Water Quality of Rivers in the North Esk Catchment

A Report Forming Part of the Requirements for State of Rivers Reporting

PART 4

Authors;
Katrina Berry [1]
Christopher Bobbi [2]
Abigail Foley [1]
Water Assessment and Planning Branch
DPIWE.

[1] Water Assessment and Planning Branch, Water Resources Division.
[2] Environmental and Resource Analysis, Hydro Tasmania.

December 2003

Preferred Citation:
DPIWE (2003) *State of Rivers Report for the North Esk Catchment.* Water Assessment and Planning Branch, Department of Primary Industries, Water and Environment, Hobart.
Technical Report No. WAP 03/06

ISSN: 1449-5996

The Department of Primary Industries, Water and Environment

The Department of Primary Industries, Water and Environment provides leadership in the sustainable management and development of Tasmania's resources. The Mission of the Department is to advance Tasmania's prosperity through the sustainable development of our natural resources and the conservation of our natural and cultural heritage for the future.

The Water Resources Division provides a focus for water management and water development in Tasmania through a diverse range of functions including the design of policy and regulatory frameworks to ensure sustainable use of the surface water and groundwater resources; monitoring, assessment and reporting on the condition of the State's freshwater resources; facilitation of infrastructure development projects to ensure the efficient and sustainable supply of water; and implementation of the *Water Management Act 1999*, related legislation and the State Water Development Plan.

2.5 Nutrient Load Estimates

2.5.1 North Esk at Ballroom

Turbidity was continuously monitored in the North Esk River at Ballroom (NE27) using an 'in situ' sensor. A wiper mechanism was used to help maintain a clean sensor surface, ensuring that data collected remained relatively free of interference from algal growth and sediment deposition. Regular checking against a portable meter was performed, during high and low flows.

The turbidity equipment has been operating at North Esk River at Ballroom since 1996 with some intermittent interruptions when the sensor either collected unreliable data due to excessive algal growth or sediment deposits, or was malfunctioning due to electronic failure. Using this record alongside sample data collected during this study, it is possible to estimate nutrient export loads from North Esk River at Ballroom for several years before the study. To develop estimates of nutrient loads leaving the North Esk River catchment above Ballroom, flood samples were collected using an automated sampling device. This machine was triggered to collect water samples from the river during flood events, recording the date and time of each sample taken. Samples were later collected, had their turbidity levels recorded (for comparison against the 'in situ' monitoring equipment) and were taken to a laboratory for determination of nutrient concentrations.

Figures 2.5.1a to 2.5.1e illustrate the time series record of river flow at Ballroom (NE27) from January 1996 to December 2000. Flow from 1996 onwards is represented here only for comparisons between annual load estimations (see below). Seasonal discharge patterns are clearly distinctive, with flows increasing towards late May and subsequently falling to lower levels in December. During the study period (1999 – 2000) a maximum instantaneous flow of approximately 59 cumecs was recorded on 21 July 2000.

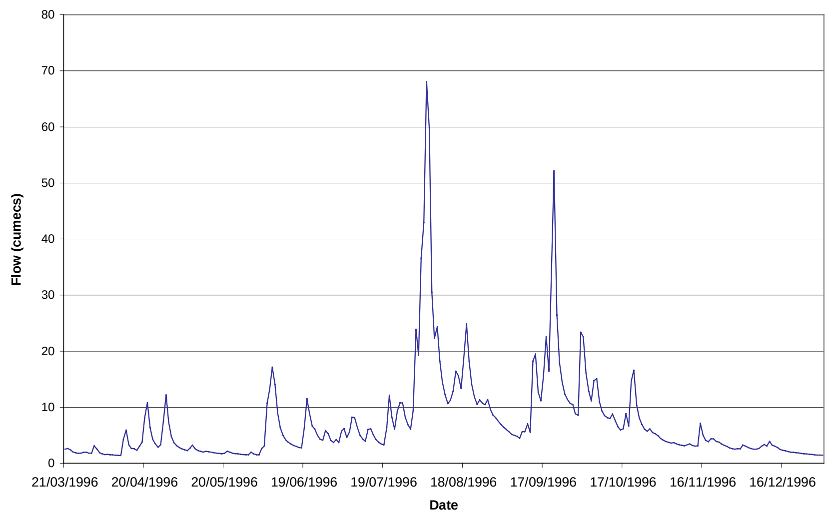

Figure 2.5.1a: Time series of flow (cumecs) for North Esk River at Ballroom (NE27) for 1996.

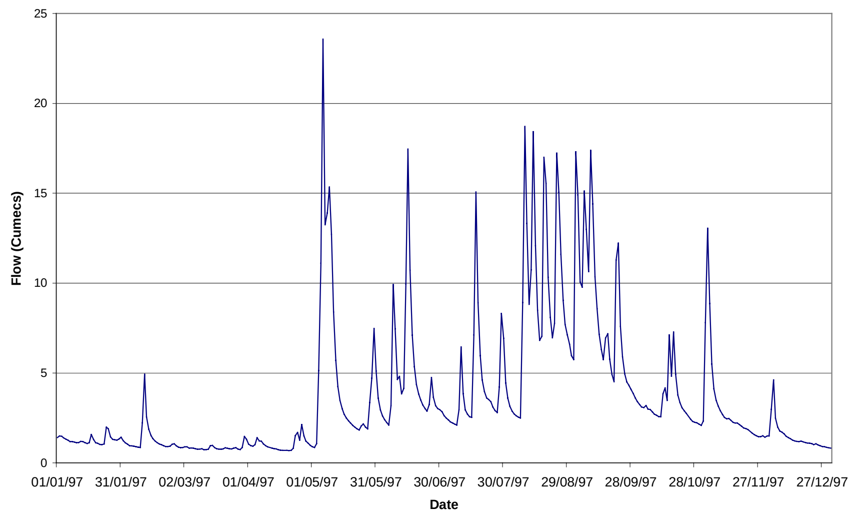

Figure 2.5.1b: Time series of flow (cumecs) for North Esk River at Ballroom (NE27) for 1997.

