

APPENDIX 4

SURFACE WATER QUANTITY AND QUALITY TREND ANALYSIS

Five Mile Creek

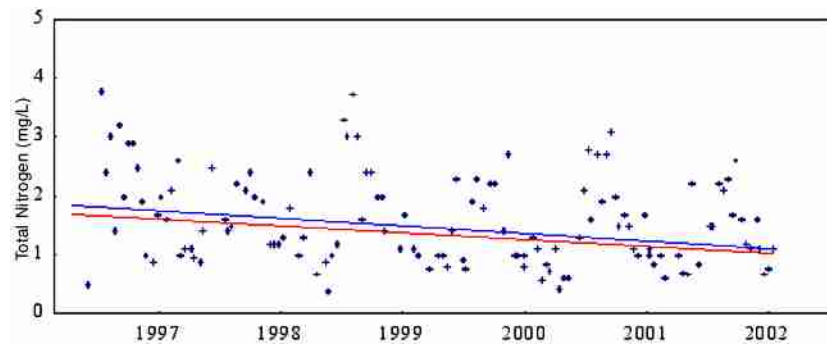


Figure 1 - Time series of observed (blue line) and flow adjusted (red line) total nitrogen for Five Mile Creek (1997-2002)

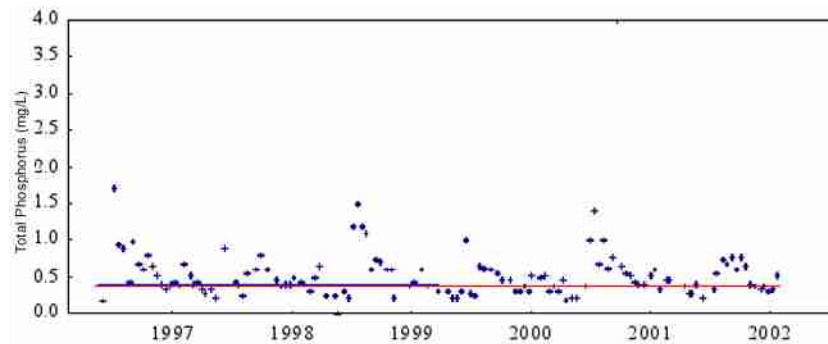


Figure 2 - Time series of observed (blue line) and flow adjusted (red line) total phosphorus for Five Mile Creek over the period 1997 to 2002.

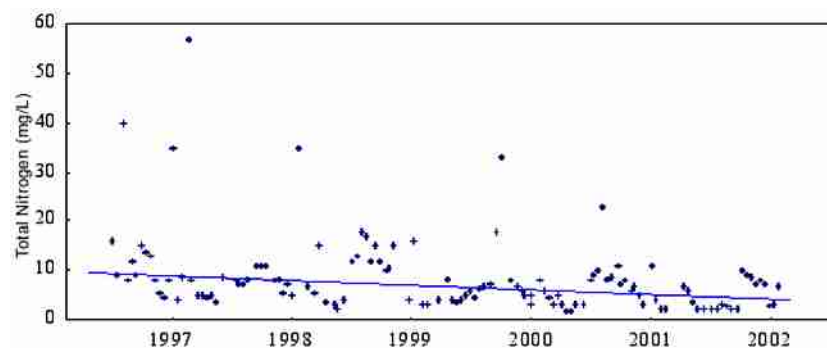


Figure 3 - Time series plot observed (blue line) turbidity for Five Mile Creek over the period 1997 to 2002.

Variable	Period	Series	Test	Slope	Z-stat	p-value	n	~n*	~n#	Result
TN	1997-02	obs	SK	-0.1	-2.917	0.004	126	124	55	Trend
	1997-02	FAC	MK	-0.072	-3.851	0	126	90	112	No trend
TP	1997-02	obs	MK	-0.008	-0.793	0.428	126	32	>1000	No trend
	1997-02	FAC	MK	-0.007	-0.835	0.404	126	69	>1000	No trend
Turbidity	1997-02	obs	MK	-0.875	-4.444	0	123	65	216	No trend

Obs = observed data; FAC = flow-adjusted data; SK = Seasonal Kendall test; MK = Mann Kendall test; n = number of samples collected; n* = number of independent samples collected; n# = required number of independent samples to detect a trend.

Table 2 - Results of statistical analysis for trends in Seven Mile Creek.

