CATCHMENT WATER QUALITY

Water Quality Variables

Water quality data from Tasmania's centralised water quality database (WQDB) provide an indication of the health of the Coal River catchment and its waterways (specifically the Coal River, White Kangaroo Rivulet and limited data from Native Hut Rivulet). The Coal River at Craigbourne Road is the most frequently sampled site, with all sampling undertaken prior to the construction of Craigbourne Dam. Averages are used as the basis for analysis (see Table 8). Water quality guidelines are those developed by the Australian and New Zealand Environment and Conservation Council (ANZECC 1992).

- Life-cycle characteristics of aquatic organisms such as breeding and migration are cued by changes in **water temperature**. Temperature increases can also reduce available oxygen levels.

  Differences in altitude, stream flow, stream-side vegetation cover, and the seasonal and diurnal variation in air temperature will produce natural changes in water temperature. Human impacts that change stream flow characteristics or riparian vegetation cover may cause 'non-natural' temperature variation. This may act to restrict the range of habitats available for ecosystem biota and reduce species diversity.

  Water temperature in the Coal River increases with the reduction in altitude. Surface samples at the Craigbourne and Richmond impoundments have the highest mean values of 13.8 °C and 15.2 °C. Coldest water temperatures are from June to August (3-5 °C in the upper catchment and 5-7 °C in the lower catchment). Warmest waters are in January and February with temperatures around 20 °C (occasionally as low as 15 °C).

  The discharge of unseasonably cold waters from Craigbourne Dam over summer may be a problem for downstream habitats.

- Most aquatic organisms require concentrations of **dissolved oxygen** in excess of 6 mg/L to survive.

  During the wetter months, turbulence in the faster-flowing reaches of streams ensures adequate oxygen uptake. However, low flow or no flow periods may result in remnant freshwater pools below critical levels due to respiration by plants, animals and micro-organisms.

  Limited data for the Coal River at Craigbourne (prior to dam construction) gave dissolved oxygen levels of around 10 mg/L which is indicative of healthy ecosystem concentrations.

- High levels of **organic inputs** into waterways in the form of sewage effluent or cattle excreta will increase turbidity, suspended solids and nutrients besides increasing oxygen demand. This may reduce oxygen availability for biota in the water column and sediments and lead to the production of toxic chemicals such as ammonia or hydrogen sulphide. The overall result is degradation of the waterway and reduction in species biodiversity such that only the most resilient of organisms (usually tubificid worms) survive.

  Biochemical oxygen demand over five days (BOD_5) is a measure of the oxygen consumed during the bacterial break down of organic matter and allows a quantitative assessment of organic loading.

  BOD_5 concentrations between 1.6 and 3.4 mg/L indicate low levels of organic loading in the Coal River.

TABLE 8: COAL RIVER WATER QUALITY

STATION NO.	STATION NAME	PERIOD	EASTING	NORTHING	n *	FLOW	n	GAUGE HT. metres	n	TEMP °C	n	DO2 mg/L	n	BOD mg/L	n	APP COL Hzn	n	TURB NTU	n	TURB Hellige	n	LAB pH	n	FIELD pH	n	TSS mg/L	n	FILT RES (104) mg/L
3030203	COAL RIVER AT BADEN.	74-96	537300	5301900			97	0.08	96	10.58					11	67.73	2	7.30	10	9.94	46	7.16	43	6.75	11	2.73	11	132.64
3030201	COAL RIVER AT CRAIGBOURNE ROAD	74-80	532900	5288500	21	0.34	104	0.13	96	11.45	62	10.52	24	3.39	74	50.68			76	13.91	104	8.64			75	25.12	76	637.07
3030204	COAL RIVER AT CRAIGBOURNE	78-85	532900	5288300	4	1.99	40	0.20	40	10.99	11	9.48	4	1.88	11	72.09			11	13.82	20	7.74	13	7.58	11	11.82	10	725.80
3030207	CRAIGBOURNE LAKE - AT DAM [SURFACE SAMPLE].	88-93	533200	5288200			12	164.36	13	13.81											35	7.96	7	7.11			1	301.00
3031211	CRAIGBOURNE LAKE - AT TOP OUTLET VALVE.	87-93	533200	5288200											1	100.00			1	4.90	16	7.93			2	2.50	2	415.50
3031212	CRAIGBOURNE LAKE - AT MIDDLE OUTLET VALVE.	87-93	533200	5288200											1	100.00			1	5.90	17	7.88			2	3.00	2	334.00
3031213	CRAIGBOURNE LAKE - AT BOTTOM OUTLET VALVE.	87-93	533200	5288200											1	125.00			1	5.10	15	7.90			1	3.00	1	241.00
3030206	COAL RIVER D/S CRAIGBOURNE DAM - [TOP OUTLET].	90-96	533000	5288000			17	0.16	17	12.25													11	7.77				
3031210	COAL RIVER AT Mt. BAINS.	88-93	533500	5285600																	31	7.85						
3031209	COAL RIVER AT ROSEDALE.	88-93	534600	5282750																	31	7.85						
3031208	COAL RIVER AT BARTON VALE ROAD BRIDGE	88-93	535800	5281850																	33	7.86						
3031207	COAL RIVER AT BROWN MOUNTAIN ROAD BRIDGE	88-93	536050	5279500																	34	7.87						
3030209	WHITE KANGAROO RIVULET - UPSTREAM COAL RIVER	90-96	538150	5277900			22	0.15	,22	11.58													16	7.06				
3030202	COAL RIVER U/S WHITE KANGAROO RIVULET	74-93	537100	5277800			70	0.19	66	11.74					6	85.00	5	5.58	2	13.10	31	7.91	36	7.52	6	3.67	6	460.33
3031206	COAL RIVER AT WHITE KANGAROO RIVER	87-93	537450	5277150																	33	7.91						
3031205	WHITE KANGAROO RIVULET U/S COAL R. JUNCT.	87-93	537550	5277100																	34	7.80						
3031200	NATIVE HUT RIVULET - EAST END	78-94	535050	5276950									3	2.47							4	8.48			4	14.75		
3031201	NATIVE HUT RIVULET - WEST END	78-94	535000	5276900									3	1.60							4	8.50			4	10.00		
3031204	COAL RIVER AT ESTATE ROAD BRIDGE	87-93	537100	5276000																	35	7.66						
3031203	COAL RIVER AT FINGERPOST ROAD BRIDGE	87-93	535600	5273500																	36	7.81						
3031202	COAL RIVER U/S INVERQUHARITY RIVULET	87-93	536400	5271350																	35	7.85						
3030208	COAL RIVER U/S RICHMOND [CREESE'S WEIR].Location 2	90-95	536000	5268800			24	0.23	25	12.72							1	1.00					20	7.23				
3030211	COAL RIVER AT RICHMOND WEIR Location 1	87-96	536050	5268100			11	0.23	11	15.21					6	53.33	6	16.90			43	7.76	3	7.03	6	30.50	5	402 00
3031214	COAL RIVER AT EDDINGTON-LAZENBY WEIR.	93	536600	5267700																	1	7.80						

