Biodiversity

Metropolitan Coal's biodiversity monitoring program has been developed to monitor impacts of the Project on aquatic and terrestrial flora and fauna, with a specific focus on swamps.

The biodiversity monitoring program includes monitoring of:

- upland swamp vegetation and groundwater;
- riparian vegetation;
- aquatic biota and their habitats; and
- amphibians.

The monitoring results are described below.

Upland Swamps Vegetation Monitoring

Eight upland swamps, namely Swamps 16, 17, 18, 20, 23, 24, 25 and 26 have been mapped above or immediately adjacent to Longwalls 20-22 (Figure 1). A swamp substrate characterisation study has also been conducted to contribute to Metropolitan Coal's understanding of the ecological, hydrological and geomorphic processes of swamps over Longwalls 20-22.

With the exception of in-valley Swamp 20, which supports tea tree thicket, all swamps over Longwalls 20-22 are small valley-side swamps and comprise restioid heath, with intergrades with banksia thicket. Transitions between restioid heath and banksia thicket are thought to be driven by fire frequency.

Three swamps (Swamps 16, 17 and 23), although showing seepage are more akin to sandstone heath woodland with low tree densities. The vegetation contains species found in upland swamps, mixed with a range of non-swamp species.

Swamps 101, 111a and 125 have been selected as control sites for monitoring of the restioid heath/banksia thicket valley-side swamps (Figure 1) and Swamps Woronora River 1, Woronora River South Arm and Dahlia Swamp have been selected as sites for monitoring of the tea tree thicket vegetation of Swamp 20 (Figure 2).

The upland swamp vegetation monitoring program includes visual monitoring, transect/quadrat monitoring and monitoring of indicator species, as described below.

<u>Visual Inspections</u>

Visual inspections of the swamps overlying and immediately adjacent to Longwalls 20-22 and at the control swamps have been conducted in spring 2010 and autumn 2011 at the same time as the vegetation surveys.

Traverses covering the majority of the extent of the swamp were conducted to record observations such as cracking of exposed bedrock areas and/or swamp sediments, areas of increased erosion, changes in water colour, changes in vegetation condition and the amount of seepage.

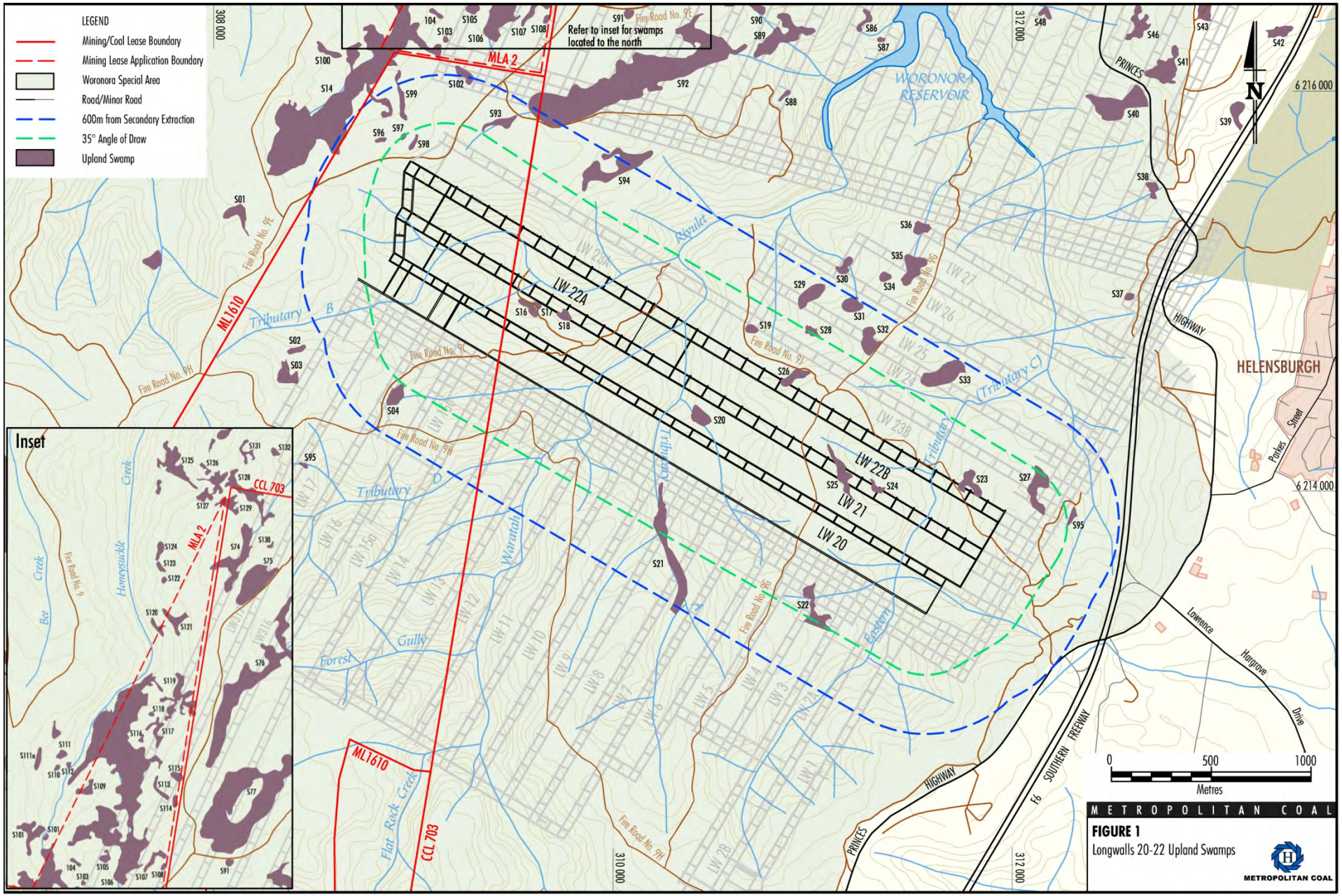
No cracking of exposed bedrock areas or swamp sediments was observed in either longwall or control swamps, other than what has been reported previously in baseline surveys in Swamps 17 and 23, and the rock displacement in Swamp 24.

No areas of increased erosion other than minor erosion and surface wash recorded in the downstream section of the drainage line through Swamp 20 (adjacent to the end of Transect 1), in the north of Swamp 24 (within the drainage line below Swamp 25) and along walking trail 9J adjacent to Swamp 23 following the heavy rainfall events in early spring. Some minor bank scour was also observed within the drainage channel which runs through control Swamp 125. No changes in water colour were observed in either longwall or control swamps; no new areas of water ponding.

General vegetation condition of both longwall and control swamps was found to be in good condition. The only exception to the generally good condition of swamp vegetation was small patches of senescent mid layer vegetation which was observed in areas adjacent to exposed bedrock in the lower portions of some of the restioid heath swamps (Swamps 17, 18, 23).

While the cause of this senescence is unknown, it is thought to be caused by the frequent or continued inundation of the shallow sediments in these areas. The shallow nature of the soils adjoining areas of exposed bedrock means that they are more frequently inundated than those areas of the swamps with deeper sediments. The wet conditions in early summer 2010 and autumn 2011 are thought to have caused the frequent/continued inundation of shallower swamp sediments creating anaerobic conditions depriving roots of necessary oxygen. While this pattern was not recorded in control swamps, it has been observed in swamps outside the Longwall 20-22 mining area which have not been undermined. As a result, these small patches of senescent shrubs are thought to be a natural phenomenon and not related to the mining of Longwalls 20-22.

METROPOLITAN COAL - ENVIRONMENTAL MONITORING SUMMARY



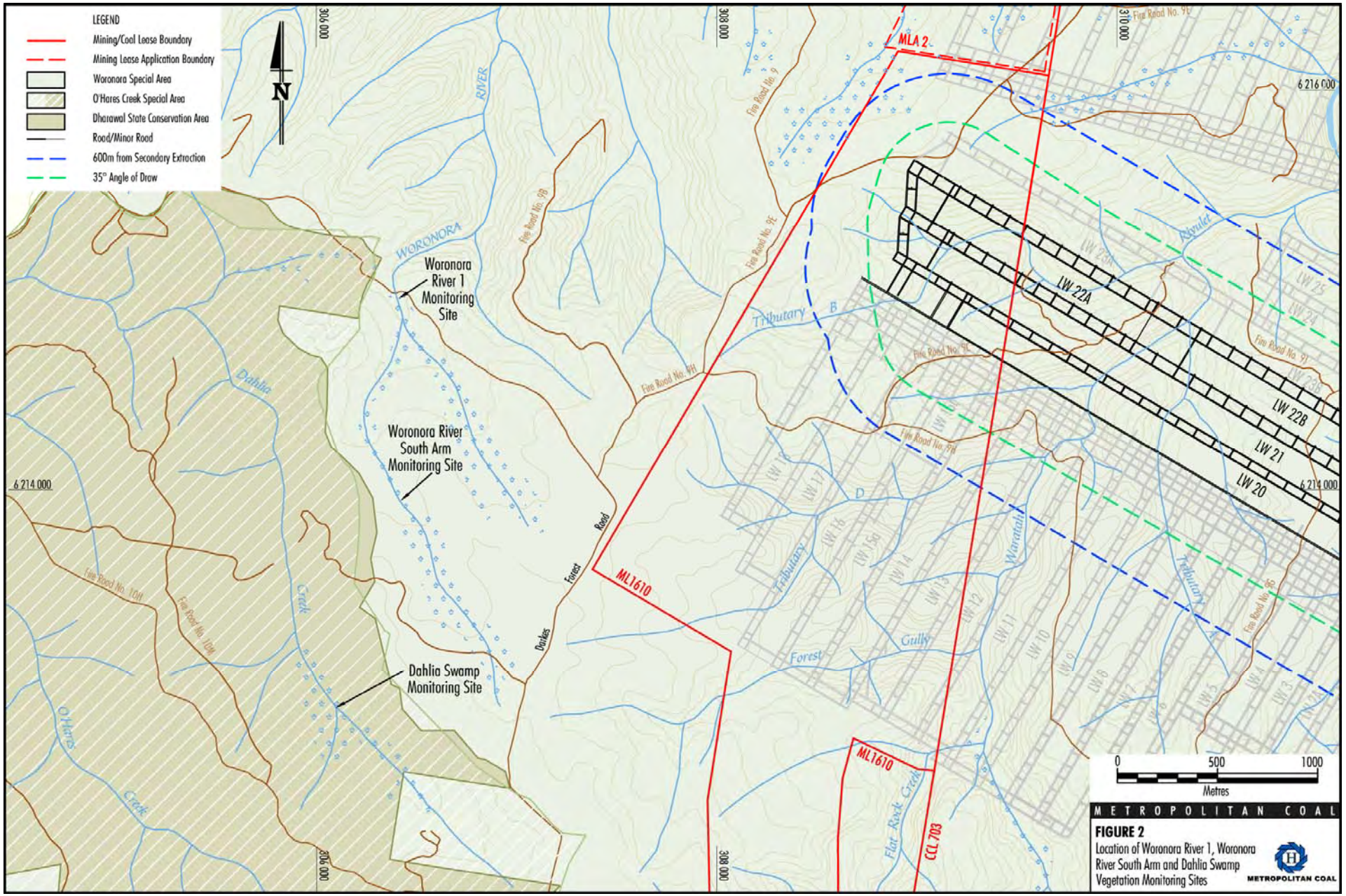

LEGEND
Mining/Coal Lease Boundary
Mining Lease Application Boundary
Woronora Special Area
O'Hares Creek Special Area
Dharawal State Conservation Area
Road/Minor Road
600m from Secondary Extraction
35° Angle of Draw
N
306 000
308 000
310 000
6 216 000
6 214 000
MLA 2
ML1610
CCL 703
LW 22A
LW 22B
LW 21
LW 20
Woronora River 1 Monitoring Site
Woronora River South Arm Monitoring Site
Dahlia Swamp Monitoring Site
WORONORA RIVER
Dahlia Creek
O'Hares Creek
Tributary B
Tributary D
Gully
Forest
Flat Rock Creek
Waratah
Darkes Forest Road
Fire Road No. 9
Fire Road No. 9B
Fire Road No. 9E
Fire Road No. 9H
Fire Road No. 9K
Fire Road No. 9M
Fire Road No. 9P
Fire Road No. 9S
Fire Road No. 10H
Fire Road No. 10M
0
500
1000
Metres
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FIGURE 2
Location of Woronora River 1, Woronora River South Arm and Dahlia Swamp Vegetation Monitoring Sites
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Minor dieback of scattered individuals were observed in both longwall and control swamps (for example within Swamp 25, Swamp 101, and Swamp 125). Small patches of senescent vegetation recorded during the baseline surveys (i.e. at the end of Transect 3 in Swamp 25 [longwalls] and between Transects 1 and 2 in Swamp 125 [control]) were found to have diminished in area.

Seepage areas were commonly observed across terminal steps and other rocky areas throughout both longwall and control sites.

Visual inspections will also be conducted monthly for the period of time that Longwall 20 is within 400 m of a swamp to record evidence of potential subsidence impacts.

Transect/Quadrat Monitoring

Transect and quadrat monitoring has been conducted in spring 2010 and autumn 2011 of:

- restioid heath vegetation – Swamps 18, 24 and 25 overlying Longwalls 20-22, and in control swamps 101, 111a and 125 (Figure 1); and
- tea tree thicket vegetation – Swamp 20 overlying Longwalls 20-22, and in control swamps Woronora River 1, Woronora River South Arm and Dahlia Swamp (Figures 1 and 2).

Swamps 16 and 17 (restioid heath/sandstone heath woodland) were also added to the vegetation monitoring program in autumn 2010 (Figure 1). Each swamp has been monitored with three transects, with the exception of the control swamps for Swamp 20 where only a single transect has been established owing to the much larger size of the control swamps.

The data collected for each quadrat includes:

- vegetation structure;
- dominant species;
- estimated cover and height for each stratum;
- full floristics;
- estimated cover abundance for each species using seven point Braun-Blanquet scale; and
- condition/health rating for each species in the quadrat.

In summary, the results of the surveys indicate the following:

- Generally, vegetation at all sites was in a healthy condition throughout the survey period.
- Fluctuations in species cover and vegetation condition were recorded across all sites.
- No general trend in height or percent cover was detectable, with the majority of sites, including both longwall and control sites, recording equal or similar values for vegetation height and percent cover in spring 2010 and autumn 2011. The relative stability of the vegetation percent cover was more widespread in the upper and mid storey vegetation layers with the lower stratum showing more variability.
- Exceptions to the relatively stable vegetation height and percent cover included Swamps 111a and 125 where a general increase in vegetation height was recorded. Additionally, vegetation height and cover generally showed an overall increase at Woronora River 1.
- Fluctuations in species richness were similar between longwall sites and control sites over the survey period, with no consistent patterns between seasons or across sites for the restioid heath sites.
- Of the six longwall sites, three sites recorded an increased species richness from any previous seasons (Swamps 16, 18 and 24) while at the remaining three sites species richness was below or equal to that recorded in previous seasons. Of the six control sites, species richness was within the previously recorded range at three sites (Swamps 101, 111a, Woronora River 1), while declines in species richness were recorded at the remaining sites.
- No weeds were recorded within any of the sites.
- The changes in species composition, cover and condition reflect normal population variation and cycles in response to seasonal variations and plant growth.

Transect and quadrat monitoring will be conducted bi-annually in autumn and spring.

Indicator Species

Population monitoring of indicator species has also been conducted in spring 2010 and autumn 2011.

Twenty tagged individuals of *Epacris obtusifolia*, *Sprengelia incarnata* and *Pultenaea aristata* have been monitored in each of the following valley side swamps:

- *Epacris obtusifolia* – Swamps 18, 24 and 25 above Longwalls 20-22 and at control sites 101, 111a and 125.
- *Sprengelia incarnata* – Swamp 24 above Longwalls 20-22 and at control sites 101 and 125.
- *Pultenaea aristata* – Swamps 18, 24 and 25 above Longwalls 20-22 and at control sites 101 and 111a. Note, survey of *Pultenaea aristata* in Swamp 24 commenced in autumn 2010.

Twenty tagged individuals of *Banksia robor, Callistemon citrinus* and *Leptospermum juniperinum* have also been monitored in Swamp 20 and at the associated control sites (Woronora River 1, Woronora River South Arm and Dahlia Swamp).

Population monitoring data collected includes a condition/health rating and a reproductive rating for each plant.

The following provides a summary of the results of indicator species monitoring:

- Within both the side valley swamps and tea tree thicket swamps the condition of tagged indicator species has progressively declined over the four seasons of surveys. This can be seen by the increase in the number of plants with some level of dieback (Conditions 1 to 4) and a subsequent decrease in the number of tagged plants in a healthy condition (Condition 5).
- This decrease in condition ratings has occurred at both longwall and control sites and has occurred in all seasons, most noticeably during autumn 2010 prior to the commencement of mining of Longwalls 20-22. The declines are considered to represent natural declines in response to climatic conditions, ageing plants and natural disturbances including storm events. The observed declines are not considered to be related to mining of Longwalls 20-22.
- Within the valley side swamps, *Sprengelia incarnata* has undergone the largest decrease in overall condition at both longwall and control sites, followed to a lesser degree by *Pultenaea aristata* with *Epacris obtusifolia* having the most tagged plants scoring a healthy condition rating (Condition 5). The decline in condition for *Sprengelia incarnata* is often due to individuals presenting with leaf dieback on the lower stems. As noted above, this species is typically found with this habit throughout all sites and probably reflects the normal growth form of this species.

