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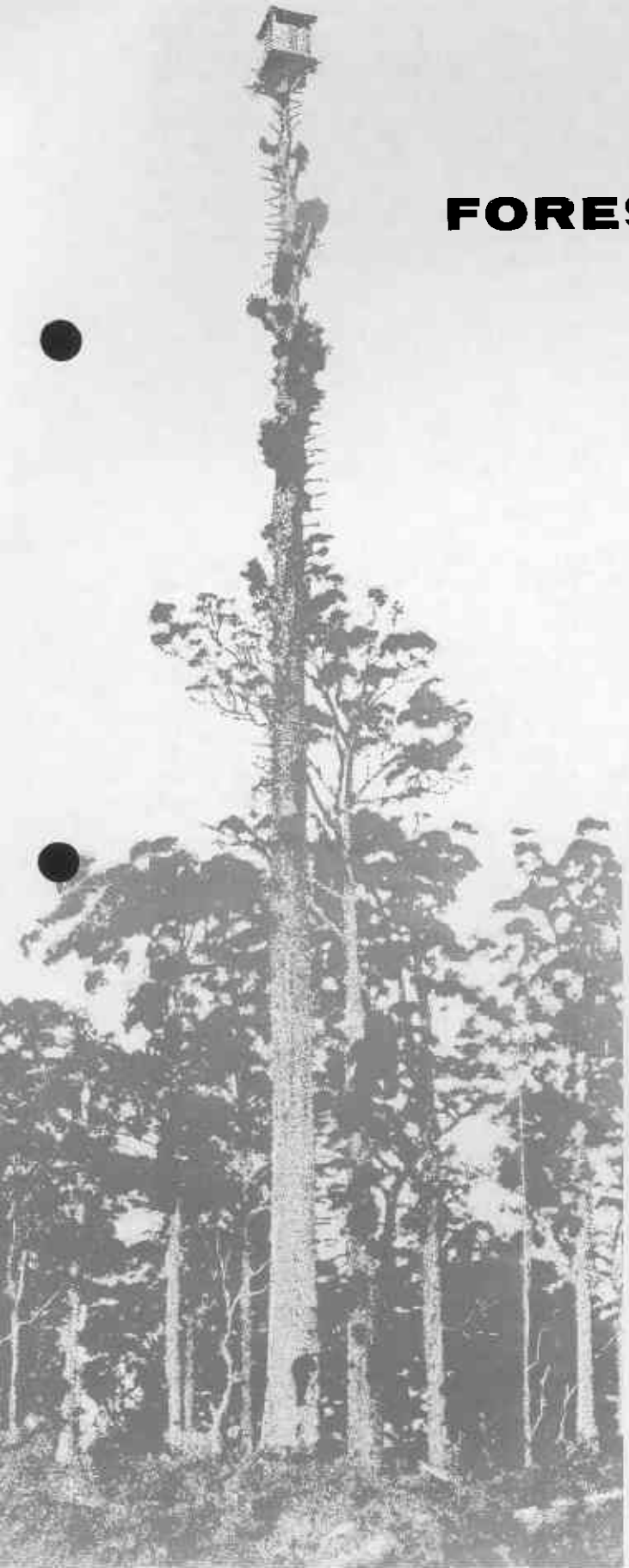

WATER QUALITY IN THE DONNYBROOK SUNKLAND (BLACKWOOD PLATEAU)

by

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SUMMARY

Streams arising within the Donnybrook Sunkland have very low levels of Total Dissolved Solids (TDS): weighted annual TDS contents generally do not exceed 200 mgl^{-1}. This study suggests that destruction of native forest by jarrah dieback disease *(Phytophthora cinnamomi)*, or a change in land use from forest to farmland, does not result in a significant rise in the salinity (TDS) of the runoff. However, there is strong evidence that the runoff from cleared areas of the adjoining Darling Plateau has a considerably increased salinity.

INTRODUCTION

The term Donnybrook Sunkland was used by Gentilli and Fairbridge (1951) to describe all the land lying south of Bunbury and west of the Darling Fault, in the south-west of Western Australia. Cope (1972) gave the name Blackwood Plateau to the area bounded by the Darling Fault, the Dunsborough Fault, the Whicher Scarp and the weak, broken scarp along the northern limit of the Scott Coastal Plain. This is approximately the same area as that referred to as the Donnybrook Sunkland by the Forests Department of Western Australia.

