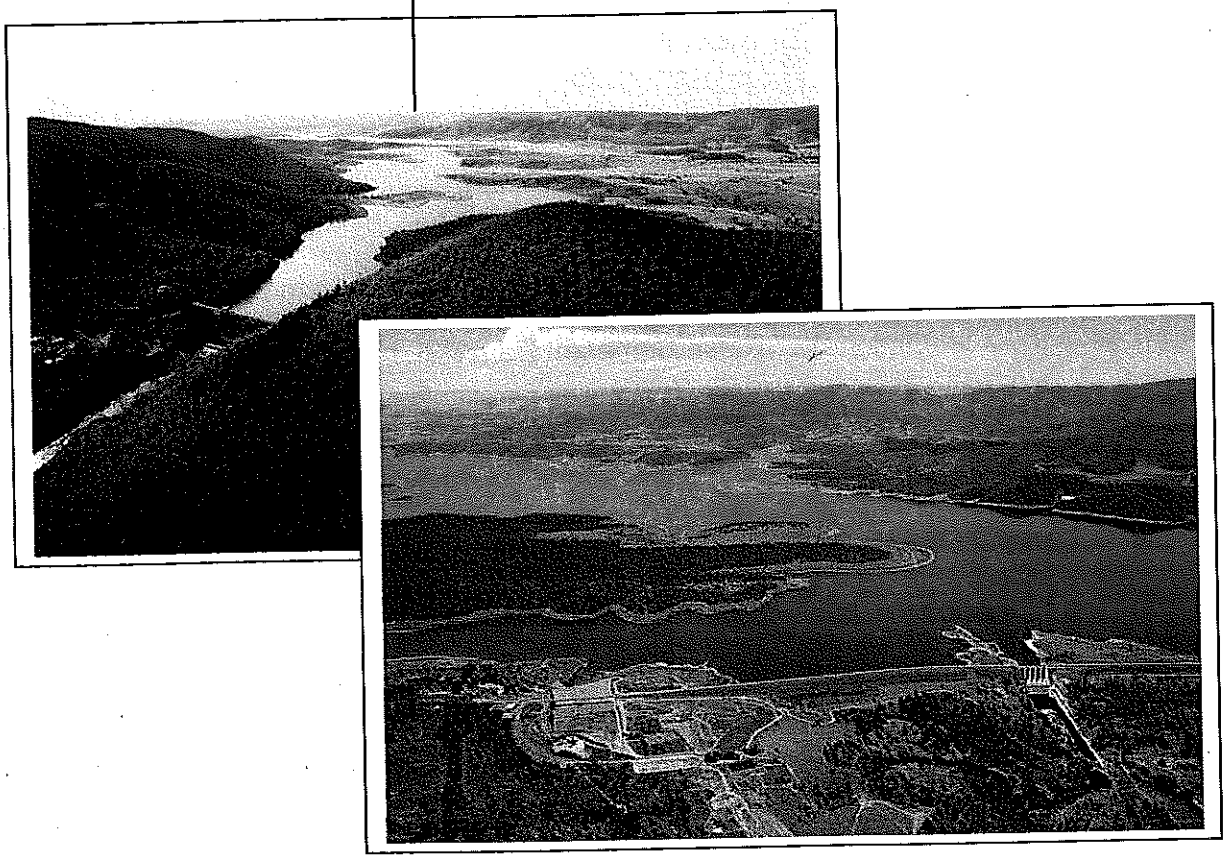
QUEENSLAND WATER COMMISSION

DEPARTMENT OF NATURAL RESOURCES AND WATER

PROVISION OF CONTINGENCY STORAGE IN WIVENHOE & SOMERSET DAMS



SEQWATER

Wivenhoe, Somerset & North Pine Dams

Quality of water. Quality of life.

March 2007

Report No WS/OPS 011106

1. Executive Summary

This report has been prepared in conjunction with the Queensland Department of Natural Resources and Water (NRW) to investigate options to provide contingency storage as part of the South East Queensland Regional Water Supply Strategy (SEQRWSS). As part of these investigations it is proposed to look at options for the provision of an additional 200 to 600 GL of contingency storage in the Brisbane River catchment. The two options for this report are:-

- Raising Wivenhoe Dam Full Supply Level (FSL)
- Raising Somerset Dam FSL

These two options are being compared with other storage options in South East Queensland.