Seven dead individuals of the tagged valley side swamp indicator species were recorded during autumn 2011 (including the single individual Tag K26 *Sprengelia incarnata* in control Swamp 101 recorded as dead in spring 2010):

- Tag J6 Pultenaea aristata in Swamp 18;
- Tags K52 and K58 Sprengelia incarnata in Swamp 24;
- Tags J86, J97 and J98 Pultenaea aristata in Swamp 24; and
- Tag K26 Sprengelia incarnata in control Swamp 101.

Senescing or dead individuals of the three indicator species were not confined to longwall sites. For example, a senescing individual (condition rating 1) of *Pultenaea aristata* (J28) was recorded at Swamp 101 during autumn 2011. Dead individuals of indicator species were also observed during the autumn 2011 surveys conducted within other non-undermined swamps (Longwalls 23-27 program).

Of the three monitored species within tea tree thickets, *Banksia robur* at both longwall and control sites has undergone the largest decrease in overall condition, followed to a lesser degree by *Callistemon citrinus* and *Leptospermum juniperinum.* The decline in condition for tea tree thicket indicator species was generally associated with some level of leaf herbivory (commonly *Banksia robur*), leaf discolouration (commonly *Callistemon citrinus*) or some loss of leaves (commonly *Leptospermum juniperinum*).

No further dead individuals were recorded in autumn 2011 (Tag A64 *Banksia robur* in control swamp Dahlia Swamp was recorded as dead in spring 2010), although Tag A58 was not relocated due to an error in the GPS information for this species. Further searches will be conducted in spring 2011 to relocate this plant or a replacement plant will be tagged.

Monitoring of indicator species will be conducted bi-annually in autumn and spring.

Upland Swamps Groundwater Monitoring

Piezometers were installed in the following upland swamps in July 2010 to monitor groundwater levels (Figure 3):

- Valley side Swamps 16/17 overlying Longwalls 20-22 (sandstone piezometer to a depth of 10 m).
- Valley side Swamp 25 overlying Longwalls 20-22 (swamp substrate piezometer to a depth of 0.9 m and sandstone piezometer to a depth of 10 m).
- Valley side Swamp 101 (control - swamp substrate piezometer to a depth of 0.9 m and sandstone piezometer to a depth of 10 m).
- In-valley Swamp 20 overlying Longwalls 20-22 (swamp substrate piezometer to a depth of 0.9 m and sandstone piezometers to depths of 3 and 10 m).
- Headwater Swamp Woronora River 1 (WRSWAMP1) (control - swamp substrate piezometer to a depth of 0.9 m and sandstone piezometers to depths of 3 and 10 m).

Longer-term groundwater level data for upland swamps has been acquired with single piezometers at sites SWAMP1, SWAMP2 and SWAMP3, and paired piezometers at site SWAMP4 and SWGW1 (Figure 3).

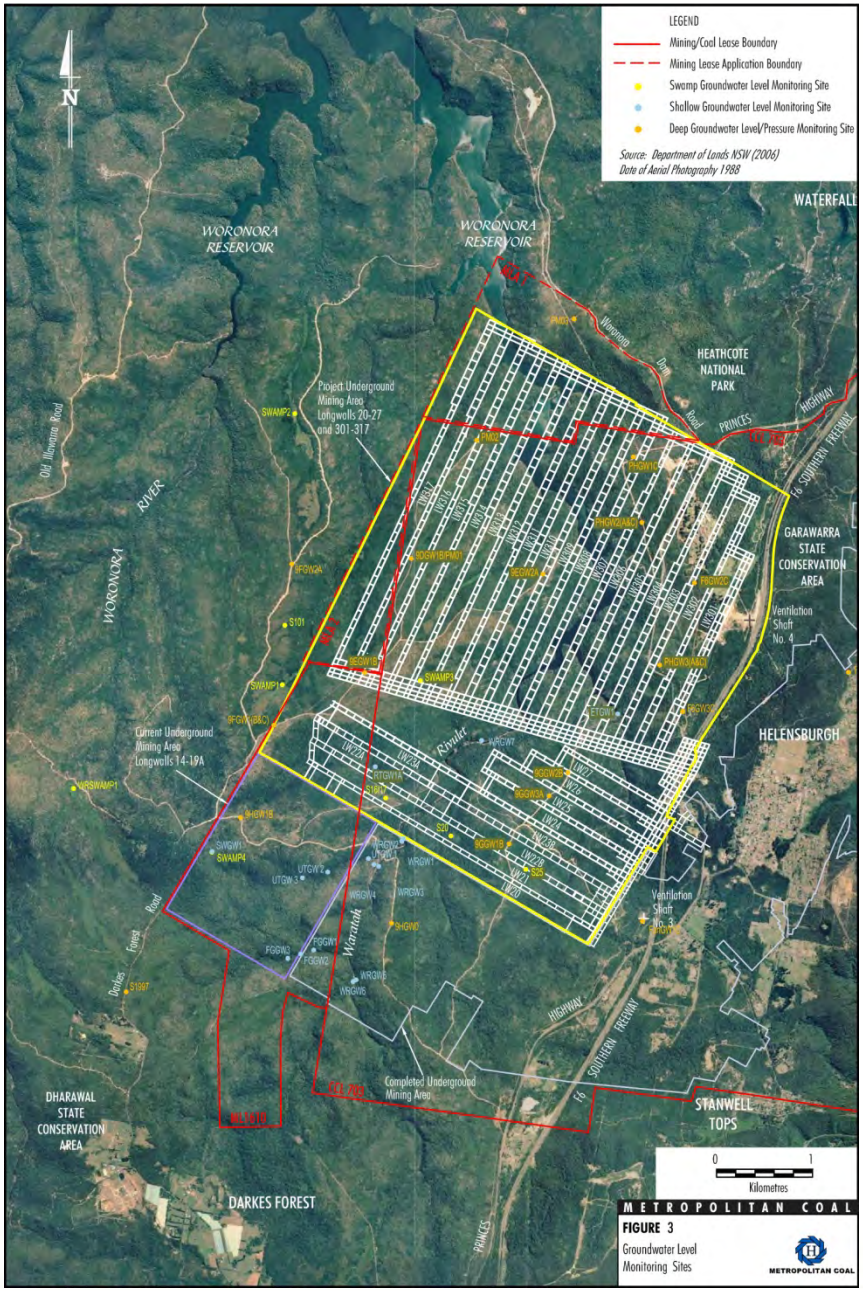

Chart 1 shows that the perched groundwater levels at SWAMP1, SWAMP2 and SWAMP3 have a highly dynamic behaviour that is characterised by an immediate response to rainfall events, followed by fairly rapid recessions as water is lost by evaporation and evapotranspiration. The monitored sites are far from current mining, and there is no evidence of any change in behaviour due to mining.

The groundwater levels in the paired piezometers at SWAMP4 and SWGW1 and their correlations to rainfall are shown on Chart 2. The groundwater levels at SWAMP4 are perched and hydraulically isolated from a deeper perched water table (or the regional water table) in the underlying sandstone aquifer (measured by site SWGW1).

SWAMP4 is considered to be characteristic of headwater upland swamps in that they typically obtain most of their moisture from direct rainfall infiltration. The water tables at SWAMP4 are greater than 3 m apart. There is a strong correlation between swamp and sandstone water level fluctuations which suggests either direct leakage from the swamp to the underlying sandstone, and/or direct rain recharge to adjacent sandstone with lateral groundwater flow to the sandstone beneath the swamp.

The residual mass curves are indicators of rainfall trends, and they show a pronounced dry period in February 2011 during the review period. This coincides with low groundwater levels in the piezometers featured in Chart 1 and Chart 2. In general, as the residual mass trends agree well with observed groundwater level trends, rainfall is the primary driving force.

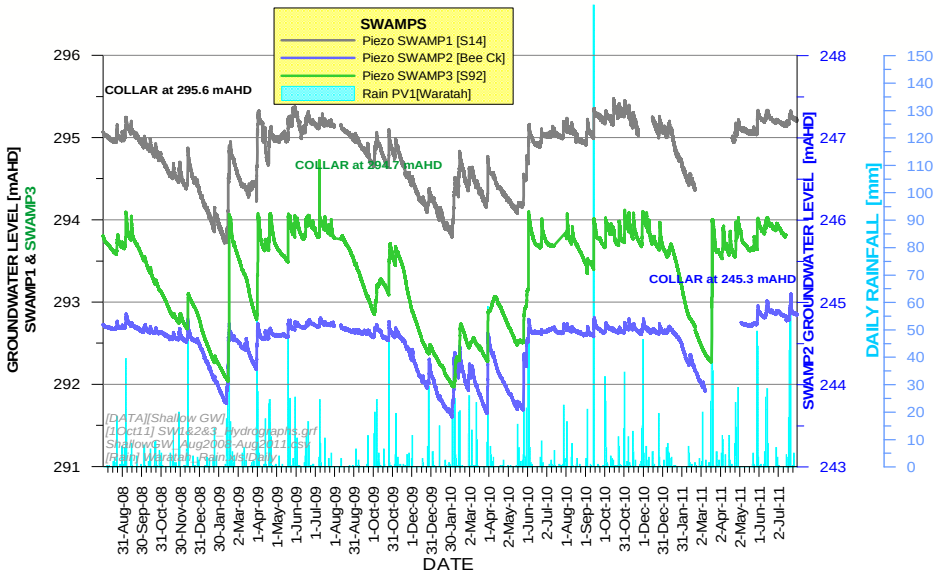

Chart 1 Perched Groundwater Hydrographs in SWAMP1, SWAMP2 AND SWAMP3

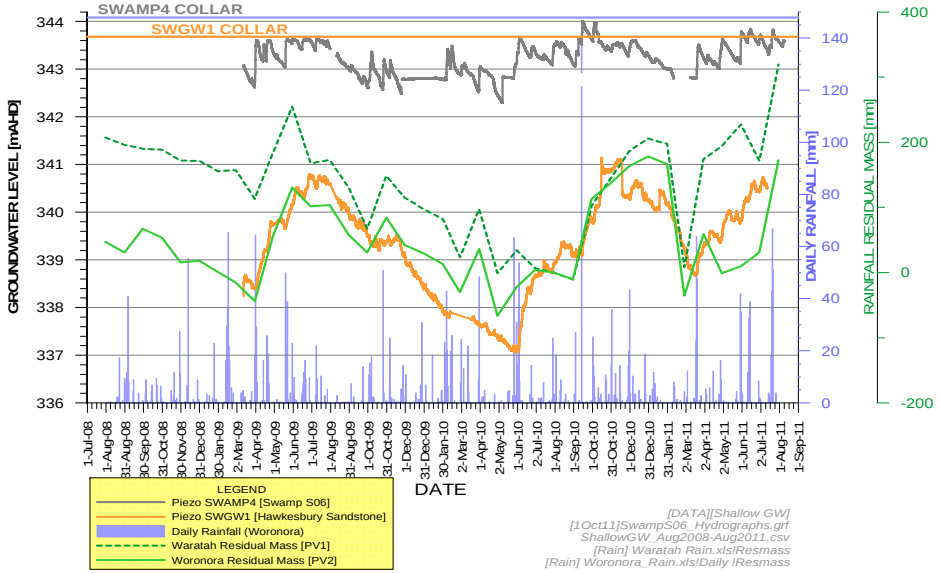

Chart 2 Separation of Water Tables at SWAMP 4

The hydrographs at the two control swamps (SWAMP 101 and WRSWAMP1 [Figure 3]) are displayed in Chart 3 and Chart 4. Both sites show a pronounced drop in groundwater levels in February 2011, associated with a rainfall deficit. At SWAMP 101, the water tables are always separated, usually by 0.5 m, and groundwater flow direction is downwards. At site WRSWAMP1, the water level in the swamp (piezometer at 1 m depth) is always lower than the potentiometric level in the deeper sandstone piezometers. This suggests that the swamp is being recharged by groundwater from below and possibly from the sides. The swamp piezometer and the 4 m sandstone piezometer show good connectivity across the swamp/sandstone interface, with separation from the groundwater head at the 10 m sandstone piezometer.

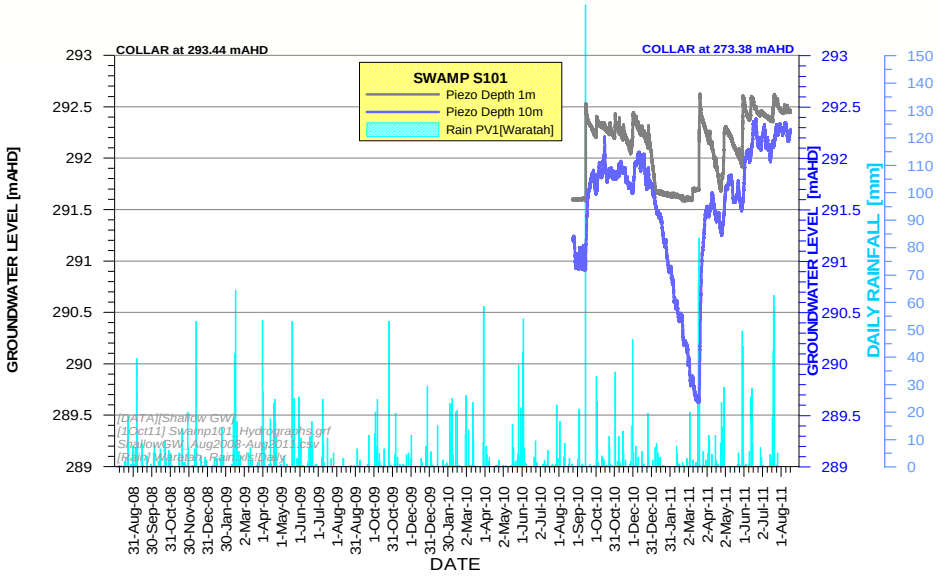

Chart 3 Groundwater Hydrographs at SWAMP 101

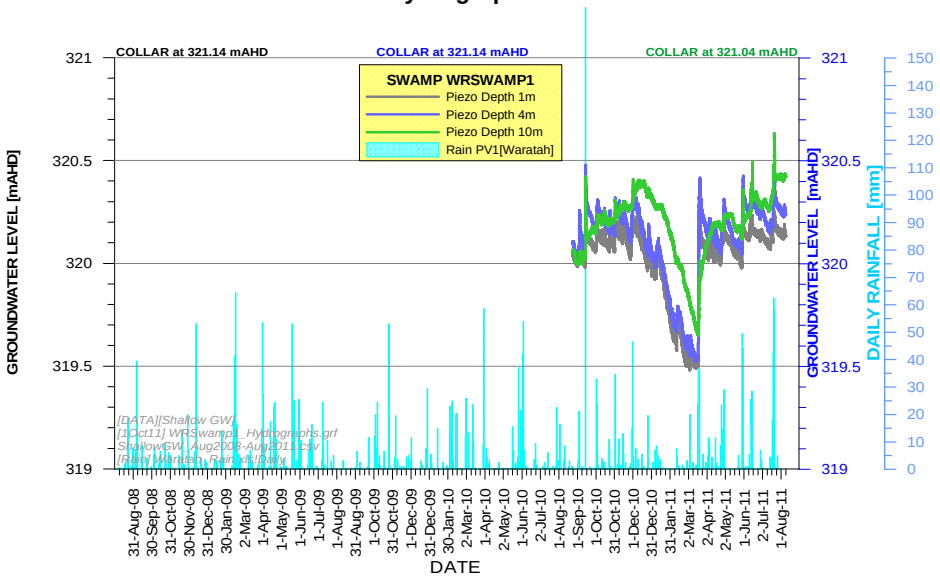

Chart 4 Groundwater Hydrographs at WRSWAMP1

Hydrographic responses for the recently monitored swamps overlying or adjacent to Longwalls 20-22 (Swamp 16/17, Swamp 20 and Swamp 25) are displayed in Charts 5 to 7. All sites show a pronounced drop in groundwater levels in February 2011, associated with a rainfall deficit. At Swamp 20, water appears to be infiltrating downwards to a series of perched water tables monitored by sandstone piezometers at 4 m depth and 10 m depth. Swamp 25 maintains a separation of about 1 m between swamp water levels and the water table level in sandstone at depth 10 m.

Longwall 20 extraction passed Swamp 16/17 in August 2010, about the time monitoring commenced, and passed Swamp 20 in January 2011. Although water levels started dropping at Swamp 20 (Chart 6) at this time, the responses at the control swamps confirm that the water level declines are due to a rainfall deficit and are not due to mining.

Longwall 20 came closest to Swamp 25 in May 2011. As water levels fluctuated with rainfall around a stable mean, there is no evidence for any mining impact to groundwater levels within Swamp 25.