The area comprises a low plateau of Mesozoic sediments which has been down-faulted relative to the Archaean rocks of the Darling Plateau in the east and the Proterozoic rocks of the Leeuwin Block in the west. It is an area of low relief and is mostly covered by poor-quality jarrah forest. Approximately 283 000 ha of the Sunkland are State Forest or Timber Reserve.

The low ridges of the area are typically crowned with lateritic boulders or gravel, while the long slopes to the drainage lines usually have deep, sandy or sandy-loam soils which become heavier in texture along the creeks. The low relief results in slow drainage, and because of the coarse texture of the soils there are very few streams which are not ephemeral.

The Sunkland is the subject of a proposal (Forests Department, 1975) to convert approximately 60 000 ha of the native forest to intensively managed plantations of exotic pines, mainly *Pinus radiata* D. Don. As part of the research programme necessary before a decision about the feasibility of this project could be made, a survey of stream salinity (Total Dissolved Solids (TDS)) in the Sunkland was undertaken since the region contains water resources which are likely to be exploited in the future. One town (Margaret River) already draws its water from the river of that name.

The aims of this survey were three-fold:

(a) to survey stream salinity;

(b) to identify areas where salinity is high;

(c) to gather circumstantial evidence for an increase in stream salinity following conversion of forest to agriculture, or as a consequence of destruction of native forest by the dieback disease *Phytophthora cinnamomi.*

This information would be a guide to the possible impact of the pine project on stream salinity.

This paper reports 1975 results and refers only to the Sunkland north of the Blackwood River. Sunkland south of the River has not been sampled as at present no large-scale planting is envisaged in that zone.

METHODS

TDS levels were obtained from weekly or fortnightly samples collected from fixed sites at the lowest points in the catchments shown in Figure 1. For the calculation of the weighted annual TDS content for each catchment the mean monthly TDS data were weighted by the percentage of annual runoff for that month, and then weighted mean monthly TDS data were totalled and divided by 100; weighted annual TDS content is a more reliable indicator of salinity than a crude mean of all sample figures. Runoff studies in the Jarrahwood area indicate that the percentages of total annual runoff for the various months are as follows:

May	5%
June	10%
July	30%
August	30%
September	20%
October	5%

These figures will vary from year to year and from one catchment to another, so the data presented here are not precise. Nevertheless, they are adequate for the purposes of this investigation. Precise data on TDS levels for each catchment would require an unrealistic expenditure of time and money.

Results from the survey above (i.e. those for St John Brook) suggested that clearing along the edge of the Darling Plateau is followed by the movement of salts into streams. However, since St John Brook Catchment is partially cleared on the Sunkland as well as on the Plateau, a more detailed survey was undertaken in the Darling Scarp—eastern-Sunkland area to determine whether the cleared Darling Plateau is the source of increased salinity. For this survey, several other streams (whose catchments lie only on uncleared Sunkland) as well as Harrington Brook and Padbury Brook (whose catchments lie partly on uncleared Sunkland and partly on cleared Plateau) were sampled in July and again just before flow ceased in November for measurement of TDS levels. These months were chosen because in July, stream water is predominantly derived from surface runoff and TDS values are at a minimum: in November, stream water is predominantly derived from subsoil seepage and TDS values are at a maximum. Therefore the comparison of July and November values indicates likely salinity problems following disturbance of the vegetation.

It is important to determine whether the proposed large-scale conversion of native forest to pine in the Sunkland will have a similar effect on water quality as that of clearing on the Plateau. Short-term circumstantial evidence for a