Total Nitrogen

Current total nitrogen status: High (both report and website)

The median TN concentration for the whole monitoring period (1997 to 2002) was 1.40 mg/L with annual medians ranging between 1.05 mg/L (2000) and 2.00 mg/L (1997). TN concentrations in Five Mile Creek varied between extremes of 0.44 mg/L and 3.80 mg/L. The observed data was seasonal so the Seasonal Kendall test for trend was used. The data was also related to flow and was subsequently flow-adjusted (the flow adjusted data was not seasonal). Trend analysis indicated that TN concentrations have not changed in Five Mile Creek since monitoring commenced in 1997.

Total Phosphorus

Current total phosphorus status: Very High (report) or Poor (website)

The median TP concentration for the whole monitoring period (1997 to 2002) was 0.450 mg/L with annual medians ranging between 0.380 mg/L (2000) and 0.550 mg/L (1997). TP concentrations in Five Mile Creek varied between extremes of 0.010 mg/L and 4.000 mg/L. The observed data was not seasonal so the Mann Kendall test for trend was used. The data was however related to flow and subsequently flow-adjusted. Trend analysis indicated that TP concentrations had remained stable in Five Mile Creek since monitoring commenced in 1997.

Turbidity

Current total turbidity status: Low (website)

The median turbidity level for the whole monitoring period (1997 to 2002) was 7.0 NTU with annual medians ranging between 3.3 NTU (2002) and 12.0 NTU (1999). Turbidity levels in Five Mile Creek varied between extremes of 1.7 NTU and 57.0 NTU. The observed data was not seasonal so the Mann Kendall test for trend was used, neither was the data related to flow. Trend analysis indicated that turbidity levels have remained stable in Five Mile Creek since monitoring commenced in 1997.

Seven Mile Creek

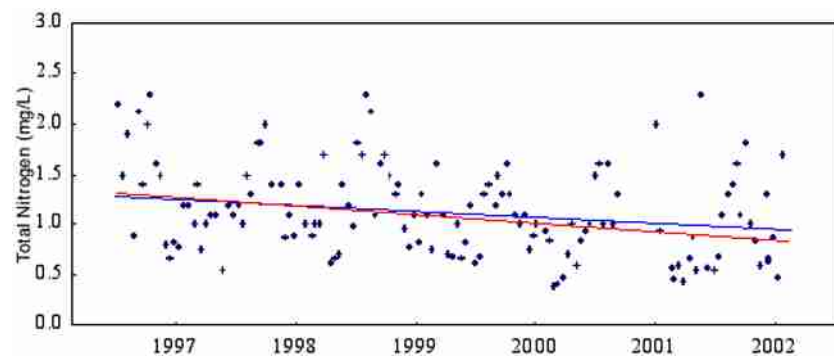


Figure 4 - Time series of observed (blue line) and flow adjusted (red line) total nitrogen for Seven Mile Creek over the period 1997 to 2002.

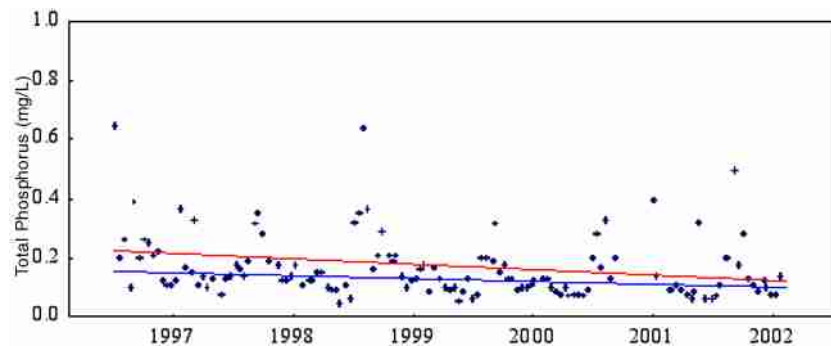


Figure 5 - Time series of observed (blue line) and flow adjusted (red line) total phosphorus for Seven Mile Creek over the period 1997 to 2002.

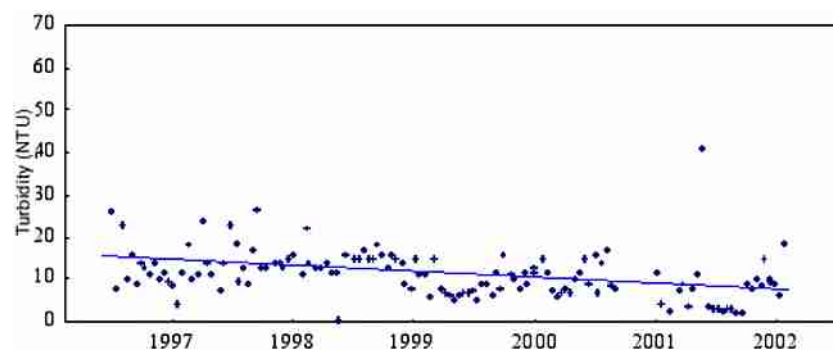


Figure 6 - Time series of observed (blue line) turbidity for Seven Mile Creek over the period 1997 to 2002.

