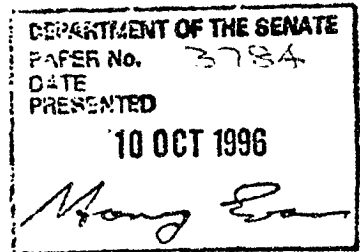




*Parliamentary Standing Committee on Public Works*

## **REPORT**

relating to the proposed



# **IMPLEMENTATION OF ROCKFALL RISK REDUCTION STRATEGIES ON CHRISTMAS ISLAND**

(First Report of 1996)

THE PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA  
1996

**The Parliament of the Commonwealth of Australia**  
**Parliamentary Standing Committee on Public Works**



Report relating

to the proposed

**Implementation of rockfall risk reduction  
strategies on Christmas Island**

(First Report of 1996)

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## MEMBERS OF THE PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS

(Thirty-Second Committee)

Mr Neil Andrew MP (Chairman)  
Mr Colin Hollis MP (Vice-Chairman)

Senate	House of Representatives
Senator Paul Calvert	Mr Richard Evans MP
Senator Alan Ferguson	Mr John Forrest MP
Senator Shayne Murphy	Mr Ted Grace MP
	Mr Michael Hatton MP*

\* Replaced The Hon Michael Lee MP on 26 June 1996

Committee Secretary:	Bjarne Nordin
Inquiry Secretary:	Michael Fetter
Secretarial Support:	Lynette Sebo

**EXTRACT FROM THE VOTES AND PROCEEDINGS OF  
THE HOUSE OF REPRESENTATIVES**

*No. 16 dated Monday, 17 June 1996*

**PUBLIC WORKS - PARLIAMENTARY STANDING COMMITTEE -  
REFERENCE OF WORK - IMPLEMENTATION OF ROCKFALL RISK  
REDUCTION STRATEGIES ON CHRISTMAS ISLAND**

Mr Jull (Minister for Administrative Services), pursuant to notice, moved-That, in accordance with the provisions of the *Public Works Committee Act 1969*, the following proposed work be referred to the Parliamentary Standing Committee on Public Works for consideration and report: Implementation of rockfall risk reduction strategies on Christmas Island.

Question-put and passed.

**PARLIAMENTARY STANDING COMMITTEE ON PUBLIC WORKS**

**IMPLEMENTATION OF ROCKFALL RISK REDUCTION  
STRATEGIES ON CHRISTMAS ISLAND**

By resolution on 17 June 1996, the House of Representatives referred to the Parliamentary Standing Committee on Public Works for consideration and report to Parliament the proposed implementation of rockfall risk reduction strategies on Christmas Island.

**THE REFERENCE**

1. The reference stemmed from a landslide risk assessment of the Kampong residential area of Christmas Island. This area is immediately beneath a steep cliff, which rises to 180 metres. The assessment report highlighted the possibility that rockfalls could cause injury and damage to or loss of Commonwealth property and community areas in addition to fatal events in extreme circumstances. Advice received from the Attorney-General's Department indicated that as injury is foreseeable, the Commonwealth owes a duty of care to the people who occupy Commonwealth land and buildings in the Kampong. The Commonwealth should therefore implement all appropriate risk reduction strategies to minimise risk of injury to people or property in the Kampong area, where that is reasonable.
2. The areas directly affected include Commonwealth-owned high-density residential units - Blocks 408 and 412 - which are occupied by government and public housing tenants. There are also other Commonwealth and community buildings which have been identified at risk; these include the boat club area, the marine building and other buildings.
3. In December 1995, the Executive Council referred a proposal to the previous Committee which involved relocation of affected residents and the construction of rockfall defences. The proposed works were estimated to cost more than \$20 million, but a range of alternatives were identified which would reduce this estimate. The reference lapsed with the dissolution of the House of Representatives on 29 January 1996.
4. Since then, an additional risk evaluation analysis was commissioned to identify a range of alternative strategies to respond to the problem. An allocation of \$1.191 million has been approved by the Government for the

construction of rockfall defensive barriers. Although this amount is less than the \$6 million threshold, strategies involving the relocation of residents from the two high density residential units (Blocks 408 and 412) would exceed the \$6 million limit.

### THE COMMITTEE'S INVESTIGATION

5. The Committee received a joint submission from the Department of the Environment, Sport and Territories (DEST) and Works Australia which was circulated for comment amongst organisations and individuals with an interest in the proposed work.

6. On 10 July the Committee inspected and viewed:

- the cliff face above the Kampong;
- a number of blocks in the Kampong area;
- the site at Poon Saan at which replacement housing is proposed; and
- a video showing tests of rockfall barriers subjected to rockfalls of various intensities undertaken in the USA.

7. In addition, the Committee held informal discussions with representatives of the Malay community in the Kampong.

8. A public hearing was held on 11 July, at which representatives of DEST and Works Australia gave evidence. At the public hearing the Committee also received submissions and took evidence from the following organisations and individuals:

- Union of Christmas Island Workers
- Christmas Island Shire Council
- Christmas Island Chamber of Commerce
- F P Woodmore Pty Ltd
- Christmas Island Boat Club
- Australian Nature Conservation Agency.

9. Submissions were also received from the following:

- Islamic Women's Group
- Christmas Island Women's Association
- Australian Council of National Trusts
- Families at Work
- Commonwealth Environment Protection Agency
- Australian Heritage Commission
- Commonwealth Fire Board.

10. A list of witnesses who gave evidence at the public hearing is at Appendix A. The Committee's proceedings will be printed as Minutes of Evidence.

