Townsville Airport: Economic Evaluation of Proposed International Facilities

Report

In this report two alternatives for the provision of international facilities at Townsville Airport are assessed in benefit-cost terms. Unquantifiable factors are considered in conjunction with economic benefits and costs.

BUREAU OF TRANSPORT ECONOMICS

TOWNSVILLE AIRPORT: ECONOMIC EVALUATION OF PROPOSED INTERNATIONAL FACILITIES

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FOREWORD

The relative isolation of North Queensland from Australia's major international airports and the growth of tourism along the Great Barrier Reef have led to the consideration of an international gateway at Townsville.

In this report two alternatives for the provision of international facilities at Townsville Airport are assessed in benefit-cost terms. Unquantifiable factors are considered in conjunction with economic benefits and costs.

The evaluation was undertaken in the Economic Evaluation Branch by T.M. Grant under the direction of G.R. Carr. J. Kjar assisted with the econometric modelling and S. Watt provided computational assistance. Annex I was written by H.B. O'Keefe of the Planning Research and Development Branch of the Department of Transport.

Acknowledgement is due to the Ground Facilities and Airways Operations Divisions of the Department of Transport and to the Department of Defence (Air) for the preparation of plans, cost estimates, technical advice and general liaison work for, and on behalf of the B.T.E. Assistance was received from the Department of Tourism, the former Departments of Environment and Housing and Construction, the former Cities Commission, and also from various branches of Qantas. Finally, the Charters Towers' City Council and the Federation of Queensland Chambers of Commerce presented submissions concerning the project, which are reproduced in this report.

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CANBERRA, A.C.T.
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SUMMARY

This report presents the results of a benefit-cost analysis of three alternate strategies for the future development of Townsville Airport. One strategy, the Base Case, corresponds to the development of Townsville Airport for domestic services only. The other strategies or project cases, are alternative ways of providing international facilities at Townsville.

Project Case 1 is a low cost option based on extensions to the present runway and is dependent upon the development of a microwave landing system prior to the commencement of international operations. This requirement constrains the implementation of this strategy until at least 1985. Project Case 2 involves substantial capital works on a new runway alignment to the west of the existing runway and does not depend upon the microwave landing system for feasibility. Construction schedules would delay the commencement of international operations until at least 1980 under this project option.

The analysis is conducted within a national framework using resource costs and benefits for factors having pecuniary values.

Non-pecuniary assessments are made of noise and other environmental quality effects of the different development options on the areas surrounding the airport. Operational limitations are considered in the same way.

The main benefits accruing from the provision of international facilities at Townsville are aircraft operating cost and passenger travel time savings due to the introduction of direct international services. These resource savings are traded-off against the capital cost of providing the facilities and the airport operating cost differences between strategies. All benefits and costs are measured using a set of forecasts of passenger movements, aircraft movements and other factors which are considered to be 'most likely' to occur. The

sensitivity of the results to changes in these forecasts is examined.

The main conclusion of the study is that an international airport at Townsville could be justified by 1985. However, there are quite distinct differences between the expected economic returns of the two project options. Project Case 1, which is based on extending the existing runway, is a lower cost, higher return alternative than is Project Case 2 which involves the construction of a new runway complex. Project Case 1 fares worse than Project Case 2 in respect of noise disturbance and operational limitations, although it is relatively better in other environmental aspects. The results of the evaluation also indicate that the commencement of international operations at Townsville would be warranted at least a decade earlier under Project Case 1 than under Project Case 2. The investigations indicate that this ranking of projects is preserved under a wide range of changes in the assumptions explored in the evaluation.

The timing of Project Case 1 is dependent on the development of a technically and operationally acceptable guidance system and is particularly sensitive to both the forecast level of international services at Townsville and the relative proportions of direct and transit services. Delays in the development of the microwave landing system, the achievement of lower than forecast travel demand and the introduction of transit rather than direct international services will all result in postponement of the date at which project implementation is warranted. Because of this sensitivity, and since a decision on project implementation need not be taken until 1980 at the earliest, it would be appropriate to monitor the parameters for changes that might result in a deferment of the upgrading beyond 1985.

CHAPTER 1 INTRODUCTION

TERMS OF REFERENCE

In November 1973 the Minister for Transport, the Honourable C.K. Jones, directed the BTE to undertake an economic evaluation of proposals to upgrade Townsville's Garbutt Airport[1] to international standard. The results of these investigations are presented in this report.

PREVIOUS STUDIES OF TOWNSVILLE AIRPORT

In 1973 a feasibility study of an international airport at Townsville[2] was undertaken by an Inter-Departmental Committee (IDC) comprising the Departments of Tourism and Recreation, Environment and Conservation, Northern Development, Civil Aviation, Urban and Regional Development, Treasury and, in consultation, Defence and Air. The IDC report was submitted, together with an Environmental Impact Statement[3], to an ad hoc committee of the Ministers responsible for the above Departments.

The IDC report and associated Environmental Impact Statement concluded that the existing facilities at Townsville had a limited potential for future development and that a new terminal and runway on alignment 05/23[4] would be necessary to overcome operational constraints. It was suggested that the

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(1) Throughout this report Garbutt Airport is referred to as Townsville Airport.

(2) Inter-Departmental Committee, "Report on the Feasibility of Establishing an International Airport at Townsville" (Canberra: March 1973).

(3) Department of Civil Aviation, "Environmental Impact Statement, Establishment of an International Airport at Townsville" (March 1973).

(4) The numbers 05/23 refer to the whole number nearest to one tenth of the magnetic bearing of each runway when viewed in the direction of approach, that is, 052 degrees and 232 degrees respectively.

proposed international airport would generate growth in the tourist and allied industries of the region, subject to satisfactory parallel development of appropriate accommodation. It was indicated that these benefits would be initially offset by losses incurred by the domestic airline operators and the additional servicing costs associated with the airport operations. The recommended change in runway alignment and the proposed exchange of Federal-owned land for certain tracts of the Town Common were expected to nullify possible adverse environmental effects including aircraft noise.

OUTLINE OF THE STUDY

The procedure used in this investigation is to examine the existing situation and define feasible development options. Then, after forecasting demand for air travel by type of passenger movement, the benefits and costs of each project alternative are identified over the project horizon and benefit-cost ratios calculated. A project implementation date is also chosen by maximising the net present value of benefits minus costs. A non-pecuniary assessment is made of the effects of each project alternative on noise levels and the environmental quality in the region surrounding the airport.

SUBMISSIONS

During the course of the study a submission was received from the Charters Towers' City Council suggesting Bredden, the site of a World War II bomber airport, as a possible alternative to Townsville. This submission is shown in Annex A. However, on examination, this site does not offer any significant additional benefits to the Townsville site. Furthermore, the capital and access costs at Charters Towers are expected to be greater than those at Townsville. It is also unlikely that the accommodation and service facilities at Charters Towers would cater satisfactorily for the number of travellers envisaged. The Charters Towers' submission was therefore not considered as a feasible alternative.

A submission from the Federation of Queensland Chambers of Commerce supporting the "early construction of an International Airport in North Queensland" was received and is also reproduced in Annex A.

Although no formal submission on the effects of international airport development at Townsville regarding airline operations were requested or received from the major airline operators, their views are contained in several items of correspondence with the Department of Transport. A summary of the main points made by the airlines and a brief commentary on the issues that emerge, are set out in Annex B.

CHAPTER 2 THE EXISTING SITUATION AT TOWNSVILLE AIRPORT

The present airport, shown in Figure 2.1, is situated between the Town Common and the Townsville suburbs of Garbutt and Belgian Gardens. It consists of the RAAF base to the south of the main runway and the domestic passenger terminal and maintenance facilities to the east. The runway configuration comprises a main runway 2438 metres in length (runway 01/19) and a cross runway 1097 metres in length (runway 07/25). The main runway was completed in 1958.

The airport although initially developed by the City of Townsville under a provisional licence granted in January 1939 is now owned by the Commonwealth Government. The airport is jointly used by the Department of Defence which is the principal user, and the Department of Transport which is a tenant user.

The present civil terminal building was originally converted from wartime structures in 1948 and significant alterations and extensions were made in 1969. However, overcrowding of the building and apron area occurs during peak traffic periods and it is not envisaged that regular scheduled international services could operate from these facilities.

Under existing arrangements some international flights transit[1] through Townsville. These consist mainly of flights to Papua New Guinea and the occasional B707 aircraft stopping over because of bad weather or other unforeseen circumstances. In the event of an international flight landing, the domestic terminal is partitioned with temporary screens in order to ensure passenger separation. This procedure would be unsatisfactory for regular international traffic.

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(1) A transit is defined as a stopover en route to some scheduled destination.

The main runway pavement is capable of taking aircraft loads up to international standard[1] although its length is insufficient for regular international movements. Furthermore International Air Transport Association guidelines for international operations require that a satisfactory precision guidance system be installed. The present main runway is not fitted with a categorised[2] instrument landing system (ILS) due to terrain difficulties at each end of the runway. At the southern end, Mt Louisa obstructs the straight flight path for landing approaches, whilst Mt Cook on Magnetic Island presents a less serious problem for take-offs and missed approaches in the 01 direction. Magnetic Island also prevents a satisfactory ILS approach from the north. These comments only apply to instrument landings. Visual landings have been carried out by domestic aircraft with a good safety record since the airport's inception.

The growth of the city of Townsville has resulted in residential development on the eastern and south-eastern boundaries of the airport.[3] The concurrent expansion of air traffic has created a noise problem in the suburbs of North Ward and Belgian Gardens to the east, Heatley and Cranbrook to the south, and Pallarenda to the north-west of the 01/19 runway. Noise abatement procedures have been introduced to ensure that the majority of aircraft land and take-off over Rowe's Bay. Consequently, most take-offs occur in the northerly direction whilst landings are generally scheduled in the

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(1) As assessed by the Department of Transport.

(2) The term "categorised" is utilised by aviation authorities to indicate that the system meets certain technical specifications set out by the International Civil Aviation Organisation (ICAO) in order to satisfy stringent operational requirements.

(3) Maps showing these geographical features are in Annex C.

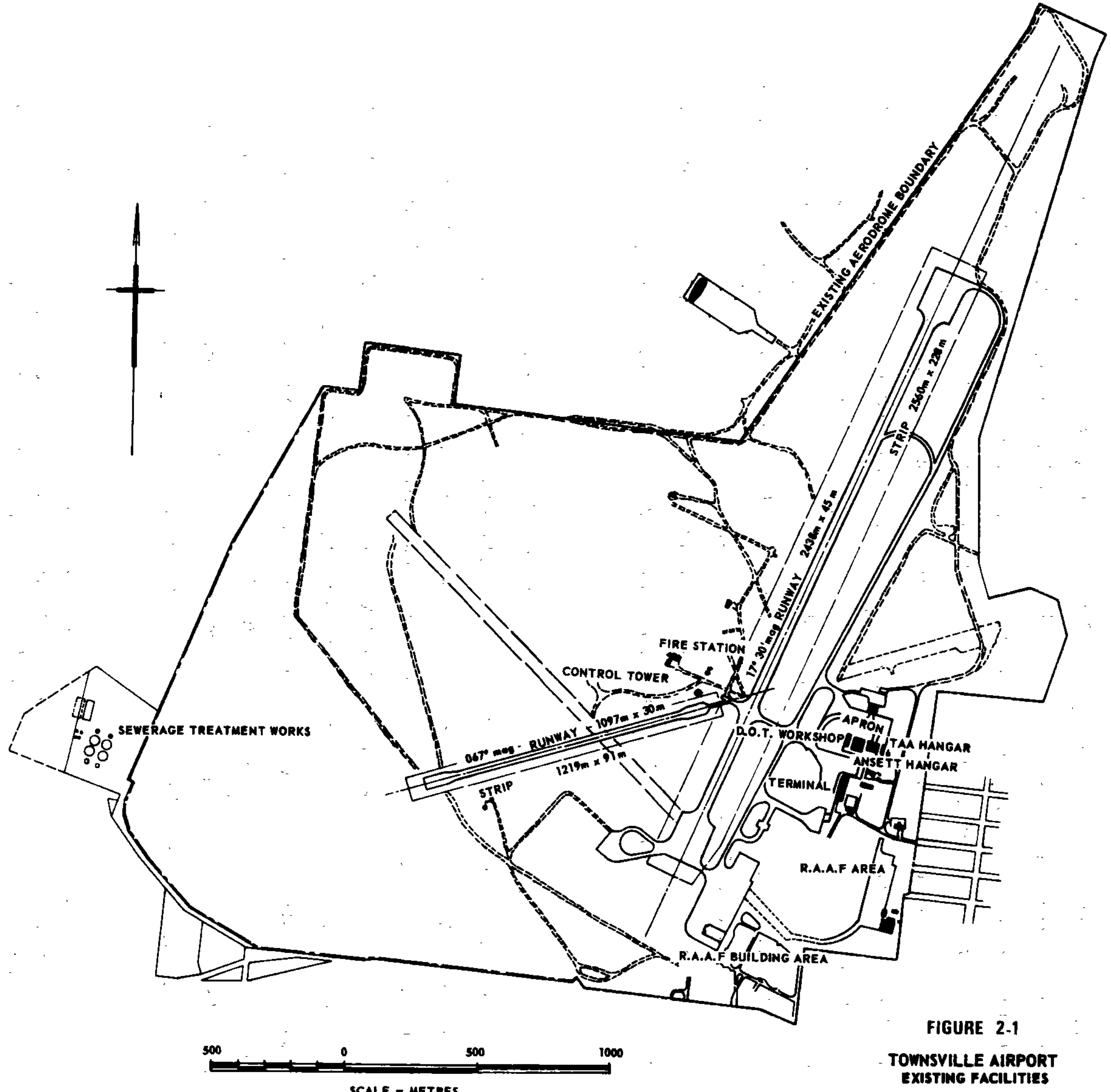

FIGURE 2-1

TOWNSVILLE AIRPORT
EXISTING FACILITIES

Source: Department of Transport

southerly direction. A significant level of noise reduction has been achieved by this procedure although there are still some suburban areas within the 25 noise exposure contour[1]. With increased aircraft movements in the future, this abatement policy may become costlier to maintain.

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(1) Noise and the methodology used to derive noise exposure contours are discussed in Annex C.

CHAPTER 3 DEFINITION OF ALTERNATIVE STRATEGIES

Three alternative strategies for the development of Townsville Airport are considered in this report. The first stragegy involves the extension of the existing runway and the construction of an international terminal. This is referred to as 'Project Case 1'. This proposal had previously been considered briefly by the IDC[1]. It was not regarded as suitable partly because the installation of a satisfactory instrument landing system (ILS) did not then appear to be feasible due to operational and terrain limitations. However, recent research has led to the development of a microwave landing system (MLS), which is expected to be able to surmount many of the constraints on ILS.

The second strategy is a modification of the main proposal considered by the IDC. It requires a western extension of the existing airport boundary. This is referred to as 'Project Case 2'.

A third strategy, against which the relative benefits and costs of the two project cases can be measured, is also developed. This is referred to as the 'Base Case'. Table 3.1 summarises the features included in each of the three strategies.

The time frame for each project differs due to the different implementation dates used. However, the year 2015 marks the end of the time horizon for all projects as it is assumed that capacity problems would necessitate further extensive capital works after this date. These would require separate analysis in the future and are not considered in the present evaluation.

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(1) Inter-Departmental Committee, op.cit.

TABLE 3.1 - COMPARISON OF FEATURES OF THE BASE AND PROJECT CASES CONSIDERED FOR TOWNSVILLE INTERNATIONAL AIRPORT

Feature	Strategies		
	Base Case	Project Case 1	Project Case 2
Terminal & Apron	Same as existing Airport	New International Terminal	New International Terminal
Runway	Same as existing Airport	Modified existing runway	New International Runway plus existing runway
Instrument Landing System	Installation of MLS in 1985	Installation of MLS in 1985 or on subsequent construction of airport	Installation of ILS/MLS on construction of airport
Apron & Taxiways	Same as existing Airport	Some widening and new construction	New construction
Land Acquisition	None required	39 hectares	766 hectares
Airport Service Buildings	Same as existing Airport	Same as existing Airport plus some new construction	New construction

BASE CASE

The Base Case is designed to act as a datum from which costs and benefits may be measured. Because the point at issue is whether or not Townsville Airport should be upgraded to international standard, the Base Case is taken as the most likely development if the airport were not upgraded.

The only current plan for redevelopment of the existing Townsville facility is the upgrading of the domestic terminal buildings and the gradual relocation of part of the RAAF base from the southern end of the main runway to the north-east end of the cross runway.[1]

(1) This includes the construction of new accommodation for RAAF personnel in the Belgian Gardens area.

The weather conditions at Townsville are good and at present an ILS is not fitted on either runway[1]. Nevertheless, the growing traffic at the airport, coupled with its location between the coastal ranges and Mt Cook on Magnetic Island, indicates that a need for a navigational guidance system could be established.

Physical constraints on the implementation of the type of ILS currently in use in Australia led to an investigation of possible alternatives. The most promising alternative appears to be the MLS, 'Interscan', which has been developed to a fairly advanced stage. It is expected to meet all the requirements stipulated by the International Civil Aviation Organisation (ICAO), which is endeavouring to develop a standard, flexible landing system for world-wide introduction.[2] 'Interscan' has therefore been used, in this report, as a proxy for the final ICAO instrument landing system. Further discussion of 'Interscan' and its technical specifications are given in Annex I. 1985 was chosen as the earliest feasible date for the installation of such a system at the existing Townsville Airport. This timing may be optimistic since the more sophisticated versions of MLS involving special airborne equipment are not likely to be in operation by 1985.[3]

There are two other aspects of the Base Case which are important. The first relates to international travel under a 'no development' alternative. The second concerns the way in which the RAAF development strategy fits into the overall scenario.

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(1) With existing technology it is impossible to introduce an operationally acceptable ILS at Townsville on the existing runway alignment.

(2) Details of the competition being conducted by the All Weather Operations Panel (AWOP), a subsidiary organisation of ICAO, are included in Annex I.

(3) This point is made with particular reference to the airborne equipment required for curved flight paths.

It is assumed that current procedures for international travel to and from the Townsville region would continue under the 'no development' alternative. Thus tourists or domestic travellers moving overseas are assumed to use scheduled domestic flights through Townsville Airport to connect with flights by international aircraft to or from their chosen destination. In the Base Case therefore, each overseas passenger is recorded as a domestic passenger movement through Townsville.

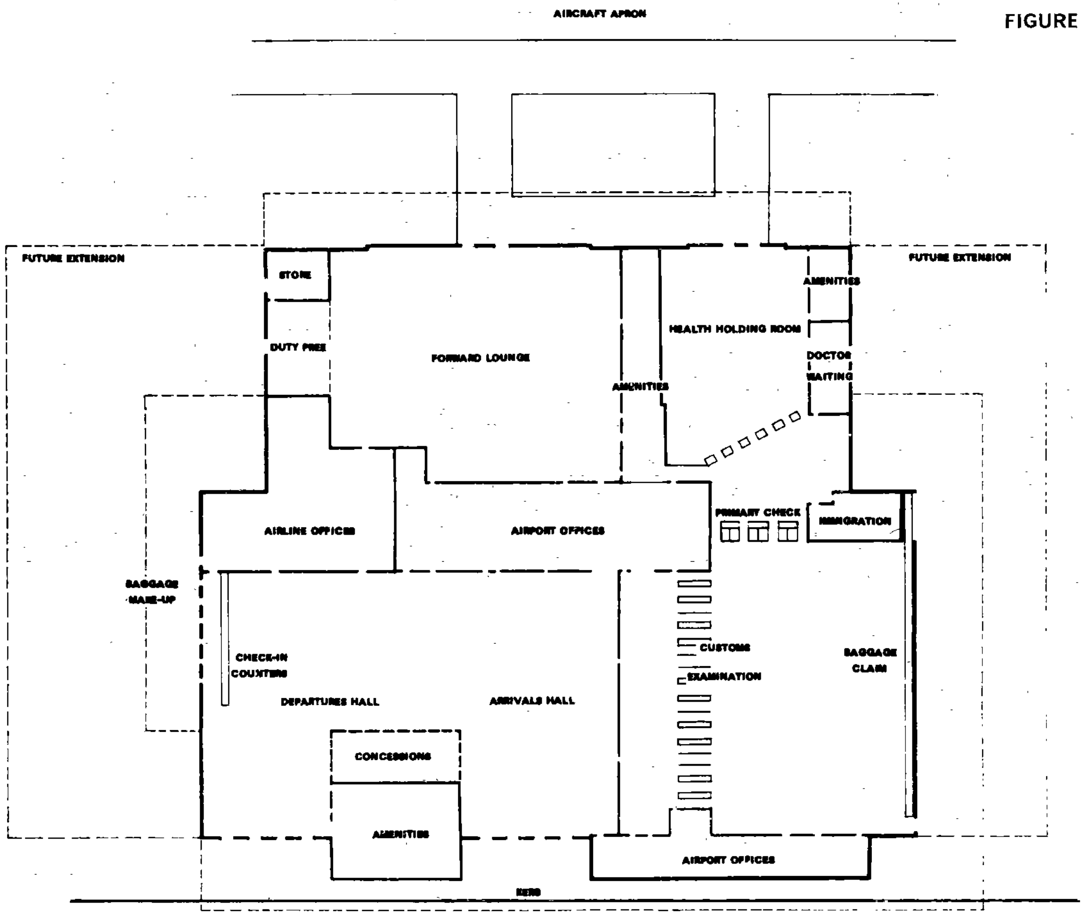
The RAAF development program is based on existing expectations of future RAAF needs in Northern Australia. Discussions with the Department of Defence revealed no immediate runway development plans at Townsville although a contingency plan exists for the construction of a runway on alignment 05/23. This is the same alignment as that proposed in Project Case 2 for the development of an international airport. The RAAF masterplan is dependent upon the acquisition of several tracts of land to the northwest of the present main runway. This acquisition is expected to be completed in the near future. While Defence requirements at Townsville are acknowledged in this report, they are assumed to be exogenous to the development of civil air transport facilities at Townsville. That is, costs and benefits that may arise solely because of the joint user arrangements at the airport are excluded from the analysis.

PROJECT CASE 1

Project Case 1 involves a limited extension of the existing runway and upgrading of existing facilities to cater for international services at Townsville. The main investments proposed are for an international terminal, an upgraded runway, and a guidance system suitable for international aircraft.

Each project would be undertaken in three stages. Stage 1 provides for the completion of runway works to satisfy international length requirements and construction of the new terminal building. Stage 2 involves an extension of this terminal to be ready for operations at some date on or after

FIGURE 3-1



SCALE METRES

10 8 6 4 2 0 5 10

TOWNSVILLE AIRPORT

PROPOSED INTERNATIONAL TERMINAL BUILDING

Source: Department of Transport

1995 depending on passenger demand. Finally, stage 3 consists of an enlargement of the aircraft apron to be completed by the year 2000.

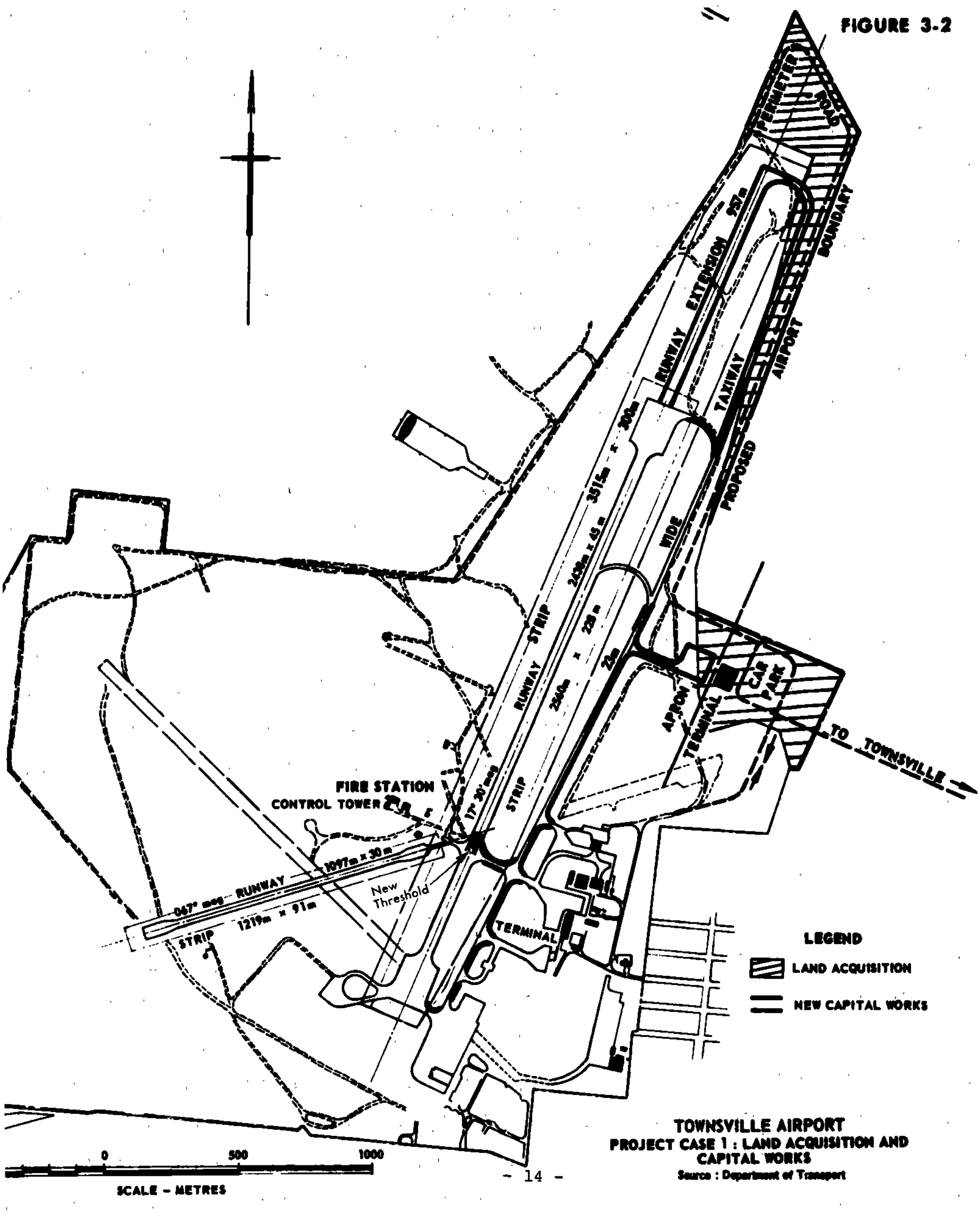
The design of the international terminal proposed as part of both Project Cases 1 and 2 is shown in Figure 3.1. Table 3.2 gives an indication of the design service levels to be provided by stage 1 of the planned terminal building. On completion of this stage the terminal would be capable of handling the passengers and baggage associated with two Boeing 747's, or aircraft of similar capacity, consisting of one arrival and one departure simultaneously. Stage 2 extensions to the terminal would double this capacity. The size and layout of the terminal plan are indicative rather than being a detailed engineering design.

The aircraft apron is extended to provide an area with dimensions 173.5 metres by 161.5 metres for each alternative, in stage 3.

International operations are assumed to commence in both project cases on the completion of stage 1. Stages 2 and 3 are subsequently introduced in order to maintain a satisfactory level of service as passenger and aircraft movements increase over time.

The runway complex assumed for Project Case 1 is an extended and modified version of the existing main runway (01/19). In order to cater for regular international flights on the existing runway, a strip 300 metres in width and an associated approach surface with an inner edge width of 300 metres is required. Buildings on the RAAF base infringe on this approach surface, consequently it is necessary for the runway landing threshold to be moved north by about 650 metres. An extension to the northern end of the runway of approximately 957 metres would more than satisfy take-off requirements for

FIGURE 3-2



TOWNSVILLE AIRPORT
PROJECT CASE 1 : LAND ACQUISITION AND CAPITAL WORKS
Source : Department of Transport

the stage lengths being considered. With the 957 metre extension, the total runway length would be 3395 metres plus a 300 metre RAAF overrun.(1) Provision of additional taxiways and widening of some existing taxiways to 23 metres is also assumed. In order to carry out these extensions it would be necessary to acquire some 39 hectares of land to the north and east of the existing runway. All these features are shown in Figure 3.2.

The introduction of regular international services on the existing runway alignment would be conditional on the provision of a satisfactory instrument guidance system. It is assumed that MLS would provide this capability and that it would be installed in 1985. The earliest feasible implementation date for Project Case 1 would therefore be 1985.

PROJECT CASE 2

Stage 1 of this alternative is a modification of the IDC recommendation for upgrading facilities at Townsville Airport to cater for international aircraft and passenger movements. A new runway alignment (05/23) was chosen to increase aircraft safety on approach and take-off, reduce noise nuisance and also to allow the immediate installation of a categorised ILS. A 2835 metre by 45 metre runway with associated parallel taxiway and an international runway strip of 2955 metres by 300 metres are proposed. An important feature of Project Case 2 is that the existing runway 01/19, would still be operational. Therefore Project Case 2, as shown in Figure 3.3, consists of an open-Vee runway configuration with an international terminal, identical in design and capacity to the terminal in Project Case 1, adjacent to the 05/23 runway. Domestic and military aircraft landing on this runway would taxi to their respective terminal points on runway 01/19 via

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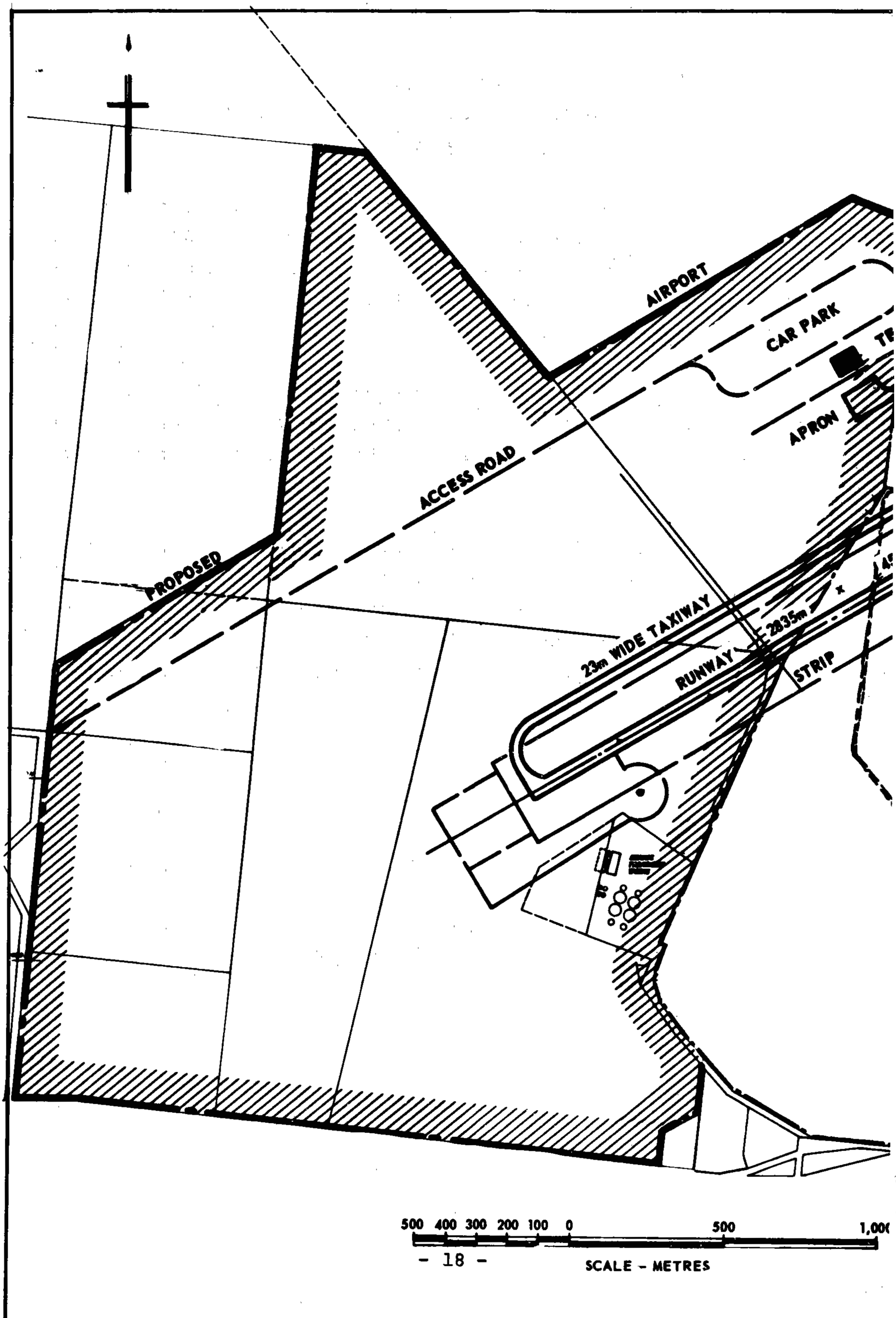
(1) Displacing the 01 threshold would also result in a reduction of the 'poor visability usability' compared to Project Case 2, but for that direction only.