1.1 Scope of Work

This scope of work for this report includes the following options for the provision of the contingency storage:-

- Option W1 - Raise Wivenhoe Dam FSL by 2m to EL69.0
- Option W2 - Raise Wivenhoe Dam FSL by 4m to EL71.0
- Option W3 - Raise Wivenhoe Dam FSL by 8m to EL75.0
- Option S1 - Raise Somerset Dam FSL by 2m to EL101.0
- Option S2 - Raise Somerset Dam FSL by 4m to EL103.0
- Option S3 - Raise Somerset Dam FSL by 6m to EL105.0

This report provides:-

- Background data for each dam including risk profiles.
- A broad description of the works required to raise each dam to the nominated FSL.
- Feasibility cost estimates for each option.
- A preliminary assessment of the environmental and social impacts of each option.
- Risks and opportunities associated with each option.

The six options for the provision of contingency storage in Wivenhoe and Somerset Dams are presented in Table 1-1.

Table 1-1 - Summary of Raising Options

Wivenhoe Raising Options				
Option	**Raising (m)**	**Raised FSL (m)**	**Increase in Storage Capacity (ML)**	**Estimated Cost ($m)**
W1	**2**	**69**	**228,000**	**63**
W1A (Operational change)	**2**	**69**	**228,000**	**5 to 10**
W2	**4**	**71**	**481,000**	**138**
W3	**8**	**75**	**1,066,000**	**248**
Somerset Raising Options				
S1	**2**	**101**	**92,000**	**55**
S2	**4**	**103**	**202,000**	**70**
S3	**6**	**105**	**332,000**	**85**

It can be seen from the table that the most attractive option for the provision of contingency storage would be a 2m raising of Wivenhoe Dam as an operational change eliminating the need for expensive capital works. Intuitively, Wivenhoe would be the most logical option for contingency storage given the size of the catchment and the corresponding probability of capturing the additional flows.

The provision of contingency storage in Somerset will be difficult due to the upstream flooding issues associated with Kilcoy and land owners.

1.2 Flood Security Costs

Neither Wivenhoe nor Somerset currently satisfies the ANCOLD Guidelines on Acceptable Flood Capacity (2003). SEQWater is committed to an agreed program of works to allow the dams to comply with both ANCOLD and the Spillway Adequacy Guidelines (NRW 2005) in the timeframe specified by NRW. Given the assumptions for this study that the dams will be required to pass the current estimate of the PMF, a substantial portion of the costs to raise the FSL is associated with the long term works to increase flood security. It is arguable whether these costs should be included for the provision of contingency storage as SEQWater is likely to incur these costs in the future even if the storage is not raised. An attempt has been made to separate out the costs associated with the provision of additional storage from the costs required to upgrade the current dams. These costs are presented in Table 1-2.

Table 1-2 – Flood Security Costs

Wivenhoe Raising Options				
Option	Increase in Storage Capacity (ML)	Direct Cost ($m_)		Total Estimated Cost ($m)*
		Raising FSL	Flood Security	
W1	228,000	13	40	63
W1A (Operational change)	228,000	NA	5 – 10	5 to 10
W2	481,000	64	40	138
W3	1,066,000	151	40	248
Somerset Raising Options				
S1	92,000	1.5	24	55
S2	202,000	1.5	24	70
S3	332,000	1.5	24	85

Note:

1. **The total costs include contingencies, design and construction supervision not included in the direct costs**
2. **The Wivenhoe flood security costs comprise the current estimated costs of the Stage 2 works. This work is required to be undertaken by SEQWater by 2035.**
3. **The works to raise the FSL at Somerset include gate seals, upgrading the crest, and upgrades to the controls. This work is constant for the three options as up to 6m additional storage could be held against the sector gates after upgrading.**
4. **The MFL for the Somerset Raising Options is similar for all three cases. Therefore, the post tensioning and downstream strengthening work are of a similar order of cost (at this level of assessment).**

For Wivenhoe it can be seen that the incremental cost associated with the small increase in the storage capacity is much less than the cost required to upgrade the dam to full PMF Capacity. For Somerset the cost of increasing the storage capacity is much less than the cost to upgrade to full PMF capacity in all cases.

