

A BIOLOGICAL SURVEY OF THE STYX RIVER CATCHMENT



Christchurch
Drainage Board

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OF THE
STYX RIVER CATCHMENT**

A report prepared for the
Christchurch Drainage Board
by
the Laboratory Division

March 1989

FOREWARD:

The Styx River lies to the north of the city of Christchurch and drains a predominantly rural catchment. Over the years increased urbanization and demands for stormwater drainage from adjacent farmland have worsened flooding problems affecting low lying areas during periods of prolonged rainfall. Early in 1986 Drainage Board planning staff reviewed proposals for a management scheme for this catchment and requested the Board's Biologist, Dr J A Robb, for an updated report on biological conditions within the river system. This request was subsequently actioned in January 1987 when four suitably qualified students (Misses L Hayes and C McDermott and Messrs S Paterson and T Swain) from the Zoology Department, University of Canterbury were employed to assist with the field work.

The report was co-ordinated and prepared by Dr Robb. Others involved in its preparation were Messrs D S Rid and K Sibly (draughting) and Mrs P Bouma (typing).

The assistance received from Dr M J Winterbourn (Zoology Department, University of Canterbury) is gratefully acknowledged.



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CONTENTS:

		Page
1	INTRODUCTION AND METHODS	1
2	RESULTS AND DISCUSSION	3
3	SUMMARY AND CONCLUSIONS	6
4	REFERENCES	21

TABLES:

1	Distribution of Invertebrates and Aquatic Weeds: Kaputone Stream	8
2	Distribution of Invertebrates and Aquatic Weeds: Styx River	12
3	Distribution of Invertebrates and Aquatic Weeds: Smacks Creek	18

APPENDICES:

1	Sampling Sites	23
2	Species Composition of the Styx River Catchment	29

1 INTRODUCTION AND METHODS:

1.1 Introduction:

The Christchurch Drainage Board's rating district of 290 km² incorporates the catchments of three rivers - the Avon (84 km²), the Heathcote (103.4 km²) and the Styx (54.8 km²). The first comprehensive biological survey of the waterways within these catchments was undertaken between November 1978 and April 1979 (Christchurch Drainage Board, 1980). The following year the neighbouring Halswell catchment was surveyed as a reference (Christchurch Drainage Board, 1981). The distribution patterns of aquatic weeds within the Avon, Heathcote and Styx were updated in 1984 - 85 (Christchurch Drainage Board, 1986) and a separate study of the heavy metal qualities of the bed sediments in all three catchments was undertaken between November 1980 and February 1981 (Christchurch Drainage Board, 1988).

The Styx River (Figure 1 and Appendix 1) traverses the northern suburbs of the Board's district and is the main outlet for the Papanui, Belfast and Northcote areas. It is 21 km long and roughly parallels the Waimakariri River which it joins near its mouth in Brooklands Lagoon. Two natural tributaries service this river - Smacks Creek (approximately 2 km long) and the Kaputone Stream (11 km). All three branches are spring-fed and maintain reasonably constant flows through predominantly rural areas. The tidegates just below Harbour Road have a major influence on the hydrology of the lower reaches of the Styx River. Not only is seawater prevented from penetrating much above site 41 but the impedance offered to the river water during each flooding tide ensures that a (freshwater) tidal regime is maintained almost up to Marshland Road where low-flows average between 1.5 and 2.0 m³/s.

Many man-made drains contribute to this river system too and although several of them were sampled in the earlier surveys they were not considered this time.

Site numbering is the same as that used in the earlier surveys. This time one additional site (12a) was included in the Styx River 50 m below the Main North Road.

1.2 Methods:

The Kaputone Stream and Styx River were sampled in January and February 1987. Unfortunately, Smacks Creek was inadvertently omitted and not sampled until November 1988 when this report was in an advanced stage of being written up.

Sampling procedures were essentially the same as those employed in one or other of the earlier surveys. Each site was located as specifically as possible and an area ranging from 20 m upstream to 20 m downstream of this point sampled thoroughly.

Kick-sampling with a close-mesh triangular nylon net was carried out wherever possible but in deeper water and areas where the bed-sediments were soft a 70 mm core sampler and an Eckman Dredge were used. A raked net (Christchurch Drainage Board 1986, Appendix 6) was used to sample beds of submerged macrophytes. Several samples were collected from each locality and taken back to the laboratory for sorting, identification and documentation. On this occasion the data was recorded on a presence/absence basis with three (not two as in 1978-79) tiers of abundance:

- "o" Trace quantities of weed/very few individual animals present.
- "*" Species present in moderate quantities/numbers - i.e. not difficult to find but not abundant.
- "+" Species abundant. Indicates that it is dominant within the area sampled.

Macrophytes were recorded if they were present in the stream-bed or on the banks. As in the 1984-85 survey plants falling into the category of "weeds of waste ground" (e.g. *Epilobium* species) were not included unless they had marginal aquatic characteristics and were specifically associated with the waterway. Trees and shrubs were excluded.

Several of the taxa encountered, notably the Orthocladinae, Tanypodinae and Ceratopoginae (all Diptera) were, unfortunately, not identified beyond family level and in most instances the filamentous green algae were lumped together in a single grouping. (Varying proportions of at least five genera - *Cladophora*, *Spirogyra*, *Ulothrix*, *Vaucheria* and *Microspora* - were verified but not specifically documented). On the other hand the Oligochaeta were well differentiated this time - an important advance on the previous surveys.

Distribution patterns are presented in Tables 1 - 3 and a complete listing of taxa recorded is given in Appendix 2.

Jaccard's Coefficient of Community (CC) provides useful indices of diversity and similarity within a defined catchment (Christchurch Drainage Board, 1980). Because this index only takes into account taxa that are present in the catchment at the time(s) of sampling it allows direct comparisons to be made on the basis of qualitative (i.e. presence/absence) data. Basically, both of the indices used are simple ratios:

- 1 The coefficient of diversity, CC_d , derived from the expression:

$$CC_d = \frac{N}{T}$$

where N is the number of taxa present within a defined section of catchment and T is the total number encountered within the catchment at the time of sampling (53 in this instance) and

- 2 The coefficient of similarity, CC_s , between two defined sections of catchment derived from the expression:

$$CC_s = \frac{P}{P + M}$$

where P is the number of taxa common to both of the sections being compared and M is the number present in one or other but not both of them.

Note:

- 1 Only the freshwater component was included in these computations and
- 2 Because Smacks Creek was sampled at a much later date than the rest of the catchment the data obtained for Sm1 - Sm3 is not included.