### BACKGROUND

#### Location and description

11. Christmas Island is located in the north-eastern Indian Ocean 2,600 kilometres west of Darwin, 2,600 kilometres north-west of Perth and 360 kilometres south of Java. The island covers about 140 square kilometres, of which about 85 square kilometres is Christmas Island National Park. In geological terms the island is the summit of a submarine mountain comprising limestone stratified by layers of volcanic rock. In most places the coastline consists of steep cliffs and the only adequate anchorage and landing is at Flying Fish Cove. A steep cliff, which rises to 180 metres, overlooks the cove.

12. The island was annexed and settled by the British in 1888. A phosphate mining operation was commenced in 1897. Labour for the mine was brought from Malaysia. The mining operation was purchased by the Australian and New Zealand Governments in 1947 and phosphate mining continued until December 1987, when the high grade ore ran out. Low grade phosphate continues to be mined by a company owned by Christmas Islanders. A further major employer is Christmas Island Resort which opened a multi-million dollar casino on the island at the end of 1993.

13. The climate is tropical, with little variation in temperature, with a monthly average of 27°C and a temperature range of 21 to 32°C. Of significance for the purposes of this report is rainfall. Mean monthly rainfalls occurring during the wettest periods (November to May) are:

Month	mm
November	152.2
December	183.1
January	207.1
February	276.8
March	287.5
April	214.3
May	210.2

14. The most recent aberrations in monthly averages occurred in May 1968 (682.0mm), January 1974 (637.6mm), and December 1989 (758.6mm). Rainfall is intense for relatively short periods.

15. Residential, administrative and phosphate processing and shipping activities are concentrated on Flying Fish Cove and on naturally occurring terraces overlooking the cove. The population of the island is about 2,000 and is fluctuating. The Commonwealth Grants Commission reported a population of 2,200 in its report on the Christmas Island inquiry. Whichever is correct, it is true to say that the population has increased since the last census when it was 1,300. The permanent population is located in five main centres:

- the Settlement - at sea level - extends from Flying Fish Cove to the north-eastern point of the island;
- the Kampong - also at sea level - is located on a narrow and relatively flat area inland from the sand and cobble beach of Flying Fish Cove; in close proximity are the Christmas Island Boat Club, jetty and marine building, phosphate loading areas, Government offices and shops;
- Poon Saan - about 2.5 kilometres by road from Flying Fish Cove;
- Silver City - adjacent to Poon Saan - comprises aluminium prefabricated housing; and

- Drumsite - a further 1.5 kilometres - comprises housing, a few retail shops and the Christmas Island school.

16. The Kampong contains a number of accommodation blocks which provide private, public and Government housing. Closest to Flying Fish Cove are blocks 410, 411 and 413 which are privately owned, having been sold by the Commonwealth. Immediately behind these blocks are Blocks 408 and 412 which provide public and Government housing. These are Commonwealth-owned. The Commonwealth also owns Blocks 401, 402 and 403 to the east of the cove. Block 401 is currently occupied and Block 402 is being refurbished to relieve pressure on the waiting list for public housing. At the time of the Committee's public hearing, the waiting list comprised 20 single people and 36 families. People on the waiting list were living with friends or parents. Some families were living in accommodation for single people.

#### **Christmas Island rebuilding program**

17. The Christmas Island Rebuilding Program (ChIRP) was examined and reported on by the Committee in 1992 (*Committee's fifth report of 1992 - Parliamentary Paper 509/92*). The need for the program was given impetus from two areas:

- the age and condition of the island's infrastructure - 30 years old, subjected to a tropical maritime environment and lack of adequate maintenance; and
- the Commonwealth's decision to introduce most Western Australian laws from 1 July 1992 and to employ Western Australian agencies to provide state-type services. The ChIRP was designed to bring the Commonwealth-owned and managed infrastructure to mainland standards.

18. The ChIRP was referred to the Committee in March 1992 and, subject to the Committee's endorsement, the Government announced a commitment of \$37 million over the next five years for the most urgent works which included:

- a new and upgraded sewerage system and water supply;
- a new hospital;
- a police station;

- extensions to the school; and
- upgrading of housing.

19. The Committee's report recommended that the ChIRP should proceed at an overall cost of \$132.85 million, subject to an assessment following completion of the initial funding program. The Committee found that funds of \$37 million committed by the Government would not cover all essential items. Of relevance to this report was a recommendation by the Committee that additional funding of \$16 million should be approved to meet the Commonwealth's housing obligations. The Government allocated \$7.95 million for this purpose.

20. Since the original program was endorsed by the Committee, new developments have resulted in changes to the scope of the ChIRP. The Committee was briefed on this by officers of DEST and Works Australia during 1995.

#### **Construction costs**

21. Christmas Island is an extremely expensive location on which to build. The Committee was advised that building costs are between 1.5 to 2 times more than on the mainland, depending on the type of building. A major component of costs is freight rates. They have varied over the duration of the ChIRP; at present there is competition between two companies and freight rates are at the lowest level for some time. In 1994, the Joint Standing Committee on the National Capital and External Territories undertook an inquiry into the effectiveness and cost of freight arrangements. The Government's response to the Committee's recommendations was to allow market forces to determine cost.

22. The Committee was advised by a representative of the Christmas Island Chamber of Commerce that shipping costs to the island from Singapore or Jakarta are \$3,500 for a landed container; from Perth the cost is \$5,700. Asian-sourced construction materials are from 20-40 per cent less than from Australia. Some caution, however, needs to be taken in making direct comparisons due to variations in quality. It was pointed out, nevertheless, that major Australian building supply companies operate from Indonesia and Singapore.

23. The Committee questioned Works Australia about the use of non-Australian sourced building materials, as a means of reducing costs. The Committee was advised by Works Australia that construction costs for the

Christmas Island Resort were about 1.5 times Perth costs and considerable construction material was sourced from Indonesia. When the first tenders for ChIRP projects were called, prices were in the order of 1.4 to 1.5 times Perth prices, using Australian material. Works Australia have not deliberately sourced materials from Asia, although contractors have obtained material from there to save time.

