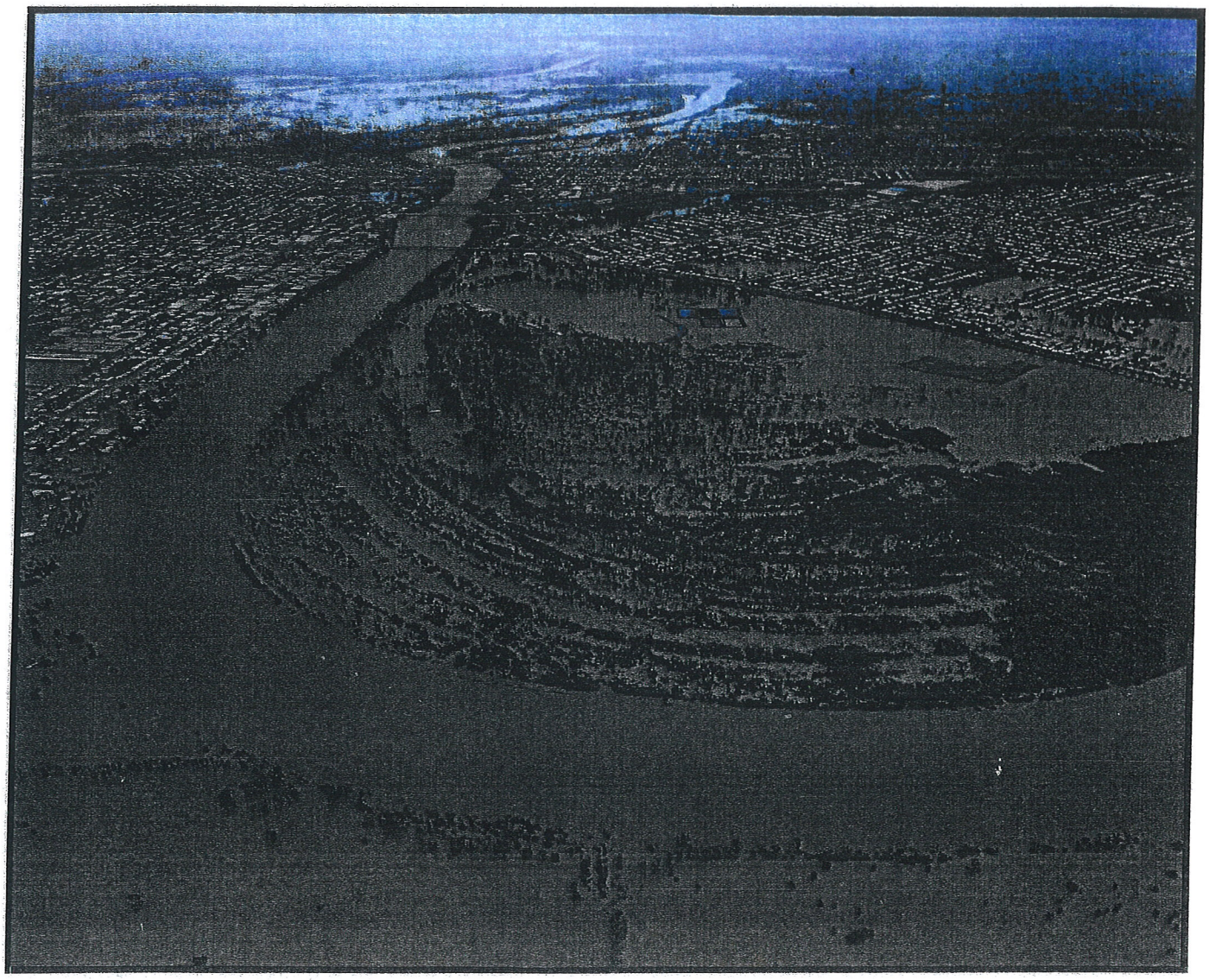
WATER RESOURCES COMMISSION



ROCKHAMPTON FLOOD MANAGEMENT STUDY

SUMMARY OF RECOMMENDATIONS

CAMP SCOTT FURPHY PTY LTD
ACN 004 939 548

NOVEMBER 1992

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PREFACE

The Rockhampton Flood Management Study was an outcome of the January 1991 flooding at Rockhampton. This flood caused major economic and social problems in the Rockhampton area. Homes and businesses were flooded and the city was isolated from the rest of Queensland for 12 days. Communities right along the Queensland coast were affected by this severing of the coastal road and rail links.

