOTAL	46,043	53,319	64,802	72,556	74,423	92,400
LOSS	368	-	-	-	16,687	2,058
£	46,411	53,319	64,802	72,556	91,110	94,458

III The Major Limitations

3.1 Without doubt the greatest problem in considering how to improve communications, and plan a cost-effective network, is the small and scattered population. The distances to be covered are relatively large, and the demand for travel between any two points small. The studies of FIGAS and Monsunen traffic and the vehicle ownership data all point to travel of passengers and goods into and out of Stanley as being of the first importance. The major social need is for improved access to Stanley, with a good deal of the passenger demand falling in the winter months, when those living in camp are less busy. Unfortunately this is also the time when conditions for road and air travel are at their worst.

3.2 One specific problem that needs to be mentioned is that if travel between points on E Falkland and Stanley is improved (eg by a Stanley-Darwin road)then there could be additional social pressures for depopulation of the West Falkland settlements. This is one argument in favour of a ferry service from East-West (see V (c) below)

3.3 At present a very high proportion of travel into Stanley is by FIGAS. For nearly a year during 1976 and 1977 the FIGAS service was interrupted by shortage of aircraft and/or pilots. There is no doubt but that this caused severe personal problems for the islanders, and badly damaged morale. At present there are again two Beavers operating, and three pilots, but there are still criticisms of the service provided. Given the limited capacity available any special demands on FIGAS will lead to demand exceeding supply. /The effect of the highly subsidised nature of the service in stimulating demand should not be neglected/. Since FIGAS returned to full strength such special demands have included the election, council meetings, and the hydatic survey. Over the next few months, without a surfeit of special demands, capacity should become less of a constraint.

3.4 There are considerable developmental and social benefits to be gained from improved passenger communications in the islands. We also believe that improved radio communications - as at present under consideration by the FIG and Sheep Owners Association - would lead to social benefits, and reduce the demands for improved passenger communications. There would also be developmental and social gains from improved freight communications. Improvement for existing traffic could lead to lower costs, and quicker deliveries. We would also hope that improved communications would lead to stimulation of domestic production of some goods at present imported into the Colony. An obvious immediate example is fruit and vegetables. At present inadequate quantities of vegetables are produced locally in Stanley - due to such reasons as unsuitable ground and the many other calls on people's time. Most settlements are largely self-sufficient, but cannot 'export' any surplus regularly and quickly to Stanley. The only significant commercial unit is at West Point Island. This operator did carry out a FIG - financed feasibility study of establishing a market garden near Stanley, but we understand that this venture will now not go ahead. Data on imports of fruit and vegetables is limited but some information is given at Table 15.

Table 15. Imports of Fruit and Vegetables /£'s/

	UK	Argentina	NZ	S Africa	Totals
1971	26,522	748	208	505	27,983
1972	34,548	6,184	-	-	40,732
1973	18,002	13,114	-	-	31,116
1974	22,115	8,536	-	-	30,651

Source: FIG

If fruit and vegetable imports were the same % of SITC Group imports in 1975 as the average % for 1971-74, then imports in 1975 reached around £74,000 - a remarkable increase. Without better import data precise calculations of the potential import savings are not possible, but it could be of the order of 6-7% of total imports.

3.5 The other immediate possibility of import savings is in dairy products. Imports for 1971-74 are set out in Table 16.

Table 16. Imports of Dairy Products [£'s]

	UK	Argentina	Denmark	NZ	Total
1971	10,863	46	-	6,504	17,413
1972	11,586	4,101	742	-	16,429
1973	15,703	6,237	-	-	21,940
1974	19,687	5,910	-	-	25,597

Source: FIG

Using a similar calculation as for fruit and vegetables, imports of dairy products in 1975 would have been close to £40,000. The scope for import substitution is again apparent, and the FIC believe that the existing dairy herd at Darwin could easily be expanded to supply the Stanley market - given improved communications. Other settlements would also be able to produce a surplus of dairy products.

3.6 Poor communications also have had a major effect on settlement location, and the type of sheep farming practice. The potential for improvement is discussed in the paper by Mr C D Kerr (5), in the context of a Stanley-Darwin road, and further considered in Appendix H. Increased agricultural output, and the prospects of more, smaller, farms are perhaps the most important developmental effects that could be expected to follow improved communications. The question of the relative cost-effectiveness of alternative transport modes is discussed later in the report, but it may be mentioned here that road transport would be more flexible than sea or air transport, and would have less severe recurrent cost implications - albeit higher capital costs. The objective of this section has been to set out in brief the limitations of the existing system, and to consider what developmental and social gains should be aimed at from an improved system.

IV. The Previous Proposals for Improvement

4.1 Various reports have discussed internal communications in the Falklands, and various proposals for improvement have been made at different times. Development of roads in camp has frequently been discussed, and a significant report was that by O'Reilly of the Road Research Laboratory in 1963 (6). More recently, the 1973/78 Development Plan (7) included a project for a Stanley/Estancia road, to begin "when heavy equipment from the Permanent Airfield is available". This road would "provide access to the capital for farms in the North Camp and open up both the Malo River and the Berkeley Sound/Volunteer Point tourist areas". This project has not been proceeded with - and the heavy equipment was still not available at the time of our visit. The offer by the FIC of Green Patch farm for sub-division has complicated the issue. The route from Stanley to Estancia and Green Patch was examined during our visit and rough cost figures are at Appendix D.

4.2 A road across East Falkland from Stanley to Darwin/Goose Green has become the major internal transport priority of the FIG, and a project application for funding has been passed to ODM. This was supported by a preliminary feasibility report by Mr C D Kerr (8). The need for this road was endorsed by a report by the Sheep Owners Association (9), and also considered in the Shackleton Report (1). In this report it was stressed that the detailed survey required to assess economic and social benefits of a road system could not be carried out in the time at the team's disposal. They made a rough approximation of VOC savings on the existing traffic, compared these with approximate costs, and concluded that "the justification [for a Stanley-Darwin road] must be on social grounds, and the argument we believe, is a powerful one".

4.3 The Shackleton report also considered coastal shipping, and concluded that the MV Monsunen - possibly after a refit - was suitable for existing needs. In the future they believed a smaller, faster - possibly bow-loading - vessel might be required, in addition to Monsunen - "if the economy develops." Such a vessel could also be used as a vehicle ferry. Within the Falkland Islands, and in particular on West Falkland, there is considerable support for the introduction of such a ferry service across the Falkland Sound.

4.4 The final area in which previous proposals for improvement have been made is FIGAS. On the one hand the 1974 CAA report (3) recommended strongly against the introduction of land planes, whilst on the other the Future of FIGAS Committee, in their interim Report (10) are strongly in favour of the addition of a Brittain-Norman Islander to the existing Beavers. The Shackleton Report sat on the fence, and concluded "... the uncertainties about the carrying capacity required in future dictate a policy of extreme flexibility towards the number and type of aircraft selected to replace the two existing Beavers. This should be incorporated into any future feasibility study on the question".

4.5 This brief section has not covered - or intended to cover - all the relevant conclusions of all the relevant reports. However, it has highlighted the (sometimes conflicting) views of several reports, and should demonstrate that for many years improvement in land, sea and air communications have been mooted, and continue to be discussed. The various recommendations are now considered in detail in Section V.

V. THE PROPOSED PATTERN

a. Camp Roads

i. The terrain and materials available

5.1 Almost the whole length of any road network would be crossing gently undulating or almost flat ground, and there will be few problems in obtaining easy gradients and gentle curves. Over much of the terrain, easy road making conditions exist, with a thin layer of topsoil overlying good clay, shales and sandstones but there are extensive areas of peat of varying thicknesses (particularly in the vicinity of Stanley). There are numerous stone runs consisting of boulders of various sizes and these are likely to prove an obstruction for low cost roads and should be avoided as far as possible when fixing the road lines.

5.2 Rock (either crushed or uncrushed) has been the main road making material used in previous road construction in and around Stanley. In general uncrushed rock is unsuitable for a road that will need to be grader maintained and crushed rock is too expensive for a low cost road. There is an abundance of seashore sand near Stanley airport and this stabilised with seashore shingle and decomposed rock/clay from near Moody Brook should prove a suitable road making material. Shales, sandstones and sandy clays are available elsewhere and once road access to these deposits is available there should generally be no problem in finding frequent sources of suitable material. Seashore sand and screened shingle would be suitable as aggregates for most of the concrete required.

ii. Appropriate construction methods

5.3 Over the peat areas the road should be constructed on an embankment on top of the natural ground following a line which as far as possible avoids the thick peat layers. A drain will be required on at least one side of the road and on both sides where there is no substantial crossfall on the ground. The peat from the drain should be side-cast away from the road but in many places suitable material for forming part of the embankment will be found beneath the peat. An excavator with back actor will be the most suitable machine for this work.

5.4 Where ground conditions are good, the road should as far as possible be sited on side-long ground and formed by an angledozer with a ripper.

5.5 Suitable material carried by dumptrucks or tippers and spread by small dozer or grader should be used to complete embankments to level and to metal formations. An excavator is the most suitable and versatile machine for digging and loading and it is likely that at some sites the material will need to be ripped and stockpiled by a large dozer.

5.6 River and stream crossings should use existing bridges where they are adequate. To cut down on cost new crossings should be by "Irish" bridges consisting of a concrete causeway with openings formed by used oil drums. Where the waterway area required is not more than $3m^2$, the use of Armco culverting with a concrete invert is recommended.

5.7 300mm dia unreinforced concrete tubes with a minimum cover of 600 mm should be used for the small culverts and it will probably be more economical to import the pipes from the Argentine than to attempt local manufacture.

5.8 For culverts where the waterway area required is greater than that provided by two 300 mm dia pipes, the use of in situ case concrete culverts using old oil drums as internal shuttering is recommended.

iii. Specification

5.9 To avoid future erosion problems and to keep down maintenance costs gradients should be limited to 7% wherever reasonably possible and to an absolute maximum of 9%. Flat sections of road will quickly become pot-holed and it is worth taking care in setting out the road to keep gradients of less than 2% to a minimum.

5.10 Horizontal curves should not normally be less than 200m radius but could be reduced to 100m to avoid excessive earthworks.

5.11 On flat sections the embankment width should be 5m and excavation for the drain not closer than 2m from the toe of the embankment. Where ground conditions are good, the width between drains on flat ground to be 8m and on sidelong ground not less than 8m from drain to edge of fill. The metalled carriageway width on this formation to be 3.2m with passing places where convenient.

5.12 The pavement thickness will have to be sufficient to carry the construction traffic which will be heavier and more frequent than any traffic likely to use the roads for some years.

