Appendix 18 Surface Water Quality and Flow Data

Table of Contents

List of Tables

List of Figures

Annexures

1. INTRODUCTION

This appendix presents a summary and commentary of the surface water quality and flow data obtained for the Water Resource Assessment and Water Management Plan for the Bickham Coal Mine project. This data has been obtained and analysed to identify baseline conditions for comparison with monitoring data to be collected during mining operations.

Two sets of water quality and flow data are available for the Pages River and its tributaries, and Kingdon Ponds:

- historic data collected by the Department of Water and Energy (DWE) and its predecessors, including the Department of Natural Resources (DNR), since the early 1970s;
- data collected by Ecowise Environmental since 2002 from the Pages River in the immediate vicinity of the site.

The following sections present further information on these two data sets.

2. DWE WATER QUALITY DATA

DWE and its predecessors have collected a range of water quality data at various locations on the Pages River and its tributaries since 1972. The relevant locations are listed in Table 2.1 and shown in Figure 2.1.

Table 2.1: DWE Water Quality Data Stations near Bickham Mine

Station	Name	Period of Record
Long Term		
Pages River and tributaries		
210030	Pages River @ Gundy Bridge	1972 - 2002
210052	Pages River @ Gundy Recorder	1972 – 2002
210061	Pages River @ Blandford	1972 – 2005
Short Term		
Pages River and tributaries		
210119	Pages River @ Camerons Damsite No.1	1983
21010019	Pages River @ Murrurundi	1999
21010219	Pages River @Haydon Lane Bridge	1999 – 2002
21010221	Scotts Creek @"Clover Leaf"	1999 – 2002
21010223	Warlands Creek @ Blandford	1999 – 2002
21010312	Pages River Above Murrurundi	2001 – 2002
21010313	Pages River @ Blandford	2001 – 2002
Kingdon Ponds		
21010314	Kingdon Ponds @ Cresfield	2001 – 2002
21010315	Kingdon Ponds between Parkville and Scone	2001

The available data sets are of two different types:

- Long term monitoring of basic water quality parameters (temperature, turbidity, salinity and basic water chemistry) at the Blandford and Gundy gauges. This monitoring was carried out predominantly in the 1980s and the data set includes of the order of 120 records. These data are summarised in Table 2.2. Further details of the water quality records are contained in Annexure 18A.

- More detailed water chemistry analyses undertaken occasionally at the Blandford and Gundy gauges as well as at a number of sites in the vicinity of Bickham mine including Scotts Creek, Warlands Creek, Kingdon Ponds and the Pages River upstream of Murrurundi. These data sets include between three and nine sets of analyses, some of which include analysis of nitrogen and phosphorus concentrations. These data are summarised in Table 2.3, which contains the range of mean values across all the short term sites. Water quality data for each individual site are contained in Annexure 18A.

Table 2.2: Summary of Long Term Water Quality Data for the Pages River

Analyte	Units	Pages River @ Gundy Bridge (210030)				Pages River @ Gundy Recorder (210052)				Pages River @ Blandford (210061)			
		No	Min	Mean	Max	No	Min	Mean	Max	No	Min	Mean	Max
pH		132	6.7	8.2	8.9		6.7	8.2	8.9	376	4.9	7.9	8.8
Temp	°C	116	7	19.3	33.0	5	7	19.3	33.0	192	8	17.4	30.0
Turbidity	NTU	86	0.3	7.3	130	5	0.3	7.3	130	261	0	92.7	1026
TSS @ 105°C	mg/L									22	0.1	3.1	8.3
EC @25°C	uS/cm	122	250	614	959	9	250	613	959	375	0	423	4999
DO	mg/L	5	7.5	9.7	11.8	0	7.5	9.7	11.8	4	11.2	12.1	12.9
Ca – total	mg/L			45			39	43.1	48	240	0	24.6	54.1
Mg – total	mg/L	5	35	38	43	5	34.9	38.0	43	241	0	21.6	49.9
Na – soluble	mg/L	7	42	56	64		42	54.8	64	240	0	26.8	61.8
K – soluble	mg/L	7	1.2	1.5	2	5	1.2	1.5	2	235	0	1.3	3.1
Chloride as Cl	mg/L	7	30	46.4	64	5	30	50.9	64	244	2	21.6	57.9
Sulphate as SO_4	mg/L	5	44	62.8	76	11	44	62.8	76	244	1.6	14.6	42.4
Alkalinity as Bicarbonate	mg/L	7	228	270	327	72	228	280	327	242	6.9	190.3	396
Alkalinity as Carbonate (CO_3)	mg/L	7	0	14.5	32	118	0	7.5	14	197	0	0.6	41
N – total	mg/L			1.1		117	0	0.0	0.1	6	0.1	0.1	0.2
Nitrate as N	mg/L	9	0	0.1	0.2	4	0	0.0	0.2	211	0	0.3	568
Phosphorus – tot	mg/L	12	0	0.1	0.1		0	0.1	0.1	228	0	1.6	95

Any interpretation of the water quality monitoring results in Table 2.2 must take account of the fact that some results represent monitoring over a period of 30 years, while others represent more recent monitoring for a short period only. Two aspects are noticeable:

- turbidity levels in the Pages River at the Blandford gauge are highly variable, with a maximum of over 1,000 NTU being recorded during high flow;
- the phosphorus levels in the Pages River at the Blandford gauge are unusually high for an upland river system with an average of 1.6 mg/L and a maximum of 95 mg/L.

Table 2.3: Summary of Short Term Water Quality Data
(mean values across all sites)

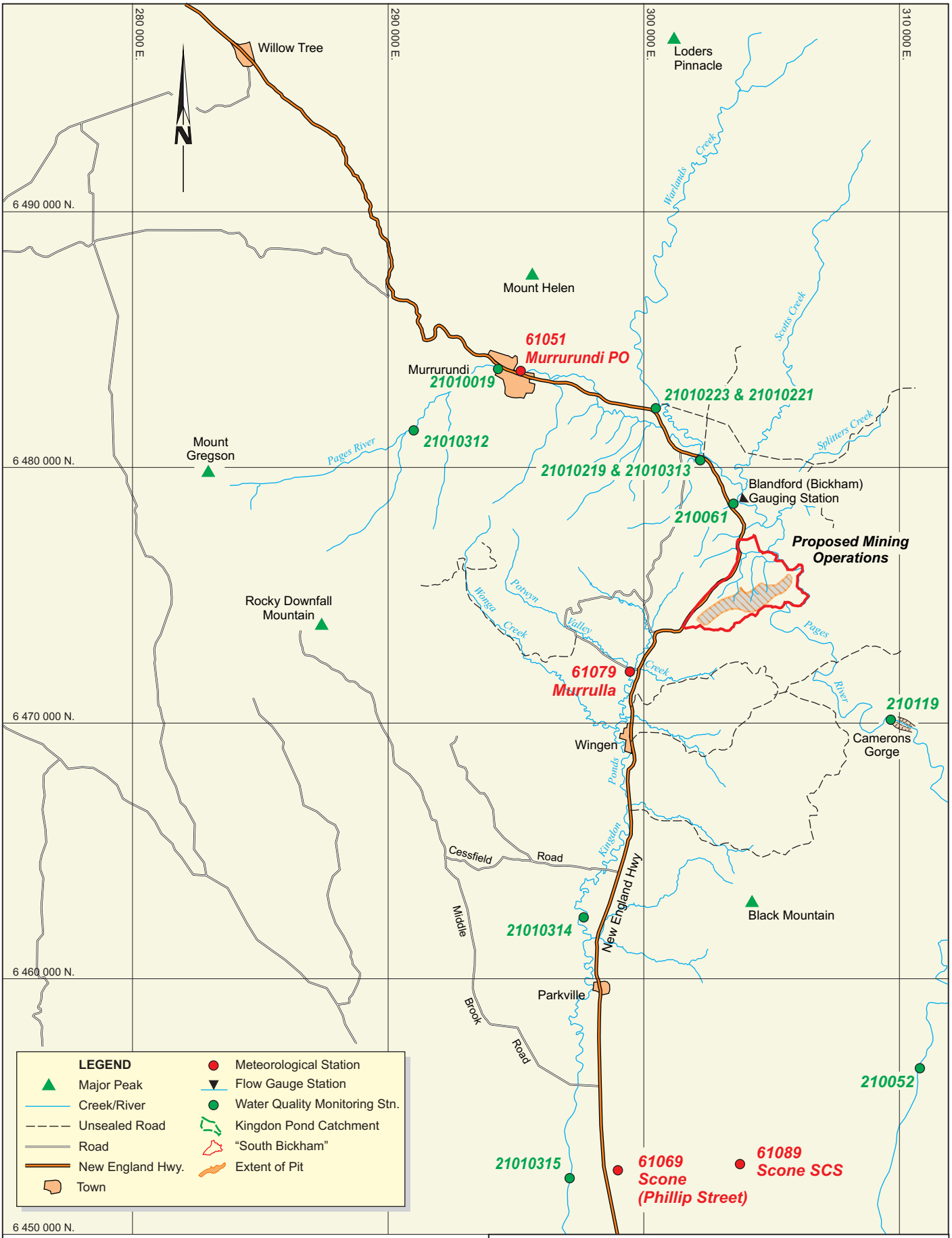
Parameter	Units	Pages River		Kingdon Ponds	
		No. of Samples	Mean	No. of Samples	Mean
pH	pH	2	8.4		
Temp	deg C	1	17.7		
Turbidity	NTU	6	0.8	9	17.3
TSS @ 105°C	mg/L	10	9.3	9	37.4
EC @ 25°C	uS/cm	5	519.4	9	673.0
DO	mg/L	2	8.2		
Ca – total	mg/L	1	27.5		
Mg – total	mg/L	1	24.9		
Na – soluble	mg/L	1	49.4		
K – soluble	mg/L	1	2.2		
Chloride as Cl	mg/L	1	30.3		
Sulphate as SO_4	mg/L	1	16.6		
Alkalinity as Bicarbonate	mg/L	1	301.0		
Alkalinity as Carbonate	mg/L	1	3.8		
N – total	mg/L	10	0.5	9	1.4
Nitrate as N	mg/L	2	164.5		
Phosphorus – total	mg/L		31.3	9	0.2

Average electrical conductivity values in the vicinity of the Bickham mine are contained in Table 2.4 below.

Table 2.4: Average EC Values in the vicinity of the Bickham mine

Station	Name	No of Samples	Mean EC µS/cm
Long Term			
Pages River and tributaries			
210030	Pages River @ Gundy Bridge	122	614
210052	Pages River @ Gundy Recorder	118	613
210061	Pages River @ Blandford	375	423
Short Term			
Pages River and tributaries			
210119	Pages River @ Camerons Damsite No.1	1	462
21010019	Pages River @ Murrurundi	2	411
21010219	Pages River @Haydon Lane Bridge	3	417
21010221	Scotts Creek @"Clover Leaf"	3	986
21010223	Warlands Creek @ Blandford	3	322
21010312	Pages River Above Murrurundi	9	494
21010313	Pages River @ Blandford	11	544
Kingdon Ponds			
21010314	Kingdon Ponds @ Cresfield	14	669
21010315	Kingdon Ponds between Parkville and Scone	4	677

The average long term conductivity over the period of record at the Blandford gauge is 423 µS/cm. Other reaches in nearby river systems, with the exception of Scotts Creek, had comparable conductivity readings in the range of 322 – 677 µS/cm. Scotts Creek had a conductivity reading of 986 µS/cm, indicating that this creek is likely to be a significant contributor of salt to the Pages River.