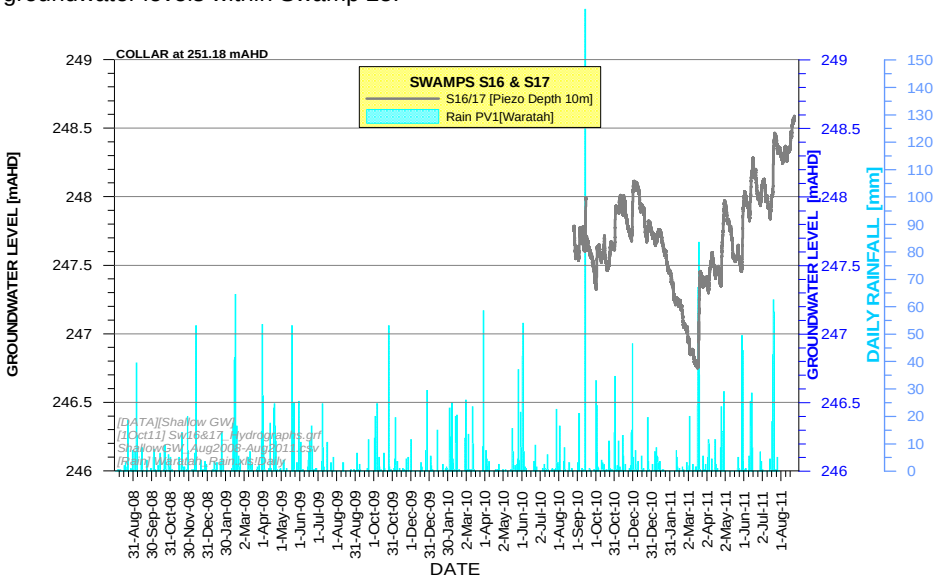

Chart 5 Groundwater Hydrographs at Swamp 16/17

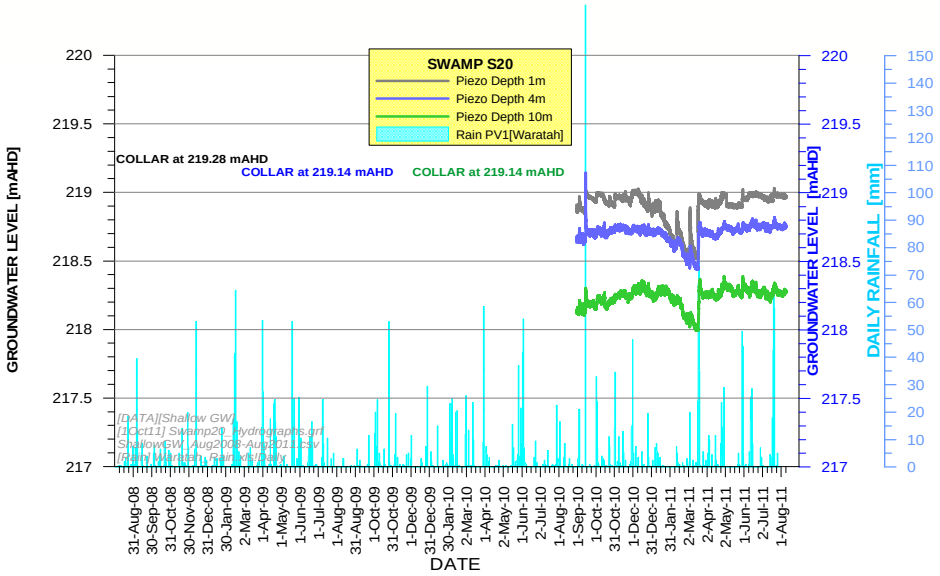

Chart 6 Groundwater Hydrographs Swamp 20

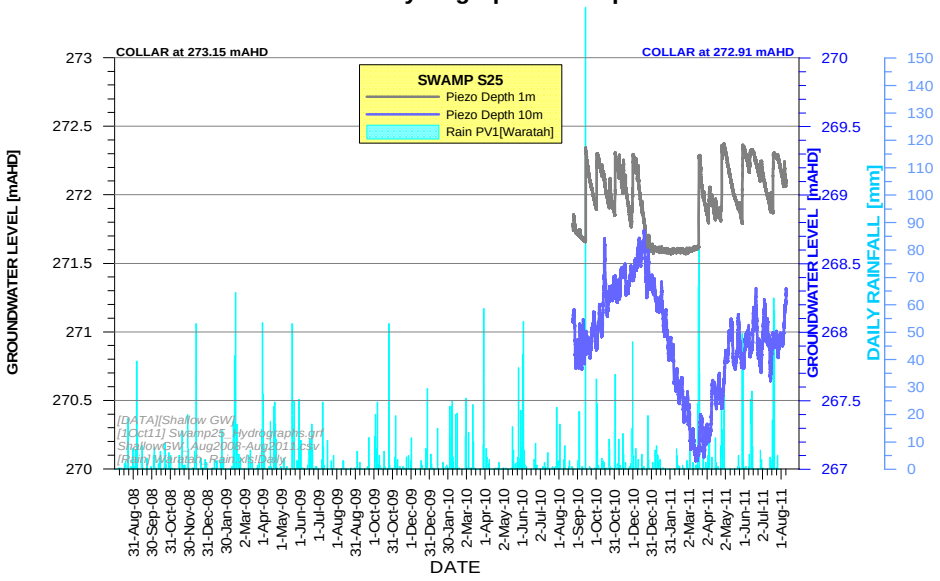

Chart 7 Groundwater Hydrographs at Swamp 25

Riparian Vegetation Monitoring

The riparian vegetation monitoring program includes visual, quadrat, transect and indicator species monitoring of riparian vegetation on the Waratah Rivulet and Eastern Tributary, as described below.

Visual Inspections

Visual inspections of riparian areas have been conducted in spring 2010 and autumn 2011 in locations adjacent to riparian vegetation monitoring sites (sites MRIP01 to MRIP10, Figure 4), and areas traversed whilst accessing the monitoring sites.

The following provides a summary of the results of visual inspections:

- Cracking of streamside rocky areas was observed during the autumn 2011 survey at the downstream end of MRIP01. A short length of cracking was observed on the western bank above the water level at the time of inspection. No dieback of vegetation was observed in areas adjacent to the cracked bedrock. No other cracking of streamside rocky areas or rock displacement was observed during the autumn 2011 survey.
- No cracking of non-sandy streamside sediments observed within either longwall or control sites.
- No new areas of water ponding observed within either longwall or control sites.
- Flood impacted and senescing vegetation was recorded at all sites, including evidence of further flooding since the spring 2009 survey. Most sites were found to have flood-swept vegetation, with plants being buried by sediment and other plant material, woody debris, and have varying degrees of mechanical damage to bark and branches. Woody debris and litter dams were common, and in some areas, soils surfaces were stripped of litter, small shrubs and groundcovers and in others sediments were deposited. In general vegetation appears to be recovering from flood impacts, although those areas where vegetation has been buried by woody debris, litter or sediments do not appear to be recovering.
- Some creek bank areas also displayed signs of erosion and scouring of sediments (likely associated with flooding), for example, along the Eastern Tributary, downstream of the ford on Fire Road 9J and within sites MRIP04 and MRIP08. For the most part, much of the flood-swept vegetation was found to be living.

Visual inspections of riparian vegetation will be conducted bi-annually in autumn and spring at the time of the vegetation surveys.

Quadrat/Transect Monitoring

Quadrat and transect monitoring has been conducted in spring 2010 and autumn 2011.

A permanent quadrat (20 m x 2 m) has been used to monitor riparian vegetation on the Waratah Rivulet and Eastern Tributary at sites MRIP01, MRIP02, MRIP05 and MRIP06 (overlying Longwalls 20-22) and at sites MRIP03, MRIP04, MRIP07 and MRIP08 (downstream of Longwalls 20-22) (Figure 4).

The data collected for each quadrat includes:

- vegetation structure;
- dominant species;
- estimated cover and height for each stratum;
- full floristics;
- estimated cover abundance for each species using seven point Braun-Blanquet scale; and
- condition/health rating for each species in the quadrat:

A permanent transect (50 m x 2 m, i.e. a 30 m extension of each quadrat) has also been used to monitor riparian vegetation at sites MRIP01 to MRIP08. The data collected along each transect includes the occurrence of weed species (species and location) and a condition/health rating for each plant along the transect.

Permanent photo points have been established for each quadrat and along each transect.

In summary, the results of the surveys indicate the following:

- Riparian vegetation at all sites was found to be flood impacted, and as a result the vegetation structure and cover abundance values for each stratum were variable compared to the previous surveys.
- Despite the damage to vegetation and the flood-swept appearance, many individuals at the time of survey were still alive, and/or recovering.
- One weed species was recorded, Whiskey Grass (*Andropogon virgincus)* at site MRIP01, downstream from Flat Rock Crossing.
- Fluctuations in species cover and vegetation condition were recorded across all sites.
- The longwall sites are generally more floristically diverse compared to the control sites. The differences in floristic diversity can be attributed to the nature of the habitats at these sites.
- All four longwall sites are generally shrubbier, and have little exposed bedrock present. Control sites MRIP03 and MRIP07 are also relatively shrubby, however sites MRIP04 and MRIP08 are characterised by extensive rock and boulders, sediments, and less vegetative cover in comparison.
- Site MRIP06 is the most floristically diverse whilst MRIP08 is the least diverse, where the ground layer comprises a combination of boulders and sparse vegetation cover dominated by *Lomandra fluviatilis.*
- Riparian vegetation at all sites was found to be flood impacted in spring 2010 and autumn 2011 as a result of floods preceding the spring 2010 survey and further flooding between the spring 2010 and autumn 2011 surveys. With the exception of sites MRIP01 and MRIP02, all sites recorded a reduction in species richness in spring 2010 which is considered to be attributed to the impacts of severe flooding causing burial and/or loss of vegetative cover. For spring 2010, sites MRIP01 and MRIP02 were the least impacted by flood.
- Vegetation was generally found to be in Condition 5 (healthy) and 4 (minor damage) despite the impacts of flooding. Although flood-swept, the vegetation at the time of survey in most sites was found to be still living, and reflects the robust nature of sandstone vegetation to disturbance.

The changes in species composition, cover and condition reflect normal population variation and cycles in response to seasonal variations and plant growth.

Quadrat and transect monitoring will be conducted bi-annually, in autumn and spring.

Indicator Species

Twenty tagged individuals of *Prostanthera linearis*, *Schoenis melanostachys* and *Lomatia myricoides* have been monitored at sites MRIP01, MRIP02, MRIP05, MRIP06 and MRIP09 (overlying Longwalls 20-22) and at sites MRIP03, MRIP04, MRIP07, MRIP08 and MRIP10 (downstream of Longwalls 20-22) (Figure 4). Note, only ten individuals of *Prostanthera linearis* were available for tagging at site MRIP08.

Population monitoring data collected includes a condition/health rating and a reproductive rating for each plant.

Monitoring of indicator species will be conducted bi-annually in autumn and spring.

In summary, the results of the surveys indicate the following:

- Many of the tagged plants within the riparian sites have been severely flood impacted, with some individuals unable to be relocated in spring 2010 and again in autumn 2011 due to burial under vegetation, sediments and woody debris. Those plants unable to be relocated have been replaced with new individuals.
- The condition of tagged plants of the three indicator species have progressively declined over the four seasons of surveys, with an increase in the number of plants with some level of dieback (Conditions 1 to 4) and a subsequent decrease in the number of tagged plants in a healthy condition (Condition 5). This decrease in condition has occurred at both longwall and control sites and has occurred in all seasons including autumn 2010, prior to the commencement of mining of Longwalls 20-22.
- The declines are considered to represent natural declines in response to climatic conditions, ageing plants and natural disturbances including floods. The observed declines are not thought to be related to mining of Longwalls 20-22.
- Of the three indicator species, *Lomatia myricoides* has been the least impacted by flooding largely in part to its robust habit and deep root zone. This is highlighted by the fact that in all surveys season the vast majority of plants have been observed in Condition 5 including 84% of tagged plants of this species in autumn 2011. Two dead *Lomatia myricoides* plants were observed in autumn 2011.
- *Prostanthera linearis and Schoenus melanostachys* were most impacted by flooding. Many individuals of *Prostanthera linearis* were found flood-swept and uprooted, whilst many *Schoenus melanostachys* were buried under sediment and woody debris.

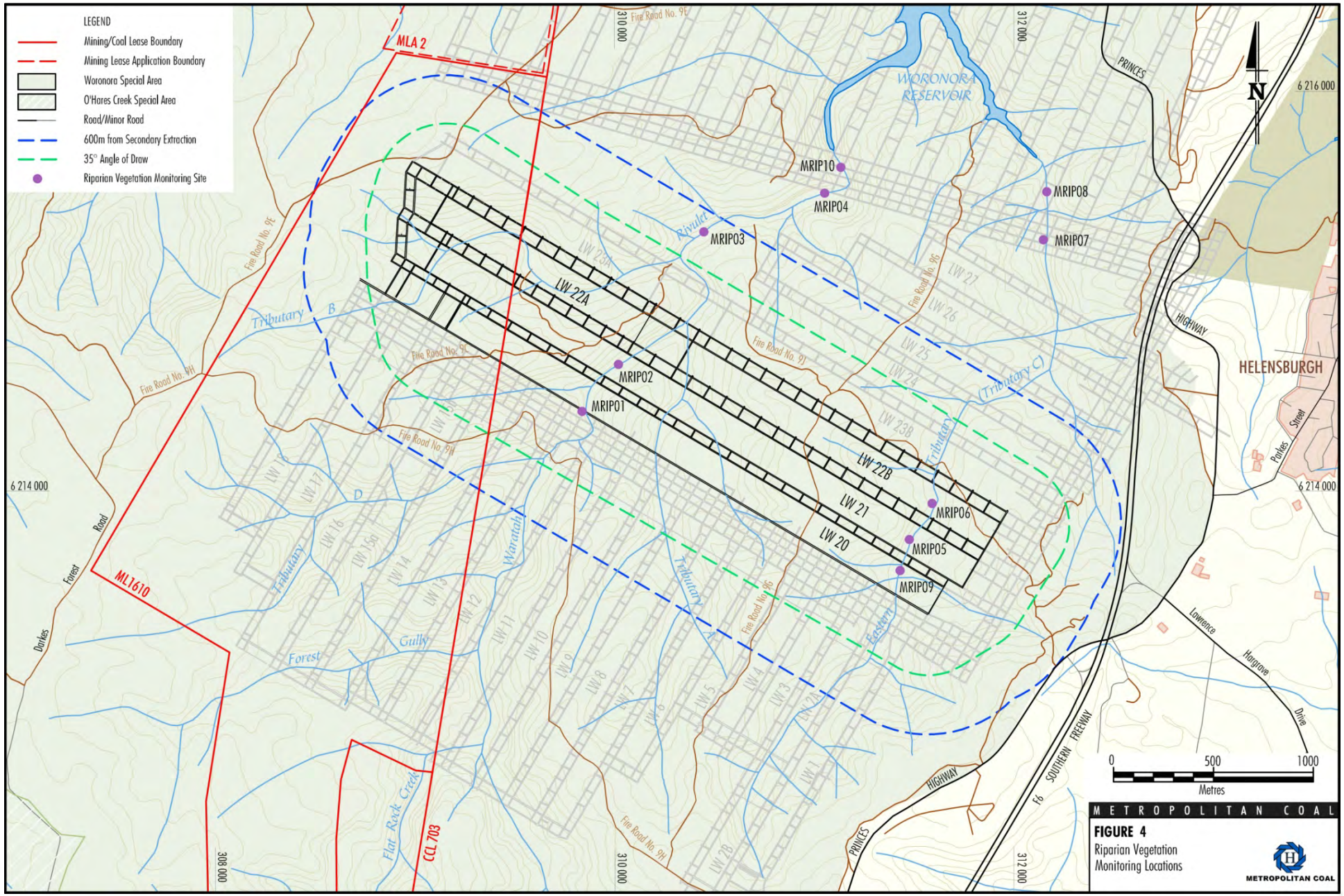

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FIGURE 4

Riparian Vegetation Monitoring Locations

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Aquatic Biota and their Habitats

The aquatic ecology monitoring program for Longwalls 20-22 has been designed to:

- monitor subsidence-induced impacts on aquatic ecology (referred to as stream monitoring); and
- monitor the response of aquatic ecosystems to the implementation of stream remediation works (referred to as pool monitoring).

The design of the monitoring programs uses a “Beyond BACI” experimental design and focuses on representative sampling within streams and pools in the Longwalls 20-22 mining area and in suitable control streams and pools not subject to mine subsidence.