AIRPORT
CAR PARK
APRON
PROPOSED
ACCESS ROAD
23m WIDE TAXIWAY
2835m
RUNWAY
STRIP
500 400 300 200 100 0 500
SCALE - METRES

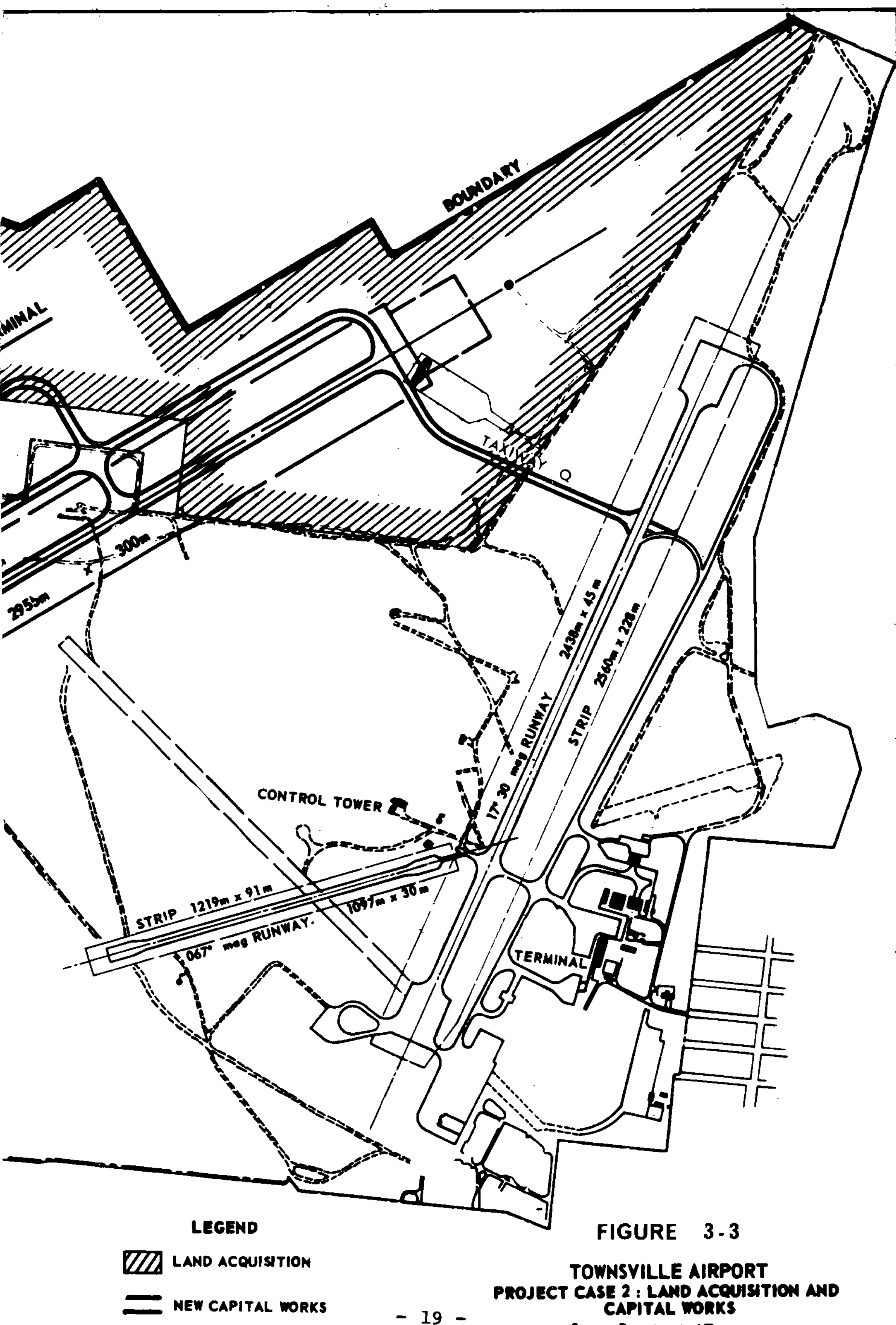


FIGURE 3-3

TOWNSVILLE AIRPORT
PROJECT CASE 2 : LAND ACQUISITION AND CAPITAL WORKS
Source: Department of Transport

CHAPTER 4 EVALUATION OF ALTERNATIVES

EVALUATION FRAMEWORK

The economic evaluation of international facilities at Townsville comprises a social benefit-cost analysis of the alternative development strategies delineated in the previous Chapter. The analysis seeks to determine firstly, whether the discounted benefits from the earliest feasible implementation of each alternative exceed the discounted costs, and secondly, the implementation dates for which each project's net present value is maximised. This latter criterion is important to the decision-maker facing a capital constraint. Further discussion of this criterion is contained in Annex G.

All benefits and costs are measured in resource terms. A 'most likely' set of assumptions is employed in calculating benefits and costs. However, the sensitivity of evaluation results to variations in these assumptions is also considered.

The analysis is conducted over the period 1975 to 2015. This latter date was chosen because it represents a date by which expected demand will have outgrown the planned facilities. After this date it is assumed that some form of new capital investment would have to be made. This, however, is not considered in the evaluation. Although the analysis covers the period to 2015, the year 2000 is regarded as a limit beyond which demand projections and assessments of technology could not be made with any degree of confidence. Therefore, valuation of post year 2000 benefits and costs is based on the assumption that passenger movement levels in the year 2000 would be sustained at that level for the remainder of the project life. This assumption of no growth after the year 2000 has a conservative bias on the project benefits and results in an understated benefit-cost ratio. Variations on this assumption are briefly considered in Annex H.

Consistent with generally accepted principles of benefit-cost analysis, the costs and benefits resulting from each strategy are discounted to a base year to enable a comparison of differing streams of costs and benefits over time. In this analysis the base year is 1975. Fixed costs[1] are discounted from the beginning of the year in which they accrue, whilst variable costs and benefits are discounted from the end of the year in which they were incurred. The discount rates used are 7 per cent per annum and 10 per cent per annum.

The establishment of a new International Airport at Townsville has a large number of direct and indirect benefits associated with it. The extent to which these benefits are relevant to an economic evaluation of the airport depends on the framework within which that evaluation is carried out. The main concern of this study is that only those benefits and costs which contribute to the social welfare of the Australian community[2] should enter into the analysis.

One of the implications of this framework is the exclusion of benefits derived from expenditure by overseas tourists in the Townsville region. The basis for this exclusion is that the best advice available indicates that the generation of new tourists to Australia as a result of the opening of an international airport at Townsville would be negligible. Admittedly it is expected that some diversion of tourists from other Australian resorts to Townsville will occur. Therefore, although tourism may be regarded as beneficial to a community, particularly through expenditure multiplier effects, diverted tourism is merely transferring these benefits from one geographical location to another without changing the level of benefits to the community as a whole. The extent to which Townsville may gain and hence the extent to which other resorts in Australia may lose is considered below.

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(1) Fixed costs include capital and land acquisition costs.
(2) Defined to include Australian residents and Australian entities such as the Federal Government and Qantas.

Although benefits from expenditure in Townsville by diverted tourists are omitted from the analysis, there are other significant potential benefits to be derived from an International Airport. These benefits include the resource savings that accrue to travellers by virtue of the shortened trip distance and travel time for direct flights to and from Townsville. These savings will be distributed between Australian and overseas beneficiaries. Therefore they should not all be included as project benefits on the grounds that they do not all accrue to the Australian community. The extent to which these benefits are distributed to non-Australian beneficiaries is dependent onmany factors including airline pricing and pricing policies adopted by the Australian Government for the provision of air transport facilities. Hence, there may be an interaction between these factors and the airport investment decision.

The working assumption adopted in this study is that the resource savings discussed above either directly accrue or are passed on to, international travellers both Australian and foreign alike, but only the resource savings to Australian resident travellers are regarded as benefits to a particular development strategy. The alternative assumption that overseas visitors would be 'willing to pay' an amount equal to their resource savings is examined in Annex H.

Two general cost categories are identified in the evaluation; fixed or capital costs and variable costs. Fixed costs are incurred on a 'once and for all' basis and include construction and land acquisition costs. As would be expected, these costs are incurred in the early years of the study period. Variable costs principally relate to aircraft movements and include the operating, access and noise costs spread over the entire project life.

Factors such as safety and environmental issues are treated in a descriptive fashion since it is regarded as inappropriate to attach monetary values to them.

Noise disturbance is treated separately from other environmental issues. Some indication of the difference in noise effects between the various alternatives has been calculated in Annex C, however, the qualifications surrounding this analysis make the usefulness of the results somewhat dubious. Nevertheless, the measures used(1) give an indication of the ranking of each project.

PASSENGER AND AIRCRAFT MOVEMENT FORECASTS

The passenger and aircraft demand projections underlying the calculation of project benefits, variable costs and noise disturbance are derived in Annexes D and E.

Projections were developed for passengers, categorised according to the terminal through which the movement occurred; domestic or international. For traffic through Townsville's domestic terminal, movements were classed as domestic movements overseas (DMO), international visitor movements (IVM), and residual internal movements (RIM). A similar classification applies to the international terminal where DMO and IVM movements constitute the passenger flows. In projecting the demand by each class of passenger, two distinct projection levels were chosen. Projection level 1 is a high projection reflecting an expansionary trend in demand up to 1985 based on an econometric analysis of historical trends and a lower rate of growth between 1986 and the year 2000 based on long term international aviation activity. Projection level 2 is a low projection which employs the long term growth rate for the whole projection period.

Forecasts for the project case assumptions are summarised in Tables 4.1 and 4.2. Corresponding projections for the base case assumptions are shown in Table 4.3. All movements at Townsville in the latter case occur through the

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(1) Essentially the number of houses within the 25 NEF contour as discussed in Annex C.

TABLE 4.1 - PROJECTED SCHEDULED PASSENGER MOVEMENTS THROUGH TOWNSVILLE'S DOMESTIC TERMINAL[1]

('000 passenger movements)

Year	Total Movements		International Visitor Movements	Domestic Movements Overseas		Residual Internal Movements
	Projection Level			Projection Level		
	1	2		1	2	
1972	222.8	222.8	30.0	34.8	34.8	158.0
1975	295.4	284.0	39.9	56.5	45.1	199.0
1980	456.2	420.0	79.1	84.7	48.5	292.4
1985[2]	740.8(717.8)	652.6(626.8)	152.5(126.7)	158.6(161.4)	70.4(70.4)	429.7
1990	1073.1	975.5	245.6	196.1	98.5	631.4
1995	1517.6	1454.6	395.5	194.4	131.4	927.7
2000	2206.4	2147.8	637.0	206.3	147.7	1363.1

(1) Transits have been omitted.

(2) The figures in parentheses are the projections for the first year of international operations for Project Case 1. All subsequent figures in the series are identical for both project cases.

Source: Annex D.

TABLE 4.2 - PROJECTED SCHEDULED PASSENGER MOVEMENTS THROUGH TOWNSVILLE'S INTERNATIONAL TERMINAL[1]

('000 passenger movements)

Year	Total Movements Projection Level 1	Total Movements Projection Level 2	International Visitor Movements	Domestic Movements Overseas Projection Level 1	Domestic Movements Overseas Projection Level 2
1972	-	-	-	-	-
1975	-	-	-	-	-
1980	77.3	56.4	35.6	41.7	20.8
1985[2]	193.2(178.8)	104.9(93.3)	68.6(57.0)	124.6(121.8)	36.3(36.3)
1990	350.1	176.2	110.5	239.6	65.7
1995	653.9	299.1	177.9	476.0	121.2
2000	1111.9	527.5	286.6	825.3	240.9

(1) Transits have been omitted.

(2) The figures in parentheses are the projections for the first year of international operations for Project Case 1. All the subsequent figures in the series are identical for both project cases.

Source: Annex D.

TABLE 4.3 - BASE CASE PROJECTIONS OF PASSENGER MOVEMENTS AT TOWNSVILLE AIRPORT (1)

('000 passenger movements)

Year	Total Movements		International Visitor Movements	Domestic Movements Overseas		Residual Internal Movements
	Projection Level 1	Projection Level 2		Projection Level 1	Projection Level 2	
1972	222.8	222.8	30.0	34.8	34.8	158.0
1975	295.4	284.0	39.9	56.5	45.1	199.0
1980	483.6	426.5	64.8	126.4	69.3	292.4
1985	816.5	640.0	103.6	283.2	106.7	429.7
1990	1233.9	962.4	166.8	435.7	164.2	631.4
1995	1866.7	1448.9	268.6	670.4	252.6	927.7
2000	2827.3	2184.3	432.6	1031.6	388.6	1363.1

(1) Transits have been omitted.

Source: Annex D.

domestic terminal while movements are distributed between the existing domestic terminal and the proposed international terminal under the project case assumptions. The absolute difference in passenger numbers between the two sets of projections is accounted for by the diversion of IVM's to Townsville from alternative resorts in Australia. This diversion is assumed to be a direct result of the construction of the new international facilities. Table 4.4 sets out the net diversion to Townsville expressed in passenger movements for selected years.

International aircraft movements are calculated directly from the passenger movement projections by dividing passenger movements by an average passenger loading for Boeing 707 type aircraft. Domestic aircraft movements are derived in a similar fashion, except that passenger loading factors are allowed to vary over time in order to cater for changing domestic fleet composition. Both sets of projections are summarised in Table 4.5.

TABLE 4.4 - DIVERSION OF INTERNATIONAL VISITOR MOVEMENTS TO TOWNSVILLE (1)

('000 passenger movements)

Year	Base Case International Visitors to Townsville	Project Case International Visitors to Townsville	Net Diversion (2)
1980	32.4	40.4	8.0
1985 (3)	51.8	78.0(64.8)	26.2(13.0)
1990	83.4	125.6	42.2
1995	134.3	202.2	67.9
2000	216.3	325.7	109.4

(1) Based on projection level 1.

(2) Column 2 minus column 1.

(3) The figures in parentheses are the projections for the first year of international operations for Project Case 1. All subsequent figures in the series are identical for both project cases.

TABLE 4.5 - AIRCRAFT MOVEMENT PROJECTIONS AT TOWNSVILLE AIRPORT[1]

('000 movements)

Year	Scheduled Domestic Aircraft Movements		International Aircraft Movements	Non-scheduled Domestic Movements[2]
	Base Case	Project Case		
1975	14.1	14.1	-	52.8
1980	21.0	21.7	0.8	66.1
1985[3]	27.2	30.9 (29.9)	2.0 (1.8)	80.9
1990	41.1	35.8	3.6	97.4
1995[4]	53.3	43.4	6.7	119.1
2000[4]	67.3	52.5	11.5	151.7

(1) Based on projection level 1.

(2) Excluding charter traffic.

(3) Parentheses indicate projections for the first year of international operations for Project Case 1. Subsequent figures in the series are identical for both project cases.

(4) Non-scheduled domestic movements between 1995-2000 have been extrapolated.

Source: Annex E.

QUANTIFIED BENEFITS

It is hypothesised that Townsville Airport could service three major international routes; Townsville-Singapore, Townsville-Nadi and Townsville-Auckland. These routes are chosen because they are likely to cater for the greatest proportion of potential passenger demand at Townsville by servicing major staging points to secondary destinations throughout the world.

The benefits quantified in the evaluation comprise the net savings in real resources and time accruing to Australian residents using the new international gateway for travel to and from their chosen overseas destinations. The stream of these benefits over time is dependent on the project implementation date and assumptions regarding passenger movement projections and aircraft resource costs. The benefits by route for both project strategies, measured in 1975 dollar values, are shown in Table 4.6.

Positive net savings accrue to DMO's on the Nadi and Singapore routes for both project strategies. However, the Auckland route shows no net savings to travellers as the shortening of trip times is offset by the higher resource costs of international aircraft over domestic aircraft. Changing the assumption regarding aircraft type whilst increasing the benefits to the Nadi and Singapore routes, fails to make the Townsville-Auckland route an economic proposition.

QUANTIFIED COSTS

Capital Costs

Capital costs, excluding land acquisition, required to construct an international standard airport at Townsville are staged through time as explained in Chapter 3. An itemised schedule of capital costs is set out in Table 4.7. The

TABLE 4.6 - BENEFITS BY ROUTE FROM THE PROVISION OF INTERNATIONAL FACILITIES AT TOWNSVILLE(1)

($'000)

Year	Resource Savings			Time Savings		
	Nadi	Townsville - Singapore	Auckland	Nadi	Townsville - Singapore	Auckland
1980	42.3	252.7	-56.8	10.2	22.9	5.0
1985(2)	148.2 (144.8)	773.8 (756.4)	-144.4 (-141.2)	30.5 (29.8)	68.6 (67.1)	14.9 (14.6)
1990	159.4	1395.7	-421.5	51.2	125.8	19.2
1995	216.6	2701.3	-952.0	101.6	249.9	38.1
2000	231.1	4579.9	-1815.6	176.2	433.2	66.0

(1) Based on projection level 1.

(2) Figures in parentheses are the projections applicable to the first year of international operations for Project Case 1.

Source: Annex F.

TABLE 4.7 - CAPITAL COSTS FOR PROPOSED UPGRADING OF TOWNSVILLE AIRPORT

($m January 1975 prices)

Item	Project Case 1 (Extn of 01/19)	Project Case 2 (New runway alignment 05/23)
STAGE 1		
Runway and Associated Taxiways		
. Earthworks	0.90	2.90
. Aircraft pavements	2.30	5.80
. Movement area drainage & ducts	0.10	1.50
. Perimeter Road, RAAF arrestor barrier	0.12	1.16
Terminal Building		
. Terminal	1.50	1.50
. Incinerator, waste disposal etc	0.10	0.11
Other Buildings		
. Field powerhouse	0.25	0.34
. International DME building	0.03	0.21
. Fire Station	0.20	
. Control Tower	-	0.21
. Maintenance Complex	-	0.27
Engineering Services		
. Earthworks	0.13	0.83
. Apron and connecting taxiway	0.52	0.69
. Drainage and ducts	0.14	0.19
. Road car parks	0.17	0.83
. Water supply and sewerage	0.25	0.83
. Electrical reticulation	0.18	0.56
. Landscaping & environmental protection	0.01	0.07
NAVIGATIONAL AIDS		
Lighting		
. Approach lighting	0.15	0.07
. Runway lighting	0.08	0.09
. Taxiway lighting	0.05	0.04
. T-VASIS (2 units)	0.06	0.06

TABLE 4.7 - CAPITAL COSTS FOR PROPOSED UPGRADING OF TOWNSVILLE AIRPORT (Continued)

. ILS/MLS	0.18	0.18
. VOR	-	0.05
. DME/M	0.06	0.06
. Domestic DME	0.04	0.04
STAGE 2		
. Terminal Extension	1.20	1.20
STAGE 3		
. Apron Extension	0.30	0.30
TOTAL	9.02	20.09

Source: Annex G.

undiscounted capital costs for Project Cases 1 and 2 are $9.02m and $20.09m respectively. The earliest possible dates for commencement of Stage 1 is 1982 for Project Case 1 and 1976 for Project Case 2. With implementation to maximise project NPV the dates for stage 1 become 1982 and 1992 for Project Cases 1 and 2 respectively.

Land Acquisition Costs

The cost of acquiring land for the construction of the international facilities is calculated at 1975 market values. Relevant acquisition dates for the earliest feasible implementation case are 1976 for Project Case 2, and 1982 for Project Case 1. For implementation based on the maximum net present value criterion, the acquisition dates are 1992 and 1982 for Project Cases 2 and 1 respectively. Some of the land involved in this acquisition is already owned by the RAAF and it has an option to purchase other tracts. In both these cases the acquisition cost is based on an opportunity cost rather than an actual financial outlay. The undiscounted land acquisition costs are $0.19m for Project Case 1 and $3.31m for Project Case 2[1].

Operating Costs

Estimates of operating costs comprise the net additional cost to the Australian community of providing international facilities at Townsville. It is expected that ground handling, maintenance, and equipment servicing costs associated with aircraft movements would be equivalent in both the Base and Project Cases because the introduction of international facilities at Townsville generates few additional aircraft movements through Australia's international airports. Therefore, the increased costs at Townsville are regarded as a transfer cost from other international airports. Cost disabilities or advantages inherent in operations at Townsville are neglected with one exception, which is the greater cost involved in providing refuelling facilities for aircraft. This cost has been estimated at an additional $800 per aircraft. Only 50 per cent of this cost is included in the analysis on the grounds that foreign travellers will bear the other 50 per cent.

The net operating costs attributable to each project strategy are shown in Table 4.8.

User Access Costs

User access costs can be expressed in terms of resource and time components. Both are proportional to the distance travelled between the airport and Townsville's central city area. Access costs are calculated according to assumptions concerning mode and distance travelled. They are estimated as

(1) Some land included in the cost for Project Case 2 may not be necessary for the civil airport but would be needed primarily for RAAF requirements.

TABLE 4.8 - NET OPERATING COSTS ASSOCIATED WITH THE PROVISION OF INTERNATIONAL SERVICES AT TOWNSVILLE (1)

Year	Net Operating Costs ($m)
1980	0.16
1985 (2)	0.40 (0.16)
1990	0.72
1995	1.34
2000	2.30

(1) Based on projection level 1.

(2) The figure in parentheses is the projection for the first year of international operations for Project Case 1. All subsequent figures in the series are identical for both project cases

Source: Annex G.

TABLE 4.9 - NET ACCESS COSTS ASSOCIATED WITH THE PROVISION OF INTERNATIONAL SERVICES AT TOWNSVILLE (1)

($'000)

Year	Project Case 1		Project Case 2	
	Real Access Costs	Time Access Costs	Real Access Costs	Time Access Costs
1980	-	-	15.3	5.4
1985	3.5	1.9	45.9	16.2
1990	6.9	3.8	88.2	31.1
1995	13.8	7.6	175.2	61.9
2000	23.9	13.2	303.7	107.3

(1) Based on projection level 1.

Source: Annex G.

cost differences between Project and Base Cases. They comprise time and resource components and are summarised in Table 4.9.

Taxiing Costs

The resource and time savings which constitute the project benefits discussed above, are calculated in terms of block-to-block times for international aircraft. Therefore, they subsume the resource and time costs associated with international aircraft taxiing at Townsville.

EVALUATION RESULTS

The results obtained from the identification and quantification of project benefits and costs are summarised in Tables 4.10 and 4.11. The parameters used to present the evaluation results are implementation date, net present value (NPV) and benefit-cost (B/C) ratio. The implementation date chosen is the key variable as it determines the time distribution of future benefits and costs which are discounted to give the NPV and B/C ratio. Two criteria are used to determine the appropriate implementation dates, the 'earliest feasible' construction criterion and the 'maximum NPV' criterion.

Project Case 1 Evaluation Results

Project Case 1, the extension of the existing facilities at Townsville Airport, is constrained by the required development of an instrument guidance system capable of overcoming certain technical problems in the current airport layout. These problems are essentially related to international operations and do not affect existing operations by domestic aircraft[1]. Whilst a possible remedy for these problems is at an advanced stage of development, it is highly unlikely that international

(1) Although it is expected that in the future even domestic operations would be somewhat constrained particularly as airport congestion becomes evident.

TABLE 4.10 - SUMMARY OF THE DISCOUNTED COSTS AND BENEFITS FOR EACH PROJECT CASE FOR EARLIEST FEASIBLE IMPLEMENTATION (1)

($m)

Item	Project Case 1 Discount Rate		Project Case 2 Discount Rate	
	7%	10%	7%	10%
COSTS				
Capital costs	4.58	3.58	15.52	14.15
Land acquisition	0.12	0.10	3.09	3.01
Operating costs	2.76	1.61	3.19	1.95
User access costs	0.03	0.02	0.40	0.23
Time access costs	0.02	0.01	0.14	0.08
Total Costs	7.51	5.32	22.34	19.42
BENEFITS				
Resource savings	9.76	5.73	11.17	6.85
Time savings	1.18	0.69	1.34	0.81
Post year 2000 net benefits	6.29	2.56	5.69	2.32
Total benefits	17.23	8.98	18.20	9.98
BENEFIT-COST RATIOS	2.29	1.69	0.81	0.51
NET PRESENT VALUES	9.72	3.66	-4.14	-9.44
IMPLEMENTATION DATES	1985	1985	1980	1980

(1) Costs common to Base and Project Cases are excluded. Costs and benefits for the Townsville-Auckland route are excluded because it was found to be uneconomic.

Source: Annexes F and G.

operations could commence on the existing runway alignment before 1985. This then is the earliest feasible implementation date for this Project Case. B/C ratios of 2.29 and 1.69 using 7 and 10 per cent per annum discount rates are obtained from such implementation. The equivalent values of NPV are $9.72 and $3.66m.

Examination of NPV's revealed that the NPV could be increased to a maximum by delaying the project implementation date to 1988 when a discount rate of 10 per cent is used. This would increase the B/C ratio to 1.89 and the NPV to $3.75m. At a discount rate of 7 per cent no delay would be worthwhile.

In Annex H of this report the sensitivity of these results to variations in the 'most likely' assumption set is analysed. Several of the modified assumptions were found to have a considerable impact on the initial results. The most sensitive assumptions were those concerning aircraft resource costs, benefits to overseas visitors, the ratio of transit flights to total flights and the traffic projection level. Only in the last case did variations in the assumptions result in a significant worsening of the results, with the B/C ratio dropping, in one case, to the breakeven point of 1.00. This was associated with a net present value of zero and maximum NPV implementation in the year 2000.

Project Case 2 Evaluation Results

The commencement date for Project Case 2, unlike that for Project Case 1, is not constrained by any technical requirement regarding an instrument guidance system. Therefore, the earliest date at which international operations could commence is 1980 based on a construction program initiated in 1976. B/C ratios of 0.81 and 0.51 are obtained for such implementation at 7 and 10 per cent discount rates respectively. The respective values for NPV associated with these B/C ratios are minus $4.14m and minus $9.44m. Clearly this project timing is not warranted in economic terms.

TABLE 4.11 - SUMMARY OF THE DISCOUNTED COSTS AND BENEFITS FOR EACH PROJECT CASE FOR IMPLEMENTATION BASED ON MAXIMISING NPV (1)

($m)

Item	Project Case 1 Discount Rate 7%	Project Case 1 Discount Rate 10%	Project Case 2 Discount Rate 7%	Project Case 2 Discount Rate 10%
COSTS				
Capital costs	4.58	2.74	5.49	2.68
Land acquisition	0.12	0.07	1.05	0.54
Operating costs	2.76	1.36	1.12	0.35
User access costs	0.03	0.02	0.15	0.05
Time access costs	0.02	0.01	0.05	0.02
Total Costs	7.51	4.20	7.86	3.64
BENEFITS				
Resource savings	9.76	4.81	3.94	1.22
Time savings	1.18	0.58	0.50	0.15
Post year 2000 net benefits	6.29	2.56	5.69	2.32
Total benefits	17.23	7.95	10.13	3.69
BENEFIT-COST RATIOS	2.29	1.89	1.29	1.01
NET PRESENT VALUES	9.72	3.75	2.27	0.05
IMPLEMENTATION DATES	1985	1988	1996	1998

(1) Costs common to Base and Project Cases are excluded. Costs and Benefits for the Townsville-Auckland route are excluded because it was found to be uneconomic.

Source: Annexes F and G.

When project timing is determined on the basis of maximum NPV, B/C ratios of 1.29 and 1.01 for 7 and 10 per cent discount rates are obtained. Corresponding NPV's are $2.27m and $0.05m and implementation dates are 1996 and 1998 respectively.

Although the results of assumption variations are not explicitly given for Project Case 2 an assessment of the response to these variations are given in Annex H. Since the direction of change brought about by each assumption variation in each project case would be equivalent, the only assumption changes capable of improving the NPV or bringing forward the maximum NPV implementation date are benefits to overseas visitors, changes of aircraft, resource costs and change of aircraft type. Further, because each of these changes represents a smaller proportional change in NPV for Project Case 2 than for Project Case 1 and due to the much later optimal timing of Project Case 2, it would not be possible to improve the results by implementing Project Case 2 prior to Project Case 1.

CHAPTER 5 CONCLUSION

On the basis of the evaluation results for each project strategy presented above, it can be concluded that Project Case 1 is a lower cost, higher return alternative than Project Case 2, and that on the basis of maximum NPV implementation, Project Case 1 could be economically warranted fully one decade earlier than Project Case 2. Further, the investigations revealed that this ranking of projects would be preserved under a wide range of assumption changes. However, the ranking of the two alternatives is not as clear-cut once non-pecuniary factors are considered.

In particular, Table 5.1 sets out the main non-pecuniary factors associated with the provision of international facilities at Townsville. The ordering used in this table is a simple ranking with no explicit weights applied. It indicates that Project Case 1 provides a superior alternative to the Base Case in terms of noise and operational limitations. With regard to environmental effects, Project Case 1 is preferable to Project Case 2 but is not preferable to the Base Case. Project Case 2 is preferable to Project Case 1 in terms of noise and operational limitations, but not with respect to the environment.

A definitive conclusion regarding strategy preference cannot be obtained without applying weights to the non-pecuniary factors and then trading off these costs against the quantified project benefits. Because of the need for value judgements in this process it should remain the prerogative of the decision maker rather than the analyst. Project Case 1 has greater operational disadvantages, greater noise nuisance, but less environmental damage than Project Case 2. This must be set against the $7.45m advantage, in present value terms using a 7 per cent discount rate, of Project Case 1 and its implementation in 1985 as compared with 1996.

TABLE 5.1 - COMPARISON OF NON-PECUNIARY EFFECTS AT TOWNSVILLE AIRPORT(1)

Non-pecuniary Parameter	Ranking(2)		
	1	2	3
Number of Operational Limitations	BC	PC1	PC2
Detrimental Environmental Effects	PC2	PC1	BC
Level of Noise Disturbance	BC	PC1	PC2

(1) For Project Case 1 (PC1) and Project Case 2 (PC2) and the Base Case (BC).

(2) A simple ordering according to magnitude with 1 as the highest.

