4.4 Catchment surveys

Snapshot surveys of the entire catchment were undertaken in summer and winter during periods of stable flow. Catchment surveys have been utilised in studies overseas (Salvia *et al*., 1999), on the mainland of Australia (Grayson, *et al*., 1997, Eyre and Pepperell 1999) and extensively in Tasmania in State of Rivers studies. The aim of this methodology is to characterise water quality at a catchment scale, providing an indication of areas of degradation. Stable base flow hydrological conditions are required for this methodology to eliminate the influences of rain and runoff, which make interpretation and comparison difficult. In the Little Swanport these base flow conditions are present for long periods and water quality at these flows is an important influence on biological processes.

All sites were sampled for nutrients, ionic composition, bacteriological characteristics, metals and standard physico-chemical parameters (turbidity, dissolved oxygen, temperature, conductivity and pH). Winter sampling was conducted on 22nd - 24th June 2004, with sampling for metals on the 23rd July 2004, summer sampling was conducted on the 15th - 16th November 2004. This section discusses some of the highlights from these surveys.

4.4.1 Total Nitrogen and Nitrate

The results for summer and winter surveys for total nitrogen are displayed in Figure 115. Thirteen sites had total nitrogen values exceeding the suggested trigger value for Tasmanian rivers and streams of 0.48mg/L (ANZECC 2000), while for the summer survey, 16 sites returned values in excess of this level.

The broad trend was for increasing nitrogen concentrations towards the top of the catchment. Lower catchment sites; Little Swanport River 3km u/s Tasman Highway (LSWA01), Little Swanport River at Deep Hole (LSWA02) and Little Swanport River downstream Green Tier Creek (LSWA03) had similar values for both winter and summer. Middle catchment sites on the Little Swanport River; Little Swanport River downstream Eastern Marshes (LSWA05b), Little Swanport River upstream Eastern Marshes (LSWA06) and Little Swanport River upstream Pages Creek (LSWA09) had significantly higher total nitrogen concentrations in winter. Upper catchment sites; Little Swanport River at Swanston Road (LSWA10), Little Swanport River at lower Inglewood

Road (LSWA12), Little Swanport River at upper Inglewood Road (LSWA14) and Little Swanport River above 'Longacres'(LSWA15) had higher total nitrogen values in summer. Higher summer values for the more elevated sites in the Little Swanport River may be due to stock access to sites, the effect of which is exacerbated by the ephemeral nature of the river. During winter, higher flows are likely to provide some dilution. This was also observed at the Crichton Creek (LSWA32) site.

The significant increase in total nitrogen in winter for the middle catchment sites appears to be a result of higher winter nitrate inputs from Nutting Garden Rivulet and Eastern Marshes Rivulet. Inputs from drainage lines that operate during winter may also contribute to elevated nutrients. There is little difference between winter and summer nitrogen levels for the lower sites on the Little Swanport River. The lower reaches of the Little Swanport have thicker, more laterally extensive riparian vegetation than middle and upper reaches, which would act as a buffer against nutrient inputs from that section of the catchment. Nitrogen concentrations therefore reflect the cumulative inputs from the middle and upper catchment. Lowest winter and summer total nitrogen concentrations were in Rocka Rivulet, Pepper Creek and the two coastal catchments of Lisdillon Rivulet and Buxton River.

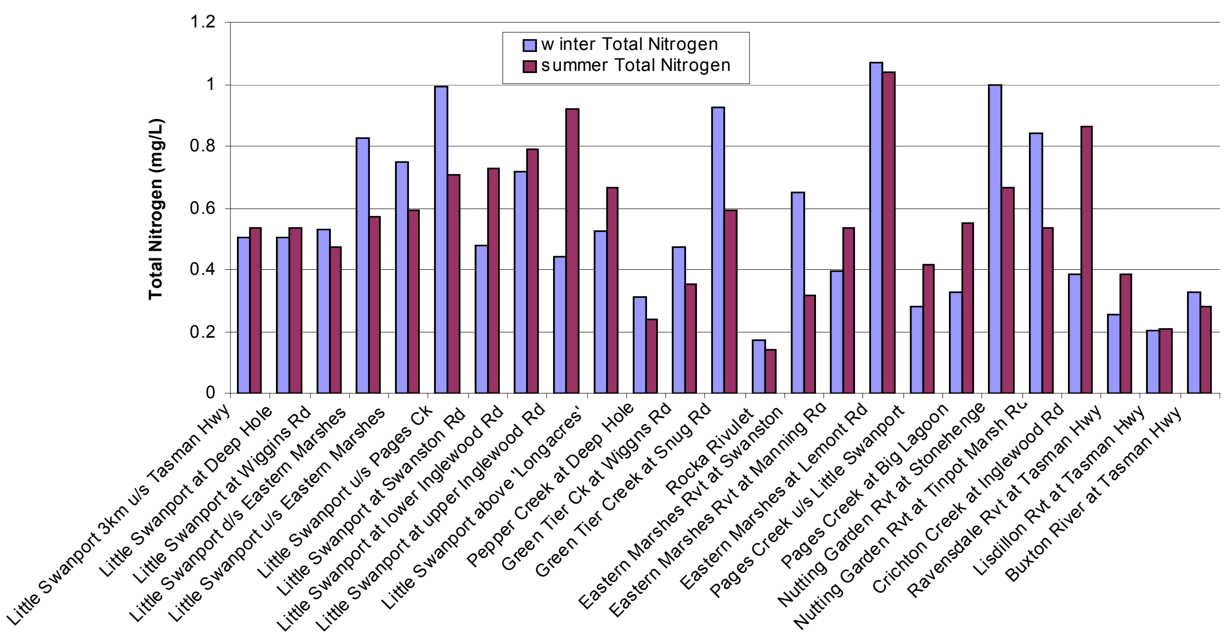

Figure 115:Total nitrogen concentrations for winter and summer snapshot surveys for the Little Swanport catchment.

Winter nitrate levels are elevated in comparison to summer in the lower and middle Little Swanport River sites (Figure 116), however this trend is not shown by sites in the upper catchment, with the exception of Little Swanport River lower Inglewood Road. It is also evident that Nutting Garden

Rivulet, which flows into the main river above Pages Creek, has substantially higher winter nitrate levels as does Eastern Marshes Rivulet at Swanston. Winter nitrate levels at LSWA05b and Nutting Garden Rivulet at Stonehenge (LSWA22) are seventy-six times those recorded during the summer survey. The effect of Eastern Marshes Rivulet can be seen in the increase in nitrate in the Little Swanport River below its confluence with Eastern Marshes Rivulet while inputs of nitrate from Nutting Garden Rivulet are apparent in the increase in nitrate at Little Swanport River upstream Pages Creek. These high winter nitrate levels in the middle catchment are largely responsible for the winter higher total nitrogen levels compared to summer for the Little Swanport River sites; LSWA09, LSWA06 and LSWA05b. In the absence of the increased winter nitrate input from Eastern Marshes and Nutting Garden Rivulet into the Little Swanport River, winter total nitrogen at these sites would follow the trend of lower values compared to summer total nitrogen exhibited in the upper catchment.