* n = number of samples
\# ND = not detected

TABLE 8: COAL RIVER WATER QUALITY

STATION NAME	n	FIELD EC @25 µS/cm	n	LAB EC@25 µS/cm	n	TOT Ca mg/L	n	TOT Cl mg/L	n	CHLORIDE as Cl mg/L	n	TOT Cu mg/L	n	TOT Fe mg/L	n	TOT Mg mg/L	n	TOT Mn mg/L	n	TOT Mo mg/L	n	TOT K mg/L	n	TOT S mg/L	n	TOT Na mg/L	n	TOT Zn mg/L	n	HARDNESS mg/L
COAL RIVER AT BADEN.	18	299.89																												
COAL RIVER AT CRAIGBOURNE ROAD					14	53.86			25	204.89			25	1.11	14	30.90	6	0.07			15	2.30			14	70.06			20	287.54
COAL RIVER AT CRAIGBOURNE					1	32.00			4	432.00			4	1.16	2	22.00	2	0.12			2	3.50			2	62.00			4	435.00
CRAIGBOURNE LAKE - AT DAM [SURFACE SAMPLE].	1	1080.00	4	462.93	37	30.11	3		32	92.94	37	0.009	37	0.12	37	19.81	37	0.03	35	0.02	36	3.17	37	5.38	37	50.19	37	0.00	9	157.33
CRAIGBOURNE LAKE - AT TOP OUTLET VALVE.			14	472.14	15	30.13	13	70.00	1	223.00	15	0.014	16	0.77	16	21.44	15	0.04	13	0.03	14	2.71	15	6.07	16	60.31	15	0.01	4	154.25
CRAIGBOURNE LAKE - AT MIDDLE OUTLET VALVE.			15	471.33	17	30.84	14	71.14	1	146.00	16	0.013	17	0.25	17	20.83	16	0.03	14	0.03	15	2.67	16	6.19	17	58.18	16	0.01	4	160.75
CRAIGBOURNE LAKE - AT BOTTOM OUTLET VALVE.			15	459.55	16	30.88	14	66.43			16	0.013	16	0.24	16	20.50	16	0.07	15	0.43	15	3.00	16	5.89	16	57.94	16	0.02	4	170.00
COAL RIVER D/S CRAIGBOURNE DAM - [TOP OUTLET].	9	522.33																												
COAL RIVER AT Mt. BAINS.			31	574.19	33	35.97	30	110.67			33	0.009	33	0.15	33	24.76	33	0.02	32	0.02	33	2.70	33	5.88	33	58.79	33		7	196.43
COAL RIVER AT ROSEDALE.			31	635.81	33	37.45	30	120.50			33	0.007	33	0.12	33	27.85	33	0.02	32	0.02	33	2.61	33	5.88	33	67.48	33		8	238.13
COAL RIVER AT BARTON VALE ROAD BRIDGE			33	655.15	35	37.91	32	131.72			35	0.007	35	0.15	35	28.46	35	0.02	34	0.02	35	2.71	35	5.71	35	69.60	35		8	216.38
COAL RIVER AT BROWN MOUNTAIN ROAD BRIDGE			34	711.76	36	38.81	33	148.73			36	0.006	36	0.12	36	31.36	36	0.01	35	0.02	36	2.78	36	5.94	36	77.14	36	0.00	8	233.25
WHITE KANGAROO RIVULET - UPSTREAM COAL RIVER	7	673.86																												
COAL RIVER U/S WHITE KANGAROO RIVULET	5	712.60																												
COAL RIVER AT WHITE KANGAROO RIVER			33	720.91	35	39.69	32	152.09			35	0.014	35	0.16	35	33.10	35	0.01	34	0.02	35	3.02	35	6.35	35	79.93	35	0.01	8	235.88
WHITE KANGAROO RIVULET U/S COAL R. JUNCT.			34	550.00	36	35.69	33	103.61			36	0.013	36	0.50	36	23.57	36	0.02	35	0.01	36	1.89	36	1.83	36	57.56	36	0.00	8	176.75
NATIVE HUT RIVULET - EAST END																														
NATIVE HUT RIVULET - WEST END																														
COAL RIVER AT ESTATE ROAD BRIDGE			35	647.43	38	36.64	34	130.38			38	0.011	38	0.21	38	28.59	38	0.01	37	0.01	38	2.74	37	5.13	38	69.96	38	0.00	8	216.13
COAL RIVER AT FINGERPOST ROAD BRIDGE			36	700.28	38	38.41	35	138.37			38	0.010	38	0.25	38	31.36	38	0.01	37	0.01	38	2.72	38	5.16	38	76.91	38	0.00	8	228.25
COAL RIVER U/S INVERQUHARITY RIVULET			35	685.26	37	37.74	33	144.73			37	0.012	37	0.25	37	31.18	37	0.01	36	0.01	37	2.85	37	5.02	37	77.38	37	0.00	8	223.00
COAL RIVER U/S RICHMOND [CREESE'S WEIR].Location 2	8	660.75																												
COAL RIVER AT RICHMOND WEIR Location 1	10	651.20	43	720.70	44	36.96	41	147.68			39	0.010	44	0.27	44	31.11	44	0.01	38	0.01	44	2.95	44	6.29	44	81.25	39	0.01	14	206.50
COAL RIVER AT EDDINGTON-LAZENBY WEIR.			1	770.00	2	36.50					2	0.005	2	0.25	2	29.00	2	0.01	2	0.01	2	6.00	2	5.00	2	76.50	2			

* n = number of samples
# ND = not detected

TABLE 8: COAL RIVER WATER QUALITY

STATION NAME	n	ALK (TOT BG +MR) mg/L	n	NO3 as N mg/L	n	NO2 as N mg/L	n	NH3-N mg/L	n	TKN mg/L	n	Phosphoru mg/L	n	REACTIVE P mg/L	n	SILICA mg/L	n	TOT COLS CFU/100 mL	n	FAEC STREP CFU/100 mL	n	FAEC COLS CFU/100 mL	n	HEXAZINONE µg/L	n	4 4'-DDD µg/L	n	4 4'-DDE µg/L	n	ALPHA BHC µg/L
COAL RIVER AT BADEN.																														
COAL RIVER AT CRAIGBOURNE ROAD	25	124.15	21	0.159	18	0.002									14	11.81	21	321	21	185	20	272								
COAL RIVER AT CRAIGBOURNE	4	135.00	4	0.569	4	0.002									2	7.10	3	1307	3	610	3	1096								
CRAIGBOURNE LAKE - AT DAM [SURFACE SAMPLE]			36	0.283							36	0.06																		
CRAIGBOURNE LAKE - AT TOP OUTLET VALVE.			14	0.064							14	0.21																		
CRAIGBOURNE LAKE - AT MIDDLE OUTLET VALVE.			14	0.071							15	0.20																		
CRAIGBOURNE LAKE - AT BOTTOM OUTLET VALVE.			15	0.587							15	0.20																		
COAL RIVER D/S CRAIGBOURNE DAM - [TOP OUTLET].																														
COAL RIVER AT Mt. BAINS.			31	0.103							33	0.06																		
COAL RIVER AT ROSEDALE.			31	0.077							33	0.06																		
COAL RIVER AT BARTON VALE ROAD BRIDGE			33	0.070							35	0.03																		
COAL RIVER AT BROWN MOUNTAIN ROAD BRIDGE			34	0.309							36	0.03																		
WHITE KANGAROO RIVULET - UPSTREAM COAL RIVER																														
COAL RIVER U/S WHITE KANGAROO RIVULET																														
COAL RIVER AT WHITE KANGAROO RIVER			33	0.045							35	0.06																		
WHITE KANGAROO RIVULET U/S COAL R. JUNCT.			34	0.053							36	0.06																		
NATIVE HUT RIVULET - EAST END																							1	N.D. #	1	N.D.	1	N.D.	1	N.D.
NATIVE HUT RIVULET - WEST END																							1	N.D.	1	N.D.	1	N.D.	1	N.D.
COAL RIVER AT ESTATE ROAD BRIDGE			35	0.429							38	0.05																		
COAL RIVER AT FINGERPOST ROAD BRIDGE			36	0.044							38	0.05																		
COAL RIVER U/S INVERQUHARITY RIVULET			35	0.120							37	0.05																		
COAL RIVER U/S RICHMOND [CREESE'S WEIR] Location 2																														
COAL RIVER AT RICHMOND WEIR Location 1	5	65.80	45	0.050	7	0.003	8	0.19	8	0.88	47	0.05	8	0.01	5	6.18							1	N.D.	1	N.D.	1	N.D.	1	N.D.
COAL RIVER AT EDDINGTON-LAZENBY WEIR.			1								2																			

* n = number of samples
\# ND = not detected

TABLE 8: COAL RIVER WATER QUALITY

STATION NAME	n	BETA BHC	n	DELTA BHC	n	ALDRIN	n	4 4'-DDT	n	DIELDRIN	n	HEPTACHLOR	n	HEPTACHLOR EXPOX.	n	LINDANE	n	METH. PARATHION	n	ENDOSULP SULPH
		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L
COAL RIVER AT BADEN.																				
COAL RIVER AT CRAIGBOURNE ROAD									8	N.D.					8	N.D.				
COAL RIVER AT CRAIGBOURNE									1	N.D.					1	N.D.				
CRAIGBOURNE LAKE - AT DAM [SURFACE SAMPLE].																				
CRAIGBOURNE LAKE - AT TOP OUTLET VALVE.																				
CRAIGBOURNE LAKE - AT MIDDLE OUTLET VALVE.																				
CRAIGBOURNE LAKE - AT BOTTOM OUTLET VALVE.																				
COAL RIVER D/S CRAIGBOURNE DAM - [TOP OUTLET].																				
COAL RIVER AT Mt. BAINS.																				
COAL RIVER AT ROSEDALE.																				
COAL RIVER AT BARTON VALE ROAD BRIDGE																				
COAL RIVER AT BROWN MOUNTAIN ROAD BRIDGE																				
WHITE KANGAROO RIVULET - UPSTREAM COAL RIVER																				
COAL RIVER U/S WHITE KANGAROO RIVULET																				
COAL RIVER AT WHITE KANGAROO RIVER																				
WHITE KANGAROO RIVULET U/S COAL R. JUNCT.																				
NATIVE HUT RIVULET - EAST END	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.
NATIVE HUT RIVULET - WEST END	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.
COAL RIVER AT ESTATE ROAD BRIDGE																				
COAL RIVER AT FINGERPOST ROAD BRIDGE																				
COAL RIVER U/S INVERQUHARITY RIVULET																				
COAL RIVER U/S RICHMOND [CREESE'S WEIR].Location 2																				
COAL RIVER AT RICHMOND WEIR Location 1	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.	1	N.D.
COAL RIVER AT EDDINGTON-LAZENBY WEIR.																				