The three levels of Government – local, state and federal – then agreed that a study was needed to allow better management of the Fitzroy River flooding at Rockhampton. The Water Resources Commission then arranged for this study and a Steering Committee, comprising the main authorities concerned with the flooded areas near Rockhampton, was formed. This Steering Committee, which provided direction during the study, consisted of representatives from the following bodies:

QDPI – Water Resources Commission
Rockhampton City Council
Livingstone Shire Council
Fitzroy Shire Council
Department of Transport
Queensland Railways
Commonwealth Department of Primary Industries and Energy

Consultant – Camp Scott Furphy Pty Ltd – was engaged to carry out this study.

The consultant considered recent Fitzroy River flow records, along with the historical flood levels since 1859, to assess the likely frequency of different flood levels at Rockhampton. The economic losses of the 1991 flood were assessed. These two aspects in combination then allowed assessment of the likely annual damages from flooding at Rockhampton. The effects of the existing major works in the flooded area were reviewed, while the social and environmental impacts of flooding were also considered.

From a whole range of possible flood mitigation options, the consultant has recommended a number of both structural and non-structural measures to best reduce the impacts of flooding at Rockhampton. The structural measures recommended are those with the highest benefit to cost advantage, whilst having acceptable hydraulic impacts. The non-structural measures recommended are those areas which need improving, based on the experiences gained from the 1991 flood.

The consultant regularly referred their findings back to the Steering Committee during the course of the study. They have also held public meetings and displays to allow input from the general public and to keep them informed. This report is the final outcome of the consultants extensive studies and its findings are endorsed by the Steering Committee. This study now allows a better understanding of the mechanisms and likely occurrence of flooding at Rockhampton, the damages flooding causes and recommends ways to better manage this flooding.

Nevertheless, the release of this study report does not imply any immediate commitment by the various authorities to carry out the recommended measures. These bodies each have ongoing work commitments, responsibilities and financial constraints which may restrict what action they take here. A statement by the Department of Transport on how they determine priorities for road works is contained in the main report.

Each authority will, no doubt, give due consideration to the study's detailed findings and recommendations in their planning and control of future works in these flood affected areas. Readers of this report should be aware, though, that it is still up to each authority to determine what measures it takes to reduce these flooding problems and for the timing of these measures.

M B McKenna
Regional Manager
Water Resources Commission
ROCKHAMPTON

&

Chairman
Rockhampton Flood Management Study
Steering Committee

ROCKHAMPTON FLOOD JANUARY 1991
Yeppen Crossing

ROCKHAMPTON FLOOD JANUARY 1991
Rockhampton Airport

ROCKHAMPTON FLOOD JANUARY 1991
Fitzroy River looking downstream to Rockhampton City

ROCKHAMPTON FLOOD JANUARY 1991
Depot Hill Area

ROCKHAMPTON FLOOD MANAGEMENT STUDY

SUMMARY OF RECOMMENDATIONS

INTRODUCTION

The Rockhampton Flood Management Study has been undertaken over the period September 1991 to October 1992. The study was divided into two phases which have been reported upon separately, as follows:

- Phase 1 Report - April 1992 - 3 volumes, namely Executive Summary, Report and Appendices;
- Phase 2 Report - November 1992 - 3 volumes as above.

The Phase 1 report contained a review of flood characteristics of the Fitzroy River; an assessment of flood damages; a review of flood management issues; and preliminary recommendations in regard to both non-structural and structural flood management measures, the latter being subject to refinement and confirmation in Phase 2.

The Phase 2 report concentrated on hydraulic model studies to establish the impact of a range of short-listed flood mitigation measures, identified in Phase 1, leading to firm recommendations in regard to measures aimed at reducing the impact of future floods.

This brief document provides a short overview of both Phase 1 and Phase 2 Reports, consisting essentially of a list of the main findings and recommendations of the study. Reference should be made to the Phase 1 and Phase 2 Reports for further information and for discussion regarding study findings.

The recommended measures provide the opportunity for substantial reduction in the economic and social costs of flooding in Rockhampton. The recommended works are capable of providing these improvements with minimal adverse impact.

