



JAMES COOK CYCLONE STRUCTURAL TESTING STATION

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## **STRUCTURAL DAMAGE CAUSED BY CYCLONE KATHY AT BORROLOOLA , N.T. MARCH 1984**

## **SUPPLEMENTARY REPORT**

TECHNICAL REPORT No.21(A)

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DEPARTMENT OF CIVIL & SYSTEMS ENGINEERING  
POST OFFICE JAMES COOK UNIVERSITY  
TOWNSVILLE QLD 4811

CYCLONE TESTING STATION

SUPPLEMENTARY REPORT

ON

STRUCTURAL DAMAGE CAUSED BY CYLCONE 'KATHY'

AT BORROLLOOLA, N.T., MARCH 1984

G.N. Boughton

G.F. Reardon

Technical Report No. 21A

SUPPLEMENTARY REPORT  
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STRUCTURAL DAMAGE CAUSED BY CYCLONE 'KATHY'  
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1. INTRODUCTION

Following the publication of the Cyclone Testing Station's Technical Report No. 21 (Boughton and Reardon, 1984), covering structural damage caused by cyclone 'Kathy', the Department of Housing and Construction saw a need for a report on the performance of structures in which that Department had a particular interest.

This report therefore presents the findings of further investigations commissioned by the Department. As the report was requested some three months after the event, the authors considered it futile to return to Borroloola. The report has therefore been compiled by reviewing photographs, notes and tape recordings made during the damage inspection, and by contacting individuals at Borroloola, Katherine and Tennant Creek

This supplementary report is not meant to be complete in itself, but should be read in conjunction with the main report (Ref. 1). Some structures of interest to DHC were well covered in the main report and therefore need only cross referencing in this study.

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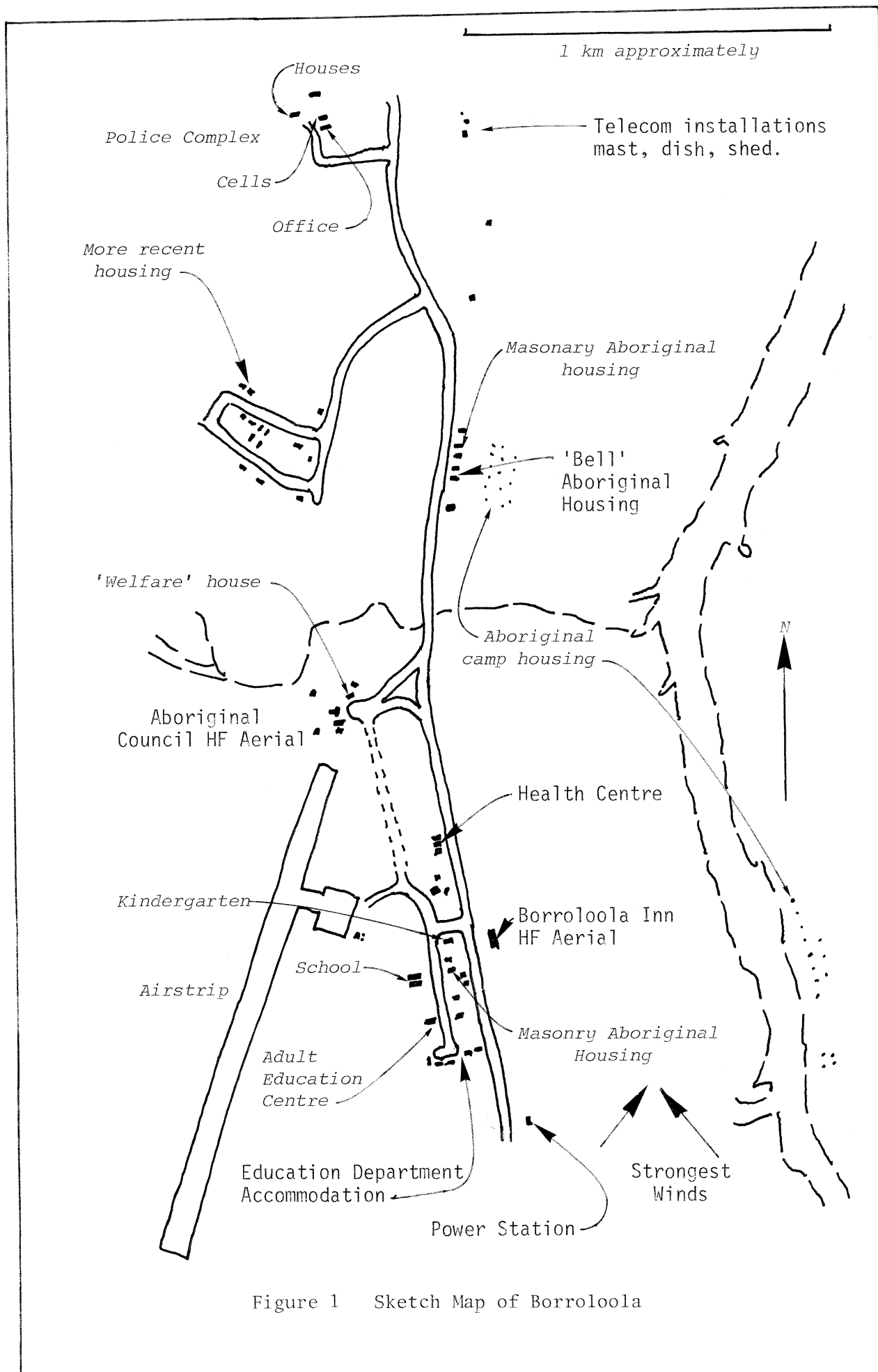