Bickham Coal Mine WRA & WMP

BICKHAM COAL COMPANY PTY LTD

Appendix 18 - Surface Water Quality and Flow Data

DWE WATER QUALITY MONITORING SITES

Date: March 2009	Assignment: 21667	**Figure 2.1**

3. WATER QUALITY MONITORING AT "SOUTH BICKHAM"

Water quality monitoring to establish baseline water quality in the reach of Pages River on "South Bickham" has been undertaken since June 2002 at a number of locations as shown on Figure 3.1. Monitoring commenced at two sites (designated WQ1 and WQ2), and was gradually expanded to provide further definition of water quality changes along the reach of the river adjacent to the mine. The current program involves monthly monitoring at the eight sites listed in Table 3.1 and shown on Figure 3.1.

Sampling, transport and laboratory analysis were carried out in accordance with standard quality assurance protocols. All samples were transported to the laboratory in prepared sample containers provided by the laboratory, preserved where required for specific analytes, and stored at below 40C. Rigorous chain of custody documentation was maintained during sample transport to protect the integrity of the samples. All analyses were performed within the laboratory-notified sample holding times, with the exception of pH. For reliable pH values, field measurements were taken at the time of sampling. Sufficient field and laboratory duplicate samples were analysed to meet quality assurance objectives and to ensure the reliability of the sample results.

Table 3.1: Summary of Water Quality Monitoring Locations (2002 - 2008)

Sample Site	Site Location	No of Samples
BCSW 1	On the Pages River immediately downstream of the gorge (at the same location as WQ1);	61
BCSW 2	On a bend in the Pages River;	62
BCSW 3	At the downstream end of a large pool on the Pages River;	61
BCSW 4	On the Pages River at riffles adjacent to the overburden dump established for the bulk sample excavation;	62
BCSW 5	At the pool on a bend in the Pages River near the southern boundary of "South Bickham" (approximately the same location as WQ2);	56
BCSW 6	In a pool in the Pages River just upstream of the junction with Creek A, near the northern boundary of "South Bickham";	44
BCSW 7	On Creek A, about 200 m upstream of the junction with the Pages River;	39
BCSW 8	On Creek A, about 400 m upstream of the junction with the Pages River.	36

Full details of the water quality monitoring in the Pages River in the vicinity of the mine site (2002 – 2008) are presented in Annexure A9A of Appendix 9 and Annexure 18B and summarised in Table 3.2 below. Table 3.2 contains the average, minimum and maximum recorded values across all of the monitoring along the Pages River within the immediate vicinity of "South Bickham".

Table 3.2: Summary of Water Quality Monitoring in the Pages River (2002 – 2008) (analysed across Pages River monitoring sites BCSW 1-BCSW 6)

Analyte	Units	Min	Mean	Max
pH		7.5	8.2	8.9
Turbidity	NTU	0.2	3.2	108.0
TSS	mg/L	1.0	8.4	480.0
Conductivity @ 25°C	µS/cm	352.0	744.7	1230.0
Calcium	mg/L	16.0	40.3	64.0
Magnesium	mg/L	17.0	35.8	58.0
Sodium	mg/L	24.0	57.0	135.0
Potassium	mg/L	1.0	2.4	5.0
Chloride	mg/L	15.3	58.8	135.0
Sulphate	mg/L	11.0	52.6	110.0
Bicarbonate as $CaCO_3$	mg/L	111.0	259.1	378.0
Carbonate as $CaCO_3$	mg/L	1.0	12.7	60.0
Total Kjeldahl Nitrogen as N	mg/L	0.0	0.5	14.2
Nitrate as N	mg/L	0.01	0.49	3.14
Total Phosphorus as P	mg/L	0.01	0.08	2.22

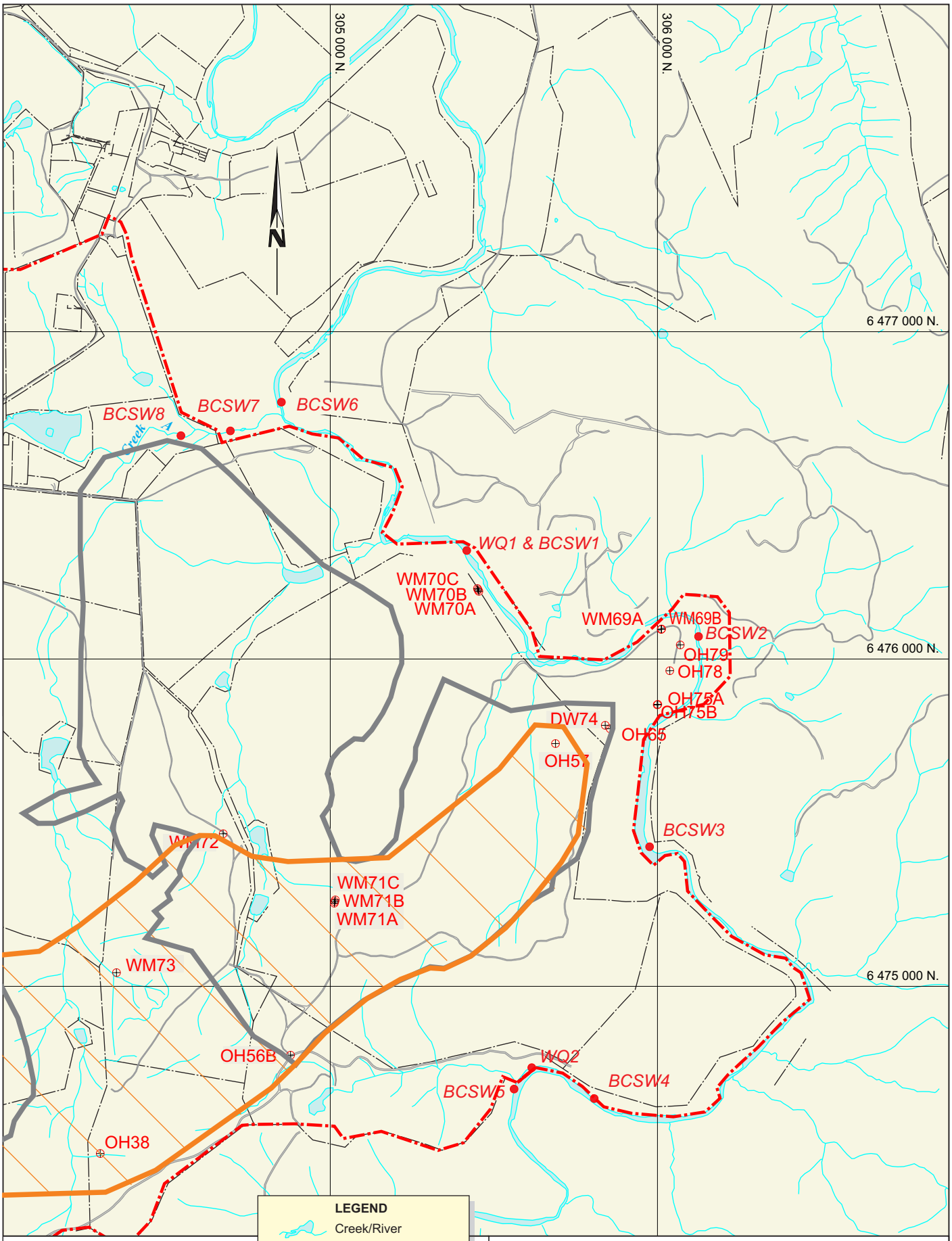
The major features shown by the water quality monitoring in the Pages River are:

- The salinity distinctly changed (increased) at two sites, and less so at a third less prominent site (Part B Section B4.8):
  - Splitters Creek and Pages River confluence, salinity increase due to an influx of higher salinity flows from the Splitters Creek catchment;
  - At the downstream end of the alluvial flats, just upstream of the Bickham Gorge, salinity increase likely to be caused by groundwater inflows from the alluvium;
  - A less prominent spike 300m further downstream, below the Bickham Gorge, coinciding with a series of small volume seepages from sediments immediately above the G Seam where it first outcrops in the river bank.
- The sites within "Creek A" (BCSW7 and BCSW8) both exhibited conductivity levels significantly higher than those in the Pages River. This may be attributable to the effects of the drought or may indicate that this creek carries higher salinity loads as a result of naturally occurring saline sources in the catchment. Ongoing monitoring will help resolve this issue.
- The existing water quality in the river exceeds all the ANZECC (2000) default trigger values for upland freshwater ecosystems. This, in itself, is not surprising given the highly disturbed nature of the catchment.
- Given that the existing freshwater ecosystems have adapted to the existing regime, the water quality monitoring undertaken to date, together with ongoing monitoring in the future, would provide a basis for deriving appropriate trigger values for the Pages River using the procedures set out in ANZECC (2000).

Details of water quality monitoring in the Pages River in the vicinity of the mine site (2002 – 2008) for aquatic ecosystem indicators and for homestead water supply indicators are presented in Annexure 18C. Also tabled is information on the average groundwater quality from bore OH72 (Bickham Formation) and the average groundwater quality (1:1 mix ratio) from bores OH72 and OH 71A (G Seam). These two bores are located in areas identified for the siting of dewatering bores.

Groundwater qualities compare favourably with that of the Pages River; the groundwater is generally of better quality than the Pages River or within the ANZECC (2000) default triggers where the river water quality is very low:

- For the aquatic ecosystem indicators, the Total Nitrogen average concentrations for the groundwater from bore OH72 and for the mixture of groundwater from bores OH71A and OH72 is around that of the average concentration for the river.
- The pH values for both groundwaters is within the ANZECC (2000) default trigger.
- The Total Phosphorus and Conductivity average concentrations of groundwater from bore OH72 exceed the average concentrations for the river, but are within the 90%ile concentrations for the river (indicated in yellow in Annexure 18C). The concentrations for the mixture of groundwater from bores OH71A and OH72 just exceed the 90%ile concentrations for the river (indicated in orange in Annexure 18C).
- For the homestead water supply indicators the groundwater qualities are within the ANZECC default triggers.


305 000 N.
306 000 N.
6 477 000 N.
6 476 000 N.
6 475 000 N.
N
BCSW8
BCSW7
BCSW6
Creek
WQ1 & BCSW1
WM70C
WM70B
WM70A
WM69A
WM69B
BCSW2
OH79
OH78
OH75A
OH75B
DW74
OH65
OH57
BCSW3
WM72
WM71C
WM71B
WM71A
WM73
OH56B
WQ2
BCSW4
BCSW5
OH38
0
500
Metres
LEGEND
Creek/River
Road/Track
Property Boundaries
"South Bickham"
Extent of Pit
Extent of Dumps
BICKHAM COAL COMPANY PTY LTD
Bickham Coal Mine WRA & WMP
Appendix 18 - Surface Water Quality Data
MINE WATER QUALITY MONITORING SITES
Date: March 2009
Assignment: 21667
Figure 3.1

4. FLOW REGIME

4.1 PAGES RIVER

Four major sub-catchments of the Pages River are located upstream of "South Bickham", as shown in Figure 4.1. These sub-catchments comprise:

- Upper Pages River and minor tributaries
- Warlands Creek
- Scotts Creek
- Splitters Creek.

The catchment area of the Pages River adjacent to the site is approximately 353 km^2.