* n = number of samples
# ND = not detected

WATER QUALITY

- Changes in **pH** affect the concentration and toxicity of chemical substances (e.g. ammonia, heavy metals) and the ionic and osmotic balance of aquatic organisms.

  Changes in these environmental parameters can displace stream fauna from specialised ecosystem 'niches'. Fish will survive in a pH range from 5.0 - 9.0 but prefer levels from 6.5 - 8.5.

  Atmosphere (carbon dioxide transfer/ carbonate-bicarbonate buffering system) and geology are the major natural forces determining water pH. Algal photosynthesis (carbon dioxide reduction) and respiration (carbon dioxide production) can also produce diurnal variation. Typical 'non-natural' sources of increased acidification include acid rain, mine drainage and industrial discharges.

  Laboratory pH results are typically slightly alkaline with levels between 7.1 and 8.6. The highest pH waters are from the Coal River at Craigbourne (8.6) and Native Hut Rivulet (8.5) which enters the lower Coal River. These sites approach the upper limit of ecosystem recommendations for fish. The upper Coal River at Baden has the minimum result of 7.2 (field pH 6.8). Field pH results are generally less than laboratory results for the same site.

  Alkalinity measurements are restricted to three sites with the Coal River at Craigbourne Rd. having the most extensive record. Mean concentration at this site is 125 mg/L. There appears to be a significant reduction in alkalinity in the lower reaches of the Coal River at Richmond (65 mg/L).

- **Water clarity** helps determine the availability of sunlight for photosynthetic reactions in aquatic ecosystems. Photosynthesis is the key process in determining biological productivity and food availability to higher organisms.

  Colour is one measure of water clarity. The soluble and insoluble substances contributing to colour include humus and peat materials, naturally occurring dissolved iron and manganese, plankton, weeds, agricultural runoff and industrial wastes.

  Apparent colour is between 50 and 85 CU with similar levels in the headwaters at Baden and for Richmond Weir at the bottom of the catchment. The most highly coloured waters (100-125 CU) were recorded on one date at Craigbourne Lake.

- The high concentration of suspended solids in turbid waters acts to reduce water clarity; smother and abrade aquatic plants and animals; and transport nutrients, bacteria, heavy metals, pesticides and other toxins. Turbidity is also undesirable from an aesthetic and recreational viewpoint.

  Although catchment weathering processes and erosion will produce natural variation in turbidity, domestic sewage and industrial discharges and runoff from degraded land which exacerbate 'natural' levels can severely degrade riverine health.

  Turbidity results (Hellige scale) are between 5 and 14 units. A limited number of NTU results range from 1 to 17 NTU. Some concurrent episodes of high turbidity and colour, usually with increased gauge heights, indicate increased runoff from rainfall.

  High **suspended solids** loads with mean of 25 mg/L and peaks over 800 mg/L were recorded at Craigbourne Rd prior to impoundment. Subsequent sampling downstream shows low levels (2 - 3 mg/L) which may result from settling of suspended solids within Craigbourne Lake.

WATER QUALITY

- Rapid change in the ecosystem concentration of dissolved solids (salinity, hardness, etc.) places increased stress on aquatic organisms. High concentrations of **total dissolved solids** (TDS) also restrict irrigation usage.

  Catchment geology and rainfall are the major determinants of TDS with irrigation and industrial effluent the major anthropogenic inputs.

  Total dissolved solids concentrations are typically high. The lowest mean concentration is for the Coal River at Baden (132 mg/L). Post-dam results from further downstream range from 240 to 460 mg/L. Higher levels (mean 725 mg/L) were evident at Craigbourne prior to dam construction.

  While drinking water is safe to concentrations of 1000 mg/L, taste problems may occur over 500 mg/L. TDS concentrations in irrigation water of greater than 175 mg/L require some selectivity in terms of crop choice.

- As a measure of the capacity of water to conduct an electric current, **conductivity** is effectively an alternative measure of the concentration of total dissolved salts (primarily mineral salts).

  Guideline values for freshwater ecosystems are less than 1500 µS/cm while low-salinity water (0-280 µS/cm) can be safely used with most crops.

  The Coal River has relatively high electrical conductivity with laboratory results between 460 and 770 µS/cm range and field measurements from 300 to 700 µS/cm. Conductivity increases as water moves from high in the catchment at Baden to the lower reaches. The lower conductivity waters of the White Kangaroo Rvt. (550 µS/cm) appear to have a diluting effect upon the waters of the Coal River with lower levels evident below their confluence. All mean results are below the freshwater ecosystem guideline of 1500 µS/cm but place restrictions on irrigation use. Peaks values are evident from August to September. The maximum individual result was 1750 µS/cm for the Coal River site at White Kangaroo Rvt.

- Where **chloride** concentration in water is greater than 100 mg/L it should not be applied to sensitive crops. For drinking purposes, concentrations greater than 400 mg/L will begin to affect taste.

  Craigbourne Dam outlet chloride concentrations of between 66 and 71 mg/L increase downstream, from 110 mg/L at Mt. Bains to 148 mg/L at Richmond Weir. The lower chloride waters from White Kangaroo Rvt. (103 mg/L) act to temporarily dilute chloride concentrations in the Coal River. These levels place some restrictions on irrigation usage.

- The major cations - **calcium, magnesium, sodium and potassium** - are present at relatively low concentrations. These levels are well below the freshwater environmental and water use guidelines for these dissolved ions which generally recommend concentrations of less than 500 mg/L.

  Results indicate the following cationic ratio: sodium (50-81 mg/L) > calcium (30-53 mg/L) > magnesium (19-33 mg/L) > potassium (1-6 mg/L). All values are less than the guidelines.

- **Calcium** shouldn't exceed 1000 mg/L in water used for watering stock. Calcium levels are generally well below these guidelines and show only minimal variation. The highest levels on the Coal River are upstream (53 mg/L) with lower levels (30-40 mg/L) downstream. Craigbourne Dam has the lowest calcium concentrations of around 30 mg/L.

WATER QUALITY

- **Magnesium** concentrations of between 20 to 30 mg/L are approximately 10 times those of other rivers in the state (Fuller & Katona 1993). These levels are still far below livestock guidelines of 600 mg/L. August and September produce peak concentrations with a maximum recording of 90 mg/L.
- **Hardness** reflects the higher calcium and magnesium concentrations upstream with peak values at Baden (287 mg/L as $CaCO_3$) and Craigbourne Road (435 mg/L as $CaCO_3$) before dropping to around 200 mg/L as $CaCO_3$ further downstream. White Kangaroo Rvt. has softer waters (mean 176 mg/L as $CaCO_3$) than the Coal River.
- Small amounts of some **metals** (e.g. copper and zinc) are required for uptake by aquatic biota. Contamination by anthropogenic activities (industry, agriculture and mining) can, however, produce high concentrations with chronic or lethal effects to aquatic organisms.

  Toxicity will also vary with the form or "species" of metal present. This is influenced by factors such as water hardness, temperature, pH and organic load.

  The Coal River at Craigbourne has a mean **iron** concentration of approximately 1 mg/L which is at the high end of recommended levels (0.5-1 mg/L). There is a reduction in iron downstream with concentrations between 0.12 and 0.25 mg/L.

  Although mean **copper** concentrations from 0.005 to 0.014 mg/L exceed ecosystem guidelines (0.002-0.005 mg/L) at most sites, levels are generally within agricultural and drinking water guidelines (0.2-1 mg/L).

  Manganese results range from 0.01 to 0.07 mg/L with samples typically below the recommended drinking water maximum of 0.1 mg/L. The highest mean level of 0.12 mg/L at Craigbourne resulted from two samples only.

  Mean **zinc** concentrations under 0.02 mg/L are within ecosystem guidelines (0.005-0.05 mg/L).
- **Microbial pollution** of the waterways by human and animal faeces can be a problem, both from a drinking water and recreational viewpoint, and due to contamination of waters used for aquaculture. Sewage treatment plant effluent, non-functional septic systems and farm stock faeces are all potential sources of the bacteria, viruses and protozoa which spread diseases such as dysentery and hepatitis.

  ANZECC (1992) suggests an environmental median of 150 faecal coliforms per 100 mL for primary contact such as swimming and a median of 1000 faecal coliforms for secondary contact activities such as fishing.