Figure 1 Sketch Map of Borroloola

## 2. SUMMARY OF METEOROLOGICAL DATA

Section 2 of the main report covers preliminary meteorological data. No further data are available at the time of writing.

The eye of cyclone Kathy crossed over Centre Island in the Sir Edward Pellew Group where wind gusts up to 125 knots (225 KPH) were measured before the anemometer failed. A central pressure of 940 millibars was also recorded.

The authors estimate that the wind speed at Borroloola, some 30 km inland was between 46 m/s and 42 m/s. These values represent the peak gust at a height of 10 m in category 2 terrain.

## 3. TELECOM FACILITIES

Telecom facilities in Borroloola consisted of a television repeater station and two High Frequency radio telephone installations.

### 3.1 Television Repeater Station

This facility consisted of a satellite receiver dish, a guyed transmission tower, and a steel shed, within a fenced enclosure. As is shown on Figure 1, there were no other buildings within 400 metres of the installation. The area around the fenced enclosure was fairly flat with sparse trees up to 10 metres high and natural grasses. The closest building to the station was totally destroyed and the debris from this light steel shed was scattered to the south and the west of the enclosure. The native vegetation around the installation did not lose many large branches which meant that the entire repeater facility was free of debris damage. There was no structural damage to the fence, shed, dish or tower and the facility functioned effectively as soon as power was restored to it. The dish did not even need realigning.

The shed did allow some water to penetrate the double skin, but this had accumulated on the floor without causing immediately obvious damage to the contents of the building. Bearing in mind the cost of the installation that the building housed, and its susceptibility to water damage the effect of water ingress at design wind speeds may warrant investigation. At design wind speed, currently 63 m/s, pressure differentials could be 60% greater than those experienced in cyclone Kathy. This would significantly increase the amount of water ingress.

### 3.2 High Frequency Radio Telephones

There were two HF Radio installations at Borrooloola each of which had its own aerial consisting of two 20 metre guyed masts carrying the horizontal wire aerial. Each installation lost one guyed mast which rendered the aerial unservicable. The HF aerial at the Borrooloola Inn was hit by a sheet of roofing material and the impact of the debris initiated failure of the tower. A temporary tower was erected to give reduced output communications within hours of the tower loss. The other installation at the Aboriginal Council, could also have sustained debris damage as it was located downwind of the 'Welfare' house (Main report Section 4.6, p. 36) and an old corrugated steel cell block that sustained severe damage and liberated much debris.