FLOOD CHARACTERISTICS

The Fitzroy River at Rockhampton and adjacent areas and townships have been subjected to flooding on many occasions as a result of heavy rainfalls in the Fitzroy River basin. The worst flood since records commenced in 1859 was in 1918, when the river level at Rockhampton reached 10.11 m on the City flood gauge (8.66 m AHD). The second highest peak was 9.40 m gauge height (7.95 m AHD) in 1954. Rockhampton again suffered major flooding in January 1991 due to heavy rainfalls associated with Cyclone Joy. The peak flood level on this occasion reached 9.30 m gauge height (7.85 m AHD), but due to changes in the floodplain characteristics in recent years this level cannot be compared directly with that of previous major floods. In river discharge terms, the 1991 flood had a peak flow at Yaamba of about 14,200 m^3/s, only slightly less than the 1954 peak discharge of 15,000 m^3/s. Both of these were substantially less than that of about 18,000 m^3/s in 1918.

On the basis of the flood frequency analysis carried out as part of the study, the 1991 peak discharge is equivalent to a 2% Annual Exceedance Probability (AEP) flood, that is a flood with a 2% chance in every year of being equalled or exceeded in magnitude. This is equivalent to an average recurrence interval (ARI) of 50 years, although this terminology is not preferred as it is often misinterpreted. The 1954 flood was found to have an AEP of 1.8% (55 year ARI). The differences in flood levels in Rockhampton and in the floodplain between these events is attributable to developments in the river and in the floodplain in the period between these floods, as well as to the slight difference in magnitude. In probability terms, the 1918 flood was found to be substantially more extreme at 0.6% AEP (160 year ARI).

FLOOD DAMAGES

The flood damage in the 1991 flood was estimated to be about $50 million, although this figure is imprecise. Of this the direct damage, ie. that caused by direct contact with floodwaters was estimated to about $15 million, made up of residential sector damage of $1 million, commercial/industrial sector damage of $5 million, and public sector damage of $9 million. By way of contrast, the indirect damages were estimated to be about $35 million resulting mainly from the disruption to business by the simultaneous closure of road, rail and air links for 12 days.

The mean annual flood damage (MAD), that is the long term average of flood damage over a period of time which includes the likely range of floods, was estimated to be $5.2 million per annum at 1992 prices. Thus the cost to the national economy, of doing nothing to improve flood management or mitigate flood damage is $5.2 million every year. This is not all attributable to the local economy as it includes the impact throughout the central and north Queensland coastal districts of road and rail closures.

This ongoing level of flood damage should be borne in mind when considering the proposals for non-structural and structural flood management measures.

RECOMMENDATIONS REGARDING NON-STRUCTURAL FLOOD MANAGEMENT MEASURES

A summary of the recommendations in regard to non structural flood management measures are given below. These are relatively low cost items which will reduce the cost and social impact of future floods.

a) Flood Maps

Flood Maps have been prepared showing the extent of inundation in 2%, 1% and 0.5% AEP floods. Also flood hazard maps showing floodways, flood storage and flood fringe areas have been prepared. These are recommended for adoption by Rockhampton City Council, initially on an interim basis. This will allow allow any anomalies to be rectified before adoption of the maps as formal planning documents.

b) Development Control

It is recommended that a flood standard of the 1% AEP flood be adopted for planning purposes. It is further recommended that no new development of a residential, commerical or industrial nature be permitted in designated floodways. Where new development is permitted in other flood liable areas, the minimum habitable floor level should be 0.5 m above the 1% AEP flood level. Access routes to any new development should be provided to the above standard.

c) Measures for Immediate Implementation

The following non-structural measures are recommended for immediate implementation:

- Flood warning
  - installation of telephone telemetry at Rockhampton Flood Gauge;
  - installation of a river level telephone telemetry station in the Pink Lily area to give warning regarding flows in the floodplain;
  - installation of river level and rainfall telephone telemetry stations on Alligator Creek and rainfall telemetry in the Neerkol Creek catchment;
  - development of a flood forecasting model.
- Flood Warning Dissemination
  - installation of street markers throughout the urban area and the floodplain. These should be plates marking the level reached by the 1991 flood at the point of installation;
  - installation of a recorded telephone message service at the Local Operations Emergency Centre which should be the single point of contact for the public;
  - discussions with local media to clarify the flood warning system and their role within it.
- Counter Disaster Planning and Operations
  - clarify respective roles of the District and Local counter disaster organisations, and maintain both centres in a permanent state of readiness;
  - the recent establishment of SES groups at Gracemere, Alton Downs and Yaamba is supported. Consideration should be given as to how best to ensure adequate SES presence in Depot Hill and Port Curtis;

- counter disaster pre-planning should consider in detail the consequences of a flood more severe than that of 1991.