Source: Annexes F and G.

On the basis of the evaluation results presented in the report, it should not be necessary to make a firm decision regarding the proposal prior to 1980. Additionally, the investigations revealed that the project timing is sensitive to certain key assumptions, particularly the development of a microwave landing system, the forecast level and the relative proportions of direct and transit flights. Consequently, it would be appropriate for the parameters underlying these assumptions to be monitored and any changes incorporated into the decision process.

Finally, the analysis presented in this report was conducted within a national framework using resource costs and benefits. Distributional or equity considerations are disregarded in such an approach because transfer payments between individuals or entities within the economy do not alter total resource costs and benefits. That is, the approach takes no account of individual losses or benefits which may result from redistributive effects of the project. In the case under consideration, there may well be equity considerations since much of the traffic which would use international facilities at Townsville is traffic converted from other international facilities within Australia. This issue is not canvassed in this report.

ANNEX A

SUBMISSIONS BY THE COUNCIL OF THE CITY OF CHARTERS TOWERS AND THE FEDERATION OF QUEENSLAND CHAMBERS OF COMMERCE

COUNCIL OF THE CITY OF CHARTERS TOWERS - NTH. QLD.

SUBMISSION [1]

Relating to a proposal for the
siting of an

INTERNATIONAL AIRPORT AT BREDDEN N.Q.

Preliminary

Proposals to establish an International Airport in North Queensland have been advanced by a number of organisations associated with the Tourist Industry.

More recently the Australian Government has examined certain locations in North Queensland to determine possible sites.

No doubt an International Airport in North Queensland would achieve a great deal for the betterment of its inhabitants. The vast northern areas would assume certain international standing in the eyes of the world and would result in the rapid expansion of an already fast-growing Tourist Industry of the many and varied attractions associated with the Great Barrier Reef with its coral and continental islands, adjacent tropical hinterland and the rich heritage of its past in old gold-mining cities and towns.

North Queensland is one of the fastest growing areas in Australia, well deserving of an International Airport.

However, the siting of such a facility is extremely important not only in the context of benefit to aviation and its demand on periphery services but also in the context of

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(1) The views expressed in this submission, received by the Minister for Tourism and Recreation on May 6, 1974, are not necessarily those of the Australian Department of Transport.

its ultimate effect on ecological processes and the close proximity of high-density urban areas.

The Charters Towers' City Council has expressed the view that an International Airport should not be established in areas which:-

(a) offer the basic minimum in desired safety levels;

(b) susceptible to adverse weather conditions;

(c) adjacent to fast developing urban areas;

(d) ecology would be adversely affected.

In short, the location of an International Airport must provide optimum planning advantages in the short and long-term to avoid counter-action at some further point in time.

Council believes that an International Airport should therefore not be located on the coast but at Bredden an old war-time air base used by long-range bomber aircraft.

In Council's opinion, Bredden (9 miles from Charters Towers) offers distinct advantages and is certainly not in conflict with its views so expressed above. These are expanded as follows:

1. It would appear that the existence of mountainous terrain in the coastal areas does not afford a high level of safety for large aircraft. In certain areas these ranges run to the coast creating intermittent valleys which do not permit long approach runs. The Bredden site however, has a relatively flat terrain clear of natural obstacles and hence ideally suited for long approach runs. This fact would no doubt have been established when it was decided to use Bredden as a base for long-range bombers.

ANNEX B

THE EFFECTS OF AIRPORT UPGRADING ON AUSTRALIAN OPERATORS

The possible effects of a new international airport at Townsville on Qantas and the two domestic airlines have been discussed in the IDC report; "The Feasibility of Establishing an International Airport at Townsville", March 1973. The main conclusion reached in the IDC study was that the domestic airlines would lose a substantial proportion of the domestic on-carriage of international traffic to and from the southern gateways in the short run. Nevertheless, in the longer term, it was believed that a new international airport at Townsville would benefit the domestic airlines, particularly through on-travel by overseas tourists visiting Townsville and the attraction of improved facilities to domestic tourists. Furthermore, the IDC report suggested potential gains to Qantas from generated tourism.

The analysis carried out in the present study confirms that there will be quite a substantial diversion of on-carriage international traffic from the domestic airlines in the event of international operations commencing at Townsville. An indication of the size of this diversion is shown in columns 5 and 6 of Table B.1 for the two projection levels used in the study. Most of the leakage is however, expected to be offset by the growth in domestic travel as was suggested in the IDC report.

The BTE could not substantiate the IDC view that the introduction of international services at Townsville will result in a marked increase in international travel to and from Australia. Thus, it has been assumed that most of the international passenger movements(1) that would make use of these services would be diverted from other international airports in Australia. The level of these movements is shown in columns 7 and 8 of Table B.1.

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(1) Both Australian residents travelling overseas and overseas visitors.

During the course of this study Qantas was given the opportunity to comment on the impact of the proposed developments on their operations. The two major domestic airline operators had previously commented on the proposal to develop Townsville as an international airport. A summary of their comments follows.

Estimates made by Trans-Australia Airlines (TAA), based on 1973 demand levels,(1) suggested that their loss of direct passenger movements on the Townsville route would amount to 6,900 movements per annum. Furthermore, losses to TAA on all routes between the southern capitals and North Queensland were expected to approach 14,000 passenger movements per annum in the event of international operations at Townsville. Ansett Airlines of Australia (AAA), on the other hand, expects the diversion of traffic from domestic services to international services to exceed 10,250 passenger movements per annum.(2) These estimates are based on 1972 demand levels. AAA also make the point, which is supported by BTE in this report, that

> "....Another gateway in the north would tend to divert traffic away from other parts of Australia. In other words, traffic currently entering through Sydney....could be diverted to the Townsville/Cairns area...."(3)

Both domestic airlines were also concerned about possible reductions in the average sector length travelled by international visitors on domestic flights. TAA estimate that this alone could represent a loss in their revenue of $600,000.

In a strong assertion of its belief that Australia cannot support another international airport, Qantas argued that the loss from the provision of even a weekly service from Townsville would be in the order of $800,000 per annum (estimated

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(1) These figures only relate to Townsville and may underestimate the effect on North Queensland as a whole.

(2) The AAA figure includes traffic to and from Papua-New Guinea.

(3) Quoted from correspondence received from AAA dated 26 January 1973.

TABLE B.1 - PROJECTED PASSENGER MOVEMENTS AT TOWNSVILLE TERMINALS (1) (2)

('000 passenger movements)

Year	Movements at the Domestic Terminal						Movements at the International Terminal	
	Base Case		Project Case		Difference		Project Case	
	Projection Level 1	Projection Level 2	Projection Level 1	Projection Level 2	Projection Level 1	Projection Level 2	Projection Level 1	Projection Level 2
1972	222.8	222.8	222.8	222.8	0.0	0.0	-	-
1975	295.4	284.0	295.4	284.0	0.0	0.0	-	-
1980	483.6	426.5	456.2	420.0	-27.4	-6.5	77.3	56.4
1985	816.5	640.0	740.8	652.6	-15.7	-12.6	193.2	104.9
			(717.8)	(626.8)	(-98.7)	(-13.2)	(178.8)	(93.3)
1990	1233.9	962.4	1073.1	975.5	-160.8	-13.1	350.1	176.2
1995	1866.7	1448.9	1517.6	1454.6	-349.1	5.7	653.9	299.1
2000	2827.3	2184.3	2206.4	2147.8	-620.9	-36.5	1111.9	527.5

(1) This table refers to Project Case 2, implementation in 1980. The figures shown in parentheses are the figures for the first year of international operations for Project Case 1 (1985). All subsequent figures in the series are identical for both project cases.

(2) Projection level 1 is based on a growth in passenger movements of 17.5 per cent per annum to 1985 and 9 per cent per annum for the period 1985 to the year 2000. Projection level 2 is based on 9 per cent per annum growth throughout the projection period.

in 1975 dollars). This argument was based on expected developments in the cost recovery requirements of the Australian Department of Transport. Qantas also argues that

> "....A minor uplift port in Australia can never become a terminal because of maintenance and crewing problems so that it must be an additional port of call, thus compounding airline costs."(1)

The airline costs mentioned above are made up of increased landing and navigational charges throughout Australia, crew utilisation costs and the costs of positioning aircraft.

The additional crew costs include accommodation and crew positioning. Approximate estimates of the additional crew costs have been made by Qantas on the basis of one flight per week to each of the three destinations Nadi, Singapore and Auckland. The estimates for these destinations in 1975 values are $0.35m, $0.05m and $0.35m respectively. These have not been included in the analysis because they are transfer payments. However, from the point of view of the operators they do represent real financial costs. Discussions with Qantas also indicated that air fares may not reflect the resource costs involved in flying a specific route because of the conference method used for setting international airfares from Australia.

Scheduling constraints have also been foreshadowed by the operators due to the relative isolation of Townsville, particularly in the early stages of operations when service frequency is low.

The views expressed by the airlines are based on the financial costs that they are likely to incur whereas this study evaluates the proposals from a national point of view. Operationally, the social gain from international services may

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(1) Quoted from correspondence from Qantas dated 31 January 1975.

only be realised if some financial incentive is used to attract the airlines to use Townsville. This is especially so under the current method of fare setting which is not closely related to the resource costs involved in providing services on particular routes. In effect, this means that the whole of the resource cost savings may not be passed on to the air travellers in terms of reduced fares.

ANNEX C

ENVIRONMENTAL EFFECTS OF THE AIRPORT PROPOSALS

The main source of information concerning the environmental effects of the various airport development proposals was the report prepared by the then Department of Civil Aviation in 1973.[1] Additional information has subsequently been made available by the Department of Environment and Conservation. An examination is also made of the effects of the extension of the main runway (01/19), which was not considered in detail in the above statement.

The environmental characteristics of each project case are discussed under two general headings; effects on the natural environment and noise. A valuation of the former in money terms was found to be impossible because of their non-pecuniary nature and the lack of appropriate measures. An environmental comparison of the two project cases with the Base Case is therefore made on a purely descriptive basis. Fortunately this results in clear and unequivocal conclusions.

Noise, on the other hand, is treated in a more rigorous fashion because noise exposure forecasts (NEF) and noise exposure concepts (NEC) were developed for both the Project and Base Cases. In order to provide a measure of the relative noise nuisance for each alternative, a count was made of the number of houses within the 25 NEF zone.

EFFECTS ON THE NATURAL ENVIRONMENT

The Town Common, on which Project Case 2 would have the greatest impact, is illustrated by Figure C.1. It includes a wide variety of unspoiled eco-systems which have been retained as a fauna and flora reserve. They include salt tolerant

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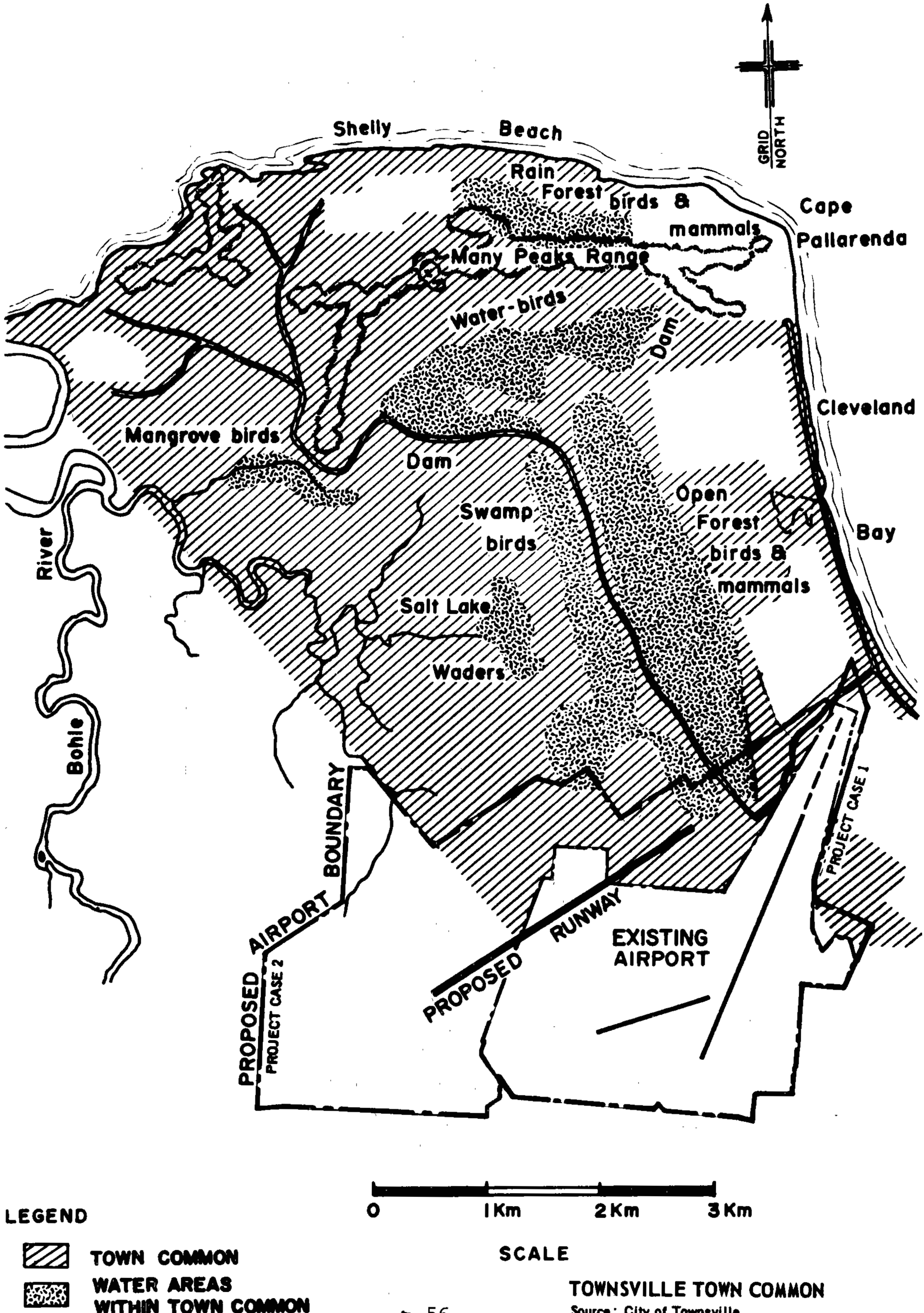
(1) "Environmental Impact Statement - Establishment of an International Airport at Townsville", March 1973.

FIGURE C1



TOWNSVILLE TOWN COMMON

Source: City of Townsville Town Common Advisory Committee habitats, mangroves and fresh water swamps surrounded by sand ridges and open woodlands. Towards the north of the Town Common, adjacent to the Many Peaks Range, the vegetation varies from open woodland to rain forest. However, environmentalists regard the tracts of land in the northern sector, away from the existing and proposed airport sites, as the more valuable. The land to be acquired from the Town Common for the proposed extension of the airport boundary is predominantly low lying.

The Town Common contains over 7,700 hectares of varying habitat and constitutes a unique reserve attracting many visitors. The Townsville City Council, which manages the Common, plans to develop the area as an educational and scenic site with controlled public access.

Project Case 2 involves the acquisition of about 766 hectares of the southern part of the Common. This area is generally grassland and tidal flats and includes 'St John's Lagoon' which is a drought refuge for the Town Common fauna. This lagoon would have to be filled and replaced in the event of a new runway being constructed on alignment 05/23. It is expected that any land acquired from the Town Common would have to be replaced by limiting fencing in the Australian Government transmitter site.

On the other hand, Project Case 1 requires the extension of the existing runway on alignment 01/19. This would involve minimal acquisition of land which would be located in the Town Common away from the more critical environmental areas. The acquisition consists of 38.6 hectares which is significantly less than that proposed for Project Case 2.

Other major environmental aspects of increased aviation activity at Townsville Airport relate to bird strikes, water courses and drainage and recreational facilities.

Bird Strikes

Available evidence supports the view that bird strikes are more frequent at Townsville than they have been at Brisbane Airport, but less frequent than at many other North Queensland airports. As aircraft movements increase, the incidence of strikes is likely to worsen. This may be offset by the construction of artificial ponds in the northern part of the Town Common to attract birds away from the airport. Development plans to this effect have been proposed by the Townsville City Council. The closer proximity of the runway to the Town Common in Project Case 2, may have been expected to cause a larger number of bird strikes than the Project Case 1 development plan. However, available evidence and advice from the Queensland Department of Primary Industries suggests that proximity of the airport to the Town Common will have no effect on the number of bird strikes per aircraft movement.

Water Courses and Drainage

The conflict between the airport development proposals and the existing drainage patterns of Louisa Creek, which runs from north to south, and the Bohle River on the western perimeter of the existing airport is potentially one of the more serious environmental problems. A new runway on alignment 05/23 would require changes to the existing Town Common drainage system, either by creek diversion or an underground drainage system. Excavations to the Bohle River would probably be required in order to alleviate the problem, although this would be mainly on Town Common land.

On the positive side it is likely that an improvement in the drainage of the industrial area south of the existing airport would result from the creek diversion.

Recreational Facilities

The Town Common is popular with tourists. It attracted approximately 80,000 visitors in the year ending March 1973.(1) The major recreational areas are located to the northern end of the Town Common where walking tracks lead into the foothills of the Many Peaks Range. As a result, neither of the proposed airport developments are likely to interfere with the recreational value of the Town Common.

NOISE

The second major environmental consideration is noise. To measure the relative effect of international operations on the surrounding residential areas, noise contours have been derived. The contours were determined by the Environment and Security Branch of the Airways Operations Division of the Department of Transport. They are for the year 1985 and are based on the assumption that international operations would have commenced by then. They employed the aircraft movement forecasts reported in Annex E. They also assume that movements are distributed according to the landing and take-off patterns used under 1975 noise abatement procedures.

Noise Forecasts

The noise exposure forecasting technique used was developed in the United States and adapted for Australian conditions by the Department of Transport.(2) Essentially a noise exposure forecast (NEF) relates to the noise emitted by aircraft landing and taking-off from established runways. A noise exposure concept (NEC) is an equivalent measure used to

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(1) IDC Report op.cit. (March 1973).

(2) In particular the Department of Transport has added a buffer zone of 5 NEF (NEC) units to the U.S. standard, set out in the land compatibility table accompanying Figure C.2.

predict noise levels on potential runways.

NEF's and NEC's relate noise to community response and are mainly used as relative measures of the nuisance effect on areas surrounding airports. A higher value implies higher noise level. A table relating NEF and NEC measures to land use compatibility standards is shown in the notes accompanying Figure C.2. Thus for example, an NEF of 30 is reckoned as compatible with residential areas. Note that in Australia an additional buffer of 5 NEF points is used.

Exposure levels are calculated on the basis of data concerning:

"(i) the magnitude and duration of noise determined by aircraft type, weight and flight profile;

(ii) the distribution of noise energy over the spectrum of audible frequencies;

(iii) the frequency of aircraft movements on various flight paths; and

(iv) the distribution of aircraft movements by day and night."[1]

The basic formula used is

$$\mathrm{NEF(NEC)} = \mathrm{EPNL} + 10 \log_{10} N - C \qquad \text{....(c1)}$$

where N = number of movements on a given flight path

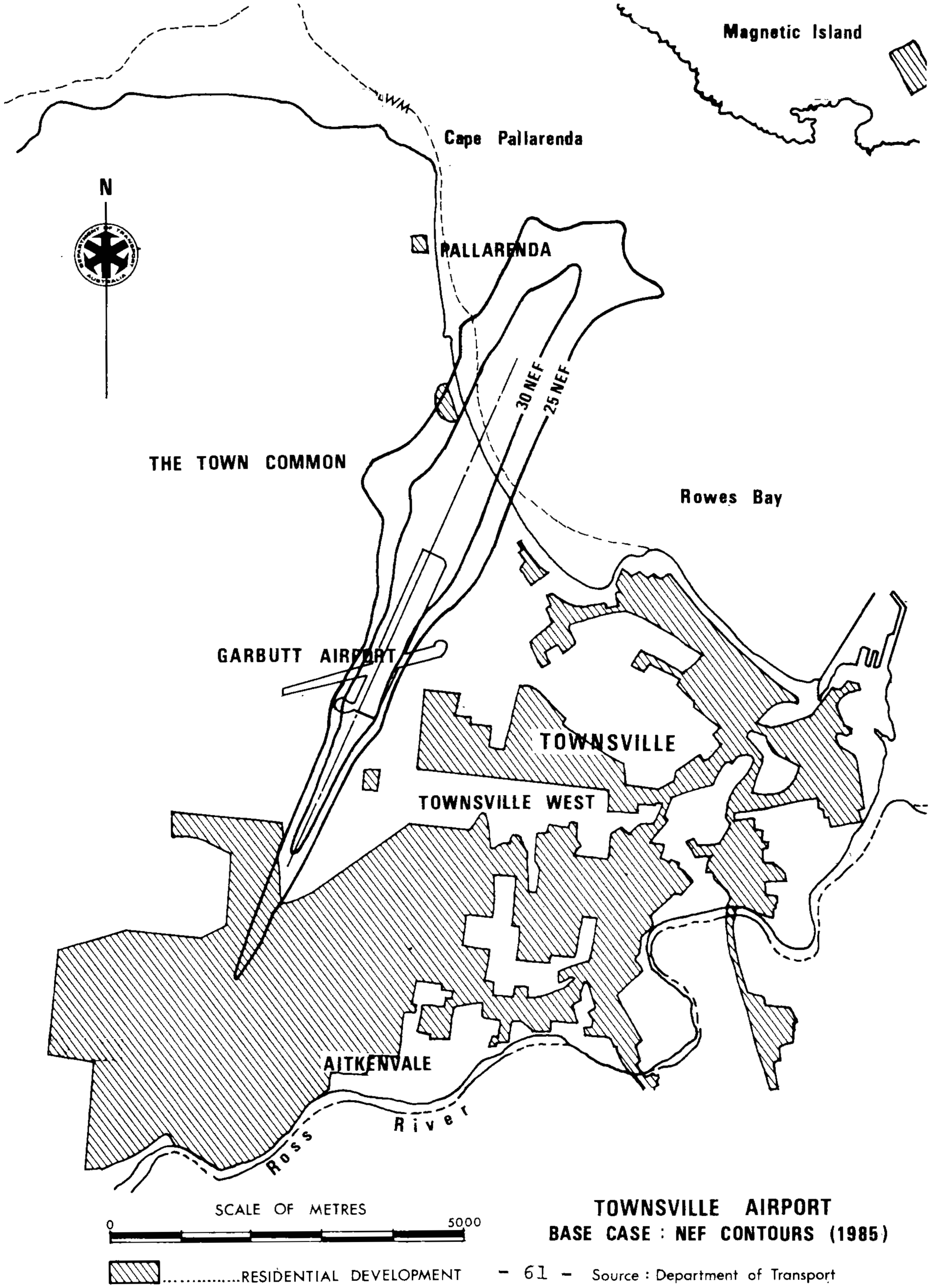
C = +88 for the period 0700-2200 hours (day)

= +75 for the period 2200-0700 hours (night)

EPNL = effective perceived noise level.

(1) Department of Transport, "Noise Exposure Forecasts", Melbourne, August 1974.

FIGURE C2



TOWNSVILLE AIRPORT
BASE CASE : NEF CONTOURS (1985)

Source : Department of Transport

NOTES ACCOMPANYING FIGURE C.2

NOISE EXPOSURE FORECAST

A Noise Exposure Forecast (NEF) is primarily intended as a land use planning tool around airports and as such is an illustration of the Department of Transport's best estimate of the aircraft noise exposure at a particular site at some future date.

A GUIDE TO LAND USE COMPATIBILITY

Land use	Noise level		
	Less than 30 NEF	30-40 NEF	Above 40 NEF
Residential	Yes	- (2)	No
Hotel, Motel, Offices, Public Buildings	Yes	Yes (3)	No
Schools, Hospitals, Churches, Indoor Theatres, Auditoriums	Yes (3)	No	No
Commercial, Industrial	Yes	Yes	- (3)
Outdoor Amphitheatres, Theatres	Yes (1) (3)	No	No
Outdoor Recreational (Non-Spectator)	Yes	Yes	Yes

(1) A detailed noise analysis should be undertaken by qualified personnel for all indoor music auditoriums and all outdoor theatres.

(2) Case history experience indicates that individuals in private residences may complain, perhaps vigorously. Concerted group action is possible. New single-dwelling construction should generally be avoided. For apartment construction, Note (3) applies.

(3) An analysis of building noise reduction requirements should be made and needed noise control features should be included in the design.

NOTE: This table may be adjusted for Australian conditions by including a buffer of 5 NEF units to the three zones i.e. the categories used in the Table would read, from left to right, less than 25 NEF, 25-35 NEF and above 35 NEF.

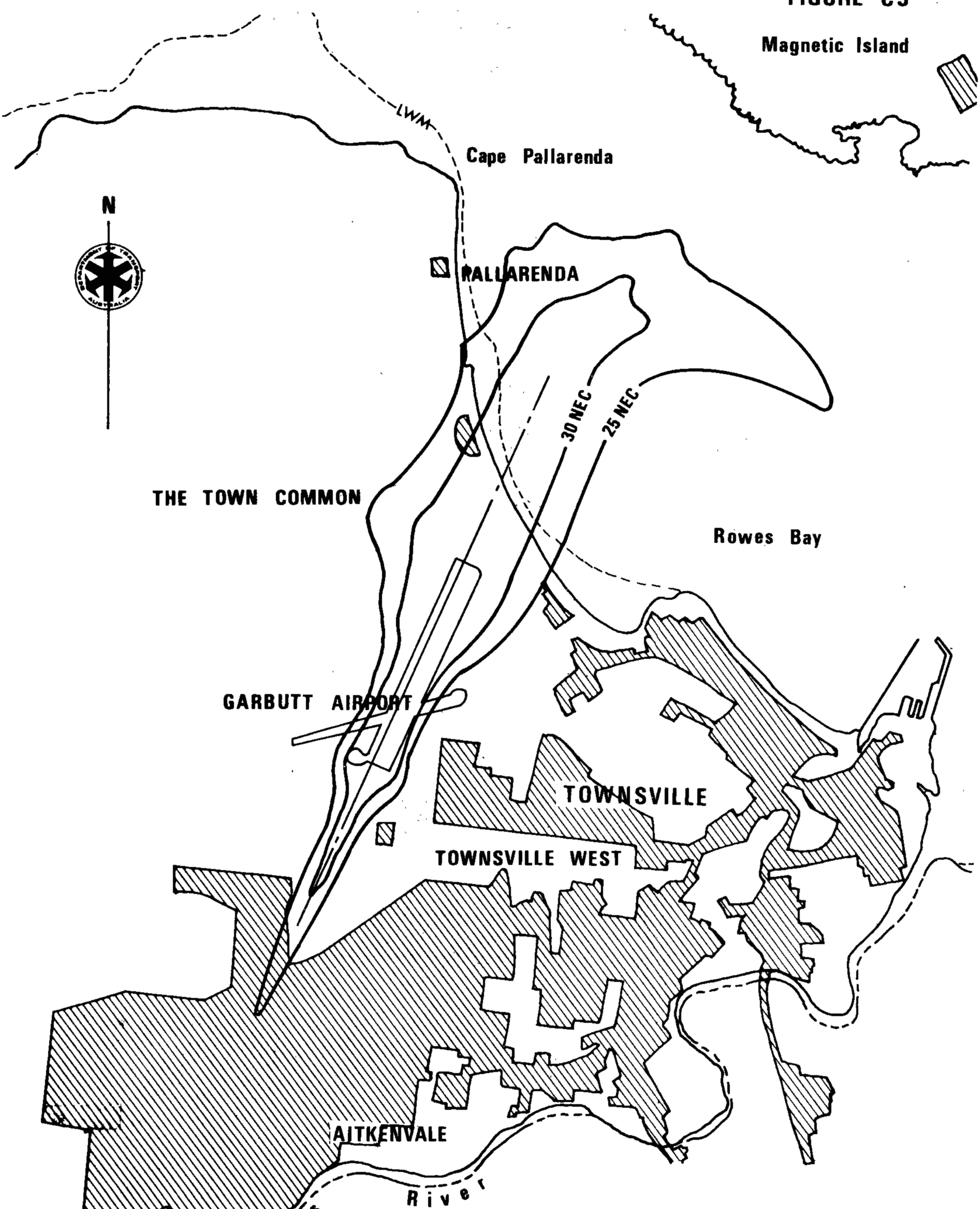
Source: FAA DS-67-10 "Procedures for Developing Noise Exposure Forecast Areas for Aircraft Flight Operations" August, 1967.

NOTES ACCOMPANYING FIGURE C2 (CONT.)

01	DEP	ARR
DAY	90	56
NIGHT	12	8
TOTAL	102	64

19	DEP	ARR
DAY	11	33
NIGHT	0	9
TOTAL	11	42

FIGURE C3



SCALE OF METRES

0 5000

TOWNSVILLE AIRPORT

PROJECT CASE 1 : NEC CONTOURS (1985)

▨ ....RESIDENTIAL DEVELOPMENT

Source : Department of Transport

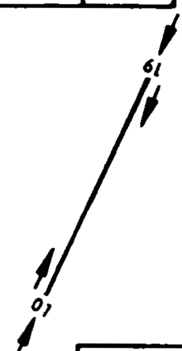
NOTES ACCOMPANYING FIGURE C3

THIS DRAWING IS NOT AN NEF

A NOISE EXPOSURE CONCEPT (NEC) IS AN ILLUSTRATION OF THE AIRCRAFT NOISE EXPOSURE AT A SITE USING DATA WHICH MAY BEAR NO RELATIONSHIP TO THE ACTUAL OR FUTURE SITUATION. ITS PRIMARY FUNCTION IS TO ASSESS THE NOISE EFFECTS OF VARIOUS OPERATIONAL OR AIRPORT DEVELOPMENT ALTERNATIVES. NECS ARE USED FOR PARTICULAR INVESTIGATIONS AND SHOULD NOT BE USED FOR DEFINITIVE LAND USE ZONING. FOR INTERPRETATION OF THE CONTOURS SHOWN THE DEPARTMENT OF TRANSPORT LAND USE COMPATABILITY TABLE IS APPROPRIATE.