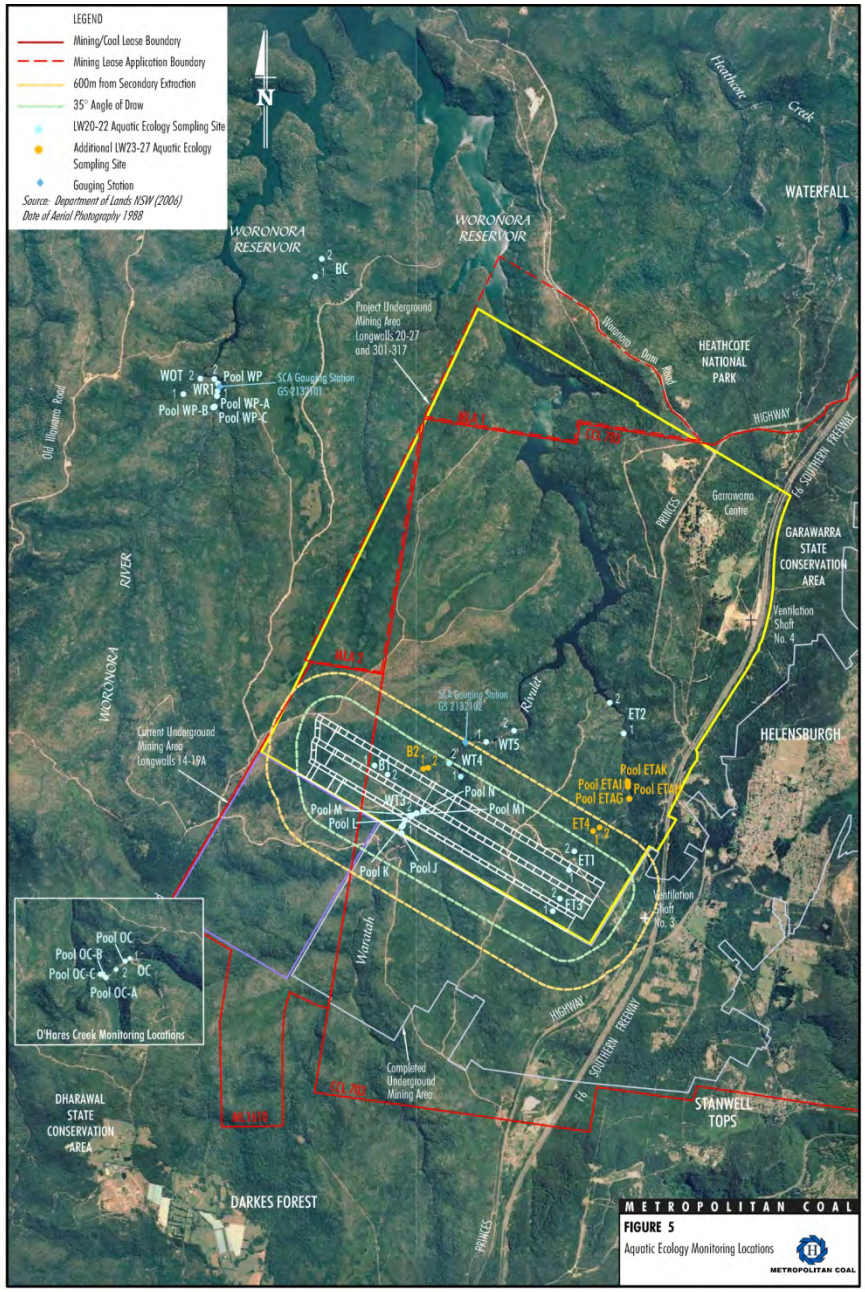
<u>Stream Monitoring</u>

The stream monitoring program includes the monitoring of aquatic habitat characteristics, water quality, aquatic macroinvertebrates and aquatic macrophytes. Baseline monitoring has been conducted in spring 2008, autumn 2009, spring 2009, autumn 2010, spring 2010 and autumn 2011.

Monitoring has been conducted at two sampling sites (approximately 100 m long) at the following stream sampling locations:

- Locations WT3 on Waratah Rivulet, ET1 and ET3 on the Eastern Tributary and B1 on Tributary B, overlying Longwalls 20-22.
- Locations WT4 and WT5 on Waratah Rivulet and ET2 on the Eastern Tributary, downstream of Longwalls 20-22.
- Control locations: WR1 on Woronora River; OC on O’Hares Creek; BC on Bee Creek; and WOT on Woronora Tributary.

The approximate locations of the sampling sites are shown on Figure 5.



The methods used to survey aquatic biota and their habitats at each site are:

- Stream characteristics are recorded in accordance with the Australian River Assessment System (AUSRIVAS) protocol (visual assessment of stream width and depth, composition of the substratum, riparian conditions, signs of disturbance, water quality and percentage cover of the substratum by algae).
- Water quality sampling is conducted for electrical conductivity, dissolved oxygen, pH, temperature, turbidity, oxygen reduction potential, alkalinity, total phosphorous and total nitrogen to provide information relevant to water quality at the time of sampling.
- Aquatic macroinvertebrate sampling is conducted using the AUSRIVAS protocol, as well as quantitative sampling where three replicate macroinvertebrate samples are collected within each site using timed sweeps.
- The distribution of submerged and emergent (occurring in-stream and in the riparian zone) aquatic macrophytes are estimated along each sampling location by assigning a cover class to each species. The cover classes are: (1) one plant or small patch (i.e. few), (2) not common, growing in a few places (i.e. scattered), and (3) widespread (i.e. common). In addition, an assessment of the in-stream (i.e. submerged and emergent) aquatic vegetation is made within each site by estimating the relative abundance (i.e. percentage cover) of aquatic macrophytes within five haphazardly placed 0.25 m^2 quadrats, using a stratified sampling technique.

Table 1 presents the AUSRIVAS Band results for each site.

Charts 1 to 4 present the mean abundance of macroinvertebrates, mean diversity of macroinvertebrates, mean percentage cover of macrophytes and mean diversity of macrophytes at each sampling location, respectively, using the quantitative sampling data.

Monitoring of the sampling sites will be conducted bi-annually, in autumn and spring.

Table 1
AUSRIVAS Band Results

Stream	Site	AUSRIVAS Band					
		sp-08	aut-09	sp-09	aut-10	sp-10	aut-11
Waratah Rivulet	WT3-1	B	B	B	B	C	C
	WT3-2	B	B	B	B	B	B
	WT4-1	D	C	C	C	C	B
	WT4-2	B	C	C	C	C	C
	WT5-1	B	C	C	C	C	C
	WT5-2	D	C	C	C	C	C
Tributary C *Note: Also referred to as Eastern Tributary (ET)*	ET1-1	D	C	B	B	B	C
	ET1-2	D	C	C	C	B	C
	ET2-1	D	B	B	C	B	C
	ET2-2	D	C	B	B	B	C
	ET3-1	#	#	B	C	C	B
	ET3-2	#	#	D	C	C	C
Tributary B	B1	B	C	C	C	C	C
	B2	C	B	C	B	C	C
Bee Creek	BC1	D	C	C	B	C	C
	BC2	C	B	D	B	C	B
Woronora Tributary	WOT1	C	B	-	B	C	C
	WOT2	C	C	D	C	C	C
Woronora River	WR1	D	B	C	B	C	C
	WR2	C	C	C	B	C	C
O'Hares Creek	OC1-1	B	B	B	A	B	B
	OC1-2	D	B	B	B	B	B

[#] Survey of Sites ET3-1 and ET3-2 commenced in spring 2009 for Longwalls 23-27.

- Insufficient water habitat available to sample.

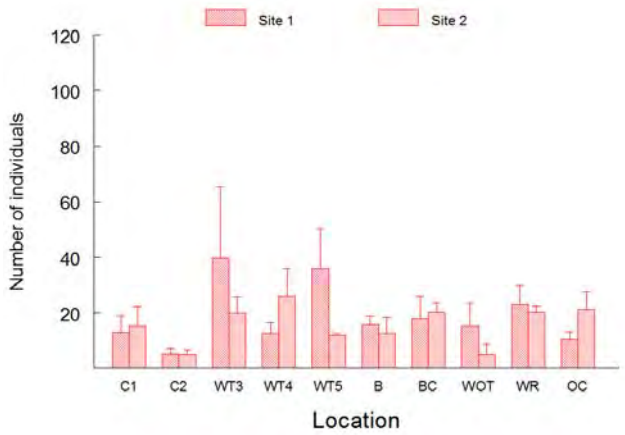


Chart 1a Mean (+SE) Macroinvertebrate Abundance, Stream Monitoring, Spring 2008

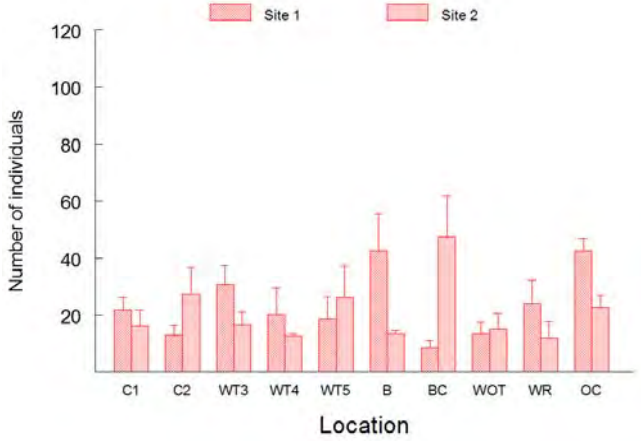


Chart 1b Mean (+SE) Macroinvertebrate Abundance, Stream Monitoring, Autumn 2009

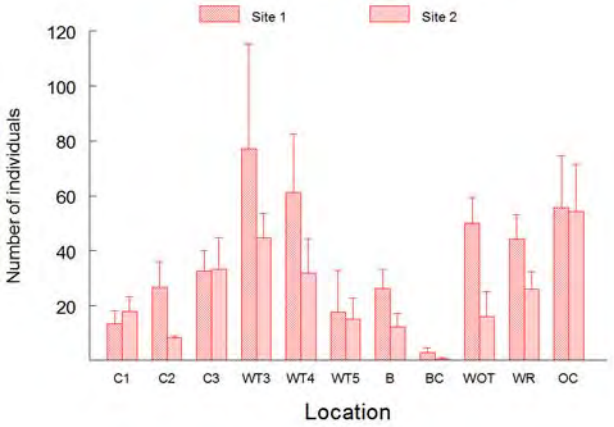


Chart 1c Mean (+SE) Macroinvertebrate Abundance, Stream Monitoring, Spring 2009

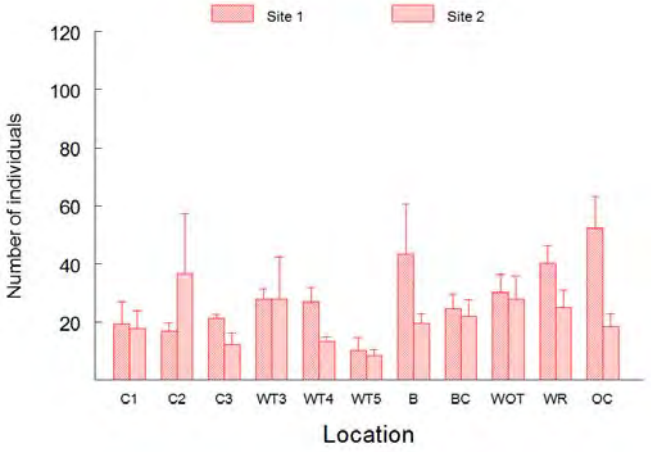


Chart 1d Mean (+SE) Macroinvertebrate Abundance, Stream Monitoring, Autumn 2010

Key: C – Tributary C/Eastern Tributary [C1 – Location 1 etc], WT – Waratah Rivulet [WT3 - Location 3 etc], B – Tributary B, BC – Bee Creek, WOT – Woronora Tributary, WR – Woronora River, OC – O'Hares Creek. (*n* = 3)

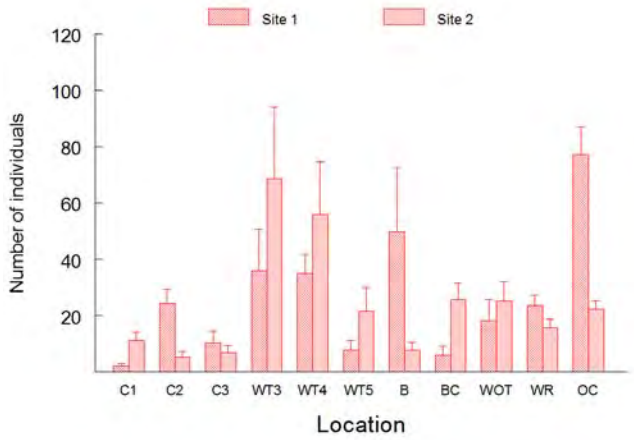


Chart 1e Mean (+SE) Macroinvertebrate Abundance, Stream Monitoring, Spring 2010

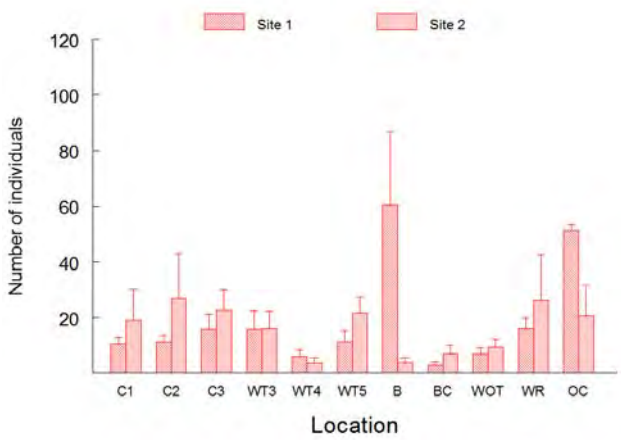


Chart 1f Mean (+SE) Macroinvertebrate Abundance, Stream Monitoring, Autumn 2011

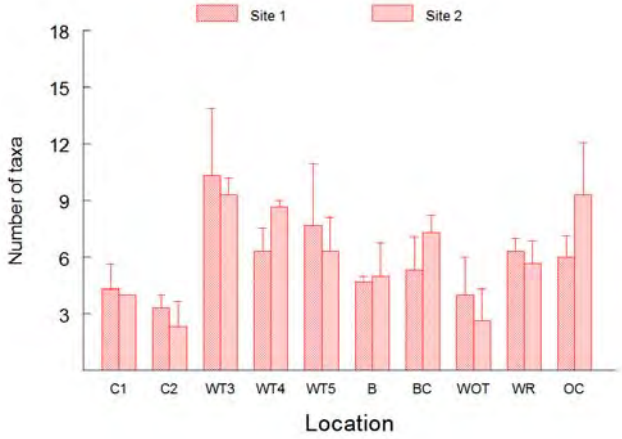


Chart 2a Mean (+SE) Macroinvertebrate Diversity, Stream Monitoring, Spring 2008

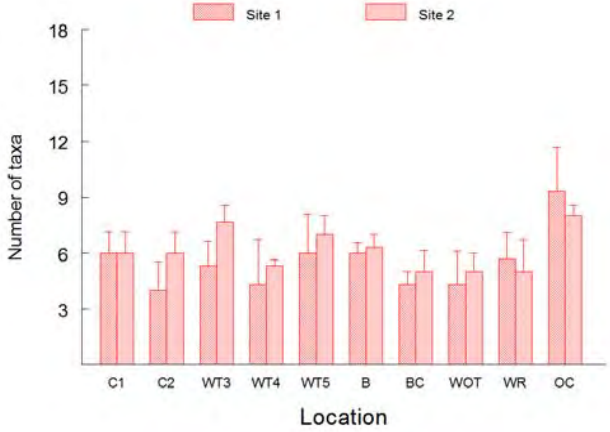


Chart 2b Mean (+SE) Macroinvertebrate Diversity, Stream Monitoring, Autumn 2009

Key: C – Tributary C/Eastern Tributary [C1 – Location 1 etc], WT – Waratah Rivulet [WT3 - Location 3 etc], B – Tributary B, BC – Bee Creek, WOT – Woronora Tributary, WR – Woronora River, OC – O'Hares Creek. (*n* = 3)

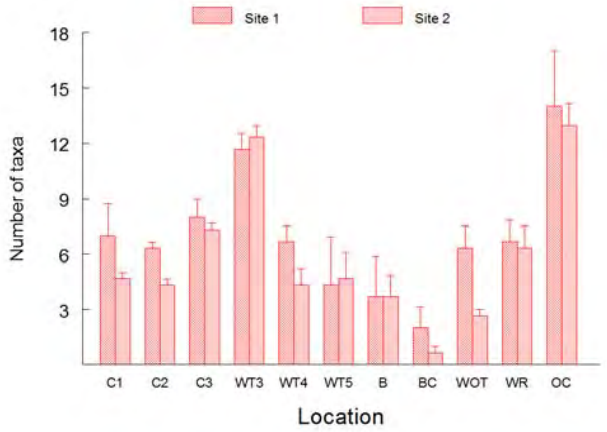


Chart 2c Mean (+SE) Macroinvertebrate Diversity, Stream Monitoring, Spring 2009

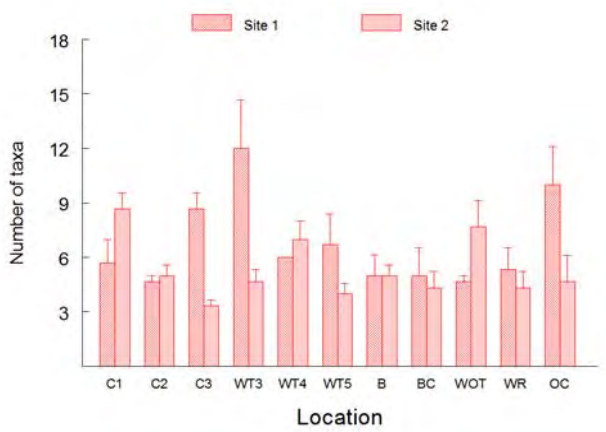


Chart 2d Mean (+SE) Macroinvertebrate Diversity, Stream Monitoring, Autumn 2010

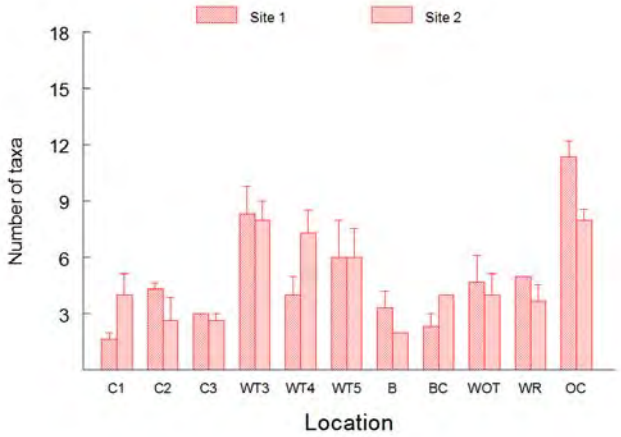


Chart 2e Mean (+SE) Macroinvertebrate Diversity, Stream Monitoring, Spring 2010

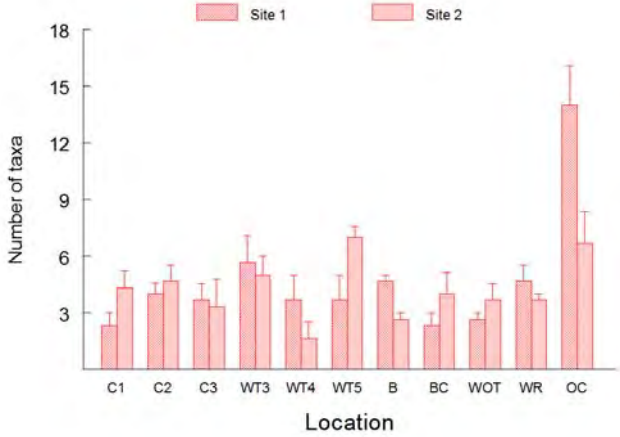


Chart 2f Mean (+SE) Macroinvertebrate Diversity, Stream Monitoring, Autumn 2011

Key: C – Tributary C/Eastern Tributary [C1 – Location 1 etc], WT – Waratah Rivulet [WT3 - Location 3 etc], B – Tributary B, BC – Bee Creek, WOT – Woronora Tributary, WR – Woronora River, OC – O'Hares Creek. (*n* = 3)