5.13 To allow for grader maintenance it is essential that the surface of the road be finished with well graded material containing no stones larger than about 60mm.

iv. Plant Requirements

5.14 Main items required for a minimum construction team are:-

2	¾ to 1 cu yard Excavators
1	Drilling, compressor and tools
8	Dump trucks or tippers
1	Concrete Mixer (mobile)
1	Loader/Digger
1	Large Angledozer with ripper
1	Small Angledozer
1	Grader
1	Vibrating Roller with tug
2	Landrovers
1	Wheeled Tractor
4	Fuel trailers

These items are in general covered by the items requested from JCL, but in view of their poor condition and the likely time lag in obtaining urgently required spares, it is desirable to hold additional items in reserve, particularly for the key machines such as the excavators and dump trucks.

v. Labour requirements

5.15 Excluding mechanical staff the requirement to operate a minimum construction team will be:-

1	Engineer
1	Works Supt or Foreman
20	Operators/Drivers
1	Survey Assistant
14	Labourers

This team is in the main already employed by the PWD, most of them having been previously employed on the construction of the airfield. If due to shortage of labour the full requirement cannot be reached, some extension of the time scale for construction will result.

5.16 The labour force above will also cover the future requirements for roads maintenance but if no further capital works are to be undertaken, eight men only will be required for maintenance and they will be employed part time only provided no more than 700 km of road is to be maintained.

vi. Rate of Progress and Costs

5.17 The team should be capable of constructing in a year 20km of road in difficult conditions (such as in the Stanley area) and up to 80km of road in easy condition (such as in the Darwin area) provided a 60 hour week is worked during the summer months, reducing to a 40 hour week in winter.

5.18 The average annual cost of the team at December 1977 prices including provision for culverting will be of the order of:-

		£
Machine Costs (using rates as Appendix C)		155,000
Wages		106,000
Materials		23,000
	Total	£284,000

giving a cost per km of between £3,600 and £14,200 excluding salaries for an Engineer and a Mechanical Superintendent, and the provision of road camps, and contingencies.

5.19 As the main part of the cost for road construction (and most other Civil Engineering work) is the cost of operating machines, it is essential if proper costings are to be obtained, that renewals, maintenance, fuel and other costs be charged to the work on which the machines are used and not, as under the present system, to a central vote. An outline of a suggested method of costing plant and vehicles is given in Appendix C. Construction costs will, to a very large extent, depend upon machine serviceability, and it is therefore essential to establish an efficient maintenance and repair organisation under a competent Mechanical Superintendent.

vii. Stanley - Darwin Road

5.20 This road would connect the two largest centres of population on the islands and it seems logical to give its construction the first priority. Possible routes were inspected in some detail and the recommended route and details of construction with estimated costs are given in Appendix G, and the full economic appraisal is at Appendix H.

5.21 The total estimated cost (in constant January 1978 prices) is £766,800, including a contingency element of 20%. This cost is made up as follows:-

Table 17.

Machines	£314,900
Wages	£236,000
Materials	£ 50,300
Road Camp, etc	£ 18,000
Engineer and Mech Sup.	£ 20,000
Total	£639,200
+ 20% Contingencies	£766,800

The machine costs are based on the hourly rates, as set out in Appendix C, and include allowances for depreciation, repair and maintenance, and fuel and oil. It is proposed that, in future, budgetted costs should be based on appropriate rates, including an allowance for depreciation. This will involve establishing a Funding Scheme, into which the allowances for depreciation are paid. These funds will then be available for purchase of new and replacement equipment, as required. The rates will need to be revised regularly, to take account of inflation.

5.22 In the economic appraisal these financial costs are converted to economic, or real resource, costs. The adjustments made are to include only a 10% contingency, and to take away direct taxation from wages. These economic costs are then compared with benefits. The economic benefits considered include:-

i. Reduced vehicle operating costs and passenger time savings for the existing traffic: (ie regular traffic)

ii. reduced costs due to transfers of passengers and freight from FIGAS and M V Monsunen, (ie diverted traffic)

iii. increased net agricultural output due to the road: (ie generated traffic)

5.23 Due to the considerable uncertainties involved, maximum and minimum benefits are estimated for each category of benefits; these are shown in Table 18 below.

Table 18 Summary of Annual Benefits from Stanley-Darwin Road

		Maximum	Minimum
i.	Regular Traffic	£22,320	£11,160
ii.	Diverted Traffic	£35,000	£16,000
iii.	Generated Traffic	£35,000	£15,000
	Total	£92,320	£42,160

Source: Appendix H

5.24 Taking a discount rate of 8% the costs and benefits are then compared. Separate calculations are made for maximum, minimum and mean benefits, which yield Net Present Values of £168,260 - £79,007 and - £328,837 respectively. The viability of the investment is thus, in developmental terms, highly sensitive to the level of benefits attained. The two major categories of benefits are diverted traffic and generated traffic. If the level of these benefits is to be maximized, then it is essential that over-capacity for FIGAS be avoided, and that every effort be made to obtain the fullest increase in net agricultural output possible. Another important question for the FIG to consider will be the distribution of benefits due to the increased output, both between public and private sectors, and within the private sector.

5.25 No allowance has yet been made for purely social benefits. If a level of developmental benefits somewhat above the 'mean' level above can be approached, then it is not necessary to call upon social benefits to assist justification. If the level of benefits is only at the 'minimum' level, then social benefits of between £30,000 and £40,000 pa would be required to obtain a positive NPV at 8%, and thus to justify the project.

5.26 The conclusion of our examination is that construction of the road is justified, on economic and social grounds, if the capacity of FIGAS is not expanded, and if efforts are made to expand net agricultural output in the area opened up by the road.

viii. Other roads

5.27 As a result of inspecting other tracks on both East and West Falklands and from information obtained from other sources, an order of cost has been attempted for all the roads shown in Table IV of the Road Research Laboratory Note LN/404 of August 1963 (Appendix D).

ix. Maintenance of Roads

5.28 If the type of road envisaged is properly maintained, there should be a gradual improvement in the running surface and the strength over the years. Inlets and outlets of culverts and drains should be inspected after periods of heavy rain, and cleared out as necessary using the JCB back hoe or by hand. Drain maintenance is particularly necessary on newly constructed sections. Grading and rolling will be necessary at least once and on some sections, twice a year. There should also be a regular programme of surfacing to replace material lost by rain, wind and traffic and this should amount to an annual average of at least 100 tonnes per kilometre. The cost of the above maintenance plus miscellaneous work will be of the order of £180 per kilometre per year on sections carrying less than an average of ten vehicles daily.

b. FIGAS

5.29 Table 10 provides a summary of the origin-distination survey carried out for four months in 1975. It has already been mentioned in paragraph 2.12 that 'over one-third of passengers flew between points either directly on the line of the Stanley-Darwin road, or potentially to be linked to such a road'. In the detailed economic appraisal of the proposed road it has been conservatively assumed that approximately 1,600 - FIGAS passengers pa would be diverted to road travel. In consideration of the future pattern of transport development this is highly relevant for two reasons. First, such diversion of traffic will release significant capacity to FIGAS to service other settlements. Second, if this spare capacity is not taken up, then the savings /and the benefit to the road project/ are signficantly reduced, as only variable costs are saved, and not full costs. The developmental viability of the road is sensitive to this factor, indicating the interdependence of developments in different transport modes.

5.30 We have studied with great interest the papers of the Future of FIGAS Committee, culminating in their Interim Report (10). One of us was present at two meetings of that Committee. We have also studied the CAA report of 1974 (3), which considers the case for land planes, and concludes:-

> "..... priority should be given to consideration of float planes or sea planes which have very definite advantages over land planes for the type of operation in which little change is envisaged in the foreseeable future. Among the reasons for this are:-

a. the siting of landing strips at many settlements would be a difficult task primarily because the generally strong and variable winds experienced in the area would necessitate provision of strips orientated in more than one direction;

b. light land-based aircraft are relatively sensitive to cross-wind both on landing and during ground manoeuvres. The number of occasions when flights would be impossible or unacceptably hazardous could be considerable;

c. due to soil conditions in the Islands where a preponderance of peat and clay is common, adequate drainage of the landing areas would be difficult, and surface water is likely to inhibit land plane operations during wet weather conditions;

d. the cost of preparation and maintenance of suitable landing areas could be expensive, and may well be beyond the means of owners of the settlements. Fencing would probably be required to avoid incursions by sheep or other animals;

e. water based aircraft involve none of these problems, and have an added advantage that emergency alighting areas are generally available in the event of engine failure or other contingencies necessitating a forced landing".

5.31 The Future of FIGAS Committee did not consider these arguments to be overwhelming. They believed that adequate strips could and would be prepared in all but a handful of settlements, and recommended that an Islander would not only provide greater capacity for FIGAS, but would also be safer, and able to operate in a greater range of weather conditions than the Beavers. They believed that the capability existed within the Falklands to judge the suitability of location for landing strips, and the safety of the strips themselves. Their recommendation was that the Islander should be based at the new airport, and the Beaver service be shifted to near that airport. A new hangar would be required, to house the Islander, and for repair and maintenance of all three aircraft. Access from the re-sited Beaver hangar to the new hangar would be needed.

5.32 The financial implications of the proposed mixed sea-plane/land-plane service were not discussed in the Interim Report, but we prepared a working paper (No 6) on this topic, circulated this to the FIG and the Committee, and discussed the assumptions and figures in this paper with the Committee. Revised cost figures were passed to FIG before we left Stanley, and these are summarized below. It should be stressed that some of the cost figures are highly tentative.

5.33 To calculate the additional costs of a joint service it is necessary first to calculate the costs of the existing service. The costs of FIGAS as set out in the Estimates do not include any allowance for depreciations, and for an adequate comparison some such allowance is required. Table 19 summarizes the projected 1978/9 costs of the existing, two Beavers, service:-

Table 19 1978/9 Costs of Existing Service

Fixed Costs	£39,454
Variable Costs	£47,850
Share of Misc Appropriations Vote	£ 1,623
Depreciation of Beavers and Hangar	£19,258
Total	£108,185

Source: Working Paper No 6 Table VIII as revised.

Working Paper No 6 provides the details lying behind these figures.