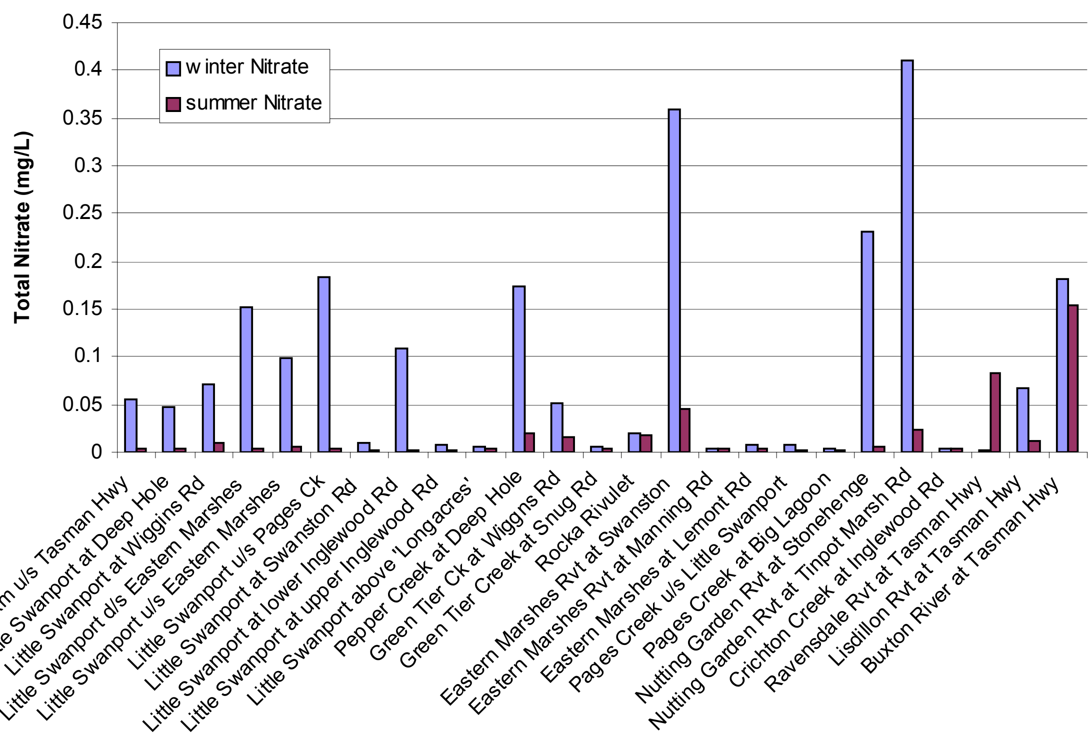

Figure 116: Nitrate concentrations for winter and summer snapshot surveys for the Little Swanport catchment.

While agricultural activities are often linked to elevated nitrate levels, the pattern from the catchment survey catchment doesn’t appear to correspond strongly to land use. Nitrate levels were found to be low in all the upper catchment sites, however, monthly sampling in the upper catchment found very nitrate high concentrations at low flows. These higher values were associated with rainfall and it is evident that in this part of the catchment there is a corresponding relationship between land use and nitrate but that in the absence of recent rainfall it may not be seen. High winter nitrate concentrations throughout the middle catchment, particularly in Nutting Garden Rivulet and Eastern Marshes Rivulet, which also appear to be major contributors to higher levels in the Little Swanport River, may be due to changes in groundwater regime, soils or geology. The addition of irrigation waters from the Hobbs Lagoon complex may also be an additional factor in Nutting Garden Rivulet.

Levels of ammonia throughout the catchment were very low with all but one sample below 0.02 mg/L. The ANZECC guideline for protecting a 'moderately disturbed' aquatic ecosystem at a pH of 8.0 suggested a trigger value of 0.9 mg/L.

4.4.2 Total Phosphorous

Total phosphorous concentrations throughout the catchment follow a similar pattern to total nitrogen, however the significant differences between summer and winter concentrations of total nitrogen that were evident for some sites in the middle catchment are not mirrored by total phosphorous (Figure 117). Most sites have similar winter and summer concentrations. Nutting Garden Rivulet, which had elevated winter total nitrogen levels, has similar total phosphorous levels for both summer and winter. Sites in the middle catchment of the Little Swanport River, which had elevated winter total nitrogen, also have similar summer and winter levels of total phosphorous. Sites in the upper Little Swanport River and Crichton Creek, where levels of total nitrogen were elevated in summer, also show this pattern for total phosphorous. As with total nitrogen, this may be attributed to disturbance by stock, which have access to these sites. Green Tier Creek, which had elevated winter nitrogen levels, also has elevated winter phosphorous levels. These results indicate that total phosphorous levels in summer and winter are related to inputs of particulate matter, whereas for some sites in the middle catchment, levels of total nitrogen are strongly influenced in winter by inputs of both particulate and dissolved nitrogen

Phosphorous levels throughout the catchment are generally below the ANZECC (2000) guideline of 0.013mg/L. Both Nutting Garden Rivulet and Green Tier catchments have total phosphorous levels above the guideline. The phosphorous input from Nutting Garden Rivulet into the Little Swanport River is evident in the elevated levels at the downstream site (Little Swanport u/s Pages Creek). Phosphorous levels in Green Tier are diluted from the high levels at the upper site (Green

Tier Creek at Snug Road ford) by the input from Rocka Rivulet and other tributaries. Levels of dissolved reactive phosphorous are low throughout the catchment, indicating a diffuse source for the phosphorous present in its surface waters.

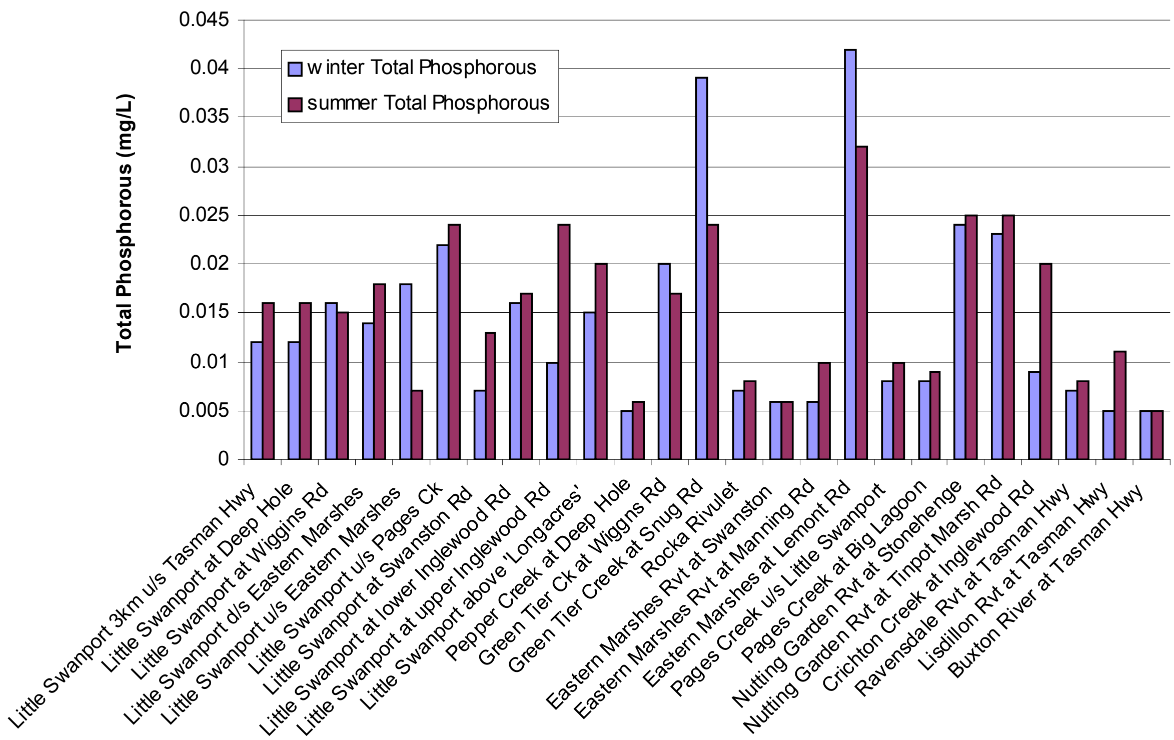

Figure 117: Total phosphorous concentrations for winter and summer snapshot surveys for the Little Swanport catchment.