Telecom had restored all of its services to the town within 48 hours of the passage of the cyclone. The guyed masts still remain potential targets for debris damage, although the television repeater station is protected by its isolation. Long range telecom plans will see the twin guyed HF aerials being superceded by a less vulnerable system.

## 4. HEALTH CENTRE

The Health Centre consisted of two light gauge steel framed transportable buildings. They were sited in a slight hollow which may have protected them a little. The southern building was used as accommodation flats and sustained the most damage. The northern building was used as the clinic and was protected by its proximity to the flats. It sustained little damage.

The damage to the flats is difficult to comment on, because of long standing deterioration of the structure. The steel fascias on the southern side of the flats were torn off during the passage of the cyclone and some fibre cement eaves lining had blown out. The initial failure of the fascia originated at the pop rivets, but the steel frame in the roof structure had rusted so badly, that in the words of one of the townspeople: "it was pure luck that there was anything left of the roof". The roof sheeting which had been adequately fastened with Tek screws and neoprene washers in accordance with the Northern Territory Deemed to Comply Standards had remained undamaged. Most of the roof structure will have to be rebuilt, but this is due primarily to accumulated rusting and resulting long term deterioration of structural members.

## 5. POLICE STATION COMPLEX

This complex consisted of two houses, an office building, cell block and ATCO unit. It was in a slightly elevated position, but remote from other buildings and hence remained free of debris damage. The buildings all fared very well and sustained only water damage and damage to fascia gutters. The buildings were all very recent and complied in most respects with the provisions of the Northern Territory Deemed to Comply Standards. A more detailed description of each of these structures can be found in Section 4.1 of the main report.

## 6. ABORIGINAL KIT HOUSES

Two light gauge steel framed Aboriginal houses supplied by 'Bell' were inspected by the authors four days after the passage of the cyclone, and another had been delivered to the town but was still in its delivery crates. The houses inspected were on slightly rising land, with an Aboriginal settlement of camp style accommodation to the windward. This settlement yielded much airborne debris (main report, Section 4.5) and hence debris damage to the outside panels of the Bell homes was not unexpected. This had mainly been the breaking of louvres and external sheets of fibre cement cladding on the steel framed modules. The houses were still largely servicable in spite of the damage. A large open verandah had been removed from the windward side of one of the houses because of poor tie down at the base of the support columns. This failure has been described in detail in the main report.

## 7. EDUCATION DEPARTMENT FACILITIES

These consisted of five accommodation units, a preschool building, a school complex, and the Adult Education Centre.

### 7.1 Accommodation Units

These were grouped on the southern edge of town on flat land with sparsely wooded open country to windward. Their exposure to the strongest winds would have been very similar to the expected in Terrain Category 2. All five buildings lost their solar hot water services, with damage ranging from complete removal, to just hanging on by one or two screws. One building lost a portion of its roof and this failure has been detailed in Section 4.3 (iii)

of the main report. The roof sheeting, with battens attached was removed from a portion of the roof that was supported on trusses. The batten to truss connection proved quite inadequate to resist the uplift forces it attracted. Metal straps can be effectively used to secure battens, but current design recommendations show at least 3 nails per side of the strap. The straps used on this roof had one nail per side.

An interesting feature of these houses was the failure mode of sliding glass windows and doors. Three large sliding doors were pushed out of their tracks by the wind pressure. It would appear that the track either rotated along its length to free the door, or portion of the guide bent sideways. Four sliding window panes (1200 x 600 mm) failed in a similar manner. Each was pushed free of its tracks. Two blew inwards and the other two, associated with door failures blew outwards. One remained quite intact on the ground outside the building. It is postulated that the sudden build up of pressure within the house as a result of the large door blowing in produced sufficient internal pressure to force the windows out of their frames.