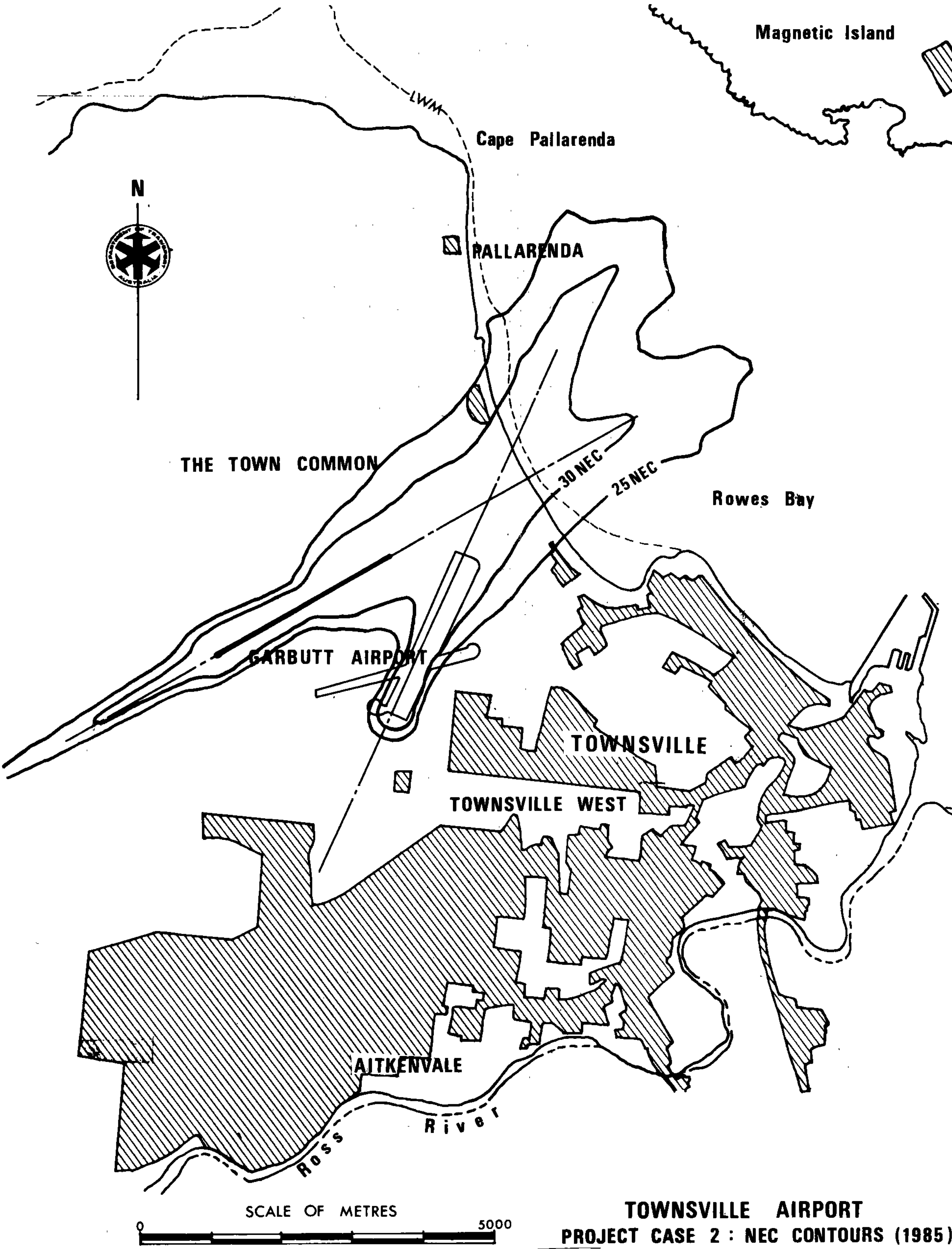
THE CURRENT STATUS OF THIS DRAWING MAY BE ASCERTAINED BY CONTACTING THE DEPARTMENT OF TRANSPORT

19	DEP	ARR
DAY	9	49
NIGHT	1	14
TOTAL	10	63



01	DEP	ARR
DAY	101	57
NIGHT	15	8
TOTAL	116	65

FIGURE C4



TOWNSVILLE AIRPORT
PROJECT CASE 2 : NEC CONTOURS (1985)

..............RESIDENTIAL DEVELOPMENT

Source : Department of Transport

NOTES ACCOMPANYING FIGURE C4

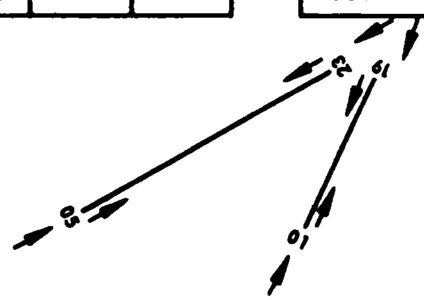
THIS DRAWING IS NOT AN NEF

A NOISE EXPOSURE CONCEPT (NEC) IS AN ILLUSTRATION OF THE AIRCRAFT NOISE EXPOSURE AT A SITE USING DATA WHICH MAY BEAR NO RELATIONSHIP TO THE ACTUAL OR FUTURE SITUATION. ITS PRIMARY FUNCTION IS TO ASSESS THE NOISE EFFECTS OF VARIOUS OPERATIONAL OR AIRPORT DEVELOPMENT ALTERNATIVES. NECS ARE USED FOR PARTICULAR INVESTIGATIONS AND SHOULD NOT BE USED FOR DEFINITIVE LAND USE ZONING. FOR INTERPRETATION OF THE CONTOURS SHOWN THE DEPARTMENT OF TRANSPORT LAND USE COMPAT ABILITY TABLE IS APPROPRIATE.

THE CURRENT STATUS OF THIS DRAWING MAY BE ASCERTAINED BY CONTACTING THE DEPARTMENT OF TRANSPORT

23	DEP	ARR
DAY	0	35
NIGHT	0	12
TOTAL	0	47

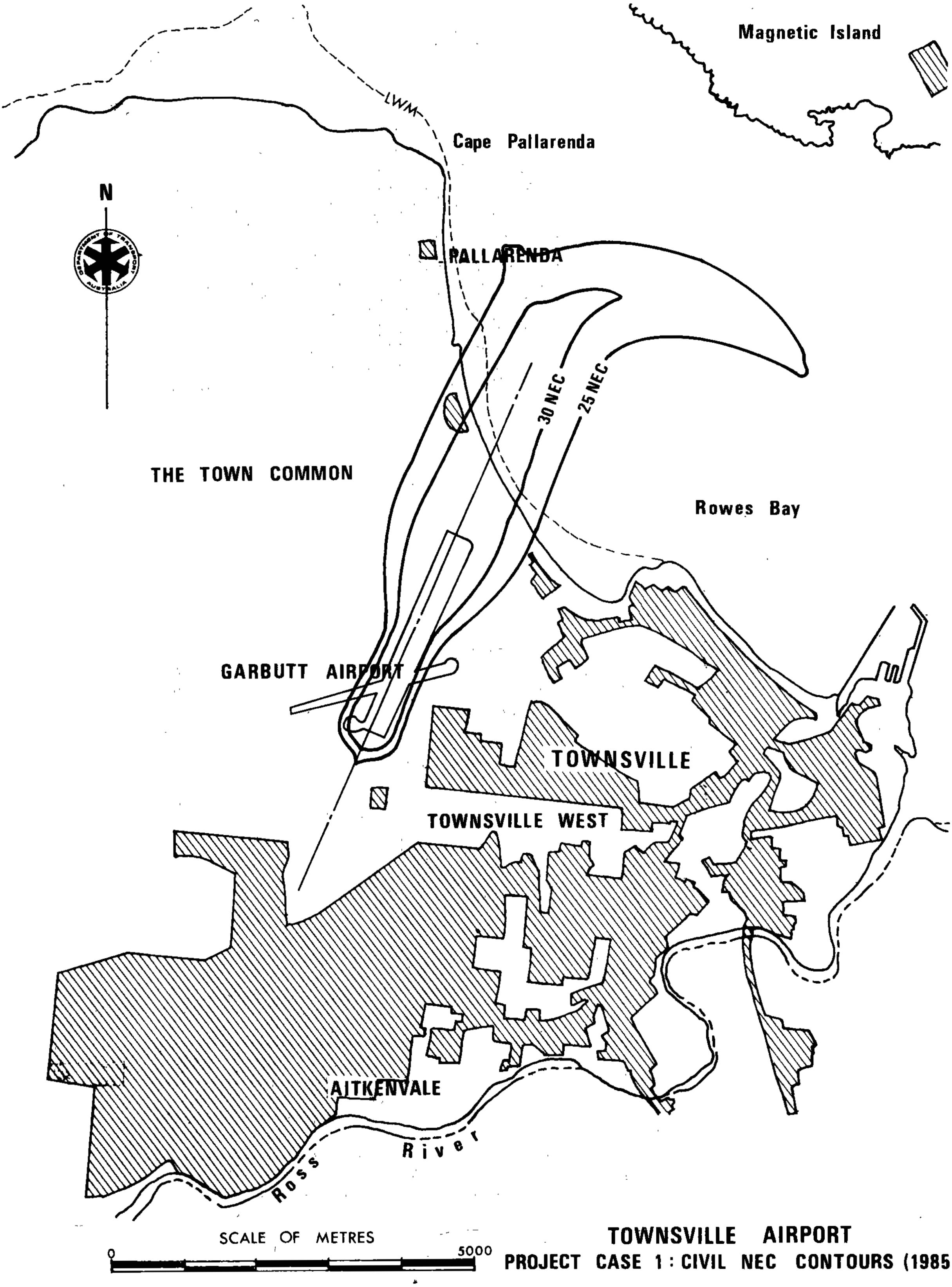
19	DEP	ARR
DAY	10	16
NIGHT	0	0
TOTAL	10	16



05	DEP	ARR
DAY	5	4
NIGHT	3	0
TOTAL	8	4

01	DEP	ARR
DAY	94	50
NIGHT	16	8
TOTAL	110	58

FIGURE C5



TOWNSVILLE AIRPORT
PROJECT CASE 1 : CIVIL NEC CONTOURS (1985

▨ ....RESIDENTIAL DEVELOPMENT

Source : Department of Transport

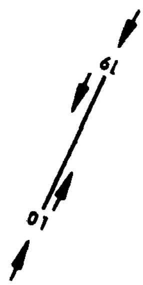
NOTES ACCOMPANYING FIGURE C5

THIS DRAWING IS NOT AN NEF

A NOISE EXPOSURE CONCEPT (NEC) IS AN ILLUSTRATION OF THE AIRCRAFT NOISE EXPOSURE AT A SITE USING DATA WHICH MAY BEAR NO RELATIONSHIP TO THE ACTUAL OR FUTURE SITUATION. ITS PRIMARY FUNCTION IS TO ASSESS THE NOISE EFFECTS OF VARIOUS OPERATIONAL OR AIRPORT DEVELOPMENT ALTERNATIVES. NECS ARE USED FOR PARTICULAR INVESTIGATIONS AND SHOULD NOT BE USED FOR DEFINITIVE LAND USE ZONING. FOR INTERPRETATION OF THE CONTOURS SHOWN THE DEPARTMENT OF TRANSPORT LAND USE COMPAT ABILITY TABLE IS APPROPRIATE.

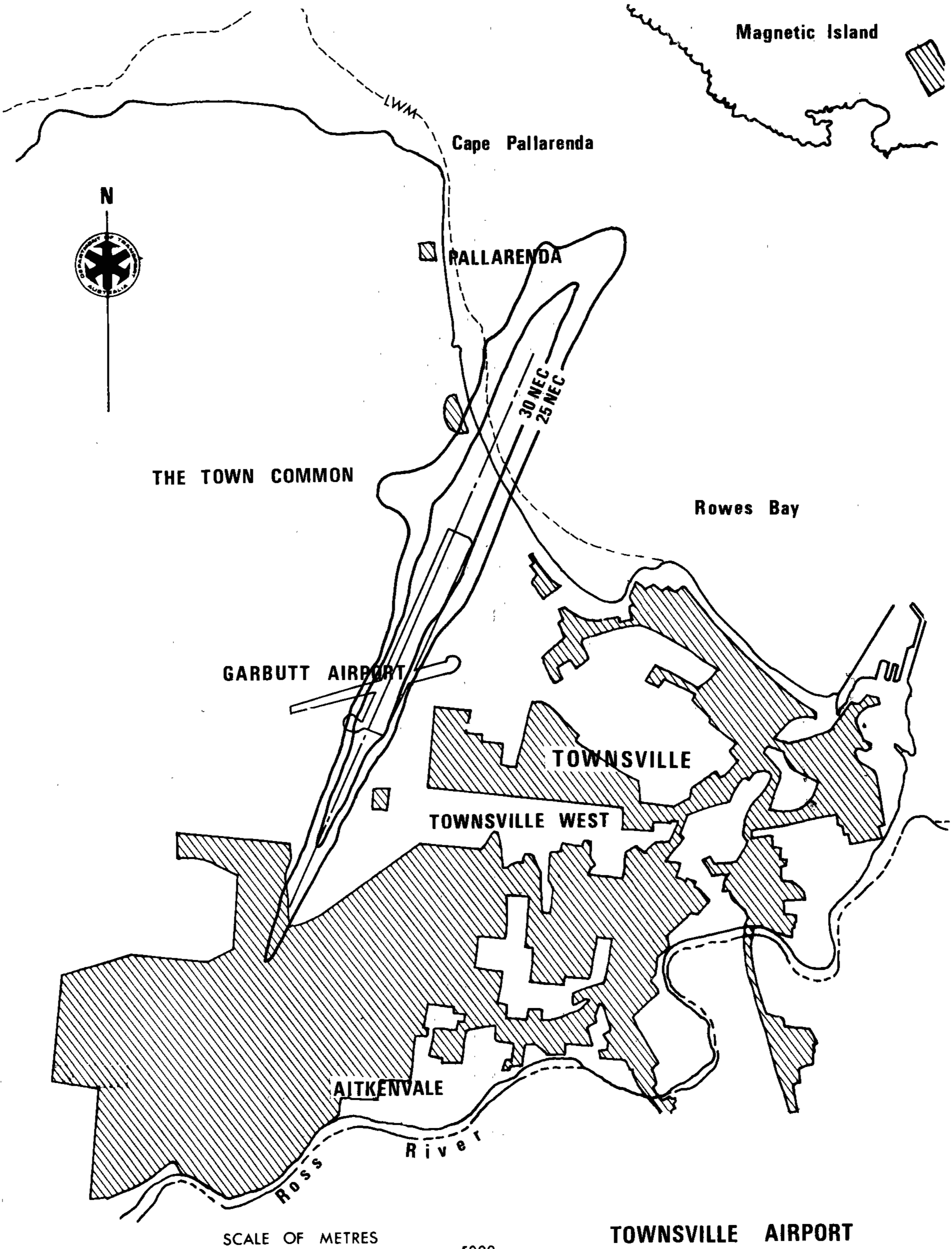
THE CURRENT STATUS OF THIS DRAWING MAY BE ASCERTAINED BY CONTACTING THE DEPARTMENT OF TRANSPORT

19	DEP	ARR
DAY	1	33
NIGHT	0	14
TOTAL	1	47



01	DEP	ARR
DAY	39	7
NIGHT	9	0
TOTAL	48	7

FIGURE C6



TOWNSVILLE AIRPORT
PROJECT CASE 1 : RAAF NEC CONTOURS (1985)

Source : Department of Transport

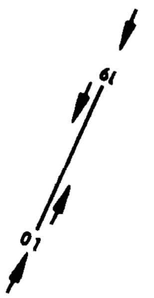
NOTES ACCOMPANYING FIGURE C6

THIS DRAWING IS NOT AN NEF

A NOISE EXPOSURE CONCEPT (NEC) IS AN ILLUSTRATION OF THE AIRCRAFT NOISE EXPOSURE AT A SITE USING DATA WHICH MAY BEAR NO RELATIONSHIP TO THE ACTUAL OR FUTURE SITUATION. ITS PRIMARY FUNCTION IS TO ASSESS THE NOISE EFFECTS OF VARIOUS OPERATIONAL OR AIRPORT DEVELOPMENT ALTERNATIVES. NECS ARE USED FOR PARTICULAR INVESTIGATIONS AND SHOULD NOT BE USED FOR DEFINITIVE LAND USE ZONING. FOR INTERPRETATION OF THE CONTOURS SHOWN THE DEPARTMENT OF TRANSPORT LAND USE COMPAT ABILITY TABLE IS APPROPRIATE.

THE CURRENT STATUS OF THIS DRAWING MAY BE ASCERTAINED BY CONTACTING THE DEPARTMENT OF TRANSPORT

19	DEP	ARR
DAY	9	16
NIGHT	0	0
TOTAL	9	16



01	DEP	ARR
DAY	62	50
NIGHT	6	8
TOTAL	68	58

The general level of annoyance has been estimated to logarithmically increase with the number of similar noise events heard each day. Hence the second component in the formula is designed to take account of repetitive noise levels and also allows for different noise sensitivities between the day and night.

A noise exposure contour defines a zone of noise annoyance equal to or greater than the level of noise attached to that contour. For example, the 25 NEF contour encloses an area within which noise is greater than or equal to 25 NEF units.

There have been several recent developments in noise forecasting which are not incorporated in the forecasts presented in this Annex.

Firstly, the noise contours are based on the assumption that DC9 aircraft would be retrofitted with quieter engines by 1985. However, DC9's have recently been accepted as meeting Federal Aviation Regulations (FAR) noise certification requirements and hence retrofitting is unlikely in the foreseeable future. This will tend to involve a marginal broadening of the noise contours shown in Figures C.2 to C.5.

Secondly, the techniques used by the Department of Transport for the preparation of airport noise exposure plans have recently been reviewed and it is expected that the modified methodology will increase the noise affected areas. It has not been possible to incorporate these changes into this study.

It would normally be expected that each of the Project and Base Cases would be affected proportionately by these changes. However, it is likely that Project Case 1 and the Base Case would be more affected than Project Case 2. This is because a greater number of houses are on the fringe of the 25 NEF/NEC contours associated with these strategies than is the case for Project Case 2, which is surrounded by a low population density area.

Other factors may also worsen the noise contours presented in this report. For example it is probable that current noise abatement procedures will have to be modified in the future to expand the runway capacity. In addition the curved flight paths postulated for runway 01, as discussed in Annex I, may change the contour pattern in such a way that increased disturbance is generated over the south western suburb of Aitkenvale.

On the other hand, there are several factors working towards contraction of the noise contours.

Firstly, the contours are based on level 1 passenger demand projections which provides an upper limit to aircraft movements, and hence noise disturbance.

Secondly, as is discussed in more detail below, the major cause of noise appears to be derived from military rather than civil aircraft movements. In 1975 actual military movements were substantially lower than those projected in the IDC study and reported in Table E.1 of Annex E.

Thirdly, aircraft types used on international routes to and from Townsville may vary from those assumed in preparing the noise forecasts. If B747 aircraft were substituted for B707 aircraft (examined in Annex H), the noise benefits would be twofold; reduced aircraft movements and reduced effective perceived noise level for each movement.

Finally, no account is taken of possible developments in aviation technology which could substantially change the noise characteristics of both domestic and international aircraft.

This of course is a long run consideration, although trends towards quieter aircraft are already apparent.[1]

Noise Exposure Contours at Townsville

Noise contours at Townsville for the Base and Project Cases in 1985 are shown in Figures C.2 to C.4. They are drawn on the basis of the high projection level discussed in Annexes D and E.

An examination of the 25 NEF contour in each case reveals that the Base Case 25 NEF contour (Figure C.2), extends further into the southern residential areas than the equivalent contours for Project Cases 1 and 2 (Figures C.3 and C.4 respectively). This is despite the slightly larger number of passengers involved in the latter instances. The main difference is that modern international aircraft are significantly larger and generally cause less noise per passenger than smaller domestic aircraft which require more movements to move the same number of passengers. Hence it can be shown for 1985 that the project case strategies are superior to the Base Case in terms of noise nuisance. Further, by scrutinising aerial photographs it is possible to determine that the number of residences within the 25 NEF contour in 1985 would fall from 85 in the Base Case to 7 in Project Case 1 and 6 in Project Case 2. This ranking is unlikely to be reversed in the period beyond 1985 to the year 2000.

A comparison of Figures C.5 and C.6 shows that military movements at Townsville are the predominant cause of noise disturbance. To a large extent RAAF aircraft noise can be attributed to jet aircraft such as the Mirage which, whilst not based at Townsville, use the airport for training purposes

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(1) One extreme is in the development of short take-off and landing (STOL) aircraft as substitutes for conventional aircraft types.

and as a stop-off point. It must be emphasised that the two noise components shown in Figures C.5 and C.6 cannot be simply summed to give the NEC contours shown in Figure C.3, because of the logarithmic term in the NEF formula. There is sufficient evidence however, to be able to conclude that RAAF movements alone would produce a significant level of noise annoyance which would approach the combined level of both RAAF and civil movements.

RAAF Noise Rating Analysis at Townsville

The siting of the international terminal in Project Case 1 has caused some concern among officers of the Department of Defence (Air). The main issue is the possible conflict between the new RAAF domiciliary quarters planned for the Belgian Gardens area and aircraft apron noise from the proposed international terminal for Project Case 1.

In order to measure the likely disturbance caused by international operations on the Project Case 1 development proposal, RAAF noise rating (RNR) contours were drawn up. RNR contours are designed as measures of noise supplementary to the NEF and NEC contours. They were prepared by the National Accoustics Laboratories for the Department of Defence.

Input for the preparation of RNR contours is similar to that for the NEF contours. However, they only take account of surface noise. In Figure C.7, RNR noise contours are presented showing the extent to which international operations in Project Case 1 are likely to affect the environment of the RAAF quarters at Belgian Gardens. Virtually all the planned residential quarters for RAAF personnel will be outside the 25 RNR contour as they lie to the eastern side of the area provided for residential development.

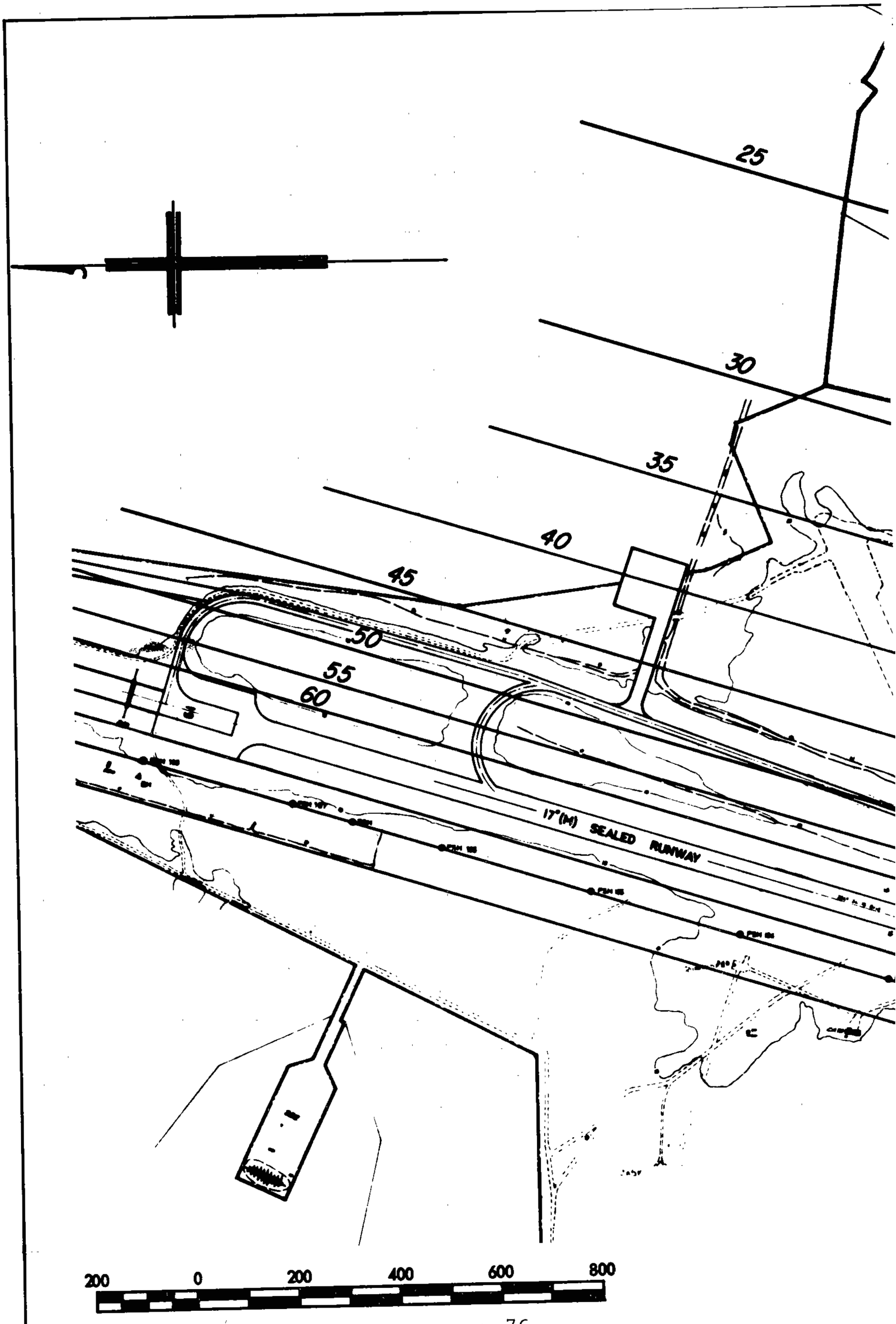
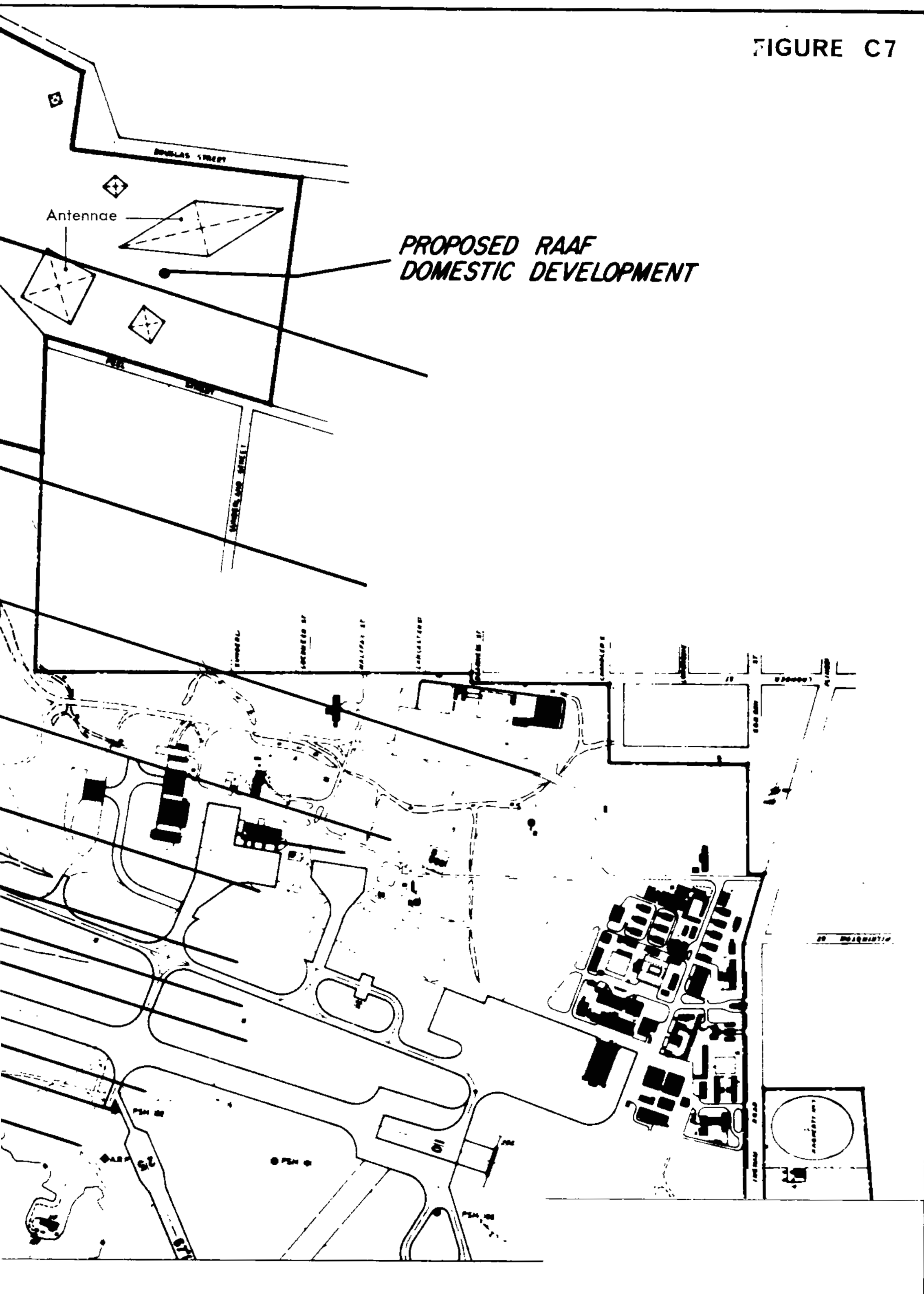

25
30
35
40
45
50
55
60
17°(M) SEALED RUNWAY
200
0
200
400
600
800
Scale of Metres

FIGURE C7



TOWNSVILLE AIRPORT
RAAF NOISE RATING CONTOUR 1985

Source : Department of Defence
Branch of the Director General of Accommodation & Works - Air Force

ANNEX D

PASSENGER MOVEMENT PROJECTIONS

The practicability of establishing an international airport at Townsville depends on two main factors. Firstly, the level of total demand at which international services become operationally efficient. Secondly, the number of overseas trips by Australian residents through the proposed international terminal. It is the level of demand by these particular passengers which is assumed to influence the economic viability of the project from a national point of view. Consequently, total user demand projections at Townsville have been broken into their main components.

As this study is confined to the planned international facilities at Townsville, domestic airport user projections have only been carried out to determine the extent to which they may affect the operation or capacity of the proposed international facilities. However, the physical separation of the domestic and international terminals in the project strategies reduces the possibility of any conflict in resource use between the two aviation services.

These projections are presented and explained below. Those most relevant to the international airport evaluation are discussed in greater detail.

ANALYSIS OF PASSENGER MOVEMENT FLOWS

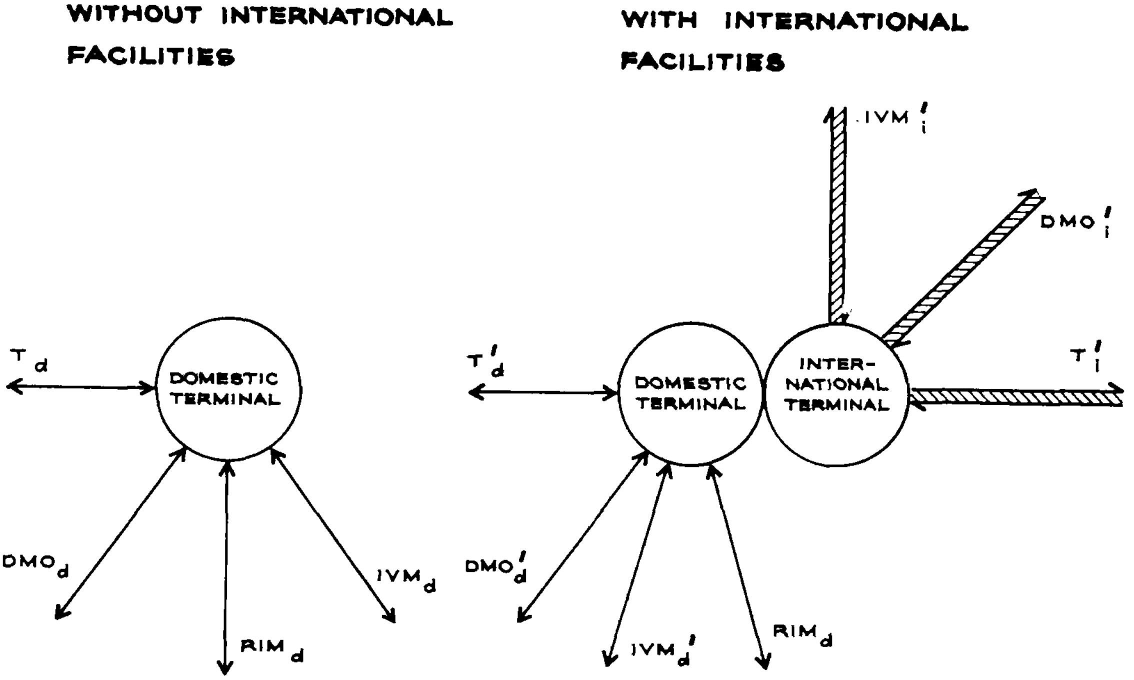
A simplified diagram illustrating international and domestic passenger movements is shown in Figure D.1. The abbreviations used in this diagram are used throughout the Annex.