  State guidelines are set for faecal coliform concentrations in effluent from sewage treatment plants (STP) under Schedule 2 of the *Environment Protection (Water Pollution) Regulations 1974*. These require discharge levels under 200 faecal coliforms per 100 mL at inland sites and 1000 per 100 mL at estuarine sites.

  There is little available information on microbiological water quality for waterways in the Coal catchment. Pre-dam data from the Coal River at Craigbourne Road exceed the primary contact guideline with a median value of 194 faecal coliforms per 100 mL. The other Craigbourne site had a higher median value of 1200 faecal coliforms (three samples only).

CATCHMENT WATER QUALITY

Nutrient Loading

High loadings of the nutrients phosphorus and nitrogen can lead to stream eutrophication. This may cause nuisance algal blooms; de-oxygenation of the water column; reduced water clarity; the production of obnoxious odours; or, in the case of nitrogen, direct toxicity to aquatic organisms.

Although climate and catchment characteristics will influence nutrient loads, the products of human activities in the catchment (fertiliser, atmospheric emissions, animal waste, detergents and sewage) can accelerate the eutrophication process.

While the Tasmanian Water Quality Database contains an extensive sampling record for nitrogen and phosphorus levels in the Coal River, lack of high flow results restricts interpretation to normal or background flows only.

Nitrogen

Because **nitrate** is highly soluble in water and is not readily retained by soil, it is commonly found in natural waters (surface and groundwater). Natural levels for waterways are typically less than 100 µg/L (Chapman 1992). Cultivation and application of nitrate fertilisers can substantially increase groundwater concentrations.

Mean nitrate (as nitrogen) concentrations for the Coal River are between 40 and 590 µg/L (Figure 11). High results are from the bottom outlet valve of Craigbourne Lake (590 µg/L); from limited pre-dam sampling at the Coal River at Craigbourne (570 µg/L); at Brown Mountain Rd. bridge (310 µg/L); and at the Estate Rd. bridge (430 µg/L). All these results are, however, skewed by single high readings of up to 9000 µg/L. If these outliers are removed, all sites drop to mean levels below 70 µg/L which indicate no consistent pollutant inputs.

As **nitrite** is oxidised to nitrate under aerobic conditions this results in minimal nitrite concentrations of around 1 µg/L in most freshwaters. Results substantially higher than this (around 1000 µg/L) are an indication of pollutant inputs (Chapman 1992). Limited sampling on the Coal River upstream at Craigbourne and downstream at Richmond Weir indicate low levels of nitrite which are typically less than the detection limit of 5 µg/L.

Results for **ammonia**, which is an indicator for organic pollution, are only available for the Coal River at Richmond Weir. Concentrations are generally low (less than 33 µg/L) except for one anomalous result of 1300 µg/L.

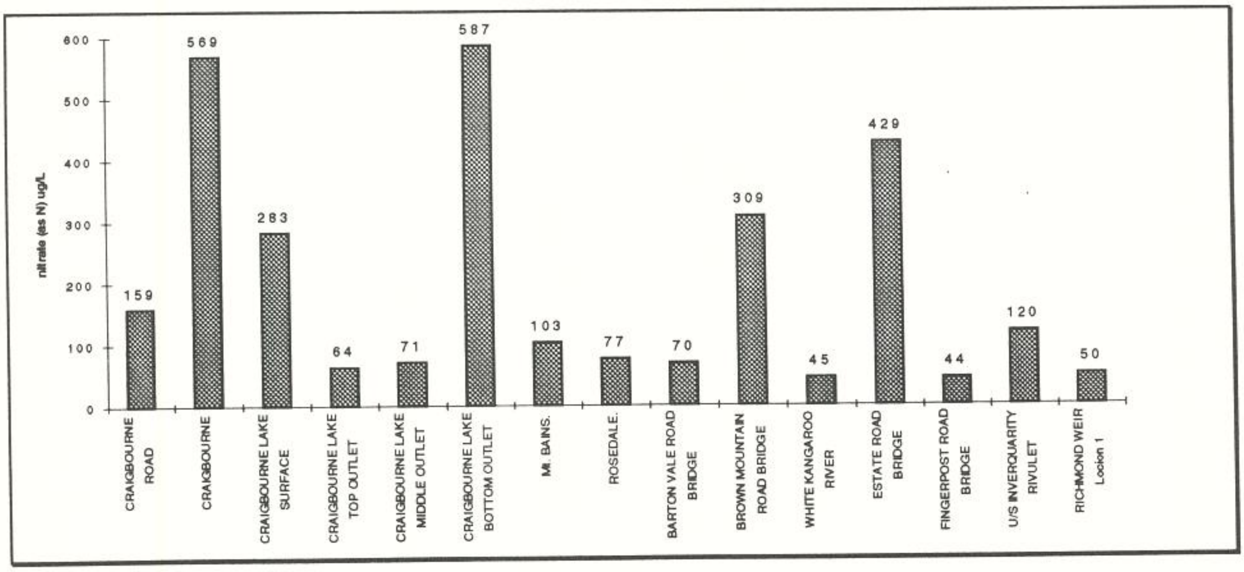

Figure 11 : Coal River mean nitrate concentration - downstream profile

CATCHMENT WATER QUALITY

Phosphorus

The majority of non-point source phosphorus enters waterways as soil particles, plant matter or animal faeces transported by runoff from intermittent storm events. Agriculture may exacerbate natural phosphorus inputs through land clearance and fertiliser application. While point-source sewage discharge may dominate during dry weather periods this is only a small proportion of total annual load.

Mean phosphorus concentrations for the Coal and White Kangaroo rivers are between 30 and 60 μg/L (Figure 12). Freshwater ecosystem guidelines for total phosphorus range from 10 to 100 μg/L. Apart from recent sampling at Richmond Weir (15 to 100 μg/L), phosphorus concentrations are typically less than detection limits. Occasional results of around 1000 μg/L may have been caused by rainfall events in the catchment.

Catchment Nutrient Status

Available data reveal that nutrient levels under background or normal flow conditions in the Coal River are generally at low levels with no major pollutant inputs apparent.

High flow events, which can carry the majority of annual nutrient loads, have not been adequately monitored to allow assessment of pollutant inputs in the Coal River catchment (see Appendix Two). Peak values of nitrogen and phosphorus have been detected, however, indicating some scope for nutrient management programmes.

Land use in the catchment (dryland grazing, intensive agriculture, forestry, towns and rural sub-divisions) can generate increased nutrient loads to waterways. The degreee of impact of these activities can be modified by the adoption of 'best management practices'(see Appendix Two).

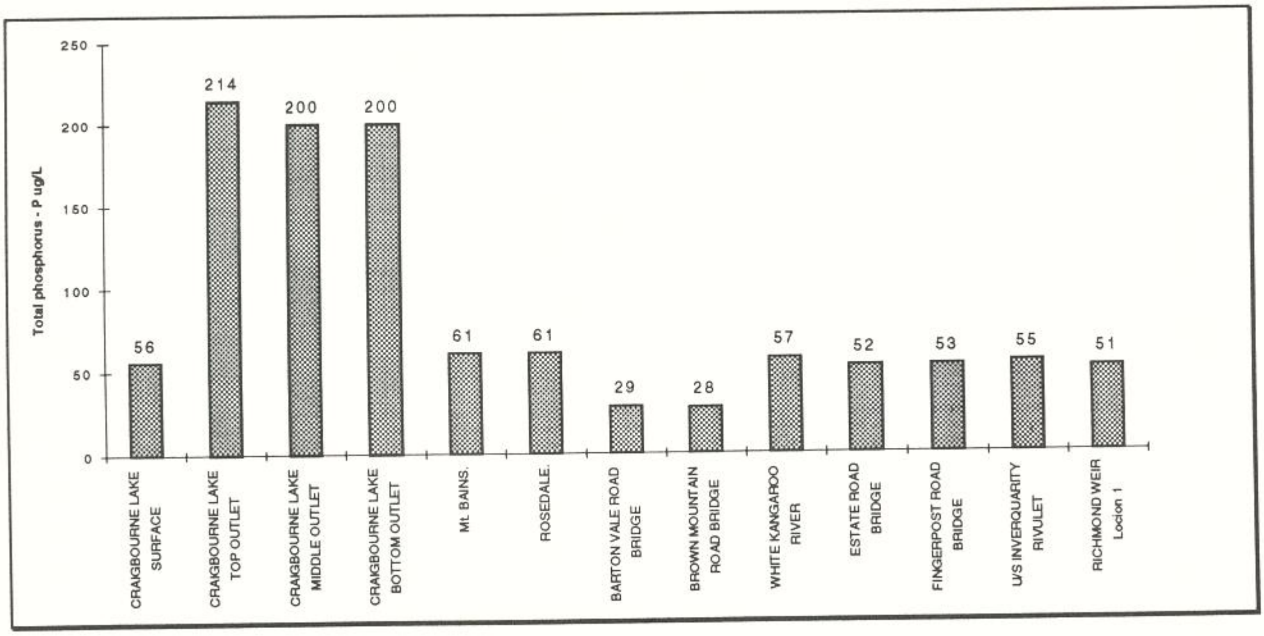

Figure 12 : Coal River mean total phosphorus concentration - downstream profile

WATER QUALITY

Algae

June 1997 saw the occurrence of what was the first recorded blue-green algal bloom in Craigbourne Dam. The species was identified as *Anabaena circinalis.* Significant numbers were also present up to four kilometres downstream of the dam.

