PRELIMINARY FLOW PATTERN STUDY OF THE NAMMING DRAINAGE SYSTEM, 1986

REPORT

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D.R. MUNRO

SENIOR TECHNICAL OFFICER

RESEARCH DIVISION

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

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FLOW PATTERN STUDY OF THE NAMMING WETLAND DRAINAGE SYSTEM

1. INTRODUCTION

1.1 The System

The Namming wetland system is located in the Shire of Dandaragan approx. 27 km SSW of Dandaragan in a low lying depression (approx. 70 m above sea level) between the Darling Scarp and the coastal sand and limestone ridge.

The wetlands and connecting streams extend and flow north from the southern most lake to the top of Lake Guraga over a distance of 10 km.

A major source of the Namming Wetland System is Caren Caren Brook which has a catchment area of approx. 350 km^2, centred 18 km NE of the system in the Darling Plateau.

Caren Caren Brook emerges from the foothills, flows under Brand Highway and then continues due West for 1.0 km before separating into two streams. The main stream continues West for another 4.5 km to enter the south-eastern corner of Namming Lake. This section of Caren Caren Brook, from Brand Highway to Namming Lake runs through farmland owned by N. Harris (loc's. 3445; 3776; 1711; 1122; 3001).

The secondary stream (herein-after referred to as Reserve Creek) flows 3.0 km SW from Caren Caren Brook to enter the Namming Nature Reserve (↑28558) system of wetlands. The first 1.6 km section of Reserve Creek to Nammen road is through Harris property; the remaining 1.4 km flows through other privately owned farmland (loc. 3832).

When these wetlands fill they overflow from the north-western end of the northern-most swamp (Crackers) into Namming Lake. It, in turn, overflows through shallow marshlands to enter the southern end of Lake Guraga, which is a contained compensating basin.

Additional input to the reserve system is received from an immediate local catchment having an estimated area of 80 km².

1.2 Purpose of Study

Namming Lake has for many years been a popular water ski venue utilised mainly by local residents.

In the autumn of 1986 the Dandaragan Progress and Ratepayers Association notified Council of its anxiety over the lack of water in Namming Lake. (Special Supplement, West Australian 6/5/86). Subsequently Council reconstructed an earthern "plug" in Reserve Creek (where it branches from Caren Caren Brook) and thus all flow down Caren Caren Brook was directed to Namming Lake.

The Department of Conservation and Land Management (C.A.L.M.) was interested to learn what effect this action might have on the wetlands in the Reserve. With the cooperation of Council it was agreed that the situation should be monitored during winter to gain an understanding of flow patterns for the total system and to determine whether any adverse impact might result from the closure of Reserve Creek.

1.3 Data Sources

The study has been based on the analysis of data from:

a) Visual observation of stream flows and land use.

b) Rainfall records for the period 1972-1986 obtained from the Bureau of Meteorology for West Dandaragan

("Dandaroo"). This recording station is located 20 km N of Namming Lake. Although the rainfall at Namming would be marginally higher, the figures are sufficiently accurate for the purpose of this study. For reference purposes a record of rainfall is appended (Table I). Note: The mean annual rainfall for this station is 621 mm.

c) Lake depth and salinity data from C.A.L.M.'s Wetland Monitoring Program (Tables II, IV and V). During this program Namming Lake was monitored in 1979 and Crackers Swamp from 1980 onward. Supplementary data for these parameters were obtained during several inspections of the area in 1986 (Tables IV and VI).

d) Historical information was provided by Mr N. Harris, the owner of "Nammen", the property on which Namming Lake is located and through which Caren Caren Brook and a section of Reserve Creek flow. Mrs S. Harris and the Dandaragan Shire also contributed relevant information.

2. LAND USE AND TOPOGRAPHY

2.1 Land Use/Status

Land between Namming Lake and the reserve and the Darling Scarp is almost totally developed to pasture for stock grazing and some cereal cropping. Remnant vegetation is predominantly Banksia and Melaleuca species with River Gum and Marri occurring in some areas.

Westward of the Lake and Reserve to Mimmigarra road (10 km) the total area consists of uncleared Banksia sandplain interspersed with shallow wetland depressions, some of which carry stands of Melaleucas (paperbarks).

2.2 Topography

The whole wetland system is contained centrally between the coastal ridge and the Darling Scarp. Landform is very flat with little relief. Because of this, numerous areas adjacent to the major wetlands, i.e., on the reserve, surrounding bushland and developed farmland, are subject to winter inundation.