Variable	Period	Series	Test	Slope	Z-stat	p-value	n	~n*	~n#	Result
TN	1997-2002	obs	SK	-0.06	-2.866	0.004	133	131	68	Trend
	1997-2002	FAC	MK	-0.089	-5.337	0	133	34	37	Trend
TP	1997-2002	obs	SK	-0.01	-3.607	0	133	69	136	Notrend
	1997-2002	FAC	MK	-0.013	-4.957	0	132	34	98	Notrend
Turbidity	1997-2002	obs	MK	-1.317	-4.815	0	131	129	47	Trend

Obs = observed data; FAC = flow-adjusted data; SK = Seasonal Kendall test; MK = Mann Kendall test; n = number of samples collected; n* = number of independent samples collected; n# = required number of independent samples to detect a trend.

Table 2 - Results of statistical analysis for trends in Seven Mile Creek.

Total Nitrogen

Current Total Nitrogen Status: Moderate (report) or Low (website)

The median TN concentration for the entire monitoring period was 1.10 mg/L, with annual medians ranging between 0.77 mg/L (2002) and 1.50 mg/L (1997). TN concentrations in Seven Mile Creek varied between extremes of 0.39 mg/L and 2.30 mg/L. The observed data was seasonal so the Seasonal Kendall test for trend was used. The data was also related to flow and was subsequently flow-adjusted (the flow adjusted data was not seasonal). Trend analysis confirmed the existence of a downward trend, indicating that TN concentrations have decreased at a rate of 0.089 mg/L/yr over the 1997 to 2002 period.

Total Phosphorus

Current Total Phosphorus Status: High (both report and website)

The median TP concentration for the entire monitoring period was 0.130 mg/L, with annual medians ranging between 0.100 mg/L (2002) and 0.210 mg/L (1997). TP concentrations in Seven Mile Creek varied between extremes of 0.047 mg/L and 0.650 mg/L. The observed data was seasonal so the Seasonal Kendall test for trend was used. The data was also related to flow and was subsequently flow-adjusted (the flow adjusted data was not seasonal). Trend analysis indicated that TP concentrations had remained stable in Seven Mile Creek since monitoring commenced in 1997.

Turbidity

Current Turbidity Status: Low (website)

The median turbidity level for the entire monitoring period was 11.0 NTU, with annual medians ranging between 8.1 NTU (2002) and 14.5 NTU (1999). Turbidity levels in Seven Mile Creek varied between extremes of 0.5 NTU and 41.0 NTU. The observed data was not seasonal so the Mann Kendall test for trends was used, nor was the data related to flow. Trend analysis confirmed the existence of a downward trend, indicating that Turbidity levels had fallen at a rate of 1.32 NTU/yr in the 1997 to 2002 monitoring period.

Cuthbert Drain

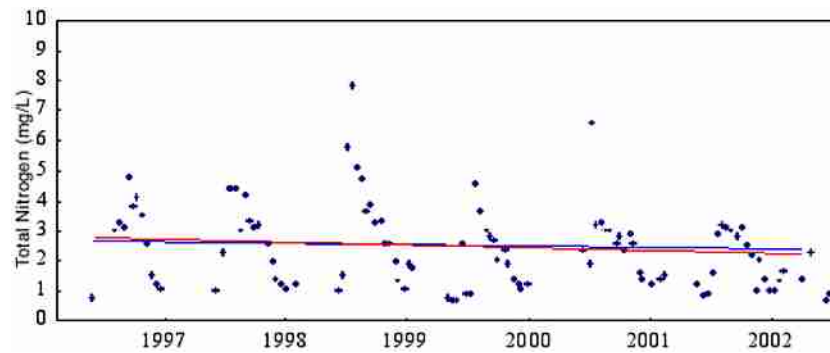


Figure 7 - Time series of observed (blue line) and flow adjusted (red line) total nitrogen for Cuthbert Drain over the period 1997 to 2002.