1.3 Limitations

This report is intended to be a preliminary feasibility investigation for options to raise Wivenhoe or Somerset Dam. The investigations carried out for the report have focused on the engineering aspects of raising Wivenhoe and Somerset. There has been no attempt to quantify:-

- The potential impacts of the raising on the end of systems flows.
- The frequency and volumes of the storage to be held above FSL at either or both of the dams.

- The potential benefit of raising Wivenhoe or Somerset on the downstream flood impacts.
- Major environmental impacts.
- Impacts of the additional storage on the levels of service.

1.4 Flood Operational Procedures.

The proposed raising options investigated for Wivenhoe are capable of producing similar outflow hydrographs to the current configuration, thereby preserving the flood mitigation benefits downstream of the dam.

The proposed options for the raising of Somerset reduce the flood mitigation capacity of the storage for downstream stakeholders (impacts on the flood mitigation capacity of both Wivenhoe and Somerset) to limit the impacts of the raised storage levels on Kilcoy and upstream areas. These options would require a substantial revision of the flood operational procedures.

Option W1A has impacts on the flood capacity of the dam for events greater than the 1 in 1,000 AEP event. Given the rarity of this event it considered that this option has potential to be acceptable to the downstream stakeholders as a short term (10 to 15 years) option to capture additional storage in Wivenhoe.

It has been assumed that minor changes to the flood operational procedures and works to the downstream bridges may reduce the adverse impact of this operational change even further. It is proposed that this assumption be investigated further by SunWater, to provide a detailed assessment of the impacts of the raised storage on the downstream flood levels.

1.5 Wivenhoe Raisings.

The raising options W1, W2 and W3 considered involve:-

- Complex work in the spillway which could only proceed one bay at a time and probably only in the dry season months.
- The cost of such complex work with limited time windows is difficult to estimate with reasonable certainty.

Options W2 and W3 involve raising the embankments and a temporary relocation of the Brisbane Valley Highway causing major disruption to traffic. Less significant disruption would be caused to the Wivenhoe - Somerset Road. The indirect cost of these disruptions has not been estimated.

For Option W1A, the increase in downstream flooding is relatively minor but its acceptability would be dependent on consultation with stakeholders. A raising of Kholo Bridge and possibly of Burtons Bridge and Savages Crossing could be required to deal with possible concerns.

For Option W1A, the existing fuse plug will be triggered more frequently (existing 1:5,000 AEP flood). The frequency and consequences will need to be examined in further detail.

1.6 Somerset Raisings

Issues associated with the raising of Somerset include:-

- Flood Mitigation. Each of the options investigated for the raising of Somerset impact on the existing flood mitigation performance. This impact is greater as the proposed raising increases. This is due to constraints on the upstream flood levels imposed by Kilcoy and other upstream development.

- Equipment age. The gates and hoist equipment at Somerset Dam are of considerable age. There is some uncertainty whether it can be adapted as proposed.

- Dam condition. Cracking in a number of the dam monoliths and other stability concerns will be addressed concurrently with the raising proposals.

- Community opposition to the higher raising proposals is likely to be very strong.

- The indirect costs associated with the increased frequency of highway disruption have not been estimated.

1.7 Recommendations

It is recommended that:-

- Raising of the FSL level of Somerset Dam be rejected due to the impacts on the upstream population during flood events. Major flood events already result in inundation of the Kilcoy and surrounding private properties and infrastructure.

- The provision of contingency storage in Wivenhoe is investigated further. A 2m raising in the FSL could be achieved with minimal capital costs subject to addressing regulator and stakeholder issues.

- A detailed flood assessment is carried out to develop and asses changes to the flood manual to allow the storage of the additional 2m in Wivenhoe. The impact of the changes should be assessed for the full range of Annual Exceedance Probabilities and Storm Durations. This assessment should also link with the Brisbane River Flood Damages Assessment currently being carried out by Brisbane City Council.

- A detailed review of the structural adequacy of the various components of the dam is carried out to confirm the assumptions of this report. The

review will provide design detail to refine the cost estimates and confirm the feasibility of the proposed increase in storage level.

- A program of consultation with the downstream stakeholders is carried out with the proposed changes to the flood manual once the assessment of flood events is completed.

- SEQWater be provided with the opportunity to instigate a public consultation process prior to the public release of options to raise the storage levels of Wivenhoe.