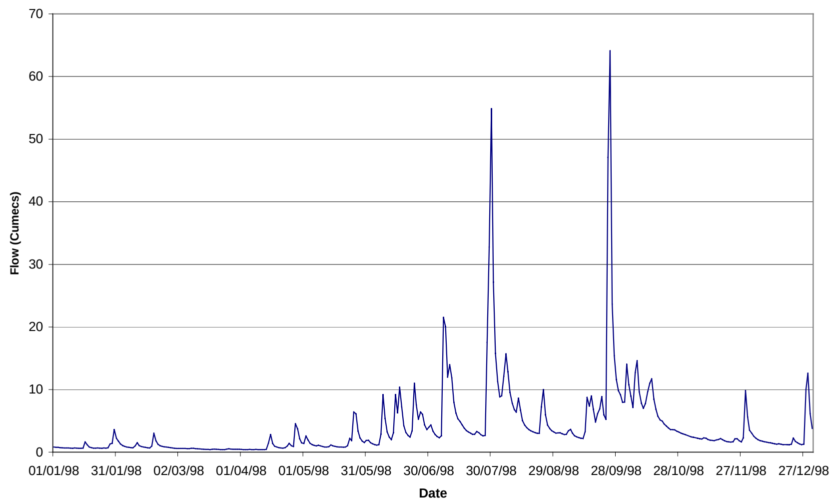

Figure 2.5.1c: Time series of flow (cumecs) for North Esk River at Ballroom (NE27) for 1998.

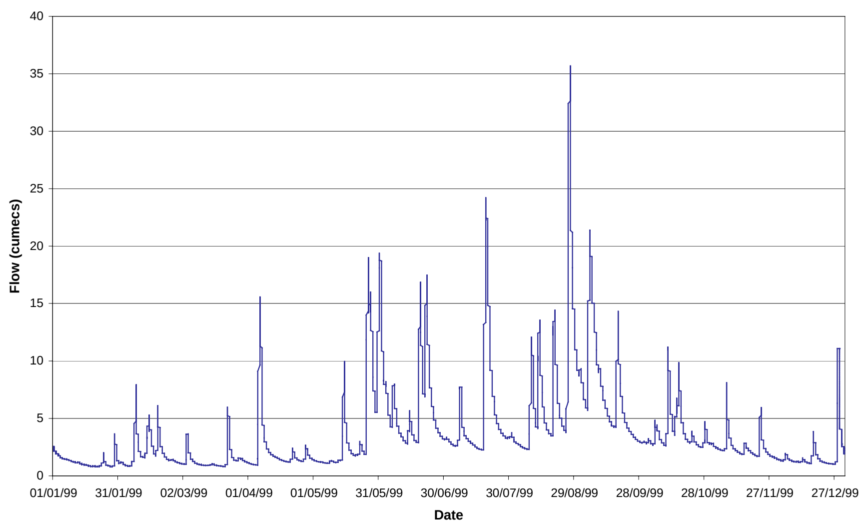

Figure 2.5.1d: Time series of flow (cumecs) for North Esk River at Ballroom (NE27) for 1999.

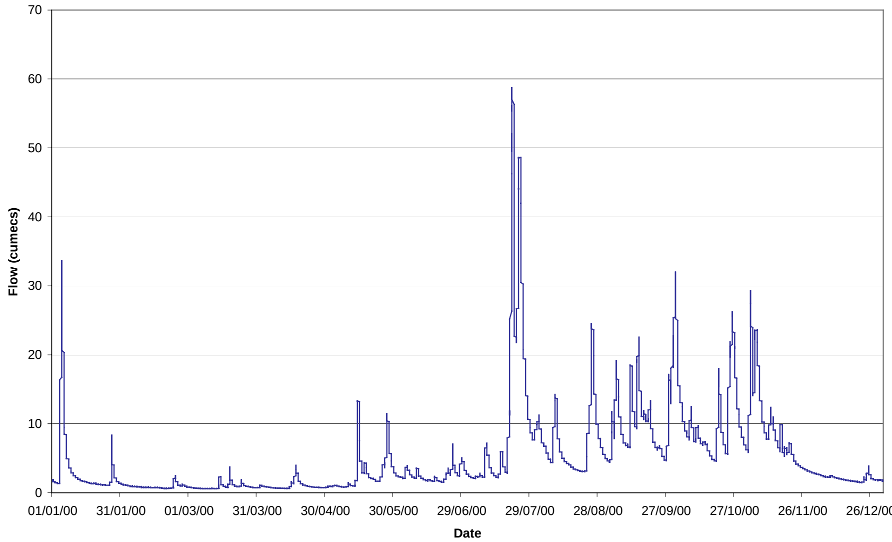

Figure 2.5.1e: Time series flow (cumecs) for North Esk River at Ballroom (NE27) for 2000.