#### **THE NEED**

##### **Rockfalls**

24. DEST believes a need exists to reduce hazards to life and property associated with rockfalls from the cliff above Flying Fish Cove. Rockfall incidents have been documented. In May 1992, at the Committee's public hearing into the ChIRP, the Committee was advised of a study by Golder Associates, expert geotechnical consultants, to investigate and report on the risk of rockfalls.

25. The 1992 study identified one high risk zone and several low to moderate risk zones which required to be addressed. At the time, the Committee was advised that it was proposed to minimise risk in the high risk zone by closing the Boat Club and the restaurant, and in other zones by constructing rock fences, rock trenches, tree planting, installing warning signs, monitoring movement and improving drainage. The report recommended that further occupation of Block 408, then a vacant accommodation block, should be avoided.

26. The Administration closed a restaurant adjacent to the Boat Club and erected signs in the vicinity which warned of the danger of falling rocks. Some funds were set aside in the ChIRP for the construction of rock safety fences.

27. The recommendation that the use of Block 408 be avoided was not adopted. Instead, as part of the ChIRP, this block, and the adjacent Block 412, were refurbished. Blocks 408 and 412 were constructed in the 1960s by the mining company. The recommendations of the 1992 Golder report were taken into account when the decision was taken to refurbish both accommodation blocks. They were refurbished to provide urgently needed accommodation. The cost of the refurbishment was \$1.2 million, or \$36,000 per unit. In comparison, new construction would have cost in the order of \$200,000 per unit. At the July 1996 hearing into the present reference, the Committee questioned the wisdom of refurbishing the blocks in the light of the recommendations of the 1992



report. DEST maintained that refurbishment of the blocks was an appropriate response in accordance with documentation then available in relation to risk.

28. The units were not refurbished to a long term life cycle and minimal work was undertaken in order to reduce costs. New construction, costing in the order of \$200,000 per unit, would provide a life cycle of over 20 years, which in unadjusted costs translates to annual costs of \$10,000. DEST believed the investment in the refurbishment of Blocks 408 and 412 to minimal standards at a unit cost of \$36,000, to provide urgently needed accommodation, could therefore be justified. The blocks are serviced by cast iron sewers which are deteriorating and which were not replaced as part of the refurbishment and will need to be replaced within five years. The blocks themselves will require refurbishment within three to five years.

#### Detailed rockfall assessment

29. It was only following an event in mid-February 1995, involving a boulder weighing approximately 30 tonnes, which prompted a more detailed geotechnical study into the stability of the cliff face, that the need to develop measured responses to hazards posed by rockfalls became more evident and urgent.

30. The boulder travelled a short distance, coming to rest on the outside of a track. Its likely path suggests that it could have posed a significant threat to life and property.

31. Following this event, more comprehensive investigations were commissioned from Golder Associates. Field work, including the preparation of a detailed geomorphological survey of the entire cliff, commenced in April 1995. Analysis of data collected and the preparation of a detailed report, which was subjected to peer assessment, occurred between May and October 1995.

32. It is worth highlighting here that the study found abundant evidence of significant rockfalls from the cliff above Flying Fish Cove having occurred at various locations within the past century. Boulders weighing several tonnes have rolled down the slopes on numerous occasions.

#### Rockfalls and probable fatalities

33. Rockfalls and risk minimisation measures which could be adopted were covered in the Golder report which, for the first time, attached levels of risk to various locations along the cliff. The Golder report assessed the probability of rockfalls of various sizes and the probability of a fatality occurring as a result.

The methodology adopted involved consideration of the condition of the cliff, slopes, an analysis of rockfall history and mathematical calculations. The assessed annual probabilities of a fatality at various locations in Flying Fish Cove are shown in Table 1 below:

**Table 1 - Risks of fatality**

Location	Individual risk of fatality per annum
Building 408	1 in 11,000 to 1 in 63,000
Building 412	1 in 53,000 to 1 in 300,000
Boat Club	1 in 450,000 to 1 in 4,500,000
Marine Building - Office	1 in 900,000 to 1 in 1,200,000
- Boatshed	1 in 5,000,000 to 1 in 66,000,000
- Workshop	1 in 2,600,000 to 1 in 83,000,000
Christian Church	1 in 3,600,000 to 1 in 550,000,000

34. "Individual risk of fatality per annum" is defined as the risk of fatality to an individual over a 12 month period if occupying one of the buildings for typical periods throughout the year. It follows that within the next 20 years, the risk of a person occupying Block 408 being killed by a rockfall is in the range of 1 in 500 to 1 in 3,000.

35. For comparative purposes, a number of typical levels of annual probability of fatality for activities commonly accepted by society, are set out in Table 2 below:

**Table 2 - Annual probability of fatalities**

Activity	Individual risk of fatality per annum
Professional deep sea fishing	1 in 360
Recreational scuba diving	1 in 2,400
Private car driving	1 in 5,900
Shipbuilding and marine engineering	1 in 10,000
Pedestrian run over by vehicle	1 in 16,000
Business/private air travel	1 in 110,000
Clothing manufacturing	1 in 200,000
Struck by lightning	1 in 2,000,000

36. The report concludes that a judgement needs to be made as to what is an acceptable level of risk of fatality from a rockfall and a course of action developed in the light of that judgement.