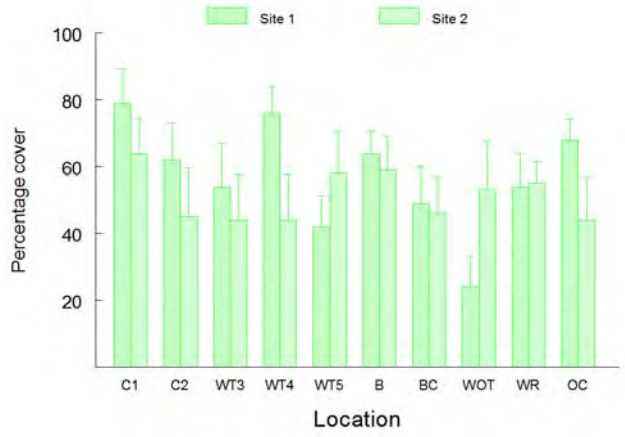


Chart 3a Mean (+SE) Macrophyte Percentage Cover, Stream Monitoring, Spring 2008

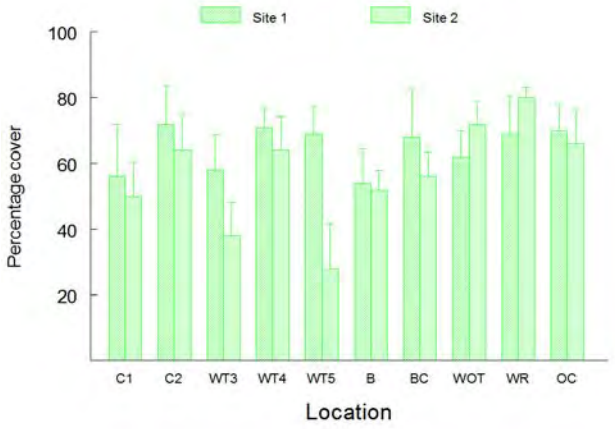


Chart 3b Mean (+SE) Macrophyte Percentage Cover, Stream Monitoring, Autumn 2009

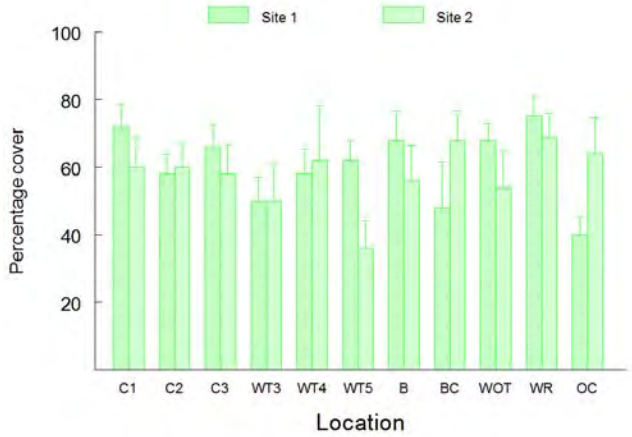


Chart 3c Mean (+SE) Macrophyte Percentage Cover, Steam Monitoring, Spring 2009

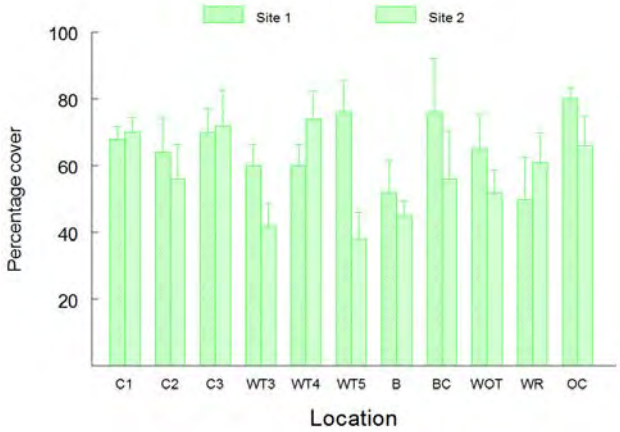


Chart 3d Mean (+SE) Macrophyte Percentage Cover, Stream Monitoring, Autumn 2010

Key: C – Tributary C/Eastern Tributary [C1 – Location 1 etc], WT – Waratah Rivulet [WT3 - Location 3 etc], B – Tributary B, BC – Bee Creek, WOT – Woronora Tributary, WR – Woronora River, OC – O'Hares Creek. (*n* = 5)

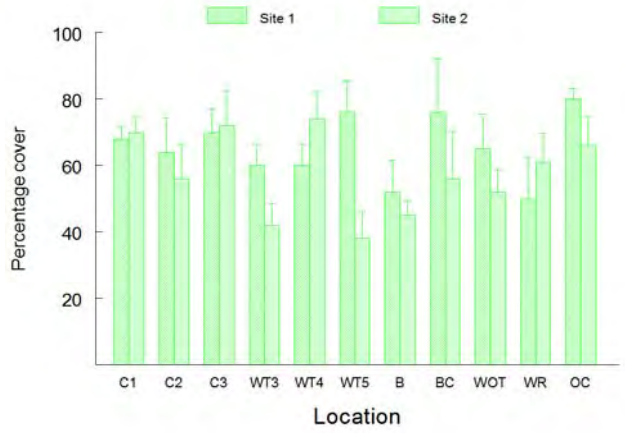


Chart 3e Mean (+SE) Macrophyte Percentage Cover, Steam Monitoring, Spring 2010

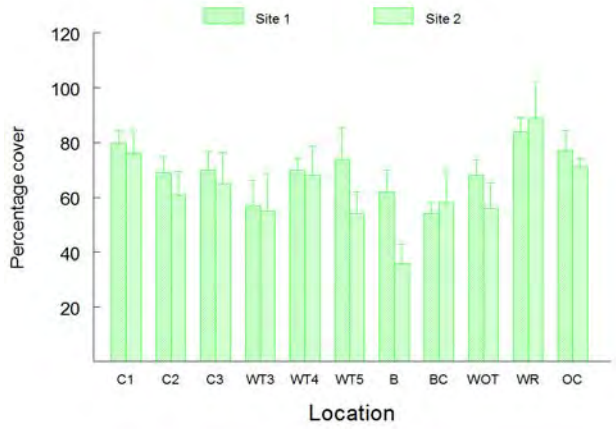


Chart 3f Mean (+SE) Macrophyte Percentage Cover, Stream Monitoring, Autumn 2011

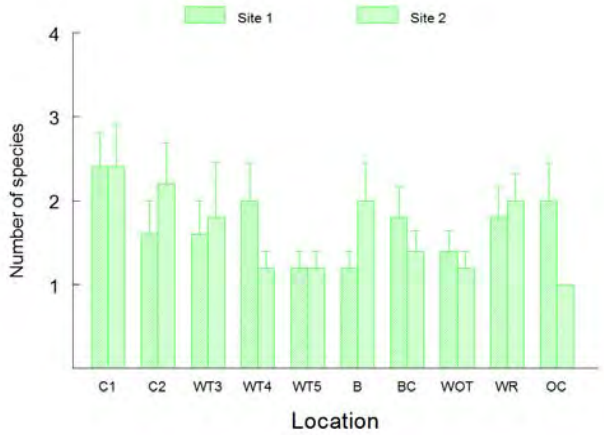


Chart 4a Mean (+SE) Macrophyte Diversity, Stream Monitoring, Spring 2008

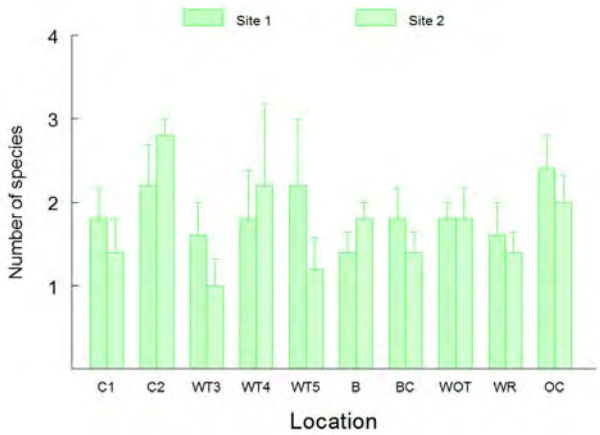


Chart 4b Mean (+SE) Macrophyte Diversity, Stream Monitoring, Autumn 2009

Key: C – Tributary C/Eastern Tributary [C1 – Location 1 etc], WT – Waratah Rivulet [WT3 - Location 3 etc], B – Tributary B, BC – Bee Creek, WOT – Woronora Tributary, WR – Woronora River, OC – O'Hares Creek. (*n* = 5)

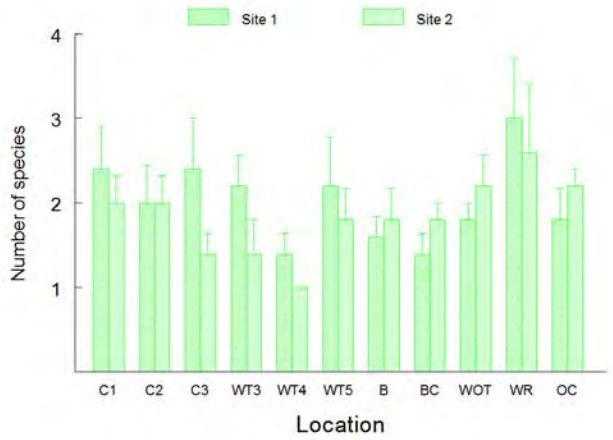


Chart 4c Mean (+SE) Macrophyte Diversity, Stream Monitoring, Spring 2009

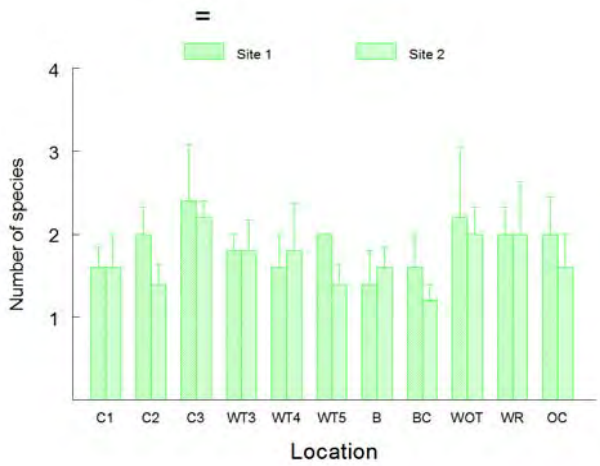


Chart 4d Mean (+SE) Macrophyte Diversity, Stream Monitoring, Autumn 2010

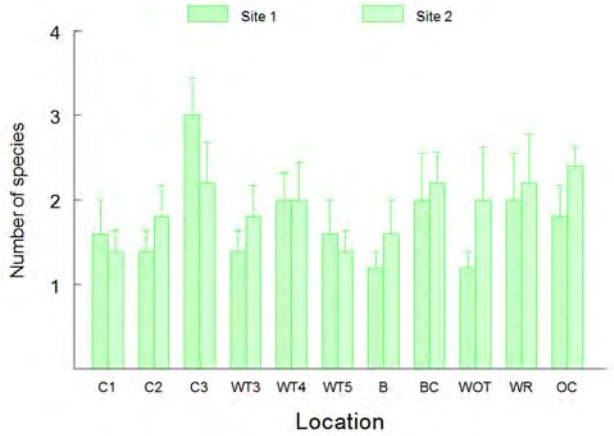


Chart 4e Mean (+SE) Macrophyte Diversity, Stream Monitoring, Spring 2010

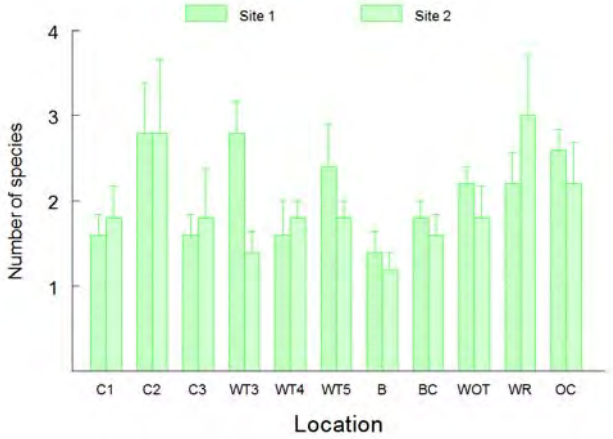


Chart 4f Mean (+SE) Macrophyte Diversity, Stream Monitoring, Autumn 2011

Key: C – Tributary C/Eastern Tributary [C1 – Location 1 etc], WT – Waratah Rivulet [WT3 - Location 3 etc], B – Tributary B, BC – Bee Creek, WOT – Woronora Tributary, WR – Woronora River, OC – O'Hares Creek. (*n* = 5)

Pool Monitoring

Baseline monitoring of pools on Waratah Rivulet has been conducted since spring 2008 or spring 2009[1] to assess the response of aquatic ecosystems to the implementation of future stream remediation works, namely:

- Larger pools, J, M1 and N on Waratah Rivulet overlying Longwalls 20-22.
- Smaller pools K, L and M on Waratah Rivulet overlying Longwalls 20-22.
- One larger control pool on Woronora River (Pool WP) and one larger control pool on O'Hares Creek (Pool OC).
- Three smaller control pools on Woronora River (Pool WP-A, WP-B and WP-C) and three smaller control pools on O'Hares Creek (Pool OC-A, OC-B and OC-C).

The approximate locations of the sampling sites are shown on Figure 5.

Sampling is conducted at two random sites within the larger pools and at one site within the smaller pools.

Within each site in each pool, aquatic macroinvertebrates and macrophytes are sampled using the same quantitative techniques described for stream monitoring above. The AUSRIVAS sampling technique is not used for macroinvertebrate sampling in the pool monitoring.

Quantitative estimates of aquatic macrophytes (i.e. emergent, floating attached and/or submerged species of aquatic plants) are collected at one site at each small pool and at two sites at each large pool. In addition, the spatial distribution of floating attached and/or submerged macrophytes (e.g. *Myriophyllum penduculatum* and *Triglochin procerum*) is also mapped in each pool, to provide a visual comparison of their distribution through time.

Charts 5 to 8 present the mean abundance of macroinvertebrates, mean diversity of macroinvertebrates, mean percentage cover of macrophytes and mean diversity of macrophytes at the larger pools, respectively, using the quantitative sampling data.

Charts 9 to 12 present the mean abundance of macroinvertebrates, mean diversity of macroinvertebrates, mean percentage cover of macrophytes and mean diversity of macrophytes at the smaller pools, respectively, using the quantitative sampling data.

The baseline monitoring data provides a benchmark against which aquatic biota and their habitats can be measured before and after stream remediation works.

Monitoring of the sampling sites will be conducted bi-annually, in autumn and spring.

[1] Pools monitored since spring 2008: larger pools - Pool N on Waratah Rivulet, Pool WP on Woronora River and Pool OC on O'Hares Creek.

Pools monitored since spring 2009: larger pools - Pools J and M1 on Waratah Rivulet; smaller pools: Pools K, L and M on Waratah Rivulet, Pools WP-A, WP-B, WP-C on Woronora River and Pools OC-A, OC-B, OC-C on O'Hares Creek.