2 **RESULTS AND DISCUSSION:**

2.1 **Aquatic Macrophytes:**

Despite some irregularities the aquatic weeds present in February 1987 were distributed in essentially the same way as they were in 1985. It is concluded that nearly all of the differences noted - especially in standing crop and relative abundance - can be attributed to the weed-cutting activities of Drainage Board maintenance staff prior to sampling.

Ten taxa - the associations of filamentous green algae, the charophyte *Nitella hookeri*, *Leptodictyum riparium* (water moss), *Nasturtium microphyllum* (watercress), *Mimulus moschatus* (musk), *Elodea canadensis* (oxygen weed), *Potamogeton crispus* (curled pondweed), *Agrostis stolonifera* (creeping bent), *Glyceria maxima* (floating sweetgrass) and *Callitriche stagnalis* (starwort) - accounted for most of the submerged and emergent aquatic weeds present in 1987. The first five were well represented throughout the catchment down to the limits of saltwater intrusion whilst *E. canadensis* and *P. crispus* totally dominated the stream bed between Marshland Road and the tide gates. *Agrostis*, *Glyceria* and *Callitriche* were irregularly distributed, seldom abundant and never dominant. Two floating species - *Azolla rubra* (waterfern) and *Lemna minor* (duckweed) - were also common at many localities, especially in Smacks Creek and the upper half of the Kaputone Stream. They were generally confined to slow-moving or stagnant sections and along the river margins - often in association with emergent macrophytes such as *Nasturtium* and *Myosotis caespitosa* (forget-me-not).

Potamogeton crispus was virtually restricted to the lower Styx; it was not present in the Kaputone Stream and recorded at only three sites (10, 13 and 17) in the Styx River above Marshland Road. It was, however, also present in several of the maintained drains not surveyed this time and if left unchecked could easily proliferate throughout the remainder of the river system. It is essential that regular monitoring and stringent control measures are maintained to ensure that this does not happen. Since it was introduced to the local catchments back in the 1960's this species has been particularly aggressive and very successful within the non-saline and low-saline tidal reaches of our local rivers. By 1979 it was well established in the Avon and Heathcote Rivers but present at only one site (40) in the Styx. Since then it has proliferated to such an extent that by February 1985 it was co-dominant with *Elodea canadensis* below Marshland Road. Since then its distribution and abundance have remained virtually unchanged.

2.2 **Freshwater Invertebrates:**

The data presented in Table 1 indicates that a wide range of invertebrate life has been maintained in this river system. The diversity and abundance of caddis larvae continues to be a distinctive feature of the ecology of the catchment and their continued presence along with taxa such as *Deleatidium*, *Coloburiscus*, *Zephlebia* and *Xanthocnemis* attests to the fact that a high standard of water quality is being maintained. At least 17 species are currently represented, which accounts for all but one (*Helicopsyche albescens*) of those currently present in the four catchments (Avon, Heathcote, Styx and Halswell) servicing the Board's district.

Fifty three taxa were recorded during the main part of this survey (i.e. in January and February 1987) - eight less than in 1979. This includes four new records - the small freshwater limpet *Ferrissia*, the crustacean *Orchestia tenuis*, an unidentified representative of the Helodidae (Insecta, Coleoptera) and a second species of the caddis *Triplectides* - *T. cephalotes*. If the observations from Smacks Creek (sampled November 1988) are included this total increases to 62 and the number of new records to seven with the inclusion of the coelenterate *Chlorohydra viridissima*, the chironomid *Maoridiamesa harrisi* and a second species of *Pycnocentria* (*P. aeris*). At least three of these taxa - *P. aeris*, *T. cephalotes* and *M. harrisi* - were probably present in 1979 but not recognised as distinct species at the time.

Several of the caddises and mollusca - notably *Oecetis* and *Sphaerium* (throughout), *Aoteapsyche*, *Hydrobiosis*, *Pycnocentria* and *Oeconesis* (above Marshland Road) and *Olinga*, *Triplectides obsoleta*, *Gyraulus* and *Physa* (in the lower Styx) were more widely distributed and possibly more abundant in 1987 than they were in 1979. This is attributed to chance differences in the timing of weed-cutting and channel maintenance operations prior to sampling and not to long-term changes.

A few taxa - notably the crustaceans *Paratya* and *Simocephalus* - were not as common. These species are usually associated with marginal macrophytes and consequently their spatial distribution is strongly influenced by the flood-control measures employed by river maintenance staff. Flooding is a very sensitive issue throughout this catchment and weed-cutting and channel maintenance operations are given a high priority-rating by the Drainage Board. Occasionally, channel widening is necessary - which may in turn lead to increased siltation of the stream bed. Such activities lead to fewer habitat opportunities and, consequently, reduced diversity within the biotic community. These effects were all evident in sections of the Styx River (particularly within the lower reaches) back in 1979. Nevertheless the community structure at that time was still far more diversified than it was in equivalent sections of the Avon and Heathcote Rivers. Conditions were essentially very similar eight years later when only one species - the cased caddis *Paroxyethira hendersoni* - exhibited significant changes in both its distribution and abundance. In 1979 this species was a dominant component of the Styx River community between Marshland Road and site 39 (just above Harbour Road). In 1987 only two individuals were found - at sites 33 and 41. The larva of *Paroxyethira* is herbivorous and normally associated with weed-beds (Christchurch Drainage Board, 1980) which were prolific within this section of river on both occasions. Unfortunately, a satisfactory explanation for this anomaly cannot be given from these observations.

Most of the remaining taxa were distributed in essentially the same manner as they were in 1979. In all three sections of river - especially the non-tidal section of the Styx River (including Smacks Creek) and the Kaputone Stream - invertebrate life was not quite as diverse as it was in 1979 (Table 3a).

Table 3: Coefficients of Diversity and Similarity:

(a) Diversity (CC_d):

	Kaputone	Upper Styx	Lower Styx
1979	0.80	0.84	0.66
1987	0.79	0.72	0.68

(b) Similarity (CC_s):

	1979	1987
Kaputone v Upper Styx:	0.82	0.70
Kaputone v Lower Styx:	0.59	0.56
Upper Styx v Lower Styx:	0.57	0.51

The range of life found in the Kaputone and upper Styx was again similar ($CC_s = 0.70$) - though not as similar as it was in 1979 when $CC_s = 0.82$. This is attributable in large measure to the proportionally greater reduction in diversity within the upper Styx (Table 3a). Nevertheless the two non-tidal sections of river continue to support a much greater diversity of invertebrate life than the lower Styx.