Passenger flows have been divided into three categories; overseas visitors passing through the international terminal at Townsville, Australian residents travelling overseas via Townsville International Airport and finally the flows through

FIG. D1

TOWNSVILLE AIRPORT

SCHEDULED PASSENGER MOVEMENT FLOWS



LEGEND :

T	TRANSITS
DMO	DOMESTIC MOVEMENTS OVERSEAS
IVM	INTERNATIONAL VISITOR MOVEMENTS
RIM	RESIDUAL INTERNAL MOVEMENTS
IM	TOTAL INTERNAL MOVEMENTS
d	DOMESTIC AIRLINE
i	INTERNATIONAL AIRLINE
'	EX POST INTERNATIONAL AIRPORT CONSTRUCTION

Townsville's domestic terminal. Each of these three flows has been expressed in terms of passenger movements. A passenger movement is defined as either an embarkation or disembarkation from an aircraft.

The relationships used to derive the final passenger flow projections are summarised in equations (d1) to (d7).

TM_d	=	$IVM_d + DMO_d + RIM_d + T_d = IM$	....(d1)
IVM'_d	=	$x_1 IVM'_i + x_2 OVT'$	....(d2)
TM'_i	=	$IVM'_i + DMO'_i + T'_i$	....(d3)
DMO'_i	=	$(1 - x_3) DMO$	....(d4)
TM'_d	=	$IVM'_d + DMO'_d + RIM'_d + T'_d$	....(d5)
DMO	=	$x_4 P$	....(d6)
IPM	=	$IVM'_i + DMO'$	....(d7)

The notation used is as follows:

TM	=	total movements,
T	=	transits,
DMO	=	domestic movements overseas,
IVM	=	international visitor movements,
RIM	=	residual internal movements,
IM	=	total internal movements,
IPM	=	potential international passenger movements,
OVT	=	overseas visitors to Townsville by air,
P	=	population,
x_1	=	proportion of 'on-travelling' international visitors; 'further travel' coefficient,
x_2	=	proportion of OVT using domestic flights; 'indirect visitor' coefficient,
x_3	=	factor for the leakage of North Queensland resident travellers to international flights through the southern gateways; DMO leakage coefficient,
x_4	=	propensity for scheduled travel overseas,

and the subscript 'd' refers to domestic, the subscript 'i' refers to international and a prime indicates post airport construction.

Overseas Visitor Projection

The Department of Tourism and Recreation has provided information on future international visitor movements through Townsville Airport. Two projections based on this information are presented in Table D.1. Column 1 shows the number of international visitors with no international airport development at Townsville, whilst column 2 shows the projection adjusted for the establishment of international facilities.

A small generation of visitors to Townsville is incorporated in these projections. This is assumed to occur as a 'once and for all' change in international visitor numbers in the first two years of international operations which are assumed to be 1980 and 1981 for Project Case 2 and 1985 and 1986 for Project Case 1. This is based on an assumption that demand levels would take two years to adjust to the provision of international facilities. Unfortunately the nature of statistics concerning international visitor movements to Australia makes such estimates highly speculative. However, these projections do not have a direct effect on project benefits as they are used only to determine the approximate number of potential aircraft movements at the proposed international terminal.

The most likely number of direct international movements is shown in column 3 of Table D.1 and is equal to column 2 multiplied by one minus the indirect visitor[(1)] coefficient. The indirect visitor coefficient represents the proportion of direct to total visits by overseas visitors. Estimates of this coefficient were obtained for Brisbane and Perth and averaged to give an indirect visitor coefficient of 0.56 for Townsville. Data on which this estimate was based is given in Table D.2.

---

(1) An indirect visitor is one who visits Townsville via an alternative international gateway.

TABLE D.1 - INTERNATIONAL VISITORS TO TOWNSVILLE

('000 visitors)

Year	Overseas Visitors with no International Airport	Overseas Visitors with International Airport	
		Total	Through the International Terminal
1972	15.0	15.0	
1973	16.5	16.5	
1974	18.2	18.2	
1975	20.0	20.0	
1976	22.0	22.0	
1977	24.2	24.2	
1978	26.6	26.6	
1979	29.3	29.3	
1980	32.4	40.48	17.8
1981	35.4	53.3 17.9	24.8
1982	38.9	58.6 19.7	25.8
1983	42.8	64.5 21.7	28.4
1984	47.1	70.9	31.2
1985 (1)	51.8	78.0 (64.8)	34.3 (28.5)
1986	57.0	85.8	37.8
1987	62.7	94.4	41.5
1988	68.9	103.8	45.7
1989	75.8	114.2	50.3
1990	83.4	125.6	55.3
1991	91.8	138.1	60.8
1992	100.9	152.0	66.9
1993	111.0	167.1	73.5
1994	122.1	183.9	80.9
1995	134.3	202.2	89.0
1996	147.8	222.5	97.9
1997	162.5	244.7	107.7
1998	178.8	269.2	118.5
1999	196.7	296.1	130.3
2000	216.3	325.7	143.3

(1) The figures in parentheses are the projections for the first year of international operations for Project Case 1. All subsequent figures in the series are identical for both project cases.

TABLE D.2 - ESTIMATION OF INDIRECT VISITOR COEFFICIENT

	Direct Visits by Overseas Travellers in Year Ended December 1972[1] ('000)	Total Visits by Overseas Travellers in Year Ended December 1972[2] ('000)	Indirect Visitor Coefficient[3]
Brisbane	37.3	82.7	0.55
Perth	19.7	48.4	0.59
Average[4]	-	-	0.56

(1) ABS unpublished data associated with the Overseas Arrivals and Departures Bulletin.

(2) Based on Australian Tourist Commission "Survey of International Visitors: Travel Within Australia", December 1972 and March 1974 adjusted for non-air travellers.

(3) Calculated as 1 - (direct visits/total visits).

(4) Weighted by total visits by overseas travellers.

Australian Resident Travel Overseas: Base Year Estimates

The second element of international operations at Townsville Airport is international air travel by residents in the population base serviced by Townsville. A projection of this component is crucial to the analysis because the main project benefits are a function of the number of Australian international air passenger movements. For this reason the benefits are expected to be highly sensitive to the levels of these projections and so two alternative sets of projections are developed.

To determine likely Australian resident travel from the Townsville region an assessment of the propensity for scheduled travel overseas is required. Due to the lack of historical data for Townsville, information relating to international travel propensities for Perth, Brisbane and Australia as a whole are used. These are given in Table D.3.

TABLE D.3 - CALCULATION OF AUSTRALIAN PROPENSITY FOR TRAVEL OVERSEAS: 1972

Airport	Total Passenger Movements (1) ('000)	Diverted Traffic Movements (2) ('000)	Overseas Visitor Movements (3) ('000)	Domestic Movements Overseas (DMO) ('000)	Propensity for Overseas Travel (DMO movements per capita)	Propensity for Scheduled Overseas Travel (5) (scheduled DMO movements per capita)
Brisbane	159	127	78	208	0.118	0.114
Perth	117	35	43	109	0.104	0.100
Total: Australia	1997	-	744	1253	0.096	0.093

(1) Total arrivals and departures through each international airport.

(2) Estimated diversion of traffic to other international gateways.

(3) Calculated from ABS "Overseas Arrivals and Departures" 1972.

(4) The population bases used are given in Table D.4.

(5) This propensity excluded charter traffic which contributed 70,100 to movements in 1972-73. This was pro-rated from each airport's total propensity for travel.

TABLE D.4 - STATISTICAL DIVISIONS SERVICED BY SELECTED INTERNATIONAL AIRPORTS

PROPOSED TOWNSVILLE INTERNATIONAL AIRPORT

Statistical Division	Population (1971 Census)	1972 (Estimated) (1)
Peninsula	11,738	11,973
Cairns	112,177	114,421
Townsville	112,167	114,410
North Western	41,408	42,236
Mackay	59,100	60,282
Central Western	26,270	26,795
Far Western	4,317	4,403
TOTAL	367,177	374,520

PERTH INTERNATIONAL AIRPORT

Statistical Division	Population (1971 Census)	1972 (Estimated) (1)
Perth	703,199	727,811
South West	77,347	80,054
Southern Agricultural	45,281	46,866
Central Agricultural	42,804	44,302
Eastern Goldfields	42,769	44,266
Central	7,420	7,680
Pilbara	28,985	29,999
North West	11,784	12,196
TOTAL	1,013,250	1,048,713

TABLE D.4 - STATISTICAL DIVISIONS SERVICED BY SELECTED INTERNATIONAL AIRPORTS (Continued)

BRISBANE INTERNATIONAL AIRPORT

Statistical Division	Population (1971 Census)	1972 (Estimated) [1]
Queensland (less Townsville population base)	1,459,888	1,489,086
N.S.W.		
Richmond-Tweed	96,908	98,499
Clarence	64,251	65,306
Northern Slopes	72,694	73,888
North Central Plain	30,445	30,945
TOTAL	1,724,186	1,757,724

(1) Growth based on average rate of State population increase 1968-72.

Source: ABS, "Population and Dwellings in Local Government Areas and Urban Centres, Australia", 1971 Census.

The propensity for scheduled overseas travel for Brisbane had the highest level with 114 passenger movements per 1000 head of population. The average for Australia as a whole, on the other hand, was 93 passenger movements per 1000 head of population. For the purposes of this study the Australian average propensity for scheduled travel overseas is used as a basis for the projection of passenger demand at Townsville.[1] The application of this propensity to the population of the Townsville region results in an estimated total of 34,800 scheduled international passenger movements in 1972 made by the Townsville population base.

This level of scheduled domestic movements overseas (DMO) for 1972 is used as a base year movement level in the overall forecasting procedure.

(1) This assumption imposes a conservative bias on the results as it probably underestimates the potential passenger demand.

Projection of Domestic Movements Overseas

The projection of DMO's is based on the results of an econometric model of aggregate international passenger movements into and out of Australia.

Relationships between total Australian international passenger movements and real household income, real farm income, real imports and real exports measured in value terms, Australian population, and real air fares were estimated.

Several functional forms for the model were tested using various transformations of the relevant variables. These included linear models in both absolute and per capita terms, as well as a logarithmic functional form also couched in absolute and per capita terms.

Annual data over the period 1960-1 to 1973-4 were used in the analysis. The income and trade parameters were deflated by the implicit GDP deflator to obtain real values. The real fare index was a weighted index of economy and concession fares to selected destinations. In the presentation of the results, passenger movements relate to scheduled movements through all Australian international airports and include Papua-New Guinea traffic.

The functional form chosen was a logarithmic equation incorporating the population trend by expressing each of the selected variables except time in per capita terms. Symbolically, the functional form used is;

$$LAIPC = f(LAHIC, LIPAF, T) + U \qquad \text{.....(d8)}$$

where:

LAIPC = log of Australian international passenger movements per capita,

LAHIC = log of Australian real household income per capita,

LIPAF = log of real international passenger airfares,

T = time,

U = residual term.

Using the method of ordinary least squares regression the following equation was obtained:

$$\underset{(-0.59)}{LAIPC = -0.75} + \underset{(2.81)*}{1.36\ LAHIC} - \underset{(-2.63)*}{0.74\ LIPAF} + \underset{(6.46)*}{0.11T}; \quad R^2 = 0.997. \qquad .....(d9)$$

The standard error of the estimate of LAIPC was 0.25, and the Durbin-Watson statistic for the equation was 2.45. The figures in brackets are t values and an asterisk(*) indicates significance at the 95% level. At this level of significance there is evidence that each of the coefficients of the explanatory variables in this equation is different from zero.

The Durbin-Watson statistic indicates the presence of serial correlation in the estimation. To overcome this it was decided to apply a Cochrane-Orcutt transformation. This provided a modified equation as follows:

$$\underset{(-0.07)}{LAIPC' = -0.06} + \underset{(5.10)*}{2.18\ LAHIC'} - \underset{(-4.69)*}{0.93\ LIPAF'} + \underset{(5.59)*}{0.08T'}; \quad \bar{R}^2 = 0.995, \qquad .....(d10)$$

where: LAIPC' = LAIPC(t) + 0.63 LAIPC(t-1),
LAHIC' = LAHIC(t) + 0.63 LAHIC(t-1),
LIPAF' = LIPAF(t) + 0.63 LIPAF(t-1),
T' = T(t) + 0.63 T(t-1).

The standard error of the estimate of LAIPC' was 0.022. The Durbin-Watson statistic for this equation was at an acceptable level of 2.08.

This analysis provides estimates for income and fare elasticities of aggregate demand per capita of 2.18 and -0.93 respectively.

If it is assumed that the elasticities can be applied to overseas travel by Australian residents, including those residing in North Queensland, then the annual rate of growth of domestic movements overseas (ΔDMO) is approximated by the following expression:[1]

$$\Delta DMO = 2.18\ \Delta RIPC - 0.93\ \Delta REALF + \Delta POP + 8.00\ \Delta T, \qquad \text{.....(d11)}$$

where: ΔRIPC = the annual percentage change in real income per capita,

ΔREALF = the annual percentage change in real air fares,

ΔPOP = the annual percentage change in population,

ΔT = the time trend change.

Forecasts of ΔDMO using equation (d11) do not include any adjustment for the serial correlation known to exist in the residuals. However, this is not a serious problem for two reasons. Forecasts obtained including the correction differ only marginally from, and rapidly approach those obtained without the correction. Secondly, as the serial correlation coefficient is negative (i.e. the calculated residuals in equation (d8) are negatively correlated) the forecast values of LAIPC when the influence of serial correlation is included oscillate about the forecast values when this correction is excluded. Hence, any errors introduced by the use of equation (d11) are only marginal.

Historical growth in real household income per capita has been in the order of 3.4 per cent per annum over the past fifteen years. In the last decade the population of North Queensland has grown at a rate of approximately 2 per cent per annum. These trends have been assumed to continue to the year 2000. Furthermore it is assumed that real air fares will stabilise at current real levels. On this basis, short term growth in DMO is forecast at 17.5 per cent per annum.[2]

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(1) This equation is obtained directly from the functional form by taking the total differential, applying the chain rule, and approximating continuous changes by the discrete form.

(2) Annual percentage growth in DMO = $(2.18 \times 3.4) + (-0.93 \times 0) + 2.00 + (8.00 \times 1.00) = 17.5$.

TABLE D.5 - PROJECTION OF SCHEDULED DOMESTIC MOVEMENTS OVERSEAS (DMO) FROM THE TOWNSVILLE REGION

('000 passenger movements)

Year	Projection 1[1]	Projection 2[2]
1972	34.8	34.8
1973	40.9	37.9
1974	48.0	41.3
1975	56.5	45.1
1976	66.3	49.1
1977	77.9	53.5
1978	91.6	58.4
1979	107.6	63.6
1980	126.4	69.3
1981	148.6	75.6
1982	174.6	82.4
1983	205.1	89.8
1984	241.0	97.9
1985	283.2	106.7
1986	308.7	116.3
1987	336.5	126.8
1988	366.8	138.2
1989	399.8	150.6
1990	435.7	164.2
1991	475.0	178.9
1992	517.7	195.0
1993	564.3	212.6
1994	615.1	231.7
1995	670.4	252.6
1996	730.8	275.3
1997	796.5	300.1
1998	868.2	327.1
1999	946.4	356.5
2000	1031.6	388.6

(1) Based on a rate of growth of 17.5 percent per annum for the period 1972-85 and 9.0 percent per annum thereafter.

(2) Based on a rate of growth of 9.0 percent per annum adopted by ICAO as the long term growth in international aviation.

It should be emphasised that historical data forms the basis for this forecast. The period with which the data are concerned may be regarded as a fairly high growth phase in the development of international aviation. Therefore, it is possible that a transition to a lower long term growth rate will occur in the not too distant future. The effect of this change would be to render the econometric forecasts unreliable beyond about 1985. Estimates of long term growth in international aviation of 9 per cent per annum have been reported in the findings of a series of seminars conducted by the International Civil Aviation Organisation (ICAO) in Paris during November 1974[(1)] and this rate of growth is adopted for the remainder of the forecast period for projection level 1; from 1985 to the year 2000.

A second set of projections is developed for sensitivity analysis by assuming a rate of growth of 9 per cent per annum for the whole projection period 1972 to the year 2000.

The outcome of applying these two projection procedures to the estimated level of passenger movements at Townsville in 1972, is shown in Table D.5. It is also necessary to further adjust the two projections in order to distinguish between 'direct' DMO travel through the international terminal and 'indirect' DMO's through the domestic terminal. A 'leakage' factor is therefore devised for this purpose to represent the proportion of indirect travellers to and from Townsville via other international gateways.

The number of passengers that make use of the proposed international facilities will depend on the number of overseas destinations serviced from Townsville and the frequency

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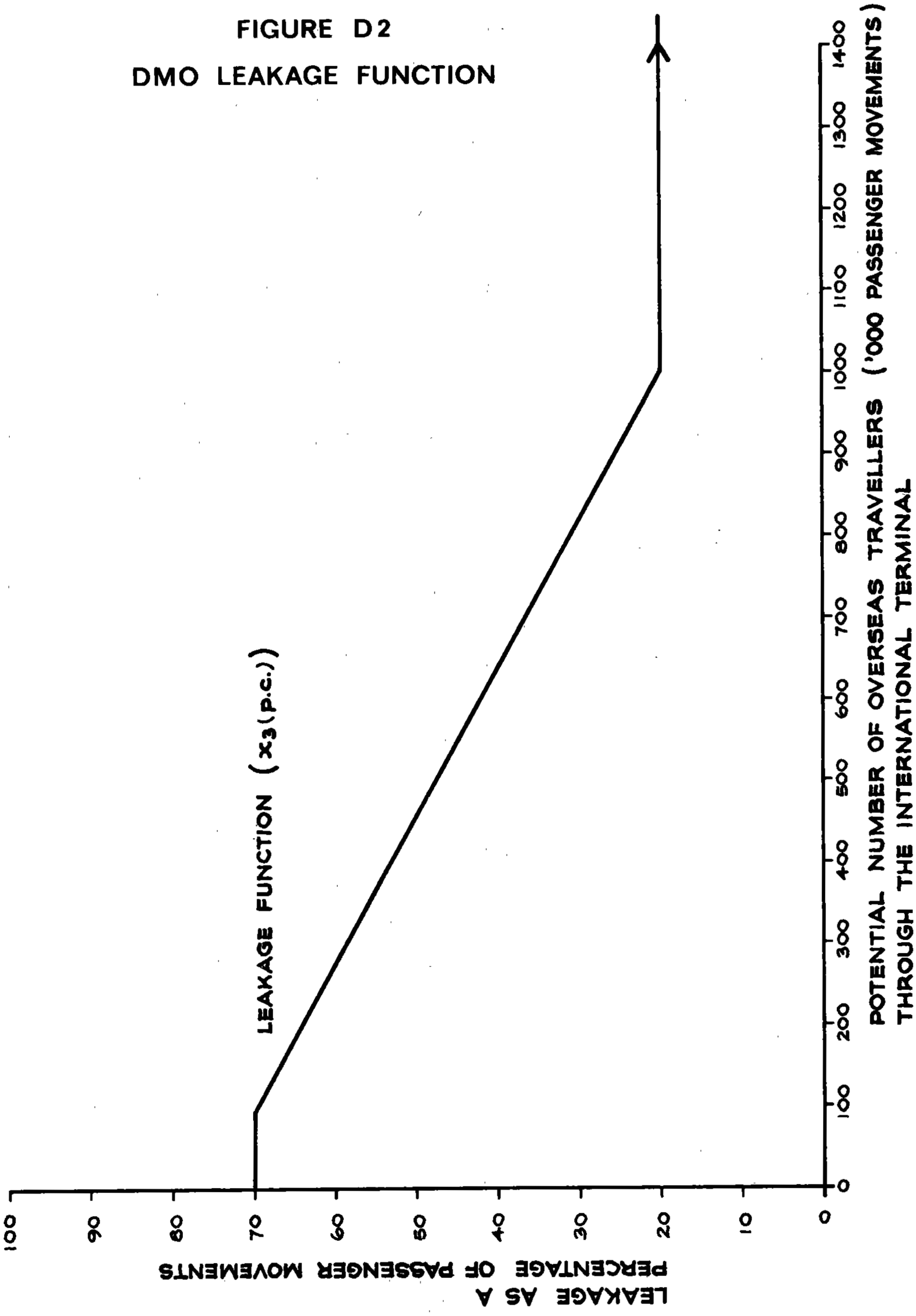
(1) Entitled "Civil Aviation Forecasting Workshop". Growth rates of this order of magnitude have also been used by IATA viz. a speech by K. Hammarskjold on "IATA International Traffic Forecasts to 1990" (1974).

FIGURE D2

DMO LEAKAGE FUNCTION



of flights offered to those destinations. It is envisaged that operations from Townsville would provide, at least initially, relatively short-range feeder services to major overseas staging points, as well as a small number of direct services. Scheduled flight frequencies obviously depend on user demand for specific routes. It would appear realistic to assume that the demand for direct flights is an increasing function of the total level of user demand. Therefore, DMO leakage from Townsville would be heaviest in the early years of operations whilst a steady climb in patronage for direct flights can be expected over time.

Historical data for Brisbane International Airport and research into traveller behaviour characteristics carried out for the Department of Transport are used to determine the leakage function shown in Figure D.2. It is indicated by these investigations, that a potential airport throughput of one million international passengers can be expected to result in a leakage factor of 20 per cent whilst 70 per cent leakage tends to occur at a potential passenger throughput of 100,000. A ramp function of the following form(1) is assumed;

$$\begin{aligned} x_3 &= 75.6 - 0.0556\ IPM; \quad 100 \leqslant IPM \leqslant 1000 \\ &= 70 \quad ; \quad IPM \leqslant 100 \\ &= 20 \quad ; \quad IPM \geqslant 1000 \end{aligned} \qquad \ldots.(d12)$$

where: IPM are total potential international passenger movements expressed in thousands, and x_3, the DMO leakage factor, is expressed in percentage terms.

International visitor movements (IVM) are treated differently from DMO's because IVM trips involve indirect travel as an integral part of tourist activities. This implies

(1) It should be noted that the upper and lower limits of 70 and 20 per cent leakage reflect the commencement of operations and saturation levels respectively.

TABLE D.6 - PROJECTED DOMESTIC MOVEMENTS OVERSEAS (DMO) BY TERMINAL[1]

Year	DMO Leakage Factor (percent) Projection Level 1	2	DMO through Domestic Terminal ('000) Projection Level 1	2	DMO through International Terminal ('000) Projection Level 1	2
1972			34.8	34.8		
1973			40.9	37.9		
1974			48.0	41.3		
1975			56.5	45.1		
1976			66.3	49.1		
1977			77.9	53.5		
1978			91.6	58.4		
1979			107.6	63.6		
1980	67	70	84.7	48.5	41.7	20.8
1981	65	69	96.6	52.2	52.0	23.4
1982	63	68	110.0	56.0	64.6	26.4
1983	61	67	125.1	60.2	80.0	29.6
1984	59	67	142.2	65.6	98.8	32.3
1985[2]	56	66	158.6	70.4	124.6	36.3
	(57)	(66)	(161.4)	(70.4)	(121.8)	(36.3)
1986	54	65	166.7	75.6	142.0	40.7
1987	52	64	175.0	81.2	161.5	45.6
1988	50	63	183.4	87.1	183.4	51.1
1989	48	62	191.9	93.4	207.9	57.2
1990	45	60	196.1	98.5	239.6	65.7
1991	43	59	204.2	105.6	270.8	73.3
1992	40	57	207.1	111.2	310.6	83.8
1993	36	56	203.1	119.1	361.2	93.5
1994	33	54	203.0	125.1	412.1	106.6
1995	29	52	194.4	131.4	476.0	121.2
1996	25	50	182.7	137.6	548.1	137.7
1997	20	47	159.3	141.0	637.2	159.1
1998	20	44	173.6	143.9	694.6	183.2
1999	20	42	189.3	149.7	757.1	206.8
2000	20	38	206.3	147.7	825.3	240.9

(1) Adjusted for leakage to international airports other than Townsville.

(2) The figures for Project Case 1 in 1985 are shown in parentheses. All subsequent figures in the series are identical for both project cases.

that leakage only occurs with respect to domestic movements overseas, hence the term DMO leakage. Table D.6 shows the final adjusted movements through both the international and domestic terminals to the year 2000.

International Visitor Movements through the Domestic Terminal

Prior to the provision of international services at Townsville, all international visitor movements by air would occur through the domestic terminal. However the establishment of an international airport would immediately open the possibility of direct visits from overseas tourists. Initially there would tend to be a substitution, by some visitors, of direct flights to Townsville for indirect movements via other gateways. It would be unlikely however, that most direct visitors would remain in the Townsville region exclusively and a majority could be expected to undertake some 'further travel to other tourist centres by domestic airline.

Further travel to other Australian destinations may be assessed from the experience of North Queensland tourist resorts. In 1972 only 27 per cent of all international visitors remained in Australia for less than one week. On the other hand 85 per cent of Barrier Reef visitors from overseas stayed on the Reef for less than one week. Furthermore in 1972-3, the simple weighted average stay of overseas visitors was approximately 8 weeks, while the Barrier Reef survey data imply that more than 99 per cent of Barrier Reef visitors must have travelled elsewhere in Australia during their stay. The results for Cairns are similar with 95 per cent of visitors to Cairns undertaking further travel. Using these values as proxies for Townsville, a further travel coefficient of 0.95 is derived.

An indirect visitor coefficient was estimated earlier to be 0.56.[1]

(1) Refer to Table D.2.

The projection equation for international visitor movements through the domestic terminal after the addition of international facilities at Townsville becomes:

$$IVM'_d = 0.95\ IVM'_i + 0.56\ OVT', \qquad \ldots.(d2')$$

where the notation is as defined for equation (d2). The projections for IVM'_i and OVT' are given in columns (3) and (2) of Table D.1 respectively.

Domestic Movements Overseas through the Domestic Terminal

Projections for domestic movements overseas through the domestic terminal were derived earlier and are presented in Table D.6.

Residual Internal Movements through the Domestic Terminal

Residual internal movements (RIM) are those relating to travel on domestic services to and from Townsville, for purposes other than international travel. Future RIM's cannot be calculated as a residual in this study, but rather must be projected independently of other movements. They are forecast by applying the historical rate of growth in total domestic movements to a base year RIM estimate.

The base year estimate of RIM's is calculated as a residual by subtracting international visitor movements and domestic movements overseas from total domestic airline passenger movements[(1)] at Townsville in 1972. An estimate of 158,000 passenger movements is derived.

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(1) Revenue plus non-revenue passenger movements on scheduled services. Calculated by increasing published Department of Transport figures by a factor of 4 per cent, estimated from time slot data for Townsville (1971-72).

The historical growth rate for total domestic airline revenue passengers was calculated to be 8 per cent per annum for the period 1967 to 1972. The projection equation for RIM's in the year t is therefore,

$$RIM'_d(t) = 158{,}000 \times 1.08^{i}, \qquad \text{....(d13)}$$

where

$$t = 1972 + i,\ i = 0, 1, 2, 3.....$$

Transits

Transits are defined as scheduled air passengers whose final destination is an airport other than that at which they are set down. That is, they are a passenger movement at that airport soley because of aircraft refuelling or because other passengers are embarking or disembarking. Available aviation statistics often do not show transit passengers separately.

Domestic transits through Townsville are estimated using Department of Transport "City Pair Statistics" for 1972-3. Data are only available for Trans-Australia Airlines flights, but it is estimated that Ansett Airlines of Australia carried 49 per cent of the revenue passenger task in 1972-3. On this basis the total level of transit passenger movements through Townsville is calculated to be approximately 105,000 movements. This represents approximately 45 per cent of the recorded revenue traffic at Townsville in 1972-3 of 231,665 passengers(1).

In general, the level of domestic transits appears to be fairly erratic depending on changing demand for services, airline scheduling and airline policy. Given this situation and a lack of historical data, domestic transits have been omitted from the estimation of total passenger movement flows.

(1) Department of Transport "Australian Domestic Air Transport Statistics" year ending 30 June 1973.

TABLE D.7 - PROJECTED SCHEDULED PASSENGER MOVEMENTS THROUGH TOWNSVILLE'S INTERNATIONAL TERMINAL [1]

('000 passenger movements)

Year	Total Movements Projection Level 1	Total Movements Projection Level 2	International Visitor Movements [2]	Domestic Movements Overseas [3] Projection Level 1	Domestic Movements Overseas [3] Projection Level 2
1972	-	-	-	-	-
1975	-	-	-	-	-
1980	77.3	56.4	35.6	41.7	20.8
1985 [4]	193.2 (178.8)	104.9 (93.3)	68.6 (57.0)	124.6 (121.8)	36.3 (36.3)
1990	350.1	176.2	110.5	239.6	65.7
1995	653.9	299.1	177.9	476.0	121.2
2000	1111.9	527.5	286.6	825.3	240.9

(1) Transits have been omitted.

(2) Derived from Table D.1.

(3) Derived from Table D.6.

(4) The figures in parentheses are the projections for the first year of international operations for Project Case 1. All the subsequent figures in the series are identical for both project cases.

Since data are not available on international transits at Australian airports, they have not been explicitly projected but are included in the sensitivity analysis discussed in Annex H.

PASSENGER MOVEMENT FLOWS: RESULTS

Scheduled Movements

The forecasts for scheduled movements described above are summarised in Tables D.7 and D.8. These projections relate to the project case strategies for development at Townsville. The forecasts assume that international services would be initiated in 1980, a date which represents the earliest practicable time for the provision of international facilities under the Project Case 2 strategy.

Changes in the implementation date can be catered for by a simple truncation of the projection of movements through the international terminal with a corresponding redistribution of movements, prior to the new starting date, back to the projection series for domestic terminal movements.[1]

The forecasts presented in Table D.9 relate to the Base Case or 'do nothing' strategy.

Table D.10 sets out the passenger flow coefficients used in equations (d2), (d4) and (d6). These coefficients were derived in this Annex and used to produce the resulting passenger forecasts.

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(1) It is also necessary to make some small allowance for the diversion of overseas visitors. For example in Table D.1 passenger diversion for 1980 is given by the difference between the projection series in columns 1 and 2.

TABLE D.8 - PROJECTED SCHEDULED PASSENGER MOVEMENTS THROUGH TOWNSVILLE'S DOMESTIC TERMINAL(1)

('000 passenger movements)

Year	Total Movements		International Visitor Movements (2)	Domestic Movements Overseas (3)		Residual Internal Movements (4)
	Projection Level			Projection Level		
	1	2		1	2	
1972	222.8	222.8	30.0	34.8	34.8	158.0
1975	295.4	284.0	39.9	56.5	45.1	199.0
1980	456.2	420.0	79.1	84.7	48.5	292.4
1985(5)	740.8(717.8)	652.6(626.8)	152.5(126.7)	158.6(161.4)	70.4(70.4)	429.7
1990	1073.1	975.5	245.6	196.1	98.5	631.4
1995	1517.6	1454.6	395.5	194.4	131.4	927.7
2000	2206.4	2147.8	637.0	206.3	147.7	1363.1

(1) Transits have been omitted.

(2) Derived using equation (d2') and data in Table D.1.

(3) Derived from Table D.6.

(4) Derived using equation (d13).

(5) The figures in parentheses are the projections for the first year of international operations for Project Case 1. All subsequent figures in the series are identical for both project cases.