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2. Glossary

Australian Height Datum (AHD)	*Mean sea level at the thirty tide gauges located around Australia*
Annual Exceedance Probability (AEP)	*The probability of a specified magnitude of a natural event being exceeded in any year.*
Dam Crest Flood	*The flood event which, when routed through the reservoir, results in a still water reservoir level at the lowest crest level of the dam.*
Design Flood Level (DFL)	*The peak level in a dam storage derived from routing the critical design flood event through the dam.*
Elevation Level (EL)	*The elevation relative to a specific datum point. For this report all elevation data is quoted in m AHD.*
Full Supply Level (FSL)	*The maximum normal operating water surface level of a reservoir when not affected by floods.*
Probable Maximum Precipitation (PMP)	*The theoretical greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends.*
Probable Maximum Flood (PMF)	*The probable maximum flood is the flood resulting from the PMOP and, where applicable, snow melt, coupled with the worst flood producing catchment conditions than can be realistically expected in the prevailing catchment metrological conditions.*
Maximum Flood Level (MFL)	*The peak water level in a dam storage derived from routing the critical design flood event through the dam. May be the same as the DFL or used to denote a different water level if the dam has a flood capacity deficiency.*
Outlet Works	*The combination of intake structure, conduits, tunnels, flow controls and dissipation device to allow release of water from a dam.*
Right Abutment	*The right hand side abutment of a dam looking in the downstream direction*
Left Abutment	*The left hand side abutment of a dam looking in the downstream direction*
Probability	*The likelihood of a specific event or outcome.*
Revise Generalised Tropical Storm Method (GTSM-R)	*A generalised method for the estimation of extreme rainfall events (PMP's) in the northern parts of Australia.*
Reservoir	*An artificial lake, pond or basin for storage, regulation, control of water, silt, debris or other liquid or liquid borne material.*

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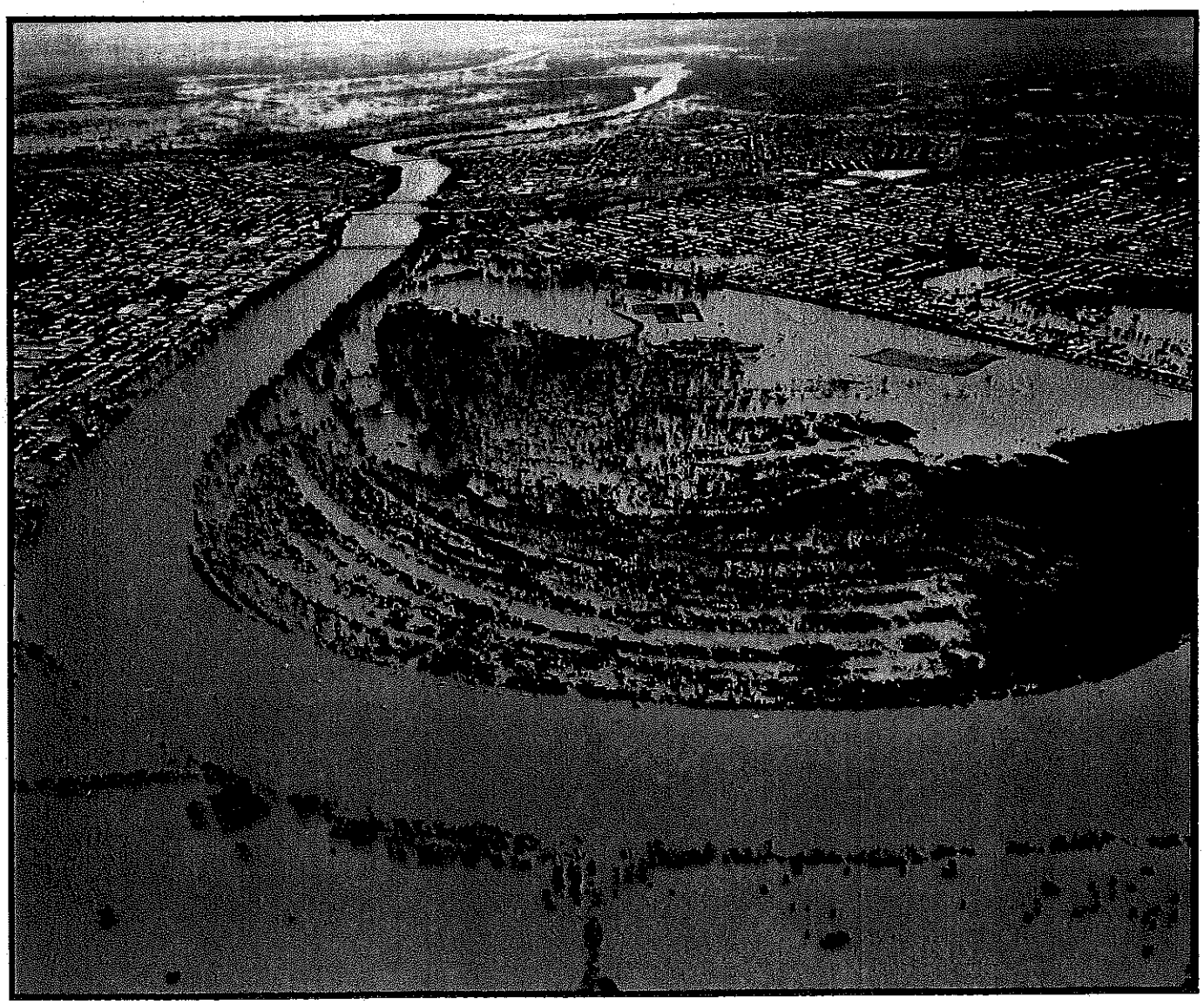