- Increasing Public Flood Preparedness and Community Flood Response

  - preparation and issue of a pamphlet explaining flooding in the area, what to do in the event of flooding to minimise damage, how to use street markers to estimate flood level at individual properties, contact telephone numbers;

  - preparation of summary information similar to the above for publication in the Rockhampton District Telephone Directory;

  - when flooding is imminent publish flood maps, flood awareness/preparedness information in the local print media;

  - business operators should be urged to prepare 'flood action plans'.

  - request Department of Family Services to review its disaster subsistence scheme with a view to making it more equitable in such situations as flooding in Rockhampton;

  - improvement to 'Operation Recovery' type response.

RECOMMENDATIONS REGARDING STRUCTURAL FLOOD MITIGATION MEASURES

A wide range of flood mitigation measures, ranging from storage dams on the Fitzroy River to dredging were considered in Phase 1. Many of these were discounted from further consideration on the grounds of their limited effectiveness, high cost and/or high environmental impact. Options discounted from further consideration were:

- flood mitigation storage;
- major upstream diversions;
- major bypass floodway;
- channel enlargement works.

Reconstruction of the Alligator Creek crossing on the Bruce Highway near Yaamba has been included by the Department of Transport in its current works program, and the contribution this will make to reducing the isolation of Rockhampton during major floods, and hence a reduction in indirect flood damage in Rockhampton and areas north of Rockhampton, is recognised.

A short list of measures was identified in Phase 1 as being worthy of detailed consideration in Phase 2. These were:

- Improvement of flood immunity at Yeppen Crossing;
- Levees to protect Lower Dawson Road – Port Curtis – Depot Hill and the lower part of the Central Business District;
- Levees to protect Rockhampton Airport.

In Phase 2, a mathematical hydraulic model (computer model) was set up to investigate and report on the effect of these measures on flood levels elsewhere in the system. This is discussed at length in the Phase 2 Report. Cost estimates and cost-benefit analyses for these measures were refined from those given in Phase 1. As a result of the Phase 2 studies, the following final recommendations are made in regard to structural flood mitigation works:

a) Yeppen Crossing

Improving the flood immunity at Yeppen is regarded as the highest priority. The current crossing on both the Bruce Highway and the North Coast railway have a flood immunity of 8.5% AEP, that is the average period between closures is 12 years. The average closure time is 0.58 days per annum. The actual performance of the crossing in the 1988 and 1991 floods together with modelled performance in the 1918 and 1954 floods are in agreement with these design criteria.

The hydraulic model study has demonstrated that the flood immunity of the crossing can be improved to 2% AEP (50 year ARI) by doubling the bridge waterway area which involves increasing the length of the bridges from 420 m to about 840 m, together with raising the highway/rail height of the embankment sections between the bridges to that at the bridges.

The estimated cost of this (road and rail crossings) is $16.5 million on the basis of existing road width (ie. no allowance has been made for widening Lower Dawson Road to the Yeppen roundabout to four lanes as recommended in the recent Rockhampton Transport Study). Taking account of the significant reduction in indirect damages caused by the frequent closure of this crossing, the proposed upgrading is cost-effective with an estimated reduction in mean annual damages of $1.3 million per annum. This is equivalent to a net present value, at 5% discount rate, of $24.7 million ($18.2 million at 7%), and a benefit-cost ratio (BCR) of 1.5 at 5% (or 1.1 at 7%).

Time of submergence would be zero for 2% AEP (compared to 10 days under current conditions) and about 7 days at 1% AEP (compared to 13 days under present conditions). The long term average closure period would be reduced to 0.15 days per annum. The combination of embankment raising and additional waterway area would reduce levels upstream by 0.05 m at the Airport, to 0.17 m just upstream of the crossing for a 2% AEP flood and 0.02 m to 0.05 m respectively for a 1% AEP flood.

b) Levee to protect Lower Dawson Road, Port Curtis, Depot Hill and the Lower CBD

This is also strongly recommended as a high priority measure. The construction of this levee should follow the proposed improvement to Yeppen Crossing rather than precede it, as it partly relies on the latter to offset the impact on flood levels this would otherwise cause.