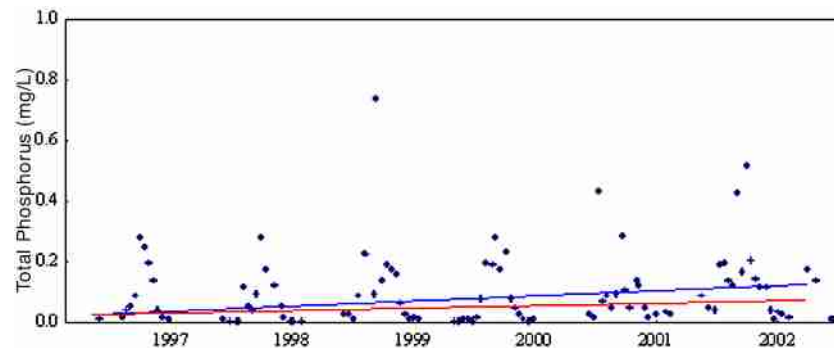


Figure 8 - Time series of observed (blue line) and flow adjusted (red line) total phosphorus for Cuthbert Drain over the period 1997 to 2002.

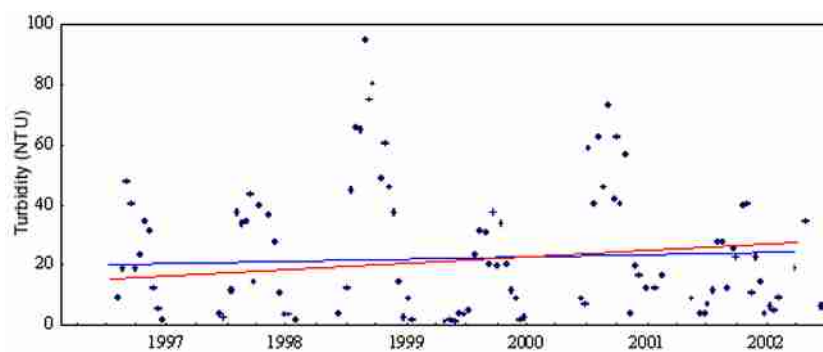


Figure 9 - Time series of observed (blue line) turbidity for Cuthbert Drain over the period 1997 to 2002.

Variable	Period	Series	Test	Slope	Z-stat	p-value	n	~n*	~n#	Result
TN	1997-2002	obs	SK	-0.02	-0.816	0.414	88	31	>1000	No trend
	1997-2002	FAC	MK	-0.048	-0.876	0.381	88	22	>1000	No trend
TP	1997-2002	obs	SK	0.016	4.105	0	88	36	83	No trend
	1997-2002	FAC	MK	0.009	2.966	0.003	88	19	335	No trend
Turbidity	1997-2002	obs	SK	0.933	1.768	0.077	87	16	761	No trend
	1997-2002	FAC	MK	1.744	1.877	0.061	87	38	252	No trend

Obs = observed data; FAC = flow-adjusted data; SK = Seasonal Kendall test; MK = Mann Kendall test; n = number of samples collected; n* = number of independent samples collected; n# = required number of independent samples to detect a trend.

Table 3 - Results of statistical analysis for trends in Cuthbert Drain.

Total Nitrogen

Current Total Nitrogen Status: High (report) or Poor (website)

The median TN concentration for the entire monitoring period was 2.45 mg/L, with annual medians ranging between 1.60 mg/L (2002) and 3.05 mg/L (1997). TN concentrations in Cuthbert Drain varied between extremes of 0.66 mg/L and 7.90 mg/L. The observed data was seasonal so the Seasonal Kendall test for trend was used. The data was also related to flow and was subsequently flow-adjusted (the flow adjusted data was not seasonal). Trend analysis indicated that TN concentrations have remained stable over the 1997 to 2002 period.

Total Phosphorus

Current Total Phosphorus Status: Moderate (report) or Low (website)

The median TP concentration for the entire monitoring period was 0.059 mg/L, with annual medians ranging between 0.026 mg/L (2000) and 0.120 mg/L (2002). TP concentrations in Cuthbert Drain varied between extremes of 0.005 mg/L and 0.740 mg/L. The observed data was seasonal so the Seasonal Kendall test for trend was used. The data was also related to flow and was subsequently flow-adjusted (the flow adjusted data was not seasonal). Trend analysis indicated that TP concentrations have remained stable over the 1997 to 2002 period.

Turbidity

Current Turbidity Status: High (website)

The median turbidity levels for the entire period was 19.0 NTU, with annual medians ranging between 10.5 NTU (2000) and 45.5 NTU (1999). Turbidity levels in Cuthbert Drain varied between extremes of 1.4 NTU and 95.0 NTU. The observed data was seasonal so the Seasonal Kendall test for trend was used. The data was also related to flow and was subsequently flow-adjusted (the flow adjusted data was not seasonal). Trend analysis indicated that turbidity levels have remained stable over the 1997 to 2002 period.