ROCKHAMPTON FLOOD MANAGEMENT STUDY

PHASE 2 REPORT

VOLUME 1
EXECUTIVE SUMMARY

CAMP SCOTT FURPHY PTY LTD
ACN 004 939 548

NOVEMBER 1992

CMPS&F.
Rockhampton Flood Management Study
:Phase 2 report.

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ROCKHAMPTON FLOOD MANAGEMENT STUDY

PHASE 2 REPORT

VOLUME 1
EXECUTIVE SUMMARY

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ROCKHAMPTON FLOOD MANAGEMENT STUDY

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 MANAGEMENT STUDY

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NOTE: Appendices unchanged from Phase 1 not included.

GLOSSARY OF TECHNICAL TERMS USED IN THIS REPORT

Term	Abbreviation	Meaning
Afflux		The increase in water level caused by the introduction of a constriction, such as a bridge, into a stream or channel.
Australian Height Datum	AHD	National Mapping datum used throughout Australia. Australia wide average of mean sea level.
Annual exceedance probability	AEP	The probability (chance) of an event (eg. flood of a given size) being equalled or exceeded in each and every year, usually expressed as a percentage.
Average recurrence interval	ARI	The reciprocal of AEP – the average period between exceedances of an event of a given magnitude, usually in years eg. 100 year ARI is equivalent to 1% AEP. This term is often misinterpreted as the actual period between exceedances rather than the average period.
Benefit–cost ratio	BCR	The ratio between economic benefits of a proposal scheme and its cost, both expressed in terms of net present value. A BCR of 1 or greater demonstrates economic viability. This is rarely achieved with flood mitigation schemes, which typically have a BCR of 0.4 – 0.7. These schemes are justified on the basis of social and other intangible ie. non monetary benefits.
Direct Flood Damage		That loss or damage caused by the physical contact of floodwaters with buildings and their contents or with other property.
Indirect Flood Damage		That loss or damage consequent upon direct flood damages. Caused by the interruption/disruption of economic or social activities as a result of direct flood damage.
Floodplain		The portion of a river valley, which is covered with water when the river overflows during floods.

Term	Abbreviation	Meaning
Levee		Embankment structure designed to protect property from damage by floodwaters by excluding flood waters from the protected area. These are usually earth embankments but may include sections of retaining walls and spillway structures.
Mean annual damage or Average annual damage	MAD AAD	The long term mean (average) of annual flood damages taking into account the probability distribution of flood magnitude and the resulting damage caused.
Net Present Value	NPV	The difference between the sum of the present value of benefits and the sum of the present value of costs. The present value of a stream of costs/benefits spread over time is their equivalent value should they be expended at the present time ie. the value of a benefit or a cost in the future discounted to a base date.
Probable Maximum Precipitation	PMP	The depth of precipitation (rainfall) which for a given area and duration can be reached but not exceeded under known meteorological conditions.
Probable Maximum Flood	PMF	The flood produced as a result of a catchment experiencing probable maximum precipitation (rainfall). Usually taken as the highest of such floods resulting from PMP of a range of durations.