In total, 134 flood samples were collected using the automated sampler, of which 40 samples were taken back to the laboratory for further analysis. A summary of the flood sample data collected during the study is given in Table 2.5.0, and shows that during high flows, median concentrations of all variables can increase by more than 35% above normal baseflow levels. The highest flow event sampled by the automated sampler during this study peaked at 1.9m and 14.42 cumecs (instantaneous flow) on 20th August 1999. The total volume for this flood event was approximately 2,240.85 megalitres, which occurred over the period 19/08/1999 to 21/08/1999. This event contributed 2% of the annual flow for 1999 at North Esk River at Ballroom.

Table 2.5.0: A summary of concentrations of total suspended solids (TSS), turbidity, total nitrogen (TN) and total phosphorus (TP) recorded during flood flows in the North Esk River at Ballroom during the study.

	TSS (mg/L)	**Turbidity (NTU)**	**TN (µg/L)**	**TP (µg/L)**
Number of Samples	32	134	39	40
Median	38	25.7	603	34
Average	43.8	30	671	43
Maximum	119	110	1230	127
Minimum	< 10	2.56	102	2

Flood sample data was used for two purposes. The first of these was to calibrate and check the quality of the turbidity data recorded by the 'in situ' probes. In all, 349 field readings were taken (using a HACH portable turbidimeter) and used to correct the turbidity time series from the 'in situ' turbidity sensor. The results from the laboratory analysis of samples was also used to derive relationships between turbidity and the major parameters of TN, TP and total suspended solids (TSS). It was found that significant relationships existed between all three parameters and turbidity ($p < 0.05$). These relationships are described below;

Total suspended solids

$[TSS] = 1.0764 \times \text{turbidity}$ $R^2 = 0.8107$, n = 32.

Total nitrogen

$[TN] = 0.1617 \times \text{turbidity}^{0.4364}$ $R^2 = 0.811$, n = 39.

Total phosphorus

$[TP] = 0.001 \times \text{turbidity} + 0.0104$ $R^2 = 0.838$, n = 40.

This data was also replotted in a different way so as to allow comparison with data collected by Skirving (1986), who conducted a study into the levels of total suspended solids being transported to the Tamar estuary.

Using these derived relationships for the North Esk River at Ballroom, the time series of turbidity was then able to be transformed to a synthetic record of TN, TP and TSS concentrations, which can then be used to estimate export loads (Table 2.5.1). As an example, using the relationships outlined above to convert turbidity to concentration, the total estimated load from a single event of 25/05/1999 to 29/05/1999 has been calculated at;

Total Suspended Solids	= 13987.6 kg
Total Nitrogen	= 281.8kg
Total Phosphorus	= 17.3 kg

The total discharge volume of this event was 4,353.06 megalitres, which was about 3.7 % of the total discharge from the North Esk River catchment above Ballroom for the year 1999.

There are some inaccuracies and assumptions associated with this load estimation method. The first of these is that while there were various checks of the 'in situ' turbidity sensor against a field instrument, it is fair to state that some of the record is likely to deviate from the true turbidity levels in the river. During low flows the effect of this on load estimates should be fairly inconsequential, however during high flows there are fewer checks on the sensor readings. Checks that were made did show the 'in situ' sensor to be accurate to within 5% to 30% during most high turbidity events. The most reasonable explanation for this difference in accuracy may be related to the sensor location, as the sensor is subject to a slight eddy under high flows and can experience silt build up on the sensor face during large events. This problem was minimised as much as possible by cleaning during the monthly sampling rounds. The location of the intake valve for the flood sampler was attached as close as possible to the sensor head.

Another common source of error in load estimates is the recording of flow in the river, especially during higher river flows. However regular flow gaugings of the river during the period of the study were able to ensure that the flow record was within +/- 5% of the rating. Bearing these assumptions in mind, Table 2.5.1 gives the monthly estimated export load of TSS, TN and TP for the North Esk River at Ballroom during the study period. Also included is the total monthly discharge volume for the river in megalitres (10^6 litres). From these data, seasonal variations are clearly illustrated with total discharge and nutrient loads increasing during the winter months and decreasing during the summer months. These data also illustrate that generally an increase in monthly discharge results in an increase in monthly TSS and nutrient loadings between months.

Table 2.5.2 illustrates the variation in annual loads at Ballroom (NE27) from 1996 to 2000 based on historical turbidity records. These data should be viewed along side the time series data for flow (cumecs) for each year (Figures 2.5.1a-e). Total discharge for the years 1997 to 2000 are below the long-term annual average (173,241 ML), with 1997 and 1999 recording very low discharge (117,386.2 ML and 116,598 ML respectively). While both of these years recorded very low discharge compared to the other years examined, annual loads for TSS, TN and TP tended to be disproportionately high. This tends to reflect the impact that more frequent high flow events during those years had on nutrient transport loads. This is best illustrated by the flow record for August and September 1997, shown in Figure 2.5.1b.

Table 2.5.1: Estimated monthly nutrient load, suspended solids load and discharge for North Esk River at Ballroom between January 1999 and December 2000.