The recommended level of protection is against the 1% AEP (100 year ARI) flood. That is, the whole of the area within the levee would not be flooded should a 1% AEP flood occur. This level of protection is intermediate between the 1991 flood (2% AEP) and the 1918 flood (0.6% AEP). Floods more extreme than 1% AEP would cause the levee to overtop but proper design will ensure this occurs in a controlled, and not a catastrophic way. Protection to a higher level, say 0.5% AEP would provide a slightly better BCR at a significantly higher capital cost, but would cause flood levels in the floodplain to be greater than those under existing conditions for a flood of this magnitude. As this was considered to be unacceptable, 1% AEP is the recommended level of protection.

Construction of this levee would significantly reduce flood damage and social impacts for the bulk of the urban area on the south side of the river. In economic terms, the mean annual damage would be reduced by $0.5 million per annum. The associated capital cost is estimated to be $7.4 million. The net present value (NPV) (at 5% discount rate) would be $9.3 million, and the benefit cost ratio (BCR) 1.25. Using a 7% discount rate, the NPV would be $6.9 million, and the BCR 0.93. These are very high benefit–cost ratios for flood mitigation schemes, illustrating the high level of effectiveness in reducing flood damages.

Built in combination with the Yeppen crossing upgrade and also with the removal of the odd railway embankment adjacent to the Old Bruce Highway between Port Curtis and Roopes bridge, and of the old Burnett Highway bridge across the floodplain, the nett effect of this levee on flood levels upstream would be reductions of 0.28 m upstream of Yeppen, 0.15 m at Fairybower Road and 0.09 m at the Airport for a 2% AEP flood. Corresponding values for 1% AEP flood would be reductions of 0.02 m at the each of the above.

One end of the levee would be tied to higher ground along Blackall Street near to Lower Dawson Road, which itself would be raised locally, then along Jellicoe Street to Port Curtis. At Port Curtis the levee would pass on the floodway side of Hastings Deering Pty Ltd, and then cross the Old Bruce Highway to include all the residential area of Port Curtis. The route of the levee would then be across mainly rural land to Gavial Creek near the Sewage Treatment Works. The levee would then extend along the river terminating near William Street. Some sections adjacent to Quay Street will need to be in the form of a low retaining wall, but elsewhere the levee will be low earth embankment. The bulk of the levee would be below 3 m in height with a maximum height of 3.8 m at a low point near Lower Dawson Road. As such, it is not anticipated that the levee will be very intrusive.

It is proposed that the levee be constructed on an easement basis, rather than by land resumption, thereby minimising the impact on landowners. The proposed route is shown on Figure 1. It is emphasised that the levee route is not finalised and that final route selection would be carried out during the design stage.

Not only would this levee protect existing properties, it would also allow development of the currently undeveloped area within the levee. The benefits of this have not been taken into account in the economic analysis.

In summary, this levee offers substantial benefits in terms of reduced flood damage and social impact to the most flood liable parts of Rockhampton. In combination with upgrading the Yeppen Crossing it will not worsen levels for 2%, 1% AEP floods. Construction on an easement basis will minimise impacts on landowners. Should construction of the levee proceed, it will be important to undertake a public awareness/education campaign to clearly state the advantages and limitations of levee protection.

c) Levee to Protect Rockhampton Airport

A lower level of priority has been allocated to this levee which is not justifiable in purely economic terms. A levee to protect the airport, which would also protect the adjacent residential areas, would need to be justified primarily on the intangible benefits of maintaining an operational airport during major floods to enable the ferrying of supplies, medical evacuations etc.

The estimated cost of this levee is $4.3 million with protection to 1% AEP but the BCR would be only 0.45 at 5% discount rate (0.33 at 7%). This levee would raise flood levels in that part of the floodplain between Pink Lily and Lion Creek by a maximum of 0.3 m at 2% AEP and 0.5 m at 1% AEP. The small number of houses along Nine Mile Road may need to be raised or otherwise flood proofed to compensate for this effect. The increase in level along the Rockhampton-Ridgelands Road is 0.05 m at 2% AEP and 0.12 m at 1% AEP. This levee would cause a minor reduction in flood level at Yeppen as it marginally reduces the flow in that part of the floodplain by increasing flow in Lion Creek.

d) Priority 3 Works

Third priority works which are recommended in the medium term are:

- a levee to prevent direct overflow from the Fitzroy River into Splitters Creek;
- the stabilisation of the high bank at Pink Lily.

e) Priority 4 Works

Fourth Priority works which are recommended are the fitting of flood gates on creeks on the northern river bank and flood valves on the storm drainage outlets.