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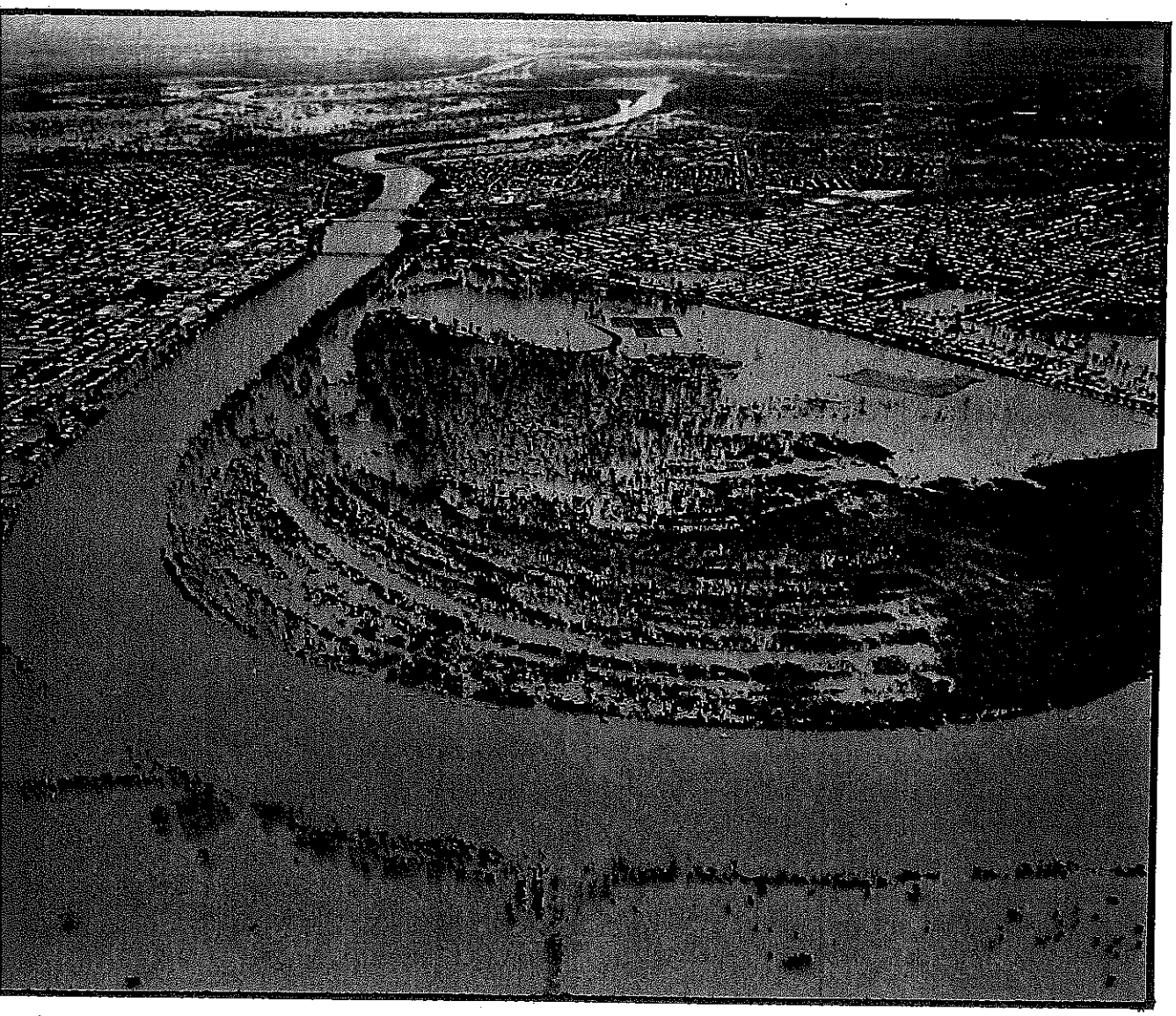