The only significant relief in land contour is in the form of low hillocks (ridges) immediately west of Namming Lake and on the western boundary of the reserve.

3. HISTORY OF FLOW MANIPULATION

3.1 Pre 1986

In the late 1940s Reserve Creek was closed by means of an earthen plug which diverted the total flow of Caren Caren Brook directly into Namming Lake. This was done to relieve flooding of pasture land along margins of Reserve Creek. The plug was maintained periodically by the land owners until about 1977.

In 1977, under the terms of an agreement (Deed) between the Dandaragan Shire Council and the landowners, Dandaragan Shire Council assumed responsibility for maintaining the plug and at that time or in the summer/autumn of 1978 it was re-instated.

The closure appears to have been effective until 1983 when it again washed out as a result of well above average rainfall (726 mm) and subsequent flooding.

3.2 Events of 1986

In the autumn of 1986 the plug was again restored in response to the request from the Dandaragan "Progress and Ratepayers Association".

As a consequence to flash flooding caused by above average rainfall over a short period, the plug breached in August 1986. The top 50 cm eroded away and following the release of the initial peak flood waters down Reserve Creek, flow across the top eased to a depth of approx. 50 mm by the 25th September. This depth equated to a steady "sectional" stream flow of approx. 2.00 m x 0.10 m (photo plates I and II).

When inspected on the 26th November, the level in Caren Caren Brook was just below the plug spillway indicating that flow down Reserve Creek had just ceased.

4. ASPECTS AND FINDINGS OF 1986 STUDY

4.1 Recreation Values/Namming Lake

Mr Harris now has an interest in a lobster fishing business which keeps him from the property for extensive periods during the summer months. As a consequence I am informed that only limited skiing now takes place at Namming Lake.

Mr Harris stated that the lake had become too low for skiing only once in recent years (possibly 1982) and he personally wasn't concerned if this situation arose occasionally, accepting that it was inevitable in some years due to climatic extremes. He adopts the same attitude to flooding of lowland pastures, acknowledging that it is to be expected because areas of the property are within the drainage system.

Mr Harris further stated that in 1969 Lake Guraga filled causing waters to bank up in Namming Lake. Flood waters rose to within metres of the homestead and flooding occurred over an extensive area of the property. This phenomenon is of interest only; it is not influenced significantly by manipulation of stream flows as discussed in this report.

4.2 Wetland (Wildlife) Values

Although all the wetlands within the system provide valuable waterbird habitat, the system of lakes in the reserve is considered to be the most important. They provide a diversity of breeding, feeding and loafing habitat for many species including Freckled duck (Stictonetta naevosa).

Namming Lake, being more permanent than the reserve swamps is an important fresh/brackish refuge area. Limited breeding also occurs there.

Lake Guraga does at times (depending on volume) support large populations of Australasian Shelduck (Tadorna tadornoides) and Grey Teal (Anas gibberifrons).

4.3 Rainfall

Examination of annual rainfall data for West Dandaragan shows that during the period 1976 to 1980 (incl) rainfall was either below or well below average. From 1981 to 1986 (incl) annual rainfall has generally been average to well above average. 1983, 1984 and 1986 were the wettest of the recent years while 1985 was the driest since 1979 (Table I).

Comments:

It should be noted that the amount of rainfall runoff is influenced considerably by rainfall "spread", i.e. heavy falls of rain received over a short period produce far greater runoff than would the same amount of rainfall over a longer period. Rainfall distribution can also result in one area of catchment

RAINFALL STATISTICS for WEST DANDARAGAN, 1972 TO 1986 (incl.)