Smacks Creek also continues to support a diverse community even though current velocities in the vicinity of and below Site Sm3 have been reduced markedly by recent developments within the Willowbank Wildlife Reserve.

Taxa not encountered during this survey include the freshwater mussel *Hyridella menziesi*, the crustaceans *Anisops* and *Phreatogammarus fragilis*, the water beetle *Antiporus strigosulus*, representatives of the Elmidae (Coleoptera) and the lepidopteran *Nymphula nitens*. These species were all sparsely distributed at the time of the first survey and their absence from the 1987 data base does not necessarily mean that they have disappeared from this catchment. It has in fact since been established that at least three of them are still represented: *Hyridella* is still regularly encountered by Drainage Board maintenance staff in clearly defined sections of river and more recent investigations by our laboratory staff have noted the presence of *Anisops* and *Antiporus strigosulus* in areas not specifically covered by our sampling schedule. It is also suspected that some of the less conspicuous taxa like the leeches *Glossiphonia multistriata* and *Barbronia weberi* and (possibly) the coelenterate *Chlorohydra* are not being adequately accounted for by our sampling procedures. Possibly the mesh-size of the nets used is a little too coarse to retain them satisfactorily, suggesting that they too may be more common in our local rivers than the data would suggest.

3 SUMMARY AND CONCLUSIONS:

- 3.1 The distribution patterns of aquatic macrophytes and benthic macroinvertebrates in the Styx River and Kaputone Stream were investigated in early 1987. Smacks Creek was sampled in November 1988.
- 3.2 Most of the aquatic weeds were distributed as they were in 1985. Distribution patterns are detailed (Tables 1 - 3) and discussed briefly. The curled pondweed *Potamogeton crispus* and the oxygen weed *Elodea canadensis* continue to proliferate within the tidally-influenced reaches of the Styx River below Marshland Road.

3.3 The macroinvertebrate community has not changed very much since 1979. The 62 taxa recognised this time (one more than in 1979) includes seven new ones and 17 of the 18 species of caddis larva so far collected by Drainage Board staff from rivers within its present rating district. Only one species (the small cased caddis *Paroxythira hendersoni*) was much less abundant than it was in 1979. Distribution patterns are detailed in Tables 1 - 3 and computations for diversity and similarity are presented and discussed.

It is concluded from the composition of the communities encountered that:

- (a) Water quality is generally of a high standard throughout the catchment and
- (b) The freshwater, non-tidal sections of this catchment continue to support a much greater diversity of invertebrate life than the tidally-influenced section below Marshland Road.

TABLE 1: Distribution of invertebrates and aquatic weeds: Kaputone Stream

Site	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	K14	K15
<i>Phaenocora</i> sp															
<i>Cura pinguis</i>	+			*	*	o	o	o	+	+	+	+	o	+	+
<i>Neppia montana</i>				o	o	*	*	*	+	*	*	+	o	o	o
<i>Tubifex tubifex</i>	o	o	o	o	o	*	*	*	+	*	*	*	o	o	o
<i>Lumbriculus variegatus</i>	o	+	*	o	*	*	o	*	+	+	+	*	*	+	o
<i>Eiseniella tetraeda</i>															
<i>Potamopyrgus antipodarum</i>	*	*	o	o	o	o	o	+	o	+	+	o	*	+	*
<i>Gyraulus corinna</i>							o		+	+	+	o	o	o	o
<i>Physa</i> sp	o	o	o	o	o	o	o	o	*	*	*	*	o	+	o
<i>Sphaerium novaezelandiae</i>	o	+	+	*	o	o	o	+	*	*	*	*	+	*	*
<i>Pisidium</i> sp									*	*	*	*	*	*	*
<i>Simocephalus</i> sp									*	*	*	*	*	*	*
<i>Herpetocypris pascheri</i>	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
<i>Eucyclops serrulatus</i>	*			o	o	o	o	o	o	o	o	o	o	o	o
<i>Paracalliope fluviatilis</i>	o	+	+	*	o	*	o	o	o	o	o	o	o	o	o
<i>Acarina</i> (unidentified)	o	+	+	o	o	o	o	o	o	o	o	o	o	o	o
<i>Xanthocnemis zealandica</i>															
<i>Microvelia macgregori</i>															
<i>Sigara arguta</i>									o	*	+	+	+	o	o
<i>Neurochorena confusum</i>									o	o	o	o	o	o	o
<i>Oxyethira albiceps</i>									o	o	o	o	o	o	o
<i>Pycnocentria evecta</i>									o	o	o	o	o	o	o
<i>Liodessus plicatus</i>	*	*	o	o	o	o	o	o	o	o	o	o	o	o	o
Helodidae	o														
<i>Zealandotipula</i> sp															
<i>Paralimnophila skusei</i>															
<i>Culex</i> sp	o														
<i>Chironomus zealandicus</i>															
Orthocladinae	o	o	o	o	o	o	+	o	+	o	*	+	+	+	*
Tanypodinae															
<i>Limnophora</i> sp								*							o

TABLE 1 : (Cont'd)

	K16	K17	K18	K19	K20	K21	K22	K23	K24	K25	K26	K27	K28	K29	K30
Phaenocora sp															
Cura pinguis					*	*								*	*
Tubifex tubifex				*	*	*	*	*	*	*	*	*	*	*	*
Lumbriculus variegatus		*	*	*	*	*	*	*	*	*	*	*	*	*	*
Eiseniella tetraeda															
Potamopyrgus antipodarum	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Gyraulus corinna	*				*	*	*	*	*	*	*	*	*	*	*
Physa sp	*				*	*	*	*	*	*	*	*	*	*	*
Sphaerium novaezealandiae		*	*	*	*	*	*	*	*	*	*	*	*	*	*
Platidium sp															
Ferrissia sp															
Simocephalus sp															
Herpetocypris pascheri	*													*	*
Eucyclops serrulatus															
Acarina (unidentified)															
Deleatidium sp															
Xanthocnemis zealandica															
Microvelia macgregori															
Sigara arguta															
Polyplectropus puerilis				*											
Hydrobiosis parumbripennis									*						
Oxyethira albiceps															
Pycnocentria evecta		*													
Pycnocentroides aureola															
Oeconesus maori															
Triplectides obsoleta	*			*											
Hudsonema anabilis						*									
Hudsonema aliena															
Oecetis unicolor							*	*	*	*	*	*	*	*	*
Chironomus zealandicus		*	*	*	*	*	*	*	*	*	*	*	*	*	*
Orthocladinae							*	*	*	*	*	*	*	*	*
Tanypodinae															
Ceratopogonidae															
Limnophora sp					*										