MONTH	Discharge Total Volume (ML)	Mean Monthly TSS (mg/L)	TSS Load (kg)	Mean Monthly TN (mg/L)	TN Load (kg)	Mean Monthly TP (mg/L)	TP Load (kg)
Jan 99	3476.7	5.8	15533.9	0.334	745.8	0.154	42.3
Feb-99	4921	8.7	21207.1	0.386	935.1	0.019	44.9
Mar-99	3573.1	5.7	15413.75	0.326	873.1	0.016	42.2
Apr-99	5699.3	8.9	23136.5	0.363	941.1	0.019	48.5
May-99	9365.4	12.6	33666.2	0.414	1136.7	0.022	59.1
June-99	17184.6	15.2	39409	0.491	1271.9	0.025	63.6
Jul-99	13187.8	9.9	26489.6	0.398	1066.3	0.02	52.5
Aug-99	19476.9	14.9	39832.1	0.461	1234.3	0.024	64.9
Sept-99	18529.2	7	18104.3	0.347	898.9	0.017	43.8
Oct-99	10167.1	6.8	18282.14	0.352	944.01	0.017	44.8
Nov-99	6296	6.7	17377.4	0.351	910.9	0.017	43.1
Dec-99	4721.1	8.2	21990.5	0.366	980.6	0.018	48.3
Jan-00	9017.3	11	29491	0.414	1107.5	0.021	55.2
Feb-00	2331	6.7	16801.6	0.357	894.6	0.017	41.7
Mar-00	2483.3	7	18848.8	0.363	971.7	0.017	45.4
Apr-00	2600.5	6.9	17885.8	0.361	936.4	0.017	43.6
May-00	7216.4	10	26826.6	0.406	1086.3	0.02	52.8
Jun-00	6584.9	8.5	22094.6	0.395	1023.1	0.018	47.5
Jul-00	28804.7	21.9	58529.1	0.564	1512.3	0.031	82.2
Aug-00	19504.4	16.5	44299	0.480	1286.6	0.026	69
Sept-00	25544.5	28.4	73703	0.648	1679	0.037	95.4
Oct-00	30566.7	26.2	70240.3	0.632	1691.6	0.035	93.1
Nov-00	22769.9	23.1	59758	0.604	1565.7	0.032	82.5
Dec-00	5702.6	17.6	47135.8	0.541	1448	0.027	71.6
TOTAL	**279724.4**		**776057.1**		**27291.1**		**1377.8**

Table 2.5.2: Estimated annual nutrient load, suspended solids load and discharge for North Esk River at Ballroom between March 1996 and December 2000.

Year	Total Discharge (ML)	TSS Load (kg)	TN Load (kg)	TP Load (kg)
1996[a]	180,062.8	381,711.5	11,545.26	292.09
1997	117,386.2	319,695.1	12,078.04	624.97
1998	125,466.6	190,199.6	7,754	229.8
1999	116,598	290,442.5	11,938.7	598
2000	163,126	467,057.5	14,957.8	762.8

[a] Total discharge and loads for this year are calculated from the start of turbidity record 21st March to 31st December. Total discharge for 1996 from January to December was 205,758 ML.

2.5.2 North Esk at Corra Linn

Load estimates were also attempted for the North Esk River at Corra Linn. Sampling of nutrient concentrations during flood events was undertaken at this site during the study using automated equipment. The Bureau of Meterology currently operate a level recorder at North Esk River at Corra Linn as part of their flood warning service, however due to surging at the gorge this data was considered unreliable for the purposes of this report. Therefore as there are no permanent turbidity or accurate flow records at this site a different approach to determine flow and nutrient export loads was required.

2.5.2.1 Modelling Flow at Corra Linn

Modelling of flows at Corra Linn was determined using a number of data sets. The only complete set of flow information exists for North Esk River at Ballroom but there are two major offtakes in the system for which historical data is available. These are, downstream of Nunamara on the St Patricks River which has been operating since 1890. The Chimney Saddle offtake, which has been operating since the early 1960's, is located below the North Esk River at Ballroom and above the confluence of the North Esk River with the St Patricks River. Natural flows for the St Patricks River were determined by adding monthly flow values from historical records (1991-1995) at Nunamara. These sites are located on the St Patricks River below the offtake and at the offtake. This data set was used to correlate flows with the North Esk River at Ballroom. A correlation of 0.964 was determined and a regression equation applied to estimate a current natural flow record on the St Patricks River at Nunamara. These data sets were further scaled using catchment area ratios to estimate flows further downstream near the confluence of the St Patricks River upstream of the confluence with the North Esk River (NE 29).

The next step in determining the final estimated flow record for the North Esk River at Corra Linn involved scaling the North Esk River at Ballroom data to the offtake at Chimney Saddle (ie. removing the offtake data). The two data sets for both rivers was then once more scaled to estimate the current natural flows just above the confluence of the North Esk River with the St Paticks River. The estimates from both the North Esk River and St Patricks River above their confluences were then added to each other to give two data sets of natural and current flow conditions. These were then scaled to the North Esk River at Corra Linn.

2.5.2.1 Nutrient Loading

In total, 218 flood samples were collected using the automated sampler, 57 of which were taken back to the laboratory for further analysis. A summary of the flood sample data collected during the study is given in Table 2.5.3, and shows that during high flows, concentrations of all variables can increase by more than 40% above normal baseflow levels.

Table 2.5.3: A summary of concentrations of total suspended solids (TSS), turbidity, total nitrogen (TN) and total phosphorus (TP) recorded during flood flows in the North Esk River at Corra Linn during the study (1999-2000).