A stream gauge operated by the DWE is located on the Pages River at Blandford (Station 210061), about 5 km upstream of the project site, as shown on Figure 3.1. This gauging site, which has a catchment area of 303 km^2, measures the combined flow from the Upper Pages River, Warlands Creek and Scotts Creek catchments. Splitters Creek joins the pages River between the Blandford gauge and the northern boundary of "South Bickham".

Continuous flow records have been collected at the Blandford gauge since 1983. For this study mean daily flow data for the period 1960 – 2008 was obtained from DWE's website (http://waterinfo.nsw.gov.au/, accessed 5/1/209). Flow duration curves for both the full period of record and the period from 2000 to 2008 are shown in Figure 4.2. A summary of the statistics obtained from the flow duration is contained in Table 4.1.

Table 4.1: Flow Duration Analysis Statistics – Pages River

Percentage of samples where flow is exceeded	1960 – 2008		2000 - 2008	
(%)	ML/d	m^3/s	ML/d	m^3/s
2	964.0	11.2	472.9	5.5
10	145.0	1.7	51.9	0.6
50	19.6	0.2	7.0	0.1
90	3.5	0.04	2.1	0.02

Figure 4.2 and Table 4.1 show that there has been much less runoff over the period from 2000 to 2008 than over the longer record.

Table 4.2 below contains monthly statistics for runoff at Blandford. This data should be interpreted with care as there are significant periods of missing data in the record.

Table 4.2: Monthly Statistics for Station 210061 - Pages River at Blandford (ML)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Min	52	31	56	32	63	46	51	32	49	61	0	10	1,302
Mean	6,928	2,926	1,957	1,567	2,646	2,538	5,032	5,896	2,991	3,476	3,445	3,022	39,685
Max	59,823	33,383	23,972	17,555	26,159	26,014	78,046	60,457	19,456	31,433	67,464	57,100	163,957
10%ile	127	102	116	107	113	90	151	193	189	225	100	227	3,687
50%ile	594	497	609	339	410	791	1,898	3,001	1,578	1,553	1,089	757	21,426
90%ile	26,240	10,418	3,593	2,605	9,213	5,722	9,202	8,930	7,815	8,257	6,066	512	92,088

Table 4.3 summarises key features of the annual flow regime in the Pages River. Average annual runoff for is about 40,000 ML/year or about 130 ML/km^2/year, but it is highly variable. Over the period of record, annual flow has varied from about 1,300 ML (3.3% of the average) to 164,000 ML (410% of average).

Table 4.3: Summary Annual Flow Statistics – Pages River at Blandford Gauge

Statistic	Flow (ML/year)
Minimum	1,302
90 percentile exceedance	3,687
Median	21,426
Average	39,685
10 percentile exceedance	92,088
Maximum	163,957

The variability of the annual flow at Blandford reflects the variability of rainfall as well as the reduction in runoff as a proportion of rainfall when rainfall is low. This effect is shown in Figure 4.3 which shows the runoff at Blandford expressed as a percentage of the annual rainfall at Murrurundi. Note that the analysis that is shown in Figure 4.3 only takes account of years in which there is a complete record.

Figure 4.3 shows that there is considerable scatter in the data for years with similar total rainfall, representing differences of rainfall distribution and rainfall intensity within a year. In years of low rainfall (about 500 mm) the flow in the river is negligible (1-2% of the rainfall at Murrurundi) but in wetter years, the runoff can be as much as 35% or more of rainfall. The overall average annual runoff in the Pages River at Blandford represents 16% of the average annual rainfall at Murrurundi. This value is considerably higher than the runoff for Kingdon Ponds on account of the fact that the Pages River catchment contains large areas in the steep upper valleys draining from the Liverpool Range. Not only are these upper reaches likely to produce more runoff because they are steeper, but they will also receive more rainfall than that recorded at Murrurundi.

4.2 KINGDON PONDS

A small area (about 158 ha) of "South Bickham" drains into an un-named tributary in the north-eastern headwaters of Kingdon Ponds. Two major sub-catchments of Kingdon Ponds are located downstream of "South Bickham", as shown in Figure 4.1. These sub-catchments comprise:

- Potwyn Valley Creek
- Wonga Creek.

The nearest flow gauging station (No 210093) on Kingdon Ponds is located at Parkville approximately 19 km downstream of "South Bickham", where the total catchment area is 177 km^2. Flow measurement began at Parkville in 1972, but the record has over four years of missing data, mainly in the period 1989 to 1993. For this study mean daily flow data for the period 1972 – 2008 was obtained from DWE's website (http://waterinfo.nsw.gov.au/, accessed 5/1/2009). A flow duration curve for the period of record is shown in Figure 4.3. A summary of the daily flow statistics is contained in Table 4.4, while Table 4.5 summarises the monthly flow statistics and Table 4.6 summarises the annual statistics.

Table 4.4: Daily Flow Duration Statistics – Kingdon Ponds

Percentage of samples where flow is exceeded	1972 - 2008	
(%)	ML/d	m^3/s
2	151.0	1.7
10	22.3	0.3
50	4.8	0.1
90	0.0	0.0

Table 4.5: Monthly Statistics for Stn 210093 – Kingdon Ponds at Parkville (ML)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	1,174	735	942	205	669	742	907	585	462	405	858	375	8,568
Max	16,660	12,962	14,538	1,136	10,457	6,829	11,847	7,203	3,916	1,640	15,124	4,284	31,099
10%ile	0	0.	0	0	0	39	33	28	18	4	1	0	815
50%ile	129	165	140	119	169	216	177	290	276	242	189	179	4556
90%ile	1880	1153	1258	476	960.	2150	1938	795	979	1341	1120	656	25,989

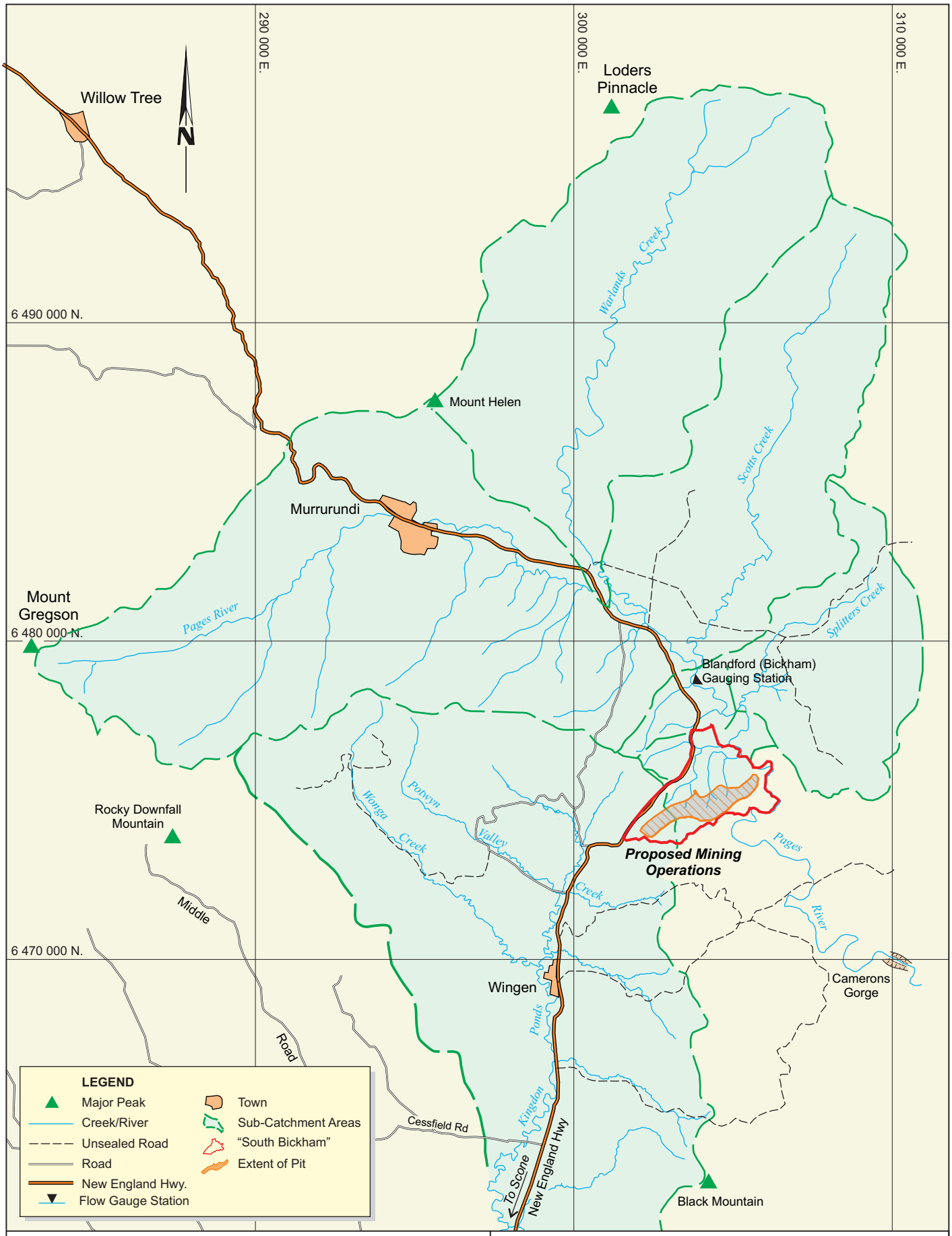
Table 4.6: Annual Flow Statistics – Kingdon Ponds

Statistic	Flow (ML/year)
Minimum	0
90 percentile exceedance	815
Median	4,556
Average	8,558
10 percentile exceedance	25,989
Maximum	31,099

The historic flow record shows that the river is dry for about 14% of the time (7 weeks per year on average) and has a flow less than 1 ML/day (<0.01 m^3/s) for about 18% of the time (10 weeks per year on average). The annual flow also exhibits significant variability ranging from zero to just over 31,000 ML.

The variability of the annual flow in the Kingdon Ponds at Parkville reflects similar variability to that displayed by the Pages River in response to variability of rainfall. This effect is shown in Figure 4.5 which shows the runoff at Parkville expressed as a percentage of the annual rainfall at Wingen. Note that the analysis that is shown in Figure 4.5 only takes account of years in which there is a complete record.

Like the data for the Pages River, Figure 4.5 shows that there is considerable scatter in the data for years of similar total rainfall, representing differences of rainfall distribution and rainfall intensity within a year. In years of low rainfall (about 400 mm) the flow in the river is negligible (2-3% of the rainfall at Wingen) but in wetter years, the runoff can be as much as 20% or more of rainfall. The overall average annual runoff in Kingdon Ponds at Parkville represents 7% of the average annual rainfall at Wingen. This value is considerably lower than the runoff for the Pagers River and reflects the lower elevations and gentler slopes present in the majority of the Kingdon Ponds catchment.