TABLE 1 : (Cont'd)

TABLE 2 : (Cont'd)

Site	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
<i>Phaenocora</i> sp	0							0						0	+
<i>Onca pinguis</i>	*	0	0			+		+	0	0	+	+	0	0	+
<i>tubifex tubifex</i>	+	*	0	+	0	0	0	0	0	+	0	*	*	*	0
<i>Lumbriculus variegatus</i>	*	0	*	0	*	0	0	0	0	0	0	0	0	0	0
<i>Eiseniella tetraeda</i>	0														
<i>Glossiphonia multistriata</i>	*	0	0	0	*	*	0	0	+	+	+	0	*	+	+
<i>Potamopyrgus antipodarum</i>	0	0	+		*	*	0	*	*	0	*	+	0	+	+
<i>Gyraulus corinna</i>	0	0	0		0	0	0	0	0	0	*	0	*	*	*
<i>Physa</i> sp	+	+	0	*	*	0	0	*	+	+	+	+	+		*
<i>Sphaerium novaezealandiae</i>	+														
<i>Pisidium</i> sp															
<i>Herpetocypris pascheri</i>	0	0	0		0	0		0	0	0	0	0		0	*
<i>Bucyclops serrulatus</i>			*											0	*
<i>Paracalliope fluviatilis</i>	+						0	0	0	0	0	0	0	0	0
<i>Orchestia tenuis</i>															+
<i>Paratya curvirostris</i>		0													
<i>Acarina</i> (unidentified)			+		0	0		0	0	+	0				
<i>Coloburiscus humeralis</i>	0		*		0	0	0	*	0	*	*	*	0		0
<i>Xanthocnemis zealandica</i>					0	0	0	*	0	*	0	0	0		0
<i>Microvelia macgregori</i>					0	0	0	0	0	0	0	0	0		0
<i>Sigara arguta</i>	0	0	+		0	0	0	0	0	+	0	0	0		0
<i>Oxyethira albiceps</i>	0	0	0		0	0	0	0	0	0	0	0	0		0
<i>Pycnocentria evecta</i>					0	0	0	0	0			0			
<i>Ollinga feredayi</i>															
<i>Oeconesus maori</i>											0				
<i>Triplectides obsoleta</i>	0										*			*	
<i>Triplectides cephalotes</i>							*	*	*	*	*	*	*	*	*
<i>Hudsonema amabilis</i>	0	0		*	0		*	*	0	*	*	+	*	0	*
<i>Oeetis unicolor</i>	0	0		0	0	+	*	0	0	0	*	0	0	0	*
<i>Mischoderus</i> sp	0														
<i>Chironomus zealandicus</i>	+	+	+	+	+	+	+	+	+	*	+	+	+	+	+
<i>Orthocladinae</i>	*		+		0	0	0	0	*	0	0	0	0	0	*
<i>Tanypodinae</i>		0									0	0			*
<i>Ceratopogonidae</i>											0	0			0
<i>Limnophora</i> sp						+									+

TABLE 2 : (Cont'd)

TABLE 2 : (Cont'd)

Site	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
<i>Baenocora</i> sp	0	*	*												
<i>Cura pinguis</i>	*	0	0	0	0	*	*	0	0	0			0		
<i>Tubifex tubifex</i>	0	0	0	0	0	*	0	0	0	0					
<i>Lumbriculus variegatus</i>	0	0	0	0	0	0	0	0	0	0					
<i>Eiseniella tetraeda</i>						0	0	0	0	0			*		
<i>Niloon aestuariensis</i>						0	0	0	0	0		*	*	0	0
<i>Scolecopelides benhami</i>						0	0	0	0	0		*	*	0	0
<i>Glossiphonia multistriata</i>										0					
<i>Potamopyrgus antipodarum</i>	*	+	*	*	*	*	+	*	*	*	*	0	0	+	+
<i>Potamopyrgus estuarius</i>										*	+	+	*	+	
<i>Gyraulus corinna</i>	+	0	+	+	0	0	*	*	*	*	0	0	0		
<i>Physa</i> sp	*	*	*	*	0	0	+	*	0	*	0	0	0		
<i>Sphaerium novaezealandiae</i>	*	*	*	*	*	0	0	*	0	*	0	0	*	*	*
<i>Chione stutchburyi</i>											+	+	+	+	+
<i>Amphibola crenata</i>															
<i>Herpetocypris pascheri</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Exosphaeroma planulum</i>															
<i>Eucyclops serrulatus</i>															
<i>Gammaropsis</i> sp															
<i>Paracalliope fluviatilis</i>	0	0	*	*	0	0	0	0	0	0	0	0	0	0	0
<i>Melita awa</i>															
<i>Orchestia tenuis</i>	+	0	0	0	0	0	0	0	0	0	+	*	0	+	+
<i>Helice crassa</i>															
<i>Acarina</i> (unidentified)															
<i>Xanthocnemis zealandica</i>	0	0	0	0	0	0	0	0	0	0					
<i>Microvelia macgregori</i>															
<i>Sigara arguta</i>	0				0										
<i>Oxyethira albiceps</i>					0										
<i>Paroxyethira hendersoni</i>	0								0						
<i>Pycnocentria evecta</i>	0	*													
<i>Ollinga feredayi</i>											0	0	0		
<i>Triplectides obsoleta</i>	0	0	0	0	0			0							
<i>Triplectides cephalotes</i>						*									
<i>Hudsonema amabilis</i>	*	*	0	0	0	0	0	*							
<i>Oecetis unicolor</i>	*	*	0	*	0	0	0	0	*	*	*	*	*	+	+
<i>Chironomus zealandicus</i>	+	+	*	*	*	0	*	+	*	*	*	*	*	+	0
<i>Orthocladinae</i>	+	0	*	0	+	*	+	0	*	+	*	*	*	*	*
<i>Tanypodinae</i>															

TABLE 2 : (Cont'd)

TABLE 2 : (Cont'd)