BUREAU OF METEOROLOGY REPORT OF MONTHLY AND YEARLY RAINFALL BY M.I.S.S. 1/ 4/86 PAGE 2465

'+' = RAINFALL BETWEEN 0.1 & 0.4 MM '-' = MISSING OBSERVATION ROUNDED TOTALS

STATION : 009014 DANDARAGIN (DANDALOO) 30 42 S, 115 35 E 150.0 M ELEV

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC		
1972	RAINFALL (MM)	0	3	1	30	34	110	130	149	28	43	•	•	528	1972
1972	NO OF RAINDAYS	0	1	2	4	6	12	18	17	10	-	1	1	-	
1973	RAINFALL (MM)	1	3	0	22	81	106	176	116	110	23	17	1	656	1973
1973	NO OF RAINDAYS	2	1	0	10	17	17	23	15	15	9	7	1	117	
1974	RAINFALL (MM)	0	23	13	92	178	126	141	110	19	65	3	0	770	1974
1974	NO OF RAINDAYS	0	1	2	4	13	12	19	11	4	6	1	0	73	
1975	RAINFALL (MM)	0	4	18	109	72	106	195	41	58	52	28	7	690	1975
1975	NO OF RAINDAYS	0	2	4	10	9	12	19	9	8	-	-	1	-	
1976	RAINFALL (MM)	17	37	0	34	80	42	42	120	46	37	40	0	495	1976
1976	NO OF RAINDAYS	5	5	0	5	9	9	10	11	7	6	3	0	70	
1977	RAINFALL (MM)	5	8	0	14	79	55	68	135	12	60	5	31	452	1977
1977	NO OF RAINDAYS	3	2	0	2	-	11	10	15	3	8	3	1	-	
1978	RAINFALL (MM)	3	10	3	26	55	152	96	32	104	21	12	38	552	1978
1978	NO OF RAINDAYS	1	1	1	-	-	15	12	5	15	3	3	5	-	
1979	RAINFALL (MM)	0	11	34	50	67	103	70	82	26	16	29	2	490	1979
1979	NO OF RAINDAYS	0	2	4	5	8	10	10	8	6	9	7	1	70	
1980	RAINFALL (MM)	0	1	2	75	48	92	129	83	126	28	7	1	594	1980
1980	NO OF RAINDAYS	0	3	1	8	7	-	8	-	-	7	3	1	-	
1981	RAINFALL (MM)	0	18	2	5	154	123	129	114	36	34	25	10	650	1981
1981	NO OF RAINDAYS	0	2	1	3	7	13	17	16	8	4	5	2	78	
1982	RAINFALL (MM)	52	23	13	1	49	136	85	116	80	21	•	0	576	1982
1982	NO OF RAINDAYS	6	5	2	1	11	10	13	8	4	5	1	0	66	
1983	RAINFALL (MM)	0	3	12*	27	20	252	166	100	82	13	31	21	726	1983
1983	NO OF RAINDAYS	0	3	-	3	2	-	6	-	11	2	4	5	-	
1984	RAINFALL (MM)	0	9	37	39	187	68	64	96	69	32	58	8	667	1984
1984	NO OF RAINDAYS	0	1	3	6	14	8	8	11	6	5	6	1	69	
1985	RAINFALL (MM)	21	3	6	20	31	58	113	131	115	27	10	11	546	1985
1985	NO OF RAINDAYS	1	1	1	-	5	8	10	13	6	2	3	2	-	
1986	RAINFALL (MM)	0	123	18	5	99	145	145	92	11	27*	0	0	672	1986
1986	NO OF RAINDAYS	-	4	-	-	-	-	-	-	-	-	-	-	-	

MEANS AND MEDIANS FOR THE PERIOD 1951 TO 1986 USING ALL AVAILABLE DATA

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
MEAN RAINFALL (MM)	10	16	13	38	78	129	120	96	55	40	16	10	621
MEDIAN RAINFALL (MM)	3	5	6	28	70	111	115	101	50	32	11	7	603
NO. OF RAINFALL OBS.	31	31	29	32	31	31	32	30	30	31	30	30	28
MEAN NO. OF RAINDAYS	2	2	2	6	9	16	13	12	9	7	4	2	82
NO. OF RAINDAY OBS.	31	31	29	30	28	29	32	27	29	29	29	30	

NOTE "*" DENOTES UNCONFIRMED RECORDING.

TABLE I

receiving greater falls than others within the same region.

As well as runoff the status of ground water tables and wetland conditions at the commencement of winter have an influence on water levels in the wetlands in any one year. A combination of unusual ground water levels, wetland conditions or aberrant rainfall could account for some discrepancies which appear when the data are analysed.

4.4 Wetland Depths: Rainfall

Crackers Swamp has been monitored for depth and salinity since 1980 (Table II). It has a stabilised depth of approx. 1.00 m but has flooded to a maximum recorded depth of 1.28 m. It would have attained a greater depth in 1969.

The lake remained dry or almost dry in 1980, 81 and 82 but filled each year from 1983 to 1986 (incl). It is of note that for the former period when the lake remained virtually dry, the plug in Reserve Creek was (as far as I have been able to ascertain) in place and fully effective.