## Acceptable levels of risk

37. Responsibility for judging what is an acceptable risk lies with the Commonwealth. This follows legal advice obtained by DEST from the Attorney-General's Department. In summary, the advice was:

- as owner of the cliffs behind the Kampong area, the Commonwealth may be liable if it does not take reasonable steps to remedy the dangerous state of affairs on its land;
- as injury is foreseeable, the Commonwealth owes a duty of care to the people who occupy Commonwealth land and buildings in the Kampong to exercise reasonable care to obviate or reduce the risk of danger on the land and buildings, and should "implement all appropriate risk reduction strategies to reduce risk of injury to people or property in the Kampong area where that is reasonable";
- the Commonwealth as an employer, under the *Occupational Health and Safety Act 1991*, must take all reasonably practicable steps to protect the health and safety of its employees. This would include protection from rockfall;
- if the area were to be abandoned, the Commonwealth would still owe a duty of care to entrants to the land, including trespassers - the use of signs to deter people from entering would be a bare minimum; and
- it is not legally possible to quantify an acceptable risk of fatality - assessment of risk is one factor used by courts in determining overall liability - as the Commonwealth is a self insurer, assessment of what is an acceptable risk of fatality from rockfall is a policy matter for determination by the Commonwealth.

## Seismic risks

38. Christmas Island is 360 kilometres south of Java and for this reason the Committee questioned the impact of seismic events precipitating rockfalls. The Committee also questioned the impact of vibrations from machinery operating at the top of the cliff.

39. The Committee was advised that vibrations from machinery or explosions at sea are unlikely to cause ground accelerations of a magnitude or

duration which would dislodge boulders. However, a minor earthquake is likely to precipitate a rockfall. A study, commissioned as part of the rockfall risk assessment, suggests that in the context of mainland Australia, Christmas Island is within relatively high seismicity and therefore a higher risk.

## Committee's Conclusion

40. **The Commonwealth has a responsibility to implement measures designed to reduce the risk of fatality at various locations in Flying Fish Cove.**

## ALTERNATIVES CONSIDERED

41. Risks from rockfalls causing death, injury or damage to property could be reduced by a number of measured responses to levels of risk at various locations and to activities taken in buildings.

42. The responses are:

- implementation of risk reduction management strategies;
- construction of personnel fences (with warning signs) or rockfall barriers; and
- relocation of residents of accommodation blocks to new or refurbished accommodation in the Kampong or elsewhere.

43. DEST identified strategies which reduce the level of risk in ascending order but increased cost. The five strategies have two common components:

- implementation of risk reduction management strategies; and
- construction of personnel fences or rockfall barriers.

## Risk reduction management and strategies

44. Risk of rockfalls causing fatalities and property damage could be reduced by implementing a management regime for the area under threat. DEST acknowledged that a risk reduction management regime (or Risk Management Plan) should be integral to risk reduction. Such a regime would identify actions which need to be implemented to limit exposure to risk. A number of actions were identified in the Golder report and are as follows:

- long term land use planning aimed at restricting access to areas subject to greater risk of rockfalls and social gatherings - for example annual events held at the Boat Club;
- rearrangement of work areas around the Marine Building and Malay Workshop;
- establishment of a response to extreme rainfalls at prescribed intensities which would cause the evacuation for prescribed periods of the Boat Club area and other buildings considered at risk and monitoring of the slopes above the Kampong;
- establishment of a response to minor rockfalls and seismic events of prescribed intensities, recognising that such events may be precursors to more significant events;
- reduction of instability on the slopes above the Kampong caused by phosphate dust from the conveyor; and
- a research program into slope processes, soil profiles and vegetation for slope management purposes.

45. This plan involves identifying events and documenting responses and assigning responsibilities, undertaking continuous research and monitoring and increasing community awareness of risks and dangers. Facets of the management plan could be implemented inexpensively. The Committee questioned DEST about the existence of a natural disaster reaction plan. The Committee was advised that a disaster plan had been published in January 1995. The plan does not specifically mention rockfalls, but lists the main island emergency service organisations and spells out their roles. The Committee was also advised that DEST is examining the formulation of an ongoing management strategy which would involve inspections of the cliff at regular intervals to monitor changes.

#### **Committee's Recommendation**

**46. Before December 1996, the Department of Environment, Sport and Territories should have ready a rockfall risk management plan for Flying Fish Cove which identifies events, documents responses, assigns responsibilities, requires continuous research and monitoring, and**

**increases community awareness of risks and dangers. Simulated exercises should be undertaken.**

#### **Rockfall barrier**

47. There is some urgency attached to completing construction before the next wet season and for this reason the Committee agreed with a request from DEST seeking approval to take immediate action to let a contract for the construction of the rockfall barriers behind Blocks 408 and 412. It was felt that this course of action would reduce present risks to occupants of both blocks.

48. The rockfall barrier system consists of wire rope netting strung between vertical girders about four metres high and about 10 metres apart. The netting would be fabricated from interlocking steel rings about 200mm in diameter, combined with finer netting similar to cyclone mesh. It would be supported from wire ropes.

49. The steel girders would be bolted to small concrete pad foundations and supported by wire anchor ropes tied back to rockbolts grouted into the ground. The anchor ropes would include "friction breaking devices" in the form of loops in ropes encased in steel tubing which can tighten up and allow the barrier system to deform when impacted by large rocks. This will dissipate kinetic energy.

50. The barrier is designed to be constructed where access is difficult and all components can be transported and erected by hand, or by using manual winches if necessary. Components would be galvanised to provide corrosion protection.

51. Such a barrier would be capable of withstanding a 1,000kJ event, which is equivalent to stopping a 10 tonne truck travelling at 50 kilometres per hour, or a 20 tonne boulder travelling at 10 metres per second. Studies, undertaken by experts, suggest that 99 per cent of possible rockfalls would be stopped by a 1,000kJ barrier and it is likely that rockfalls exceeding the fence design capacity would be significantly retarded by the barrier.