	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Filamentous green algae	+	+	+	+	+	+	*	o	+	+	+	+			
Cladophora sp															*
Nitella hookeri		o	o	o	o	o	o	o	o						
Leptodictyum riparium	o	o	o	*	*	*	o	o	o						
Potamogeton crispus	*	*	*	+	*	*	*	*	+	+					
Elodea canadensis	+	+	+	*	*	+	+	+	*	*					
Agrostis stolonifera	o	o	*	*	*	*	o	o	o	*					
Callitriche stagnalis	o	o	o	*	*	*	o	o	o	*					
Nasturtium microphyllum	o	o	o	*	*	*	o	o	o	*	*				
Mimulus moschatus	o	*		*	*	*	o	o	o	*	*				
Myosotis caespitosa								o	o	o					
Juncus articulatus	*	*	o		*	o	o	*	*	*	+	+			
Juncus gregiflorus						o	*		*	*					
Typha orientalis									*	+	*	*			
Enteromorpha spp								o	*	*	*	*	*	*	*
Porphyra sp														*	*
Bostrychia harveyi								o	o	*	*	*	*	*	*
Caloglossa leprieurii											*	*	*	*	*
Zostera muelleri											+	+	+	+	+
Juncus maritimus											*	*	*	*	*
Leptocarpus similis											*	*	*	*	*
Eleocharis acuta					*	*	*	*	*	*	*	*	*	*	*
Scirpus americanus									*	*	*	*	*	*	*
Scirpus cernuus									*	*	*	*	*	*	*
Carex sp(p)	*		*		*			*	*					*	*

TABLE 3 : Distribution of invertebrates and aquatic weeds: Smacks Creek (November 1988)

Site	Sn1	Sn2	Sn3
<i>Chlorohydra viridissima</i>			o
<i>Cura pinguis</i>	*	*	*
<i>Lumbriculus variegatus</i>	+	+	*
<i>Glossiphonia multistriata</i>	o		o
<i>Barbronia weberi</i>			o
<i>Potamopyrgus antipodarum</i>	+	o	o
<i>Gyraulus corinna</i>	o		o
<i>Physa</i> sp		*	o
<i>Sphaerium novaezelandiae</i>	*	o	*
<i>Herpetocypris pascheri</i>	o	*	*
<i>Eucyclops serrulatus</i>		o	o
<i>Paracalliope fluviatilis</i>	*	*	+
<i>Paraleptamphopus subterraneus</i>		*	o
<i>Acarina</i> (unidentified)	o		
<i>Daleatidium</i> sp		+	o
<i>Coloburiscus humeralis</i>		o	o
<i>Zephlebia nodularis</i>			o
<i>Austrolestes colenisonis</i>			o
<i>Microvelia macgregori</i>	o	o	o
<i>Polypectropus puerilis</i>		*	o
<i>Hydrobiosis parumbripennis</i>			o

TABLE 3 : (Cont'd.)

Site	Sm1	Sm2	Sm3
<i>Psilochorema bidens</i>		○	○
<i>Neurochorema confusum</i>		○	
<i>Oxyethira albiceps</i>	*	*	+
<i>Paroxyethira hendersoni</i>			○
<i>Pycnocentria evectora</i>		+	○
<i>Pycnocentria aeris</i>			○
<i>Pycnocentroides aureola</i>		○	
<i>Olinga feredayi</i>		○	
<i>Aoteapsyche colonica</i>		*	○
<i>Hudsonema amabilis</i>		+	*
<i>Oecetis unicolor</i>		○	
<i>Liodessus plicatus</i>	○		○
<i>Zelandotipula</i> sp		○	
<i>Mischoderus</i> sp		○	
<i>Chironomus zealandicus</i>		○	*
<i>Maoridiamasa harrisi</i>			○
<i>Orthocladinae</i>	○	+	*
<i>Austrosimulium</i> sp	○	○	
Muscidae	○		

TABLE 3 : (Cont'd.)

Site	Sm1	Sm2	Sm3
<i>Spirogyra</i> sp	+		+
<i>Nitella hookeri</i>	o	o	*
<i>Batrachospermum</i> sp		o	
<i>Leptodictyum riparium</i>	o	*	o
<i>Blechnum</i> sp	o	*	o
<i>Blechnum perna-marina</i>	o	*	o
<i>Potamogeton cheesemani</i>		o	*
<i>Elodea canadensis</i>		+	*
<i>Agrostis stolonifera</i>	o	*	o
<i>Glyceria fluitans</i>		o	*
<i>Glyceria maxima</i>			+
<i>Azolla rubra</i>	+	*	o
<i>Lemna minor</i>	+	*	o
<i>Callitriche stagnalis</i>	+	*	
<i>Nasturtium microphyllum</i>	+	+	*
<i>Myosotis caespitosa</i>	o	*	o
<i>Marchantia berteroana</i>	o	*	o
<i>Mentha</i> spp		*	*
<i>Mimulus guttatus</i>		+	*
<i>Ranunculus repens</i>	o	*	*
<i>Juncus articulatus</i>	*		o
<i>Polygonum</i> sp	o		
<i>Rumex obtusifolius</i>		o	
<i>Craspedia uniflora</i>	o	o	o
<i>Geranium molle</i>		o	

4. REFERENCES:

- Christchurch Drainage Board (1978) **Environmental assessment of the Woolston Cut and associated stopbanking on the Heathcote River.** Unpublished Report, November 1978. 84 pp.
- Christchurch Drainage Board (1980) **A biological survey of rivers in the metropolitan Christchurch area and outlying districts. The Avon, Heathcote and Styx Rivers.** Unpublished Report, March 1980. 214 pp.
- Christchurch Drainage Board (1981) **A biological survey of rivers in the metropolitan Christchurch area and outlying districts. The Halswell River Catchment.** Unpublished Report, August 1981. 71 pp.
- Christchurch Drainage Board (1986) **A botanical survey of the rivers in the metropolitan Christchurch area and outlying districts. The Avon, Heathcote and Styx Rivers and their tributaries.** Unpublished Report, May 1986. 91 pp.
- Christchurch Drainage Board (1988) **Heavy metals in the rivers and estuaries of metropolitan Christchurch and outlying areas.** Unpublished Report, March 1988. 221 pp.