Grasmere Creek

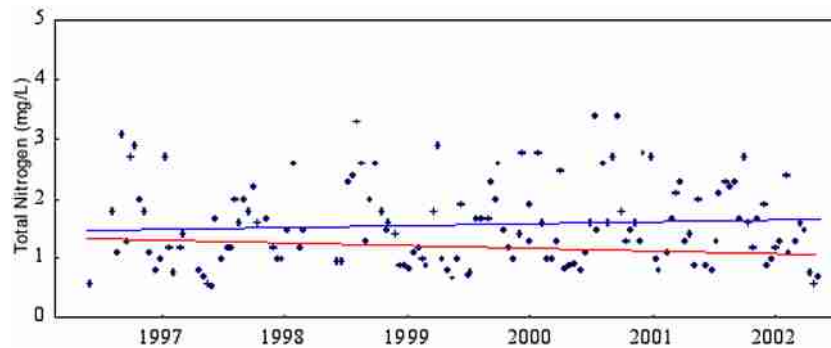


Figure 10 - Time series of observed (blue line) and flow-adjusted (red line) total nitrogen for Grasmere Creek over the period 1997 to 2002.

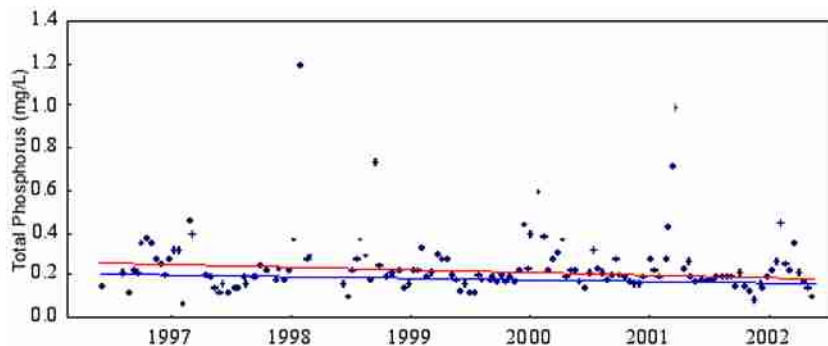


Figure 11 - Time series of observed (blue line) and flow-adjusted (red line) total phosphorus for Grasmere Creek over the period 1997 to 2002.

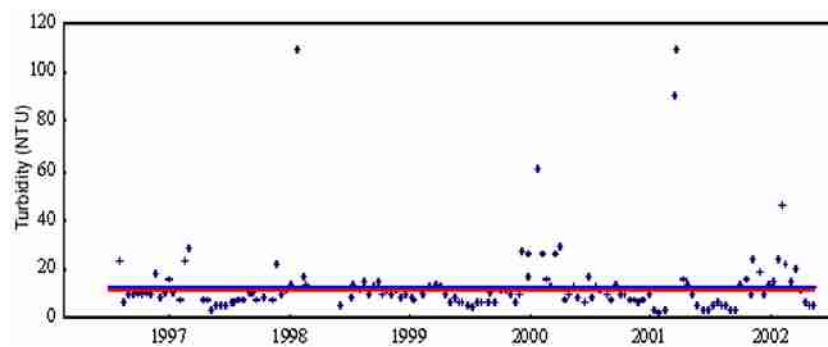


Figure 12 - Time series of observed (blue line) turbidity for Grasmere Creek over the period 1997 to 2002.

Variable	Period	Series	Test	Slope	Z-stat	p-value	n	~n*	~n#	Result
TN	1997-02	obs	MK	0.030	1.066	0.286	131	31	>1000	No trend
	1997-02	FAC	MK	-0.033	-1.492	0.136	131	41	633	No trend
TP	1997-02	obs	MK	-0.004	-1.191	0.234	131	30	>1000	No trend
	1997-02	FAC	MK	-0.007	-1.992	0.046	131	47	>1000	No trend
Turbidity	1997-02	obs	SK	-0.125	-0.514	0.607	128	127	>1000	No trend
	1997-02	FAC	MK	-0.042	-0.163	0.871	128	44	>1000	No trend

Obs = observed data; FAC = flow-adjusted data; SK = Seasonal Kendall test; MK = Mann Kendall test; n = number of samples collected; n* = number of independent samples collected; n# = required number of independent samples to detect a trend.

Table 4 - Results of statistical analysis for trends in Grasmere Creek.