TABLE D.9 - BASE CASE PROJECTIONS OF PASSENGER MOVEMENTS AT TOWNSVILLE AIRPORT [1]

('000 passenger movements)

Year	Total Movements		International Visitor Movements [2]	Domestic Movements Overseas [3]		Residual Internal Movements [4]
	Projection Level			Projection Level		
	1	2		1	2	
1972	222.8	222.8	30.0	34.8	34.8	158.0
1975	295.4	284.0	39.9	56.5	45.1	199.0
1980	483.6	426.5	64.8	126.4	69.3	292.4
1985	816.5	640.0	103.6	283.2	106.7	429.7
1990	1233.9	962.4	166.8	435.7	164.2	631.4
1995	1866.7	1448.9	268.6	670.4	252.6	927.7
2000	2827.3	2184.3	432.6	1031.6	388.6	1363.1

(1) Transits have been omitted.

(2) Derived from Table D.1.

(3) Derived from Table D.5.

(4) Derived using equation (d13).

TABLE D.10 - PASSENGER FLOW COEFFICIENTS FOR AIR TRAVEL TO TOWNSVILLE AIRPORT [1]

Coefficient	Label	Estimated Value
Further travel	x_1	0.95
Indirect visitor	x_2	0.56
DMO leakage	x_3	Range 0.70 -0.20
Propensity for scheduled travel overseas	x_4	0.093

(1) Coefficients relate to equations (d1) to (d7) in the text.

Non-scheduled Movements

Non-scheduled civil aviation movements at Townsville consist of both charter and general aviation traffic. The provision of international services is unlikely to have any substantial effect on the latter but could influence charter operations. Data concerning international charter traffic are limited so that a detailed assessment of the likely developments in non-scheduled charter traffic could not be undertaken. The Department of Tourism and Recreation however, has carried out an examination of the likely level of charter traffic to the Great Barrier Reef and Townsville in 1980.[1] These predictions are shown in Table D.11.

The confidence that can be placed in these estimates is low. Furthermore, there is likely to be a significant degree of double counting if the possibility of charter traffic were to be included in the analysis because many charter flights would act as substitutes for scheduled services. Consequently, the projections set out in Table D.11 are only

(1) Unpublished estimates of expected charter traffic through the proposed Townsville Airport. Working papers for the "IDC Report on the Feasibility of Establishing an International Airport at Townsville." March 1973.

presented in order that they be available for sensitivity testing purposes.

General aviation demand cannot be readily assessed in terms of passenger movements. General aviation aircraft movement forecasts as well as anticipated military aircraft movements are discussed separately in Annex E.

TABLE D.11 - FORECAST OF DIRECT INTERNATIONAL CHARTER TRAFFIC TO TOWNSVILLE AIRPORT, 1980

Traffic Origin	Charter Traffic ('000 passengers)
N.Z.	18
U.S.A.	18
U.K.	5
Papua/NG	-
Japan	18
Canada	5
Malaysia/Singapore	-
Western Europe	9
Other	-
TOTAL	73

Sources: Department of Tourism and Recreation and Cities Commission.

ANNEX E

AIRCRAFT MOVEMENT PROJECTIONS

Total aircraft movements at Townsville may be divided into four aviation categories; scheduled air services, charter services(1), RAAF aircraft movements and general aviation activity. Movements in the latter two categories were projected in the Inter-Departmental Committee report.(2) As neither are affected by proposals to develop international facilities at Townsville Airport, these projections have been accepted without alteration and are given in Table E.1.(3) Scheduled aircraft movements, on the other hand, depend on the passenger movement forecasts developed in Annex D. The basis for conversion of these forecasts to aircraft movements is set out below. No attempt is made to produce forecasts of charter aircraft movements because of the lack of suitable data and reservations concerning forecasts of charter activity.

SCHEDULED AIRCRAFT MOVEMENTS

In order to convert passenger movements to aircraft movements, certain assumptions regarding passenger loading factors(4) for domestic and international services are required. These are used in conjunction with estimates of the aircraft fleet mix for scheduled domestic and international traffic over time.

An average passenger loading of 31 per cent of aircraft capacity is used for movements by the domestic aircraft fleet. This estimate is derived from an analysis of time slot

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(1) Defined as services which are generated in direct response to demand as opposed to commercial scheduled services which, in the short run, are insensitive to passenger demand.

(2) IDC op.cit., March 1973.

(3) Some doubt has been cast on the projection of military movements as the actual number of movements recorded for 1975 was 4,800 compared to 12,300 projected in Table E.1.

(4) A ratio denoting the number of embarkations or disembarkations per aircraft movement at a particular airport.

data for Townsville in 1971-72[1].

Three probable international routes from Townsville are examined; Townsville-Singapore, Townsville-Nadi and Townsville-Auckland. International services to Nadi and Auckland are assumed to originate and terminate at Townsville, whilst Singapore flights are assumed to transit at Townsville on the way to or from Brisbane or Sydney. All route configuration assumptions result from discussions with Qantas. A passenger loading factor for direct flights of 65 per cent of aircraft capacity was assumed, also on the advice of Qantas.

The Townsville-Singapore route presents a special case because the transit nature of the flights through Townsville implies that a lower loading factor would apply. However, to simplify analysis the loading factors for the Townsville-Singapore route are taken to be the same as for direct flights. The implication of this assumption is a slight over-estimation of benefits and a reduction in operating costs which may be viewed as negative benefits. The relaxation of this assumption is discussed in Annex H.

The projected domestic aircraft fleet mixes are shown in Tables E.2 and E.3. These are based on time slot data, projections of technological developments and advice from Air Divisions of the Department of Transport. The aircraft categories used as column headings are intended as a general guide rather than as a specific classification of the fleet. It is assumed that for the Base Case projections, where no direct international services from Townsville are expected, the introduction of wide bodied aircraft would occur earlier than in either project case to cater for the larger number of domestic passengers. Figures relating to this assumption are given in parentheses in Table E.2.

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(1) Information relating to aircraft types and routes in each hour of the day recorded for the twelve month period from 1 July 1971 to 30 June 1972.

TABLE E.1 - NON-SCHEDULED AIRCRAFT MOVEMENTS THROUGH TOWNSVILLE AIRPORT (1)

('000 movements)

Year	Military Aircraft	General Aviation	Total
1972	8.9	30.4	39.3
1975	12.3	40.5	52.8
1980	14.2	51.9	66.1
1985	16.5	64.4	80.9
1990	19.0	78.4	97.4
1995 (2)	21.5	97.6	119.1
2000 (2)	26.0	125.7	151.7

(1) Charter traffic has not been included.

(2) Extrapolated.

Source: IDC Report "Environmental Impact Statement: Establishment of an International Airport at Townsville" Attachment 5.

TABLE E.2 - DOMESTIC AIRCRAFT FLEET MIX ASSUMED FOR ALL ROUTES FROM TOWNSVILLE AIRPORT (1)

(percentage of fleet)

Period	Representative Aircraft Type					
	DC9	727-200	727-100	Wide Body	F27	Freighter
Aircraft Passenger Capacity	90	130	100	300	40	-
1972-75	58	1	2	-	30	8
1976-80	48(46)	3	8	-(2)	33	8
1981-85	40(35)	8	20(15)	-(10)	24	8
1986-90	30	10	20	10	20	10
1991-95	20	20	15	15	20	10
1996-2000	10	40	10	20	15	5

(1) Figures in brackets relate to fleet mix for calculations relating to the Base Case situation which involves no international services.

NOTE: Rows may not sum to 100 per cent due to rounding.

TABLE E.3 - DOMESTIC AIRCRAFT FLEET MIX ASSUMED FOR CAPITAL CITY ROUTES FROM TOWNSVILLE

(percentage of fleet)

Period	Representative Aircraft Type			
	DC9	727-200	727-100	Wide Body
Aircraft Passenger Capacity	90	130	100	300
1972-75	95	2	3	-
1976-80	81	5	14	-
1981-85	59	12	29	-
1986-90	28	18	36	18
1991-95	17	33	26	25
1996-2000	3	14	55	27

NOTE: Allowance is made for the use of DC9 type aircraft on non-capital city routes. Therefore weights are applied to DC9 aircraft as follows:

- 1986-95 only 50 per cent of DC9's are included.
- 1995-2000 only 25 per cent of DC9's are included.

Combining fleet mix for any year with the capacity loading(1) for each aircraft results in an average passenger loading per aircraft movement. Scheduled aircraft movements are then derived by dividing scheduled passenger movements by the average passenger loading for each year. Forecasts of scheduled domestic aircraft traffic to the year 2000 for the project case strategies are shown in Table E.4, while those for the Base Case are shown in Table E.5.

International aircraft movements at Townsville are calculated from scheduled international passenger movement forecasts by assuming a constant passenger loading of 65 per cent of a 707 type aircraft's capacity using standard seat configurations. This results in a passenger loading capacity of 97 passengers per aircraft movement. Table E.6 shows the international aircraft movement forecasts for Townsville to the year 2000 based on these assumptions.

(1) Capacity loadings for each aircraft type are calculated by multiplying the approximate passenger loading factor by the aircraft passenger capacity.

TABLE E.4 - SCHEDULED DOMESTIC AIRCRAFT MOVEMENT PROJECTIONS AT TOWNSVILLE AIRPORT FOR PROJECT CASE STRATEGIES (1)

Year	Average Passenger Loading (passengers/ aircraft)	Aircraft Movements ('000) Projection Level 1	Aircraft Movements ('000) Projection Level 2
1972	21	10.6	10.6
1975	21	14.1	13.5
1980	21	21.7	20.0
1985 (2)	24	30.9 (29.9)	27.2 (26.1)
1990	30	35.8	32.5
1995	35	43.4	41.6
2000	42	52.5	51.1

(1) Based on passenger movement projections in Table D.8.

(2) Parentheses indicate projections for the first year of international operations for Project Case 1. Subsequent figures in the series are identical for both project cases.

TABLE E.5 - SCHEDULED DOMESTIC AIRCRAFT MOVEMENT PROJECTIONS AT TOWNSVILLE AIRPORT FOR THE BASE CASE (1)

Year	Average Passenger Loading (passengers/ aircraft)	Aircraft Movements ('000) Projection Level 1	Aircraft Movements ('000) Projection Level 2
1972	21	10.6	10.6
1975	21	14.1	13.5
1980	23	21.0	18.5
1985	30	27.2	21.3
1990	30	41.1	32.1
1995	35	53.3	41.4
2000	42	67.3	52.0

(1) Based on passenger movements shown in Table D.9.

TABLE E.6 - SCHEDULED INTERNATIONAL MOVEMENT PROJECTIONS AT TOWNSVILLE AIRPORT (1)

Year	Aircraft Movements ('000)	
	Projection Level 1	Projection Level 2
1980	0.8	0.6
1985 (2)	2.0 (1.8)	1.1 (1.0)
1990	3.6	1.8
1995	6.7	3.1
2000	11.5	5.4

(1) Based on passenger movements shown in Table D.7.

(2) Figures in parentheses indicate projections for the first year of international operations for Project Case 1. Subsequent figures in the series are identical for both project cases.

ANNEX F

RESOURCE AND TIME SAVINGS

The main benefits to be derived from upgrading Townsville Airport are the cost savings attributable to North Queenslander's making use of the new international facilities for overseas travel rather than the current method of using the southern international gateways.(1) These savings may be expressed in terms of physical resources and time. Individual resource and time savings by route are calculated annually to the year 2000. These results are based on the econometric projections of passenger demand set out in Annex D. Beyond the year 2000 a residual net benefit is developed using year 2000 projection levels.

BENEFITS PRIOR TO THE YEAR 2000

Resource and time savings vary by the route travelled. Therefore, separate analyses are made of each of the three potential routes Townsville-Nadi, Townsville-Singapore and Townsville-Auckland. These routes are assumed to have 35 per cent, 25 per cent and 40 per cent shares of the forecast travel market respectively.(2) The forecasts used in calculating these savings are projection level 1 estimates of domestic movements overseas (DMO's) developed in Annex D. The sensitivity of results to different forecast levels is considered in Annex H.

Total costs by route per annum are calculated by multiplying resource cost per passenger by the annual number of DMO's through the new international terminal at Townsville for a particular route. The net resource saving is determined by subtracting the resource cost involved in transporting the DMO passengers via Brisbane International Airport from the

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(1) Detailed discussion of this approach is given in Chapter 4.
(2) Based on advice from Qantas.

resources employed in moving the same domestics via Townsville's international terminal. Time savings are calculated in a similar manner.

Direct flights, as opposed to flights calling at Townsville and other Australian ports, are assumed for all three routes. This assumption has the effect of overestimating benefits slightly because international aircraft movements are underestimated. This assumption is examined in the sensitivity analysis reported in Annex H.

In trading off the domestic movement of DMO passengers against international movements directly from Townsville, it is necessary to calculate the aircraft cost per passenger block hour for the various mixes of aircraft types and then to apply this unit cost to aircraft block hour transit times. The fleet mix for domestic airline operations varies during the study period, while it is assumed that the international aircraft fleet mix remains constant. The aircraft types and fleet mixes employed in the analysis were set out in Annex E.

The block times, by route, and the aircraft resource costs used in the analysis for different aircraft types are shown in Tables F.1 and F.2 respectively.

TABLE F.1 - AIRCRAFT BLOCK TIMES BY ROUTE FROM TOWNSVILLE AND BRISBANE AIRPORTS

(hours)

Origin	Aircraft	Destination			
		Nadi	Singapore	Auckland	Brisbane
Townsville	707	4.3	6.9	4.3	1.8
	727	-	-	-	1.7
	DC9	-	-	-	1.8
	Wide body	-	-	-	1.8
Brisbane	707	3.3	7.6	2.8	-

TABLE F.2 - HOURLY RESOURCE COSTS BY AIRCRAFT TYPE

(1975 prices)

Aircraft Category	Seats	Passengers (1)	Cost/Passenger Block Hour (2) ($)
DC9	90	59	8.4
727-100	100	65	10.0
727-200	130	85	8.5
Wide body	300	195	5.9
707	149	97	12.6

(1) Based on 65 per cent load factor.

(2) Cost estimates were based on work carried out for the Department of Transport.

TABLE F.3 - ESTIMATION OF AVERAGE RESOURCE COST PER PASSENGER FOR DOMESTIC AIRCRAFT FROM TOWNSVILLE TO BRISBANE

Period	Average Resource Cost/Passenger Block Hour (1) ($)	Average Block Time (2) (hrs)	Average Cost/ Passenger ($)
1972-75	8.5	1.8	15.3
1976-80	8.6	1.8	15.5
1981-85	8.9	1.8	16.0
1986-90	8.5	1.7	14.5
1991-95	8.2	1.7	13.9
1996-2000	7.9	1.7	13.4

(1) Calculated by weighting cost/passenger in Table F.2 by the fleet mix developed in Annex E.

(2) Calculated by weighting aircraft block times in Table F.1 by the fleet mix.

Times and costs for international operations can be obtained directly from these tables since the analysis assumes that 707 aircraft only are used. For domestic operations however, the calculation of resource cost and time savings requires estimation of average times and costs which take account of the fact that domestic aircraft fleets are mixed rather than all of the same type. Average domestic resource cost and time estimates based on the fleet mix assumptions reported in Annex E are given in Table F.3.

The costs used assume that adjustments by both domestic and international airlines are marginal with respect to their total operations. Hence it is assumed that long run marginal unit costs remain unchanged.

The general formulae used to calculate net resource savings (NRS) and net time savings (NTS) between Townsville and an overseas origin/destination are given below:

$$NRS_{TO} = a_{TO} . DMO_i^! (b.H_{TB}^D + c(H_{BO}^I - H_{TO}^I)), \qquad ....(f1)$$

$$NTS_{TO} = a_{TO} . DMO_i^! . d(H_{TB}^D + H_{BO}^I - H_{TO}^I), \qquad ....(f2)$$

where:

- NRS = net resource cost savings,
- NTS = net time savings,
- $DMO_i^!$ = domestic movements overseas via the Townsville international terminal,
- H = time expressed in hours,
- a = route share of total market,
- b = average resource cost per passenger hour for domestic aircraft,
- c = resource cost per passenger hour for international aircraft,
- d = value of travel time savings per hour,

and where the subscripts T, B and O refer to Townsville, Brisbane and 'overseas' origins or destinations respectively, and the superscripts D and I refer to domestic and international aircraft types respectively.

Equation (f1) states that net resource cost savings are equal to the resource cost per DMO passenger moving overseas via a domestic flight to Brisbane followed by an international flight from Brisbane, less the resource cost involved in moving the same DMO passengers to their destination direct from Townsville's international terminal. This is multiplied by a market share factor. Movements both into and out of Australia are included so that the reverse of the flow described above is also taken into account.

Equation (f2) is defined in a similar manner to equation (f1) except that it refers to travel time savings.

Average resource costs for domestic airline traffic, b, by year are given in Table F.3. For international traffic the resource cost per passenger per block hour, c, for Boeing 707[1] aircraft is assumed to be constant over time, at $12.60, measured in 1975 dollars. The passenger projections, DMO'_i, and the market shares, a, were discussed above.

Net time savings per passenger, d, is valued at 87 cents per hour, and is based on estimates derived by Hensher and Carruthers.[2]

The total resource and time cost savings from international operations at Townsville in the period 1980-2000 for Project Case 2 and 1985-2000 for Project Case 1, as calculated from equations (f1) and (f2), are summarised in Table F.4. These results are presented for each route, in present value terms, using discount rates of 7 per cent and 10 per cent per annum.

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(1) The assumption regarding aircraft type used for international services is relaxed in Annex H.
(2) D.A. Hensher and R.C. Carruthers, "Resource Value of Business Air Travel", Unpublished, November 1974.

The Townsville-Auckland route presents a particularly interesting result because the term $(H^I_{BO} - H^I_{TO})$ is negative. In fact it is sufficiently large to offset the positively valued bH^D_{TB}. This resulted in negative values for NRS_{TO} in each year. On this basis an international service probably would not be offered on the Townsville-Auckland route. This route is therefore excluded from further analysis.

TABLE F.4 - SUMMARY OF PRESENT VALUES OF RESOURCE AND TIME SAVINGS AT TOWNSVILLE AIRPORT (PRIOR TO 2000)[1]

($m)

Benefit by Route	Project Case 1 Discount Rate (2)		Project Case 2 Discount Rate (2)	
	7%	10%	7%	10%
RESOURCE SAVINGS				
Townsville-Nadi	0.73	0.45	0.94	0.62
Townsville-Singapore	9.03	5.28	10.23	6.23
(Townsville-Auckland	-3.19	-1.83	-3.41	-2.01)[3]
TOTAL RESOURCE SAVINGS (3)	9.76	5.73	11.17	6.85
TIME SAVINGS				
Townsville-Nadi	0.34	0.20	0.40	0.24
Townsville-Singapore	0.84	0.49	0.94	0.57
(Townsville-Auckland	0.13	0.07	0.15	0.09)[3]
TOTAL TIME SAVINGS[3]	1.18	0.69	1.34	0.81
TOTAL SAVINGS[3]	10.94	6.42	12.51	7.66

(1) International operations are assumed to commence in 1985 for Project Case 1 and 1980 for Project Case 2.

(2) Per annum.

(3) Note that the Townsville-Auckland route has been omitted from the total.

POST YEAR 2000 BENEFITS

Each project strategy is assumed to have a practical working life extending to the year 2015, after which date the pressures of increasing passenger demand would necessitate further upgrading work to be carried out in order for the airport to remain operational. However, the degree of confidence which may be attached to the econometric and trend forecasting carried out in Annex D is such that projections beyond the year 2000 are regarded as unrealistic. Nevertheless, benefits and costs may occur in this period for which some value must be imputed.

Due to the high degree of uncertainty the procedure for measuring these net benefits is to assume that the level of passenger movements occurring in the year 2000 remains at a constant level.

Variable costs and benefits are calculated following exactly the same procedure as before. They are then aggregated to form net benefits for the post year 2000 period.

In present value terms the net benefit attributable to Project Cases 1 and 2 after the year 2000 are \$6.29m and \$5.69m respectively at 7 per cent per annum and \$2.56m and \$2.32m respectively at 10 per cent per annum discount rate.

ANNEX G

COSTS

Five main cost elements are examined in the evaluation of Townsville Airport; capital costs of upgrading or constructing airport facilities, operating costs involved in maintaining and operating the proposed development, user access costs involved in commuting to and from Townsville Airport, taxiing costs for aircraft landing or taking-off from Townsville International Airport and finally the non-pecuniary costs associated with the proposed facility. Each of these costs is discussed separately and itemised cost schedules for both project cases are presented. All costs are measured in January 1975 prices.

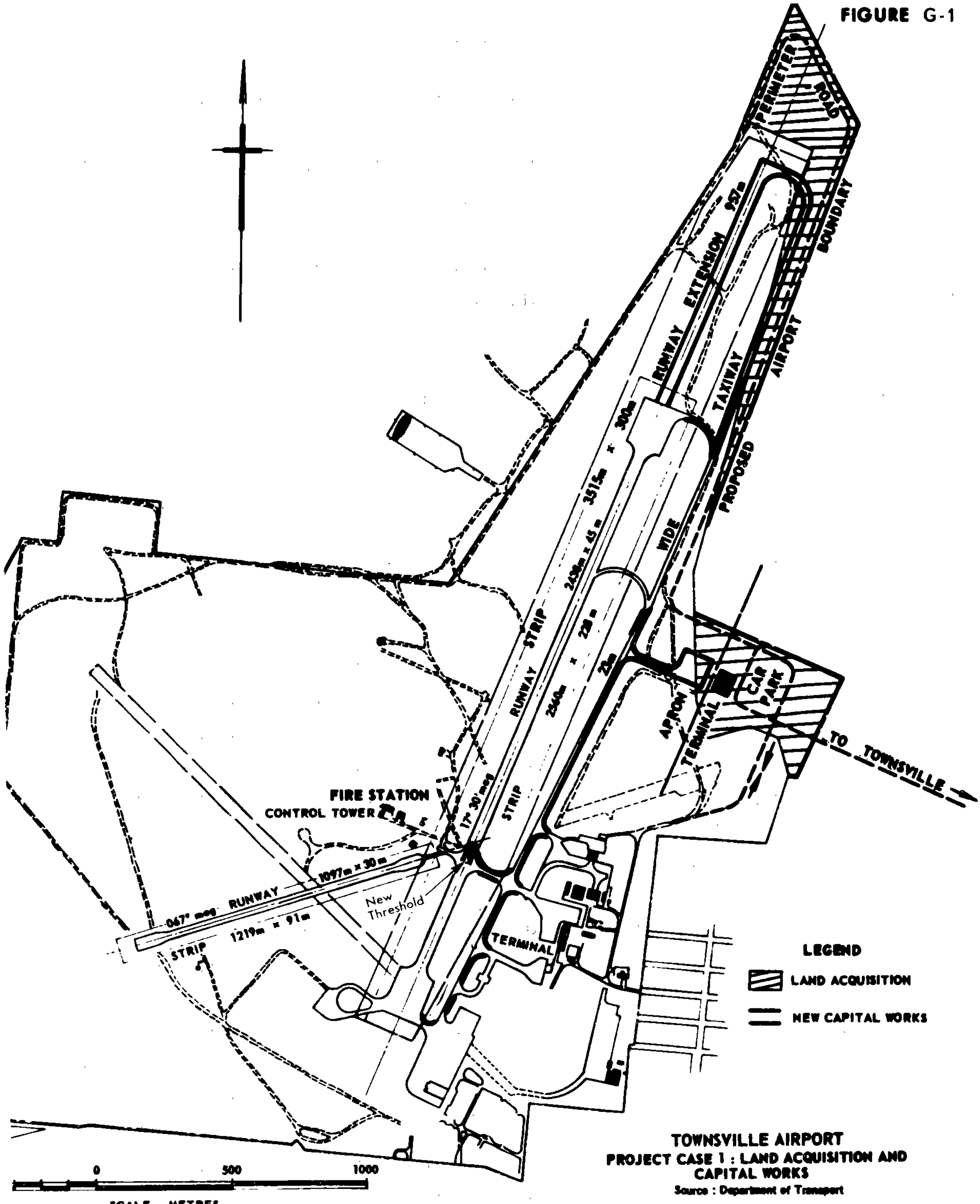
COSTS

Capital Costs

A detailed schedule of capital costs for Project Cases 1 and 2 is shown in Table G.1. These costs were provided by the former Department of Housing and Construction. It should be noted that some items, for example the control tower and maintenance complex, are associated with Project Case 2 only. This is because some existing buildings on runway 01/19 are capable of handling the proposed international services without modification or replacement.

The ILS/MLS item is given special consideration because both the Base Case and Project Case 1 involve the construction of an MLS in 1985 or at some subsequent date. On the other hand Project Case 2 involves the construction of a new ILS installation on a new alignment. This could be either additional to, or would foreshadow an MLS on runway 01/19 depending on when it was constructed. If the new runway were built after 1985 the costs of an ILS would be additional, otherwise construction of an MLS would be pre-empted on runway 01/19.

FIGURE G-1



TOWNSVILLE AIRPORT
PROJECT CASE 1 : LAND ACQUISITION AND CAPITAL WORKS
Source : Department of Transport

The cash flows associated with these capital costs depend on the development alternative and its timing. In particular, capital works are staged as shown in Table G.2. Stage 1 involves construction works to allow international operations at Townsville by 1985 for Project Case 1 and 1980 for Project Case 2. Stages 2 and 3 are identical for both project cases and involve the expansion of terminal and apron facilities by 1995 and 2000, respectively.

Land Acquisition

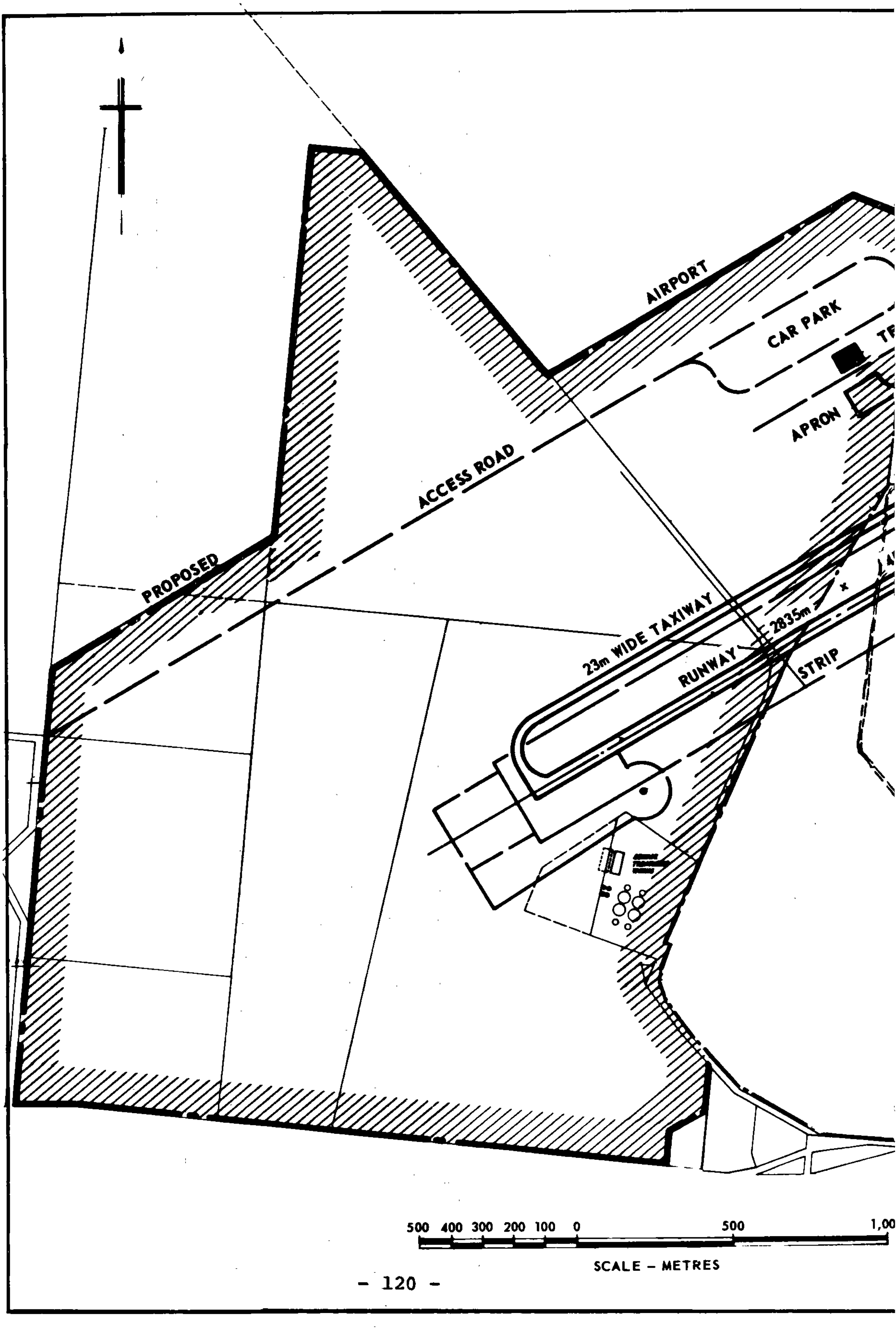
The land acquisitions associated with Project Cases 1 and 2 are shown on Figures G.1 and G.2 respectively. In 1975 prices the Project Case 1 acquisition of 38.6 hectares is valued at $190,000 whilst the acquisition of 766 hectares necessary for Project Case 2 is valued at $3,310,000 (1). The 'earliest feasible implementation' timing of acquisition is 1982 for Project Case 1, and 1976 for Project Case 2.

Operating Costs

There are several components of operating costs which, whilst associated with all international aircraft movements at Townsville, would not represent any net increase in resource use for the air transport network at large. These costs include airline ground handling costs such as traffic handling, engineering inspection and maintenance, as well as the labour and equipment components of airport operations.

In addition there are operating costs attributable to the Commonwealth Government and the airlines in the administration of the new international terminal. These include the costs of (terminal) airline office staff, airport security, customs,

(1) This may be an overestimate as part of the land is required for future extensions and RAAF purposes only. This point is further considered in Annex H.