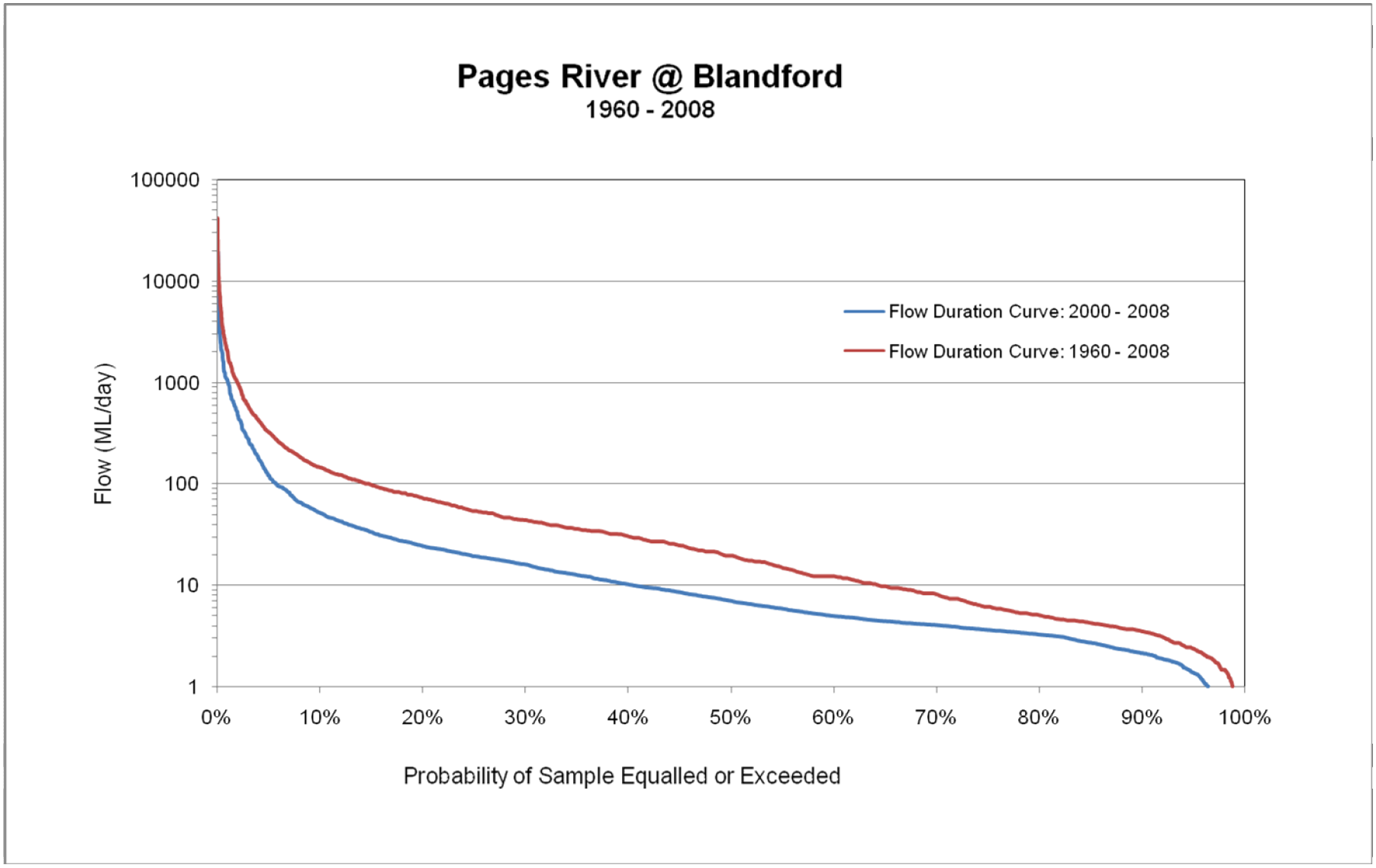
Bickham Coal Mine WRA & WMP

BICKHAM COAL COMPANY PTY LTD

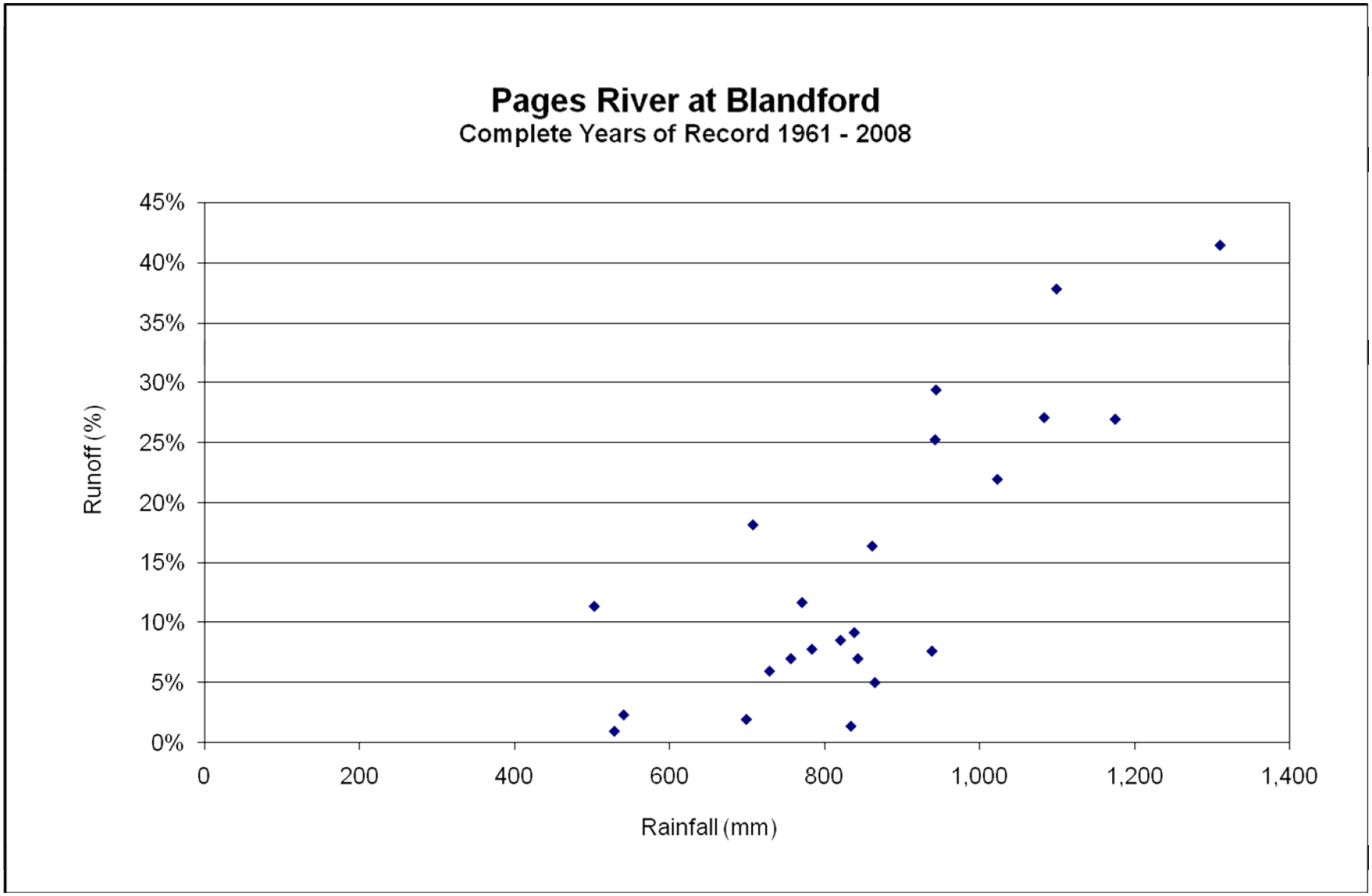
Appendix 18 - Surface Water Quality and Flow Data

PAGES RIVER AND KINGDON PONDS SUB-CATCHMENTS

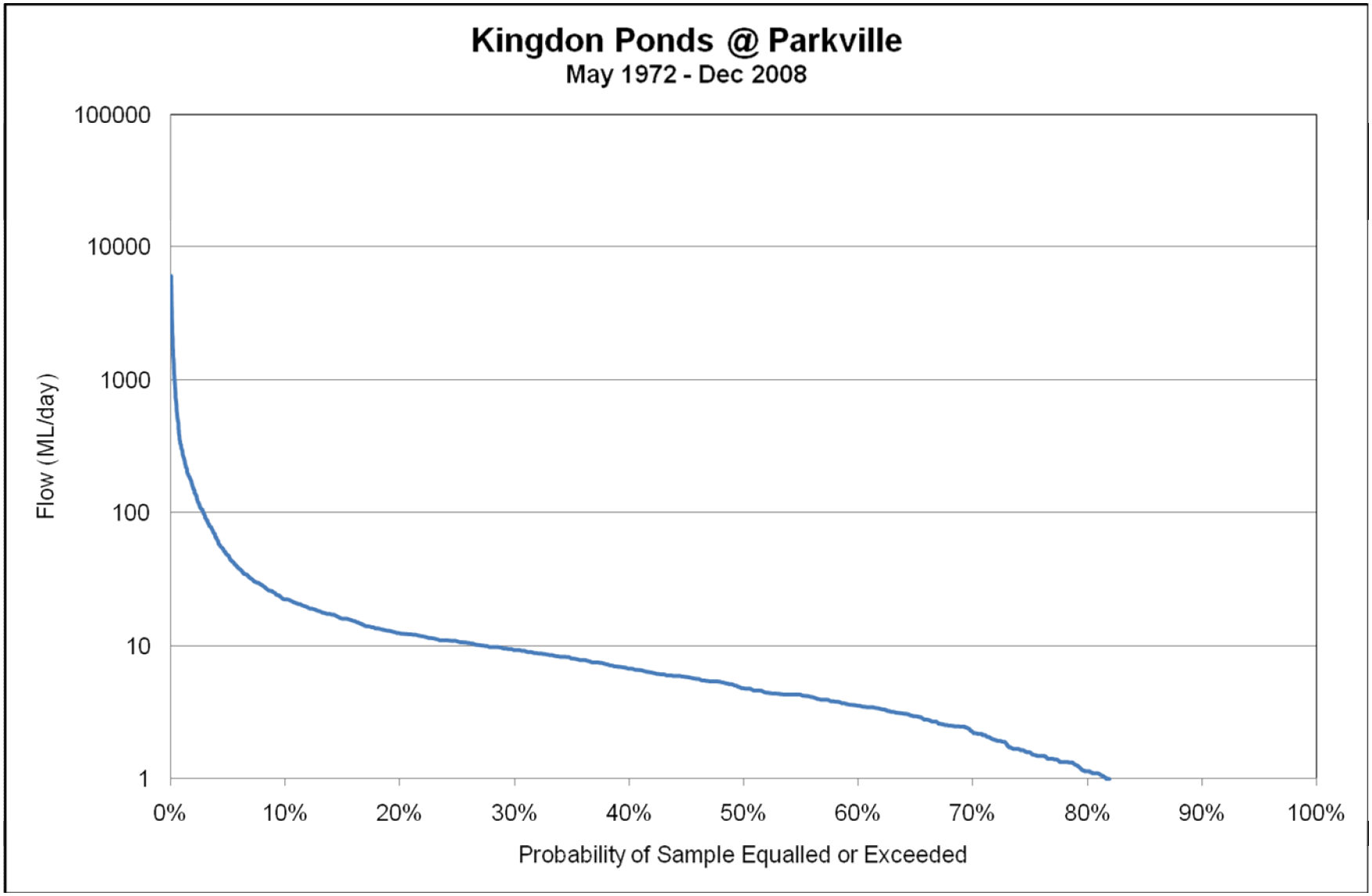
Date: March 2009	Assignment: 21667	**Figure 4.1**