Total Nitrogen

Current Total Nitrogen Status: High (both report and website)

The median TN concentration for the entire monitoring period was 1.50 mg/L, with annual medians ranging between 1.20 mg/L (1998) and 1.60 mg/L (2002). TN concentrations in Grasmere Creek varied between extremes of 0.53 mg/L and 3.40 mg/L. The observed data was not seasonal so the Mann Kendall test for trend was used. The data was related to flow and was subsequently flow-adjusted (the flow adjusted data was not seasonal). Trend analysis indicated that TN concentrations have remained stable over the 1997 to 2002 period.

Total Phosphorus

Current Total Phosphorus Status: High (report) or Poor (website)

The median TP concentration for the entire monitoring period was 0.200 mg/L, with annual medians ranging between 0.190 mg/L (1998 and 2002) and 0.270 mg/L (1997). TP concentrations in Grasmere Creek varied between extremes of 0.069 mg/L and 1.200 mg/L. The observed data was not seasonal so the Mann Kendall test for trend was used. The data was related to flow and was subsequently flow-adjusted (the flow adjusted data was not seasonal). Trend analysis indicated that TP concentrations have remained stable over the 1997 to 2002 period.

Turbidity

Current Turbidity Status: High (website)

The median turbidity levels for the entire period was 9.8 NTU, with annual medians ranging between 7.9 NTU (1998) and 11.0 NTU (1997). Turbidity levels in Grasmere Creek varied between extremes of 2.4 NTU and 110.0 NTU. The observed data was seasonal so the Seasonal Kendall test for trend was used. The data was also related to flow and was subsequently flow-adjusted (the flow adjusted data was not seasonal). Trend analysis indicated that turbidity levels have remained stable over the 1997 to 2002 period.

Marbellup Brook

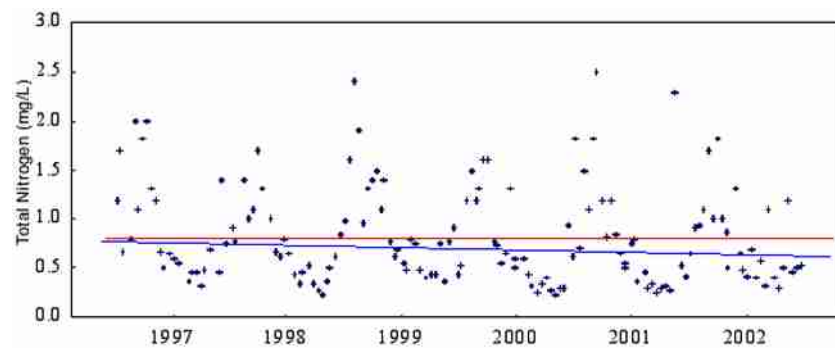


Figure 13 - Time series of observed (blue line) and flow-adjusted (red line) total nitrogen for Marbellup Brook over the period 1997 to 2002.

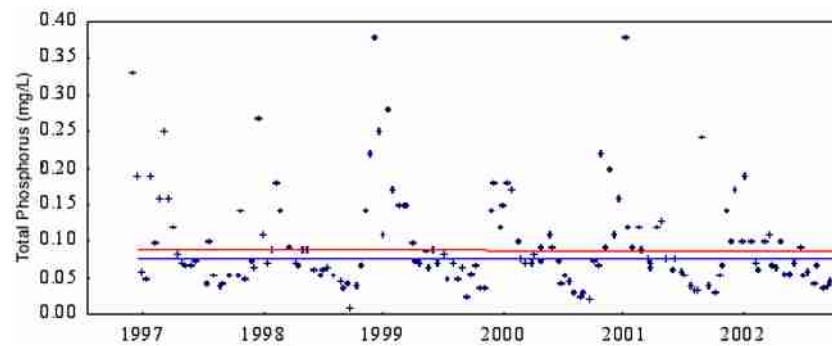


Figure 14 - Time series of observed (blue line) and flow-adjusted (red line) total phosphorus for Marbellup Brook over the period 1997 to 2002.

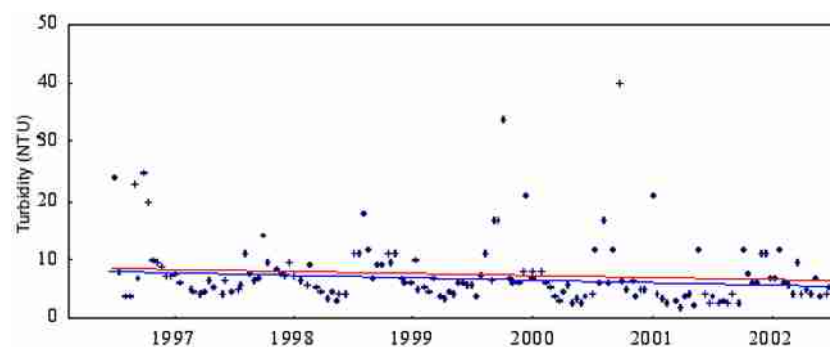


Figure 15 - Time series of observed (blue line) and flow-adjusted (red line) turbidity for Marbellup Brook over the period 1997 to 2002.