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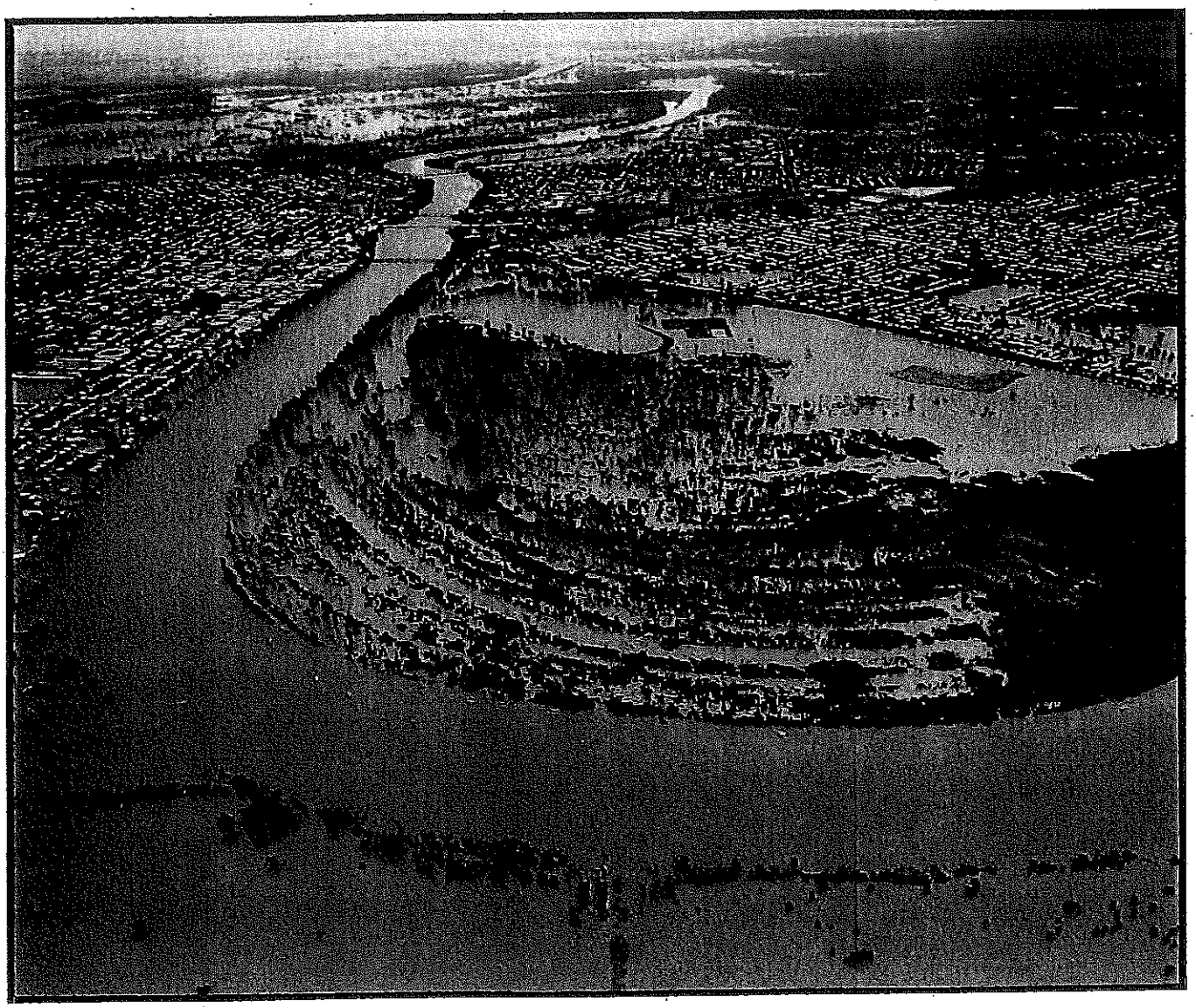

ROCKHAMPTON FLOOD MANAGEMENT STUDY

SUMMARY OF RECOMMENDATIONS

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MANUAL

OF

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FOR

FLOOD MITIGATION

AT

WIVENHOE DAM

AND

SOMERSET DAM

Revision 7
November 2009

Revision No.	Date	Amendment Details
0	27 October 1968	Original Issue
1	6 October 1992	Complete revision and re-issue
2	13 November 1997	Complete revision and re-issue
3	24 August 1998	Change to page 23
4	6 September 2002	Complete revision and re-issue
5	4 October 2004	Complete revision
6	20 December 2004	Miscellaneous amendments and re-issue
7	November 2009	Complete Revision

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