4.4.3 Metals

Samples taken during snapshot surveys were analysed for some of the main metals commonly found in waters that may pose some risk to aquatic organisms or human health. Due to financial constraints, only total metal concentrations were determined. Where high concentrations are detected it is suggested that future studies at these sites include analysis of the dissolved fraction. The detection limits for those metals analysed are listed below:

Metal	Limit of Detection
Aluminium	20μg/L
Arsenic	5μg/L
Cadmium	1μg/L
Copper	1μg/L
Cadmium	1μg/L
Cobalt	1μg/L
Chromium	1μg/L
Manganese	5μg/L
Nickel	1μg/L
Lead	5μg/L
Zinc	1μg/L

Similar to many other parameters commonly tested for in surface waters, metals can be present in various forms. Trace amounts of some metals are naturally present in surface waters as a consequence of the weathering of rocks and soil. Metals can be present attached to suspended matter, colloids, or complex organic compounds (ie. humic and fluvic acids). The relative toxicity of metals is dependant upon the degree of oxidation of the metal ion together with the form with which it is associated (UNESCO, 1992). The toxicity of metals can also vary depending upon the environment in which they occur. Acid conditions tend to increase the toxicity of the majority of metals whilst for others high concentrations of hardness reduce toxicity (ANZECC, 2000). Dissolved metals are more toxic to biota than other forms absorbed to clays and other particles.

Within the National Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 2000) trigger values for toxicants (ie. metals, pesticides) are derived using a statistical distribution method calculated at 4 different protection levels. Each level signifies the percentage of aquatic macroinvertebrate species that is expected to be protected. In the majority of cases the 95% protection level should be used for most ecosystems which can be classified as slightly to moderately disturbed and is suggested here as the default level of protection (Table 30).

Table 30: Trigger values for observed metals at alternate levels of protection. Values in the grey shaded areas are the trigger values applying to typical *slightly to moderately disturbed* ecosystems (ANZECC 2000). NOTE: ID = Insufficient data to derive a reliable trigger level.

Metals	Trigger Values for freshwater (µg/L)			
	Level of Protection (% species)			
	99%	95%	90%	80%
Aluminium pH > 6.5	27	55	80	150
Aluminium pH < 6.5	ID	ID	ID	ID
Arsenic (As III)	1	24	94	360
Arsenic (As V)	0.8	13	42	140
Cadmium H	0.06	0.2	0.4	0.8
Cobalt	ID	**ID**	ID	ID
Chromium (Cr III)	ID	ID	ID	ID
Chromium (Cr IV)	0.01	1.0	6	40
Copper H	1.0	1.4	1.8	2.5
Iron	ID	ID	ID	ID
Manganese	1200	1900	2500	3600
Nickel H	8	11	13	17
Lead H	1.0	3.4	5.6	9.4
Zinc H	2.4	8.0	15	31

In Table 30 'H' represents those metals for which values have been calculated using a hardness of 30 mg/L $CaCO_3$. These should be adjusted based on specific site hardness. In the Little Swanport catchment hardness is generally greater than 30 mg/L which would increase trigger value concentrations.

Concentrations of Arsenic, Cadmium, Cobalt, Chromium, Copper, Manganese, Nickel, Lead and Zinc from the catchment survey were all below or marginally above detection limits and below the 95% trigger value for 30 mg/L hardness.

Aluminium concentrations varied both spatially and temporally throughout the catchment. Median and maximum total aluminium concentrations in the Little Swanport are generally considerably higher than that of other south-east Tasmanian catchments (Coal and Jordan) examined under previous State of Rivers investigations (DPIWE 2003a and DPIWE 2003b). It should be noted that ANZECC trigger values for aluminium is based on absolute bioavailable forms of aluminium not total aluminium. It is likely that the high concentrations found in this catchment are linked to the presence of clay and other suspended particles. This is evident in the strong relationship between aluminium concentrations and turbidity (Figure 118).

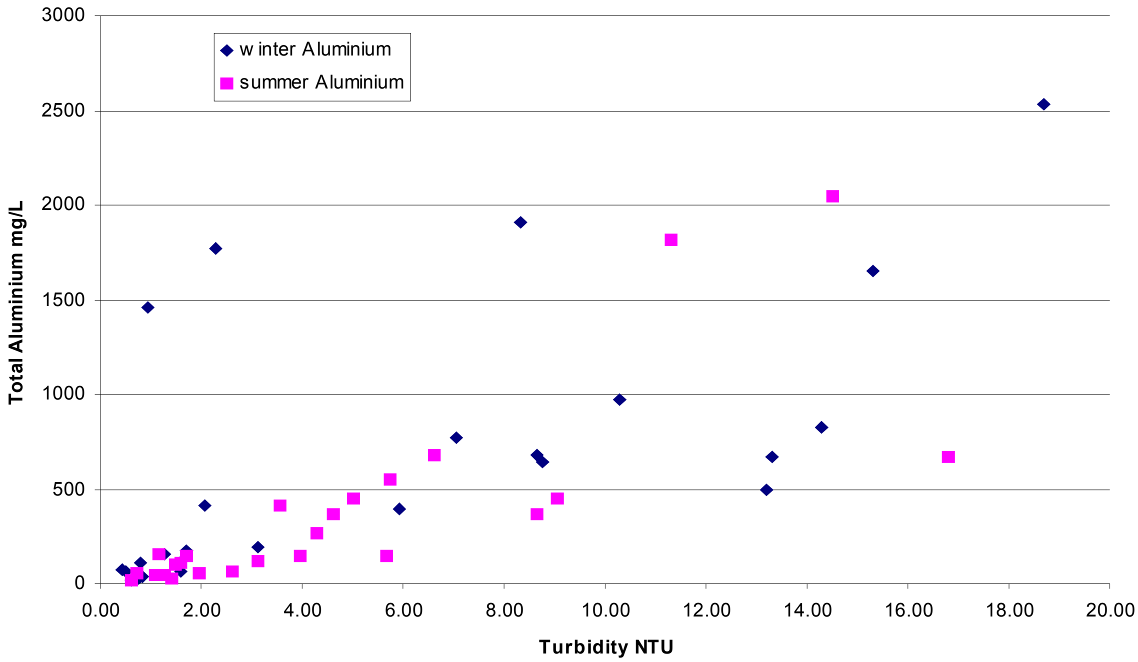

Figure 118: Turbidity vs Total aluminium concentrations during snapshot surveys of the Little Swanport catchment.