Algal blooms of the genus *Anabaena* are fairly common in lakes, dams and slow flowing rivers across Australia. They appear to be more successful in cooler climates than other blue-green algal species. In bloom proportions they discolour water, impart a distinctive taste or smell to water, and form surface slicks or scums.

A. circinalis, while not always toxic, may release toxins when stressed. Livestock deaths have been reported in Australia where toxicity has been associated with *A. circinalis*. There is also evidence of allergic responses in humans resulting from skin contact with compounds in the algal mucilage. The boiling of water will not remove these toxins.

To date, no single cause has been identified as responsible for bloom development. Generally though, excessive growth of phytoplankton ('blooms') may be triggered by favourable environmental conditions - sunlight (extended periods), temperature (higher), low wind (less water turbulence) and increased nutrient availability (phosphorus and to a lesser extent nitrogen).

A.circinalis uses gas vacuoles to vary its depth in the water column. Thus growth is maximised by achieving an optimal depth for algal photosynthesis or nutrient uptake. It also has the ability to "fix" or create organic matter from atmospheric nitrogen rather than relying upon pollutant inputs of nitrogen into waterways.

Health warnings with regard to water supply and recreational use should be issued where toxic species are at concentrations of 15000 cells/mL or higher. Sampling of Craigbourne Dam soon after bloom development revealed different concentrations at different depths, all being in excess of the 15000 cells/mL guideline (Figure 13).

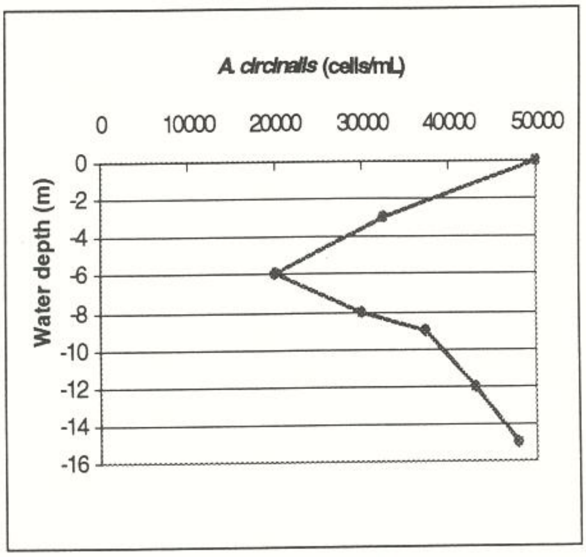

Figure 13 : Vertical distribution of *A. circinalis* in the water column near the dam wall, Craigbourne Dam, 12/6/97 (DPIF data).

The significance of this bloom lies not only in showing that conditions can be conducive for bloom development in Craigbourne, but also that algal spores dropping to the sediment may provide the 'seed-bank' for an increased frequency of algal blooms in the future.

Stream Fauna

A study on the Coal River by Read [4], assessing the impact of willow removal on stream invertebrates and fish, provides some information on catchment stream fauna and ecosystem health.

General observations were that degraded water quality (in terms of limited oxygen availability) in areas of severe willow infestation restricted the diversity and abundance of aquatic species. Willow removal resulted in improved water quality with a corresponding increase in numbers and diversity. A fish inventory for 'cleared sites' included brown trout, redfin perch, common jollytail, spotted galaxiid, Tasmanian smelt and short-finned eel. Willowed sites were characterised by redfin perch and the short-finned eel.

Irrigation releases from Craigbourne Dam ensure relatively cool and constant flow with episodes of turbidity after heavy rains. These conditions are ideal for trout. Brown trout have been in the Coal River since 1870 with some restocking in recent years to supplement natural recruitment. A few rainbows are also present as emigrants from Craigbourne Dam. Although the brown trout and redfin perch are self-supporting in Craigbourne Lake, the rainbow trout fishery is entirely dependent upon artificial stocking (French 1994).

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[4] Martin Read, Ph.D *in progress*. University of Tasmania.

WATER QUALITY

Catchment Water Quality Summary

The limited data available (primarily from the Coal River) provide some indication of water quality issues within the catchment.

- High salinity levels appear to be the major water quality problem. Irrigation has the potential to exacerbate naturally high salinity concentrations in ground and surface waters.
- Nutrient levels in the Coal River are typically low although occasional high nitrate and phosphate concentrations may indicate pollution by animal or human waste, or fertiliser run-off.
- Microbiological data from Craigbourne Rd show levels of faecal coliforms exceeding guidelines prior to dam construction. No subsequent data are available.
- While occasional peaks in turbidity and suspended solids coincide with rainfall events, the settling of solids within Craigbourne Dam appears to reduce sediment load downstream.
- Willow infestation appears to degrade waterways causing a reduction in the diversity and abundance of fish and aquatic invertebrates.
- Other parameters of aquatic ecosystem health - dissolved oxygen, pH, biochemical oxygen demand, cations, colour and metals - are generally within ANZECC ecosystem guidelines.
- June 1997 marked the occurrence of the first recorded blue-green algal bloom in Craigbourne Dam. *Anabaena circinalis* was detected both throughout the water column and also in significant concentrations up to four kilometres downstream of the dam. The significance of this bloom lies not only in showing that conditions can be conducive for bloom development in the Craigbourne impoundment, but also that algal spores dropping to the sediment may provide the 'seed-bank' for an increased frequency of algal blooms in the future.

CULTURAL RESOURCES

Archaeological

Aboriginal inhabitation of southern Tasmania may stretch back over 20,000 years. Limited archaeological research has been carried out in the Coal River catchment.

Brown (1985, 1986) surveyed the area to be inundated by the construction of Craigbourne Dam and detected widespread evidence of aboriginal presence in the form of artefacts and rock shelters. Sites were typically on the valley-floor flood-plain (36%), footslopes (34%) and sandstone escarpments (27%). Elevated footslopes close to water and with a northerly aspect appeared to be favoured locations for camping areas.

Brown suggests that there was "..widespread use and exploitation of the floodplains and footslopes of the Coal River and Wallaby Rivulet" with a core band of forty to fifty people (part of the Oyster Bay Tribe) utilising the area from Lake Tiberias in the north to Pitt Water in the south. Movement was determined to some extent by the availability of seasonal food with the highlands more frequented in the summer.

The *Aboriginal Relics Act 1975* prohibits destruction of aboriginal artefacts. The present approach is that the aboriginal community, as owners of their heritage, has central role in interpretation, assessment and management of sites[5]. Hence, information on aboriginal sites requires approval from the Aboriginal Lands Council before release. Generally sites are not identified for public release. Heritage officers from the Lands Council are available for survey work.

Suggested process:

- New developments should be surveyed, or ideally, more comprehensive regional surveys should be done to allow development to be steered away from sensitive areas.
- Council should be made aware of their obligations under the *Aboriginal Relics Act 1975.*
- Education of land-owners regarding responsibilities under the *Aboriginal Relics Act 1975.*
- Onus on people discovering artefacts or sites to notify National Parks and Wildlife for inclusion in the Tasmanian Aboriginal Site Index.

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[5] Dave Collett, Tasmanian Aboriginal Lands Council

CULTURAL RESOURCES

Population

Although Australian Bureau of Statistics collector districts don't coincide with catchment boundaries, an estimate for the regional population (less Midway Point) is 3000 people. ABS census data from 1991 gave the populations for the major centres of Richmond (755), Campania (231), Cambridge (179) and Colebrook (265). Urban areas that drain into Pitt Water on the western side of Midway Point also need to be considered as part of the catchment The ABS 1991 population estimate for the Penna and Midway Point area is 2500.

Population trends point to increases in Richmond and Campania (and probably Cambridge) with a decline at Colebrook. Much of the growth is due to rural sub-divisions. Hepper *et al.* (1988) suggest there is a move towards an urban profile with smaller families and older residents.