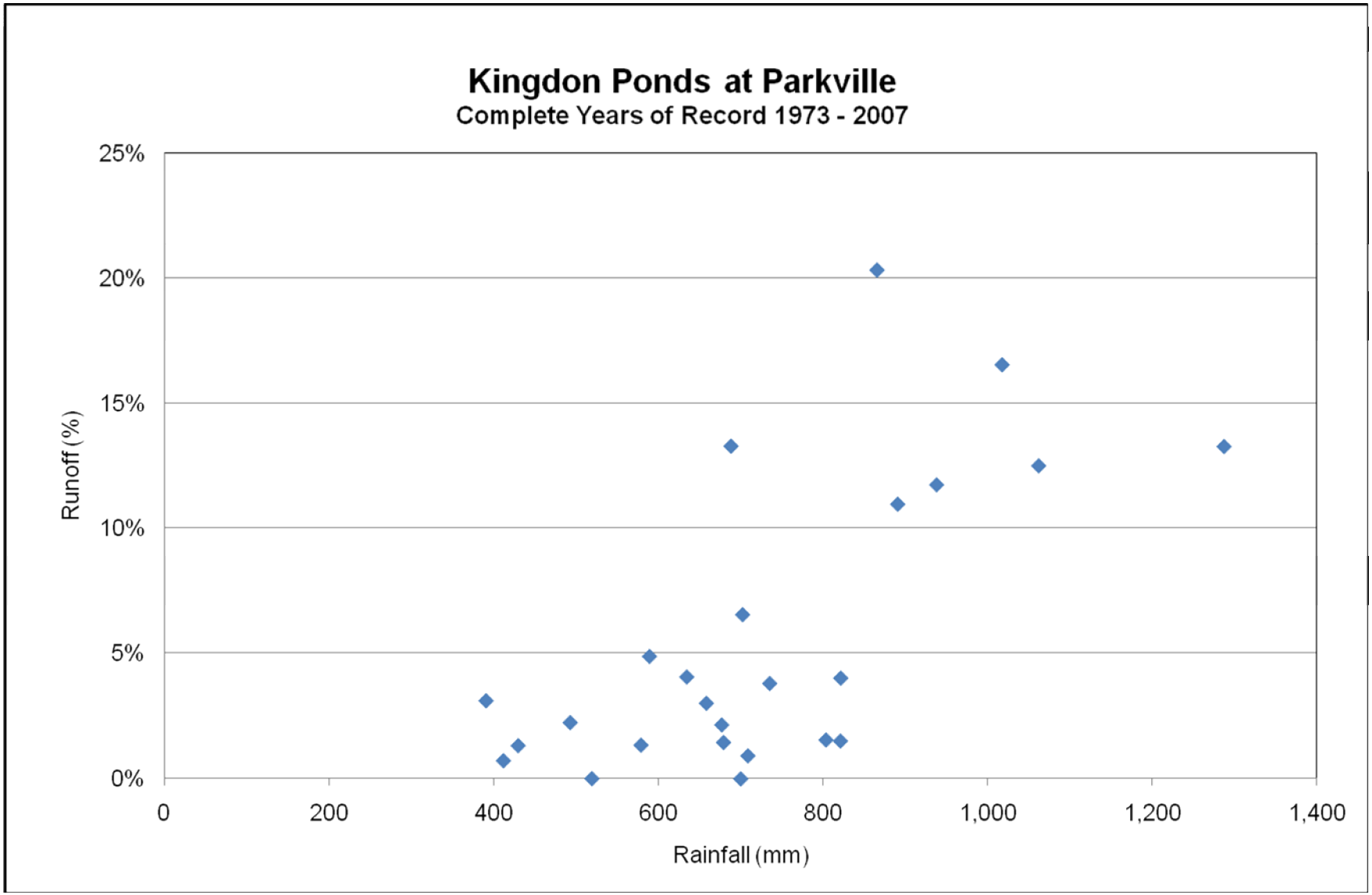
BICKHAM COAL COMPANY PTY LTD	**Bickham Coal Mine WRA & WMP**	
	Appendix 18 – Surface Water Quality and Flow Data	
Flow Duration – Pages River at Blandford		
Date: March 2009	Assignment: 21667	**Figure 4.2**



BICKHAM COAL COMPANY PTY LTD	**Bickham Coal Mine WRA & WMP**
	Appendix 18 – Surface Water Quality and Flow Data
Annual Rainfall:Runoff Relationship - Pages River at Blandford	
Date: March 2009	Assignment: 21667	**Figure 4.3**



BICKHAM COAL COMPANY PTY LTD	**Bickham Coal Mine WRA & WMP**	
	Appendix 18 – Surface Water Quality and Flow Data	
Flow Duration – Kingdon Ponds at Parkville		
Date: March 2009	Assignment: 21667	**Figure 4.4**



BICKHAM COAL COMPANY PTY LTD	**Bickham Coal Mine WRA & WMP**	
	Appendix 18 – Surface Water Quality and Flow Data	
Flow Duration – Kingdon Ponds at Parkville		
Date: March 2009	Assignment: 21667	**Figure 4.4**

5. REFERENCES

ANZECC (2000), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*

DLWC (1999). *Farm Dams Assessment Guide*

DWE Waterinfo website: http://waterinfo.dlwc.nsw.gov.au/ accessed 5/1/2009

Muswellbrook Shire Council. *Community Water Quality Monitoring Program.*

Annexure 18A: DWE Surface Water Quality Data

		210030 - Pages River at Gundy Bridge									210052 - Pages River at Gundy Recorder								
Parameter	**Units**	**Start Date**	**End Date**	**No#**	**Mean**	**SD**	**Min**	**Max**	**10%**	**90%**	**Start Date**	**End Date**	**No#**	**Mean**	**Min**	**Max**	**SD**	**10%**	**90%**
Period of Record		21/03/1972	23/09/2002								0/01/1900	0/01/1900							
Alkalinity (Total) as CaCO3	mg/L																		
Alkalinity as Bicarbonate (HCO3)	mg/L	10/01/1979	13/04/1999	7	270.3	36.2	228.0	327.0	238.8	316.2			5	280.0	228.0	327.0	39.4		
Alkalinity as Carbonate (CO3)	mg/L	10/01/1979	13/04/1999	7	14.5	13.3	0.0	32.0	0.0	32.0			5	7.5	0.0	14.0	7.1		
Ammonia as N -soluble	mg/L																		
Ammonia as N - total	mg/L	10/01/1979	27/06/1980	9	0.0	0.0	0.0	0.1	0.0	0.1			9	0.0	0.0	0.1	0.0		
Boron as B - total	mg/L	21/07/1999			0.1							0		0.0	0.0				
Boron as B - soluble	mg/L	31/05/1982			ND														
Calcium as Ca - total	mg/L	21/07/1999			45.0							5	43.1	39.0	48.0	4.0			
Calcium as Ca - soluble	mg/L	10/01/1979	31/05/1982	5	43.1	4.0	39.0	48.0	39.4	47.5									
Chemical Oxygen Demand (COD)	mg/L	15/11/1979	27/06/1980	5	14.0	4.7	9.0	19.0	9.8	19.0			5	14.0	9.0	19.0	4.7		
Chloride as Cl	mg/L	10/01/1979	21/07/1999	7	46.4	13.4	30.0	64.0	33.0	61.6			5	50.9	30.0	64.0	13.4		
Colour - Apparent	Col	25/09/1979	30/09/1980	11	5.5	1.5	5.0	10.0	5.0	5.0			11	5.5	5.0	10.0	1.5		
Colour - True	Col	25/09/1979	20/08/1990	72	10.0	13.2	1.0	95.0	3.0	17.8			72	10.0	1.0	95.0	13.2	3.0	17.8
Electrical Conductivity @25 C	uS/cm	21/03/1972	21/07/1999	122	613.7	124.7	250.0	959.0	462.9	764.5			118	613.4	250.0	959.0	126.7	460.7	765.9
Flow - instantaneous	ML/day	21/03/1972	2/07/1990	117	365.0	2216.5	0.4	23800	5.2	368.0			117	365.0	0.4	23800.0	2216	5.2	368.0
Fluoride as F - soluble	mg/L	28/02/1979	9/12/1980	4	0.4	0.1	0.2	0.5	0.3	0.5			4	0.4	0.2	0.5	0.1		
Hardness as CaCO3 (calculated)	mg/L	21/07/1999	21/07/1999	2	265.0	0.0	265.0	265.0	265.0	265.0									
Iron as Fe - total	mg/L	10/01/1979	31/05/1982	4	ND							1							
Level - Stream Water (Gauge Hgt)	m	21/03/1972	20/08/1990	122	0.6	0.3	0.2	3.5	0.3	0.7									
Magnesium as Mg - total	mg/L	10/01/1979	31/05/1982	5	38.0	3.0	34.9	43.0	35.7	41.0			5	38.0	34.9	43.0	3.0		
Magnesium as Mg - soluble	mg/L	21/07/1999			37.0														
Nitrate + nitrite as N (NOx)	mg/L	21/07/1999			0.1														
Nitrate as N	mg/L	10/01/1979	21/07/1999	9	0.1	0.1	0.0	0.2	0.0	0.1			7	0.0	0.0	0.2	0.1		
Nitrogen - Kjeldahl	mg/L																		
Nitrite as N	mg/L																		
Nitrogen - total	mg/L	21/07/1999			1.1														
Oxygen - dissolved	mg/L	15/11/1979	27/06/1980	5	9.7	1.7	7.5	11.8	7.9	11.2			5	9.7	7.5	11.8	1.7		
pH	pH	3/02/1977	21/07/1999	132	8.2	0.4	6.7	8.9	7.9	8.7			129	8.2	6.7	8.9	0.4	7.8	8.6
Phosphorus - acid hydrolysable - total	mg/L	15/11/1979	23/01/1980	4	0.1	0.0	0.0	0.1	0.0	0.1			4	0.1	0.0	0.1	0.0		
Phosphorus - reactive (orthophosphate) - dissolved (FRP)	mg/L	21/07/1999			0.0														
Phosphorus - total	mg/L	10/01/1979	21/07/1999	12	0.1	0.0	0.0	0.1	0.0	0.1			11	0.1	0.0	0.1	0.0		
Potassium as K - soluble	mg/L	10/01/1979	21/07/1999	7	1.5	0.3	1.2	2.0	1.2	1.8			5	1.5	1.2	2.0	0.3		
Silica as SiO2 - reactive	mg/L	10/01/1979	6/06/1979	4	14.0	7.5	8.0	23.8	8.1	21.5			4	14.0	8.0	23.8	7.5		
Silica as SiO2 - soluble	mg/L	21/07/1999			3.7														
Sodium as Na - soluble	mg/L	10/01/1979	22/07/1999	7	56.0	7.2	42.0	64.0	47.9	61.6			5	54.8	42.0	64.0	8.4		
Sulphate as S	mg/L	23/09/2002			46.0														
Solids - total suspended @ 105°C	mg/L																		
Strontium as Sr - total	mg/L																		
Sulphate as SO4	mg/L	10/01/1979	31/05/1982	5	62.8	15.1	44.0	76.0	46.0	75.2			5	62.8	44.0	76.0	15.1		
Sulphide as S	mg/L																		
Temperature - Air maximum	deg C																		
Temperature - Water	deg C	21/03/1972	23/09/2002	116	19.3	6.0	7.0	33.0	11.0	26.0			115	19.3	7.0	33.0	6.0	11.0	26.0
Total Organic Carbon (TOC)	mg/L																		
Turbidity	NTU	3/02/1977	20/08/1990	86	7.3	20.9	0.3	130.0	0.5	12.5			86	7.3	0.3	130.0	20.9	0.5	12.5
Zinc as Zn - total	mg/L																		