APPENDIX 1**SAMPLING SITES****Smacks Creek:**

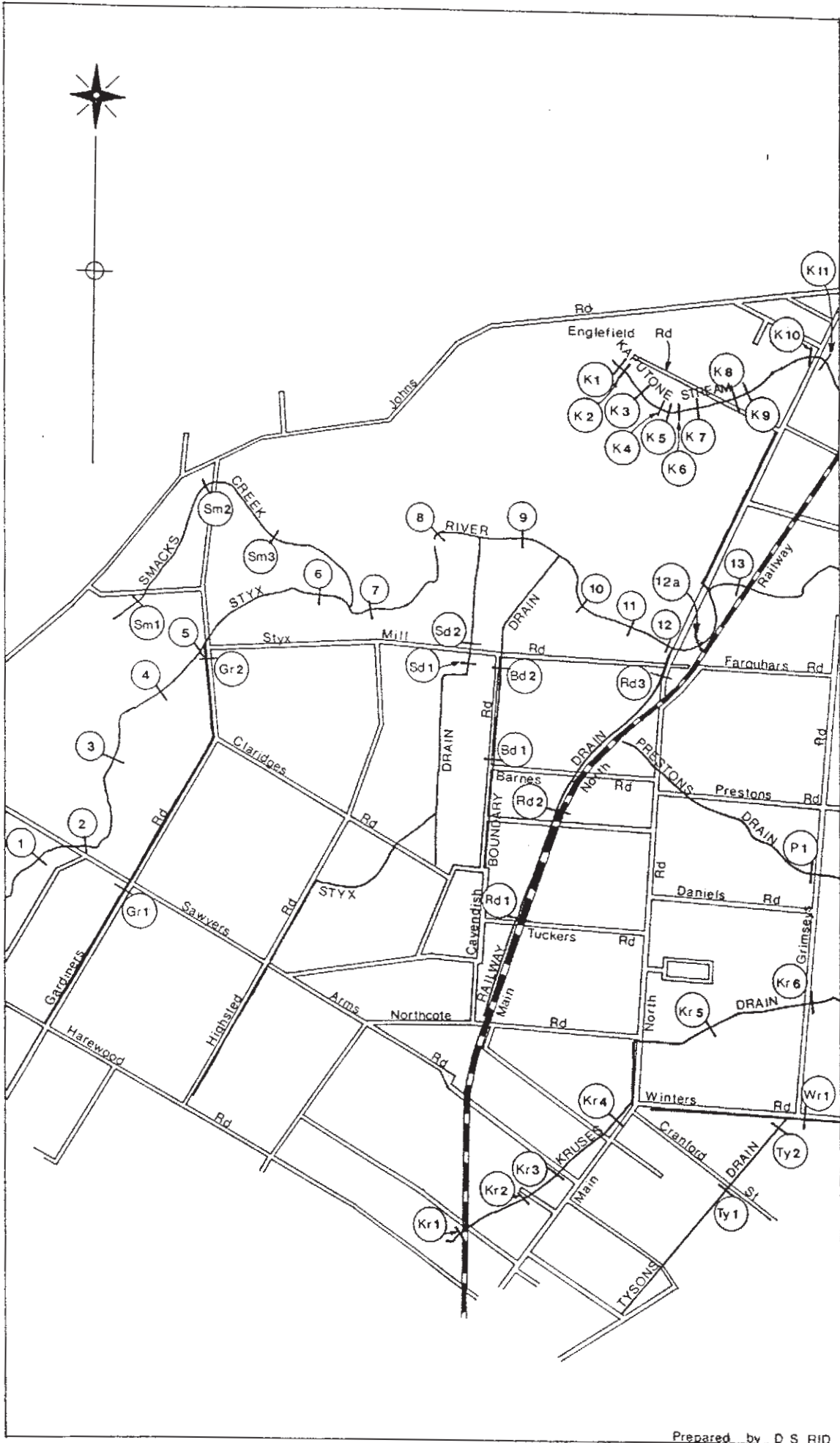
- Sm 1 Wilkinsons Road by Harewood Crematorium
- Sm 2 Top of Gardiners Road
- Sm 3 By Willowbank Wildlife Reserve where Smacks Creek emerges under
 Hussey Road

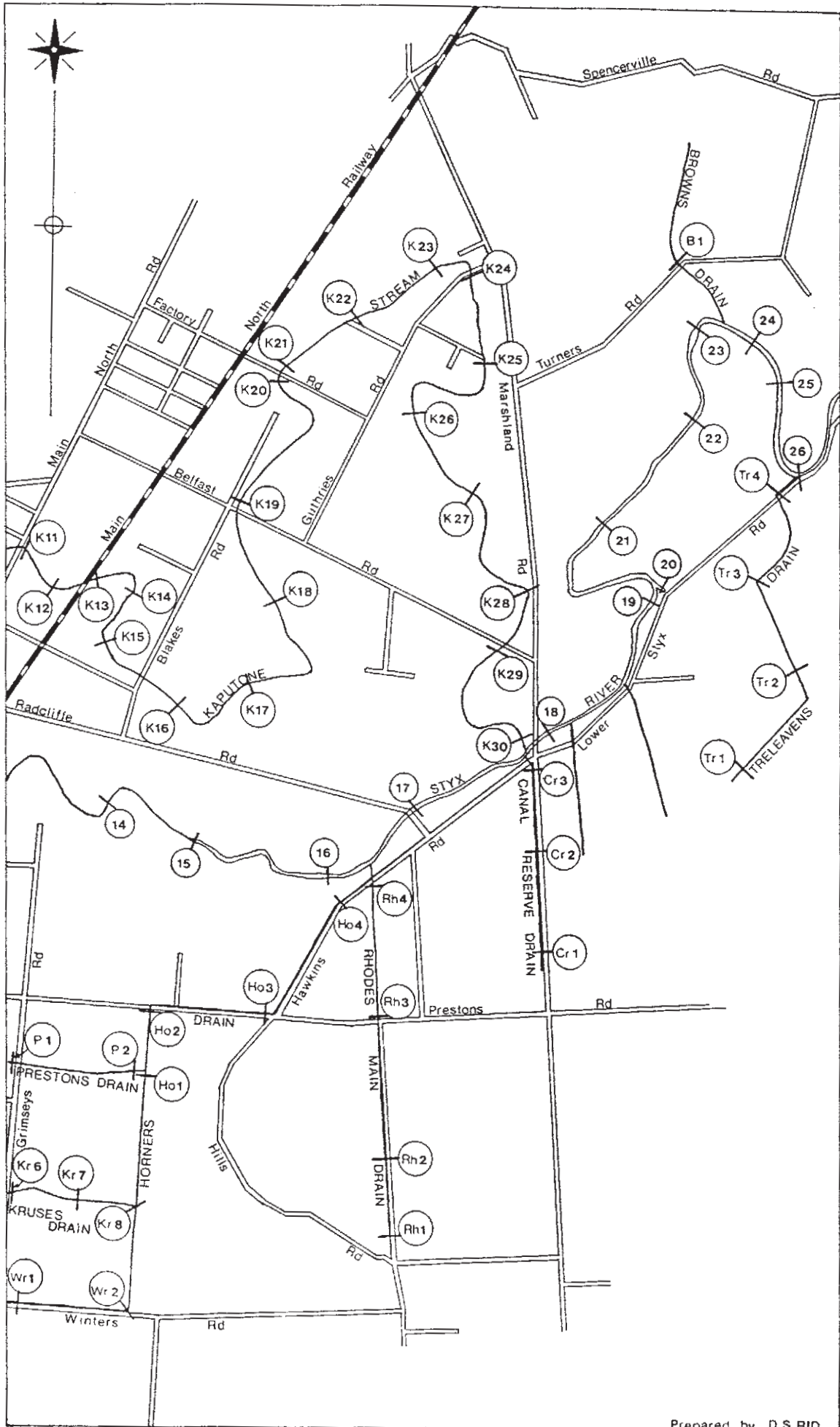
Kaputone Stream:

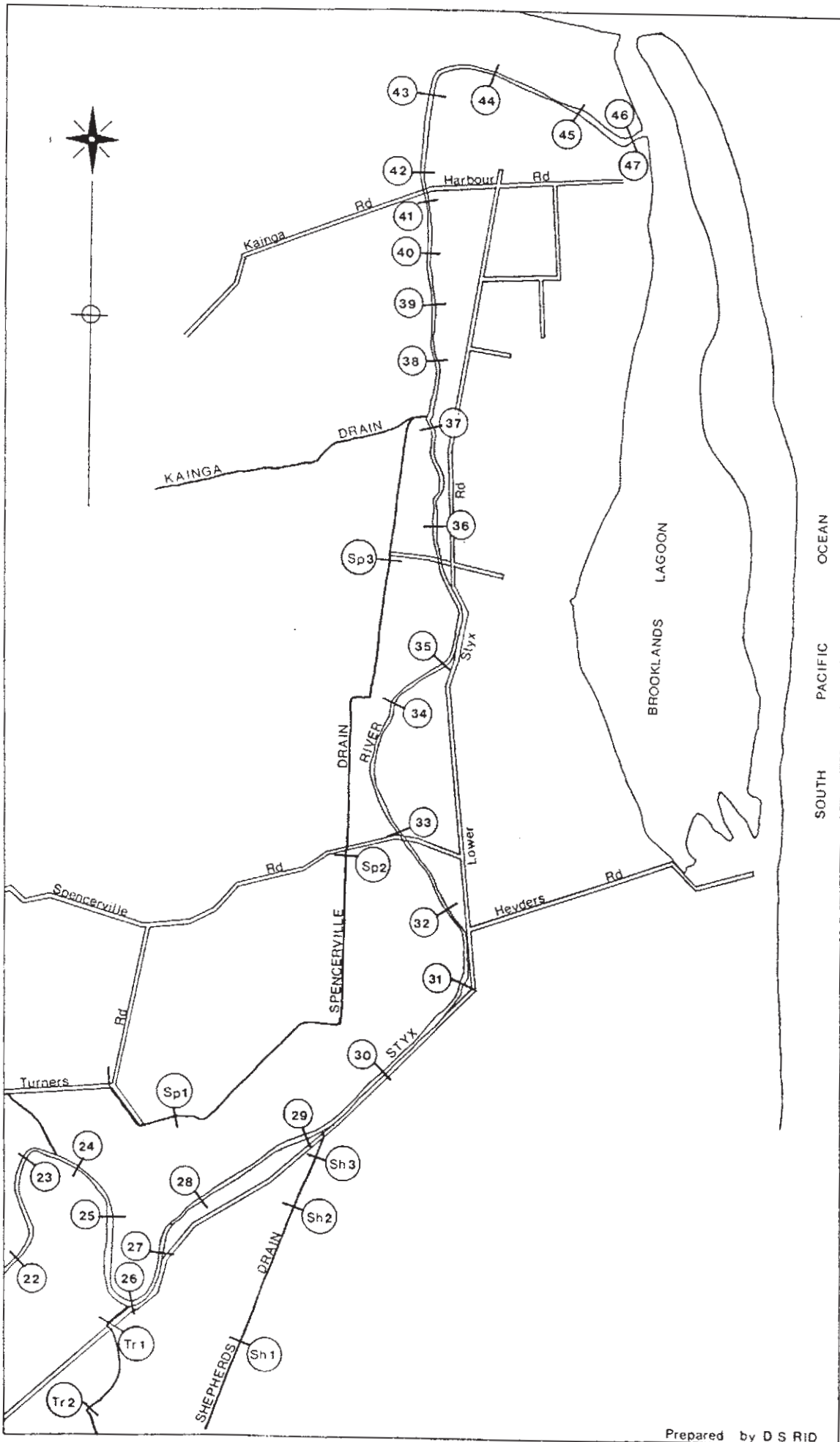
- K 1 Headwaters top end Englefield Road, above race
- K 2 10 m downstream of K 1, below race
- K 3 200 m down from K 1, below private right-of-way to market garden
- K 4 200 m down from K 3, opposite orchards
- K 5 50 m downstream from K 4.
- K 6 30 m downstream of K 5, below Meadowland playground
- K 7 100 m upstream of Englefield Road, upstream of private residence
- K 8 5 m downstream of Englefield Road
- K 9 20 m downstream from K 8.
- K 10 Just upstream of Main North Road
- K 11 684 Main North Road, above and below culvert under driveway
- K 12 100 m downstream from K 10, halfway to railway line
- K 13 10 m below railway line
- K 14 100 m below railway line, below culvert under race
- K 15 Access by Thompsons Road, below culvert under race to paddock 16
- K 16 Freezing works paddock
- K 17 Midway around curve in river
- K 18 Opposite end of Guthries Road
- K 19 5 m below Belfast Road
- K 20 50 m above Factory Road through freezing works property, below
 vehicle bridge
- K 21 5 m below Factory Road
- K 22 5 m below end of side road
- K 23 Upstream end of Ouruhia Park, off Chenery Avenue
- K 24 Just below Guthries Road
- K 25 Downstream of end of MacDonaldis Road
- K 26 By pump shed, 132 Guthries Road
- K 27 Downstream end of Everglades Golf Club, Marshland Road
- K 28 Point of river closest to Marshland Road
- K 29 10 m below Belfast Road
- K 30 25 m upstream of confluence with Styx River