As stated earlier, the plug washed out in 1983 and remained so until the end of 1985. During this period, swamps in the reserve system (at least the three northern ones) filled and overflowed into Namming Lake, even in 1985 when rainfall was well below average.

In 1986, all wetlands of the system flooded even though the plug had been reinstated. It did however breach partially and thus permitted a reasonable flow from Caren Caren Brook to enter the reserve swamps. These waters, combined with substantial local catchment quickly filled and flooded the reserve wetlands. I

Wetland Data Report - Routine And Non-Routine Samples

TABLE II

Sampler	Group	Sample Date	Depth (m)	Salinity (ppt)	pH	Remark Present	Survey	Lake Bed Level Near Shore	Lake Bed Level Off Shore
			----	CRACKERS	----				
MUNRO D	C	10/07/80	0.06	0.1	.	N	Routine	.	.
LANE J	C	12/01/81	BD	BD	BD	N	BD	.	.
MUNRO D	C	06/11/80	Dry	Dry	Dry	N	Routine	.	.
LANE J	C	12/05/81	BD	BD	BD	N	BD	.	.
MUNRO D	C	14/07/81	0.15	0.1	.	N	Routine	.	.
MUNRO D	C	19/09/81	0.31	0.4	.	N	Routine	.	.
PEARSON G	C	08/11/81	0.05	1.4	9.4	N	Routine	.	.
PEARSON G	C	11/01/82	BD	BD	BD	N	BD	.	.
PEARSON G	C	18/03/82	BD	BD	BD	N	BD	.	.
MUNRO D	C	10/05/82	BD	BD	BD	N	BD	.	.
ANDERSON L	W	11/07/82	Dry	Dry	Dry	N	Routine	.	.
LANE J	C	27/07/82	0.15	.	.	N	Not Rout.	.	.
ANDERSON L	W	19/09/82	0.10	0.40	.	N	Routine	.	.
MUNRO D	C	10/11/82	Dry	Dry	Dry	N	Routine	.	.
ANDERSON L	W	09/01/83	Dry	Dry	Dry	N	Routine	.	.
LANE J	C	19/03/83	BD	BD	BD	N	BD	.	.
ANDERSON L	W	21/05/83	Dry	Dry	Dry	N	Routine	.	.
PEARSON G	C	12/07/83	0.16	0.093	7.0	N	Routine	.	.
ANDERSON L	W	18/09/83	1.20	0.535	.	N	Routine	.	.
MUNRO D	C	07/11/83	0.96	0.68	7.1	N	Routine	.	.
PEARSON G	C	14/01/84	0.67	1.15	8.4	N	Routine	.	.
MUNRO D	C	15/03/84	0.23	3.15	8.6	N	Routine	.	.
ANDERSON L	W	19/05/84	0.06	0.180	.	N	Routine	.	.
PEARSON G	C	18/07/84	1.14	0.834	7.4	N	Routine	.	.
ANDERSON L	W	15/09/84	1.28	0.548	.	N	Routine	.	.
MUNRO D	C	07/11/84	0.96	0.865	8.0	N	Routine	.	.
PEARSON G	C	11/03/85	0.18	5.0	.	N	Routine	.	.
MOTTERAM R	W	14/01/85	0.61	1.622	.	N	Routine	.	.
MOTTERAM R	W	19/05/85	BD	BD	BD	N	BD	.	.
LANE J	C	20/09/85	1.02	1.032	7.7	N	Routine	.	.
PEARSON G	C	03/11/85	0.96	1.073	7.5	N	Routine	.	.
PEARSON G	C	14/09/86	1.07	0.664	7.0	N	Routine	.	.
LANE J	C	04/11/86	1.00	0.77	8.1	N	Routine	.	.

A total of 1 wetlands and 33 records.

believe the reserve swamps would have filled without input from Caren Caren Brook in 1986.

It is difficult to relate those events of 1986 to 1981 when the annual rainfall was only marginally below that of 1986 and still above average. The plug apparently was in place and did not breach, thus preventing any flow from Caren Caren Brook reaching the reserve. Even local catchment appears to have been insignificant as Crackers Swamp was dry by the end of November that year.

The only explanation is a combination of the rainfall "spread" factor, the status of the lakes at the commencement of winter and presumably a low water table (the preceding several years had been very dry).

However, I expect that without the plug the reserve swamps would have achieved a reasonable depth or filled in 1981, as they did in 1985 when rainfall was below average yet the reserve wetlands flooded.