52. The Committee was advised, by experts in their fields, that based on these statistics, in any five year period at Block 408 there is approximately a one in three chance of a 100kJ event and a one in 2,500 chance of a 10,000kJ event.

53. As part of its inquiry, the Committee viewed a video of this type of rockfall barrier undergoing trials in the United States. The video showed

various facets of barrier design and construction and, importantly for the purposes of this report, the barrier being subjected to rockfalls of various weights and intensities. The Committee was therefore in a position to query a number of features with technical experts at the public hearing. These features and relevant answers are summarised below:

- adequacy of design - the type of rockfall barrier proposed is used extensively in the United States and Europe. The design has been verified in the same way that any structural design can, and should be, verified;
- design life - barriers of the type proposed would have a design life of 5 to 20 years;
- risks to construction personnel - construction of the barrier would need to be undertaken in a supervised manner and areas would need to be cordoned off to allow for the possibility that a rock might be dislodged. The barrier itself would be a minimal intrusion into the landscape in terms of excavation;
- confidence of costing - Works Australia advised that the cost estimate is conservative. Cost estimates were based on quotes obtained from three firms on a per metre basis. It would be necessary for intending tenderers to undertake inspections of the sites. Works Australia are reasonably confident that tenders would not exceed the cost estimate. The work would be undertaken on a design and construct basis; and
- construction timetable - Works Australia advised the Committee that documentation for tendering purposes has been prepared; the work will be undertaken on a design and construct basis. A number of international companies have been identified. The timetable for completing the work is as follows:

tendering period - four weeks  
tender assessment - two to three weeks  
construction period - 18 weeks  
(A six week slippage period is included for shipping construction materials to the island.)

### **Planting of *Ficus microcarpa* trees**

54. The Australian Nature Conservation Agency (ANCA) suggested that a planting of *Ficus microcarpa* trees, which are native to the island, be undertaken upslope from the base of the cliff and buildings to provide additional protection against rockfalls. The plantings would not be a substitute for other protective measures against rockfalls; they would be a supplementary measure in the longer term.

55. The trees proposed are a type of banyan fig which send out lateral branches producing aerial roots. Over time, a curtain of roots is formed which could form a barrier against rockfalls. ANCA estimated that it would require 10 to 20 years after planting before the trees would begin to have the desirable effect. Although ANCA has previously carried out plantings of this species above the Kampong with poor results, a number of measures could be implemented to enhance growth prospects. Earlier plantings occurred with the requirement of expediency and the trees which were planted out were not well advanced. ANCA advised the Committee that there are 3,000 trees in stock and 20 advanced trees have been planted out as a trial.

### **Committee's Recommendation**

**56. *Ficus microcarpa* trees should be planted upslope from the rockfall barrier to provide extra protection in the longer term.**

### **Five strategies and six options**

57. As mentioned above, DEST identified five strategies which incorporate risk reduction measures, the construction of fences and barriers and alternative accommodation which are described in the following paragraphs.

#### **Strategy 1**

58. This involves the provision of a fence designed to deter people from entering areas at risk and can be summarised as follows:

- risks of fatality range from 1 in 11,000 to 1 in 63,000 for people living in Block 408 to 1 in 53,000 to 1 in 300,000 for people in Block 412; and
- the strategy has been funded under the ChIRP, costing \$131,000. DEST believes the personnel fence and warning signs would

reduce risk by restricting access, but the effects are difficult to assess quantitatively.

### Strategy 2

59. This involves the provision of the fence (Strategy 1), construction of a rockfall barrier behind Block 408 and the implementation of a risk reduction management regime which would include changes to work practices in the Marine Building and result in:

- risks of fatality range from 1 in 40,000 for people living in Block 408, 1 in 53,000 to 1 in 300,000 for Block 412 and 1 in 450,000 to 1 in 4.5 million for the Boat Club. After implementation of a risk reduction management regime, risk reductions by factors of 2 to 20 would apply to the Marine Building; and
- the cost would be about \$1 million, which has already been funded and committed under the ChIRP.

### Strategy 3

60. This involves the provision of the fence, a rockfall barrier behind Block 408 and a further barrier behind block 412, vacating and demolition of the Boat Club and replacement with landscaping and the implementation of a risk reduction management regime.

- risk of fatality range from 1 in 40,000 for block 408 to 1 in 200,000 Block 412. DEST advised that statistics suggest that 99 per cent of rockfalls would be stopped by a 1,000kJ rockfall barrier; and
- the cost would be \$1.929 million of which \$1.765 million is already funded under the ChIRP.

### Strategy 4

61. This involves the provision of the fence, relocation of occupants from Block 408 and demolition of the block and landscaping, a rockfall barrier behind Block 412, vacating and demolition of the Boat Club and the implementation of a risk reduction management regime.

- risk of fatality to occupants of Block 412 is 1 in 200,000.

62. From this strategy DEST derived three options which would provide units for residents displaced from Block 408 as follows:

- *Option 1* - refurbishment of Blocks 401 and 402 in the Kampong (45 units) - estimated cost: \$6.901 million;
- *Option 2* - refurbishment of Block 402 in the Kampong (24 units) and refurbishment of Blocks 516 and 517 at Poon Saan (18 units) - estimated cost \$9.944 million;
- *Option 3* - refurbishment of Blocks 516 and 517 at Poon Saan (18 units) and construction of 18 new units at Poon Saan - estimated cost \$13.302 million.

63. DEST advised the Committee that Option 1 is not recommended because it would add significantly to the current problems of overcrowding and lack of parking and outdoor amenity.

### Strategy 5

64. This involves the provision of the fence, relocation of the occupants of Blocks 408 and 412, demolition of the blocks and landscaping, provision of a rockfall barrier behind the Marine Building and the implementation of a risk reduction management regime.