Aluminium concentrations in the Little Swanport River increase substantially below LSWA10 (Little Swanport at Swanston Road) due to the input of Nutting Garden Rivulet and Green Tier Rivulet, both of which have high aluminium concentrations (Figure 119). Green Tier Creek in particular has very high summer and winter aluminium levels and influences aluminium concentrations in the Little Swanport River downstream of the junction. There is a strong correlation between aluminium concentration and turbidity in Green Tier Creek, indicating that the aluminium is not present in dissolved form and is unlikely to pose a threat to the aquatic environment, however any further sampling of aluminium within the catchment should include dissolved aluminium. Rocka Rivulet, which has a largely undisturbed catchment, has high levels of winter aluminium, indicating that its presence in Green Tier Creek is largely a reflection of natural processes. The higher summer levels in Green Tier Creek compared with Rocka Rivulet however, may indicate adverse land use impacts above the upper Green Tier site, Green Tier Creek at Snug Road (LSWA20).

Two sites, Eastern Marshes at Lemont Road and Pages Creek upstream Little Swanport, had high winter aluminium concentrations and low turbidities. This indicates that the aluminium may be present in a bioavailable form and may pose a risk to biota. The determination of possible impacts of high levels of aluminium at these sites would require further investigation.

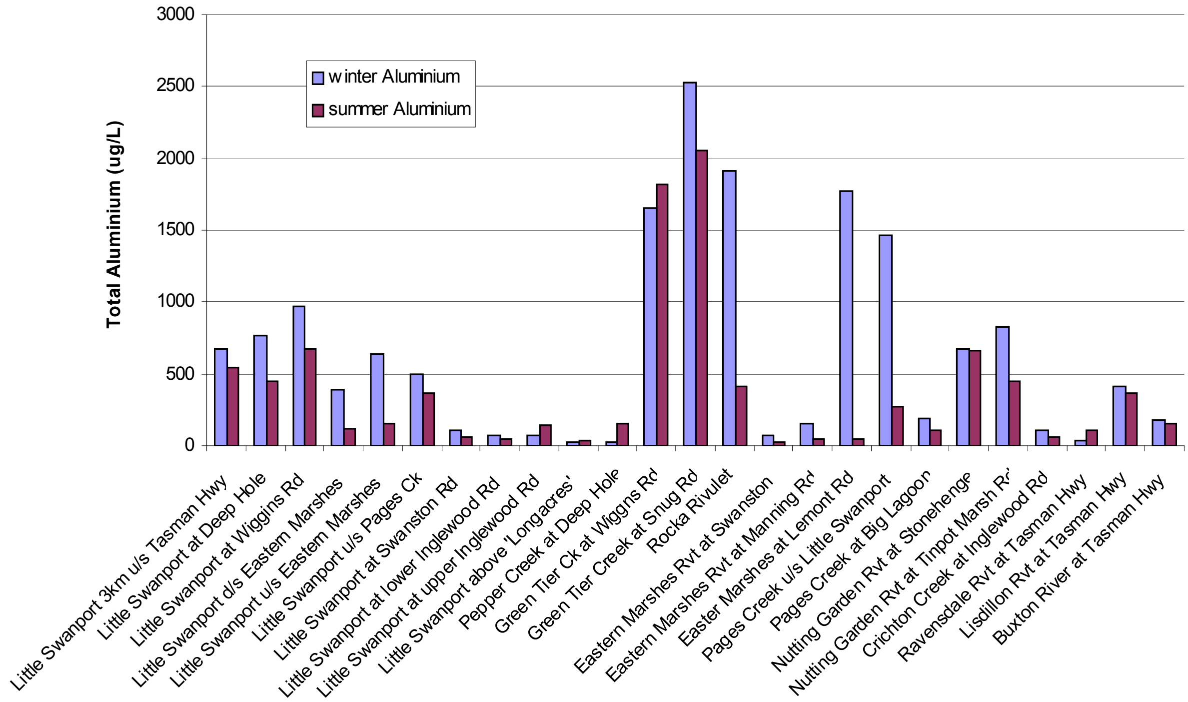

Figure 119: Total aluminium concentrations for winter and summer snapshot surveys for the Little Swanport catchment.

Levels of total zinc were low throughout the catchment, with all sites having summer and winter levels below the ANZECC guideline of 8 µg/L. The exception is Lisdillon Rivulet, which had a summer concentration of 153 µg/L (winter concentration: 1µg/L). Given that the corresponding turbidity was low (4.61 NTU), the presence of zinc at this concentration is a concern and may indicate an anthropogenic source, as zinc is a common ingredient in domestic and agricultural products. Further sampling would be required to determine the nature of zinc concentrations in Lisdillon Rivulet.

4.4.4 Bacteria

Sampling for coliforms was conducted for the winter and summer snapshot surveys. Samples were tested for total coliforms, *E. coli*, faecal (thermotolerant) coliforms and faecal streptococci. Faecal coliforms are a common indicator for the assessment of biological contamination of waterways and are the focus of the following discussion.

Counts of bacteria of faecal origin in lakes and rivers worldwide that have minimal human impact can vary between <1 to 3000 organisms per 100ml (UNESCO 1992). Sites within the Little Swanport catchment that have minimal disturbance (Rocka Rivulet, Pepper Creek) have counts of less than 100 per 100ml and 10 per 100ml respectively, while the majority of sites through the catchment have counts below 250 per 100ml (Figure 120). ANZECC guidelines for microbiological water quality require the use of median values derived from routine monitoring and therefore cannot be applied to these results. The sampling of bacteria as part of the summer and winter surveys is intended only to highlight sites that may be subject to faecal pollution.

Generally, faecal coliform levels during summer tended to exceed winter levels at most sites. However, the highest concentrations of faecal coliforms were recorded in winter. These high winter levels were from sites with little or no riparian vegetation and where stock are able to access the entire stream width except during high flow. These sites may also be subject to contamination from local runoff.

The two upper sites on Eastern Marshes Rivulet (Eastern Marshes at Lemont and Eastern Marshes at Manning Road Ford) for example, both of which have no riparian vegetation and are open to stock, had low counts. This difference between similar sites may be a reflection of stock use at the time of sampling or a result of the type of stock present, as cattle will often enter waterways while sheep rarely do. During the survey, cattle were often seen in the upper and middle sites of the Little Swanport River but not at the Eastern Marshes Rivulet sites. The susceptibility of sites open to stock access to faecal contamination has been documented in other catchment surveys in Tasmania (DPIWE 2003a and DPIWE 2003b).