5.34 In calculating the costs of the proposed joint Islander/Beaver service it is first necessary to estimate the pa equivalent of the capital costs of introducing the service; ie the costs of the aircraft, the new hangar, and relocation of the Beaver hangar and building of an access road between the hangars. This estimate is set out in Table 20. It will be noted that maximum and minimum figures are given for the new hangar, and the costs involved in relocating the old hangar. Firm plans were not available for either item, and the FIG would need to firm up costings on the basis of agreed plans. The minimum figures are almost certainly too low, and were originally included in Working Paper No 6 as a basis for discussion. Using these figures along with estimates of the fixed costs for the new service (again maximum and minimum figures are given), revised variable costs and depreciation for the Beavers, and estimates of variable costs for the Islander and maintenance costs of the road joining the hangars, an estimate is obtained of the total annual costs of the proposed new service. This is shown in Table 21. It must immediately be pointed out that no allowance has been made for the cost of building and maintaining runways at the settlements. Even though this cost would not fall to FIG, it is a real cost to the economy of the Falklands, and should thus be included. However, no sensible estimate could be reached during our visit, and all that including this cost would show is that the additional costs were even higher.

5.35 Comparison of Tables 19 and 21 shows that the additional costs of the new service would range between c. £33,500 and c. £52,000 pa in 1978/9 prices. The increase in operating costs alone is lower [c. £8,750 to c. £19,250 p a], but any comparison which excludes consideration of capital costs is unreal, and could be considered meaningless.

5.36 The assumptions involved in preparing these calculations are considerable, and we would not claim to have gone further than providing a framework for cost comparisons, and an indication of the order of magnitude of the costs involved. To consider whether the Islander purchase is justified, it is necessary to consider what benefits would flow from the improved service. Without a road, it is probable that additional capacity available to FIGAS would, to some extent, be utilized, particularly so long as fares remain well below average, and long-term marginal costs. If some additional passengers and freight could be carried without additional flying hours (ie by increased load factor) then revenue would rise without increased costs. If additional flying hours were required for part of the additional traffic, then the load factor for such traffic would determine whether incremental revenue was greater or less than incremental variable costs. [It is projected by the FIG in the Estimates that

Table 20 Per Annum Equivalents of Islander Service Capital Costs

Item	Capital Cost Max	Capital Cost Min	P.A. Equivalent Max	P.A. Equivalent Min
A. New Aircraft, etc	£170,000	£170,000	£25,330[1.]	£25,330[1.]
B. New Hangar, etc	£100,000	£30,000	£8,173[2.]	£2,452[2.]
C. Relocate old Hangar, etc	£30,000	£7,500	£2,452[2.]	£613[2.]
Total	£300,000	£207,500	£35,955	£28,395

1. Annuity @ 8% over 10 years.
2. " " " " 50 "

Source:- Working Paper No 6 Table VII as revised.

Table 21 1978/9 Costs of Improved Service

	Max	Min
P.A. equivalent of Islander Capital Costs	£36,000[1.]	£28,000[1.]
Fixed Costs	£55,000	£44,500
Variable Costs of Beavers	£19,140	£19,140
Variable Costs of Islander	£32,400	£32,400
Share of Misc Appropriations Vote	£1,623	£1,623
Depreciation of Beavers and old Hangar	£15,590	£15,590
Maintenance Costs of Road	£500	£500
Total	£160,253	£141,753

1. Rounded from Table 5.

Source:- Working Paper No 6 Table VIII as revised.

revenue in 1977/8 will be only marginally greater than variable costs.7 No data at all is available on the present load factor for FIGAS, and we recommend that such data should be collected regularly in the future. Projecting load factors is simply not possible.

5.37 In the above paragraph we have not clearly distinguished between developmental benefits and revenue. If passengers would be prepared to pay more than the existing fares, then they enjoy a 'consumer surplus' and benefits are greater than revenue, as they effectively include a transfer from FIG to FIGAS passengers. To even begin to estimate the demand surve for FIGAS, and hence the level of consumer surplus and benefits proved impossible.

5.38 Our view is that improvement of road communications, initially via a Stanley-Darwin road, would yield greater developmental benefits than improvement of FIGAS. With a road, the capacity available to FIGAS would be increased, and the level of increased net revenue and benefits from the introduction of an Islander would be limited. On the basis of the passenger and freight service it is not possible, in our view, to justify the capital and recurrent costs involved in the introduction of an Islander service. However, Mr C D Kerr of the GTU had produced a short paper on The Use of Aircraft in Agriculture (11). We discussed the possibility of an Islander being used for agricultural purposes as well as for FIGAS, to see whether this could lead to increased benefits, and an increase in net revenue for FIG.

5.39 The major agricultural uses that the GTU have indicated for an aircraft are:-

a. Sowing
b. Fertilising
c. Trace element distribution

All these involve granular or powdered chemical distribution. Unfortunately, although a version of the Islander has been developed for liquid spraying, there is no capabilility at present for granular or powder distribution. Development of a suitable version was started, but - as with a float version - all work has been indefinitely suspended,whilst the company is in the hands of the Receiver. Thus, there is no prospect of use of an Islander for the agricultural purposes required.

5.40 The costs involved in setting up an Islander service must, therefore, be compared with the benefits from its use for FIGAS alone. Our conclusion is that provided construction of the Stanley-Darwin road proceeds, the costs would substantially outweigh the developmental benefits, and the potential social benefits are not sufficient to provide justification for the substantial capital and recurrent costs involved.

c. <u>East-West Ferry</u>

5.41 In paragraph 4.3 above mention is made of the proposal for the introduction of a vehicle ferry, linking East and West Falkland.The most recent report which mentions this proposal is that by Pepper (14). He concludes that:- "There can be no economic case for providing a new (additional) vessel primarily for ferry service between the two halves of the country". However, he does suggest that the Forrest and/or the Monsunen might be used on an occasional basis to ship land rovers across the Sound - perhaps for four periods of a week or so per annum.

5.42 In considering a specific ferry service two immediate questions are (i) what type of vessel would be required and (ii) what route might a ferry take. The Master of the Forrest informed us that for about 20 days each year there are waves of up to 20 ft, and that sea conditions change rapidly. He does not see major problems in operating a flat-bottomed bow - loading vessel, provided it is of adequate size. In his view the optimum route would be from Port Howard in the West to Egg Harbour in the East. Brenton Lock, which would be nearer the Darwin end of the proposed road, is not considered suitable.

5.43 Various types of bow-loading vessels are available in the UK, including those made by Rotork and Cheverton. A Rotork 512, which could handle land-rovers, but probably not the seas, would cost around £40,000-£45,000 delivered. The delivered price of vessels suitable for the sea conditions might be between £150,000 and £250,000. It is clear that the existing demand for a ferry service is far too low to justify expenditure of this order of magnitude.

5.44 If a Stanley-Darwin road is built, then the demand for a ferry service should increase. Also, if road construction work on West Falkland is envisaged, then some means of transporting equipment across the Sound will be required, and regular transport of the maintenance equipment would also be needed. The justification for such road construction will depend in part on the potential for increase in agricultural output - to be judged in part by the effects of the Stanley-Darwin road - and on the general pattern of development in the Falklands. The latter factor will also affect the demand for a ferry service. It is thus recommended that the possibility of purchasing a bow-loading vessel, suitable for a ferry service and for transporting road building and maintenance equipment, be further investigated, at the earliest, towards the end of the construction period of the road. [It is suggested in section V(d) below that this be linked with an overall review of inter-island shipping].

5.45 As an interim measure the proposal of Pepper for using Monsunen and/or Forrest could be further investigated. If the costs of positioning one of these boats had to be included in the costs of providing the service, then it appears that the costs would not be covered. If positioning costs were excluded (ie if one of the boats could provide a ferry service for a short period during a voyage which involved passing through the Sound and when time could be spared to break off to operate as a ferry) then the proposition might just be viable. However, even in the latter case the charge that would need to be made for land-rover passage, in order to cover costs, would probably be too high, compared to FIGAS fares, for the service to be a success.

d. Inter-Island Shipping

5.46 The existing service is considered in Section 2(d), and the possible effects of a Stanley-Darwin road in Appendix H paragraph 16. At present the Monsunen is running into financial problems, and if and when the road is built the time may have been reached to re-organise the inter-island shipping service. It may well be that the Monsunen is not the most cost-effective type of vessel available for the type of service required now, or when a road is built. One possibility would be for some type of bow-loading vessel to be introduced, which could also serve as a vehicle ferry (see section V (c) above) and for the transport of road-building and maintenance equipment across the sound. Demand for a vehicle ferry will increase when the road is built, and this coincidence of timing between the effect on Monsunen and the demand for a ferry should be fully taken into account.

5.47 We do not believe that there is any justification for bringing the Forrest back into service, although we agree that for some specific purposes which the Monsunen cannot cater for (eg oil to Darwin school) it is appropriate for the Government to lease her back from the marine detachment.

5.48 An added factor to be taken into account is the proposal by Mr Julian Fitter to operate a tourist boat service around the Islands. As he was in Stanley during the course of our visit, we were able to discuss with Mr Fitter. Apparently he would operate his boat for tourists during the summer months, and to improve commercial viability would hope that the boat could be used by the FIG during the winter months, for the transport of Islanders between settlements. In consideration of this possibility the FIG should consider - at varying fares - the likely demand for such a service, whether that demand would consist of generated traffic or traffic diverted from FIGAS, and the effects of any such diversions on FIGAS. The likely revenue from fares should then be set against the charges for leasing the boat proposed by Mr Fitten, to see whether such leasing is justified, taking into account the wider benefits to the economy as a whole of the overall tourist enterprise. If deemed appropriate the ODM economist who will visit the Falklands in March 1978 to draft a new Development Plan and carry out a Manpower Review could assist with the FIG's consideration of the Fitter proposals.

5.49 We do not wish at this time to reach firm conclusions as to the future form of inter-island shipping. If the proposed road does go ahead, then we would recommend that a carefuly study should be carried out, during the construction period. The study could be carried out by a naval architect/marine engineer and transport economist. They would receive valuable guidance from such experienced men as the Masters of the Monsunen and the Forrest. We are well aware of the complications, such as the fact that the Monsunen is operated by Coastal Shipping and not by FIG. However, if the FIG believes that such a study would be useful, and that its recommendations, if accepted, would be likely to be implemented, then we would recommend an approach to ODM for finance for the study out of TC funds. It is very much to be hoped that any revised inter-island shipping service would be operated without a Government subsidy: there is no such subsidy at present to Coastal Shipping.

5.50 A further issue raised with us was the possibility of developing a local dry-docking type facility for the Forrest, and possibly the Monsunen. This has been discussed with Mr Pike, who will be in the Falklands for 3-4 months from early February, acting as Director of Public Works. He should be able to cost up the proposed slipway, and consider whether the capital cost would be justified in the light of potential savings. Such savings and the capital cost will depend upon whether the facility is to be used by both the Forrest and the Monsunen, or by just the Forrest.