	TSS (mg/L)	Turbidity (NTU)	TN (μg/L)	TP (μg/L)
Number of Samples	57	218	52	52
Median	35	22	872	43
Average	45.3	28	929	46
Maximum	148	105	1520	102
Minimum	<10	3.13	382	2

As for North Esk River at Ballroom these data can be used to derive relationships between turbidity and the major parameters of TP, TN and TSS during high flow events. However unlike Ballroom (NE27) where turbidity is monitored continuously (approximately every 20 minutes), turbidity data at Corra Linn was monitored either monthly (under base flow conditions), or by automated sampling equipment installed for the duration of the project to sample high flow events. As no continuous turbidity data is recorded at this site, data from the rising limb of monitored high flow events was used to derive relationships between turbidity, TN, TP and TSS as this is when the majority of sediments and nutrients are transported in rivers. It was found that significant relationships existed between all three parameters and turbidity. ($p < 0.05$). These are;

Total suspended solids

$[TSS] = 1.2332 \times \text{turbidity}^{0.9644}$ $R^2 = 0.8278$, n = 23.

Total nitrogen

$[TN] = 0.0103 \times \text{turbidity} + 0.4584$ $R^2 = 0.7918$, n = 23.

Total phosphorus

$[TP] = 0.0038 \times \text{turbidity}^{0.6778}$ $R^2 = 0.7745$, n = 23

In order to use the above relationships for load estimates, a synthetic record for turbidity at Corra Linn was created. Turbidity readings from event sampling at Corra Linn (NE32) were corrected for time lag and plotted against the continuous record from the Ballroom (NE27) turbidity probe. Baseline turbidity samples were not used as the correlation of this data set with Ballroom had R^2 values less than 0.5. Correlations for 7 monitored events between turbidity at both these sites were recorded and ranged from poor ($R^2<0.5$) to good ($R^2>0.8$). The percentage of sediment decline using turbidity records from both data sets were assessed for all events. This revealed that for those events which held good correlations ($R^2 >0.7$) there was a distinct decrease in turbidity concentrations between Ballroom (NE27) and Corra Linn (NE32). This is likely to be linked to lower flows exiting St Patricks River that would not have the capacity to retain particles suspended within the water column. Those events which recorded correlations of $R^2 < 0.6$ showed an increase in turbidity concentrations between Ballroom (NE27) and Corra Linn (NE32). These events are likely to reflect an increase in flow and loading from St Patricks River. This illustrates the uneven pattern of rainfall that occurs between the North Esk River catchment above Ballroom (NE27) and the St Patricks River catchment. Therefore high flow events at Ballroom do not always simultaneously occur with high flow events exiting the St Patricks River.

Due to the lack of continuous turbidity record from the St Patricks River on a time scale sufficient to capture flood flows, load estimates for Corra Linn are based on a synthetic turbidity record. This was determined using four monitored floods events ($R^2 >0.7$) at Ballroom (NE27). An important caveat is that any interpretation of these data needs to consider that loads represent possible contributions from the North Esk River above Ballroom (NE27) only. The correlation derived for Corra Linn is as follows;

$\text{Corra Linn Turbidity} = -1.0673 * \text{Ballroom Turbidity}^{0.9583}$ $R^2 = 0.675$

Table 2.5.4 provides a rough estimation of monthly loads exiting Corra Linn (NE32) when discharge from the St Patricks River is not sufficient to retain particulate matter suspended in the water column. These data illustrate that all parameters generally increase in May and decrease in December. In comparison with Ballroom both TSS and TP loads from Corra Linn are lower while TN loads are greater. The decline in TSS and TP concentrations between Ballroom and Corra Linn illustrates that the majority of TP exiting the North Esk River catchment is likely to be attached to particulate matter.

Table 2.5.4: Estimated monthly nutrient load, total suspended solids load and discharge for North Esk River at Corra Linn between January 1999 and December 2000.

MONTH	Discharge Total Volume (ML)	Mean Monthly TSS (mg/L)	TSS Load (kg)	Mean Monthly TN (mg/L)	TN Load (kg)	Mean Monthly TP (mg/L)	TP Load (kg)
Jan 99	9988.48	7.1	16622.62	0.522	1374.899	0.013	31.49783
Feb-99	14758.9	11.4	21720.01	0.563	1307.338	0.018	35.90061
Mar-99	10740.24	8.1	16381.1	0.532	1374.273	0.014	30.66961
Apr-99	17180.32	11.5	23078.25	0.565	1399.555	0.017	36.21053
May-99	32288.98	15.5	32949.69	0.602	1532.279	0.021	47.32541
June-99	47844.07	18.4	38788.49	0.63	1545.346	0.025	55.10019
Jul-99	39686.28	12.6	26692.03	0.575	1470.729	0.019	42.0395
Aug-99	59855.78	18	38658.18	0.626	1586.441	0.023	53.36614
Sept-99	54062.12	9.5	18845.6	0.544	1357.632	0.015	32.97469
Oct-99	30471.2	9.3	19214.4	0.543	1399.839	0.016	34.41416
Nov-99	18560.19	9.2	18314.38	0.541	1351.973	0.015	33.06815
Dec-99	14352.27	10.8	22444.2	0.557	1430.789	0.017	37.14007
Jan-00	26831.75	13.8	29384.08	0.586	1496.622	0.02	44.67182
Feb-00	6888.88	9.2	17795.34	0.542	1307.391	0.016	32.46015
Mar-00	7417.47	9.6	19856.26	0.545	1405.418	0.016	35.62315
Apr-00	7812.31	9.4	18897.47	0.544	1357.017	0.016	34.1858
May-00	22144.21	12.8	27119.3	0.576	1474.84	0.019	42.93478
Jun-00	20054.44	11.2	22947.17	0.560	1394.784	0.018	39.0766
Jul-00	87587.43	18	39181.69	0.627	1595.174	0.024	54.94417
Aug-00	56707.15	19.7	42565.75	0.643	1624.452	0.025	56.87817
Sept-00	78663.24	32.5	69222.05	0.767	1840.153	0.037	83.01372
Oct-00	86525.66	30.2	66565.14	0.744	1852.239	0.035	82.1506
Nov-00	67175.43	26.9	57392.41	0.711	1723.403	0.033	73.94049
Dec-00	16811.62	21.1	46307.12	0.654	1655.271	0.028	64.54416
Total	**834,408.4**		**750942.7**		**35857.86**		**1114.13**

