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WATER *and* ENVIRONMENT
Tasmania

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Water Quality of Rivers in the Inglis – Flowerdale Catchment

PART 2

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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.

3.3 Nutrient Results

Monthly sampling for nutrients was carried out at 11 key sites in the catchment (listed in Table 3.1 and in Section 3.2 above). While the main focus for testing was total concentrations of nitrogen and phosphorus, laboratory testing included analysis for nitrate, nitrite, ammonia and dissolved reactive phosphorus. The discussion in this report will generally be limited to nitrate-N (NO_3-N), which generally forms the largest portion of dissolved nitrogen, total N (TN) and total phosphorus (TP). Where significant or unusual concentrations of other parameters have been recorded, specific mention may be made where these add to the discussion regarding water quality conditions at particular sites.

Nutrient concentrations in rivers draining predominantly agricultural areas may be impacted to various degrees by activities such as pasture drainage, fertiliser application, stock access to rivers, riparian vegetation clearing and river bank erosion. The level of agricultural production often has some influence on the level of nutrient enrichment that occurs, and in areas where agricultural activities are less intense the concentrations of nutrients in waterways tends to be markedly lower.

The Inglis-Flowerdale catchment is characterised by a reasonably patchy distribution of land activities, with the main areas of agricultural production centred in the floodplains around Moorleah and Flowerdale, and on the hilltop areas such as Yolla, Calder and Takone. Because of the steeper hill slopes leading down to the middle reaches of the Inglis and Flowerdale Rivers, agricultural activities are less, and these areas tend to be more dominated by forest of some type. In some cases these areas are subject to forest harvesting (eg in the area around Calder and on the lower sections of Blackfish Creek), but nevertheless this provides some buffering against nutrient runoff that might originate from the more elevated agricultural areas. This patchwork of land-use activities makes interpretation of nutrient results from these two rivers difficult.

Because the gradient of both Camp Creek and Seabrook Creek tend to be less, and because these creeks drain areas with richer soils (Moreton, 1999) with greater agricultural activity, these creeks have less riparian and near-stream vegetation. The absence of this buffer is likely to result in higher nutrient levels in these streams.

3.3.1 Total Nitrogen

Nitrogen is present in freshwaters primarily as organic and inorganic compounds, nitrate nitrogen (NO_3-N) normally being the main inorganic form. In most cases, organic nitrogen is the dominant form and tends to be present in the water column as fine particulate material. Nitrate nitrogen is dissolved, and often varies on a seasonal basis (Bobbi. *et al*., 1996), with higher concentrations generally occurring in winter when plant uptake is minimal (Neill, 1989; Wright, *et al*., 1991) and NO_3-N is leached from the soil profile by sub-surface water movement (Kladivko, *et al*., 1991). Nitrate nitrogen is usually found at higher concentrations in waterways that drain landscapes where the overlying vegetation has been removed (Stevens & Hornung, 1988), and where fertilisers are used to boost agricultural production. The presence of dense riparian forest has been shown to assist in the removal of nitrate nitrogen from shallow sub-surface water (Hill, 1996) and reduce nitrate concentrations in rivers.

The data for monthly sampling of total nitrogen (TN) in the Inglis-Flowerdale catchment is presented in Figure 3.16, and shows that nitrogen concentrations in the smaller streams is higher that in the main rivers. Median concentration at 7 of the 11 sites monitored exceeds the National trigger level for TN in Tasmanian lowland rivers (0.5 mg/L). Highest of these were sites in the lower reaches of Seabrook and Camp creeks, where the median concentration exceeded 0.7 mg/L and TN concentrations in excess of 1 mg/L were commonly measured. High concentrations of TN were also recorded at IF1 (Big Creek) IF5 (Blackfish Creek) and at IF4 at the bottom of the Inglis River. Many of these elevated concentrations were recorded during higher flows in winter, when turbidity was also elevated, suggesting that most of this

TN was present as particulate organic material. However when the data for dissolved nitrate is examined (see Figure 3.18), it is clear that high concentrations of this form also occur in winter.