Catchment Administration

While most of the catchment had at one time been in a single council area, redistribution of boundaries in 1993 split the catchment into two administrative zones. Two-thirds of the catchment to the north (including Colebrook and Campania) joined the Southern Midlands Municipal Area. The remaining one-third in the south (including Richmond) became part of the City of Clarence Municipal Area. Small areas of the western drainage divide are located within the Brighton Municipality. Areas around Penna and Midway Point are within the Sorell Municipality.

Council amalgamations pending at time of writing may place all of the catchment back within one council area.

Land Use

- Agriculture - Historically the valley has been used for dryland cropping and grazing (cereals and sheep). Stages 1 and 2 of the SEIR have allowed a change in farm production. The majority of crops (80-85 %) are field crops, lucerne, cereals, poppies, and canning peas. Other crops included market vegetables, orchards, vineyards and turf.
- Forestry - Approximately 235 square kilometres of the catchment have forest cover. Considerable resources are located on private land (175 square kilometres) with additional areas of State Forest (60 square kilometres). Areas with the potential for commercial forestry include Eastern Hills north of Black Charlies, Flat Top Tier, Quoin Mountain, Gunners Quoin and Grass Tree Hill.
- Mining - There is a limited mineral resource base with present mining activities restricted to quarries. The history of coal mining within the valley is one of intermittent operations in the late 1800s and early 1900s.
- Tourism - The historical character of Richmond and its proximity to Hobart combine to make it one of the premier tourist sites in the state with approximately 147 thousand visitors per annum (Kinhill 1993)
- Recreation - The major activities within the catchment include bushwalking; rockclimbing; nature study; sightseeing and daytripping; hunting, 4WD and horses on private land and State Forest; road cycling; fishing; golf; football and cricket.
- Aquaculture - Seven oyster leases (Pacific & Flat) cover nearly 120 hectares north of the causeway in western Pitt Water. Production peaked in 1989 at 8.7 million marketable oysters. This decreased to 6.2 million adult and 1.5 million juvenile oysters (for ongrowing) in 1994 (DPIF 1996). A detailed economic, social and ecological analysis of this industry is outlined in a discussion paper prepared for the Australian Seafood Industry Council (ASIC 1996).

SERVICE INFRASTRUCTURE

Scheduled Premises

The Department of Environment and Land Management has the responsibility to issue licenses to "scheduled premises" which are engaged in activities likely to result in pollutant discharges into waterways. These activities are regulated by the *Environment Protection Act 1973* and supported by the *Environment Protection (Water Pollution) Regulations 1974* which sets emission standards. Licensed activities in the region include sewage treatment plants, refuse disposal sites, sawmills, screening plant, grain processing plant, and quarries or gravel pits (see below).

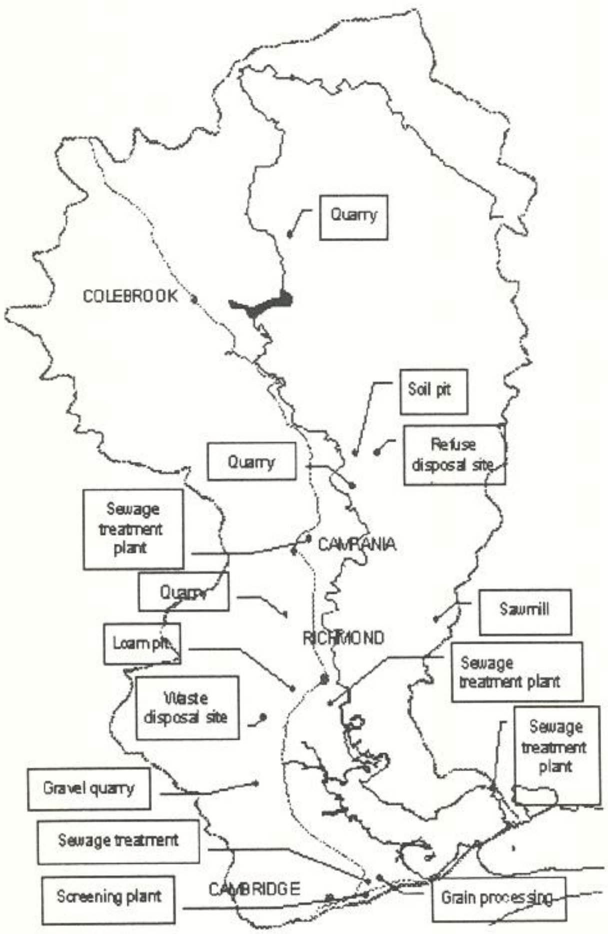

Figure 14: Scheduled premises Coal River Valley

Sewerage

Table 9 gives estimates of sewage flow rates for plants within and adjacent to the catchment. Responsibility for assessment, licensing and monitoring of sewage treatment plants (with a mean dry weather flow of greater than 25 kL/day) and effluent disposal lies with the Department of Environment and Land Management. Stated policy is to cease effluent disposal from sewage lagoons into inland waters by December 1997 unless local councils can demonstrate that land application using treated waste water for irrigation is not feasible (DELM 1994).

Table 9 : STP average dry weather flow rate estimates (Kinhill 1993)

Sewage Treatment Plant	Flow Rate (kL/d)	Population Equivalent
Cambridge	125	446
Richmond	85	800
Airport	350	800 - 900
Campania	48	230
Sorell	378	1400
Midway Pt.	510	2000

The balance of households within the region are on septic tanks. Sewage treatment and retention lagoons are being constructed on the western side of Midway Point. It is envisioned that effluent will be used for irrigation purposes as an alternative to discharge into Pitt Water.

Water Supply

Richmond and Campania have supplied domestic water from the Bryn Estyn clear water storage reservoirs as part of the Southern Regional Water Supply. There is also wayside supply on the Brighton-Richmond Northern Line via Tea-Tree and Colebrook Rd. Storage reservoirs are at Tea Tree, Rekuna, Campania and Richmond. Work is being carried out on the Colebrook water scheme to improve the quality of water.

IRRIGATION

Legislation

The Rivers and Water Supply Commission drafted the *Coal River Irrigation Water District By-laws 1986* under the *Irrigation Clauses Act 1973* to allow the supply of water from the Coal River under a system of irrigation rights. The Act treats natural watercourses as channels for the purpose of irrigation supply during the irrigation season.

South East Irrigation Scheme (SEIS)

Stage 1 of the SEIS was completed with the construction of Craigbourne Dam in October 1986. This has a capacity of 12500 ML and is designed to release 5400 ML per annum with 65% efficiency providing 3500 ML for irrigation (Davey & Maynard 1992a). With a catchment area of approximately 24700 hectares, average yearly rainfalls should be adequate to fill the dam within any given year (R&WSC 1996).

The Richmond Weir pump station and the Middle Tea Tree/Cambridge distribution pipeline comprising Stage 2 of the SEIS were completed in 1993. It takes 2 days for water to travel from Craigbourne Dam to Richmond Weir. Another weir was built downstream of Richmond by the Richmond Irrigation Trust to catch spillage. Scheme coverage is outlined in Table 10.

Table 10 : SEIS regional coverage (ha)

Area	Total	Suitable for irrigation	For single season irrigation
Stage 1	9410	4193	675
Stage 2	4222	3210	500
Total	13632	7403	1175

Management

The South-East Irrigation Scheme is managed by the Rivers and Water Supply Commission which is a Government Business Enterprise.

Day to day operation of the scheme is the responsibility of Department of Primary Industry and Fisheries personnel acting for the R&WSC.

The South-East Irrigation District Advisory Committee (SEIDAC) represents regional irrigators and provides input into scheme operation through consultation with the DPIF.

Water Usage

Figure 15 shows the upward trend in water usage from the scheme over the last ten years. Lower usage in 1996 reflects reduced demand arising from high rainfall over the summer-autumn period.

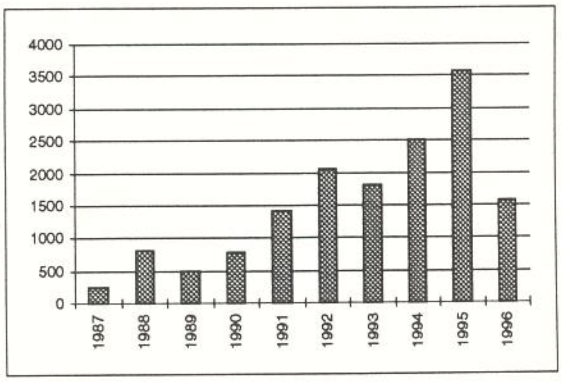

Figure 15 : SEIS annual water consumption (ML)

Figures 16 and 17 outline relative water consumption and area of different crops within the scheme for the 1995/6 irrigation season which extended from June 15 1995 to May 8 1996 (source R&WSC 1996).