To compare these levels of nutrient and sediment loss with other catchments, the export figures from Ballroom (NE27) and Corra Linn (NE32) need to be corrected for catchment area and discharge (ie catchment runoff). The derivation of these ‘export coefficients’ allow catchments of different sizes and rainfall patterns to be compared (see ‘Glossary of Terms’ at the front of this document). The export coefficients for the North Esk River catchment derived from the data from this study are given in Table 2.5.5. These calculations show that while total discharge for North Esk River at Corra Linn is more than double that for North Esk River at Ballroom, export loads for TSS, TP and TN are significantly less. The most likely explanation for this is the lower yield of nutrients per hectare from the St Patricks River acting to dilute the influence of nutrients and sediment from the North Esk River catchment above Ballroom.

Table 2.5.5: Export coefficients for the North Esk River derived from data collected during the period January '99 to December 2000.

Catchment	Discharge (ML)	Suspended Solids ($kg/mm/km^{-2}$)	Total P ($kg/mm/km^{-2}$)	Total N ($kg/mm/km^{-2}$)
North Esk at Ballroom 1996[a]	180,062.8	2.12	0.002	0.064
North Esk at Ballroom 1997	117,386.2	2.723	0.005	0.103
North Esk at Ballroom 1998	125,466.6	1.516	0.002	0.062
North Esk at Ballroom 1999	116,598.1	2.491	0.005	0.102
North Esk at Ballroom 2000	163,126.3	2.863	0.005	0.092
North Esk at Corra Linn 1999[b]	349,788.83	0.840	0.001	0.049
North Esk at Corra Linn 2000	484,619.59	0.943	0.001	0.039

[a] North Esk at Ballroom catchment area = 362.6 km^{-2}. Total discharge and export coefficients for 1996 are based on turbidity records starting 21st March to 31st December.
[b] North Esk at Corra Linn catchment area = 870 km^{-2}.

These coefficients can be compared to others that have been calculated for rivers elsewhere in Tasmania (Bobbi, Fuller and Oldmeadow, 1996; Bobbi, 1998). Some of the figures in Table 2.5.6 are averages calculated over several years, while others were calculated from a single year's worth of data. This is important to keep in mind when looking at export coefficients, as the amount of rainfall in a catchment will influence the levels of nutrients exported, and hence the export coefficient for that catchment. If export coefficients are calculated from data collected during a period with 'below average' rainfall, they can underestimate the level of export, and vice versa for wetter years. It is worth noting that for the North Esk River at Ballroom the total discharge for 1999 (116,598.1 ML) and 2000 (163,126.3 ML) are below the annual average of 173,241ML for the entire length of record for flow at Ballroom. Therefore the export loads and coefficient determined here are representative of drier than average conditions and are likely to underestimate long-term export loads.

Export coefficients between catchments will also vary depending upon land use activities. It is reasonable to assume that load estimates and export coefficients from catchments which are intensively farmed (ie. Montagu catchment and Duck catchment) will be far greater than those experienced in the North Esk River catchment where agriculture is relatively dispersed. Load estimates within a catchment will also vary over time depending on the land use and catchment characteristics during data collection. This is important when comparing loads derived by Skirving in 1986. Skirving calculated an annual sediment transport rate for Ballroom (NE27) of 1,427 tonnes, with a minium of 211 tonnes and a maximum of 3,985 tonnes based on 29 years of continuous flow data. Annual load estimated for TSS from this study, based on 5 years of continuous turbidity data (1996-2000), is 330 tonnes. This figure is representative of relatively dry years and is comparable to the minimum values determined by Skirving (Figure 1.2.1). However it is important to note that TSS data gathered during Skirving's study used to derive load estimates included the possible effects from a "significant logging episode" (Skirving, 1986) approximately 3 km upstream of the Ford River. This may result in an over estimation of annual loads.

The suspended sediment loads derived for Corra Linn between the two studies differed significantly. Estimates from Skirving (1986) varied between a minimum of 1,534 tonnes and maximum of 16,449 tonnes with an annual average of 7,225 tonnes (1950-1978). This is in stark contrast to the approximate annual average of 375 tonnes derived during the current study (1999-2000). The variation in loads passing through Corra Linn reflects the type of data used to determine these estimates. Discharge at Corra Linn in Skirving's report was based on actual measurements from the in situ gauge board and determined using a stage-discharge rating curve. TSS data collected during the study was then combined with simultaneous measurements of river discharge to produce a sediment rating curve for Corra Linn. In contrast, due to "surging" at the gorge, it was decided during the course of this study that level data from Corra Linn was unreliable and hence a synthetic record was determined for Corra Linn based on flows from the St Patricks River and North Esk at

Ballroom. This fundamental difference in determining discharge for Corra Linn would account for a portion of variance in estimated loads between the two studies. Possible changes in catchment characteristics and activities during TSS sampling between these two studies will also effect load estimates.