It is somewhat of a surprise to find that TN concentrations in the Hebe River (IF23) are as high as sites in the lower catchment such as IF16 (Flowerdale at Preolenna Rd), where land-use activities might be expected to have some impact on nutrient levels. When the data from IF23 is examined more closely, it is revealed that almost all of the TN that is found in the river at this site is present as organic nitrogen, with only 14% being found in the dissolved form as NO_3-N. This indicates that TN concentrations in this river reflect the naturally high levels of humic and other organic compounds that give water in this river its typical brown 'tea coloured' appearance (see plot for apparent colour – Figure 3.11).

TN concentrations were lowest throughout the middle and upper reaches of the Inglis River (IF6, IF8 and IF14), although median TN concentration gradually increases downstream with the input of nutrients from tributaries. The median concentration at the catchment outlet (IF4) only marginally exceeds the ANZECC (2000) 0.5 mg/L trigger level.

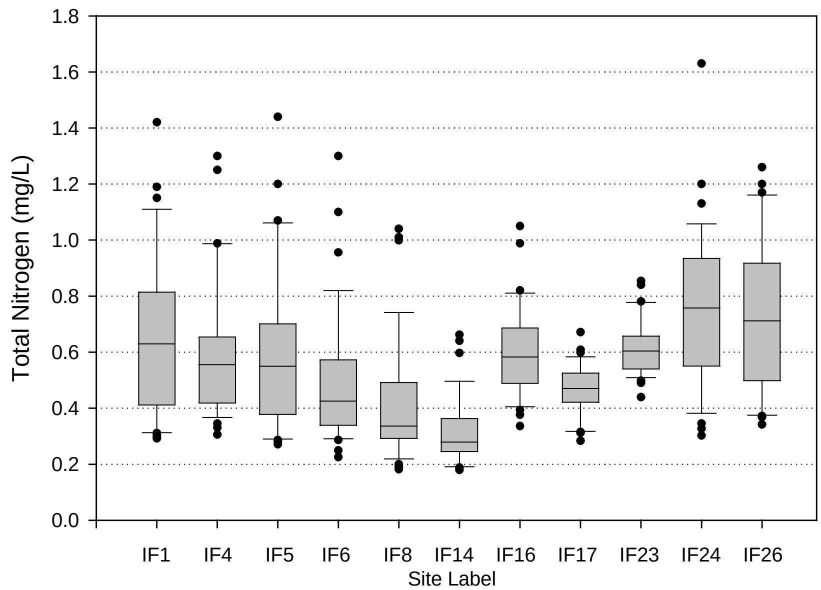

Figure 3.16: Statistical plot of total nitrogen (TN) concentration at sites in the Inglis-Flowerdale catchment, recorded during monthly monitoring between February 1999 and December 2001. #Solid horizontal line denotes the 0.5 mg/L trigger values for Tasmanian lowland rivers.

3.3.2 Nitrate-N

As has been mentioned above, nitrate is normally the dominant form of dissolved nitrogen in freshwaters, and its presence is influenced by natural processes as well as a number of human related land-use activities. Nitrate leaching to rivers is known to vary seasonally (Wright, *et. al.*, 1991) and is generally influenced by the water balance in the catchment, the quantity of nitrogen already present in the soil and the nature and extent of vegetation cover in the catchment.

The data for monthly sampling of nitrate nitrogen (NO_3-N) in the Inglis-Flowerdale catchment is presented below in Figure 3. 17. The plot shows that NO_3-N concentration is highest and most variable at sites on the smaller streams (IF1, IF5, IF24 and IF26) in the catchment. The median NO_3-N concentration at all of these sites exceeds the nationally recognised trigger level for smaller rivers in Tasmania (0.19 mg/L), and when compared to other sites in the catchment that are surrounded by extensive forest (especially IF14, IF17 and IF23) clearly demonstrates the impact of land use and vegetation removal on NO_3-N concentrations.