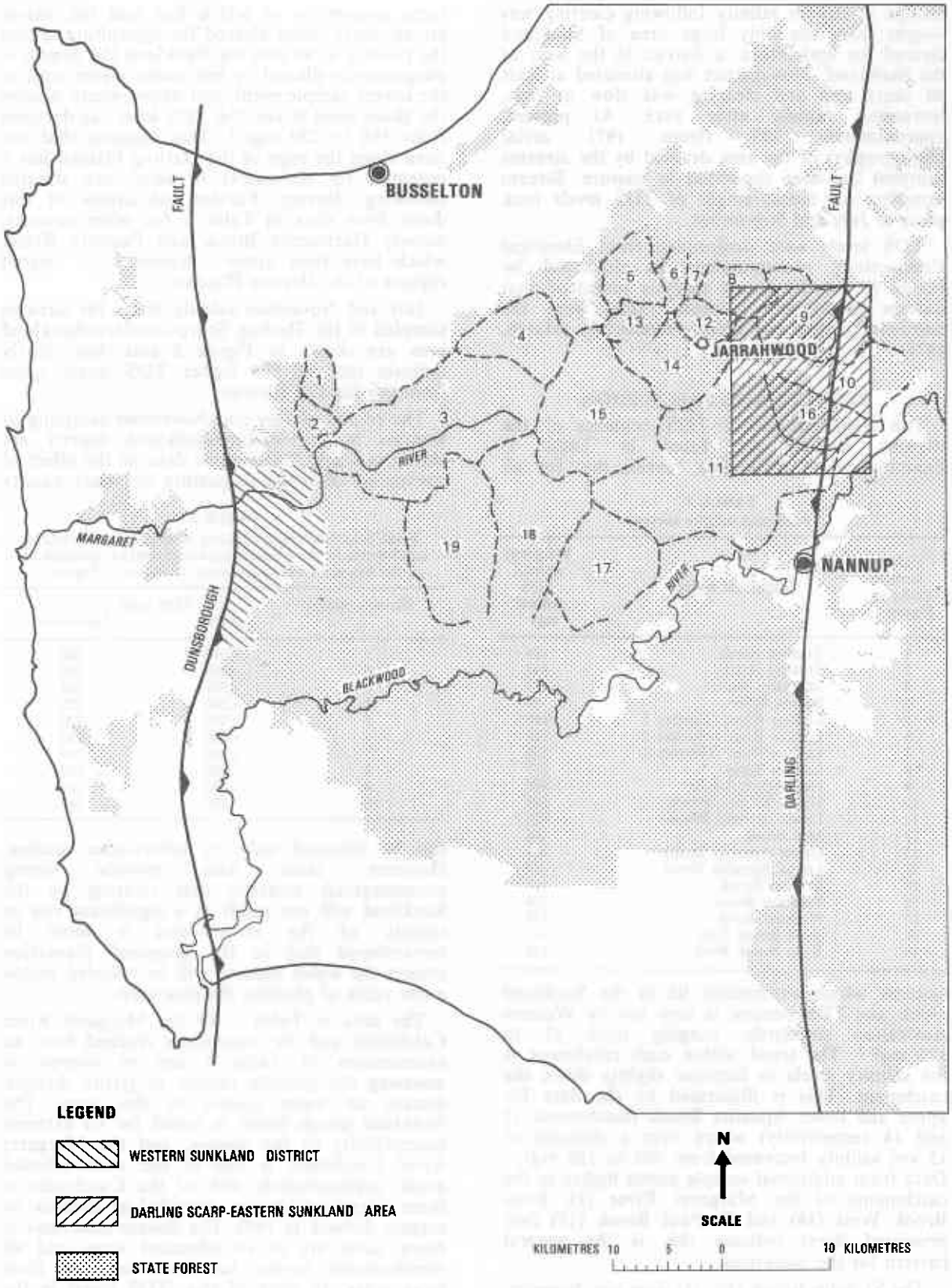

FIGURE 1: Locality plan of the Donnybrook Sunkland showing the catchments sampled (Table 1), the Darling Scarp—eastern-Sunkland area (Figure 2), and the western-Sunkland district (Table 2)

change in stream salinity following clearing was sought from the only large area of Sunkland cleared for agriculture: a district in the west of the Sunkland. This district was alienated at least 40 years ago and clearing was slow at first, increasing rapidly after 1945. At present, approximately 70% (from 1971 aerial photography) of the area drained by the streams sampled has been converted to pasture. Stream sampling for measurement of TDS levels took place in July and November.

TDS levels were determined from Electrical Conductivity measurements as described by Hatch (1976). Chemical analysis indicated that sodium (86%) and chloride (72%) were the dominant cation and anion respectively (Hatch, 1976).