Namming Lake was monitored for depth and salinity in 1979 only. It has a stabilised depth of approx. 2.00 m but in 1979 it flooded to a maximum recorded depth of 2.19 m on the 11th September (Table II). In 1979 the plug is assumed to have been in place and rainfall was very much below average with only 490 mm being recorded.

TABLE III

DEPTHS & SALINITIES - LAKE NAMMING - 1979

Dates	13/6/79	18/7/79	11/9/79	6/11/79
Depth (m)	1.28	2.17	2.19	1.98
Salinity (ppm T.D.S)	1230	1700	1250	1300

4.5 Salinity Levels

In addition to routine monitoring of depths and salinities of Crackers Swamp (Table II), additional sampling for salinities was conducted on the 25th September 1986, at Caren Caren Brook (adjacent to the Reserve Creek branch), Reserve Creek (where it enters the reserve), Crackers Swamp outlet (which was overflowing at the time) and from the water course which enters the reserve swamps at the southern end of this system (Table IV). To put the salinity levels obtained in some kind of context, sea water is approx. 35,000 p.p.m., "World Health Organisation" limit for human consumption is 700 p.p.m. and the Australian Health Standard limit for human consumption is 1000 p.p.m. Therefore the waters sampled in September 1986 are all deemed to be fresh and of good to reasonable quality. By the time of sampling, however, salt levels would have stabilised following an initial flushing of more saline waters from reservoirs of concentrated salts in depressions and creek pools.

TABLE IV

WATER SALINITIES (p.p.m T.D.S.) 25th SEPT. 1986

Caren C. Brk	Reserve Crk	Sth Water Course	Crackers Swp
780	800	540	680

Examination of the salt levels show that the salinity of water entering the reserve system from Caren Caren Brook is higher than that which departs the system from Crackers Swamp. This is undoubtedly due to dilution in the reserve swamps by the fresher water entering the system from the south and south-east catchment. The degree of dilution suggests that a reasonable volume of input was received from this catchment source in 1986.

TABLE V

SEPT./NOV. DEPTH & SALINITY LEVELS VS RAINFALL
CRACKERS SWP - 1980 TO 1986 (INCL.)

	1980		1981		1982		1983		1984		1985		1986	
	Sept	Nov	Sept	Nov	Sept	Nov	Sept	Nov	Sept	Nov	Sept	Nov	Sept	Nov
DEPTH (M)	-	DRY	0.31	0.05	0.10	DRY	1.20	0.96	1.28	0.96	1.02	0.96	1.07	1.00
NaCl (ppm)	-	DRY	400	1400	400	DRY	535	680	548	865	1030	1070	664	770
RAINFALL (MM)	594		650		576		726		647		546		672	

TABLE VI

SUPPLEMENTARY DEPTH & SALINITY LEVELS
CRACKERS SWAMP - 1986

	5TH JUNE	4TH SEPT	14TH SEPT	25TH SEPT	9TH OCT	4TH NOV	26TH NOV	16TH DEC
DEPTH (M)	0.30	1.20	1.07	1.06	1.08	1.00	0.96	0.73
NaCl (ppm)	-	650	664	680	-	770	-	1030

However, to determine the percent of input would have entailed a complex study using sophisticated equipment.

Although no salinities were obtained from Namming Lake in 1986 (it is of little or no relevance to this study), the results of monitoring in 1979 are shown in Table III. The comparatively high salinity levels (then) support the supposition that more saline waters enter the lake via Caren Caren Brook during the initial winter flow.

4.6 Silting

Inspection of the plug site after it breached revealed a high degree of silting in Reserve Creek. It is difficult to accurately assess what impact this has on the flow without historical knowledge of the original depth of the stream. However, I believe it is reasonable to assume that accumulating silt must to some degree restrict the flow and therefore aggravate the flooding potential to pasture in this area.

In the long term, continued deposition of silt along the Reserve Creek watercourse and, possibly, in the reserve swamps, must have an undesirable impact.

4.7 Denial of Water

One objection was received in response to Council's decision to close Reserve Creek. This was from the owner of land adjacent to the reserve (on the south side of Nammen road), through which a section of Reserve Creek flows (Loc. 3832).

His objection was on the basis that if rainfall for the year was below average, Reserve Creek may not flow or receive input from Caren Caren Brook, subsequently he would be denied an important water source.

5. CONCLUSIONS

5.1 Comments

Most aspects of this study have been summarised under each of the respective headings. Those comments disclose the variables and influences which affect the flow pattern from one year to another.