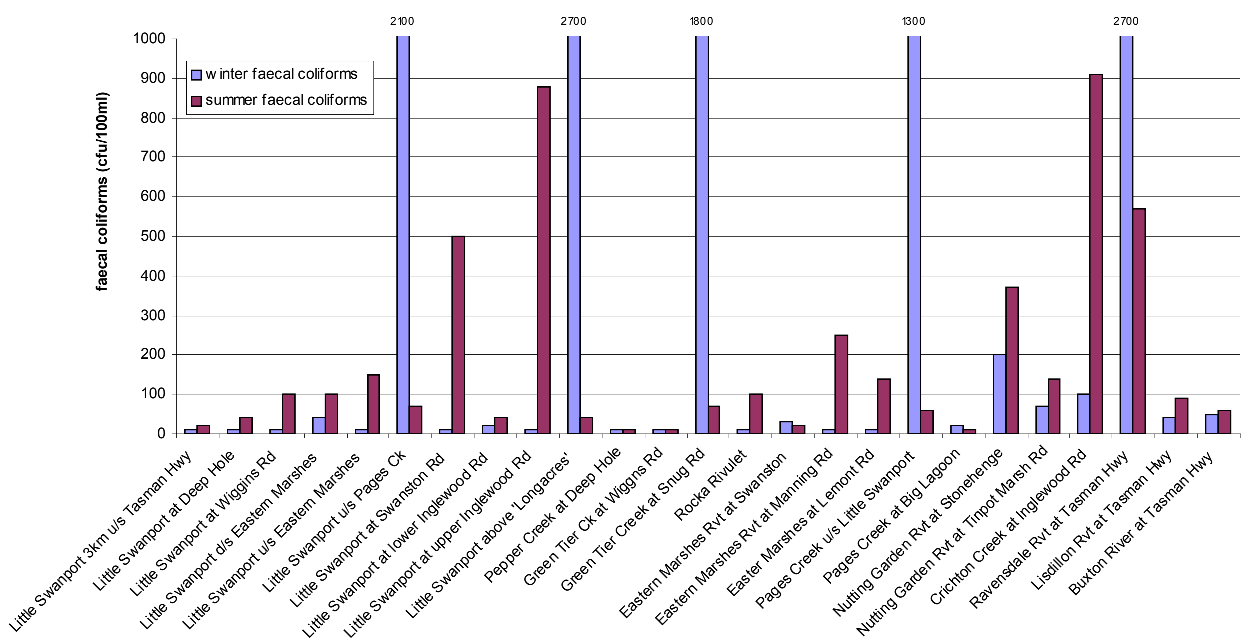

Figure 120: Faecal coliform counts for winter and summer snapshot surveys for the Little Swanport catchment.

4.4.5 Ionic composition

Quarterly surveys to determine ionic composition were undertaken for a subset of 11 sites where monthly nutrient samples were taken. Samples were taken in November 2003, and March, June and November of 2004. The analyses included determination of dissolved minerals and salts, total suspended solids, apparent colour, alkalinity and hardness. Median, maximum and minimum values of the combined data are given in Table 31a&b. The large range of minimum and maximum values is a reflection of the very high dissolved salt levels in upper catchment sites and the very low levels recorded at other sites, particularly Rocka Rivulet.

Table 31a: Summary statistics for ionic parameters for the Little Swanport catchment (Sites = 11; n per site = 4).

	Total Dissolved Solids (mg/L)	Total Suspended solids (mg/L)	Apparent Colour (Hazen units)	Alkalinity (mg/L)	Hardness (mg/L)	Chloride (mg/L)
Median	455	1	30	105	206	190
Maximum	1920	11	125	453	1440	1000
Minimum	57	1	5	21	14.5	14

Table 31b: Summary statistics for ionic parameters for the Little Swanport catchment (n=4).

	Flouride (mg/L)	Sulphate (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Calcium (mg/L)	Potassium (mg/L)
Median	0.06	7.4	29.7	79.7	43.3	1.68
Maximum	0.3	280	230	465	320	5.4
Minimum	0.02	0.88	2.07	4.69	2.38	0.16

The ionic composition of rivers is largely a reflection of the chemical composition of the underlying soils and geology, the influence of climate and of current and historical land use patterns (Wayland *et al.,* 2003). In Tasmania, freshwater systems have been variously categorised according chemical composition, most notably by Buckney and Tyler (1973), who divided the inland waters of Tasmania into five provinces (Meyer, 2002). Northeast waters were found to be generally dominated by sodium and chloride but also with high relative proportions of carbonate (Buckney and Tyler 1973). Relative ion concentrations in the Little Swanport catchment conform to this general categorisation. The dominance of sodium and chloride is most likely a reflection of the influence of ocean aerosols. Tasmania is subject to the influence of maritime weather systems and east coast catchments in particular often receive heavy rainfall from low pressure systems off the east coast. The influence of ocean aerosols on sodium and chloride concentrations at baseflow conditions has also been noted in New Zealand (Close and Davies-Colley 1990, Kim *et. al*., 1996) and in Tasmania (Grose, 2003).

Within the catchment, with the exception of sulphate, relative proportions of major anions and cations remains fairly constant (Figure 127). Total concentrations of dissolved salts increases towards the upper catchment. Within the Little Swanport River this increase is most apparent upstream of the upper gauging station (Little Swanport downstream Eastern Marshes Rivulet, LSWA05b) where groundwater inputs begin to dominate stream chemistry as the river becomes increasingly ephemeral in nature. In addition, inputs from upper tributaries, which generally have more elevated concentrations of dissolved salts, clearly contribute to salt levels within the Little Swanport River. The Green Tier Rivulet/Rocka Rivulet catchment had significantly lower levels of dissolved salts than other catchments in the quarterly survey and had proportionally less chloride.

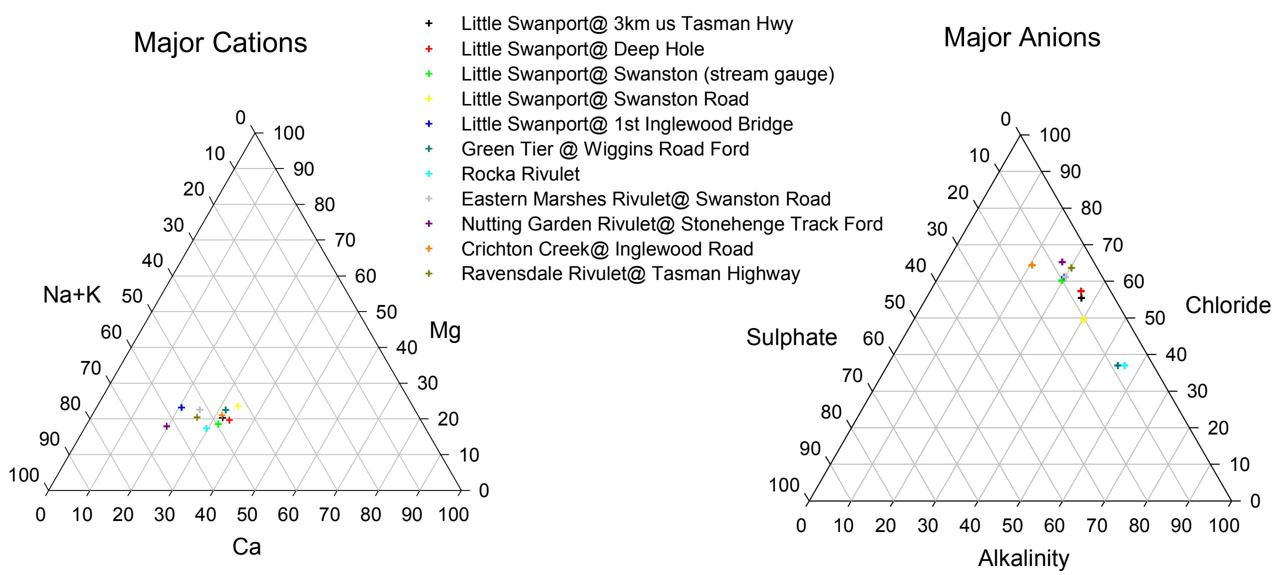

Figure 121: Major ion percentage composition for the Little Swanport catchment from quarterly surveys.