AIRPORT
CAR PARK
APRON
ACCESS ROAD
PROPOSED
23m WIDE TAXIWAY
2835m
RUNWAY
STRIP
500 400 300 200 100 0 500 1,00
SCALE - METRES

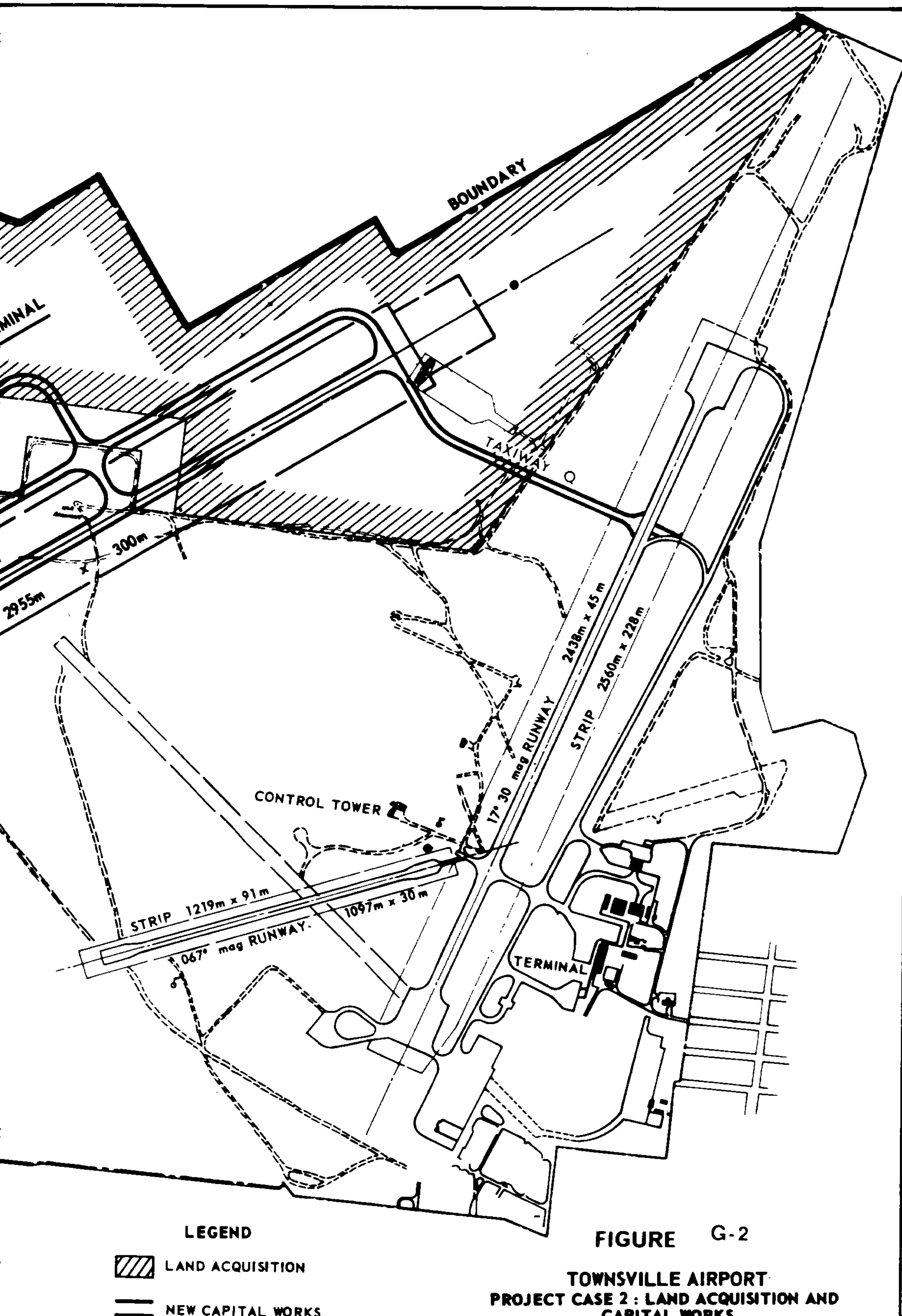


FIGURE G-2

TOWNSVILLE AIRPORT
PROJECT CASE 2 : LAND ACQUISITION AND CAPITAL WORKS

Source: Department of Transport

TABLE G.1 - CAPITAL COSTS FOR INTERNATIONAL FACILITIES AT TOWNSVILLE AIRPORT

($m)

Item	Project Case 1 (Extension of 01/19 runway)	Project Case 2 (New runway alignment 05/23)
STAGE 1		
Runway and Associated Taxiways		
. Earthworks	0.90	2.90
. Aircraft pavements	2.30	5.80
. Movement area drainage & ducts	0.10	1.50
. Perimeter road, RAAF arrestor barrier	0.12	1.16
Terminal Building		
. Terminal	1.50	1.50
. Incinerator, waste disposal etc	0.10	0.11
Other Buildings		
. Field powerhouse	0.25	0.34
. International DME building	0.03	0.21
. Fire Station	0.20	
. Control Tower	-	0.21
. Maintenance Complex	-	0.27
Engineering Services		
. Earthworks	0.13	0.83
. Apron and connecting taxiway	0.52	0.69
. Drainage and ducts	0.14	0.19
. Road car parks	0.17	0.83
. Water supply and sewerage	0.25	0.83
. Electrical reticulation	0.18	0.56
. Landscaping & environmental protection	0.01	0.07
NAVIGATIONAL AIDS		
Lighting		
. Approach lighting	0.15	0.07
. Runway lighting	0.08	0.09
. Taxiway lighting	0.05	0.04
. T-VASIS (2 units)	0.06	0.06

TABLE G.1 - CAPITAL COSTS FOR INTERNATIONAL FACILITIES AT TOWNSVILLE AIRPORT (Continued)

. ILS/MLS	0.18	0.18
. VOR	-	0.05
. DME/M	0.06	0.06
. Domestic DME	0.04	0.04
STAGE 2		
. Terminal Extension	1.20	1.20
STAGE 3		
. Apron Extension	0.30	0.30
TOTAL	9.02	20.09

TABLE G.2 - CAPITAL EXPENDITURE ALLOCATION BETWEEN STAGES FOR PROJECT CASES 1 & 2 (1)

($m in 1975 prices)

Construction Schedule	Project Case 1	Project Case 2
STAGE 1: CONSTRUCTION OF TERMINAL AND PROVISION OF INTERNATIONAL RUNWAY		
Year 1	0.69	3.81
Year 2	4.75	3.50
Year 3	2.27	8.81
Year 4	-	5.78
STAGE 2: TERMINAL EXTENSION TO HANDLE INCREASED TRAFFIC		
Year 1	0.40	0.40
Year 2	0.80	0.80
STAGE 3: APRON EXTENSION TO HANDLE INCREASED TRAFFIC		
Year 1	0.30	0.30
TOTAL	9.21	23.40

(1) Stage 1 includes land acquisition in year 1.

Health, Immigration and Department of Transport administrative and technical personnel.

It is assumed that all these costs would be transferred from movements in the Base Case to movements in the Project Cases, resulting in zero net operating costs.

On the other hand, the costs which will represent a net additional use of resources are those involved in the provision of fuel storage facilities and the additional transport cost component of fuel at Townsville compared to the Base Case. This resource cost has been estimated by Qantas[1] as an additional 1.76 cents per litre.

On the basis of refuelling Qantas aircraft with 45,000 litres per aircraft call and neglecting costs to foreign airlines[2], the net operating costs per annum are shown in Table G.3 for the period 1980 to the year 2000.

User Access Costs

The direct pecuniary costs (net of the Base Case) involved in access to the proposed international terminal are proportional to the difference in the distance from that terminal to a traveller's 'geographical centre of gravity', less the distance from the domestic terminal to the centre of gravity. In Townsville the centre of gravity for domestic movements overseas via the international terminal is designated as the central city area. This is regarded as the average origin/ destination point for the majority of international travellers. Justification for this is based on the proximity of hotel accommodation and the likelihood that many domestic overseas travellers would use these facilities in

(1) Qantas op cit.
(2) Due to the fact that foreign costs are not assumed to affect the Australian community.

TABLE G.3 - PROJECTED ANNUAL OPERATING COSTS FOR INTERNATIONAL SERVICES AT TOWNSVILLE AIRPORT

Year	Aircraft Movements (1) ('000's)	Refuelling Costs ($m)
1980	0.8	0.16
1981	1.0	0.20
1982	1.2	0.24
1983	1.4	0.28
1984	1.7	0.34
1985 (2)	2.0 (1.8)	0.40 (0.36)
1986	2.2	0.44
1987	2.5	0.50
1988	2.8	0.56
1989	3.2	0.64
1990	3.6	0.72
1991	4.0	0.80
1992	4.6	0.92
1993	5.2	1.04
1994	5.9	1.18
1995	6.7	1.34
1996	7.7	1.54
1997	8.8	1.76
1998	9.6	1.92
1999	10.5	2.10
2000	11.5	2.30

(1) Derived from Annex E.

(2) The figures in parentheses are the projections for the first year of international operations for Project Case 1.

TABLE G.4 - ACCESS DISTANCES BETWEEN TERMINALS AND TOWNSVILLE CITY PROPER

(kms)

Case	Distance (1)	Net Distance to City (2)	Distance from Domestic to International Terminal
Base Case	6.6	-	-
Project Case 1	6.6	0.0	3.0
Project Case 2	14.4	7.8	10.2

(1) Measured from the terminal to the intersection of Stanley and Flinders Streets, Townsville City Centre.

(2) Estimated by subtracting the Base Case access distance from each project case access distance.

conjunction with their departure or arrival at Townsville. In addition to the money cost of travel to and from the airport, the time cost to passengers must also be considered.

Distances from the respective Project and Base Case terminals are shown in Table G.4. It is assumed that 70% of passengers travel between the international terminal and the centre of gravity in Townsville by airport bus, private vehicle and taxi in the proportions 3:2:2. This leaves 30% of passengers transferring between the domestic and international terminals. The operating costs per kilometre for each vehicle type and estimated average passenger loadings are shown in Table G.5.

The assumptions made about the average speed of vehicle types in order to calculate time access costs are 48 kms per hour for buses and 60 kms per hour for taxis and cars. This information is sufficient to estimate net user access costs for each project case and for each projection over time. These are given in Table G.6. No allowance has been made in these estimates for the inclusion of the costs associated with friends and relatives farewelling travellers.

TABLE G.5 - VEHICLE OPERATING COST PER KILOMETRE

Vehicle	Proportion of Traffic (%)	Operating Cost/km ($)	Average Passenger Loading/ Vehicle	Resource Cost/ Passenger km ($)
Airport Bus	30	0.63	20	0.032
Private Car	20	0.06	2	0.030
Taxi	20	0.19	2	0.095
Intra-Terminal bus	30	0.63	20	0.032

Net access costs are expressed as the cost of access over and above the cost associated with travel to and from the existing domestic terminal building which occurs in the Base Case. It is clear from Table G.4 that the terminals in Project Case 1 and the Base Case are equidistant from the Townsville city area. Hence the net user access cost for Project Case 1 consists of inter-terminal traffic only and assumes a starting date of 1985. Project Case 2 net access costs are expressed in resource terms for all vehicular traffic and are based upon the introduction of international services in 1980. These starting dates represent earliest feasible implementations.

The net time access cost is formulated by applying average vehicle speeds to the distances travelled for each project case. Time is valued at 87c per hour.[(1)] Net time access costs are shown in Table G.6.

Taxiing Costs

The Base Case for this study assumes that domestic movements overseas (DMO) prior to, or in the absence of an international airport at Townsville, would take place at one or more of Australia's other international gateways. Therefore, there is a resource cost and time cost involved in taxiing international aircraft between the international terminal and the runway ends, and also in taxiing the domestic aircraft used on the Townsville-Southern Port routes. Consequently under a direct flight assumption each aircraft movement would result in a saving of two manoeuvres by domestic aircraft (in the Base Case). However, because the resource cost and time savings of Annex F use block-to-block times, the savings in taxiing time are already included in the project benefits.

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(1) D.A. Hensher & R.C. Carruthers "Resource Value of Business Air Travel Time" (Unpublished) Nov. 1974.

TABLE G.6 - PROJECTED ANNUAL NET USER ACCESS COSTS AT TOWNSVILLE AIRPORT[1]

Year	Domestic Movements Overseas[2] ('000)	Net Real Access Costs ($'000)		Time Access Costs ($'000)	
		Project Case 1	Project Case 2	Project Case 1	Project Case 2
1980	41.7	-	15.3	-	5.4
1981	52.0	-	19.1	-	6.8
1982	64.6	-	23.8	-	8.4
1983	80.0	-	29.4	-	10.4
1984	98.8	-	36.4	-	12.8
1985[3]	124.6 (121.8)	3.5	45.9	1.9	16.2
1986	142.0	4.1	52.3	2.3	18.5
1987	161.5	4.7	59.4	2.6	21.0
1988	183.4	5.3	67.5	2.9	23.8
1989	207.9	6.0	76.5	3.3	27.0
1990	239.6	6.9	88.2	3.8	31.1
1991	270.8	7.9	99.7	4.3	35.2
1992	310.6	9.0	114.3	5.0	40.4
1993	361.2	10.5	132.9	5.8	47.0
1994	412.1	12.0	151.7	6.6	53.6
1995	476.0	13.8	175.2	7.6	61.9
1996	548.1	15.9	201.7	8.8	71.3
1997	637.2	18.5	234.5	10.2	82.8
1998	694.6	20.1	255.6	11.1	90.3
1999	757.1	22.0	278.6	12.1	98.4
2000	825.3	23.9	303.7	13.2	107.3

(1) After subtracting those access costs which are incurred in the Base Case.

(2) International passenger movements by Australian residents through the international terminal at projection level 1.

(3) Figures in parentheses indicate the projection for the first year of international operations for Project Case 1. All subsequent figures in the series are identical for both project cases.

Non-pecuniary Costs

Costs associated with safety and environmental factors have not been evaluated in monetary terms in this study. A general discussion of both of these factors was given in Annex C.

DISCOUNTED COSTS

The cost stream generated by the introduction of international services at Townsville depends on the construction timing pertinent to each development strategy. These costs must be discounted to enable comparisons between benefits and costs and between alternatives.

Discounted costs using a 7 and 10 per cent discount rate for the two project cases, on the assumption that they are implemented by the earliest feasible dates, are given in Table G.7.

Alternative project implementation timings are also considered in this study. These are determined by maximising the net present value for each alternative. The net present value will be maximised in that year when the benefits derived in the first year after implementation of the project exceed the costs that would be saved by delaying the project for another year (1) if the net benefit and fixed cost functions are well behaved (2).

The benefits from implementing international services at Townsville in any year are obtained by subtracting the variable costs associated with the provision of airport services to internationals, shown in Table G.3, from the annual resource

(1) This criteria is relevant in decision making only in situations where the benefits are time dependent as they are in this case.

(2) That is the net benefit function is continuous and monotonically increasing and cuts the linear fixed cost function only once and from below.

TABLE G.7 - DISCOUNTED RESOURCE AND TIME COSTS AT TOWNSVILLE AIRPORT FOR EARLIEST FEASIBLE IMPLEMENTATION [1]

($m)

Cost Item	Project Case 1 Discount Rate		Project Case 2 Discount Rate	
	7%	10%	7%	10%
Resource Costs				
Capital costs [2]	4.58	3.58	15.52	14.15
Land acquisition	0.12	0.10	3.09	3.01
Operating costs				
-Townsville-Nadi	1.61	0.94	1.86	1.14
-Townsville-Singapore	1.15	0.67	1.33	0.81
-(Townsville-Auckland)	(1.83)	(1.07)	(2.12)	(1.30)
User access costs				
-Townsville-Nadi	0.02	0.01	0.23	0.13
-Townsville-Singapore	0.01	0.01	0.18	0.10
-(Townsville-Auckland)	(0.02)	(0.01)	(0.25)	(0.16)
Taxiing costs	-	-	-	-
Non-pecuniary costs	-	-	-	-
Total Resource Costs	7.49	5.31	22.20	19.34
Time Costs				
Time access costs				
-Townsville-Nadi	0.01	0.01	0.08	0.05
-Townsville-Singapore	0.01	0.00	0.06	0.03
-(Townsville-Auckland)	(0.01)	(0.01)	(0.10)	(0.06)
Taxiing time costs	-	-	-	-
Total Time Costs	0.02	0.01	0.14	0.08
Total Costs	7.51	5.32	22.34	19.42

(1) The Townsville-Auckland route is shown but is omitted from total costs on the grounds that it would be uneconomic.

(2) To obtain capital costs for Project Case 1 net of the Base Case, it was necessary to subtract the cost of installing an MLS on runway 01/19 in 1985. Capital costs include expenditure on terminal and apron extensions in 1995 and 2000 (stages 2 and 3).

and time benefits calculated in Annex F. These net benefits are shown diagrammatically as NB1 and NB2 for Project Cases 1 and 2 respectively in Figure G.3.

The costs saved by delaying implementation of international facilities comprise the opportunity cost of capital that would have been tied up in the project in that year, together with the capital resources that would have been used up in that year. The opportunity cost of capital is calculated using the two rates of interest employed as discount rates; that is, 7 and 10 per cent. An estimate of capital resources used in the first year after implementation is obtained by assuming straight line depreciation over a 30 year project life. That is, the capital is assumed to be used at a rate of 3.3 per cent per annum. Therefore, the costs saved by delaying implementation by one year are calculated as either 10.3 per cent or 13.3 per cent of capital costs depending on the opportunity cost of capital assumed. These costs are shown diagrammatically as DC1 and DC2 for Project Cases 1 and 2 respectively in Figure G.3.

The implementation dates for which the net present values for the two project cases are maximised can be derived directly from Figure G.3. These are 1985 and 1988 for Project Case 1 at 7 and 10 per cent opportunity costs respectively, and 1996 and 1998 for Project Case 2 at 7 and 10 per cent opportunity costs. The discounted costs using 7 and 10 per cent discount rates for implementation at these dates are given in Table G.8.

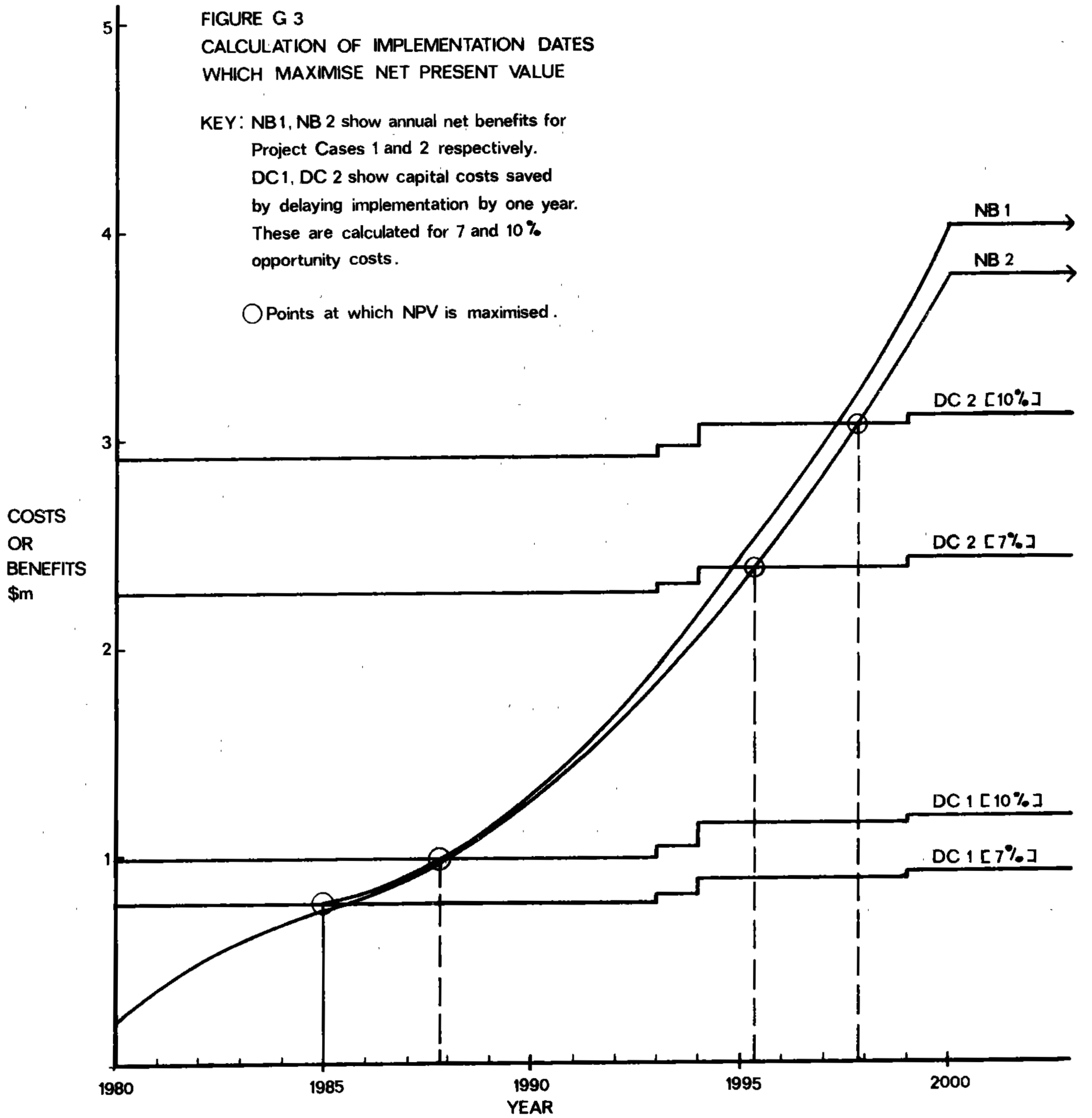
FIGURE G 3
CALCULATION OF IMPLEMENTATION DATES
WHICH MAXIMISE NET PRESENT VALUE
KEY: NB1, NB 2 show annual net benefits for
Project Cases 1 and 2 respectively.
DC1, DC 2 show capital costs saved
by delaying implementation by one year.
These are calculated for 7 and 10 %
opportunity costs.
Points at which NPV is maximised.
NB 1
NB 2
DC 2 [10%]
DC 2 [7%]
DC 1 [10%]
DC 1 [7%]
COSTS
OR
BENEFITS
$m
5
4
3
2
1
1980
1985
1990
1995
2000
YEAR

TABLE G.8 - DISCOUNTED RESOURCE AND TIME COSTS AT TOWNSVILLE AIRPORT FOR IMPLEMENTATION BASED ON MAXIMUM NET PRESENT VALUE (1)

($m)

Cost Item	Project Case 1 Discount Rate		Project Case 2 Discount Rate	
	7%	10%	7%	10%
Resource Costs				
Capital costs (2)	4.58	2.74	5.49	2.68
Land acquisition	0.12	0.07	1.05	0.54
Operating costs				
-Townsville-Nadi	1.61	0.79	0.65	0.20
-Townsville-Singapore	1.15	0.57	0.47	0.15
-(Townsville-Auckland)	(1.83)	(0.91)	(0.93)	(0.24)
User access costs				
-Townsville-Nadi	0.02	0.01	0.08	0.03
-Townsville-Singapore	0.01	0.01	0.07	0.02
-(Townsville-Auckland)	(0.02)	(0.01)	(0.10)	(0.03)
Taxiing costs	-	-	-	-
Non-pecuniary costs	-	-	-	-
Total Resource Costs	7.49	4.19	7.81	3.62
Time Costs				
Time access costs				
-Townsville-Nadi	0.01	0.01	0.03	0.01
-Townsville-Singapore	0.01	0.00	0.02	0.01
-(Townsville-Auckland)	(0.01)	(0.01)	(0.03)	(0.01)
Taxiing time costs	-	-	-	-
Total Time Costs	0.02	0.01	0.05	0.02
Total Costs	7.51	4.20	7.86	3.64

(1) The Townsville-Auckland route is shown but is omitted from total costs on the grounds that it would be uneconomic.

(2) To obtain capital costs for Project Case 1 net of the Base Case, it was necessary to subtract the cost of installing an MLS on runway 01/19 in 1985. Capital costs include expenditure on terminal and apron extensions in 1995 and 2000 (stages 2 and 3).

ANNEX H

SENSITIVITY ANALYSIS OF THE RESULTS

The main results presented in this report are based upon a set of assumptions considered to be the most likely given existing data and current knowledge about developments in air transport in the foreseeable future. The reliability of the results obtained and the confidence which can be placed in them depends upon the accuracy of these assumptions. This Annex summarises the changes that would occur if the key assumptions are varied and in so doing, provides an indication of the sensitivity of the evaluation outcome.

Consideration is given to the following factors:

(i) projection level and charter traffic,
(ii) project implementation date,
(iii) value of travel time,
(iv) the ratio of transit flights to total flights,
(v) the discount rate,
(vi) passenger load factor,
(vii) aircraft type,
(viii) aircraft resource costs,
(ix) benefits to overseas visitors,
(x) the level of unrecorded transits.

Results are reported only for Project Case 1 because variations in the factors listed above affect both strategies in a similar fashion and without changing the project ranking. The results are presented on the basis of project implementation chosen so as to maximise project net present value (NPV). The parameters used to demonstrate the effects of changes are NPV, change in NPV, new benefit-cost (B/C) ratio, change in B/C ratio and the implementation date at which maximum NPV is achieved.

Projection Level

Two demand levels were developed in Annex D for use in this report. The higher level projection was used in developing the results for the 'most likely' assumption set. The lower projection is now used for sensitivity testing. Both of these projection series show growing demand to the year 2000 based on econometric forecasts and historical trends but at differing rates. Beyond the year 2000 however, a 'no growth' assumption was imposed due to lack of information and the remoteness of this period from the present. Therefore, in considering the sensitivity of the evaluation results to projection level, these two components are examined independently.

A lower rate of growth in the pre-year 2000 demand projection results in fewer resource and time savings up to the year 2000 and also reduces the absolute level of post-year 2000 net benefits. The variable costs associated with the provision of international services are also a function of passenger demand and hence are influenced by the change to more conservative projections. The net effect of substituting the projection level 2 forecast for projection level 1 is to reduce the project's NPV to zero and the benefit-cost ratio to one. Furthermore, the implementation date at which project NPV is maximised is changed from the year 1985 to the year 2000 as is shown in Figure H.1.

Changing the assumptions relating to growth of demand in the post year 2000 period has no effect on the maximum NPV implementation date, although it does change the B/C ratio and the NPV. Changing the no growth assumption to a positive growth assumption results in increases in both the B/C ratio and the NPV.

Charter traffic was not specifically considered in earlier calculations but it may be treated as a special case of projection level changes. Whilst no time series data is available to determine actual levels of charter traffic, it is possible to make the following generalisation. An increase

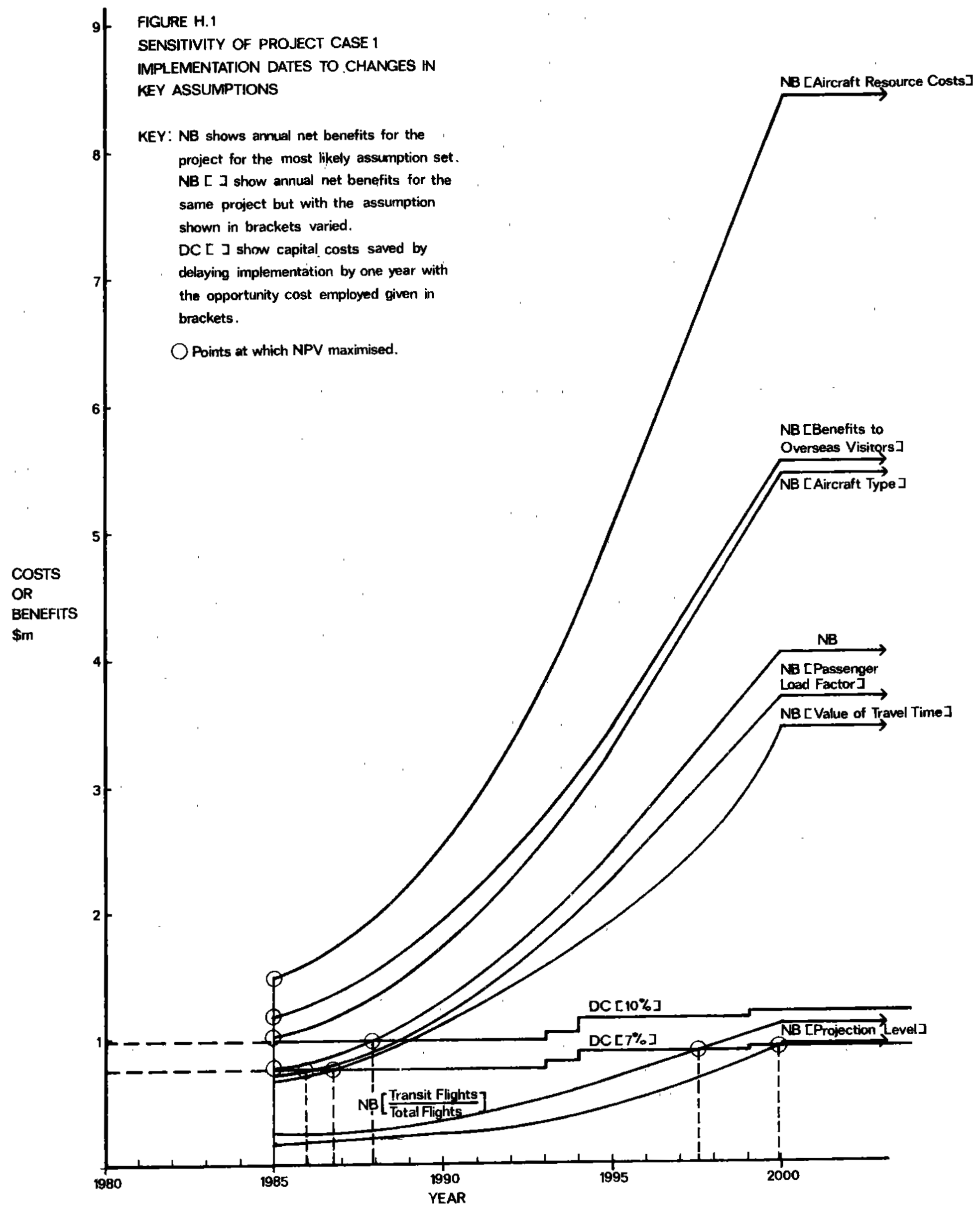

FIGURE H.1
SENSITIVITY OF PROJECT CASE 1 IMPLEMENTATION DATES TO CHANGES IN KEY ASSUMPTIONS

KEY: NB shows annual net benefits for the project for the most likely assumption set.
NB [ ] show annual net benefits for the same project but with the assumption shown in brackets varied.
DC [ ] show capital costs saved by delaying implementation by one year with the opportunity cost employed given in brackets.

○ Points at which NPV maximised.

in passenger movements due to the inclusion of charter traffic would increase both the net present value and the benefit-cost ratio, but would not bring forward the implementation date as this is constrained to 1985 by the need for the development of a suitable instrument landing system.

Project Implementation Date

Postponement of the project for any year between the earliest feasible implementation date and maximum NPV implementation date brings about an increase in NPV over and above the previous year. However, delays in implementation beyond the maximum NPV date, whilst maintaining benefit-cost ratios at levels greater than unity, involve an absolute reduction in NPV and therefore, are not economically worthwhile.

Value of Travel Time

Throughout this study a value of travel time of 87 cents per hour was used to calculate time access costs and time savings for domestic passengers travelling overseas. This value was judged to be the most appropriate of the many values derived in recent studies of the value of travel time. Alternative values of leisure travel time have been formulated in various publications, ranging from values significantly greater than 87 cents, to values as low as 48 cents per hour(1).

Values of leisure travel time less than 87 cents per hour would reduce the B/C ratios and NPV's derived earlier. Setting the value of travel time at zero cents per hour delays the implementation date which maximises NPV to 1987 and reduces the B/C ratio and net present value to 2.13 and $7.57m respectively using a 7 per cent discount rate.

(1) Main Roads Department, Queensland, "Brisbane Airport: Development strategy 'K'", August 1974, values of travel time by private car, per hour.

Ratio of Transits to Total Flights

The assumption that all international flights will be direct is relaxed and in its place the benefits and costs are calculated on the basis of 75 per cent transit flights for all routes. An increase in the number of transits results in lower passenger loading factors at Townsville Airport. On the advice of Qantas this factor is assumed to be 50 passengers per aircraft which reduces the effective loading from 97 passengers per movement to 62 passengers per movement. Thus, the number of aircraft movements required to service the projected level of passenger movements will increase. Consequently total operating costs will rise. This will affect different routes differently as is shown below.