I don't believe the needs of water skiers justify the expense and potential adverse impacts of either aggravated flooding or denial of water to farmland as can occur with the existing method of control. The events of 1986 lend strong support to this view. It has also been shown that it is only on very rare occasions that skiing at Namming Lake has not been possible because the lake fills almost every year whether Reserve Creek is closed or not. The proposed recommendations would still ensure that Namming Lake received a greater proportion of the flow from Caren Caren Brook.

The plug in Reserve Creek, designed to alleviate flooding of pasture has proven to be far from satisfactory. It is unreliable, inequitable, costly to maintain and has the potential to create undesirable impacts on the farmlands and drainage system.

5.2 Objectives

The aim of this study was to determine whether a system of control could be designed which would achieve the initial objectives equitably, i.e. to this end, the principal values of farming and the nature reserve must receive priority consideration.

Therefore, the scheme should be designed to:

a) alleviate or minimise flooding to pasture land in the region of Reserve Creek and Namming Lake,

b) ensure an adequate supply of water to farming properties and the reserve wetlands and,

c) to achieve these goals at minimum long term cost without undue disturbance to the natural system, i.e. silting, erosion and water quality.

6. RECOMMENDATIONS

6.1 Comment

Suggested proposals involving dredging etc. are subject to further examination and feasibility studies. Foremost of these is a survey to determine the gradient from the base flow level of Caren Caren Brook to the minimum achievable creek bed level of Reserve Creek at the reserve boundary. The gradient (fall) between these two points has significant bearing on the practicability of pursuing modifications in this region as considered in the proposed optional recommendations.

Adoption would be conditional to acceptance by all parties directly affected by implementation of the proposals.

Regardless of whatever options might be adopted, there will always exist the possibility of flooding to susceptible areas. The proposals are designed to achieve the objectives (as summarised) in years of near average rainfall and to reduce the impact caused during flood periods.

The proposals are developed from a basic trial concept (6.2) with additional options for consideration (6.3).

6.2 Initial Trial Proposal

a) Completely remove the earthern plug from Reserve Creek at the earliest opportunity.

b) Construct a temporary check structure of sandbags faced with P.V.C. sheeting across Reserve Creek to a height approximately one third of the mean winter flow depth of Caren Caren Brook, i.e. approx. 20 cm above the minimum flow depth of Caren Caren Brook. It need not necessarily create an absolute water seal.

Such a structure would permit the initial flow of higher saline water to pass directly into Namming Lake. As the stream depth rose in Caren Caren Brook, waters would become fresher and overflow would occur down Reserve Creek to serve farming properties and the reserve wetlands.

This trial should be permitted to operate through at least one year of near average rainfall.

If it is found that unreasonable flooding still occurs in the region of Reserve Creek the following measures should be considered.

6.3 Optional Modifications/Extensions to Initial Trial Proposal.

a) Remove all sediment from Reserve Creek.

b) Raise the height of the check structure by a small margin. This practice should be monitored and adjusted over a minimum of two (2) years if possible to establish the optimum height for maximum efficiency.

c) Construct levee banks where necessary to prevent spill to lowland areas.

d) Deepen and widen Reserve Creek where restrictions to the flow occur.

e) Wherever necessary or possible, channel water from areas of ponding into Reserve Creek.

6.4 Permanent Structure

At the conclusion of a satisfactory trial period consideration should be given to the installation of a permanent concrete check structure. There are two alternatives:

a) Fixed Check Structure
A simple concrete wall built to a pre-determined height (established during trial period) so as to permit a reasonable flow down Reserve Creek in years of slightly below average rainfall.

b) Adjustable Height Check Structure
A structure where the overflow height could be adjusted to regulate flow by raising or lowering the stop boards. Although this type of installation allows for greater control it does require frequent adjustment and the cost would be substantial.