Apparent Colour

The apparent colour of river water generally reflects the amount of dissolved organic matter (ie. humic material), biological matter (phyto- and zooplankton) and suspended particles in the water column. Apparent colour is caused by coloured particulates and by the refraction and reflection of light on suspended particulates and is measured in Hazen Units. In natural waters, colour can range from <5 in very clear waters to >300 in dark peaty waters. The catchment wide median of 30 Hazen

Units (Table 31) is below that recorded for the Coal (40 Hazen Units) and Jordan (50 Hazen Units) catchments (DPIWE, 2003a and DPIWE, 2003b). Colour can be influenced by flow, with higher apparent colour recorded during flood events due to suspended fine organic material. The variability of apparent colour for Green Tier Creek (Figure 122) however, is related to turbidity rather than flow, with high readings corresponding to higher turbidity at baseflow levels during winter and spring 2004, possibly a result of land use disturbance. Nutting Garden Rivulet had the highest mean apparent colour, this site also has elevated turbidity, nutrient and suspended solid levels. At this site, the level of apparent colour is a further indicator of land use impacts. Apparent colour levels do not necessarily reflect disturbance at Rocka Rivulet, which is largely undisturbed, which has higher mean apparent colour than several sites in disturbed areas.

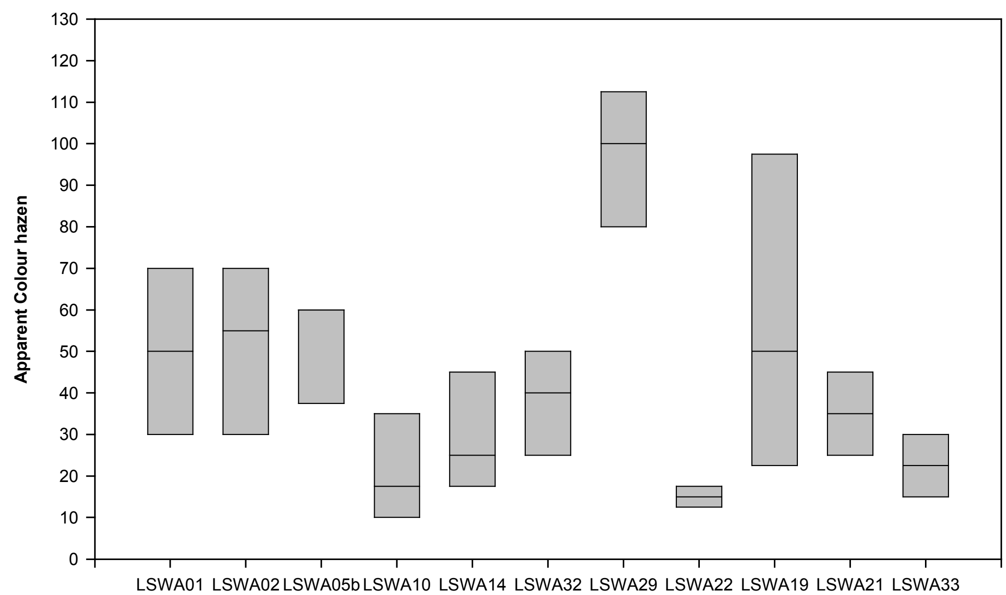

Figure 122: Box plots showing statistics for apparent colour at eleven sites in the Little Swanport catchment from quarterly surveys.

Total suspended solids and Total dissolved solids

Total suspended solids (TSS) consist of silt, clay, fine particles of organic and inorganic matter, soluble organic compounds, plankton and other microscopic organisms. Excessive levels can cause a range of environmental damage including benthic smothering, irritation of fish gills and transport of adsorbed contaminants (Davies-Colley and Smith, 2001). TSS and TDS correspond to non-filterable and filterable residue, respectively. The type and concentration of TSS controls the level of turbidity and transparency of surface waters, while TDS is related to conductivity, as it is a physical method of measuring total salt concentrations in water.

Total suspended solids were low at most sites, reflecting the generally good level of water clarity within the catchment. The highest mean TSS was at Nutting Garden Rivulet, which also had elevated turbidity. Concentrations of TSS increased during rainfall events as a result of increased surface runoff and mobilisation of instream sediments (see sections on flood sampling).

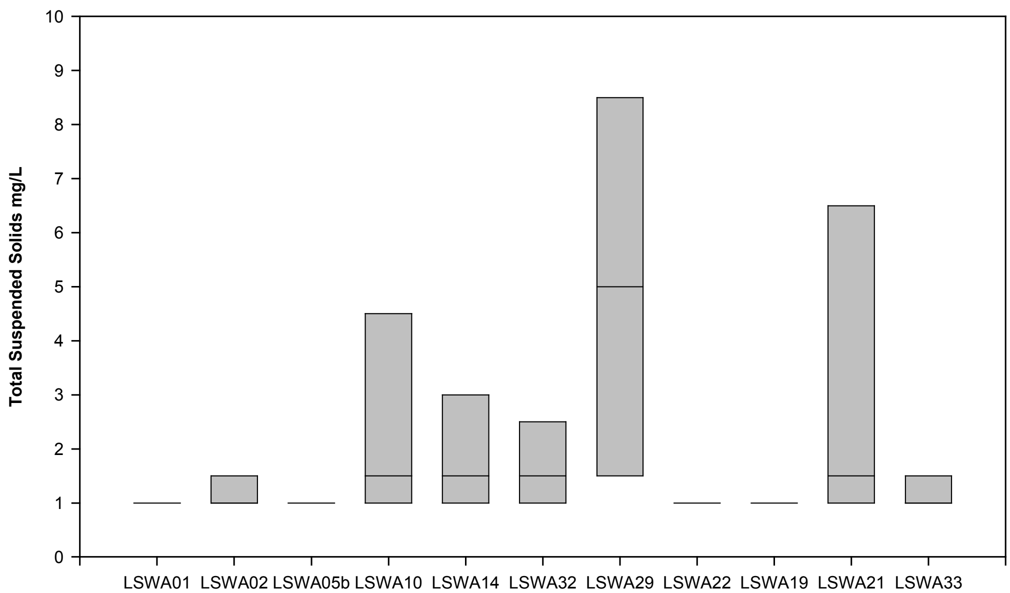

Figure 123: Box plots showing statistics for Total Suspended Solids at eleven sites in the Little Swanport catchment from quarterly surveys.

Total dissolved solids are transported in solution and are usually a reflection of local geology, weathering processes and land use (Gordon *et al*., 2004). In general, surface water originating from groundwater tends to have a higher soluble load than water derived from surface runoff. Agricultural fertilisers can also be a significant source of solutes. Total dissolved solid concentrations are higher towards the top of the Little Swanport River. This is also evident for the upper catchment sites of Nutting Garden Rivulet and Crichton Creek, while elevated levels measured in Eastern Marshes Rivulet originate from its upper catchment. Lowest mean concentrations and variability were from the Green Tier Creek/Rocka Rivulet catchment.

The pattern of higher salt levels in the upper catchment is the opposite of that found for the Coal and Jordan River catchments (DPIWE, 2003a and DPIWE, 2003b), where salt concentrations increased with distance from source. This reflects the unusual land use patterns within the Little Swanport catchment, where the upper catchment has been extensively cleared for grazing, while the mid to lower part of the catchment is subject to minimal disturbance and is often thickly vegetated.