VI. The Budgetary Implications

6.1 In various parts of this report, and in appendices, mention has been made of the financial and economic costs of the different proposals considered. The financial costs have usually been gross of taxation, and in constant prices. The economic costs have taken account of adjustments to reflect any divergence between financial and real resource costs. The purpose of this section is to consider the capital and recurrent costs to the budget of the different proposals considered. An attempt is made to project such costs in current price terms (ie taking account of future inflation). Where capital items are concerned, an estimate is made not only of capital costs and 'normal' recurrent costs, but also of the pa depreciation allowance required to provide funds for future replacement purchases.

6.2 This section needs to be set against the background of the budgetary position in the Falklands. It is not intended to discuss this at length, but the following brief points should be made. The Falkland Islands are not dependent on budgetary aid per se, and have continued to more than balance their recurrent budget. However, budgetary costs are rising sharply, particularly with the opening of the new airport. Also budgetary revenue is heavily dependent on direct personal and company taxation, and thus sensitive to fluctuations in the price of wool. No allowance is made for depreciation of capital equipment, and replacement equipment as well as new investment have to be met from the Development budget. Although some Colony funds are available for the Development budget, the bulk of past, present and projected expenditures come from UK aid funds.

6.3 We have not attempted to produce projections of the budgetary position - this was not part of our brief - but we were required to take account of "the availability of funds and the alternative demands which will be made upon them". Our judgement is that whilst the 'ordinary' budget will continue to be stretched, an attempt should be made to make some allowance for depreciation in costing the use of capital equipment, and move towards a situation where the Development budget funds are used for new investment. The true cost of using capital equipment should certainly include an appropriate depreciation allowance, and this is reflected in our costing of the road proposals and the FIGAS alternatives.

6.4 For the Stanley-Darwin road the capital costs are set out in Appendix G, in constant prices. These need to be adjusted to take account of inflation over the construction period. We have no projections of inflation for the Falklands, and thus have used estimates of inflation of UK exports of goods and services for the relevant years - ie 6.7% in UK FY 1978/9, and 8.5% for subsequent years. As mentioned in paragraph 3 of Appendix H, the 'wages' element of costs includes income tax, and in budgetary terms the net cost will exclude such taxation. The projected budgetary capital costs are set out in Table 22, in constant and current price terms. This table also excludes the cost of the engineer and mechanical superintendent. As with a good few of the other road workers, the senior staff will be regular PWD personnel. To the extent that they would have been employed by the FIG whether or not this road were to be built, their net of tax salaries will not be an additional cost to the budget. Thus, in order to move from the figures in Table 22 to an estimate of the actual, net, additional budgetary cost, some reduction is required to take account of the wages element that would

Table 22

Budgetary Capital Cost of Stanley-Darwin Road

	1978	1979	1980	Total
Machines	56,920	158,200	99,780	314,900
Wages	31,440	92,180	65,180	188,800
Materials	4,330	20,550	25,420	50,300
Road Camp, etc	-	18,000	-	18,000
i. Constant Price Total	92,690	288,930	190,380	572,000
ii. + 20% Contingency	111,228	346,716	228,456	686,400
Inflator *	3.33%	11.13%	20.57%	
iii. Current Price Total (Excl contingencies)	95,777	321,088	229,541	646,406
iv. Current Price Total (with contingencies)	114,932	385,305	275,449	775,687

*. As at mid-point of period.

have been incurred, without the road being constructed. There should be some positive effects on the budget in the longer term if the benefits discussed in Appendix H are realized. For example if net agricultural output rises then direct personal and company taxation should also rise. It is not possible to quantify these positive budgetary effects at this time.

6.5 The maintenance costs of the road are estimated (in constant prices) at £17,000 pa from 1981, and around £8,750 in 1980. [This latter is a very rough estimate]. These again have to be reduced to take account of income tax payments on the wages element, and then inflated. This process gives current price estimates of £9,646 in 1980, and £20,275 in 1981.

6.6 It should further be mentioned that plant will be available at the end of the construction period. If this is to be used for further construction - eg feeder roads to link in to the Stanley-Darwin road, or a road on West Falkland - there will be further budgetary costs, for machines, wages and materials. Capital for replacement plant purchase should be available from the payments into the funding scheme, if our proposals are accepted.

6.7 We do not wish at this stage to make firm recommendations about how such costs should - in the longer term - be financed. As mentioned in paragraph 6.4 above revenue should increase if the effect of road construction is to increase net agricultural output. The FIG could consider raising additional funds to finance road construction in several ways. They could impose a betterment levy on the owners of land through which roads would pass. They could arrange for the PWD to build roads on payment by land-owners - with the rates charged taking account of wider benefits to the economy as a whole. There are other possibilities. At the same time the FIG might consider fiscal incentives to encourage new investment - perhaps including smaller units - to maximize the increase in net agricultural output. In all there are a wide range of issues to be considered by FIG.

6.8 On FIGAS we recommend (paragraphs 5.37 and 5.39) that capacity should not be increased if the Stanley-Darwin road is to be built. If this is accepted, then there is no additional capital cost for this sector, but it is still of interest to examine the recurrent costs. These are set out in Table 19 above, and our estimate of total costs in 1978/9 (Falklands FY) is c. £108,000, including an allowance for depreciation on the Beavers and the existing FIGAS hanger. Revenue in 1977/78 is estimated by FIG at £52,000. If this level of revenue continued into 1978/9, the net cost to the budget of FIGAS would be £56,000. If revenue rose in line with projected inflation [say 7.5% over that FY] then the net cost would be around £52,000. We believe that this level of subsidy - around 50% - is too high, and that steps should be taken to reduce the subsidy element to around 25%. It would also be beneficial if some method was arranged of provision of funds for aircraft replacement - perhaps by a transfer from the ordinary budget of an amount corresponding to depreciation. Without such provision a special call on the Development budget will be required for aircraft replacement.

6.9 At present the MV Monsunen is operated by Coastal Shipping and no FIG contribution is involved. We see no reason why any such contribution should be made in the future. The MV Forrest is on charter to the Ministry of Defence, and the effect is a recurrent surplus to FIG. We have not attempted to calculate whether this surplus is adequate to account for depreciation, but have noted that no depreciation allowance is accounted for in the Estimates.

6.10 Our recommendation is that no ferry service should be introduced at this time, but that a review of coastal shipping needs (including the possibility of a ferry) might be carried out at a later date. We have suggested that this should be - at the earliest - towards the end of the construction period of the Stanley-Darwin road. In our view one objective of such a review should be to retain the lack of FIG subsidy to shipping, including any ferry service.

6.11 We have also mentioned the tourist boat operation which is under consideration with Mr Fitter. As mentioned in paragraph 5 the budgetary implications of either an FIG winter months charter of the boat, or FIG investment in the operation (or both) will merit careful consideration. We are not in a position to comment further at this stage.

6.12 The main thrusts of this section have been:-

i. that FIG direct subsidies to the various transport modes should be limited; and

ii. that some method should be introduced to make allowance for depreciation for capital equipment.

The rational for limiting the subsidy is primarily economic. Short of budgetary aid the total costs of any service have to be met by either the consumers of that service or by the FIG. The main relevant economic criteria for efficient allocation of resources is that consumers should pay a price approximately to the long-term marginal economic cost (LMC) of the service.

At present for some services (eg FIGAS) they are paying below LMC, and it is difficult to justify the full extent of the difference between price and LMC. We do not wish to develop this argument at the great length (or the academic detail) that would be possible, but do believe that limiting such subsidies will improve the efficiency of resource allocation, without any adverse distributional effects.

APPENDICIES

A. Terms of Reference

B. Documents passed to FIG

C. Plant and Vehicle Costs

D. Rough order of Cost for road system

E. Details of Construction Methods

F. Surveying and setting out

G. Stanley-Darwin Road Recommended Route and Detailed Costings

H. Economic Appraisal of Stanley-Darwin Road.

APPENDIX A

Terms of Reference for Internal Communications Study, Falkland Islands.

1. To assess how well the present internal transport network meets the needs of freight and people for movement round the Falkland Islands in a situation requiring adequate facilities for social, economic and agricultural development.

2. To indicate broadly the capital and recurrent costs of establishing and operating an efficient and cost effective internal transport service, taking into account:

(a) Float planes versus land based planes;
(b) Alternative road standards;
(c) Any coastal vessel alternatives;
(d) The possible use of hovercraft and hydrofoils.

3. To justify the recommended mix of internal transport services on the basis of:

(a) Expected freight and passenger movements;
(b) Minimization of subsidy required from Falkland Islands Government to operate the service;
(c) Manpower availability to operate the service (this point is of especial importance in relation to pilots and road maintenance labour);
(d) The availability of funds and the alternative demands which will be made on them.

Latin America Department
Ministry of Overseas Development
August 1977.

APPENDIX B

Internal Communication Survey

List of Working Papers

1. Proposed new P.W.D. Workshop Complex
2. Vehicle Ownership - Stanley.
3. Darwin School Project.
4. Questionnaire - Origin/Destination and Vehicle Operating Costs.
5. Methodology for Appraisal of Stanley-Darwin Road.
6. The costs of an Islander Service

Other Papers Passed to F.I.G.

Proposed Stanley-Darwin Road
" " " " - Estimated Cost
" " " " - Financial Resources Required
" " " " - Estimated Annual Maintenance Costs.
FIGAS Traffic Survey 1975.
M.V. Monsunen Cargo tables.

APPENDIX C

Plant and Vehicle Costs

Under the present system, the budgeted cost of work carried out by the Public Works Department does not include the cost of the plant and vehicles used on such work. Instead, the cost of buying new machines, spare parts etc, mechanics wages and fuel and oil is covered by a separate vote. As a result the apparent cost of all jobs on which machines are used is less than the true cost. Possibly such a system is acceptable for maintenance and minor works, but if a more realistic cost is required for major construction work, such cost must include machine costs which are more than 50% of total costs for road construction.

The cost of operating machines can be broken down into three main parts:-

a. depreciation
b. maintenance, repairs, overheads and miscellaneous
c. fuel and oils.

a. is a function of the capital cost of the item of plant (or possibly the replacement cost), the useful life and the residual value. This cost would need to be divided between the various jobs on which the machine is used in proportion to that part of its useful life consumed by each job.

b. includes spare parts and tyres, wages of mechanical and workshop staff, garage and workshop overheads and possibly such costs as movement of plant between jobs. Again, these costs need to be divided between the jobs on which the various vehicles and items of plant are used.

c. includes the cost of fuel and oils and associated costs such as transport and storage.

In view of the difficulty of making a direct charge for the above costs to the work on which the machines are used, it is suggested that all the above charges be debited to a central vote as at present but that the vote be changed to a suspense account kept in reasonable balance by credits from the job on which the machines are used. A simple and reasonably accurate method of calculating the amounts to be debited to each job and credited to the mechanical vote, is to allocate an hourly charge for each machine and to multiply this charge by the number of hours used on each job during the accounting period.