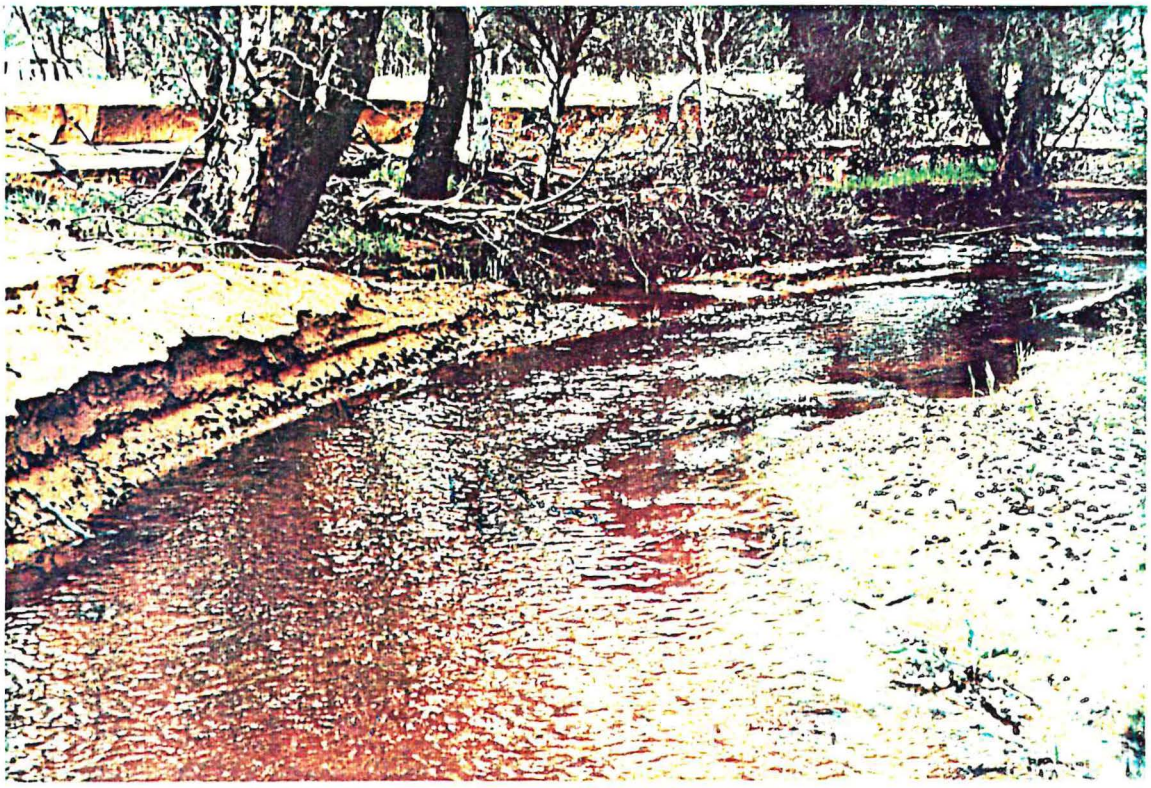
These are the options I believe would achieve an acceptable solution to the problems which currently exist in the Namming Drainage System.

D.R. MUNRO
SENIOR TECHNICAL OFFICER
RESEARCH DIVISION April 9, 1987

7. ACKNOWLEDGEMENTS

I am grateful to Mr Neville Harris and Mrs Shirley Harris for providing valuable background information. Dandaragan Shire Council and in particular, the Shire Clerk Mr Ian Stubbs have been most cooperative and helpful during the period of this study. I also appreciate the constructive comments of Dr Stuart Halse in the preparation of this report.

PLATE I - Taken 4/9/86 approx. 2-3 weeks after plug breached - initial flood flow ceased - had been 0.50 m higher. Flow across top of plug rapid and approx. 3.00 m wide x 5 mm deep.