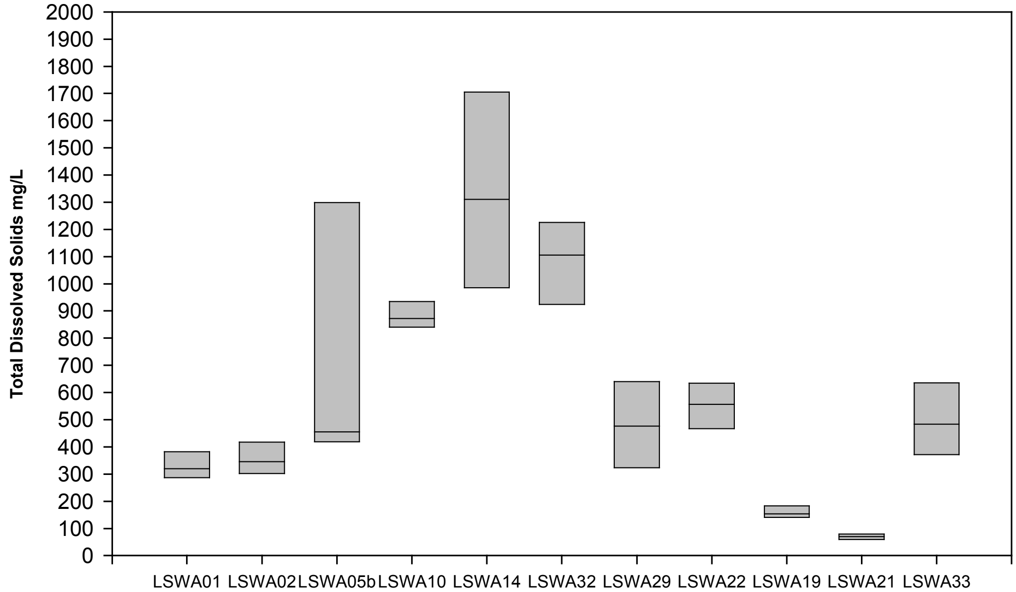

Figure 124: Box plots showing statistics for Total Dissolved Solids at eleven sites in the Little Swanport catchment from quarterly surveys.

Hardness

Water hardness is a total measure of the major cations (predominantly calcium and magnesium) present in water and is an important parameter in freshwaters as it can have a major effect on the toxicity of metals. Water hardness can range from <1mg/L (very soft) to >400 mg/L (very hard). The hardness of most freshwaters in Australia ranges between 25-400 mg/L and $CaCO_3$.

Total hardness is significantly higher at the upper sites on the Little Swanport River (Figure 125), with the two uppermost sites surveyed for the quarterly survey (LSWA10 and LSWA14) having a median hardness in excess of 500 mg/L $CaCO_3$. Crichton Creek also had a median hardness in excess of 400 mg/L $CaCo_3$. Both Nutting Garden Rivulet and Eastern Marshes Rivulet had moderate levels of hardness. Concentrations in the Eastern Marshes catchment increasing upstream, while levels in Nutting Garden Rivulet decrease upstream. Hardness also increases upstream within Green Tier Creek. Green Tier Creek and Rocka Rivulet had the lowest median hardness (67.1 mg/L $CaCO_3$ and 23.6 mg/L $CaCO_3$) and the least variability.

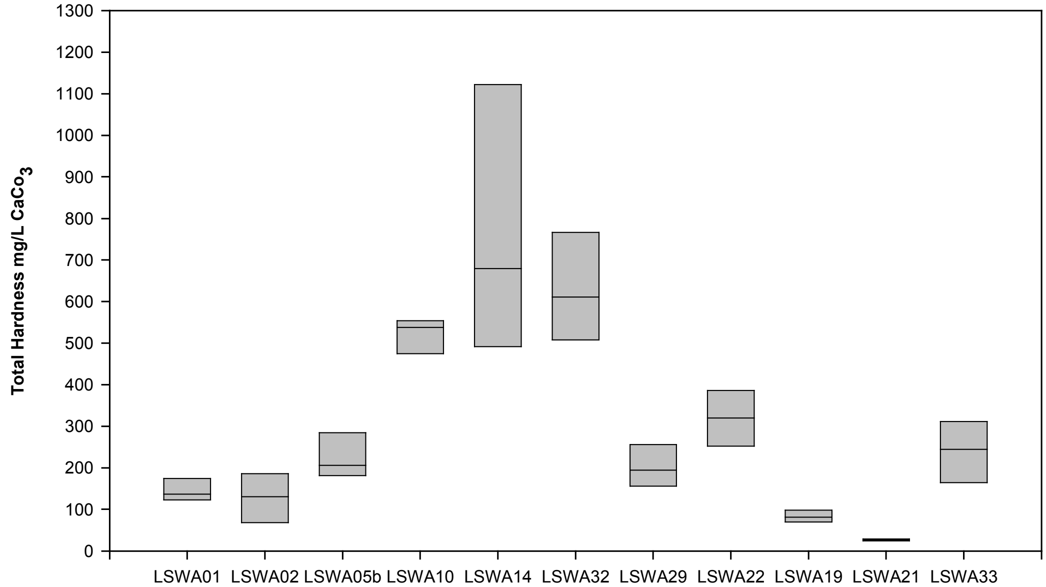

Figure 125: Box plots showing statistics for total hardness at eleven sites in the Little Swanport catchment from quarterly surveys.

Major Cations

As expected individual statistical patterns for sodium, magnesium follow TDS and total hardness, with higher concentrations at more elevated sites in the Little Swanport catchment as a whole. Calcium levels also increase upstream within the Little Swanport River, with the exception of the upper-most site in the Little Swanport River (LSWA14), which has a median calcium concentration marginally below the next downstream site (LSWA10). The upstream increase in ionic concentrations within the Little Swanport River is also more marked for sodium and magnesium than for calcium.

When the contributions of these cations to TDS is examined, it is clear that the major contributor is sodium, with sodium concentrations highest in the upper catchment. However, in the last quarterly survey, in November 2004, the catchment is dominated by calcium, with the exception of LSWA14, where sodium continues to dominate. This difference underlies the different upstream trend for calcium concentrations evident in Figure 126. The significant change in the relative proportion of calcium observed for the Little Swanport River sites was not evident in Crichton Creek, Eastern Marshes Rivulet, Nutting Garden Rivulet or Green Tier Creek. The change in the relative proportions of cations in the Little Swanport River in the November 2004 sampling round is shown in Figure 126. The June 2004 sampling round results are used as a comparison, as there is little variation in the results from the first three quarterly sampling rounds.

While overall, there is limited variability of cation concentrations within the quarterly survey sites (Figure 121), with ionic composition at all sites dominated by sodium, it is clear that for periods of time sites in the middle and lower Little Swanport River may be calcium dominated. The mechanism for this is not clear and would require further investigation.

	June 2004			
	LSWA01	**LSWA05b**	**LSWA10**	**LSWA14**
Calcium%	27.7	23.0	32.5	22.0
Magnesium%	23.0	21.4	24.3	25.8
Sodium%	49.3	55.7	43.5	52.2
	November 2004			
	LSWA01	**LSWA05b**	**LSWA10**	**LSWA14**
Calcium%	64.2	65.5	61.7	28.2
Magnesium%	10.4	10.5	10.8	20.9
Sodium%	25.4	24.1	27.6	50.8

Figure 126: Cation composition from quarterly surveys, June 2004 and November 2004, Little Swanport River.

Major Anions

Statistical results for alkalinity and chloride follow those for TDS, hardness, sodium and magnesium. Alkalinity is an indicator of the concentration of carbonate, bicarbonate and hydroxide, but may include contributions from borate, phosphates, silicates and other basic compounds (UNESCO, 1992). It is a capacity factor that represents the acid neutralising capacity of an aqueous system (ANZECC, 2000). Levels within the Little Swanport catchment (catchment median 105 mg/L) are similar to those found in the Coal River catchment (median 122 mg/L) (DPIWE, 2003a). The pattern of increasing alkalinity levels in the upper catchment for the Little Swanport was not found for the Coal River catchment, where levels tended to increase with distance from source. Chlorine enters surface waters through the atmospheric deposition of oceanic aerosols, with the weathering of some sedimentary rocks and from agricultural and road runoff (UNESCO, 1992). The catchment median for chloride (190 mg/L) is similar to both the Coal and the Jordan catchments (160 mg/L and 220 mg/L respectively) but again the increasing concentration from source evident for those catchments is not seen in the Little Swanport where concentrations increase upstream.