/Suggested

Suggested hourly rates for the main machines required are:-

Item	Depreciation £	Repair & Maintenance	Fuel & Oil £	Total £
Excavators JCB 807 22RB & Hydraulic Hammer	3.50	2.50	1.20	7.20
Drill rig, compressor & tools	1.50	1.50	0.50	3.50
6 ton tipper	1.80	1.40	0.80	4.00
Belaz dump trucks	2.00	2.00	1.50	5.50
Landrover	0.30	0.30	0.20	0.80
Concrete mixer	0.80	0.40	0.40	1.60
County tractor	1.00	0.50	0.70	2.20
Vibrating roller	0.70	0.60	0.30	1.60
JCB digger/loader	1.00	0.50	0.70	2.20
D8 Bulldozer	7.00	5.00	2.00	14.00
D6 Angle dozer	3.00	2.50	1.50	7.00
Grader	2.50	1.50	1.00	5.00
8/10 Ton S W Roller	0.50	0.40	0.60	1.50

These are the rates which have been used for all the costs given in this report.

The total hourly rates suggested contain an allowance for depreciation, and these amounts should be held in a separate account to provide funds for the purchase of replacements for machines which have reached the end of their useful life. Any receipts from the sale of surplus machines should also be credited to this account.

It would be preferable to apply this method of costing to all the plant and vehicles maintained by the PWD and the charge should be made for all working hours when a machine is allocated to a particular job and is serviceable. A check should be kept on the chargeable hours by means of a simple log.

APPENDIX D

Rough order of cost[y] for the road system proposed in Table IV of RRL Note LN/404 of August 1963 (6)

Location	Approximate Length Km	Order of cost £
Stanley-Darwin	94	639,000
Darwin-Douglas Station	70	480,000
Douglas Station-Teal Inlet	21	123,000
Teal Inlet-Stanley	45	312,000
Branch roads to:-		
San Carlos	11	90,000
Port San Carlos	21	167,000
Johnsons Harbour via Green Patch and Port Louis (North)	32	156,000
Rincon Grande	15	100,000
Salvador	26	180,000
North Arm	55	234,000
Fox Bay East to Hill Cove	77	312,000
Branch roads to:-		
Fox Bay West	5	22,000
Chartres	5	20,000
Port Stephens	77	312,000
Port Howard	55	245,000
Roy Cove	18	100,000

y All at constant December 1977 prices.

APPENDIX E

Details of Construction Methods

1. Road Formation

a. Over peat or other flat areas in soft conditions use back hoe on tracks to excavate drain on high side of road or both sides where the ground crossfall is less than about 5%. The drain(s) to be about 3m wide at the top and between 0.6m and 1.0m deep and the inside edge of the drain to be at least 5m from the centre-line of the road. All peat and other unsuitable material from the drain(s) to be side-cast as far as possible away from the road. If material suitable for the road embankment is found beneath the peat, the drain to be widened away from the road and deepened to win material for spreading on the road to form the bottom layer of the embankment. Normally the excavator should travel along the line of the drain excavating behind, but this technique may have to be modified in difficult ground conditions.

Progress using a JCB 807 should average 25m of drain per hour.

The stripping off of peat is not recommended even where it is shallow, except possibly for short lengths over a high point on the road line, where a cutting is required to improve the vertical line. Almost all the peat on the Islands is reasonably well drained with a tough vegetation cover and a low embankment on the peat will carry the amount of traffic likely to use the roads in the foreseeable future.

b. On firm ground

Use angledozer, bulldozer with (if necessary) ripper and grader. Where there is little crossfall, cut ditches 4m each side of road centre-line with angledozer or grader and use material from ditches to raise the level of the road formation. Continue work with D8 and, if necessary, rip out material to deepen ditches and in cuttings, any longitudinal earth moving required to be done by D8 Bulldozer.

On sidelong ground ditch only on high side of the road and side-cast to low side. Complete formation by grading and rolling.

The initial forming with D6 Angledozer or grader should progress at an average of 50m per hour.

The completion of the formation with the D8 ripper and bulldozer will probably average 30m an hour overall, but the rate of progress will vary with the quantity of earth to be moved, the distance the earth must be moved and the hardness of the ground.

Grading and rolling should progress at an average of 150m per hour.

2. Bridges and Culverts

a. Irish Bridges - should normally be used when the width of the stream at bed level is more than 5 or 6m. the width of the base to be 4.2m and the thickness 0.2m thickening to 0.6m at the downstream side to prevent underscour. The old oil drums are about 0.55 dia and they should be laid in lengths of about 3.6m and at 1m centres and concrete poured to give a minimum cover of .15m. Reinforcing mesh to be provided in both base and top slabs. The minimum length of the Irish bridge (including concrete approach ramps) to be 20m finished to a vertical curve giving a transition from - 10% gradient to +10%. This will give a difference in level from the centre to the ends of 0.5m. The minimum number of culvert openings will be 6 and the total waterway area available before the water rises above the end of the concrete ramps will be $8m^2$. For the longer Irish bridges each additional metre (plus an additional opening) will give an additional waterway area of $0.74m^2$.

Although a depth of 0.5m will not be safe for small vehicles to cross, it is not unreasonable to design on this basis as maximum flood conditions will be infrequent and short-lived.

In general, catchment areas are reasonably flat and the 20m long Irish bridge should suffice for catchments up to 9 s.miles, 28m long for 20 s. miles, 35m for 30 s.miles, 41m for 40 s.miles, 47m for 50 s.miles, 52m for 60 s.miles, 57m for 70 s.miles, 62 for 80 s.miles and 67m for 90 s.miles.

The 20m long minimum length Irish bridge will contain $32m^3$ of concrete requiring 12,000 kg of cement and each additional metre length will contain an additional $2.7m^3$ of concrete requiring 1,000 kg of cement.

b. <u>Armco culverts.</u> It is recommended that 1.2m dia nestable Armco pipes be used for the smaller streams where the waterway area required is not more than $3m^2$. These culverts should be provided with a concrete invert to prevent wear and corrosion and may be laid in one two or three rows to provide for catchment areas of up to 0.6 s. mile, 1.7 s.mile and 3.0 s.mile respectively. The spaces between the rows of pipes should be not less than 0.8m and filled with well compacted selected fill material.

c. <u>In situ concrete culverts</u>. To consist of a 0.15m thick by 0.85 wide concrete base on which is laid a row of used oil drums and concrete poured to give 0.15 of cover at the sides and over the top. The normal length will be 8m requiring $3.8m^3$ of concrete, (1,000 kg of cement) and may be laid in one or two rows to provide for catchment areas of up to 0.1 s.mile and 0.3 s.mile respectively. The minimum cover over the concrete culverts to be 0.3m.

d. <u>Small culverts</u> to be 0.3m dia unreinforced concrete tubes laid if necessary on a bed of selected imported material and with at least 0.6m of cover.

3. <u>Completion of embankments and metalling</u>

Suitable material (or a mixture of materials) to be loaded by excavator and carried by dump trucks or tippers and spread on road by small dozer or by grader. Suitable shales for metalling are available over large areas of the Islands but it may be necessary to rip and stockpile material with the D8 where digging conditions are difficult. Various mixtures of sand and fine shingle are also available on some beaches to which access is possible and these materials with a proportion of clay binder will make suitable surfacing material. Suitable materials are scarce in the Stanley area and it will be necessary to use seashore sand and shingle plus decomposed rock and clay binder and fairly long hauls will be involved. It will probably be economical to complete a rudimentary road out of Stanley, as far as areas where suitable material is more easily available and complete the road back towards Stanley. It will be of assistance to keep a detailed record of the source of materials used on different sections of the roads to assist in choosing the most suitable materials for finishing and for maintenance. It is essential that the final surface be free of large rocks or stones to facilitate grader maintenance.

Provided sufficient transport is available to match the hauls involved, the rate of progress on metalling should average 100 tonnes per hour.

The road should be finished with a final grading and rolling at an average of 12 passes giving a rate of progress of 150m per hour.

The use of crushed stone for the final surface of the road is not recommended because of the high cost of quarrying and crushing.

APPENDIX F

<u>Surveying and setting out</u>

As there are almost no obstructions to visibility, there should be no difficulty in walking along the line of the road and marking the ideal position of the centre-line with poles or ranging rods bearing in mind the desirability of avoiding deep peat and stone runs and checking on gradient limits with an Abney level. Streams should be crossed as nearly as possible at right angles and areas of soft, uneven ground avoided.

The approximate centre-line should be pegged at 20m intervals with the chainage marked on the pegs and with additional pegs between at changes of gradient, streams etc. This pegged line should then be surveyed using a prismatic compass and the gradient of the ground between pegs and crossfalls each side of the line measured with an Abney level. This will enable the pegged line to be plotted (suggested scale $\frac{1}{500}$) and a longitudinal section drawn (suggested scale $\frac{1}{1000}$ horizontally $\frac{1}{100}$ vertically).

The final road centre-line can then be designed in the office within the geometric limitations specified and with a minimum of earth moving. For ease of setting out, it is recommended that all tangent points be at an even chainage. A table giving tangent lengths and radii of circular curves for a series of deflection angles and lengths of curves, will save time on this work.

The tangents can be easily set out in the field using a compass and tape and checking on distances from the survey pegs as scaled off the plan. The curves can be fitted in using offsets from the tangents.

For convenience during construction, centre-line pegs should be offset to a fixed convenient distance outside the construction width. Where formation is to be by angledozer 7m is normally outside the construction width, but on flat sections across peat or soft ground 10m offset pegs will be required. These offsets pegs should be on the high side of the road where there is a substantial crossfall, but on both sides where there is little crossfall and drains are to be provided on both sides of the road.

Where ground conditions are geometrically easy and straightforward it should be possible to omit the survey and plan preparation, and to set out the road centre-line from tangents set out in the field.

A final levelling should be done along the offset pegs and the ground crossfall measured below each peg over the total road construction width, to enable a final longitudinal section to be plotted along the offset pegs in one colour, the road centre-line in a second colour and along a line 3m from the centre-line on the lowside of the road in a third colour. These three levels will enable the road formation level to be fixed, to give as even a gradient as possible with a minimum of earthmoving. This level can be related to the level of the offset peg and the difference marked on the peg as a guide for the operator and supervisor. This final levelling and plotting can be omitted where ground conditions are longitudinally uniform and there is little cross-fall on the ground.

The survey and setting out work is very simple and it is recommended that a suitable assistant be trained to carry the work in the field and the plotting in the office.