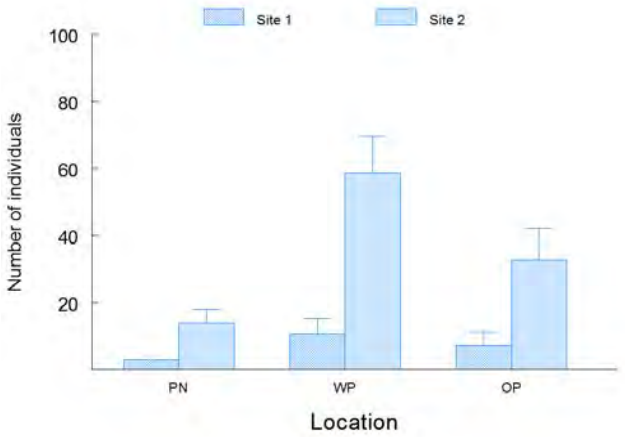


Chart 5a **Mean (+SE) Macroinvertebrate Abundance, Larger Pools, Spring 2008**

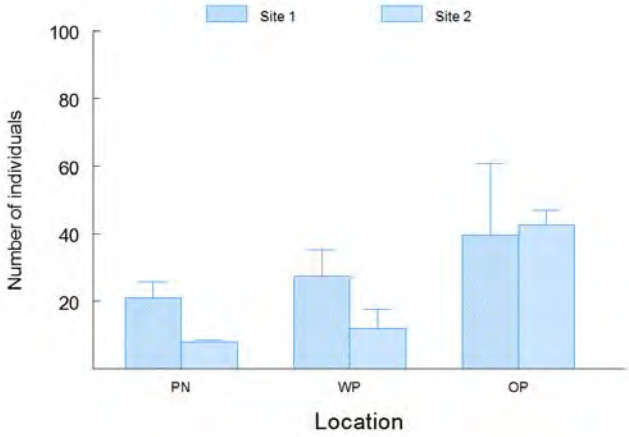


Chart 5b **Mean (+SE) Macroinvertebrate Abundance, Larger Pools, Autumn 2009**

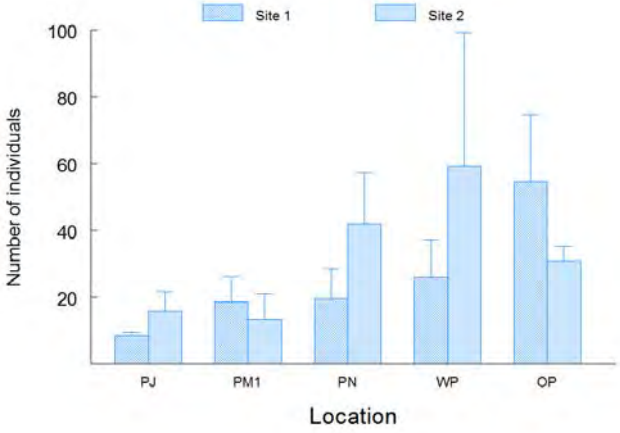


Chart 5c **Mean (+SE) Macroinvertebrate Abundance, Larger Pools, Spring 2009**

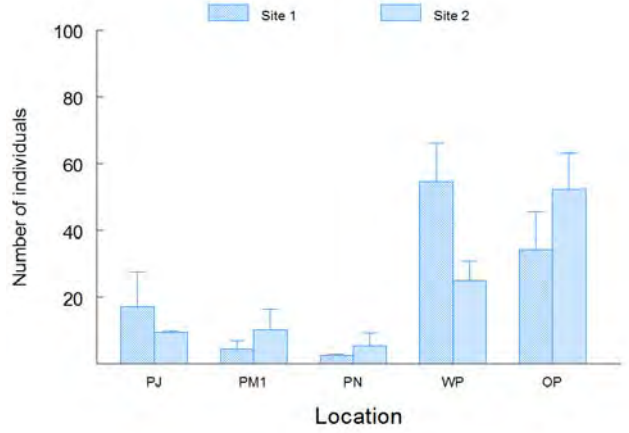


Chart 5d **Mean (+SE) Macroinvertebrate Abundance, Larger Pools, Autumn 2010**

Larger Pools Key: PJ – Pool J, PM1 – Pool M1, PN – Pool N, WP – Woronora Pool, OP - O'Hares Creek Pool (*n* = 3).

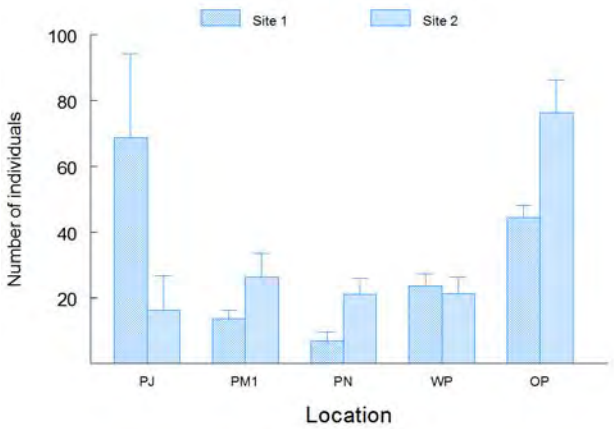


Chart 5e Mean (+SE) Macroinvertebrate Abundance, Larger Pools, Spring 2010

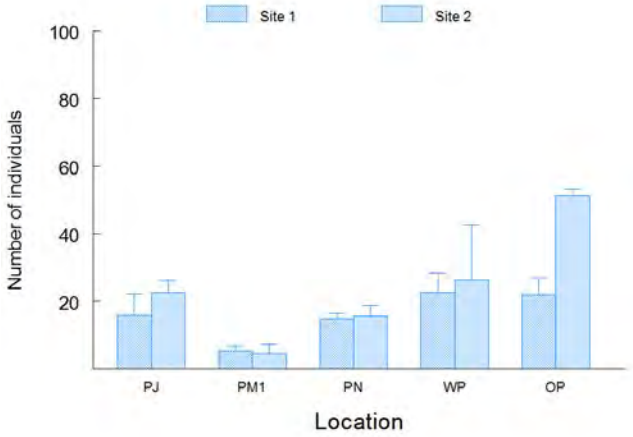


Chart 5f Mean (+SE) Macroinvertebrate Abundance, Larger Pools, Autumn 2011

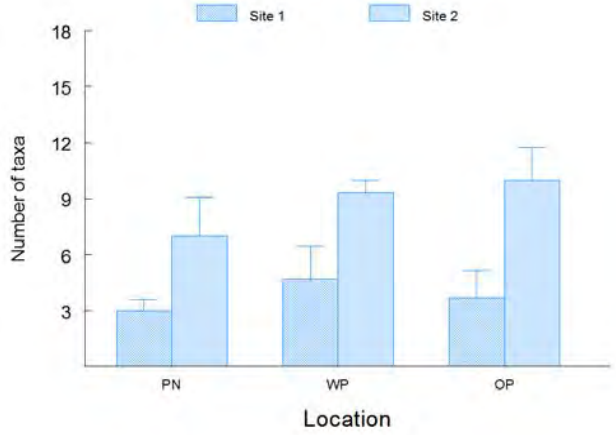


Chart 6a Mean (+SE) Macroinvertebrate Diversity, Larger Pools, Spring 2008

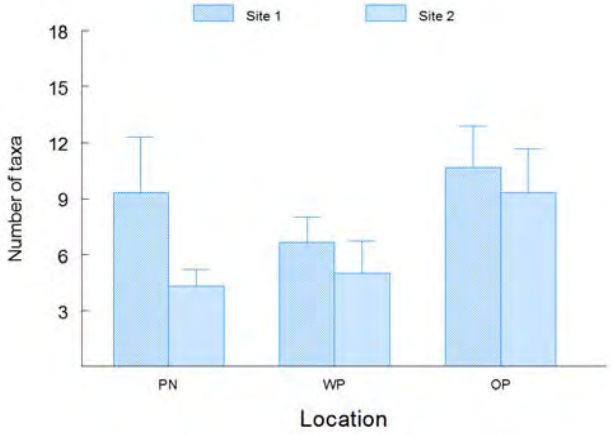


Chart 6b Mean (+SE) Macroinvertebrate Diversity, Larger Pools, Autumn 2009

Larger Pools Key: PJ – Pool J, PM1 – Pool M1, PN – Pool N, WP – Woronora Pool, OP - O'Hares Creek Pool (*n* = 3).

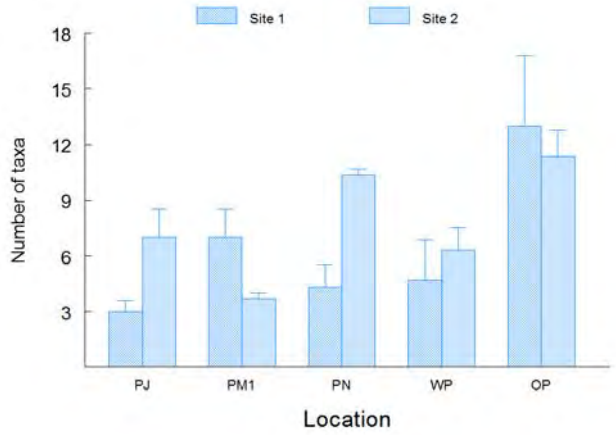


Chart 6c Mean (+SE) Macroinvertebrate Diversity, Larger Pools, Spring 2009

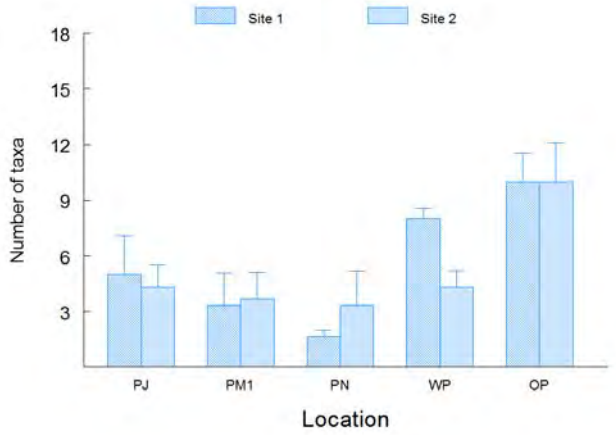


Chart 6d Mean (+SE) Macroinvertebrate Diversity, Larger Pools, Autumn 2010

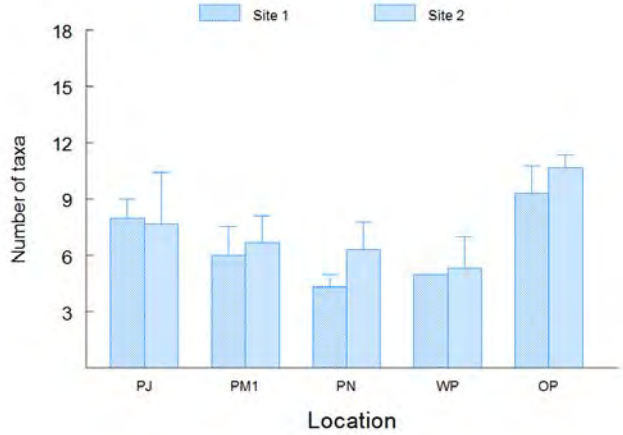


Chart 6e Mean (+SE) Macroinvertebrate Diversity, Larger Pools, Spring 2010

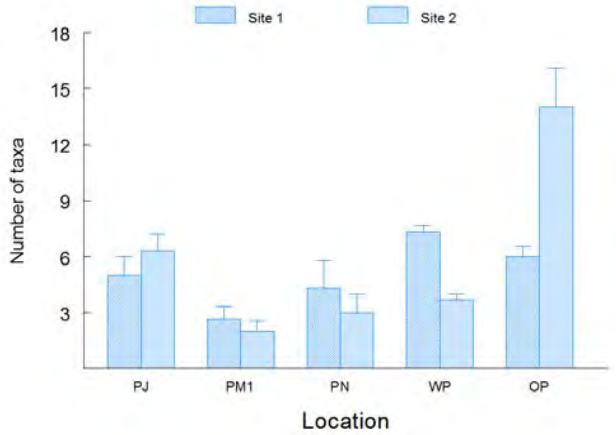


Chart 6f Mean (+SE) Macroinvertebrate Diversity, Larger Pools, Autumn 2011

Larger Pools Key: PJ – Pool J, PM1 – Pool M1, PN – Pool N, WP – Woronora Pool, OP - O'Hares Creek Pool (*n* = 3).

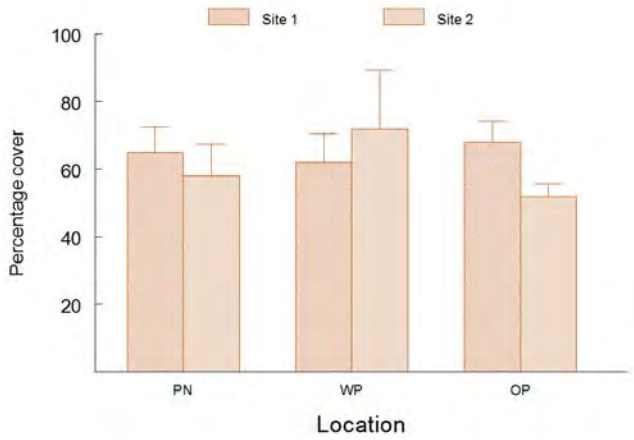


Chart 7a Mean (+SE) Macrophyte Percentage Cover, Larger Pools, Spring 2008

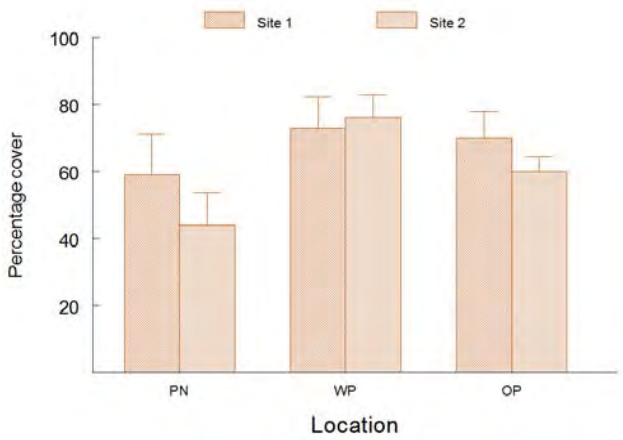


Chart 7b Mean (+SE) Macrophyte Percentage Cover, Larger Pools, Autumn 2009

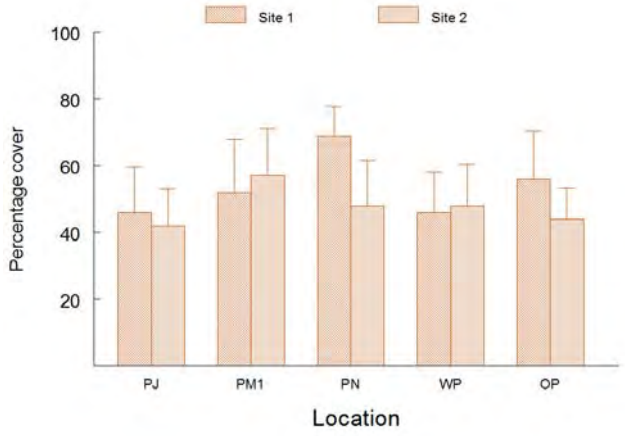


Chart 7c Mean (+SE) Macrophyte Percentage Cover, Larger Pools, Spring 2009

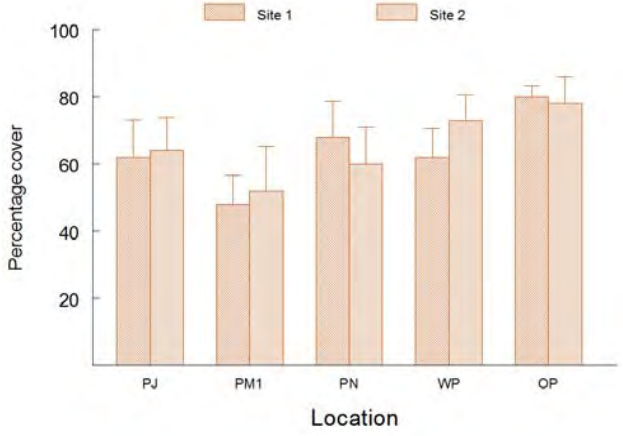


Chart 7d Mean (+SE) Macrophyte Percentage Cover, Larger Pools, Autumn 2010

Larger Pools Key: PJ – Pool J, PM1 – Pool M1, PN – Pool N, WP – Woronora Pool, OP - O'Hares Creek Pool (*n* = 5)