When compared to data from other catchments in Tasmania, export coefficients for phosphorus in the North Esk River are well below those of other agricultural catchments with nitrogen in the lower to middle range (Figure 2.5.6). These coefficients reflect the relative dispersed nature of agriculture in the catchment. However it is important to consider that these figures were derived during a period of lower than average discharge.

Table 2.5.6: Export coefficients for catchments in Tasmania. In some cases data are averages calculated over several years. For others coefficients are estimated from only a single year of data.

Catchment	Years of Data	Catchment Area (km^2)	Mean Annual Discharge (ML)	Total P ($kg/mm/km^{-2}$)	Total N ($kg/mm/km^{-2}$)
North Esk River at Ballroom	5	362.6	125,446.6	0.01	0.09
North Esk River at Corra Linn	2	870	417,204.2	0.001	0.044
Pipers River	1	298	96,700	0.083	1.17
Brid River	1	136	40,986	0.066	1.13
Meander River at Strathbridge	3	1,012	427,904	0.058	0.67
Liffey River	3	224	80,661	0.052	0.78
South Esk at Perth	3	3,280	624,508	0.034	0.66
Break O'Day River	3	240	53,177	0.065	0.94
Huon River above Judbury	1	2,097	2,562,475	0.010	0.33
Kermandie River**	1	130	36,760*	0.122	1.42

* Estimated flow data

** Export figures include nutrients discharged to the river from the Geeveston sewage treatment plant.

2.5.3 'Snapshot' Flood Sampling

Flood samples were taken at a select number of sites around the North Esk catchment to provide a snapshot illustrating changes in turbidity and nutrient concentrations during high flow events. Of particular interest was the region upstream of the permanent probes located at North Esk River at Ballroom (NE27). Continuous data from the turbidity probe located at this station shows a distinctive spike (Figure 2.5.1) in the trace before the main peak of turbidity during any particular event. This appears to be caused by instream disturbances at Old Mill Creek (NE24), Musselboro Creek (NE25) and surrounding drainage lines. During a number of snapshot flood surveys in the catchment above NE27, high levels of turbidity were recorded at Old Mill Creek (NE24) and Musselboro Creek (NE25), paddock drainage lines adjacent to Musselboro Creek (NE25a) and North Esk River at Musselboro Bridge (NE25). Figure 2.5.2 illustrates turbidity levels recorded on 26th August 1999 at these sites. From these data (Figure 2.5.2) it can be seen that high turbidity was recorded in the vicinity of Musselboro Creek and Old Mill Creek while two sites upstream of these, River O'Plain Creek (NE23) and North Esk River at Burns Creek Road (NE22) recorded lower levels of turbidity in comparison. It is reasonable to consider that the spike in turbidity recorded at North Esk River at Ballroom on the 26th August 1999 (shown in Figure 2.5.1 inside the circle) is a result of localised inputs from both Musselboro Creek (NE25 and NE25a) and Old Mill Creek (NE24).

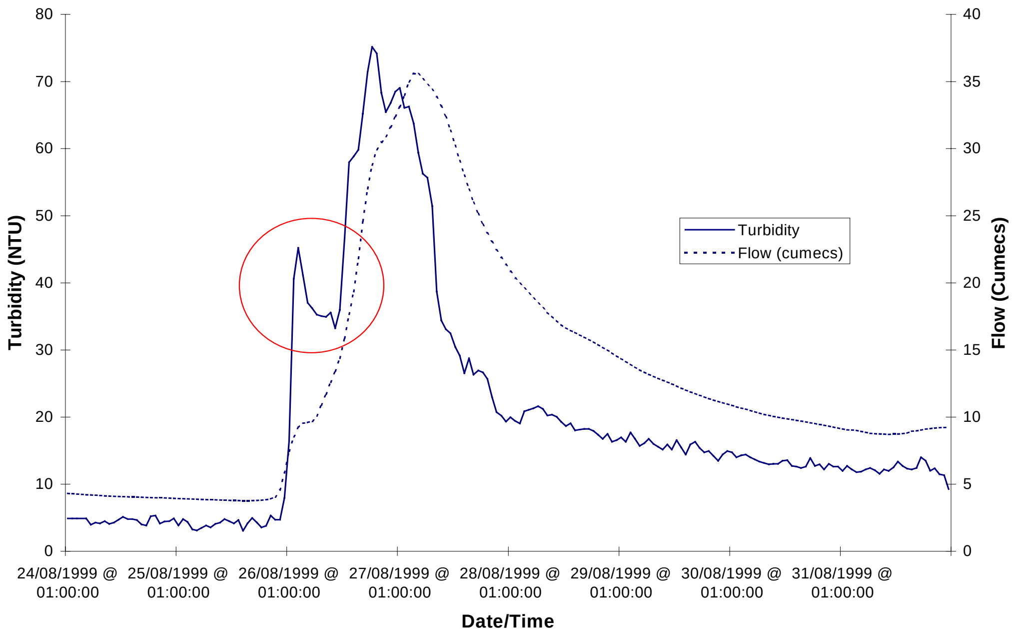

Figure 2.5.1: Record of continuous turbidity at North Esk River at Ballroom (NE 27) 24th August 1999 to 31st August 1999 (HYDROL).