Proposed Stanley-Darwin Road

Recommended route

	Approximate Length km	Order of cost
1. Following existing stone road. Cheaper than new road construction. To be improved by excavating each side to drains, culverting & filling over stones with sand/clay/shingle from Stanley beach.	8.5	43,700
2. Generally following line of Government track from end of stone road to Bluff Cove. Firmer ground and smaller drainage structures than more southerly routes. Build on top of existing ground excavating large drain on higher (or where ground crossfall is less than 5% both) sides of road using suitable excavated material to form embankment. Concrete pipe culverts. 2 x 1.2m dia Armcos at km 8.6, 8.7 and 23.0 3 x 1.2m dia Armcos at km 25.0. Metal and surfacing partly from Stanley beaches, partly from borrow pits alongside road and partly shales from Bluff Cove Area.	16.5	219,500
3. From Bluff Cove west generally following the Government track for about 3km, then continuing in a westerly direction to the north of Fitzroy inlet for another 6km, then turning south round the head of the inlet and generally in a southerly direction for another 8km joining the existing clay track about 2km to the east of The Frying Pan.	17.0	141,600

The loop from the existing track round Fitzroy inlet is 14km or about 1 km longer than the section of track bye-passed. In general, ground conditions are similar on the two routes and the additional roadcost will be of the order of £9,000. Fitzroy bridge is inadequate for a permanent road and will eventually require reconstruction at a cost of at least £100,000 if done in permanent materials. Fitzroy settlement can connect to the new road by the use of 6km of existing track via Fitzroy bridge to km 28 from Stanley or alternatively for larger vehicles by 6km of track via Fitzroy ridge to km 37 from Stanley. About 8km of this section is similar to Section 2 and construction methods will be the same suitable road making materials are much more plentiful. Over another 6km construction methods will be the same but firmer ground and frequent sources of road making materials will reduce costs. The balance of 3km is over ground with some crossfall or gradient and with good solid ground conditions where the road will be formed by angledozer and very little metalling will be required. One 67m long Irish bridge is required at Fitzroy river (Km 35.2) plus three 20m long Irish bridges at Km 29.1, 32.3 and 34.0. Also required are 1.2 dia Armcos, 3 at Km 25.4 and 3 at Km 30.2.

4. From 2km east of the Frying Pan to Darwin the road should follow fairly closely the line of the existing clay track which appears to be the best available line. Almost the whole length is over very easy ground for road construction and after forming with angledozer and grader, a minimum of metalling is required. Recommended formation width is 8m from drain to drain where there is little or no crossfall and 8m from drain to fill edge of formation where there is an appreciable crossfall. Suitable shales and sandstones for metalling are available at frequent intervals. There will be a number of short lengths across flat, wet areas where formation and embankment will require forming as Section 2. Frying Pan bridge to be used for road. Swan Inlet bridge is not in good condition and a 51m Irish bridge will be made for heavy traffic. Other Irish bridges are required at Km48 (20m), Km62, L'Antioja (32m) Km 72 Canada Runde (20m) and Km90 (20m) 1.2m dia Armcos are required at Km 46 (2 rows) Km 55 (1 row) Km 57 (2 rows), Km57.5 (2 rows), Km 64.5 (2rows), Km81 (3 rows), and Km86 (2 rows). — 52.0 — 196,400

Total	94Km	601,200
Plus roadcamp		18,000
Engineer and Mech Supt		20,000
Total		639,200

Estimated Costs

Section (1) Existing stone road 8.5km

Formation

		Machines £	Wages £	Materials £	Total £
Excavating to new drains Total of 15,000m at 30m per hour					
JCB 807	500 hours	3,600	1,100	-	4,700
Hydraulic Hammer (for stone runs)	100 hours	720	220	-	940
Drilling & compressor & explosives (for stone runs)	100 hours	350	440	200	990
D8 (for stone runs)	50 hours	700	110	-	810
Foreman supervision (and Landrover)		260	660	-	920
Additional Labour			1,100		1,100
Total Formation		5,630	3,630	200	9,460

Culverts

a. 4 x 8m 0.55m dia in situ concrete culverts

		Machines £	Wages £	Materials £	Total £
JCB807	20 hours	140	40	-	180
Mixer plus 4 labourers	50 hours	80	330	-	410
Tipper	30 hours	120	70	-	190
Cement 4 tonnes		-	-	460	460
Timber & Miscellaneous		-	-	40	40
Foreman supervision (& Land Rover)		20	50	-	70
Additional Labour			300		300
Total for 4 culverts		360	790	500	1,650

b. 28 x 8 or 9m 300mm dia precast concrete pipe culverts

JCB807	30 hours	220	70	-	290
JCB digger/loader (2 men)	200 hours	440	880	-	1320
Tipper	20 hours	80	40	-	120
Concrete pipes 250 @ £4		-	-	1000	1000
Foreman supervision (& Land Rover)		70	170	-	240
Additional Labour		-	500	-	500
Total for 28 culverts		810	1660	1000	3570
Total for culverts		1170	2450	1500	5120

NB, Any blasting required included in Formation.

Filling and Metalling

Seashore sand and shingle plus any suitable material encountered in formation excavation. 21,000 tonnes required to give 200mm cover over existing stone road plus additional at low points. Average round trip haul is 23km. Assume one hour trip per load and 3-6 ton tipper and 3 12T Dump trucks. Spreading by grader

Loader	400 hours	2880	880	-	3760
6 T Tipper	1200 "	4800	2640	-	7440
12 T Dump Trucks	1200 "	6600	2640	-	9240
Grader	400 "	2000	800	-	2880
Tug and Vibrating Roller	200 "	760	440	-	1200
Foreman supervision (& Land Rover)		260	640	-	900
Additional Labour			3700		3700
Total Metalling		17300	11820	-	29,120
Total for 8,5Km Section (£5,140 per Km)		24100	17900	1700	43,700

Section2. End of stone road to Bluff Cove 16.5Km

Formation

Excavating drains Total of 30,000m at 25m per hour

JCB 807	1200 hours	8640	2640	-	11280
Hydraulic Hammer (for stone runs)	200 "	1440	440	-	1880
Drilling, compressor and explosives (for stone runs)	200 "	700	800	400	1980
D8 (for stone runs)	200 "	2800	440	-	3240
Survey assistant		-	1000	-	1000
Foreman supervision (& Land Rover)		480	1320	-	1800
Additional Labour			3000		3000
Total Formation		14060	9720	400	24180

Culverts

a. No 3 2 x 1.2m dia Armcos and No 1 3 x 1.2 dia Armcos

90m 1.2m dia Nestable Armco pipe		-	-	2880	2880
Cement for inverts	2 tonnes	-	-	230	230
JCB 807	120 hours	860	260	-	1120
Mixer	50 hours	80	-	-	80
Tipper	30 hours	120	70	-	190
Additional labour		-	650	-	650
Foreman Supervision (and Land Rover)		110	300	-	410
Total for 4 culverts		1170	1280	3110	5560

b. 5 8m 0.55 dia in situ concrete culverts

JCB 807	30 hours	220	70	-	290
Mixer + 4 labourers	70 hours	110	460	-	570
Tipper	40 hours	160	90	-	250
Cement 5 Tonnes		-	-	570	570
Timber and miscellaneous		-	-	40	40
Additional Labour		-	400	-	400
Foreman supervision (and Landrover)		30	80	-	110
Total for 5 culverts		520	1100	610	22300

c. 50 - 8 or 9m 300mm dia precast concrete pipe culverts

JCB 807	50 hours	360	110	-	470
JCB digger/loader (2men)	350 hours	770	1540	-	2310
Tipper	40 hours	160	90	-	250
Concrete pipes 420 @ £4		-	-	1680	1680
Additional Labour		-	900	-	900
Foreman Supervision (and Land Rover)		100	270	-	370
Total for 50 culverts		1390	2910	1680	5980
Total for culverts		3080	5290	5400	13770

Filling and Metalling

Total requirement of material 108,000 tonnes

Assume 27,000 tonnes from Stanley area (2 hour round trip)
27,000 tonnes from road line (½ hour round trip)
54,000 tonnes from Bluff Cove area (1 hour round trip)
Total time with 3-6 tonne tippers and 3-12 tonne dump trucks is 2250 hours. Spreading by D.6

Loader	2250 hours	16200	4950	-	21150
6 Tonne Tippers	6750 hours	27000	14850	-	41850
12 " Dump Trucks	6750 hours	37130	14850	-	51980
D6	2250 hours	15750	4950	-	20700
D8 (Ripping and Stock-piling)	400 hours	5600	880	-	6480
Grader	860 hours	4300	1900	-	6200
Tug and Vibrating roller	860	3270	1900	-	5170
Additional Labour		-	22300	-	22300
Foreman Supervision (and Land Rover)		1410	4310	-	5720
		110660	70890	-	181550
Total for 16.5 Km section (£13,300 per Km)		127800	85900	5800	219500

Section 3 Bluff Cove to 2Km east of Frying Pan - 17.0Km

Formation

Excavating drains Total of 15,000m at 25m per hour

JCB 807	600 hours	4320	1320	-	5640
D6	140 hours	980	310	-	1290
D8	250 hours	3500	550	-	4050
Grader	50 hours	250	110	-	360
Tug and Vibrating roller	50 hours	190	110	-	300
Survey Assistant		-	1150	-	1150
Additional Labour		-	1900	-	1900
Foreman Supervision (and Land Rover)		260	710	-	970
		9,500	6,160	-	15,660

Bridges and Culverts

a. One 67m long and three 20m long Irish Bridges

Cement	95 tonnes	-	-	10920	10920
JCB 807	500 hours	3600	1100	-	4700
Mixer	1200 hours	1920	-	-	1920
Tipper	1000 hours	4000	2200	-	6200
Additional labour		-	12900	-	12900
Timber, reinforcing mesh etc		-	-	1600	1600
Foreman Supervision (and Land Rover)		1360	3730	-	5090
Total for four Irish Bridges		10880	19930	12520	43330

b. 2 No 3 x 1.2m dia Armco pipes

60m 1.2 dia nestable Armco pipe		-	-	1920	1920
Cement for inverts 1.5 tonnes		-	-	350	350
JCB 807	100 hours	720	220	-	940
Mixer	30 hours	50	-	-	50
Tipper	20 hours	80	40	-	120
Additional labour		-	470	-	470
Foreman Supervision (and Land Rover)		80	220	-	300
Total for two culverts		930	950	2270	4150

c. 8 No - 8m 0.55 dia insitu concrete culverts

JCB 807	50 hours	360	110	-	470
Mixer and 4 labourers	100 hours	160	660	-	820
Tipper	60 hours	240	130	-	370
Cement	8 tonnes	-	-	920	920
Timber and miscellaneous		-	-	90	90
Additional labour		-	500	-	500
Foreman supervision (and landrover)		50	130	-	180
Total		810	1530	1010	3350

d. 48 - 8 or 9m 300mm precast concrete pipe culverts

JCB 807	50 hours	360	110	-	470
JCB Digger/Loader (2 men)	300 hours	660	1320	-	1980
Tipper	40 hours	160	90	-	250