- risk of fatality to occupants of the Marine Building following the erection of a rockfall barrier would be marginally reduced.

65. As with Strategy 4, DEST identified three options which would provide 72 units for residents of Blocks 408 and 412 as follows:

- *Option 1* - refurbishment of Blocks 401 and 402 in the Kampong (45 units); refurbishment of Blocks 516 and 517 at Poon Saan (18 units) and construction of 9 new units at Poon Saan - estimated cost \$19.349 million;
- *Option 2* - refurbishment of Block 402 in the Kampong (24 units); refurbishment of Blocks 516 and 517 at Poon Saan (18 units) and construction of 30 new units at Poon Saan - estimated cost \$19.349 million;

- *Option 3* - refurbishment of Blocks 516 and 517 at Poon Saan (18 units); construction of 54 new units at Poon Saan - cost \$22.523 million.

66. As with Strategy 4, Option 1 is not recommended by DEST because it would add significantly to the current problems of overcrowding and lack of parking and outdoor amenity.

## CONSIDERATION OF ALTERNATIVES

### DEST position

67. The proposal referred to the Committee in December 1995, proposed the implementation of a range of risk reduction measures, estimated to cost \$20 million, which included housing for 200 relocated residents and the construction of rockfall defences. During the intervening period, Works Australia commissioned an additional risk evaluation analysis, which resulted in the identification of the range of strategies and options mentioned above. For the present reference, DEST were unwilling to identify a preferred Strategy, believing the Committee to be best placed to make a recommendation after considering evidence from expert witnesses and the reactions from representatives of the community.

### Community reactions

68. Representatives of a number of community organisations made useful comments and recommendations about the risk of rockfalls and accommodation strategies.

69. The Christmas Island Shire Council advocated a conservative approach involving the construction of rockfall barriers, as a short term solution, the demolition of Blocks 408 and 412 and the provision of replacement accommodation in the longer term. The Council also advocated a risk assessment of other residential areas.

70. The Union of Christmas Island Workers made the following observations and recommendations:

- replacement housing proposed for the rockfall project (Strategies 4 and 5) would do nothing to alleviate current housing conditions which were described as "poor";

- replacement housing will do nothing for people willing to purchase or rent properties at reasonable rates;
- house prices are currently high;
- there is a need to provide public housing, including a first home ownership scheme;
- there is a need for land to be released for housing and other development - sites at Poon Saan, Silver City and Drumsite could be made available for development by the private sector or the Government; this would reduce pressure on the home ownership and rental market; and
- it is important for the Malay community to live together. Blocks 401 and 402 could be refurbished and preference be given to Malay people who want to live in the Kampong.

71. The Christmas Island Chamber of Commerce made the following observations and recommendations:

- the rockfall barrier should proceed as a short term measure to reduce risks and blocks 408 and 412 should eventually be demolished;
- housing development has in the past been characterised by quick fix solutions - for example, the refurbishment of Blocks 408 and 412;
- there should be subdivisional development under a properly legislated Town Plan, with the Commonwealth providing low cost land on which individuals can build their own houses; and
- lack of a light industrial area has been a disincentive to potential developers.

72. The Islamic Women's Group advised the Committee that based on informal discussions with some of the affected residents in Blocks 408 and 412, the majority would prefer to stay, but would like steps to be taken to remove the high risks. At the time of the public hearing, 24 Malay families were housed in the two blocks and most would prefer to stay with the rest of the Malay

community. The Committee was requested to consider the redevelopment of Blocks 401 and 402 to accommodate Malay families. If new housing is to be provided to house Malay families elsewhere, it was suggested that the inclusion of extended family members within family groups would necessitate any housing having a minimum of three bedrooms. The Committee had informal discussions with representatives of the Malay community during the inspections and the views expressed were basically similar.

73. Mr Frank Woodmore, who has considerable experience in resort and associated development on Christmas Island, advised the Committee that there is considerable demand for rental accommodation from the public and private sectors. The law of supply and demand has resulted in high rents. If land were made available, he was certain that private investors would purchase it and construct houses (both detached and semi-detached) suitable for rent. This would reduce the pressure on the Government and the local community. Mr Woodmore believed there was sufficient latent demand for the purchase or rental of at least 100 dwellings.

74. In relation to the future of Blocks 408 and 412, Mr Woodmore believed that even if the rockfall barriers were constructed, the level of risk attached to residents of Block 408 would remain unacceptably high. Housing would therefore need to be provided for displaced residents either at Poon Saan or in Blocks 401 and 402.

75. Based on anecdotal evidence, Mr Woodmore believed the Malay people were concerned about being forced to move out of the Kampong. He therefore suggested that protective measures be provided to Block 412 and the renovation of Blocks 401 and 402 to house the displaced residents of Block 408. This would be the least cost solution and would provide housing in an area most in need. Surplus units could be sold to help defray the cost of the overall refurbishment.

76. Mr Woodmore indicated that there has been strata titling of most of the ocean-front residential blocks. Once this was proceeded with, the demolition of the blocks, to make way for a complete redevelopment, has been taken off the agenda for 20 or 30 years. Lack of a Town Plan and the ad hoc measures undertaken to address issues as they arise, have locked the area into its present mode.

#### **Recommendations from expert**

77. As DEST was unwilling to identify a preferred strategy and because the Committee does not consider itself to be competent to judge the acceptability of

risks attached to working or living at various locations in the Kampong, the Committee requested the consultant who prepared the 1995 Golder report to make independent expert recommendations on what should be done. The consultant is expert in the fields of landslide investigations, coastal geomorphology and engineering geological studies of civil and mining projects. The Committee therefore believes the consultant to be eminently qualified to provide expert technical advice.