Townsville-Nadi: Transits on this route may occur in two different ways; flights may go from Brisbane to Townsville to Nadi (and return) or they may go from Townsville to Brisbane to Nadi (and return). The change in the assumed level of transits on this route would render services on the route uneconomic because total additional costs would exceed total resource savings.

Townsville-Singapore: The only feasible alternative for this route is Brisbane-Townsville-Singapore (and return). Such an operation would result in project benefits significantly smaller than under the 'no transit flight' assumption, although net resource savings would still occur.

Townsville-Auckland: It was found under the 'no transit flight' assumption that this route would not be economic. The introduction of transit flights on the route would imply even greater losses.

Given that only the Townsville-Singapore route is economic under the changed assumptions, the new implementation date which maximises NPV is 1998 using a 7 per cent discount rate. This is associated with a net present value of $5.30m and a B/C ratio of 3.05. This last result is in fact an increase and occurs because delaying the project reduces both the costs and benefits in present value terms, but costs are reduced proportionally more than benefits.

Passenger Load Factor

A change in load factor from 65 per cent to 72 per cent of saleable aircraft seats has a small effect. Selecting implementation to maximise NPV, the B/C ratio for Project Case 1 is reduced from 2.29 to 2.20 using a 7 per cent discount rate, a fall of approximately 4 per cent. This is brought about by reductions in operating costs and project benefits simultaneously. The net present value also falls to $8.23m. The implementation date is delayed by one year to 1986.

Discount Rate

Throughout this report results have been presented for the two discount rates 7 per cent per annum and 10 per cent per annum. The change from 7 per cent to 10 per cent postpones the maximum NPV implementation date to 1988. This is associated with a lowering of the B/C ratio to 1.89 and a NPV of $3.75m. That is, the increased discount rate effects a reduction in the present value of benefits which are distributed over the project life more than it reduces the present value of capital costs which mostly occur at the start of the project life. The higher discount rate then favours the project with the lower initial capital cost.

Aircraft Type

The original assumption made regarding international aircraft type was that Boeing 707 aircraft would be used on all routes for the full project life. This assumption may be regarded as particularly conservative considering the current Qantas policy of selling their older B707's and replacing them with B747 aircraft.

Taking the extreme case of all aircraft movements being of the B747 type, the implementation date based on maximising NPV remains at 1985 (due to the MLS constraint) but NPV rises to $11.64m and the new B/C ratio becomes 2.55 using a 7 per cent discount rate. This change results from an increase in benefits brought about by reducing per passenger, and hence total resource costs.

Aircraft Resource Costs

The resource costs per passenger for domestic and international aircraft, used in Annex F, were based on work carried out for the Department of Transport by R. Travers Morgan and Partners. There is evidence to suggest that these resource costs may be conservative. To test the effect of this possible bias the results are recalculated on the basis of information provided by TAA and the Department of Transport. These are tabulated below:

Aircraft type	Cost/Passenger Block Hour ($)
DC9	14.5
727-100	17.8
727-200	15.3
Wide Body	12.1
707	21.4

The effect of these changes is to boost the project benefits relative to costs such that the B/C ratio rises to 4.35 using a 7 per cent discount rate and the net present value is altered to $25.16m. Once again the MLS constraint prevents the maximum NPV implementation from being brought forward and the date therefore remains at 1985.

Benefits to Overseas Visitors

It was earlier assumed that only those project benefits accruing to Australian residents from North Queensland would be included in the analysis. The reasoning for this assumption was outlined in Chapter 4. However, the point was made that foreign visitors would also benefit from the development at Townsville airport and such benefits could be diverted to the Australian community by various means such as the adoption of suitable pricing policies. Such procedures may not be costless in terms of reductions in passenger demand and the possibility of retaliatory action by overseas governments. Nevertheless, should such a policy be envisaged, an upper limit for the additional net benefits that might be reaped is estimated at $6.02m in present value terms for a 7 per cent discount rate. Adding this potential benefit to the results obtained for the 'most likely' assumption set produces an NPV of $15.74m and a B/C ratio of 2.89. Implementation timing is still constrained to 1985.

The Level of Unrecorded Transits

Due to the procedure used to record passenger movements, a certain proportion of transit passenger movements are not included in the projections made in Annex D. Some indication of the significance of unrecorded transits on domestic flights was obtained in Annex D for the year 1972-73. Unfortunately no information is available to allow a similar calculation for international transits. Nevertheless, the inclusion of unrecorded transits would be expected to have the converse effect to that reported above under the heading 'Projection Level'. That is, both the NPV and the B/C ratio would be increased. Implementation would not be affected because of the MLS constraint.

Summary

Table H.1 summarises the changes that would occur in Project Case 1 results for the assumption variations discussed above. These assumption variations lead to similar changes in the evaluation results for Project Case 2. However, the

TABLE H.1 - SUMMARY OF EFFECTS OF CHANGES IN ASSUMPTIONS [1]

Variation in Assumption	Implementation Date based on Maximisation of NPV	NPV ($m)	Change in NPV [2] (%)	B/C Ratio	Change in B/C Ratio [2] (%)
'Most Likely' Assumptions	1985	9.72	-	2.29	-
Increased Aircraft Operating Costs	1985	25.16	+159	4.35	+90
Inclusion of Overseas Visitor Benefits	1985	15.74	+62	2.89	+26
B747 instead of B707 for International Travel	1985	11.64	+20	2.55	+11
Increased Passenger Load Factor	1986	8.23	-15	2.20	-4
Zero Value of Travel Time	1987	7.57	-22	2.13	-7
Increased Discount Rate	1988	3.75	-61	1.89	-17
Increased $\frac{\text{Transit}}{\text{Total}}$ Flight Ratio(3)	1998	5.30	-45	3.05	+33
Lowered Projection Level	2000	0.00	-100	1.00	-56

(1) Changes in each assumption are made on the basis of all other assumptions held constant and are reported only for Project Case 1.

(2) Changes in NPV or B/C ratio over the 'most likely' assumption case.

(3) Based on the consideration of the Townsville-Singapore route only, as the Townsville-Nadi route becomes uneconomic.

substantially higher capital costs in the latter case mean that any improvements in the Project Case 2 results are relatively smaller than they are in the Project Case 1 case. It follows that the ranking of the two project cases is quite insensitive to variations in the key assumptions.

Examination of the changes in implementation date brought about by varying the assumptions shows that the implementation date which maximises NPV is quite sensitive to likely changes in the forecast level and also to the relative proportions of direct and transit flights assumed. The latter assumption is particularly important since it was assumed in the analysis that all international services would be direct, whereas Qantas advice (reported in Annex B) suggests that services are more likely to be of a transit, rather than of a direct, nature. On the basis of this advice the assumption employed in the analysis is optimistic in that it favours early implementation.

Finally, although the evaluation results as measured by the NPV's and B/C ratios, varied to a greater or lesser extent under all assumption changes, the only change that is likely to render the project viability uncertain is a change in the forecasts of passenger movements. The B/C ratio falls to one if the forecast rate of growth in international passenger movements at Townsville falls to an average rate of growth of 9 per cent per annum up to the year 2000. A growth rate lower than this would result in a B/C ratio less than one.

ANNEX I

APPLICATION OF A MICROWAVE LANDING SYSTEM TO TOWNSVILLE AIRPORT

BACKGROUND TO MICROWAVE LANDING SYSTEM DEVELOPMENT

Introduction

Microwave Landing Systems (MLS) are being developed in a number of countries as part of a programme co-ordinated by the International Civil Aviation Organisation (ICAO) to standardise a new approach and landing guidance system to meet the foreseeable needs of international civil aviation. A new system called INTERSCAN is being developed as a joint project between the Australian Department of Transport and CSIRO to meet ICAO requirements. This section of the annex gives the background to MLS developments and the likely time scale for implementation.

The Present ILS

Approach and landing guidance for aircraft is presently provided by Instrument Landing Systems (ILS) which conform to ICAO standards and are widely used throughout the world. The ILS is "protected" by ICAO, and so the ICAO standards will not be changed to render present equipment unusable, until 1985. It seems likely however, that ILS will continue as an ICAO standard until the year 2000. Although there have been considerable developments in ILS in recent years, these systems do have fundamental limitations which make the demands of modern air transport increasingly difficult to meet.

ILS provides a single fixed approach path aligned with the runway centreline and at a fixed approach angle which is usually 3 degrees from the horizontal. A landing aircraft must join this straight line track at about 8 nautical miles from the runway threshold. This means that the obstacle clearance surfaces and noise zones extend out for a considerable distance on the extended runway centreline. A new system that provides a variety of approach paths is required, so that flight paths which can now be flown under visual conditions can also be flown under instrument conditions. With precision guidance available over wide sectors, it may eventually be possible to have flight paths limited only by the dynamics of the aircraft and passenger comfort. With such a system, only the last one or two nautical miles of the approach need be on the extended runway centreline if preceded by an appropriate curve and if an approach path can be provided (both horizontally and vertically) to avoid noise sensitive areas.

The guidance signal radiated by an ILS can be degraded by reflections from local terrain, airport buildings and taxiing aircraft. To ensure that false guidance is not given to landing aircraft, siting constraints and restrictions have been imposed on ground movements of aircraft. The first adds directly to the cost of an ILS installation and may even prevent ILS being installed. The second reduces airport capacity by requiring taxiing aircraft to be held clear of the ILS "critical areas" while an aircraft is on an ILS approach.

The general view is that the ILS cannot be developed to provide the additional capabilities and overcome interference caused by reflections, while remaining compatible with existing ground and airborne equipment.

Microwave Landing System Requirements

A specialised panel of ICAO, the All Weather Operations Panel (AWOP), on which the Department of Transport is represented, began a study of the requirements for a new system in 1968. Over the next four years, AWOP developed the Operational Requirements which were approved by ICAO in 1972. These were not met by any existing system and ICAO invited member States to submit proposals for the development of suitable systems.

Australia responded with INTERSCAN and system proposals were also received from the US, UK, Germany and France.

The introduction to the Operational Requirements is set out in Appendix A. It will be noted that the new system is to be designed for use at most aerodromes and runways to obtain the flexibility of visual approach operations in all weather conditions and so that the guidance system is not the limiting factor on airport design and utilisation.

The flight paths which are expected to be possible with the new system are shown in Figures I.1 and I.2. Flying such paths will undoubtedly require new avionics and instrumentation. These Operational Requirements would have been better termed "Operational Objectives" since they are ideals towards which system development is being directed. The laws of physics and economics will limit the performance of all guidance systems and MLS is no exception. The degree to which the MLS (including INTERSCAN) approach the ideal of the Operational Requirements has yet to be determined. If the ideal is achieved and applied to Townsville and if visual landings can be made on Runway 01, instrument approaches would also be feasible using MLS.

Time Scale for Microwave Landing System Development and Implementation

The five countries developing MLS submitted their system proposals, test results and supporting documentation to ICAO in December 1975. ICAO, through AWOP, is proceeding to select a system for international standardisation and to develop the standards and technical specifications for international agreement. Implementation of MLS would then follow. The likely time scale is shown in Table I.1.

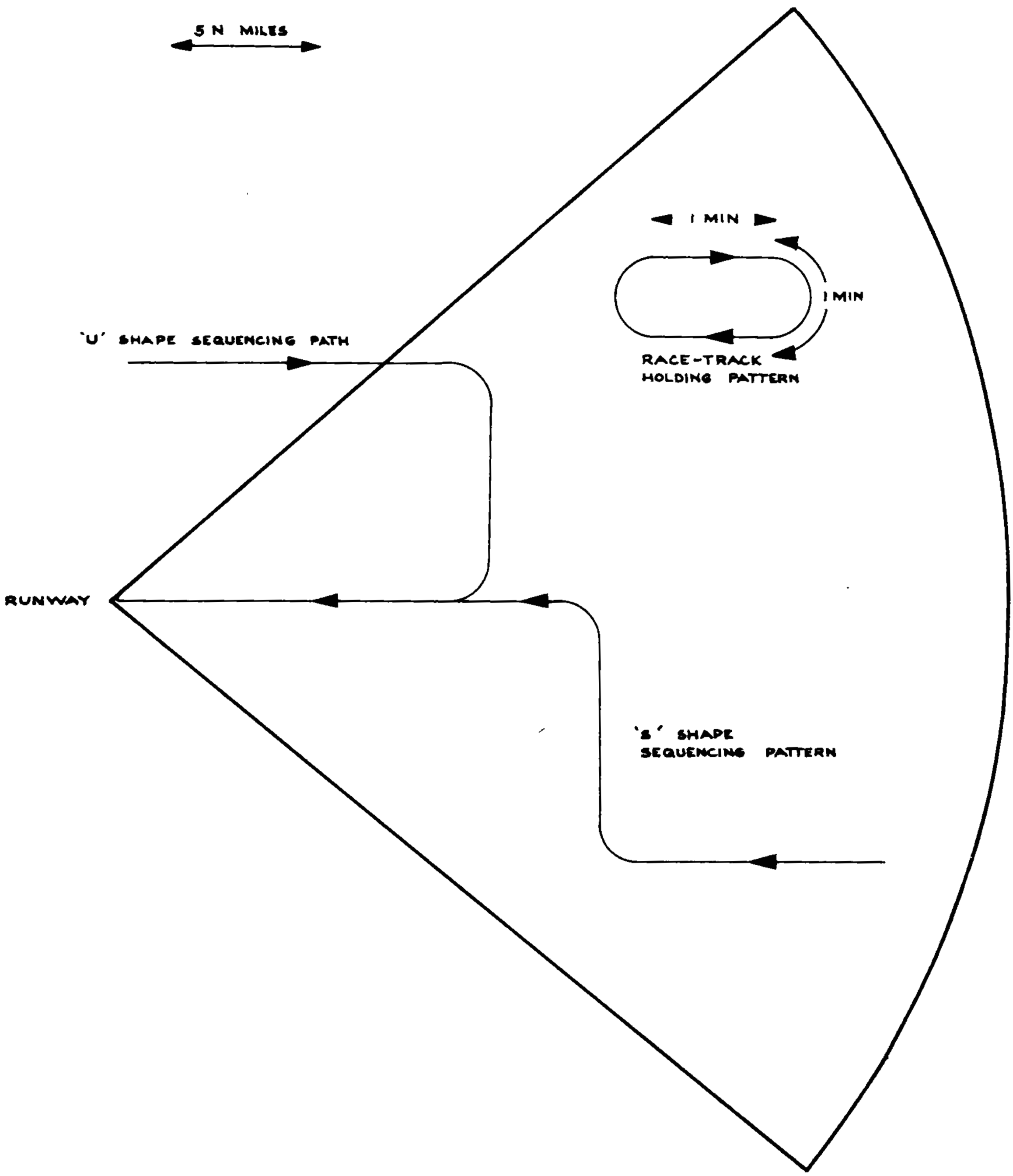

FIGURE I.1

MANOEUVRE AZIMUTH FLIGHT PATHS

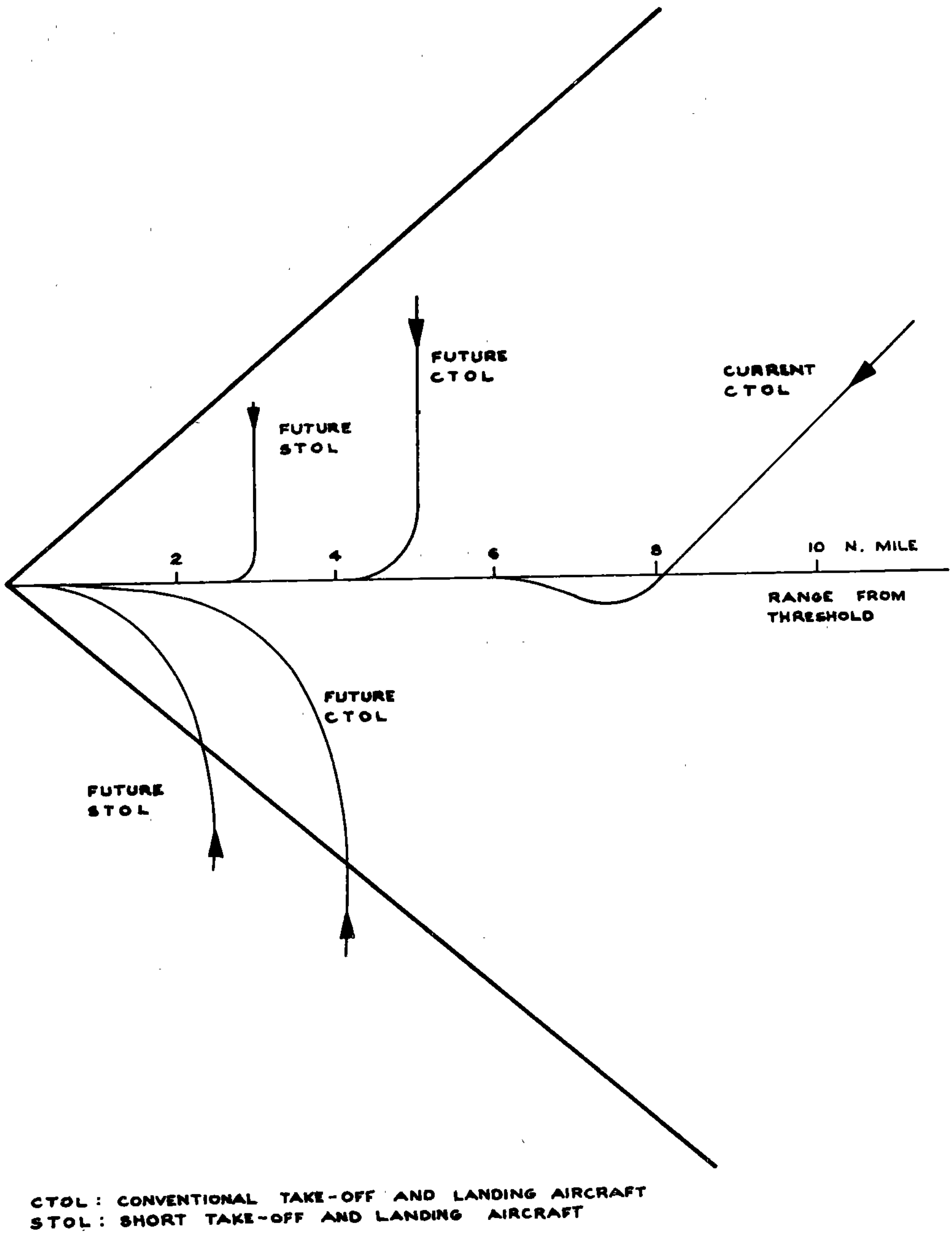

FIGURE I.2

INTERCEPT AND LAST PART OF FINAL APPROACH

TABLE I.1 - EXPECTED DEVELOPMENT TIMING FOR THE ICAO MICROWAVE LANDING SYSTEM

Time	Development
Jan 1976 to Sept. 1976	AWOP assesses the proposals from countries
October 1976	AWOP recommends the preferred system
mid-1977	ICAO world-wide meeting selects system for international standardisation
mid-1977 to mid-1978	AWOP develops international standards and specifications for the system
1978	International standards are adopted
1980	Procurement and implementation of MLS ground equipment begins
1982	Significant numbers of aircraft fitted.

It should be noted that MLS will not be completely specified until 1978. Nevertheless it is assumed, in this report, that the ICAO system will not be substantially different from INTERSCAN.

For MLS to be operational, both the airport and the aircraft using the airport must be fitted with MLS components. The airborne equipment is likely to be the major limiting factor and an implementation date of 1982 is probably optimistic. It could well be 1985 before international and domestic aircraft are equipped.

At the present stage of development it is certain that MLS will provide a precision co-ordinate system to enable the aircraft to fix its position. The airborne instrumentation which will be required to fly curved and segmented approach paths and the limitations on these paths is not yet determined.

So even when MLS is implemented, there is likely to be a considerable period of development before curved and segmented flight paths can be utilised.

International Development

Of the ICAO programmes, Australia, US and UK fall into one group and France and Germany into another. France proposes a system with wider implications than simply meeting the ICAO requirements, by incorporating data links and air traffic control functions. The German system (DLS) is along similar lines to the French proposal.

Both Australia and the UK selected an MLS technique before proceeding with the development of a full scale system for test and evaluation. Australia selected a time referenced scanning beam (TRS) format, codenamed INTERSCAN. The UK selected a Doppler technique. In the US it was decided to build two scanning beam and two Doppler systems and evaluate them before making a decision on a single system to present to ICAO. The two Doppler systems were similar in concept to that of the UK but their scanning beam system differed from the Australian proposal. The Australian TRS was not initially included in the US national programme, but the Federal Aviation Administration decided to include it as a result of their visit to Australia in February 1974. TRS was subsequently demonstrated in the US using part US and part Australian equipment. A combined Department of Transport and CSIRO team participated in this TRS evaluation and the US MLS selection process. In December 1974, the US selection committee recommended TRS to be the US national system for presentation to ICAO. This decision was ratified by their MLS executive committee in February 1975. Thus the US and Australia will be submitting compatible MLS to ICAO in December 1975.

Additional Capabilities

The additional capabilities which MLS aims to provide can be summarised as follows:

- wide sections of proportional guidance information to support a variety of straight, segmented and curved flight paths for approach, missed approach and take-off,
- greater freedom from siting constraints caused by airport buildings and terrain,
- less disturbance to the guidance signals caused by taxiing aircraft,
- lower site preparation costs at "difficult" sites,
- guidance for Vertical or short take-off and landing operations.

TOWNSVILLE AIRPORT AND THE MICROWAVE LANDING SYSTEM

Guidance Capabilities

An MLS installed at Townsville should provide guidance information in a wide sector of the approach on Runway 01 but shadowing would occur behind Mt Louisa resulting in a lack of guidance in that area. Some degradation in the quality of the MLS guidance would probably occur in close proximity to such mountains, but at this early stage of MLS development the extent cannot be predicted with certainty.

Possible Flight Paths

Although MLS guidance could be provided in the approach area, the actual flight paths, other than the present straight-in approach, which could be used will not be known until several prerequisites have been met: when the flight paths possible with existing instrumentation have been determined; when new avionics and instrumentation have been

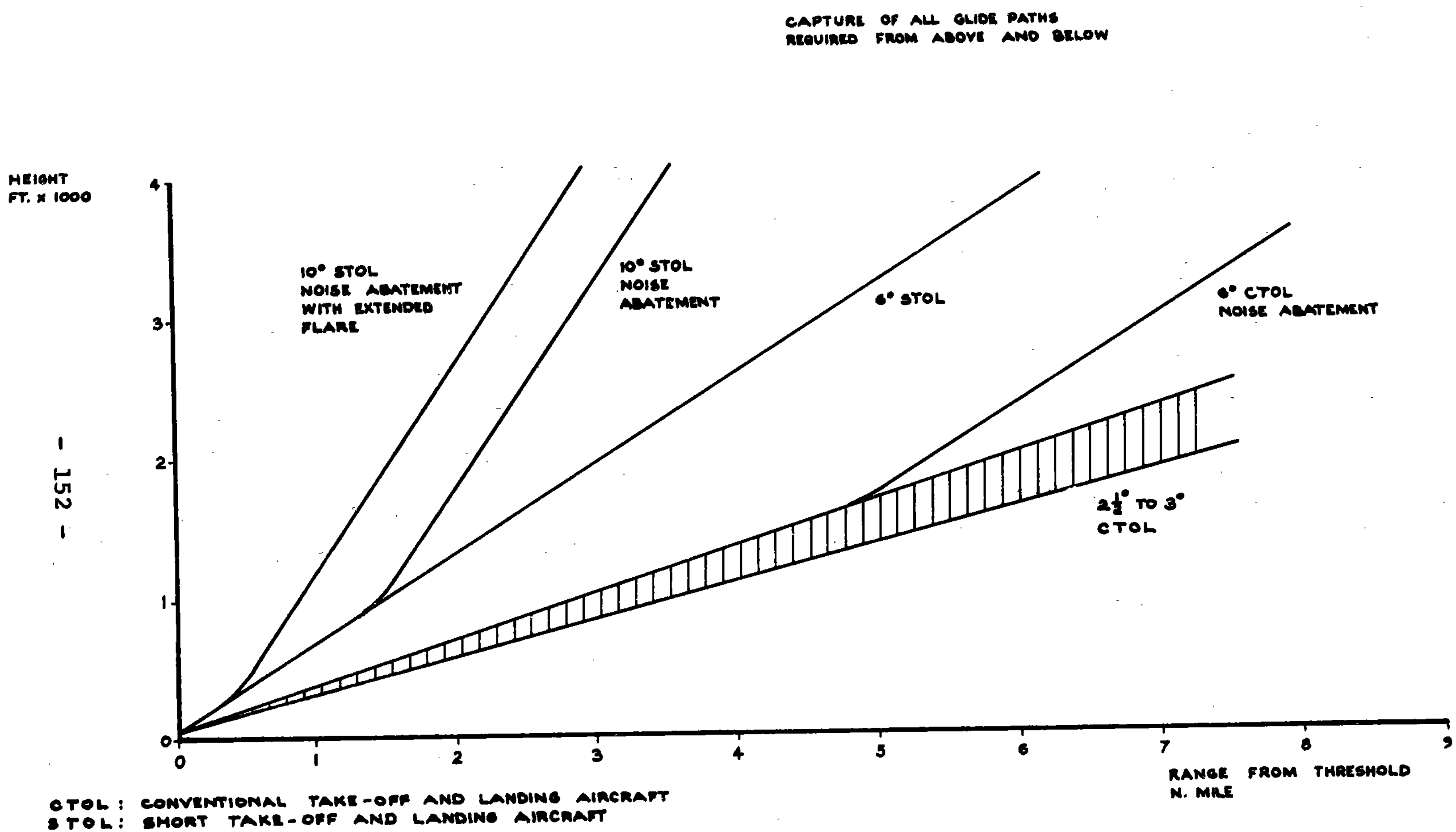

FIGURE I.3

FINAL APPROACH ELEVATION FLIGHT PATHS

designed and installed in aircraft to provide for additional flight paths; when the new obstacle clearance surfaces for such curves and segmented flight paths and the limitations on these paths have been determined; and finally when a period of development and operational flying has taken place to build confidence in flying such new paths.

If the flight paths shown in Figures I.1, I.2 and I.3 are assumed to be possible in the future, with the development of suitable avionics, instrumentation and procedures, then the following flight paths may become feasible at Townsville:

Straight

Contraction of the obstacle clearance surfaces to allow straight-in approaches would require the MLS performance to be substantially better than ILS and the reliability and the integrity of the ground and airborne equipment used for the approach would have to be of the same high order as for automatic landing. There are no such proposals for ground equipment and suitable airborne equipment would probably be too expensive for many users.

Segmented

A segmented approach in azimuth would require guidance signals to be available behind and close to the edge of Mt Louisa. This cannot be guaranteed until much more development and testing of INTERSCAN has taken place. A segmented approach in elevation is not likely to be permitted since the transition to a normal approach angle would occur too close to the threshold.

Curved

Lack of adequate guidance signals would preclude a curved approach path from the west behind Mt Louisa and the radius of turn would be too small to permit a curved approach in front of Mt Louisa. A curved approach, of the type shown in Figures I.1 and I.2 from the east, would seem to be possible, but would take the aircraft over the south-west portion of the town. This would have to be assessed in terms of noise. High reliability and integrity of the ground and airborne equipment of the same order as for automatic landing, may be necessary to support this curved approach, since failure of the guidance could place the aircraft in a critical situation especially with respect to the mountainous terrain.

Cost

Unlike ILS, MLS has been designed as a modular system consisting of a number of sub-systems of varying capabilities. A range of options is available for selection, the selection being governed by operational requirements and cost effectiveness. ICAO has defined two broad system categories. System B is a full capability system of maximum integrity and large volume of proportional guidance. It would be largely confined to the major terminals. System A would be the system most commonly deployed, having somewhat lesser capacity than System B. Several options are available within each category.

It is expected that a form of system A would be appropriate for Townsville. In Table I.2 typical configurations of each system are costed.

Airborne Equipment

The airborne MLS equipment will also be available in modular form in order to provide a variety of capabilities. In its most complete form, the equipment will enable the aircraft to follow curved and segmented approach tracks over a wide sector and to descend on pre-selected profiles including curved and segmented descent paths. While some of these flight paths may be possible using existing aircraft instrumentation, the full capability will undoubtedly require the development and fitting of new instrumentation.

TABLE I.2 - CAPITAL COSTS FOR VARIOUS MLS CONFIGURATIONS

($)

		System A (1)		System B
EQUIPMENT				
Azimuth (2)	$\pm 22^{\circ}$	79,000	$\pm 24.5^{\circ}$	118,000
Elevation	$+5^{\circ}$	56,000	$+15^{\circ}$	86,000
DME/M		58,000		58,000
Missed approach Azimuth		-		41,000
INSTALLATION		41,750		90,500
TOTAL		234,750		393,500

(1) System A is a lower capability system than system B which would tend to be used only at the major airports It is likely that system A would be appropriate for Townsville.

(2) The azimuth, elevation and DME/M sub-systems are duplicated.

One of the modular forms, and probably the only one initially available, will provide for a single straight approach path. This will be a minimum cost system. The airlines can be expected to examine the additional cost of the complete system against the benefits of additional capabilities, such as curved approaches in their operations.

Conclusion

Bearing in mind that MLS is in an early stage of development, only general guidelines can be provided for the application of MLS to Townsville Airport. Runway 01 represents a difficult case for MLS and thus the MLS performance would have to be known in much greater depth than is currently possible for an accurate assessment to be made. Provided avionics, instrumentation and procedures can be developed to support the flight paths foreseen by AWOP, a curved approach from the east would seem to be possible for Runway 01. If such an approach path can be flown with the aircraft instrumentation which is currently available, then this could be feasible by 1982. However, it is more likely to be 1985, provided the airlines fit the full capability airborne MLS equipment and display instrumentation. If new avionics and instrumentation are required, then the time scale would be much later - perhaps 1990 - again assuming the airlines fit the new equipment. However, none of these problems would be encountered for an MLS installation on the 19 direction of Townsville, although this would be inferior from the point of view of wind direction.

APPENDIX A

ICAO OPERATIONAL REQUIREMENTS [1]

These Operational Requirements are aimed at stating the objectives of present international civil aviation operations and those which can be foreseen within the next 20-30 years, and which if satisfactory would be of immediate benefit. Although this document addresses the requirements for international civil aviation, it is recognised that any new approach and landing guidance system under consideration as an international requirement should also be adaptable for meeting the national requirements of individual countries.

These requirements are for a high integrity precision guidance system to permit an approach, landing and missed approach capability:

a) at most aerodromes and most runways;
b) at maximum acceptance rate;
c) with no cloud base or visibility restriction;
d) with the flexibility of visual approach operations in all weather conditions;
e) with no limitations or constraints imposed by the guidance system (except where they are deliberately accepted for economy and simplicity) e.g. with guidance signals unaffected by local terrain, buildings and ground or air traffic; and with accuracy, volume of coverage, reliability and integrity suitable for any desired approach and landing operation by any type of aircraft;
f) with simplified versions of air and ground equipment for limited operations but with a

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(1) Extract from ICAO "Operation Requirements for a New Non-visual Precision Approach and Landing Guidance System for International Civil Aviation" DOC 9004, Appendix A, pp. 3-6.

system design to permit compatibility between all versions of the air and ground equipment;

g) in order to aid noise abatement.

These requirements describe the foreseen full operational needs for a new non-visual precision approach and landing guidance system for international civil aviation. Some lesser requirements, which are not described, are likely to exist for some operations.

It is recognised that in the course of future development addressed to meeting these Operational Requirements, analysis may result in the deletion of those requirements which can be shown to be most costly and of only marginal operational value.

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