		210061- Pages River at Blandford									210119 - Pages Camerons DS1								
Parameter	**Units**	**Start Date**	**End Date**	**No#**	**Mean**	**SD**	**Min**	**Max**	**10%**	**90%**	**Start Date**	**End Date**	**No#**	**Mean**	**SD**	**Min**	**Max**	**10%**	**90%**
Period of Record		27/03/1972	13/04/2005								15/12/1983								
Alkalinity (Total) as CaCO3	mg/L	27/03/1972	26/03/2003	8	211.3	35.5	170.0	255.0	170.0	255.0									
Alkalinity as Bicarbonate (HCO3)	mg/L	5/06/1972	21/08/1990	242	190.3	108.7	6.9	396.0	76.0	338.4	15/12/1983			255.0					
Alkalinity as Carbonate (CO3)	mg/L	28/02/1979	21/08/1990	197	0.6	4.4	0.0	41.0	0.0	0.0	15/12/1983			0.0					
Ammonia as N -soluble	mg/L																		
Ammonia as N - total	mg/L	13/10/1983	21/08/1990	143	0.5	1.6	0.0	9.0	0.0	0.5									
Boron as B - total	mg/L	29/06/1983	21/08/1990	103	19.2	102.0	0.0	690.0	0.0	0.0	15/12/1983			0.0					
Boron as B - soluble	mg/L																		
Calcium as Ca - total	mg/L	28/02/1979	21/08/1990	240	24.6	14.0	0.0	54.1	10.6	43.7	15/12/1983			27.5					
Calcium as Ca - soluble	mg/L																		
Chemical Oxygen Demand (COD)	mg/L	22/07/1984	27/02/1986	4	47.5	14.4	35.0	60.0	35.0	60.0									
Chloride as Cl	mg/L	28/02/1979	21/08/1990	244	21.6	16.3	2.0	57.9	6.1	49.4	15/12/1983			23.3					
Colour - Apparent	Col	27/07/1984	7/08/1984	2	43.0	0.0	43.0	43.0	43.0	43.0									
Colour - True	Col	29/06/1983	7/03/1990	79	6.6	11.7	0.0	56.0	0.0	8.0	15/12/1983			5.0					
Electrical Conductivity @25 C	uS/cm	27/03/1972	26/03/2003	375	422.9	406.1	0.0	4999.0	107.5	700.0	15/12/1983			462.0					
Flow - instantaneous	ML/day	27/03/1972	3/07/1990	300	1529.5	2646.7	1.3	13200	8.4	6055.0	15/12/1983			38.9					
Fluoride as F - soluble	mg/L	28/02/1979	21/08/1990	125	0.2	0.2	0.0	1.0	0.0	0.5	15/12/1983			0.0					
Hardness as CaCO3 (calculated)	mg/L																		
Iron as Fe - total	mg/L	29/06/1983	7/03/1990	158	1.1	2.6	0.0	8.5	0.0	6.5	15/12/1983			0.0					
Level - Stream Water (Gauge Hgt)	m	15/02/1977	21/08/1990	272	1.2	0.7	0.3	3.4	0.5	2.3	15/12/1983			0.4					
Magnesium as Mg - total	mg/L	28/02/1979	21/08/1990	241	21.6	13.4	0.0	49.9	7.3	39.6	15/12/1983			24.9					
Magnesium as Mg - soluble	mg/L																		
Nitrate + nitrite as N (NOx)	mg/L	23/01/1986	26/03/2003	9	2.2	4.4	0.0	10.0	0.0	10.0	15/12/1983			0.0					
Nitrate as N	mg/L	29/06/1983	21/08/1990	211	0.3	0.3	0.0	568.0	0.0	0.4									
Nitrogen - Kjeldahl	mg/L	27/02/1986	21/10/1997	6	0.2	0.1	0.1	0.3	0.0	0.3									
Nitrite as N	mg/L																		
Nitrogen - total	mg/L	26/08/1986	26/03/2003	6	0.1	0.1	0.1	0.2	0.1	0.2									
Oxygen - dissolved	mg/L	26/08/1986	21/10/1997	4	12.1	1.0	11.2	12.9	11.2	12.9									
pH	pH	15/02/1977	26/03/2003	376	7.9	0.5	4.9	8.8	7.5	8.5	15/12/1983			8.5					
Phosphorus - acid hydrolysable - total	mg/L	18/06/1987	7/03/1990	20	0.1	0.0	0.0	0.2	0.0	0.1									
Phosphorus - reactive (orthophosphate) - dissolved (FRP)	mg/L	6/11/1984	26/03/2003	52	0.1	0.1	0.0	0.4	0.0	0.2									
Phosphorus - total	mg/L	29/06/1983	26/03/2003	228	1.6	9.0	0.0	95.0	0.1	1.0	15/12/1983			0.1					
Potassium as K - soluble	mg/L	28/02/1979	21/08/1990	235	1.3	0.8	0.0	3.1	0.3	2.2	15/12/1983			3.2					
Silica as SiO2 - reactive	mg/L	28/02/1979	21/08/1990	234	30.1	70.0	0.0	540.0	0.4	24.0	15/12/1983			33.6					
Silica as SiO2 - soluble	mg/L	28/02/1979	21/08/1990																
Sodium as Na - soluble	mg/L			240	26.8	16.3	0.0	61.8	9.7	49.6	15/12/1983			30.6					
Sulphate as S	mg/L																		
Solids - total suspended @ 105°C	mg/L	9/11/1988	7/03/1990	22	3.1	2.1	0.1	8.3	1.2	4.8									
Strontium as Sr - total	mg/L	18/11/1986	7/03/1990	28	847.3	1513.3	2.6	4321.0	3.1	4122.0									
Sulphate as SO4	mg/L	28/02/1979	21/08/1990	244	14.6	10.5	1.6	42.4	4.2	30.8	15/12/1983			16.6					
Sulphide as S	mg/L	27/07/1984	10/08/1989	2	0.7	0.0	0.7	0.7	0.7	0.7									
Temperature - Air maximum	deg C	15/02/1977	10/08/1989	2	7.6	0.0	7.6	7.6	7.6	7.6									
Temperature - Water	deg C	27/03/1972	26/03/2003	192	17.4	5.5	8.0	30.0	10.2	24.0	15/12/1983			25.0					
Total Organic Carbon (TOC)	mg/L	9/11/1988	7/03/1990	14	0.7	1.1	0.0	299.6	0.0	1.9									
Turbidity	NTU	15/02/1977	26/03/2003	261	92.7	178.3	0.0	1026.0	0.3	178.0	15/12/1983			0.6					
Zinc as Zn - total	mg/L	28/07/1983	13/04/2005	109	2.3	7.0	0.0	572.0	0.0	4.3	15/12/1983			0.0					

		21010019 - Pages River at Murrurundi									21010219 - Pages River @ Haydons Lane Bridge								
Parameter	**Units**	**Start Date**	**End Date**	**No#**	**Mean**	**SD**	**Min**	**Max**	**10%**	**90%**	**Start Date**	**End Date**	**No#**	**Mean**	**SD**	**Min**	**Max**	**10%**	**90%**
Period of Record		7/05/1999	13/12/1999								21/07/1999	24/09/2002							
Alkalinity (Total) as CaCO3	mg/L	7/05/1999	7/05/1999	2	170.0	42.4	140.0	200.0	146.0	194.0									
Alkalinity as Bicarbonate (HCO3)	mg/L										21/07/1999			255.0					
Alkalinity as Carbonate (CO3)	mg/L										21/07/1999			3.0					
Ammonia as N -soluble	mg/L	7/05/1999	7/05/1999	2	5.5	3.5	3.0	8.0	3.5	7.5									
Ammonia as N - total	mg/L																		
Boron as B - total	mg/L																		
Boron as B - soluble	mg/L										21/07/1999			0.1					
Calcium as Ca - total	mg/L																		
Calcium as Ca - soluble	mg/L										21/07/1999			35.0					
Chemical Oxygen Demand (COD)	mg/L																		
Chloride as Cl	mg/L										21/07/1999			30.0					
Colour - Apparent	Col																		
Colour - True	Col																		
Electrical Conductivity @25 C	uS/cm	7/05/1999	7/05/1999	2	411.0	117.4	328.0	494.0	344.6	477.4	21/07/1999	24/09/2002	3	416.7	180.8	208.0	525.0	269.8	523.4
Flow - instantaneous	ML/day																		
Fluoride as F - soluble	mg/L																		
Hardness as CaCO3 (calculated)	mg/L										21/07/1999			194.0					
Iron as Fe - total	mg/L																		
Level - Stream Water (Gauge Hgt)	m																		
Magnesium as Mg - total	mg/L																		
Magnesium as Mg - soluble	mg/L										21/07/1999			26.0					
Nitrate + nitrite as N (NOx)	mg/L	7/05/1999	7/05/1999	2	165.0	148.5	60.0	270.0	81.0	249.0									
Nitrate as N	mg/L	7/05/1999	7/05/1999	2	164.5	149.2	59.0	270.0	80.1	248.9	21/07/1999								
Nitrogen - Kjeldahl	mg/L	7/05/1999	13/12/1999	2	0.3	0.0	0.3	0.3	0.3	0.3									
Nitrite as N	mg/L	7/05/1999	7/05/1999	2	1.5	0.7	1.0	2.0	1.1	1.9									
Nitrogen - total	mg/L																		
Oxygen - dissolved	mg/L	13/12/1999	13/12/1999	2	8.2	3.3	5.9	10.5	6.4	10.0									
pH	pH	13/12/1999	13/12/1999	2	8.4	0.2	8.3	8.5	8.3	8.5	21/07/1999	24/09/2002	2	8.2	0.1	8.2	8.3	8.2	8.3
Phosphorus - acid hydrolysable - total	mg/L																		
Phosphorus - reactive (orthophosphate) - dissolved (FRP)	mg/L	13/12/1999	13/12/1999	2	99.5	57.3	59.0	140.0	67.1	131.9									
Phosphorus - total	mg/L	13/12/1999	13/12/1999	2	185.0	7.1	180.0	190.0	181.0	189.0	21/07/1999			1.1					
Potassium as K - soluble	mg/L																		
Silica as SiO2 - reactive	mg/L																		
Silica as SiO2 - soluble	mg/L										21/07/1999			7.4					
Sodium as Na - soluble	mg/L										21/07/1999			36.0					
Sulphate as S	mg/L										21/07/1999			15.0					
Solids - total suspended @ 105°C	mg/L																		
Strontium as Sr - total	mg/L																		
Sulphate as SO4	mg/L																		
Sulphide as S	mg/L																		
Temperature - Air maximum	deg C																		
Temperature - Water	deg C	13/12/1999	13/12/1999	2	17.8	6.2	13.4	22.1	14.3	21.2	24/09/2002			15.1					
Total Organic Carbon (TOC)	mg/L																		
Turbidity	NTU	13/12/1999	13/12/1999	2	0.8	1.1	0.0	1.5	0.2	1.4									
Zinc as Zn - total	mg/L																		