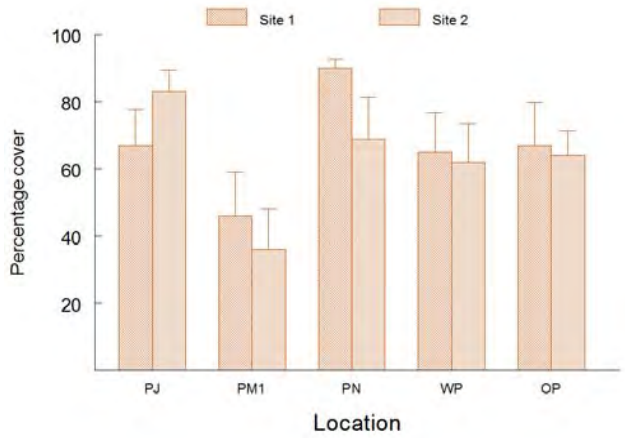


Chart 7e Mean (+SE) Macrophyte Percentage Cover, Larger Pools, Spring 2010

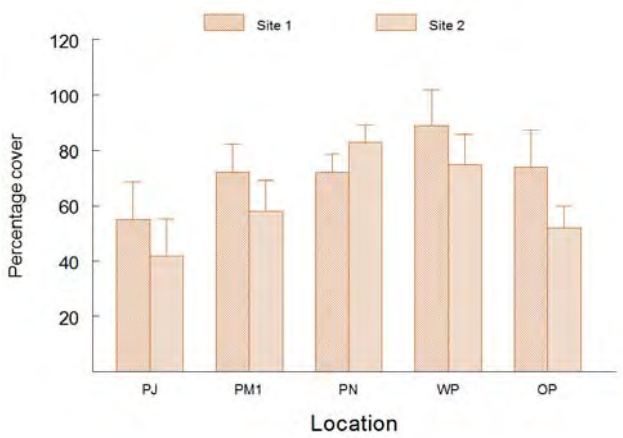


Chart 7f Mean (+SE) Macrophyte Percentage Cover, Larger Pools, Autumn 2011

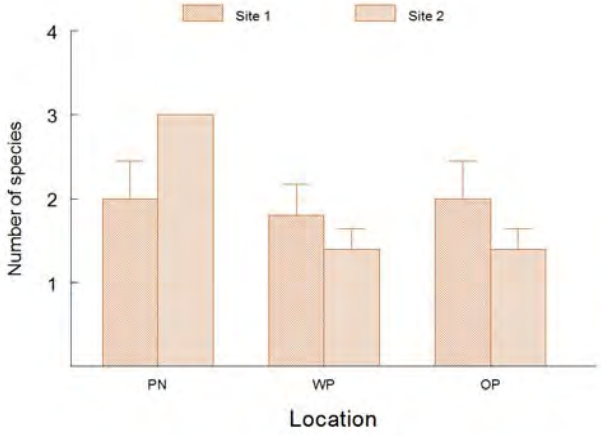


Chart 8a Mean (+SE) Macrophyte Diversity, Larger Pools, Spring 2008

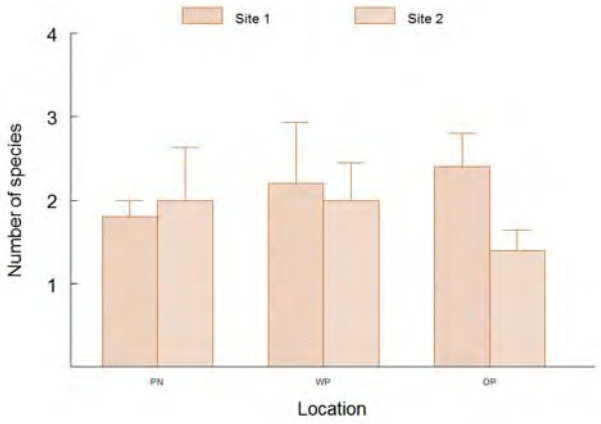


Chart 8b Mean (+SE) Macrophyte Diversity, Larger Pools, Autumn 2009

Larger Pools Key: PJ – Pool J, PM1 – Pool M1, PN – Pool N, WP – Woronora Pool, OP - O'Hares Creek Pool (*n* = 5)

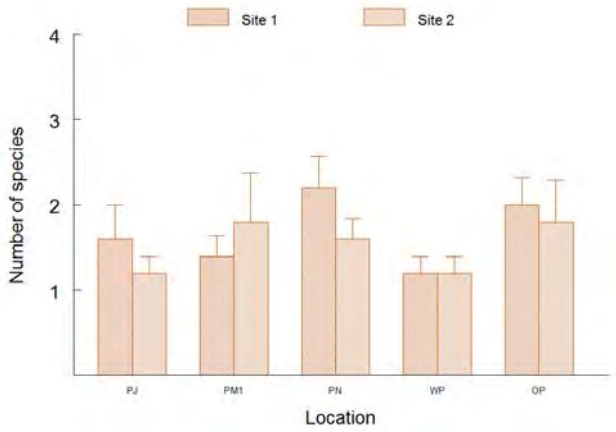


Chart 8c Mean (+SE) Macrophyte Diversity, Larger Pools, Spring 2009

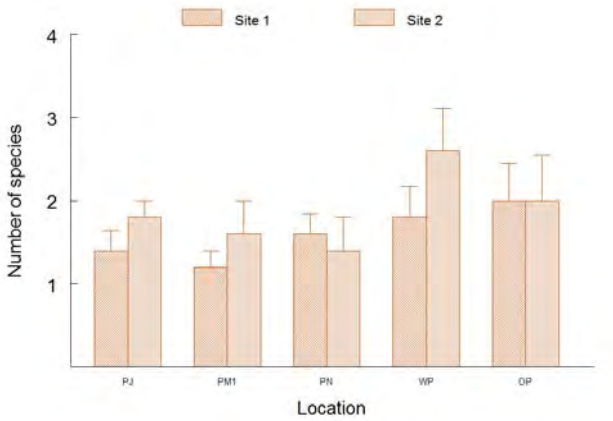


Chart 8d Mean (+SE) Macrophyte Diversity, Larger Pools, Autumn 2010

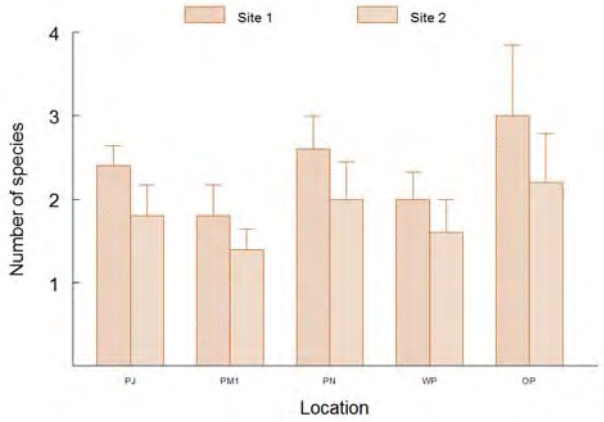


Chart 8e Mean (+SE) Macrophyte Diversity, Larger Pools, Spring 2010

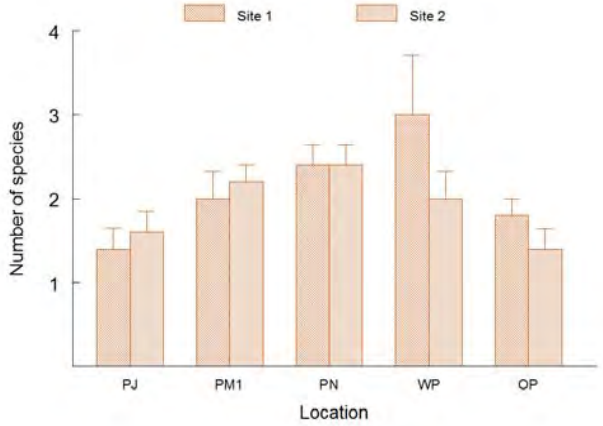


Chart 8f Mean (+SE) Macrophyte Diversity, Larger Pools, Autumn 2011

Larger Pools Key: PJ – Pool J, PM1 – Pool M1, PN – Pool N, WP – Woronora Pool, OP - O'Hares Creek Pool (*n* = 5).

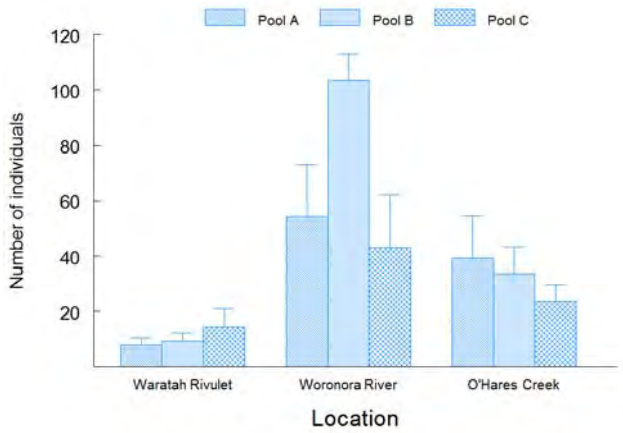


Chart 9a Mean (+SE) Macroinvertebrate Abundance, Smaller Pools, Spring 2009

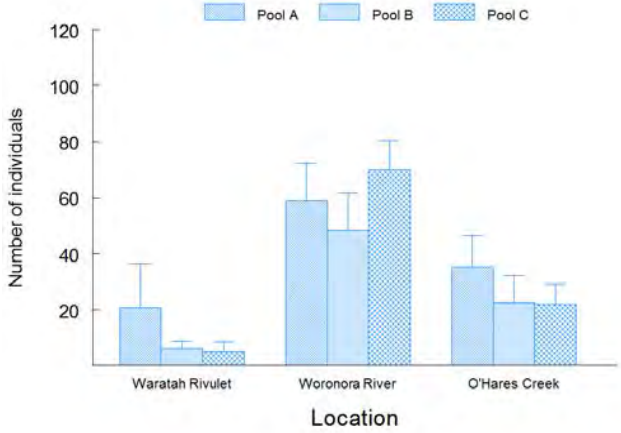


Chart 9b Mean (+SE) Macroinvertebrate Abundance, Smaller Pools, Autumn 2010

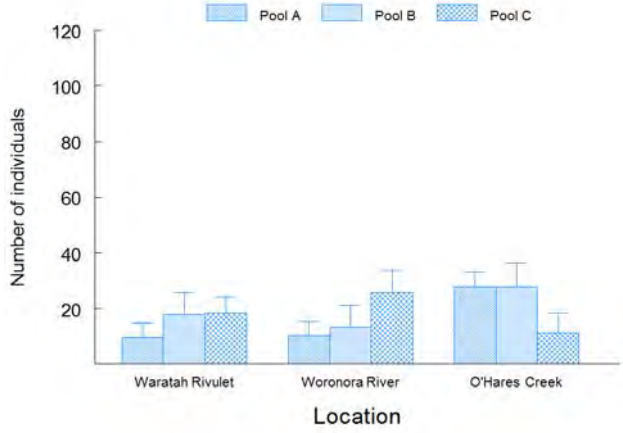


Chart 9c Mean (+SE) Macroinvertebrate Abundance, Smaller Pools, Spring 2010

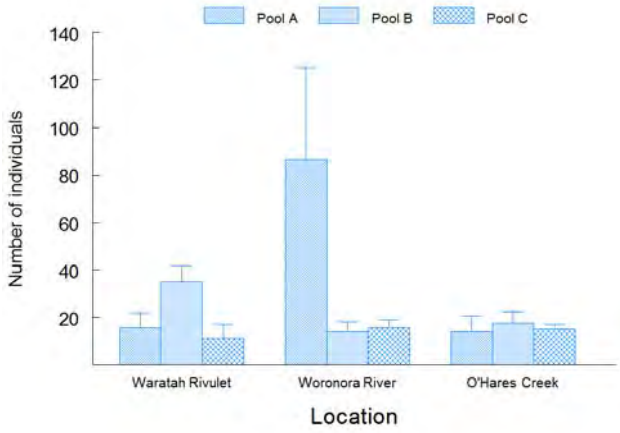


Chart 9d Mean (+SE) Macroinvertebrate Abundance, Smaller Pools, Autumn 2011

Note: Pools A, B and C on Waratah Rivulet represent Pools K, L and M, respectively (n = 3).

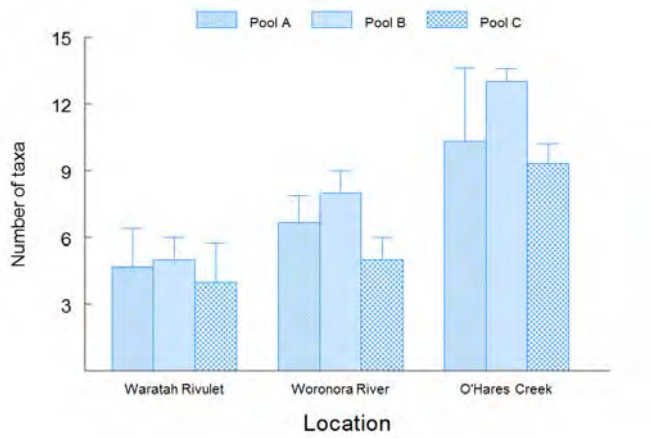


Chart 10a Mean (+SE) Macroinvertebrate Diversity, Smaller Pools, Spring 2009

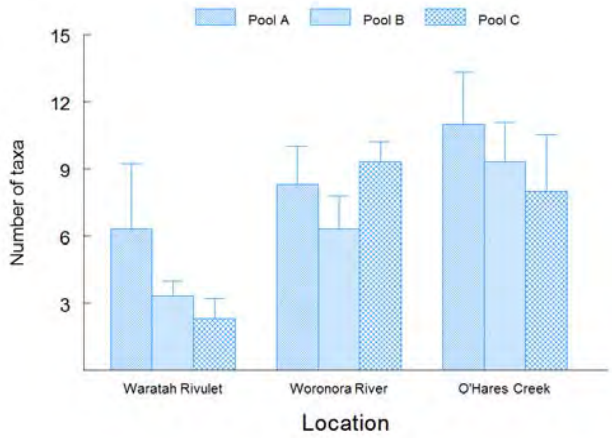


Chart 10b Mean (+SE) Macroinvertebrate Diversity, Smaller Pools, Autumn 2010

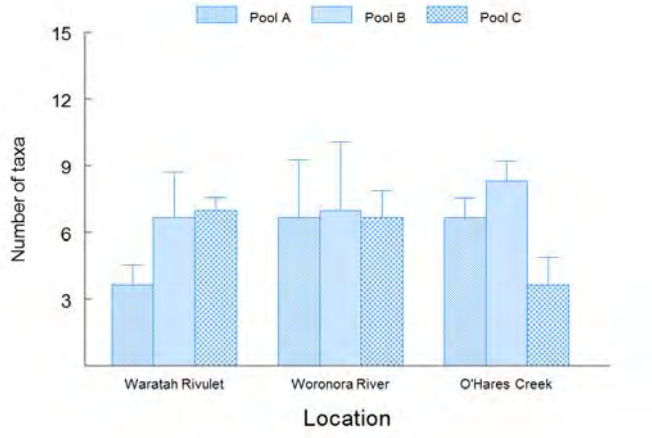


Chart 10c Mean (+SE) Macroinvertebrate Diversity, Smaller Pools, Spring 2010

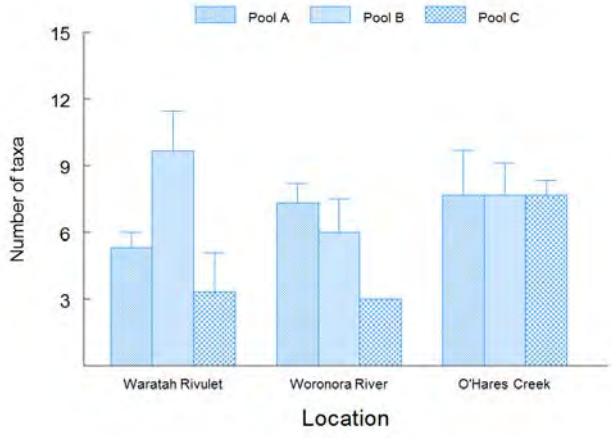


Chart 10d Mean (+SE) Macroinvertebrate Diversity, Smaller Pools, Autumn 2011

Note: Pools A, B and C on Waratah Rivulet represent Pools K, L and M, respectively (n = 3).

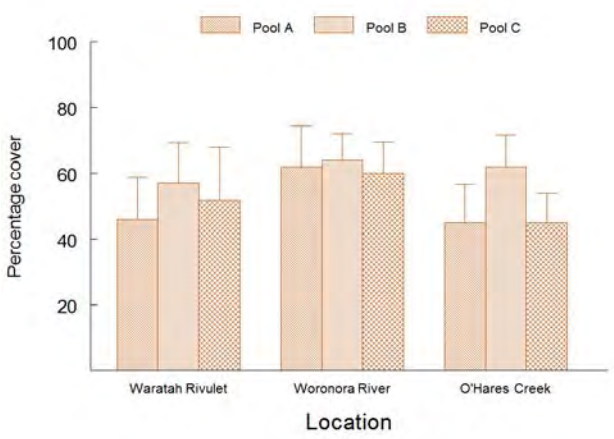


Chart 11a Mean (+SE) Macrophyte Percentage Cover, Smaller Pools, Spring 2009

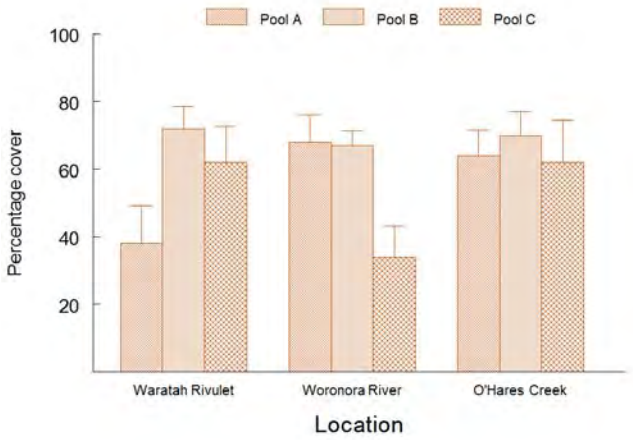


Chart 11b Mean (+SE) Macrophyte Percentage Cover, Smaller Pools, Autumn 2010

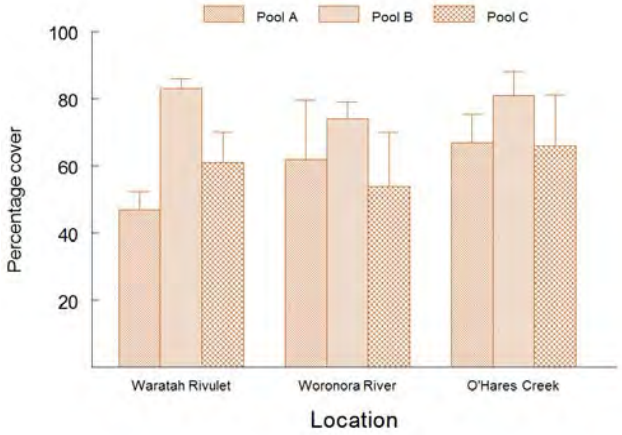


Chart 11c Mean (+SE) Macrophyte Percentage Cover, Smaller Pools, Spring 2010

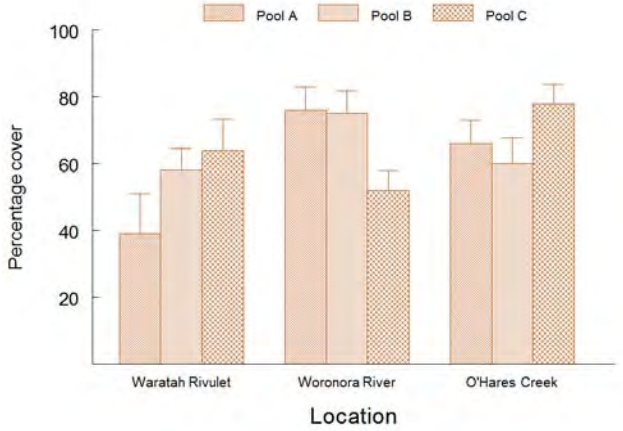


Chart 11d Mean (+SE) Macrophyte Percentage Cover, Smaller Pools, Autumn 2011

Note: Pools A, B and C on Waratah Rivulet represent Pools K, L and M, respectively (*n* = 5).