78. Following the public hearing, the consultant recommended the following action:

- immediately implement a specific accommodation management strategy aimed at reducing the occupancy of the south-west ends of Blocks 408 and 412, these being parts of the buildings that are most at risk;
- immediately establish and implement a general rockfall risk reduction management plan for the Flying Fish Cove area;
- immediately proceed to construct rockfall barriers behind Blocks 408 and 412. The barriers should be completed before the onset of the rainy season. If the rockfall barriers are not completed before the onset of the rainy season, the south-west ends of Blocks 408 and 412 should be partially evacuated;
- immediately close the Boat Club and demolish the restaurant and club buildings, to reduce community use of this area in the long term;
- plan now to empty and demolish Block 408 as it reaches the end of its current design life; and
- re-evaluate the risk of Block 412 after construction of a rockfall barrier and the implementation of a general rockfall risk reduction management plan.

79. The Committee has already recommended the implementation of the risk management plan and the construction of the rockfall barriers behind Blocks 408 and 412. The questions remaining concern the Boat Club and the future use of Blocks 408 and 412.

## Closure of Boat Club

80. The consultant recommended that the premises occupied by the Christmas Island Boat Club should be demolished. This recommendation is at variance with earlier advice from DEST that, with a carefully managed risk reduction management regime, the level of risk to gatherings at the Boat Club could be acceptably reduced.

81. The Boat Club occupies a site at the western end of Flying Fish Cove, beneath a steeper portion of the cliff. Club premises were established in 1958. The Club has a membership of 120 and the premises are used by the community as a venue for social functions. The premises have been subjected to a number of significant rockfalls in recent years. A graphic description of a potentially catastrophic event is contained in a report prepared in 1972 by the Island's chief geologist, then employed by the British Phosphate Commissioners:

*On Monday 20th March 1972, after several days of heavy rain, a number of boulders of approximately 1 to 2 foot diameter rolled down the steep soil slope to the north of the Christmas Island Boat Club. Two of the boulders reached the bottom of the hill, breaking a water pipe and cracking a sewerage main from Government House. Both rocks then continued across the road and on to the beach.*

*At 6.05am on the morning of Tuesday 21st March, a large section of cliff face about 400 feet above sea level rolled down the slope. This material completely demolished a barbecue area and caused severe structural damage to the Boat Club building. A police Landrover passing the Boat Club at the time of the fall was damaged, and Landrover V146 which had stopped nearby was fortunate to escape undamaged. The drivers of both vehicles...were also lucky to escape injury...*

*The fall occurred during wet weather and followed a period of four days when almost 12 inches of rain were recorded.*

*The destruction was caused principally by four large boulders totalling about 30 tons. The largest weighed 15 tons and stopped in the middle of the road. Another smashed through the Boat Club barbecue area and on to the edge of the road, while the third and fourth remained in the barbecue area proper. (Transcript, Thursday 11 July 1996, pp. 217-219)*

82. The Committee can only agree with the expert recommendations made by the consultant that the Boat Club should be demolished. However, the Committee recognises the importance of the Club to the community and believes therefore that a new, safer site, proximate to water frontage, should be identified and reserved for this purpose. The island Administration and the Christmas Island Shire Council, which the Committee understands are responsible for disbursing funds amongst community organisations from the Community Benefit fee obtained from casino operations, should make available funds for the replacement of club premises at the new site.

## Committee's Recommendations

83. As is evident from the major rockfall in 1972, the Committee believes that the Boat Club site remains a high risk area. Therefore, the Committee recommends that premises owned by the Christmas Island Boat Club should be demolished and a new safer site, proximate to water frontage, and consistent with the Town Plan, be found.

84. The Department of the Environment, Sport and Territories and Christmas Island Shire Council should give favourable consideration to construction costs of a new club building being wholly or partially funded from the Community Benefit Fund.

## Housing and planning

85. Despite the construction of rockfall barriers, the Committee agrees with the demolition of Block 408 at the end of its economic life - expected to be at the end of three to five years, and the re-evaluation, at the end of the same period, of risks associated with Block 412. Dwelling units at the south-west corners, considered by the consultant to be at greatest risk, should be progressively vacated and closed, as recommended.

86. From the evidence, it is clear that land available for private development on Christmas Island is the most pressing need facing the community. Many witnesses believed the time has come for a reassessment of the Commonwealth's role as the major holder of, and investor in, housing.

87. The Committee agrees that this provides an opportunity to address the perceived problem of housing shortages in a broader context. If there is to be growth, which there must be to gain the full advantage of the Commonwealth investment in infrastructure improvements, it should be further stimulated by the private sector. For private investment to take place with any confidence, an agreed planning framework is essential. Town planning and land tenure were



issues raised by most community groups at the Committee's public hearing. The history of town planning during the first stage of the ChIRP and following the introduction of the Western Australian legal regime to the island, has been long and tortuous. As yet, there is no Statutory Plan for the development of the island. The chronicle of attempts to develop an agreed town planning framework commenced in 1992 when, during the Committee's inquiry into the ChIRP, DEST advised as follows:

*Because of the extensive nature of the upgrading identified by Australian Construction Services it was first necessary to prepare a construction Master Plan for the Rebuilding Program. This Master Plan was developed by Australian Construction Services at the same time as the development of a draft Town Plan for the Island. (Transcript, Thursday 14 May 1992, p. 50).*

88. Following the introduction of the Western Australian legal regime to the island's affairs, town planning processes were modelled on Western Australian legislation which requires the Shire Council to prepare a draft Town Plan, which must be submitted to the Planning Commission (in the case of Christmas Island, the Administrator) who makes a recommendation to the Minister (the Commonwealth Territories Minister) to put the plan on display for three months. At the end of that period, comments are considered by the Minister (with the advice of the Planning Commission).