Differences in patterns of ionic concentration between the Little Swanport catchment and the Coal and Jordan catchments may be attributed to patterns of land use. Unlike the Coal and Jordan catchments, the most intensive land use in the Little Swanport River is in the upper catchment. The ephemeral nature of the upper catchment and the clearing of riparian and surrounding vegetation results in water quality being strongly influenced by groundwater, particularly the composition and concentration of salts. Whereas for the Coal and Jordan catchments, where land use impacts increase and have a cumulative impact on water quality downstream, the steep, vegetated lower catchment of the Little Swanport River, which is relatively undisturbed, results in a overall improvement in water quality downstream.

Overall the catchment anion composition is dominated by chloride. While still chloride dominated, higher proportions of sulphate occur at LSWA10 and LSWA32. There is a higher degree of variability in sulphate concentrations throughout the catchment than that of alkalinity, with higher sulphate concentrations resulting in a corresponding lowering of the proportion of chloride. The difference in cation proportions observed between the June 2004 and November 2004 quarterly surveys is not evident for relative anion proportions. While concentrations of chloride increase upstream within the Little Swanport River, the proportion of chloride remains relatively stable. Results for quarterly surveys of chloride are shown in Figure 127.

Within Green Tier Creek and Rocka Rivulet, anion composition is dominated by alkaline anions, with overall concentrations low in comparison with other sites, and reflects the low median TDS within Green Tier Creek and Rocka Rivulet. Sulphate levels for these sites remained consistently low.

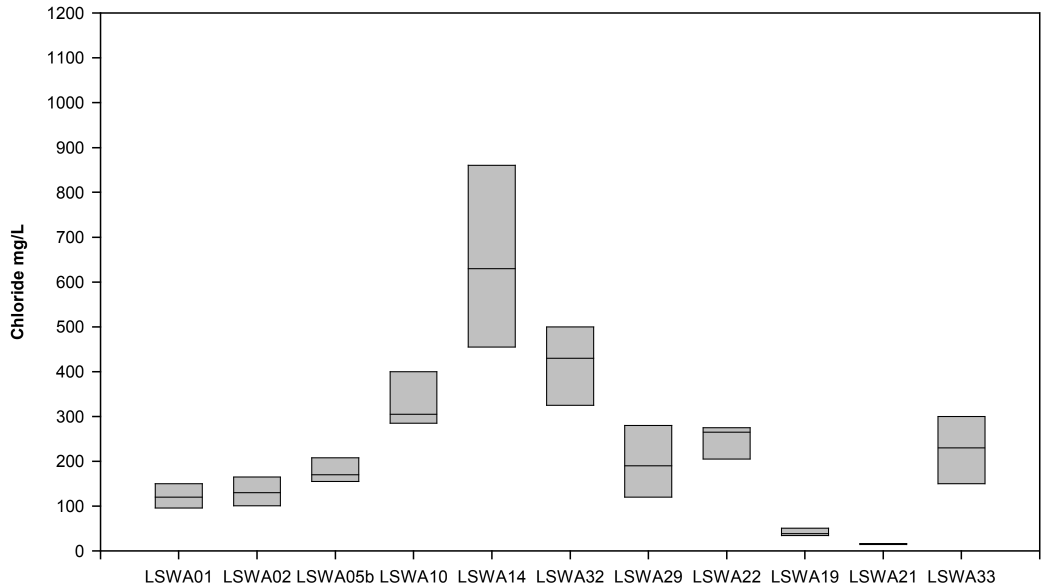

Figure 127: Box plots showing statistics for chloride at eleven sites in the Little Swanport catchment from quarterly surveys.

Sulphate

Sulphate is naturally present in surface waters as SO_4^{2-}, and originates from the atmospheric deposition of ocean aerosols or from geological processes such as the leaching of sulphite minerals from sedimentary rocks (UNESCO 1992). Studies in Tasmania have shown that sulphate concentrations in natural waters are usually around 5mg/L, however the catchment studies of the Coal and Jordan Rivers found sulphate levels generally higher than this (catchment medians of 16.5 mg/L and 8.7 mg/l respectively). It has been suggested that while this may be due to fertiliser use, local geology may be a more important factor, particularly as high salt levels are also present (DPIWE, 2003b). The catchment median for the Little Swanport is 7.4 mg/L, however a number of sites have high to very high median values for sulphate. The upper two quarterly sites on the Little Swanport River, LSWA10 and LSWA14 have median concentrations of 73mg/L and 30mg/L respectively. Crichton Creek also had particularly high concentrations of sulphate, with a median level of 210 mg/L. There appears to be no relationship between sulphate levels at Crichton Creek and those recorded at LSWA10 which is located downstream. It is difficult to determine the source of sulphate at this site, as it is the only site within the Crichton Creek catchment. It could indicate diffuse or point source pollution within Crichton Creek or a more localised characteristic of the site itself. Statistical results for sulphate do not follow the catchment pattern for other dissolved ions, however the lowest medians were for the Green Tier Creek/Rocka Rivulet catchment, which is consistent with relative concentrations for other ions at this sites.

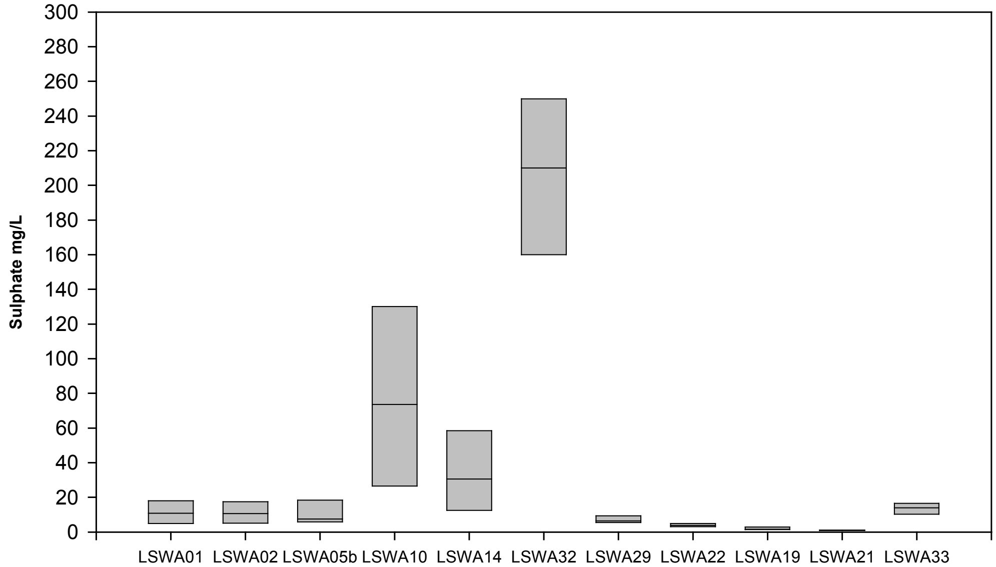

Figure 128: Box plots showing statistics for Sulphate at eleven sites in the Little Swanport catchment from quarterly surveys.