		21010221 - Scotts Creek @"Clover Lear"									21010223 - Warlands Creek @ Blandford								
Parameter	**Units**	**Start Date**	**End Date**	**No#**	**SD**	**Mean**	**Min**	**Max**	**10%**	**90%**	**Start Date**	**End Date**	**No#**	**Mean**	**SD**	**Min**	**Max**	**10%**	**90%**
Period of Record		21/07/1999	24/09/2002								21/07/1999	24/09/2002							
Alkalinity (Total) as CaCO3	mg/L																		
Alkalinity as Bicarbonate (HCO3)	mg/L	21/07/1999				455.0					21/07/1999			239.0					
Alkalinity as Carbonate (CO3)	mg/L	21/07/1999				8.0					21/07/1999			4.0					
Ammonia as N -soluble	mg/L																		
Ammonia as N - total	mg/L																		
Boron as B - total	mg/L																		
Boron as B - soluble	mg/L	21/07/1999				0.1					21/07/1999			0.1					
Calcium as Ca - total	mg/L																		
Calcium as Ca - soluble	mg/L	21/07/1999				59.0					21/07/1999			34.0					
Chemical Oxygen Demand (COD)	mg/L																		
Chloride as Cl	mg/L	21/07/1999				48.0					21/07/1999			20.0					
Colour - Apparent	Col																		
Colour - True	Col																		
Electrical Conductivity @25 C	uS/cm	21/07/1999	24/09/2002	3	30.0	986.0	956.0	1016.0	962.0	1010.0	21/07/1999	24/09/2002	3	322.0	278.9	0.0	485.0	96.2	484.2
Flow - instantaneous	ML/day																		
Fluoride as F - soluble	mg/L																		
Hardness as CaCO3 (calculated)	mg/L	21/07/1999				399.0					21/07/1999			204.0					
Iron as Fe - total	mg/L																		
Level - Stream Water (Gauge Hgt)	m																		
Magnesium as Mg - total	mg/L																		
Magnesium as Mg - soluble	mg/L	21/07/1999				61.0					21/07/1999			29.0					
Nitrate + nitrite as N (NOx)	mg/L																		
Nitrate as N	mg/L	21/07/1999								21/07/1999									
Nitrogen - Kjeldahl	mg/L																		
Nitrite as N	mg/L																		
Nitrogen - total	mg/L																		
Oxygen - dissolved	mg/L																		
pH	pH	21/07/1999	24/09/2002	2	0.2	8.3	8.2	8.5	8.2	8.5	21/07/1999			8.5					
Phosphorus - acid hydrolysable - total	mg/L																		
Phosphorus - reactive (orthophosphate) - dissolved (FRP)	mg/L																		
Phosphorus - total	mg/L	21/07/1999				1.3													
Potassium as K - soluble	mg/L										21/07/1999			1.3					
Silica as SiO2 - reactive	mg/L																		
Silica as SiO2 - soluble	mg/L	21/07/1999				8.2					21/07/1999			7.3					
Sodium as Na - soluble	mg/L	21/07/1999				90.0					21/07/1999			41.0					
Sulphate as S	mg/L	21/07/1999				85.0					21/07/1999			26.0					
Solids - total suspended @ 105°C	mg/L																		
Strontium as Sr - total	mg/L																		
Sulphate as SO4	mg/L																		
Sulphide as S	mg/L																		
Temperature - Air maximum	deg C																		
Temperature - Water	deg C	24/09/2002				13.0													
Total Organic Carbon (TOC)	mg/L																		
Turbidity	NTU																		
Zinc as Zn - total	mg/L																		

		21010312 - Pages River Above Murrurundi									21010313 - Pages River @ Blandford								
Parameter	**Units**	**Start Date**	**End Date**	**No#**	**Mean**	**SD**	**Min**	**Max**	**10%**	**90%**	**Start Date**	**End Date**	**No#**	**Mean**	**SD**	**Min**	**Max**	**10%**	**90%**
Period of Record		17/07/2001	16/04/2002								17/07/2001	19/06/2002							
Alkalinity (Total) as CaCO3	mg/L																		
Alkalinity as Bicarbonate (HCO3)	mg/L																		
Alkalinity as Carbonate (CO3)	mg/L																		
Ammonia as N -soluble	mg/L																		
Ammonia as N - total	mg/L																		
Boron as B - total	mg/L																		
Boron as B - soluble	mg/L																		
Calcium as Ca - total	mg/L																		
Calcium as Ca - soluble	mg/L																		
Chemical Oxygen Demand (COD)	mg/L																		
Chloride as Cl	mg/L																		
Colour - Apparent	Col																		
Colour - True	Col																		
Electrical Conductivity @25 C	uS/cm	17/07/2001	16/04/2002	9	493.8	118.7	336.0	648.0	338.4	632.0	17/07/2001	19/06/2002	11	544.5	62.2	406.0	618.0	483.0	613.0
Flow - instantaneous	ML/day																		
Fluoride as F - soluble	mg/L																		
Hardness as CaCO3 (calculated)	mg/L																		
Iron as Fe - total	mg/L																		
Level - Stream Water (Gauge Hgt)	m																		
Magnesium as Mg - total	mg/L																		
Magnesium as Mg - soluble	mg/L																		
Nitrate + nitrite as N (NOx)	mg/L																		
Nitrate as N	mg/L																		
Nitrogen - Kjeldahl	mg/L																		
Nitrite as N	mg/L																		
Nitrogen - total	mg/L	17/07/2001	16/04/2002	9	0.5	0.2	0.2	0.8	0.3	0.8	17/07/2001	19/06/2002	11	0.6	0.3	0.2	1.1	0.3	1.1
Oxygen - dissolved	mg/L																		
pH	pH																		
Phosphorus - acid hydrolysable - total	mg/L																		
Phosphorus - reactive (orthophosphate) - dissolved (FRP)	mg/L																		
Phosphorus - total	mg/L	17/07/2001	16/04/2002	9	0.1	0.0	0.1	0.2	0.1	0.2	17/07/2001	19/06/2002	11	0.1	0.0	0.1	0.2	0.1	0.1
Potassium as K - soluble	mg/L																		
Silica as SiO2 - reactive	mg/L																		
Silica as SiO2 - soluble	mg/L																		
Sodium as Na - soluble	mg/L																		
Sulphate as S	mg/L																		
Solids - total suspended @ 105°C	mg/L	17/07/2001	16/04/2002	9	11.8	20.0	1.0	47.0	1.0	47.0	17/07/2001	19/06/2002	11	6.8	6.3	1.0	18.0	1.0	18.0
Strontium as Sr - total	mg/L																		
Sulphate as SO4	mg/L																		
Sulphide as S	mg/L																		
Temperature - Air maximum	deg C																		
Temperature - Water	deg C																		
Total Organic Carbon (TOC)	mg/L																		
Turbidity	NTU	17/07/2001	16/04/2002	9	0.9	0.8	0.3	2.8	0.4	1.3	17/07/2001	19/06/2002	11	1.0	0.6	0.6	2.4	0.6	1.7
Zinc as Zn - total	mg/L																		

		21010314 - Kingdon Ponds @ Cresfield									21010315 - Kingdon Ponds between Parkville and Scone								
Parameter	**Units**	**Start Date**	**End Date**	**No#**	**Mean**	**SD**	**Min**	**Max**	**10%**	**90%**	**Start Date**	**End Date**	**No#**	**Mean**	**SD**	**Min**	**Max**	**10%**	**90%**
Period of Record		18/07/2001	17/12/2002								18/09/2001	18/12/2001							
Alkalinity (Total) as CaCO3	mg/L																		
Alkalinity as Bicarbonate (HCO3)	mg/L																		
Alkalinity as Carbonate (CO3)	mg/L																		
Ammonia as N -soluble	mg/L																		
Ammonia as N - total	mg/L																		
Boron as B - total	mg/L																		
Boron as B - soluble	mg/L																		
Calcium as Ca - total	mg/L																		
Calcium as Ca - soluble	mg/L																		
Chemical Oxygen Demand (COD)	mg/L																		
Chloride as Cl	mg/L																		
Colour - Apparent	Col																		
Colour - True	Col																		
Electrical Conductivity @25 C	uS/cm	18/07/2001	18/09/2001	14	669.4	121.6	282.0	796.0	629.5	755.3	18/09/2001	18/09/2001	4	676.5	71.6	592.0	757.0	609.1	742.3
Flow - instantaneous	ML/day																		
Fluoride as F - soluble	mg/L																		
Hardness as CaCO3 (calculated)	mg/L																		
Iron as Fe - total	mg/L																		
Level - Stream Water (Gauge Hgt)	m																		
Magnesium as Mg - total	mg/L																		
Magnesium as Mg - soluble	mg/L																		
Nitrate + nitrite as N (NOx)	mg/L																		
Nitrate as N	mg/L																		
Nitrogen - Kjeldahl	mg/L																		
Nitrite as N	mg/L																		
Nitrogen - total	mg/L	18/09/2001	19/12/2001	14	0.7	1.0	0.2	4.2	0.2	0.7	18/09/2001	17/10/2001	4	2.0	1.4	0.8	4.0	1.0	3.3
Oxygen - dissolved	mg/L																		
pH	pH																		
Phosphorus - acid hydrolysable - total	mg/L																		
Phosphorus - reactive (orthophosphate) - dissolved (FRP)	mg/L																		
Phosphorus - total	mg/L	19/12/2001	15/04/2002	14	0.1	0.1	0.0	0.4	0.0	0.2	17/10/2001	12/11/2001	4	0.3	0.2	0.1	0.6	0.1	0.5
Potassium as K - soluble	mg/L																		
Silica as SiO2 - reactive	mg/L																		
Silica as SiO2 - soluble	mg/L																		
Sodium as Na - soluble	mg/L																		
Sulphate as S	mg/L																		
Solids - total suspended @ 105°C	mg/L	15/04/2002	17/09/2002	14	23.2	57.9	1.0	218.0	1.0	42.9	12/11/2001	18/12/2001	4	51.5	39.2	2.0	98.0	17.3	84.5
Strontium as Sr - total	mg/L																		
Sulphate as SO4	mg/L																		
Sulphide as S	mg/L																		
Temperature - Air maximum	deg C																		
Temperature - Water	deg C																		
Total Organic Carbon (TOC)	mg/L																		
Turbidity	NTU	17/09/2002	17/12/2002	14	10.1	28.9	0.5	110.0	0.6	8.0	18/12/2001	18/12/2001	4	24.4	24.9	1.7	60.0	6.6	47.4
Zinc as Zn - total	mg/L																		