Table 2.5.7 shows concentrations of nutrients sampled during a high flow event on 24th July 2000. These data illustrate the potential input of nutrients into the North Esk River during a flood event. All sites that were sampled at this time showed high concentrations of nitrates, indicative of the flushing of this nutrient from the soil profile into surface waters. Both Old Mill Creek at Blessington Road and Rose Rivulet above Patersons Island recorded the highest concentrations for all nutrient parameters measured. The high concentrations of ammonia, nitrite-nitrogen and phosphates record at these two sites is also likely to reflect the impact of agricultural activities in these catchments.

Table 2.5.7: Nutrient snapshot flood data for the North Esk River on 24th July 2000.

Site	Site No	Time Date	Turbidity (NTU)	TSS (mg/L)	Ammonia (ug/L)	Nitrate (ug/L)	Nitrite (ug/L)	DRP (ug/L)	TN (ug/L)	TP (ug/L)
North Esk River u/s Clarks Ford	NE4	24/07/2000 11:10	35	22	20	928	3	8	1340	37
River O'Plain Ck at Blessington Rd	NE23	24/07/2000 13:50	15.4	<10	10	1950	<2	3	2160	19
Old Mill Ck at Blessington Rd	NE24	24/07/2000 13:40	145	60	96	7710	15	41	8680	177
North Esk River at Musselboro Rd	NE26	24/07/2000 13:15	47.6	38	18	491	<2	16	1210	71
Ross Rvt above Patersons Island	NE31	24/07/2000 11:30	293	163	43	3590	14	44	5470	176

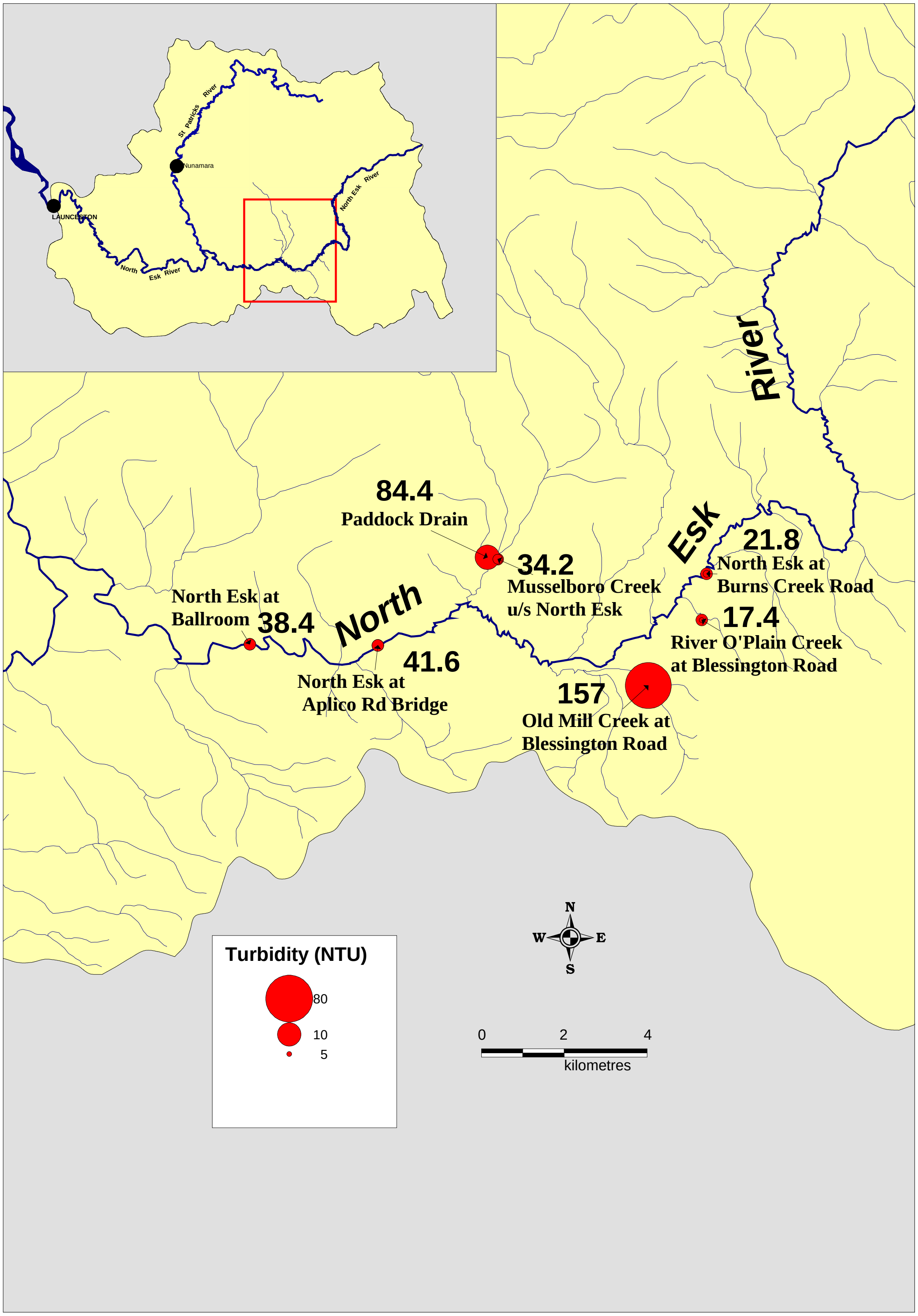

Figure 2.5.2: Flood snapshot of turbidity recorded at selected sites in the North Esk River catchment on 26th August 1999.