89. The Committee was advised that a draft Town Plan had been prepared on the Council's behalf by consultants and submitted to the Planning Commission. Certain deficiencies in the draft were identified - for example, land for residential development in close proximity to the airport. Identification of deficiencies followed an examination of the plan by the National Capital Planning Authority - which reviewed the planning context, and the Western Australian Department of Planning.

90. The power of the Commonwealth to do "certain things" was also challenged by the Council through lawyers. Both parties - the Council and the Commonwealth, have now agreed to redraft the plan to meet identified deficiencies.

91. A single theme which emerged in response to the proposals put forward as five strategies by DEST was the need to make more land available for development. This theme was also made, with some force, by the Commonwealth Grants Commission, which reported that difficulties with

making land available appear to be causing problems for both the social and economic development of the island. In October 1995, the Commission was advised that a "ground audit" had been commissioned by DEST. The Commission's report recommended that additional funds should be made available in 1996/97, possibly from within the ChIRP, to enable the backlog of management tasks for priority sites listed by the ground audit to be completed and to allow a new land management system to be implemented.

92. At the public hearing in July, the Committee was advised that the report of the ground audit had been received and, as a consequence, a Task Force had been established within DEST to implement an improved land release strategy for the island. The Committee was, at the time, assured that the objective would be given a high priority.

#### **Committee's Conclusion**

**93. Land for private development is the most pressing need on Christmas Island.**

#### **Committee's Recommendations**

**94. Block 408 in the Kampong should be demolished at the end of its economic life, expected to be in three to five years time.**

**95. Following the construction of the rockfall barrier and the implementation of a general rockfall risk reduction management plan, the future of Block 412 should be re-evaluated at the end of the same period. However, the Committee favours the eventual removal of Block 412.**

**96. Dwelling units at the south-west corners of both blocks, considered to be at greatest risk, should be progressively and permanently vacated.**

**97. The Department of the Environment, Sport and Territories, in conjunction with Christmas Island Shire Council, should identify parcels of land for residential and other developments that comply with the Draft Town Plan.**

**98. Land for private housing development should be offered without delay.**

## Future of the sites

99. ANCA advised the Committee that demolition of Blocks 408 and 412 would provide the opportunity to revegetate the sites, enabling the expansion of the nesting area of the Christmas Island frigate bird. This species, endemic to the island, is classified as endangered. It has a highly selective preference for nesting sites - tree species and their elevation above sea level. A limited number of nesting sites exist on the island at present. For these reasons, ANCA believes that the one or two hectare site at the base of the cliff in the Kampong area would be a valuable addition to the restricted nesting habitat.

100. The Committee believes that the future use of the site involves town planning issues as well. There may be potential for some trade-offs between the vacated site and other sites, outside the national park, suitable for development which ANCA at present would prefer not to occur, because of the presence of vestiges of primary rainforest.

## Committee's Recommendations

101. The future use of the site of Block 408, post demolition, should not preclude its use as a revegetated area to provide nesting sites for the Christmas Island frigate bird. If Block 412 is demolished, the same uses could apply.

102. Potential trade-offs between the use of the sites as recommended and the use of land containing vestiges of primary rainforest, at present not favoured for development by the Australian Nature Conservation Agency, should be investigated.

## CONCLUSIONS AND RECOMMENDATIONS

103. The conclusions and recommendations of the Committee and the paragraph in the report where they appear are set out below.

### Paragraph

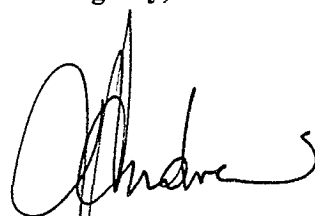
1. The Commonwealth has a responsibility to implement measures designed to reduce the risk of fatality at various locations in Flying Fish Cove.

40

2. Before December 1996, the Department of Environment, Sport and Territories should have ready a rockfall risk management plan for Flying Fish Cove which identifies events, documents responses, assigns responsibilities, requires continuous research and monitoring, and increases community awareness of risks and dangers. Simulated exercises should be undertaken. 46
3. *Ficus microcarpa* trees should be planted upslope from the rockfall barrier to provide extra protection in the longer term. 56
4. As is evident from the major rockfall in 1972, the Committee believes that the Boat Club site remains a high risk area. Therefore, the Committee recommends that premises owned by the Christmas Island Boat Club should be demolished and a new safer site, proximate to water frontage, and consistent with the Town Plan, be found. 83
5. The Department of the Environment, Sport and Territories and Christmas Island Shire Council should give favourable consideration to construction costs of a new club building being wholly or partially funded from the Community Benefit Fund. 84
6. Land for private development is the most pressing need on Christmas Island. 93
7. Block 408 in the Kampong should be demolished at the end of its economic life, expected to be in three to five years time. 94
8. Following the construction of the rockfall barrier and the implementation of a general rockfall risk reduction management plan, the future of Block 412 should be re-evaluated at the end of the same period. However, the Committee favours the eventual removal of Block 412. 95

## WITNESSES

9. Dwelling units at the south-west corners of both blocks, considered to be at greatest risk, should be progressively and permanently vacated. 96
10. The Department of the Environment, Sport and Territories, in conjunction with Christmas Island Shire Council, should identify parcels of land for residential and other developments that comply with the Draft Town Plan. 97
11. Land for private housing development should be offered without delay. 98
12. The future use of the site of Block 408, post demolition, should not preclude its use as a revegetated area to provide nesting sites for the Christmas Island frigate bird. If Block 412 is demolished, the same uses could apply. 101
13. Potential trade-offs between the use of the sites as recommended and the use of land containing vestiges of primary rainforest, at present not favoured for development by the Australian Nature Conservation Agency, should be investigated. 102



Neil Andrew MP  
Chairman

19 September 1996

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