IRRIGATION

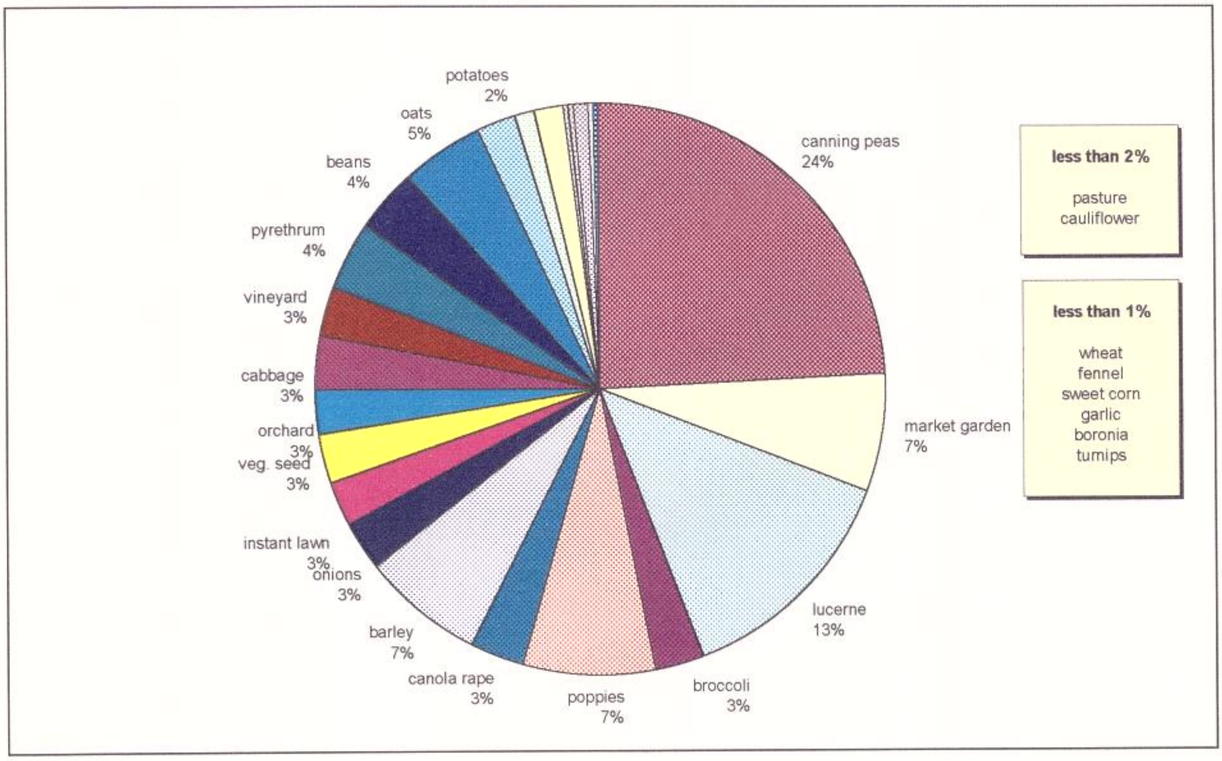

Figure 16: South East Irrigation Scheme. Irrigated crop area 1995/6. Total 1116.9 ha.

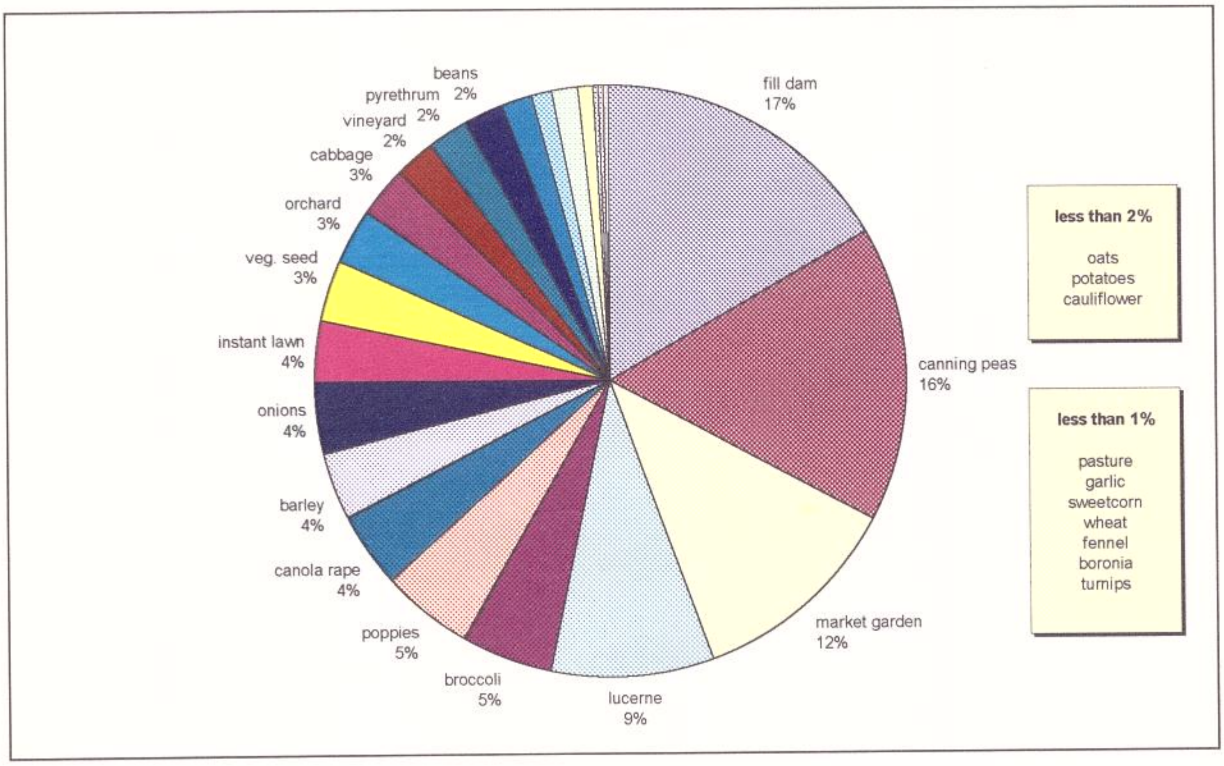

Figure 17 : South East Irrigation Scheme. Crop water usage 1995/6. Total use 1565 ML.

IRRIGATION

Future Directions

The future success of the SEIS requires adaptation to changing conditions within the valley and to policy driven changes from without (COAG).

Large salt stores and near surface watertables highlight the potential for increases in the extent and severity of soil salinity in irrigated areas (Finnigan 1995). Land management and irrigation practices may need to be modified to prevent production loss due to increasing salinisation.

Economic necessity will force a change from lower value irrigated cropping such as lucerne, irrigated pastures and poppies to higher value irrigated crops such as fresh vegetables and tree fruits (Hardy 1995).

The demand for more water and a greater emphasis on reliability of supply will require lifting distribution efficiency from an estimated 50% at present (i.e. half of water lost between dam and farm) to at least 65% efficiency.

SEIS Review

The Barrett Purcell & Associates review of the SEIS (1995) recommended a range of measures to achieve 65% water delivery efficiency. These include

- Encourage on-farm storage for 'excess' dam release with lower rates for unregulated flows. Surplus water is deemed to be flows in excess of riparian rights, irrigation and environmental requirements. This 'off-quota' system is presently being trialed.
- Determination and maintenance of Coal River environmental flows.
- Construction of a new weir at Richmond to increase the storage capacity for the pumps and increase water delivery efficiency.
- Privatisation of the scheme.

COAG Reforms

Initiatives arising from the Council of Australian Governments (COAG) agreement on water industry reform will also significantly impact upon the future operation of the SEIS. These include

- Transfer of irrigation scheme management to an independent body (Corporation or Trust) with increased user input.
- Approach full cost recovery within the capacity of the user to pay.
- Separation of irrigation rights from land titles and allow trading of irrigation rights.
- Administration and decision making to provide an integrated catchment management approach to water resource management.

Impacts on Aquaculture

Aquaculture operations within the Coal River Estuary may place some obligations upon the SEIS in terms of

- maintaining adequate freshwater inflows into the estuary, and
- preventing pesticide runoff from intensive agriculture operations.

RESERVES

Coal River Gorge north of Colebrook was declared a State Reserve in December 1980. Covering 209 hectares of what had been freehold and Crown land, it was a relatively undisturbed area in a pastoral landscape. Significant attributes included - high bird diversity (26 species including peregrine falcon nesting site) and 209 recorded plant species (8 endemics); rugged gorge incised greater than 200 metres; habitat refuge when surrounding land cleared or fired; recreational area for bushwalking, birdwatching, etc. (Johnson 1992). A draft management plan has been drawn up with the principal objective of protecting and conserving the natural landscapes of the Reserve and the habitat and diversity of species and communities of flora and fauna indigenous to the Reserve (P&WS 1997).