RESULTS AND DISCUSSION

The weighted annual TDS contents of the streams studied are listed in Table 1. Examination of these data reveals that for all

TABLE 1
Sunkland salinity survey

Catchment number (refer to Figure 1)	Catchment name	Weighted annual TDS content, mgl^{-1}
1	Treeton North	119
2	Treeton South	117
3	Margaret River	117
4	Sabina River	87
5	Ludlow River tributary 1	140
6	Ludlow River tributary 2	125
7	Ludlow River tributary 3	110
8	Ludlow River	177
9	Harrington Brook	362
10	Upper St John Brook	358
11	Lower St John Brook	220
12	Mill Brook	144
13	Upper Apostles Brook	103
14	Lower Apostles Brook	120
15	St Paul Brook	110
16	Padbury Brook	454
17	McAtee Brook	179
18	Rosa Brook East	117
19	Rosa Brook West	128

streams whose catchments lie in the Sunkland alone, the TDS content is very low by Western Australian standards, ranging from 87 to 179 mgl^{-1}. The trend within each catchment is for salinity levels to increase slightly down the catchment. This is illustrated by the data for upper and lower Apostles Brook (catchments 13 and 14 respectively) where over a distance of 12 km salinity increased from 103 to 120 mgl^{-1}. Data from additional sample points higher in the catchments of the Margaret River (3), Rosa Brook West (18) and St Paul Brook (15) (not presented here) indicate this is the general pattern for the Sunkland.

The St John Brook (10, 11) does not, however, fit this pattern: TDS levels are higher in its upper than in its lower Catchment. The upper Catchment is located on the Darling Plateau, a large proportion of which has had the native jarrah-marri forest cleared for agriculture. From the point it flows into the Sunkland the stream is progressively diluted by less saline water until at the lowest sample point, just above where it joins the Blackwood River, the TDS level has declined from 358 to 220 mgl^{-1}. This suggests that the zone along the edge of the Darling Plateau has a potential for movement of salts into streams following clearing. Further indications of this come from data in Table 1 for other streams, namely Harrington Brook and Padbury Brook which have their upper catchments on cleared regions of the Darling Plateau.

July and November salinity levels for streams sampled in the Darling Scarp—eastern-Sunkland area are shown in Figure 2 and they clearly indicate that all the higher TDS levels come from the Darling Plateau.

The results of July and November sampling of streams in the western-Sunkland district are shown in Table 2. Definitive data on the effect of conversion of forest to pasture on water quality

TABLE 2
Total Dissolved Solid contents of streams on farmland catchments in the western-Sunkland district; location of the western-Sunkland district is shown in Figure 1

Stream number	TDS (mgl^{-1}) July	November
1	<200	200
2	<200	210
3	<200	205
4	<200	220
5	<200	220
6	<200	210
7	<200	210
8	<200	210
9	<200	210
10	<200	240

can be obtained only by before-after studies. However, these data provide strong circumstantial evidence that clearing on the Sunkland will not result in a significant rise in salinity of the runoff—and it must be remembered that in the proposed plantation project the water balance will be restored within a few years of planting the pine crop.

The data in Table 1 for the Margaret River Catchment and the conclusions reached from an examination of Table 2 are of interest in assessing the possible impact of jarrah dieback disease on water quality in this area. The Sunkland jarrah forest is noted for its extreme susceptibility to the disease, and the Margaret River Catchment is one of the worst-affected areas: approximately 40% of the Catchment is State Forest which was classified as dieback or suspect dieback in 1973. The disease infections in many cases are at an advanced stage and all merchantable timber has been removed from large areas. In spite of this, TDS levels in the River are very low, indicating that destruction of the forest by the pathogen has not led to a significant movement of salts into the water.