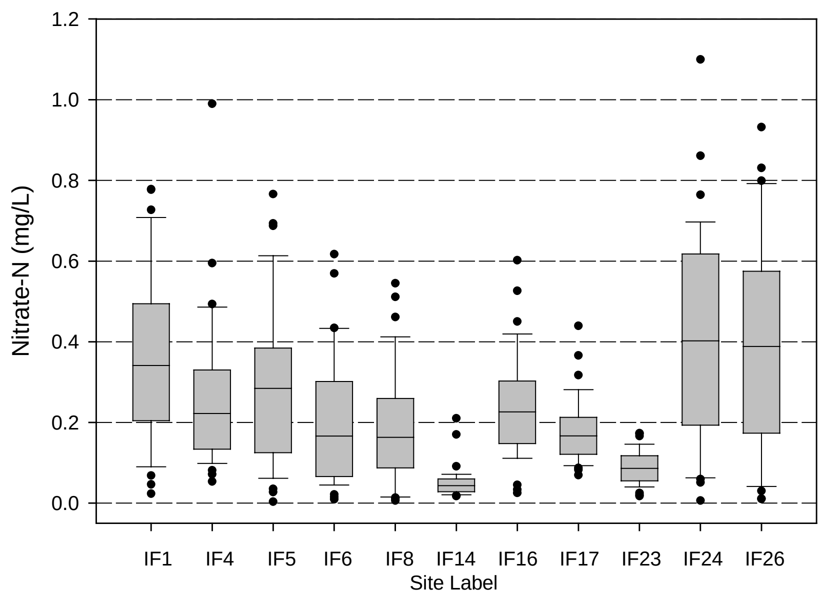

Figure 3.17: Statistical plot of nitrate nitrogen (NO_3-N) concentration at sites in the Inglis-Flowerdale catchment, recorded during monthly monitoring between February 1999 and December 2001.

Sites lacking an adequate riparian buffer zone (IF4 & IF24) showed a clear seasonal change in NO_3-N concentration (Figure 3.18). This contrasts markedly with areas where there was no agricultural or forest harvesting activities such as the top of the Inglis River and the Hebe River. Nitrate concentration at these sites was consistently very low (<0.10 mg/L) and demonstrates the influence that a solid riparian zone has on minimising NO_3-N concentrations in waterways. While it is recognised that land must be cleared and used for agricultural and forestry production, these data emphasise the benefit of maintaining an adequate and functional riparian zone to reduce NO_3-N concentrations in waterways. It has been shown elsewhere that maintaining high organic content in surface and subsurface soils through maintaining vegetated buffer zones greatly increases the capacity of these areas to consume NO_3-N via denitrification (see review of Groffman, 1997). It would appear that this process is active in reducing NO_3-N concentrations in the upper and middle reaches of both the Inglis and Flowerdale Rivers, where there is generally a healthy and substantial forest on each side of these rivers.

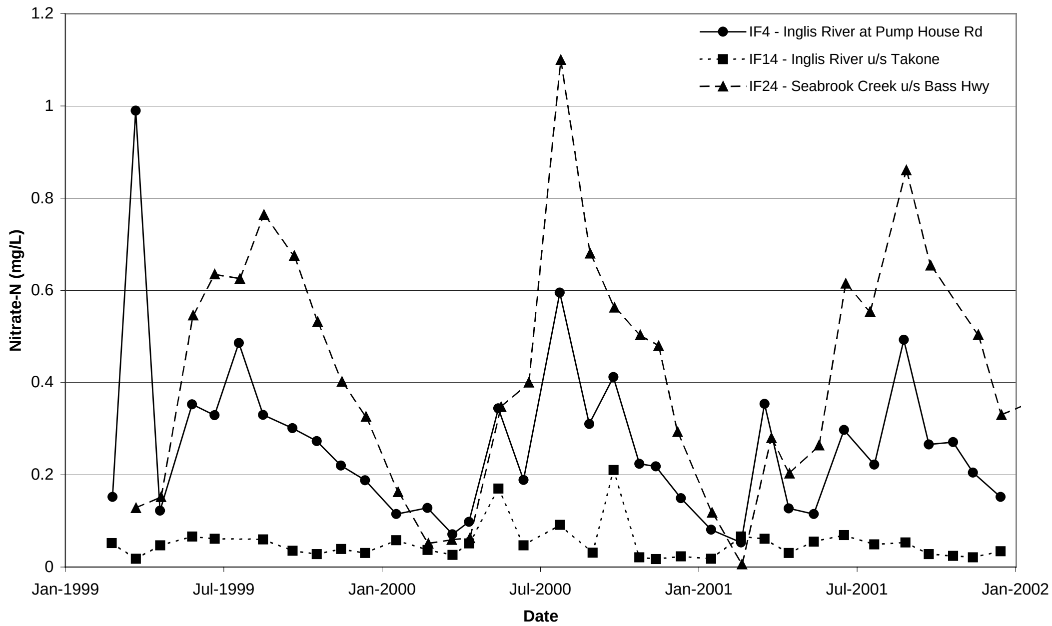

Figure 3.18: Time series plot of nitrate-N concentration at three sites in the Inglis-Flowerdale catchment between February 1999 and December 2001.