While buildings should be designed to withstand full internal pressure due to windows and doors failing, clearly more rugged track details need to be incorporated into door and window fittings to be supplied in cyclone-prone areas unless replacement is to be tolerated after events such as cyclone 'Kathy'. Wind pressures at Borroloola were only 53% to 68% of the design wind pressure.

## 7.2 School Buildings

This group consisted of two separate transportable units joined by a roofed breezeway. They suffered minimal structural damage. Two window panes were broken, probably due to debris, as a number of buildings to the windward of these buildings had lost sheets of roofing. Two flyscreen doors were also wrecked as their catches did not work properly, and the continued flapping tore them away from their hinges. The solar hot water service suffered a similar fate to those on the accommodation units.

The school buildings remained servicable after the cyclone and were utilized as temporary accommodation for some days until tent accommodation became available.



### 7.3 Adult Education Centre

This solidly constructed, steel portal framed building had been chosen for use as a shelter during the passage of the cyclone, and proved worthy of the choice. Superficial damage was all that was sustained by the building. Its good performance is described in Section 4.3 of the main report.

### 7.4 Kindergarten Building

This large transportable building was assembled on site from 4 separate modules and suffered a most spectacular lateral load failure, which has been described in detail in Section 4.6 (iii) of the main report. The four individual parts of the building were each adequately tied to the foundations, but the two central parts relied on the two external parts for lateral stability and had been inadequately tied to them. As a result the two central units collapsed completely, leaving the two external units essentially intact.

## 8. POWER HOUSE

While plans for a new power house have been available for some time, construction on it has not yet commenced. The existing powerhouse did suffer some wind damage. Approximately 50% of the roofing was lost off the southern (windward) side of this building, due to either nail withdrawal or sheeting tearing out the nails. Some sheeting was also removed from the southern wall. In spite of this loss of sheeting, and substantial water ingress, the function of the powerhouse could be reinstated rapidly after the passage of the cyclone.

Two transportables joined by a roofed breezeway also on the site, also lost some roof sheeting due to failure at the connections. All the lost sheeting was replaced using screws into the original battens.

The power reticulation system for the town sustained minimal damage.

## 9. CONCLUSIONS

- (i) Given the important post disaster functions of communications, power generation and health clinic services, the buildings which support these services should have been engineered to sustain no structural damage in the event of the magnitude of cyclone 'Kathy'. To that

end, the television repeater performed well, and Telecom is involved in research and development to reduce the risk to radio communication systems; the existing powerstation performed poorly but hopefully the new building will improve the reliability of the power generation function; the health centre needs a thorough check to assess the structural integrity of the steel frame on those buildings. Parts of these installations may need to remain free of water ingress, and particular attention needs to be assigned to those areas to maintain the function of electronic communication and control equipment, and the sterility of dressings and purity of drugs.

- (ii) The good performance of buildings that were constructed in accordance with the Northern Territory Deemed to Comply Standards indicated that they were capable of resisting cyclone Kathy's loads but cannot be interpreted as meaning that they are cyclone proof. The loads they were required to resist were between 53% and 68% of current design loads. Nevertheless the clear difference between the buildings constructed in accordance with the standards and those of substandard construction point to the success of the standards in minimising damage.
- (iii) The large number of window and door track failures in the education department houses, raises questions about the performance of sliding doors and windows in tropical cyclones.
- (iv) Many other conclusions can be drawn from the examination of damage at Borroloola and are presented in the CTS Technical Report No. 21 (Boughton and Reardon 1984).

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## REFERENCES

BOUGHTON G.N. and REARDON G.F. (1984). "Structural Damage caused by Cyclone Kathy at Borroloola, N.T. March 1984". Technical Report No. 21, Cyclone Testing Station, May 1984.

NORTHERN TERRITORY BUILDING BOARD (1982). "Northern Territory Cyclonic Areas Deemed to Comply Standards" 4th Edition.