Concrete pipes 400 @ £4	-	-	1600	1600
Additional labour	-	800	-	800
Foreman Supervision (and Land Rover)	100	270	-	370
Total	1280	2590	1600	5470
Total for bridges and culverts	13900	25000	17400	56300

Filling and Metalling

Approximate quantities of material required

2Km by 5m by 800mm	19,000 tonnes
3Km by 5m by 700mm	25,000 tonnes
4Km by 5m by 600mm	28,000 tonnes
2Km by 5m by 500mm	11,000 tonnes
2Km by 5m by 400mm	9,000 tonnes
4Km by 3.2m by 300mm	8,000 tonnes
Total	100,000 tonnes

Length of hauls should all be short as material is plentiful. Team of loader, 2-6T Tipper and 2-12T Dump trucks with D6 or grader spreading should give average output of 100 tonnes per hour

Loader	1000 hours	7200	2200	-	9400
6T Tipper	2000 hours	8000	4400	-	12400
12T Dump Trucks	2000 hours	11000	4400	-	15400
D6	900 hours	6300	1980	-	8280
D8	600 hours	8400	1320	-	9720
Grader	300 hours	1500	660	-	2160
Tug and vibrating roller	300 hours	1140	660	-	1800
Additional labour		-	8000	-	8000
Foreman Supervision (and Land Rover)		660	1820	-	2480
		44200	25440	-	69640
Total for 17.0Km Section (£8,330 per Km)		67600	56600	17400	141600

Section 4 From 2Km E of Frying Pan to Darwin - 52.0Km

Formation

Excavating drains. Total of 12,500m at 25m per hour

JCB 807	500 hours	3600	1100	-	4700
D6	900 hours	6300	1980	-	8280
D8	1500 hours	21000	3300	-	24300
Grader	300 hours	1500	660	-	2160
Tug and vibrating roller	300 hours	1140	660	-	1800
Survey assistant		-	2600	-	2600
Additional labour		-	5700	-	5700
Foreman supervision		860	2300	-	3160
		34400	18300	-	52700

Bridges and Culverts

a. One 57m long, one 32m long, and 3 20m long Irish Bridges

Cement 110 tonnes		-	-	12650	12650
JCB 807	500 hours	3600	1100	-	4700
Mixer	1300 hours	2080	-	-	2080
Tipper	1000 hours	4000	2200	-	6200
Additional labour		-	12500	-	12500
Timber, reinforcement etc		-	-	1250	1250
Foreman supervision (and Land Rover)		920	2700	-	3620
Total for 5 Irish Bridges		10600	18500	13900	43000

b. One 1 x 1.2m dia, five 2 x 1.2m dia and one 3 x 1.2m dia Armco pipes

140m 1.2m dia nestable Armco pipe		-	-	4460	4460
Cement for inverst 3 tonnes		-	-	340	340
JBC 807	150 hours	1080	330	-	1410
Mixer	60 hours	100	-	-	100
Tipper	30 hours	120	70	-	190
Additional labour		-	830	-	830
Foreman Supervision (and Land Rover)		100	270	-	370
Total for 7 culverts		1400	1500	4800	8700

c. 12 No - 8m 0.55 dia insitu concrete culverts

JCB 807	70 hours	500	150	-	650
Mixer and 4 labourers	140 hours	220	920	-	1140
Tipper	80 hours	320	170	-	490
Cement 12 tonnes		-	-	1380	1380
Timber and miscellaneous		-	-	120	120
Additional labour		-	700	-	700
Foreman Supervision (and Land Rover)		60	160	-	220
Total for 12 culverts		1100	2100	1500	4700

d. 150 8 or 9m long 300mm dia precast concrete pipe culverts

JCB 807	100 hours	720	220	-	940
JCB digger/loader (2 men)	1000 hours	200	4400	-	6600
Tipper	100 hours	400	220	-	620
Concrete pipes 1300 @ £4		-	-	5200	5200
Additional labour		-	2500	-	2500
Foreman Supervision (and Land Rover)		280	760	-	1040
Total for 150 culverts		3600	8100	5200	16800
Total for bridges and culverts		16700	30200	25400	72300

Filling and metalling

Approximate quantities of material required:-

1Km by 5m by 800 mm 9000 tonnes
2Km by 5m by 600 mm 14000 tonnes
2Km by 5m by 500 mm 11000 tonnes
2Km by 5m by 400 mm 9000 tonnes
10Km by 3.2m by 300 mm 21,000 tonnes
10Km by 3.2m by 200 mm 14,000 tonnes

12Km by 3.2m by 150 mm 12,000 tonnes
13Km - no metalling required

Total 90,000 tonnes

Total time with team as Section 3 - 900 hours

Loader	900 hours	6480	1980	-	8460
6T Tipper	1800 hours	7200	3960	-	11160
12T Dump truck	1800	9900	3960	-	13860
D6	600 hours	4200	1320	-	5520
D8	500 hours	7000	1100	-	8100
Grader	1000 hours	5000	2200	-	7200
Tug and vibrating roller	1000 hours	3800	2200	-	6000
Additional labour		-	8400	-	8400
Foreman Supervision (and Land Rover)		720	1980	-	2700
		44300	27100	-	71400
Total for 52.0Km Section (£3,780 per Km)		95400	75600	25400	196400
Grand Total for 94 Km		314900	236000	50300	601200

APPENDIX H

ECONOMIC APPRAISAL OF STANLEY-DARWIN ROAD

i. Introduction

As the ODM has been requested to finance the construction of this road out of aid funds, and as this mission was agreed in order that the road proposal could be considered within the overall context of internal communications, considerable attention was focussed on the costs and benefits of the proposed road. The recommended route and method of construction are considered in Section Va and Appendices E-G and the financial costs in January 1978 prices are at Appendix G.

ii. The Economic Costs

2. The capital costs have been estimated including an allowance for plant consumption during the construction period. The capital costs, broken down into machinery, wages and materials are set out in Table 1 below:-

Table 1

	Machines	Wages	Materials	Total
Section 1 (8.5km)	24,100	17,900	1,700	43,700
Section 2 (16.5km)	127,800	85,900	5,800	219,500
Section 3 (17.0km)	67,600	56,600	17,400	141,600
Section 4 (52.0km)	95,400	75,600	25,400	196,400
	314,900	236,000	50,300	601,200
		Plus road camp, etc		18,000
		Engineer and Mech Sup		20,000
		Overall Total		£639,200
(NB. All figures in £'s)		+ 20% Contingency		£766,800

3. For the purpose of the economic appraisal it is necessary to allocate these costs to calendar years, and to make any adjustments required to make allowance for financial costs diverging from economic or real resource costs. The contingency allowance is only an economic cost if it is fully expected that the allowance will be used. Costing of road construction in the Falklands must be subject to uncertainties and thus one half of the contingency allowance (ie 10%) has been included as an economic cost. The only other divergance is due to wages including direct taxation, which is a transfer, and not a real resource cost. Examination of income tax rates in the Falklands, and the level of incomes assumed for the costings demonstrate that wage rates should be reduced by around 20% to reach a net of tax wages cost. The annual cost stream taking account of this 20% reduction of wages is shown in Table 2 below:-

Table 2

	1978	1979	1980
Machines	56,920	158,200	99,780
Wages	31,440	92,180	65,180
Materials	4,330	20,550	25,420
Road Camp etc	-	18,000	-
Engineer & Mech Sup	3,080	9,230	7,690
Overall Total (Incl 10% Contingency)	105,350	327,980	217,880

(NB. All figures in £'s)

4. In addition to capital costs it is necessary to make allowance for maintenance costs. In financial terms, and on the basis of the level of traffic anticipated for the first few years, the maintenance costs are estimated at £17,000 p a from 1981. When the wages element of maintenance costs is reduced by 20% this falls to £15,500 p a. If the traffic grows very fast then higher maintenance will be required. This could pose budgetary problems but not economic ones, as the road will have proved itself justified by the traffic growth.

5. As an indication of the order of magnitude of benefits required to justify the road, the annual annuity equivalent of total costs is around £72,000. Thus allowing for limited benefits during the construction period, annual benefits of around £75,000 are required to justify, in developmental terms, the road's construction. If this level of benefits cannot be substantiated, then it is necessary to consider whether the social benefits would justify the gap between costs and benefits.

iii. <u>The Developmental Benefits</u>

6. The major sources of benefits for non-rural road appraisals are reduced vehicle operating costs (VOC's), and passenger time savings, for existing traffic. In this case the level of existing traffic is extremely low, and although VOC's are very high in 'camp', and journeys very time consuming, the scale of benefits from this source cannot be expected to justify the road's construction. However, an attempt has been made to examine the order of magnitude of these benefits. The other forms of benefits examined include savings from transfers of passenger traffic from FIGAS and of freight traffic from MV Monsunen to a road, and additional agricultural output permitted by road construction. In all cases a maximum and minimum level of benefits has been calculated, as the levels are subject to too great uncertainties for any one firm figure to be put forward.

a. <u>VOC's and Passenger Time Savings</u>

7. The first stage in estimating benefits from reduced VOC's and passenger time savings from existing traffic is to estimate the extent of such traffic. To gain full information a lengthy survey at different points along the line of the track would have been required, but time and logistics (and indeed common sense) did not permit this. To gain some information, on this and other subjects, a marine was stationed at Bluff Cove for a week, with questionnaires to be filled in by all traffic passing through. Also enquiries were made of vehicle owners in Darwin and Stanley, to gain some impression of the extent of existing travel along the line of the proposed road. It is clear that the amount of travel is extremely variable, and that a high percentage travels along only some part or parts of the line of the proposed road. For example during the Falkland's winter people travel more than in summer, despite the adverse weather conditions. The marine's survey showed a good deal (in relative terms) of travel between Bluff Cove/Fitzroy and Stanley, and the studies in Darwin showed that there are a fair number of relatively short trips out of Darwin. Overall our best estimates are between 25,000 miles and 50,000 miles p a along the total line of the proposed road.