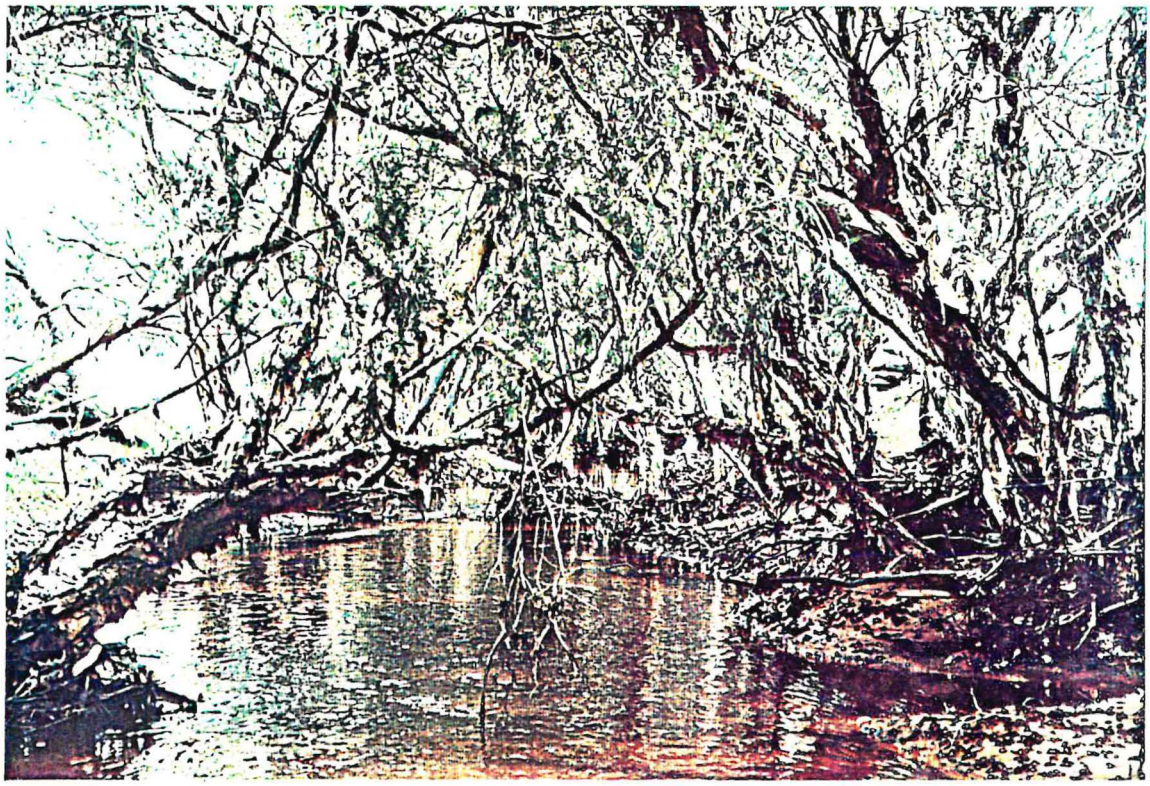


PLATE II

PHOTOS OF RESERVE CREEK 4/9/86

Top - Facing upstream - plug in background flow steady and approx. 2.0 m wide x 50 mm deep.
Note silting & erosion.

Bottom - Facing downstream approx. 50 m below plug.

PLATE III

Taken 25/9/86 - facing upstream in watercourse flowing from Crackers Swamp to Namming Lake.

On the 4/9/86 water was flowing across this section approx. 40 m wide and up to 30 cm or 40 cm deep, while flow down Reserve Creek was only approx 2.0 m x 10 cm on the same day.

MIMEGARRA HOMESTEAD 12 km

12 km MIMEGARRA HOMESTEAD 11 km

Cataby Brook
Balgar Plains
YANDINA HILL
Menardie
Yowerdabbie
Yatheroo Brook
Yatheroo
Yathroo
Ingarno Waterhole
Walyer Walyer Well
Dambagee
Boilingarra Swamp
Attunga
Elevated
Claypons
MIMEGARRA ROAD
Enominga Pool
Enominga
Enominga Swamp
Brook
BRAND HIGHWAY
Yaramie
Yangy Lake
BIDGERABBIE HILL
Hohenfels
Ruins
NAPPLE HILL
Bidgerabbie
Bidgerabbie West
Marry Hills
Western Nodes
STOCKYARD HILL
Carpan Spring
Koojan
SUGARLOAF HILL
234 △WALYER WALYER HILL
Walyer Walyer
Kilbride
Capitela
Capitela West Well
Capitela Well
Ruins
Claypan
Salt
Bulla-Bulla
Caren Caren Brook
Altino
Nammel
Nanming Lake
Doghole Pool
Tickeroo
RESERVE CAGER
NAMMEH Rd
CRACKERS SWAMP
Walyoo
WALYOO HILL
Tumuit
RESERVE BOUNDARY
RESERVE CATCHMENT
Griffiths
Howley Downs
Tower
Piddaree
△S/KH
△S136
Nine Mile Swamp
GABYS PEAK
EVANS PASS
Jendesco
NANNING NATURE RESERVE 28558.
FOUR WHEEL DRIVE
BRAND HIGHWAY
Dovedale
Moore River
Regans Ford
MOOCHAMULLA CLIFF
QUINS HILL
Edengerie Cascade
WHITE GUM POINT
Moore River
APPROX. BOUNDARY OF THE CAREN CAREN BROOK CATCHMENT AREA

31°00'S 357000mE 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96