SUMMARY OF ESTIMATED COSTS OF RECOMMENDED WORKS

PRIORITY 1 MEASURES	
NON-STRUCTURAL	
• Floodplain Management Policy	$30,000
• Upgrading of flood warning system	$53,000
• Installation of Flood Markers	$25,000
• Recorded message service	$30,000
• Community awareness programme	$25,000
SUB-TOTAL	$163,000
CAPITAL WORKS	
• Upgrade Yeppen Crossing to increase embankment height to that of the bridges, plus increase waterway area by increasing bridging length to 840 m (BCR 1.5)	$16.5 m
• Construction of levee from Blackall Street to Quay Street protecting Lower Dawson Road, Port Curtis, Depot Hill and the lower CBD (BCR 1.25)	$6.9 m
• Removal of disused railway embankment adjacent to Old Bruce Highway (material may be used in levee works) Demolition and removal of bridge/causeway on Old Burnett Highway	$0.5 m
SUB-TOTAL	$23.9 m
TOTAL PRIORITY 1	$24.063 m

PRIORITY 2 MEASURES	
NON STRUCTURAL	
• Development of Flood Forecasting model	$80,000
• Commercial Flood Proofing Pilot Study	$40,000
SUB-TOTAL	$120,000
CAPITAL WORKS	
• Construction of levee to protect airport extending from Savage Street to Denham Street Extd (BCR 0.45)	$4.3 m
TOTAL PRIORITY 2	$4.42 m

PRIORITY 3 MEASURES	
• Construction of levee to prevent overflow from River to Splitters Creek (BCR approximately 0.7)	$0.14 m
• Bank stabilisation works at Pink Lily	$0.9 m
TOTAL PRIORITY 3	$1.04 m

PRIORITY 4 MEASURES	
• Flood gates on Splitters Creek, Moores Creek, Frenchmans Creek and Thozet Creek	$2.0 m
• Flood valves on stormwater drainage outfalls	$0.5 m
TOTAL PRIORITY 4	$2.5 m

OVERALL TOTAL RECOMMENDED WORKS	**$32.023 m**
Note: BCRs at 5% discount rate.	

FUNDING OF WORKS

In recent years flood mitigation works have been eligible for funding under the Federal Water Resources Assistance Program (FWRAP). From 1993/94 flood mitigation works and measures are expected to be eligible for funding under the National Landcare Program (NLP) which will integrate FWRAP and other programs.

In Queensland, it is the responsibility of the relevant Local Authority to apply for funding under the program to the State Government in the first instance through the Water Resources Commission, customarily by December each year. The State Government will integrate and prioritise applications and submit those programs it supports as part of a Partnership Agreement with the Commonwealth Government. Notification of successful applications is made following the Federal Budget each August.

Projects funded under this program normally require a 20% contribution from the Local Authority with 40% each being contributed by both Federal and State Government. The local authoriity is responsible for maintenance costs.

It should be noted that NLP funds are limited, and that submissions for funding are considered on their merits and cost-effectiveness and also on the basis of priority with other state projects as this program is placing increasing emphasis on well integrated land and water resource management projects and non-structural flood mitigation measures. However, due to the magnitude of flood damages in the recent flood and the isolation of a city of the size of Rockhampton which results from such floods, it may be expected that the chances of a support by the State would be high, but would of course depend on the State's priorities in the particular year. Criteria for Commonwealth support under the new NLP may evolve from those under FWRAP with increasing emphasis on Commonwealth funds being used to stimulate micro-economic reform or improvements in procedures and perceptions of natural resource management issues. Consequently, successful projects would need to engender new local and regional financing schemes and viable, beneficial, community-based flood management strategies.

Thus if funding were obtained under NLP for all the first priority works, the Local Authority Contribution would be expected to be $4.8 million. However, if only the levee works and the non-structural works were funded in this way, for example, this would reduce to $1.5 million.

Whilst the proposed upgrading at Yeppen principally relates to flood mitigation in respect of reduction of indirect damages, it would be expected that part of the upgrading costs would be met by the Department of Transport. This would be the subject of negotiation between relevant Government Departments and Local Authorities. A statement setting out the Department of Transport's perspective in this regard is given in the Phase 2 Report.

ROCKHAMPTON FLOODS

1991