8. To quantify benefits from this source it is next necessary to estimate existing and future VOC's, and also the present and prospective average speeds. (For simplicity we assume all existing travel is by landrover, although motor cycles are also used. This assumption should not significantly affect the results). The Shackleton report estimated VOC's over camp for diesel landrovers at 33p per mile <u>excluding</u> the cost of labour in repair and maintenance. We believe that this estimate is, if anything, too low. Very few records of VOC's are available, and perceived VOC's are clearly very much lower than actual VOC's. Expenditure on spares is extremely high, due to the nature of the terrain, and the time spent on

repairs and maintenance is correspondingly high. This coupled with the very low mileages typical of vehicles in the Falklands, leads to our extremely high estimates of VOC's. The details are in Section II /Table 7/ but we estimate existing VOC's over the track involved at between £0.46 and £0.61 per mile - nearer the latter. Estimates for VOC's with a road have been made, using tables produced by TRRL (13). These tables permit such details as rise and fall, curvature, roughness, road width etc to be taken into account. For a petrol land rover our estimate with a road is £0.23 per mile, and for a diesel land rover £0.21 per mile. For a passenger car this could fall to £0.13 per mile. The relative number of diesel rovers has increased in recent years, and with a road some rover owners might well switch to cars. If - for existing traffic - the future pattern of vehicles is taken to be 40% diesel rovers, 40% petrol rovers and 20% cars, the weighted average VOC is £0.20 per mile. This indicates a potential saving in VOC's of around £0.35 per mile, and combined with the mileage figures in paragraph 7 above, the total VOC savings would be £8,750 - £17,500 p a.

9. Just as the savings per trip in VOC's would be high, so there would be a considerable saving in passengers time. Average speeds at present are around 5-8 mph. With a road they should rise to 35-40 mph. The TRRL tables (13) indicate an average speed of 37 mph on the type of road to be built. Taking a figure of £1.00 per hour as a measure of the opportunity cost of passengers time the potential value of passenger time savings are set out in Table 3 below:-

Table 3 Passenger Time Savings

	5-35 mph	5-40 mph	8-35 mph	8-40 mph
25,000 miles	4,286	4,375	2,411	2,500
55,000 miles	8,572	8,750	4,822	5,000

10. The 8 mph - 35 mph increase is taken as a conservative estimate for calculating benefits, and this together with the VOC savings in para 8 yields maximum and minimum potential benefits of £22,320 and £11,160 respectively.

b. Transfers from FIGAS

11. Another source of benefits to take into account is due to passengers, who at present travel by FIGAS, transferring to the road. From the FIGAS origin - destination survey our estimate of the total number of Stanley - Darwin (and vice versa) trips p a is 900. In addition we estimate around 350 trips p a between Stanley and other points directly on the line of the road, and 1,000 other trips p a, between points that might link into the road (eg c.400 North Arm-Stanley or Stanley-North Arm trips p a).

12. In working paper No 6 a range of estimates of FIGAS costs per passenger mile were produced, with a central estimate of around £0.50 per passenger mile. This gives a cost per Stanley-Darwin trip of c.£30 per passenger. If these passengers went by road, at a VOC of £0.20 per mile, in vehicles with an average of 2 passengers (including driver) per vehicle, then the cost would be £6 per passenger. This indicates a saving of £24 per passenger, but there might be some time loss - say 1 hour per trip - reducing the saving to £23.00 per passenger per trip. If 90% of existing traffic moved to the road, the saving would then be £18,630 p a.

13. If 90% of the 350 trips between Stanley and other points on the road line were switched to cars, and if each of these trips averaged 30 miles, and involved no time loss, the saving would be £3,849 p a. Finally if 50% of the other 1,000 trips between Stanley and points that might be linked to the road switched to the road, and assuming the same saving per trip as for Stanley - Darwin, the saving from this source would be £11,500 p a.

14. In total the possible savings are just under £34,000 p a. However, not all of this potential benefit can immediately be attributed to the road. If the capacity released from FIGAS cannot be taken up, then the savings would only be in the variable costs associated with the trips, ie about 43% of total costs. Under these circumstances the total benefits would fall to around £14,620. Under present circumstances it is probable that a high percentage of capacity released would be taken up, but if an Islander was purchased for FIGAS, then capacity would be greatly increased, and it would seem probable that most of the capacity released by the road's construction would not be taken up.

15. In view of these uncertainties, and the fact that the calculations in paras 11-14 above involved several assumptions, we have allocated a maximum of £30,000 and a minimum of £15,000 as benefits due to traffic being diverted from FIGAS to the road.

c. Transfers from Monsunen

16. Tables 4.10 and 4.11 in this report show that around one third of the cargo of the MV Monsunen is carried between points either on the line of the road, or which might be linked to the road. A good deal of the general cargo might be expected to be carried on the road, and possibly some of the wool clip. The cost of road transport should be lower than the existing freight rates, and the real resource cost of sea transport, and some benefit can thus be expected. However, given the fact that the Monsunen is running into financial problems, and only variable costs would be saved - and indeed only a small part of these given that the Monsunen would still have to pass the settlements involved to reach West Falkland - only a notional benefit is taken into account here. A maximum of £5,000 and a minimum of £1,000 is included in the benefit stream.

d. Increases in Agricultural Output

17. The final category of developmental benefits to be considered is the net increase in agricultural output that could be attained with a road. This issue was discussed with Mr C D Kerr, the Team Leader of the Grasslands Trial Unit (GTU), and he produced a paper which discussed the potential gain, and also the relevant constraints (5). His paper considers the increases in productivity under the following headings:-

a. Current allocation of Stock
b. Reduced farm size
c. More intensive farming
d. Labour efficiency
e. Labour specialization
f. Neighbouring
g. Transport
h. Transport speed
i. Accessible land
j. Other services

18. The details of his paper will not be repeated here, as they are already available to the FIG. In summary Mr Kerr believes that net output could be increased by 100-200% due to the road, or 50-100% without more intensive farming. On the basis of his calculations, existing net output for the area under consideration is around £48,450 p a and thus using his lower 50-100% range of increase, the potential addition to GNP is around £25,000-£50,000 p a. Using his 100-200% range the increase is around £50,000-£100,000 p a.

19. The factors involved in consideration of allocation of benefits from increased agricultural output to a specific infrastructure output are complex. [For rural roads see for example World Bank Staff Working Paper No 241 (12)].

In brief the two main issues are whether the potential increase is totally due to the road, and whether the potential increase will in fact be realized. It is also necessary to consider whether the increased output in the area opened up by the road is to any extent offset by reduced output in other areas. Mr Kerr believes that the potential increase can be accounted to the road. We accept this view, but without further evidence cannot take full account of the potential increase he suggests. His paper also discusses the constraints to achieving the increased output, and the major issues were discussed with HE the Governor, and the Chief Secretary. Most of the land involved is owned by the Falkland Islands Company, and their re-investment has been limited in recent years. Under their ownership reduced farm size is unlikely, and the investments required to take account of the potential may not be made in full. It is not our intention to attempt to dictate policy to the FIG on this problem of maximising the increase to agricultural output. We are aware that consideration is being given to purchasing some of the land, and we would suggest that if the land remains with FIC consideration should be given to fiscal incentives to increase investment. If the land is taken over, and/or sold to form smaller units, then it will be necessary for the FIG to make capital available on suitable terms, and if necessary to provide appropriate extension and advisory services. The GTU would have an obvious role to play.

20. Given these uncertainties we have included a maximum of £30,000 p a and a minimum of £15,000 p a as the benefits from this source. The FIG will no doubt keep ODM informed on their plans for maximising the benefit, if a road goes ahead.

21. This concludes this discussion of the developmental benefits. The categories identified correspond to regular traffic (ie VOC and passenger time savings), diverted traffic (ie FIGAS and MV Monsunen) and generated traffic (equated here to the net increase in agricultural output). One possibility not discussed in this appendix but considered in the main report is of increased domestic production of vegetables and dairy products - produced in camp and transported by road to Stanley. Quantification of these benefits is not considered possible, and may best be taken as being subsumed in the benefits from increased agricultural production. The maximum and minimum levels of benefits are summarized in Table 4 below:-

Table 4 Summary of Annual Benefits from Stanley-Darwin Road

	Maximum	Minimum
Regular Traffic	£22,320	£11,160
Diverted Traffic (FIGAS & Monsunen)	£35,000	£16,000
Generated Traffic	£35,000	£15,000
Total	£92,320	£42,160

iv. The Cost-Benefit Analysis

22. The discounted cash flow calculations are set out in Table 5. For this project we have calculated an NPV on the basis of the maximum and minimum benefits in Table 4, and also using the mean of the maximum and minimum. (This is not to suggest that this last is in any sense the expected value of benefits, but merely as an illustration). A discount rate of 8% has been used, which is intended to be a rough proxy for the social opportunity cost of capital in the Falklands.1/ The NPV ranges from + £168,260 to - £328,837 with a value corresponding to the mean of maximum and minimum benefits of - £79,007. On the basis of this analysis the construction of the road is not justified unless the benefits reach a level of £75,250 p a, ie above the mean level.

1/ (It could be argued that given the paucity of investment opportunities this rate should be lower, particularly as ODM funds might be available for this project, but not for any alternative uses of capital).

v. Conclusions

23. The most lengthy part of this appendix, and the most time-consuming element of the economist's input in the Falklands has been the attempt to quantify potential benefits. In brief it is concluded that it would be possible for developmental benefits to be gained which would more than justify the road's construction. In order to attain the required level of benefits, and more important to maximize the return to the Falkland Islands economy, it is necessary for the FIG to consider:-

i. The optimum use of the released FIGAS capacity.
ii. The maximiation of increased agricultural output in the area opened up by the road's construction.
iii. The optimum distribution of these benefits from increased agricultural output.

24. The planning for ii. and iii. above should be set in hand as soon as possible after agreement has been reached on finance, and not delayed until construction begins. Consideration should also be given to uses of the plant after the Stanley-Darwin road has been completed. One possibility would be for the PWD to build feeder roads to other settlements, on the basis of a set of charges similar to that set out in Appendix C. In considering the order in which future roads should be built, attempts should be made to estimate potential benefits - separated into the categories in Table 4 - and compare these with the relevant cost estimates - based on an updating of the figures in Appendix D. Social factors will also have to be considered, but should not be the sole factor in determining priorities.

Table 5 Discounted Cash Flow Calculations

	1978	1979	1980	1981 - 2,028
Costs				
a. Capital	105,350	327,980	217,880	
b. Maintenance			8,000	15,500
N P V of Costs = £743,074				
Benefits				
a. Maximum			40,000	92,320
N P V of Maximum Benefits = £911,334				
b. Minimum				
N P V of Minimum Benefits = £414,237			16,000	42,160
c. Mean				
N P V of Mean Benefits = £664,067			27,500	67,240

ie With Max Benefits NPV of Road @ 8% = + £168,260
" Min " " " " " " = - £328,837
" Mean " " " " " " = - £ 79,007