Variable	Period	Series	Test	Slope	Z-stat	p-value	n	~n*	~n [#]	Result
TN	1997-2002	obs	SK	-0.03	-1.352	0.176	139	137	335	No trend
	1997-2002	FAC	MK	-0.004	-0.362	0.717	139	137	>1000	No trend
TP	1997-2002	obs	SK	0.001	0.476	0.634	139	137	>1000	No trend
	1997-2002	FAC	MK	0	0.195	0.846	139	137	>1000	No trend
Turbidity	1997-2002	obs	SK	-0.55	-3.039	0.002	137	67	181	No trend
	1997-2002	FAC	SK	-0.313	-1.196	0.232	137	62	165	No trend

Obs = observed data; FAC = flow-adjusted data; SK = Seasonal Kendall test; MK = Mann Kendall test; n = number of samples collected; n* = number of independent samples collected; n[#] = required number of independent samples to detect a trend.

Table 5 - Results of statistical analysis for trends in Marbellup Brook.

Total Nitrogen

Current Total Nitrogen Status: Low (both report and website)

The median TN concentration for the entire monitoring period was 0.70 mg/L, with annual medians ranging between 0.64 mg/L (2001 and 2002) and 1.10 mg/L (1997). TN concentrations in Marbellup Brook varied between extremes of 0.22 mg/L and 3.10 mg/L. The observed data was seasonal so the Seasonal Kendall test for trend was used. The data was related to flow and was subsequently flow-adjusted (the flow adjusted data was not seasonal). Trend analysis indicated that TN concentrations have remained stable over the 1997 to 2002 period.

Total Phosphorus

Current Total Phosphorus Status: High (report and website)

The median TP concentration for the entire monitoring period was 0.075 mg/L, with annual medians ranging between 0.067 mg/L (2002) and 0.099 mg/L (1997). TP concentrations in Marbellup Brook varied between extremes of 0.009 mg/L and 0.380 mg/L. The observed data was seasonal so the Seasonal Kendall test for trend was used. The data was also related to flow and was subsequently flow-adjusted (the flow adjusted data was not seasonal). Trend analysis indicated that TP concentrations have remained stable over the 1997 to 2002 period.

Turbidity

Current Turbidity Status: Low (website)

The median turbidity levels for the entire period was 6.2 NTU, with annual medians ranging between 4.2 NTU (2002) and 8.0 NTU (1997). Turbidity levels in Marbellup Brook varied between extremes of 1.9 NTU and 40.0 NTU. The observed data was seasonal so the Seasonal Kendall test for trend was used. The data was also related to flow and was subsequently flow-adjusted (the flow adjusted data was also seasonal). Trend analysis indicated that turbidity levels have remained stable over the 1997 to 2002 period.

Torbay Drain

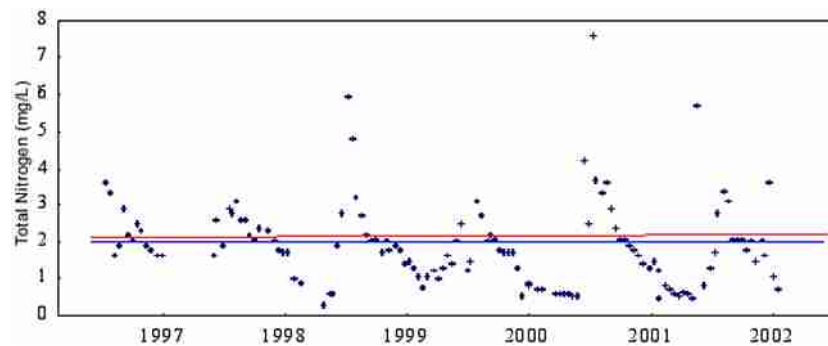


Figure 16 - Time series of observed (blue line) and flow-adjusted (red line) total nitrogen for Torbay Drain over the period 1997 to 2002.