3.3.3 Total Phosphorus

Phosphorus in freshwaters is normally derived from natural processes such as the input of vegetation (eg. leaf litter and larger woody debris) and the chemical weathering of rock. However in catchments where there are significant human-related activities this can be greatly increased by inputs from both diffuse sources (fertiliser use, erosion and stock grazing) and point sources (sewage effluent discharge and urban runoff). Throughout most of the Inglis-Flowerdale catchment, phosphorus levels are likely to reflect impacts from diffuse sources, as there are no significant establishments discharging nutrient-rich effluent into waterways.

Phosphorus exists in water in both the dissolved and particulate forms, the former generally being termed 'bioavailable', as it is the form most easily accessed for plant production. The main forms of dissolved phosphorus include inorganic orthophosphates, polyphosphates and organic colloids, while particulate phosphorus is usually bound to complex organic compounds such as proteins or more commonly adsorbed to suspended material such as clays and organic detritus (dead and decaying plant and animal matter). A significant increase in the concentrations of this important plant nutrient in freshwaters generally has the effect of causing prolific growth of aquatic plants (algae and macrophytes), which in turn have indirect impacts on aquatic ecosystems (UNESCO, 1992). In modified or impacted freshwater systems, the presence of high concentrations of dissolved reactive phosphorus usually indicates organic (faecal) pollution or excessive or inappropriate fertiliser application.

Figure 2.19 shows the concentration of TP at monthly monitoring sites in the Inglis-Flowerdale catchment during 1999-2001. The median concentration of TP at sites throughout the catchment were between 0.01 - 0.026 mg/L, which is relatively low compared to other catchments on the north-west coast that were studied over the same period (Duck and Montagu catchments). The highest median TP concentration (0.026 mg/L) was at IF24 (Seabrook Creek) which has poorest water quality overall and proportionally highest agricultural activity of any of the sub-catchments.

Closer inspection of the phosphorus data also shows that the large majority of the phosphorus present in the system exists as adsorbed to particulate material, as only very low concentrations of dissolved reactive phosphorus (DRP) was found. In 75% of samples collected during monitoring at all sites, DRP comprised 25% or less of the TP present. Only at sites such as IF1 and IF5, where more direct sources of input may occur (eg. urban runoff or faecal pollution by stock), were greater proportions of DRP detected (i.e. DRP >45% of TP). In general, the data suggest that the sources of TP in waterways in the catchment are therefore likely to be sediment and particulate material transported to the river by either catchment runoff or river-bank and hill-slope erosion. Previous work done by staff from DPIWE (Sims & Cotching, 2000) has estimated that soil loss from cultivated pasture in north-west Tasmania can be as high as 142 t/ha/rainfall event, with the majority of this soil eroded by uncontrolled movement of surface water across bare soil. This has serious implication for nutrient and sediment levels in waterways.