Approximately 3000 hectares of the Coal River Estuary and upper Pitt Water are wetland areas of international significance (under the Ramsar Convention). The Dept. of Environment and Land Management are presently preparing a management plan for this site as part of their obligations under the Ramsar agreement. State Nature Reserves are located within this area at Orielton Lagoon, Barilla Bay and the Coal River Estuary.

Forestry Tasmania has set aside 25 hectares of *E. obliqua* wet sclerophyll forest on Hungry Flats Rd as the Spinning Gum Reserve.

The Working Group for Forest Conservation nominated "recommended areas for protection" (RAPs) containing forest types and communities which enhance the conservation value of the existing reserve system in Tasmania (Forestry Commission 1990). The areas recommended for protection within the Coal River catchment due to dry sclerophyll forest type are Mt. Ponsonby (455 ha), Brown Mountain (659 ha), Gravelly Ridge (412 ha), Hungry Flats (17 ha), Little Quoin (283 ha), Alpha Pinnacle (267 ha), Spinning Gum (33 ha) and the Meehan Range State Recreation Area (483 hectares).

The Meehan Range State Recreation Area (Redgate Section) is an "unresolved" RAP that covers nearly five square kilometres of the south-west corner of the Coal catchment. It is characterised by *Eucalyptus viminalis* woodland forest on dry dolerite hills and is a reservoir of biological diversity due to the presence of rare plant species and the threatened swift parrot. In addition to a visual role as a backdrop to the Hobart suburban landscape it is also used by walkers, horse and bike riders.

It is this recreational use aspect which has caused some disagreement as to its RAP status. Recent recommendations arising from the Regional Forest Agreement process propose it to be proclaimed a State Reserve under the existing reserve classification system which would cater both for nature conservation and managed recreational activity (TPLUC 1997).

CATCHMENT ISSUES

The issues below are drawn from a range of sources such as Local and State Government reports and discussions with resource managers and local residents. It is a preliminary list only and provided a guide to the types of issues requiring management within the catchment.

Planning

- problems arising from *ad hoc* planning in past
- lack of long term goals
- lack of community consultation
- need rural approach to planning (not urban)
- limited information base to allow informed decision making
- need to plan for ecologically sustainable development

Population

- Changing population makeup - moves towards urban profile
- increase in commuting population
- imbalance in population growth - increase at Richmond, decline at Colebrook

Rural Issues

- land as community resource, conflicting demands
- loss of rural amenity and environmental quality
- protection of existing rural character
- protection of good agricultural land from sub-division
- increasing development pressure
- impact of "right to farm" legislation
- sub-division conflicts with *bona-fide* primary producers
- inflation of rural land values
- less experienced farmers (hobby farmers?) and land management consequences
- poor land management through fragmented land ownership - erosion, vegetation removal, fire, noxious weeds and loss of soil fertility
- need to develop codes of good agricultural practice
- need to encourage adoption of whole farm planning process
- intensive agriculture requires additional capital
- move from pastoral landscape to horticultural landscape
- economies of scale may require bigger farms (40 ha)
- intensive agriculture may generate dust, noise, pesticides and fertilisers - may need buffers

CATCHMENT ISSUES

Urban Issues

- balancing rates with the provision of infrastructure (sewage, water, roads) and services (support services, health and community care, transport, recreation etc.) required
- threats to Richmond heritage/historical values
- traffic and parking
- need for replacement of Brown Mountain tip
- equitable arrangement for forest industries input into road maintenance

Land & Water Management

- preserve scenic features and rural aspect
- preserve regional environmental features
- Coal River in-stream or environmental flow requirements
- Ramsar obligations at Pitt Water wetlands
- management issues for Coal River Gorge Reserve - reserve size, exotic plants, domestic grazing, fire, bushwalkers and rubbish
- tree dieback
- siltation
- impact of irrigation on soil salinity
- need for more information on salinity sources and seepage
- development of remediation methods
- encourage tree planting on marginal or degraded lands
- identification of areas requiring special land use planning controls due to ecological, conservation and recreation significance
- adequate reserves to protect ecological, conservation and recreation values
- restrict development along riparian land
- salt marsh protection from the effects of landfill, catchment modification, fire, grazing, off-road vehicles and exotic species invasion.

Waterways

- oyster farms - river flow and quality (stock, fertiliser and pesticides) requirements
- monitoring of river and estuary water quality
- monitoring of the environmental impacts of extractive industries
- maintenance of recreational fishing in waterways
- willow infestation
- flood mitigation

CATCHMENT SURVEY

The issues outlined above provided the basis for a questionnaire distributed in December 1996 to all property owners within the Coal River catchment. Copies of the survey were also available at shops and post-offices within the catchment. Respondents were asked to score issues (0-2) according to perceived importance and to raise any additional issues requiring attention in the valley.

Of the 1728 questionnaires posted, 132 were completed and returned. This was a response rate of nearly 8 percent. A further 80 forms were distributed to shops and post offices at Cambridge, Richmond, Campania and Colebrook with only 3 returned. Results are tabulated below.

Table 11 : Community survey results

ISSUE	SCORE
not enough tree planting on degraded lands	156
need to plan for ecologically sustainable development	155
poor land management through fragmented land ownership - erosion, vegetation removal, fire, noxious weeds and loss of soil fertility	147
need for long term goals	142
loss of good agricultural land to sub-division	142
pesticide residues in waterways	138
maintaining infrastructure (sewage, water, roads) and services (support services, health and community care, recreation etc.) on existing rates base	132
the impact of irrigation on soil salinity	126
providing adequate in-stream or environmental flows for the Coal River	123
need more information to allow informed decision making	119
preservation of scenic features and rural aspect	119
willow infestation of waterways	108
tree dieback	101
high nutrient runoff	99
need to protect salt marsh from the effects of landfill, catchment modification, fire, grazing, off-road vehicles and weeds	97
changing population makeup - move to urban profile	95
threats to Richmond heritage/historical values	91
inadequate water quality monitoring of river & estuary	90
Coal River Gorge Reserve management issues - reserve size, weeds, domestic grazing, fire, bushwalkers & rubbish	86
primary producers conflict with sub-division development due to dust generation, smell, noise, pesticides and fertilisers	85
inadequate reserves to protect catchment's ecological, conservation and recreation values	83
requires more community consultation	81
insufficient information on salinity sources and prevention methods	81
maintenance of recreational fishing in waterways	79
land management consequences of less experienced farmers ("hobby farmers")	76
increase in commuting population	71
development along riparian/river bank land	71
lack of awareness of Ramsar Treaty significance for Pitt Water wetlands	69
loss of rural amenity and environmental quality	68
effects of changes in river flow on oyster farming	58
need for replacement of Brown Mountain tip	55
move from pastoral landscape to horticultural landscape	53
additional capital required for intensive agriculture	50
inflation of rural land values	46
economies of scale may require bigger farms (40 ha)	46
imbalance in population growth between north & south	28

Other issues raised by respondents ...

weed infestations	8
lack of "on-ground" technical support by government	6
bush zones need to be established by sub-dividers prior to sale	6
sand-mining impacts- visual, traffic and runoff	6
motor-boat noise on Pitt Water	4
need further water supply at Dulcot	4
need for recreational use of rural land - i.e. walking trails, trail riding	4
aerial spraying	4
need for more public open space	4
sewage / nitrate load at Barilla Creek	4
unsuitable recreational use of waterways	2
need for limit to growth of urban developments	2
water quality Pitt Water	2
rubbish on Pitt Water foreshore	2
"white weed" dispersal via railway ballast, rail maintenance, bird life & potentially via waterways/ irrigation	2
inappropriate irrigation methods/ crop types	2
sewage effluent shouldn't be discharged into waterways	2
increase opportunities for community involvement in environmental work	2
vandals in north of catchment (Tunnack - Colebrook)	2
fishing access to Coal River without trespass	2
vegetation needed around Craigbourne Dam to encourage fishing	2
upstream irrigation using Craigbourne Dam	2
too many ducks at Richmond	2
too much talk and not enough "on-ground" action	2
silting up of Pitt Water	2
change in river ecology below Craigbourne Dam	2
should be 35% conversion limit of heritage buildings to tourism	2
contamination of Stage 2 irrigation water by township runoff	2
need secondary treatment of stormwater	2
need to integrate tourism and agriculture	2
bush retention on higher slopes	2
untreated sewage from old houses discharging into waterways	2
shooting on five acre blocks	2
sub-division land clearing near waterways	2
over watering in intensive irrigation zone	2
negative impact of breakup of old Richmond Council	2
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