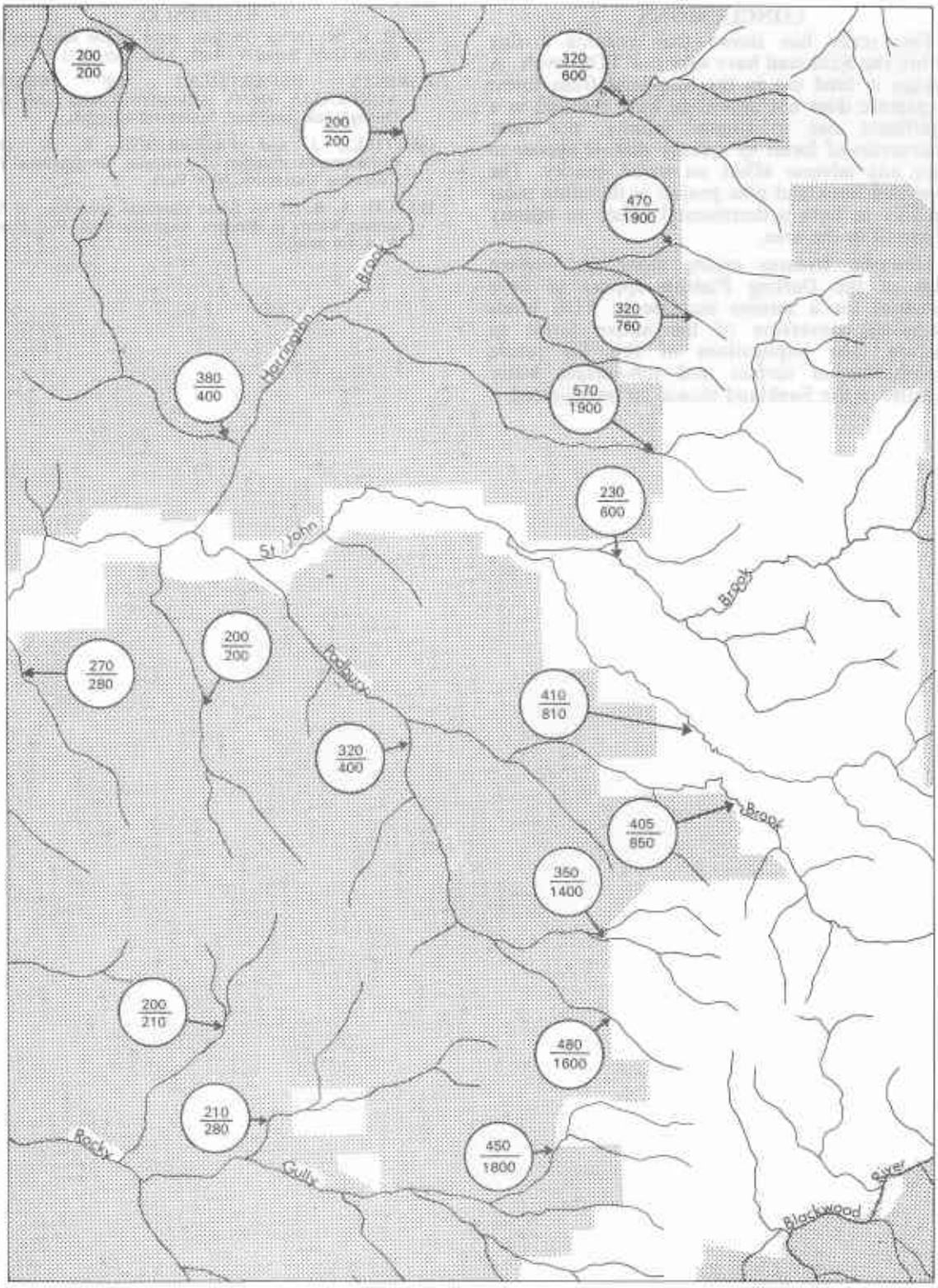

FIGURE 2: Darling Scarp—eastern-Sunkland area showing $\frac{\text{July TDS}}{\text{November TDS}}$ levels in mgl^{-1} for the streams sampled

CONCLUSIONS

This study has shown that streams arising within the Sunkland have very low TDS levels. A change in land use in the Sunkland from forest to pasture does not appear to have resulted in a significant rise in stream salinity, nor does destruction of forest by dieback disease appear to have any adverse effect on water quality. The proposed Sunkland pine project is therefore most unlikely to have a detrimental effect on salinity of runoff in the area.

However, streams arising along the western edge of the Darling Plateau appear to have potential for a serious increase in TDS levels following conversion of the native forest to pasture. The implications of this for future exploitation of surface and sub-surface water supplies in the Sunkland should be investigated.

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