Annexure 18B: "South Bickham" Surface Water Quality Data

Sampling Location *		LOR		ANZECC Guideline Value for		BCSW 1						BCSW 2						BCSW 3						BCSW 4					
Sampling start date						05-March-2003						05-March-2003						05-March-2003						05-March-2003					
Sampling finish date						17-September-2008						17-September-2008						17-September-2008						17-September-2008					
Total period of sampling/ months						67.4						67.4						67.4						67.4					
No# of samples						61						62						61						62					
Parameter	Units	ALS	*Ecowise*	ANZECC (1992)	ANZECC (2000)	Mean	SD	Min	Max	10%	90%	Mean	SD	Min	Max	10%	90%	Mean	SD	Min	Max	10%	90%	Mean	SD	Min	Max	10%	90%
pH Value		0.01	*0.1*	6.5 - 9.5		8.11	0.24	7.49	8.64	7.80	8.42	8.22	0.21	7.62	8.66	7.98	8.49	8.29	0.19	7.92	8.87	8.05	8.54	8.32	0.20	7.91	8.73	8.04	8.55
Turbidity	NTU					2.99	3.16	0.20	15.70	0.60	7.44	2.25	1.89	0.30	8.60	0.53	5.02	3.39	3.90	0.20	22.90	0.50	7.38	1.72	1.74	0.10	7.80	0.32	4.52
Total Suspended Solids (TSS)	mg/L		*2*			6.75	6.42	1.00	34.00	2.00	15.00	10.12	26.51	1.00	199.00	1.00	18.30	6.54	8.07	1.00	49.00	1.00	13.20	2.87	2.17	1.00	10.00	1.00	6.00
Conductivity @ 25°c	µS/cm	1	*10*			805.68	197.80	355.00	1230.00	586.60	1058.00	793.30	192.54	353.00	1230.00	570.80	1028.00	789.69	173.40	352.00	1190.00	586.00	1020.00	770.84	164.34	352.00	1150.00	575.50	963.70
Calcium	mg/L	1	*1*			43.62	8.63	23.00	61.00	32.00	54.00	42.86	8.94	16.00	64.00	32.20	54.00	40.44	7.58	24.00	58.00	31.00	51.00	39.03	6.76	22.00	52.00	29.20	47.90
Magnesium	mg/L	1	*1*			38.00	8.54	17.00	55.00	27.20	49.00	37.51	8.74	17.00	58.00	25.20	47.80	38.23	8.35	18.00	54.00	27.00	48.00	36.97	8.21	17.00	52.00	27.00	47.90
Sodium	mg/L	1	*1*			64.17	24.09	25.00	135.00	38.20	96.80	62.54	21.70	24.00	110.00	36.20	95.20	62.64	19.98	27.00	100.00	38.00	90.00	60.52	18.67	24.00	101.00	38.00	84.90
Potassium	mg/L	1	*1*			2.43	0.84	1.00	5.00	1.58	3.80	2.40	0.88	1.00	4.00	1.00	3.80	2.47	0.95	1.00	5.00	1.00	4.00	2.37	0.71	1.00	4.00	1.62	3.00
Chloride	mg/L	1	*2*			62.01	24.97	15.40	122.00	31.28	91.20	60.79	24.51	15.40	116.00	24.20	89.68	60.32	22.19	17.00	108.00	24.00	88.10	58.72	21.99	12.00	113.00	30.01	81.80
Sulphate	mg/L	1	*2*			55.33	25.31	11.00	110.00	24.60	90.40	55.05	24.59	16.00	116.00	22.40	89.00	55.56	23.90	16.00	108.00	24.00	85.00	52.29	22.72	13.00	98.00	26.10	83.00
Bicarbonate as CaCO3	mg/L	1	*2*			274.48	51.20	140.00	378.00	214.00	343.60	266.78	52.43	111.00	368.00	213.40	335.00	262.44	43.49	138.00	341.00	212.00	326.00	252.77	42.16	138.00	325.00	203.10	306.00
Carbonate as CaCO3	mg/L	1	*2*			7.67	10.17	1.00	40.00	1.00	21.40	14.08	11.46	1.00	46.00	2.00	27.40	12.79	13.91	1.00	60.00	1.00	29.80	15.15	12.49	1.00	40.00	1.60	37.80
Total Kjeldahl Nitrogen as N	mg/L	0.1				0.43	0.53	0.02	3.80	0.12	0.67	0.43	0.51	0.10	2.40	0.10	0.79	0.44	0.37	0.10	1.90	0.20	0.80	0.45	0.73	0.00	4.10	0.10	0.60
Nitrate as N	mg/L	0.01	*0.01*		0.7	0.03	0.04	0.01	0.30	0.01	0.05	0.03	0.06	0.01	0.30	0.01	0.06	0.04	0.06	0.01	0.32	0.01	0.06	0.03	0.04	0.01	0.30	0.01	0.03
Total Phosphorus as P	mg/L	0.01	*0.01*			0.10	0.09	0.01	0.60	0.03	0.16	0.07	0.05	0.01	0.34	0.02	0.14	0.08	0.05	0.01	0.24	0.02	0.15	0.08	0.08	0.01	0.40	0.01	0.15

BICKAM COAL COMPANY
Surface Water Quality Monitoring - Pages River

Sampling Location *		LOR		ANZECC Guideline Value for		BCSW 5						BCSW 6						BCSW 7						BCSW 8					
Sampling start date						16-September-2003						05-March-2003						05-March-2003						05-March-2003					
Sampling finish date						17-September-2008						17-September-2008						17-September-2008						17-September-2008					
Total period of sampling/ months						60.9						67.4						67.4						67.4					
No# of samples						56						44						39						36					
Parameter	Units	ALS	*Ecowise*	ANZECC (1992)	ANZECC (2000)	Mean	SD	Min	Max	10%	90%	Mean	SD	Min	Max	10%	90%	Mean	SD	Min	Max	10%	90%	Mean	SD	Min	Max	10%	90%
pH Value		0.01	*0.1*	6.5 - 9.5		8.04	0.20	7.83	8.89	8.06	8.55	8.15	0.24	7.60	8.69	7.90	8.46	7.49	0.31	6.62	8.07	7.11	7.80	7.53	0.33	6.60	8.33	7.31	7.81
Turbidity	NTU					3.96	12.30	0.20	82.80	0.33	4.56	4.72	16.67	0.30	108.00	0.50	5.80	11.97	18.82	1.30	90.00	1.70	32.05	6.97	15.48	0.40	90.00	0.96	9.11
Total Suspended Solids (TSS)	mg/L		*2*			14.13	65.02	1.00	480.00	1.00	9.70	9.90	22.42	1.00	134.00	1.00	18.00	30.89	52.18	1.00	218.00	2.00	79.00	20.32	45.80	1.00	218.00	2.00	32.10
Conductivity @ 25°c	µS/cm	1	*10*			737.70	211.63	368.00	1120.00	535.80	969.70	757.64	174.43	363.00	1100.00	535.40	950.60	3409.00	1218.18	401.00	6370.00	1716.00	4404.00	3096.67	1319.02	401.00	6370.00	1084.50	4220.00
Calcium	mg/L	1	*1*			36.63	9.56	23.00	52.00	27.70	46.60	41.89	8.18	22.00	57.00	31.30	50.70	178.59	60.44	21.00	320.00	119.40	236.80	143.11	51.24	21.00	213.00	64.50	191.50
Magnesium	mg/L	1	*1*			35.77	10.31	17.00	52.00	24.10	48.00	36.73	8.82	17.00	54.00	24.90	46.70	121.03	44.73	12.00	212.00	61.60	172.20	112.61	49.87	12.00	212.00	35.00	170.50
Sodium	mg/L	1	*1*			57.61	20.90	25.00	100.00	32.80	81.30	53.75	14.93	25.00	79.00	33.30	72.00	435.79	173.42	37.00	824.00	214.00	608.80	396.06	196.49	37.00	824.00	97.50	619.00
Potassium	mg/L	1	*1*			2.41	0.89	1.00	5.00	1.00	3.00	2.19	0.77	1.00	4.00	1.00	3.00	6.41	3.14	1.00	13.00	2.90	10.00	7.74	3.43	1.00	17.00	4.00	11.50
Chloride	mg/L	1	*2*			57.11	23.89	15.50	113.00	22.88	82.00	54.22	22.91	15.30	135.00	24.33	77.49	827.59	357.51	39.40	1630.00	333.80	1186.00	801.58	408.45	39.40	1630.00	141.00	1210.00
Sulphate	mg/L	1	*2*			48.93	23.77	11.00	96.00	19.70	83.30	48.32	22.28	15.00	85.00	18.30	78.40	449.72	172.49	62.00	970.00	291.20	590.60	346.47	167.52	62.00	705.00	82.50	550.50
Bicarbonate as CaCO3	mg/L	1	*2*			241.61	59.26	137.00	316.00	198.90	299.20	252.41	44.23	138.00	325.00	190.30	309.40	336.90	117.72	68.00	507.00	185.00	485.20	267.28	88.60	68.00	484.00	167.50	384.50
Carbonate as CaCO3	mg/L	1	*2*			13.00	10.60	1.00	36.00	1.00	27.00	13.43	13.45	1.00	44.00	1.00	35.00	1.13	0.35	1.00	2.00	1.00	1.60	1.29	1.21	1.00	6.00	1.00	1.00
Total Kjeldahl Nitrogen as N	mg/L	0.1				0.76	2.11	0.10	14.20	0.10	0.96	0.46	0.39	0.10	1.40	0.20	1.12	1.37	1.84	0.10	11.40	0.53	1.80	1.43	1.81	0.30	11.40	0.63	1.80
Nitrate as N	mg/L	0.01	*0.01*		0.7	0.04	0.11	0.01	0.70	0.01	0.06	0.14	0.56	0.01	3.14	0.01	0.12	0.02	0.01	0.01	0.06	0.01	0.03	0.02	0.01	0.01	0.03	0.01	0.03
Total Phosphorus as P	mg/L	0.01	*0.01*			0.14	0.31	0.01	2.22	0.02	0.18	0.09	0.05	0.01	0.30	0.03	0.15	0.11	0.16	0.01	0.91	0.01	0.18	0.09	0.16	0.01	0.91	0.01	0.17

Annexure 18C: Water Quality of Pages River and of Groundwater Bores

BICKHAM COAL COMPANY Water quality of Pages River and of groundwater bores						
Indicator	Average Bore Water Quality (OH71A and OH72)	Average Bore Water Quality (OH72)	Bickham Surface Water Averages - Average Values across BCSW1-6			ANZECC Default Trigger
			10%ile	average	90%ile	
Aquatic ecosystems						
TP conc (mg/L)	0.19	0.12	0.021	0.083	0.148	0.020
TN conc (mg/L)	0.50	0.50	0.14	0.49	0.82	0.25
EC (salinity) $uScm^{-1}$	917	853.67	592.7	744.7	890.6	350
pH	6.7	7.09	8.08	8.24	8.58	6.5-8.0
Homestead water supply						
Antimony (mg/L)						0.003
Arsenic (mg/L)	0.004	0.007				0.007
Barium (mg/L)	0.09	0.11				0.7
Boron (mg/L)	0.06	0.06	0.030	0.046	0.052	4
Cadmium (mg/L)	0.0002	0.0002				0.002
Chromium (as Cr(VI)) (mg/L)	0.003	0.005				0.05
Copper (mg/L)	0.004	0.006				2
Cyanide (mg/L)						0.08
Fluoride (mg/L)	0.205	0.209	0.100	0.209	0.200	1.5
Iodide (mg/L)						0.1
Lead (mg/L)	0.003	0.005	0.0002	0.0009	0.001	0.01
Manganese (mg/L)	0.407	0.081	0.007	0.025	0.054	0.5
Mercury (mg/L)	0.0001	0.0002	0.0001	0.0001	0.0001	0.001
Molybdenum (mg/L)						0.05
Nickel (mg/L)	0.02	0.005	0.001	0.002	0.002	0.02
Nitrate (as nitrate) (mg/L)	0.58	0.740	0.044	0.111	0.191	50
Nitrite (as nitrite) (mg/L)	0.042	0.021				3
Selenium (mg/L)			0.010	0.010	0.010	0.01
Silver (mg/L)						0.1
Sulfate (mg/L)	181	59.3	24.8	49.1	76.4	500