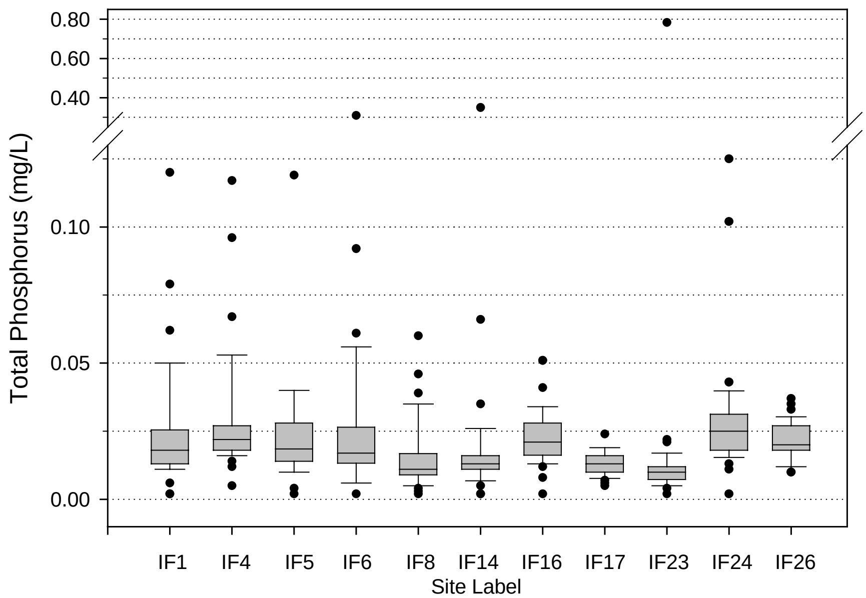

Figure 3.19: Statistical plot of total phosphorus (TP) concentration at sites in the Inglis-Flowerdale catchment, recorded during monthly monitoring between February 1999 and December 2001.

3.4 Bacterial Monitoring

As mentioned at the start of Section 3, monthly sampling was undertaken at 5 sites in the Inglis-Flowerdale catchment to assess the level of faecal pollution. This sampling was undertaken using a newly developed technique (NALGENE® 'Micro Monitors') that allowed presumptive colony counts to be made locally at relatively low expense. While this testing was not able to be quality assured in the way that registered laboratories might choose, some comparative tests were carried out against a registered laboratory in Launceston to determine whether results from this procedure were likely to reflect 'true' environmental conditions. These preliminary tests showed that results gained from this newer, technically simpler methodology are capable of yielding data that are within acceptable limits for accuracy and could be used to show 'relative bacterial condition' with some degree of confidence. The limitations of this technique meant that there was an upper maximum for readings of 12,000 cfu/100mL.

The data from monitoring in the Inglis-Flowerdale catchment is presented in Figure 3.20, and shows that the spread of data at all sites is quite similar, resulting in similar median values for each site (ranging between 90-160 cfu/100mL). While peak concentrations of 12,000 cfu/100mL were recorded at IF6, IF16 and IF24, the majority of the data at these sites was not significantly different to that for the other sites monitored. No seasonal pattern was found at any site, although higher faecal coliform concentrations tended to occur in Camp Creek in late summer and autumn. Values at this time were well in excess of the National guidelines for primary contact (150 cfu/100mL).

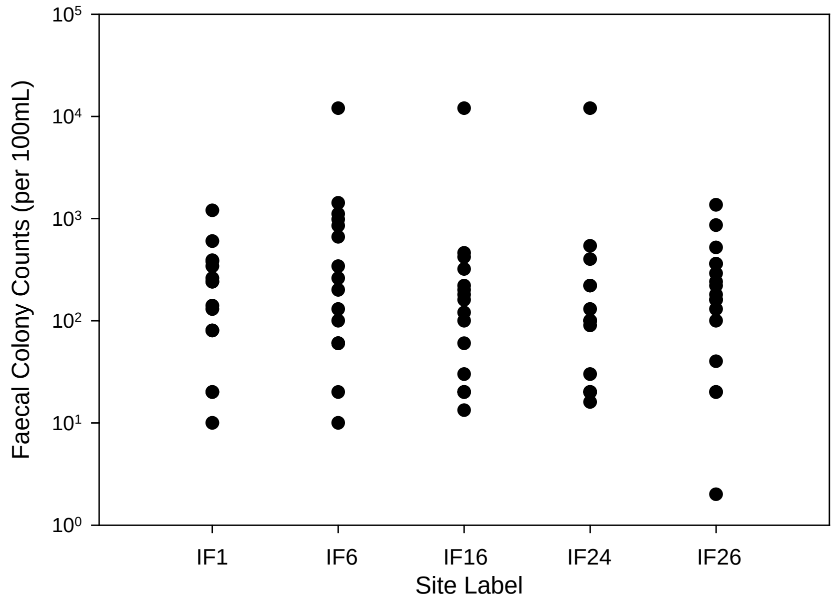

Figure 3.20: Vertical scatter plot illustrating spread of faecal coliform data from monthly monitoring at 5 sites in the Inglis-Flowerdale catchment, collected between January 2000 and June 2001. # Horizontal lines represent median value for each site.