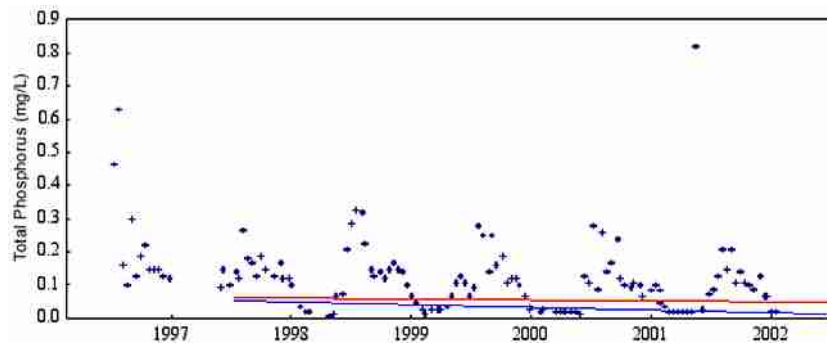


Figure 17 - Time series of observed (blue line) and flow-adjusted (red line) total phosphorus for Torbay Drain over the period 1998 to 2002.

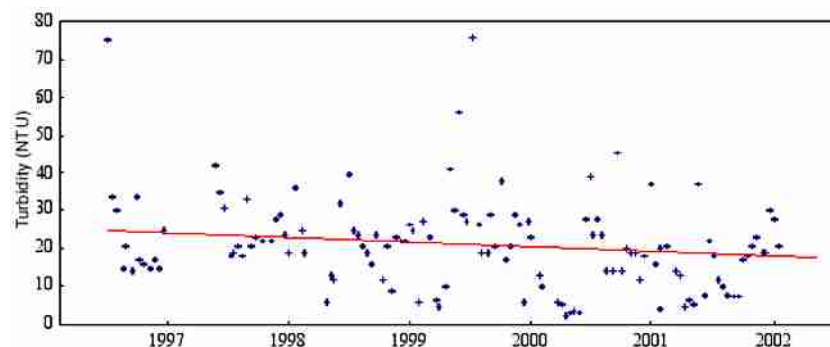


Figure 18 - Time series of observed (blue line) and flow-adjusted (red line) turbidity for Torbay Drain over the period 1997 to 2002.

Variable	Period	Series	Test	Slope	Z-stat	p-value	n	~n*	~n [‡]	Result
TN	1997-2002	obs	SK	0	0.371	0.711	106	105		No trend
	1997-2002	FAC	MK	0.016	0.612	0.541	105	104	>1000	No trend
TP	1998-2002	obs	SK	-0.01	-2.363	0.018	93	92	302	No trend
	1998-2002	FAC	MK	-0.004	-1.299	0.194	92	55	>1000	No trend
Turbidity	1997-2002	obs	MK	-1.206	-2.026	0.043	105	45	275	No trend
	1997-2002	FAC	SK	-1.31	-1.563	0.118	104	57	113	No trend

Obs = observed data; FAC = flow-adjusted data; SK = Seasonal Kendall test; MK = Mann Kendall test; n = number of samples collected; n* = number of independent samples collected; n[‡] = required number of independent samples to detect a trend.

Table 6 - Results of statistical analysis for trends in Torbay Drain.

Total Nitrogen

Current Total Nitrogen Status: High (both report and website)

The median TN concentration for the entire monitoring period was 1.80 mg/L, with annual medians ranging between 1.45 mg/L (2000) and 2.20 mg/L (1998). TN concentrations in Torbay Drain varied between extremes of 0.30 mg/L and 7.60 mg/L. The observed data was seasonal so the Seasonal Kendall test for trend was used. The data was related to flow and was subsequently flow-adjusted (the flow adjusted data was not seasonal). Trend analysis indicated that TN concentrations have remained stable over the 1997 to 2002 period.

Total Phosphorus

Current Total Phosphorus Status: High (report and website)

The median TP concentration for the entire monitoring period was 0.100 mg/L, with annual medians ranging between 0.076 mg/L (2002) and 0.135 mg/L (1999). TP concentrations in Torbay Drain varied between extremes of 0.010 mg/L and 0.820 mg/L. The observed data was seasonal so the Seasonal Kendall test for trend was used. The data was also related to flow and was subsequently flow-adjusted (the flow adjusted data was not seasonal). Trend analysis indicated that TP concentrations have remained stable over the 1998 to 2002 period.

Turbidity

Current Turbidity Status: High (website)

The median turbidity levels for the entire period was 21.0 NTU, with annual medians ranging between 16.0 NTU (2001) and 24.5 NTU (2000). Turbidity levels in Torbay Drain varied between extremes of 2.6 NTU and 76.0 NTU. The observed data was not seasonal so the Mann Kendall test for trend was used. The data was related to flow and was subsequently flow-adjusted (the flow adjusted data was seasonal). Trend analysis indicated that turbidity levels have remained stable over the 1997 to 2002 period.