Styx River:

- 1 69 Crofton Road
- 2 Just below Sawyers Arms Road
- 3 Mid-way between sites 2 and 4
- 4 Claridges Road
- 5 5 m above Gardiners Road
- 6 20 m above Smacks Creek confluence
- 7 15 m below Smacks Creek confluence
- 8 On curve in river
- 9 Halfway between Styx Drain and Boundary Drain
- 10 On curve downstream of Boundary Drain
- 11 Halfway along straight stretch of river
- 12 5 m upstream of Main North Road
- 12A 50 m downstream of Main North Road
- 13 10 m upstream of railway line
- 14 Farmland, swamp area. Access through cow paddocks, off end of Grimseys Road
- 15 River widens, marshy land, by old river channel
- 16 Behind 10 Selkirk Place
- 17 Radcliffe Road bridge
- 18 10 m downstream of Marshland Road
- 19 30 m upstream of loop
- 20 Start of loop
- 21 River narrows (approximately 10 m wide)
- 22 30 m upstream of sharp bend
- 23 Wide point just above apex of loop, near radio mast
- 24 Meadow, intermittent tree cover
- 25 Grass bank, willows and meadow, near radio mast
- 26 At staff gauge where Styx River meets Lower Styx Road
- 27 Marshy area where river meets Lower Styx Road
- 28 Just below bend in Lower Styx Road
- 29 80 m upstream of Shepherds Drain confluence
- 30 Halfway along straight stretch of river adjacent to Lower Styx Road, by pump and telegraph pole
- 31 At sharp bend in Lower Styx Road
- 32 200 m downstream of Heyders Road
- 33 10 m downstream, Spencerville Road bridge
- 34 Approximately 250 m upstream of site 35
- 35 Bend where river meets Lower Styx Road
- 36 200 m below Earlham Road bridge
- 37 50 m upstream of confluence with Kainga Drain
- 38 At island, centre stream
- 39-41 Stretch of river unchanging; sites equidistant. Site 41 just upstream of bridge.
- 42 Just downstream of bridge
- 43 Just downstream of floodgate
- 44 60 m from major bend downstream of floodgate
- 45 200 m upstream of jetty, by cutting
- 46-47 Either side of mouth of Styx River







APPENDIX 2

SPECIES COMPOSITION OF THE STYX RIVER CATCHMENT, 1987 - 88

A THE INVERTEBRATES

Phylum: Coelenterata

Chlorohydra viridissima

Phylum: Platyhelminthes

Phaenocora sp**Cura pinguis****Neppia montana**

Phylum: Annelida

Class: Oligochaeta

Tubifex tubifex**Lumbriculus variegatus****Eiseniella tetraeda**

Class: Polychaeta

Nicon aestuariensis***Scolecoclepides benhami***

Class: Hirudinea

Glossiphonia multistriata**Barbronia weberi**

Phylum: Mollusca

Class: Lamellibranchia

Sphaerium novaezelandiae**Pisidium sp****Chione stutchburyi**

Class: Gastropoda

Potamopyrgus antipodarum**Potamopyrgus estuarinus****Physa sp****Gyraulus corinna****Ferrissia sp****Amphibola crenata***

Phylum: Arthropoda

Class: Crustacea

Simocephalus sp**Herpetocypris pascheri****Eucyclops serrulatus**

Unidentified Harpacticoida

Exosphaeroma planulum***Gammaropsis sp (aff. G. thomsoni)****Paracalliope fluviatilis****Paracalliope sp (aff. P. fluviatilis)*****Melita awa*****Orchestia tenuis****Paratya curvirostris****Helice crassa*****Paraleptamphopus subterraneus**

Class: Arachnida
 Order: Acarina
 Unidentified representatives

Class: Insecta
 Order: Ephemeroptera
 Deleatidium sp
 Coloburiscus humeralis
 Zephlebia nodularis

Order: Odonata
 Xanthocnemis zealandica
 Austrolestes colenisonis

Order: Hemiptera
 Microvelia macgregori
 Sigara arguta

Order: Trichoptera
 Aoteapsyche colonica
 Hudsonema amabilis
 Hudsonema aliena
 Hydrobiosis parumbripennis
 Neurochorema confusum
 Psilochorema bidens
 Polyplectropus puerilis
 Oecetis unicolor
 Olinga feredayi
 Oxyethira albiceps
 Paroxyethira hendersoni
 Pycnocentroides aureola
 Triplectides obsoleta
 Triplectides cephalotes
 Oeconesus maori
 Pycnocentria evecta
 Pycnocentria aeris

Order: Coleoptera
 Liodesus plicatus
 Helodidae
 (Unidentified representatives)

Order: Diptera
 Limnophora sp
 Muscidae
 (Unidentified representatives)
 Paralimnophila skusei
 Limonia sp
 Zealandotipula sp
 Mischoderus sp
 Ceratopogonidae
 (Unidentified representatives)
 Austrosimulium sp
 Chironomus zealandicus
 Maoridiamesa harrisi
 Orthocladinae
 (Unidentified representatives)
 Tanypodinae
 (Unidentified representatives)
 Culex sp(p)

B THE PLANTS

Phylum: Chlorophyta (green algae)

Ulothrix sp
Microspora sp
Spirogyra sp
Vaucheria sp
Nitella hookeri
Enteromorpha sp*

Phylum: Rhodophyta (red algae)

Batrachospermum sp
Porphyra sp*
Caloglossa leprieurii*
Bostrychia harveyi*

Phylum: Bryophyta (Mosses and Liverworts)

Leptodictyum riparium

Phylum: Tracheophyta (Vascular plants)

Class: Filicopsida (Ferns)

Azolla rubra
Blechnum sp
Blechnum penna - marina

Class: Spermatopsida

Subclass: Angiospermae

I Dicotyledones

Ranunculus repens
Nasturtium microphyllum
Mimulus moschatus
Callitriche stagnalis
Myosotis caespitosa
Rumex obtusifolius
Geranium molle
Craspedia uniflora

II Monocotyledones

Elodea canadensis
Zostera muelleri*
Potamogeton cheesemani
Potamogeton crispus
Phormium tenax
Lemna minor
Juncus articulatus
Juncus gregiflorus
Juncus maritimus*
Leptocarpus similis*
Eleocharis acuta*
Scirpus americanus*
Scirpus cernuus*
Carex spp
Typha orientalis
Agrostis stolonifera
Glyceria maxima
Glyceria fluitans