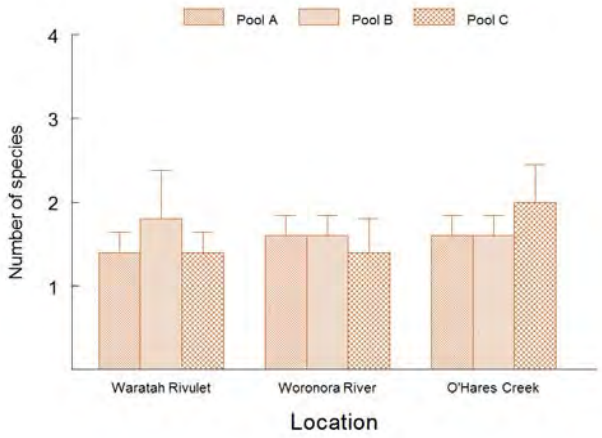


Chart 12a Mean (+SE) Macrophyte Diversity, Smaller Pools, Spring 2009

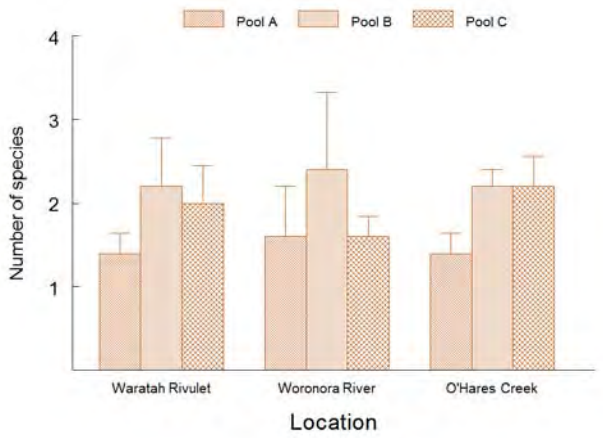


Chart 12b Mean (+SE) Macrophyte Diversity, Smaller Pools, Autumn 2010

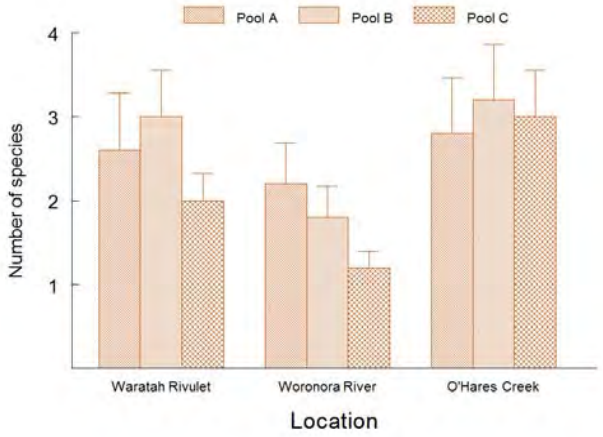


Chart 12c Mean (+SE) Macrophyte Diversity, Smaller Pools, Spring 2010

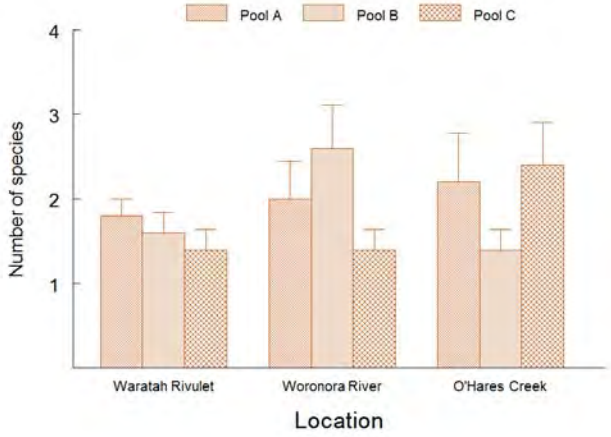


Chart 12d Mean (+SE) Macrophyte Diversity, Smaller Pools, Autumn 2011

Note: Pools A, B and C on Waratah Rivulet represent Pools K, L and M, respectively (*n* = 5).

Amphibian Surveys

A monitoring program has been developed for Longwalls 20-22 to monitor amphibian species, with a focus on the habitats of the Giant Burrowing Frog (*Heleioporus australiacus*) and Red-crowned Toadlet (*Pseudophryne australis*) associated with tributaries. Monitoring has been conducted in spring/summer 2009 and spring/summer 2010.

Six sites overlying Longwalls 20-22 and six control sites will be surveyed annually in spring/summer (i.e. October to February) during suitable weather conditions. The approximate locations of the sampling sites are shown on Figure 6. Each site is surveyed once during a standard one hour general area day search (early morning and late afternoon) supplemented by an evening 60 minute search/playback session using hand held spotlights and head lamps.

Species are assigned to the following relative abundance categories for tadpole and adult stages:

- 0 = no sightings;
- 1 = one sighting of adult or tadpole stage;
- UC = uncommon (i.e. 2 to 10 individuals), adult or tadpole stage;
- MC = moderately common (i.e. 11 to 20 individuals), adult or tadpole stage;
- C = common (i.e. 21 to 40 individuals), adult or tadpole stage; and
- A = abundant (>40 individuals), adult or tadpole stage.

The results of the two surveys to date (2009/2010) are presented in Table 2.

The Red-crowned Toadlet was observed at five test sites (sites 2 to 6) in spring/summer 2010 compared with three test sites (sites 2 to 4) in spring/summer 2009 and at three control sites (sites 10 to 12) in spring/summer 2010 compared with two test sites (sites 9 and 10) in spring/summer 2009. The Giant Burrowing Frog was not recorded during the 2010 survey (compared to 1 tadpole at site 10 during the 2009 survey).

Chart 13 shows the number of species recorded at each site in 2009 compared to 2010. A higher number of species was recorded at sites 1, 3, 7, 8, 11 and 12, and a lower number of species was recorded at sites 4, 5, 6, 9 and 10, in 2010 compared with 2009.

Chart 14 shows the number of sites at which each species was recorded during the 2009 and 2010 surveys.

These data reflect an expected variability across sites and years. A portion of the variability is likely associated with survey weather conditions at the time or in the weeks preceding the surveys. The year 2009 was a very dry year, whereas 2010 was a much wetter year and more free surface water and damp micro-habitat areas were present across the survey area than in 2009. In 2010 daytime temperatures were generally milder and night-time temperatures during evening surveys were lower which may have affected frog calling behaviour. Based on the results of the surveys of longwall and control sites to date, amphibian species diversity and abundance are consistent with expected population variations and cycles in response to seasonal variations.

In summary, the amphibian surveys identified the following:

- Six test sites are located above Longwalls 20-22, however only one site (site 1) had been undermined at the time of the spring/summer 2010 survey.
- Ten amphibian species were located across the survey area including seven in test sites and seven in control sites.
- No amphibians were located at control site 9.
- Species diversity across sites varied from 0-7.
- Three frog species located at control sites were not located in test sites. Three frog species were located in test sites but not at control sites.
- Three frogs not located in the 2009 survey were located in the 2010 survey.
- Breeding events were identified for six species located in test sites and five species located in control sites.

The amphibian species diversity and abundance data are consistent with expected population variations and cycles in response to seasonal variations.

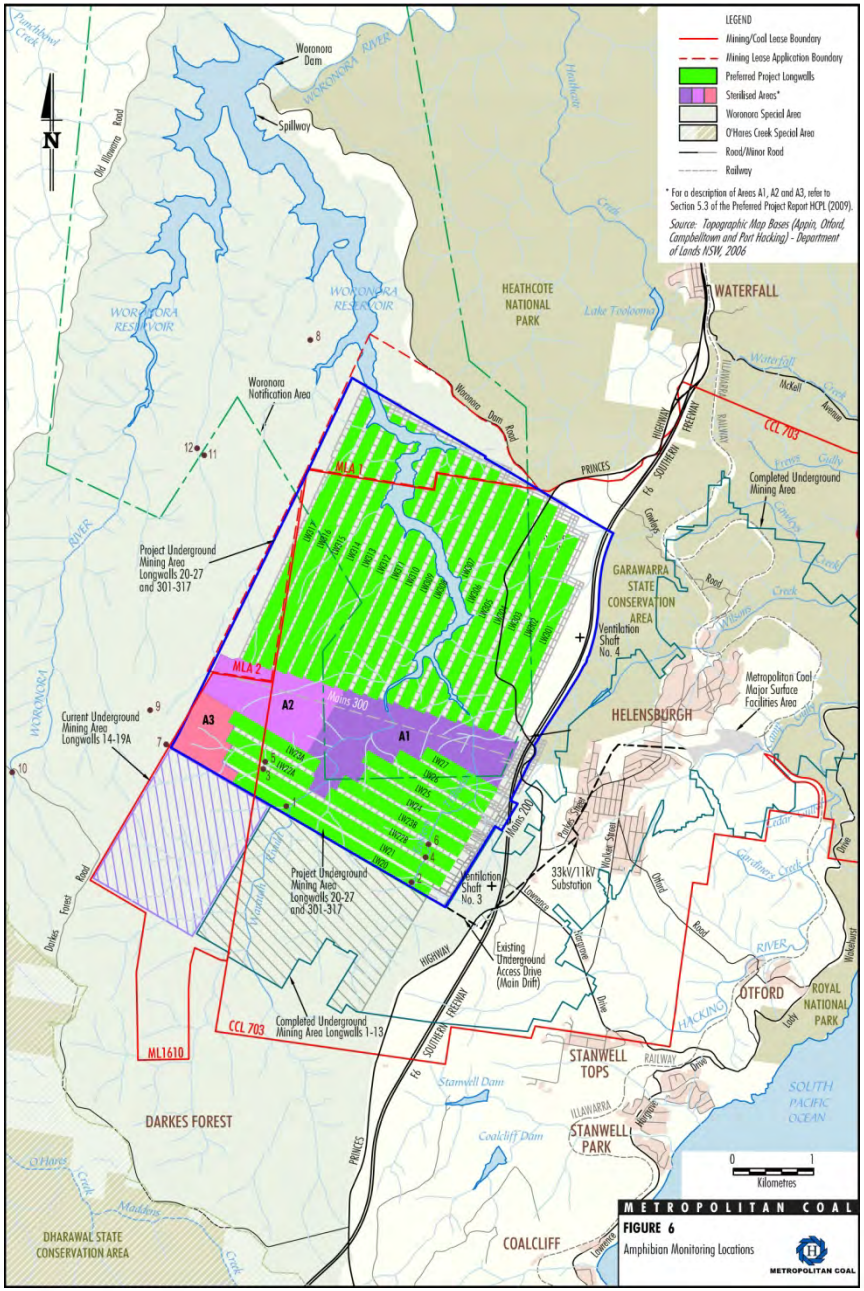


Chart 13 Amphibian Species Diversity, 2009 and 2010

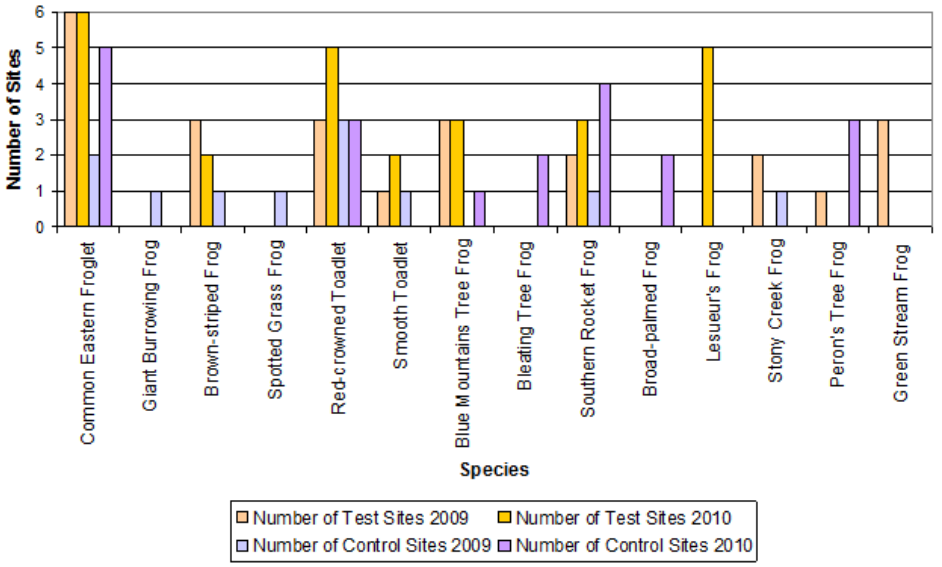


Chart 14 Number of Sites per Species, 2009 and 2010

Table 2
Amphibian Species Diversity and Abundance, Spring/Summer 2009 and 2010

Scientific Name	Common Name	Survey	Sites Above Longwalls 20-22						Control Sites						Total		Relative Abundance[2]	
			1	2	3	4	5	6	7	8	9	10	11	12	Test	Control	Test	Control
Myobatrachidae																		
Crinia signifera	Common Eastern Froglet	2009	1[1] 0	1 0	1 0	>10 0	2 0	1 0	1 0	0 0	0 0	5 >10	0 0	0 0	>16 0	6 >10	MC MC	U MC
		2010	3 0	4 0	3 c100	2 0	3 0	5 0	4 0	3 0	0 0	4 c200	1 27	2 6	20 c100	14 c233	MC A	MC A
Heleiporus australiiacus	Giant Burrowing Frog[V, V]	2009	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 1	0 0	0 0	0 0	0 1	0 0	0 1
		2010	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Limnodynastes peronii	Brown-striped Frog	2009	0 0	0 0	0 0	1 0	1 0	1 0	0 0	0 0	0 0	2 0	0 0	0 0	3 0	2 0	UC 0	UC 0
		2010	0 0	0 0	0 53	0 0	0 76	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 129	0 0	0 A	0 0
Limnodynastes tasmaniensis	Spotted Grass Frog	2009	0 0	0 0	0 0	0 0	0 0	0 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	1 0	0 0	1 0
		2010	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Pseudophryne australis	Red-crowned Toadlet[V]	2009	0 0	1 0	2 0	2 0	0 0	0 0	1 0	0 0	1 0	1 0	0 0	0 0	5 0	3 0	UC 0	UC 0
		2010	0 0	1 0	7 0	1 0	6 0	9 0	0 0	0 0	0 0	1 0	1 0	2 0	24 0	4 0	C 0	UC 0
Uperoleia laevigata	Smooth Toadlet	2009	0 0	0 0	0 0	1 0	0 0	0 0	0 0	0 0	0 0	1 0	0 0	0 0	1 0	1 0	1 0	1 0
		2010	0 0	2 0	2 10	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	4 10	0 0	UC UC	0 0
Hylidae																		
Litoria citropa	Blue Mountains Tree Frog	2009	0 0	1 0	0 0	1 0	0 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	3 0	0 0	UC 0	0 0

[1] First line of data refers to the presence or absence of adults, while the second line of data refers to absence or presence of tadpoles.

[2] Relative Abundance: 0 – no sightings, 1 – One sighting of adult or tadpole stage, UC – Uncommon, 2 to 10 individuals (adult or tadpole stage), MC – Moderately common, 11 to 20 individuals (adult or tadpole stage), C – Common, 21 to 40 individuals (adult or tadpole stage), A – Abundant, >40 individuals (adult or tadpole stage).

[V, V] Listed as vulnerable under the NSW *Threatened Species Conservation Act, 1995* and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999*.

[V] Listed as vulnerable under the NSW Threatened Species Conservation Act, 1995.

Table 2 (Continued)
Amphibian Species Diversity and Abundance at Test Sites, Spring/Summer 2009 and 2010

Scientific Name	Common Name	Survey	Sites Above Longwalls 20-22						Control Sites						Total		Relative Abundance[2]	
			1	2	3	4	5	6	7	8	9	10	11	12	Test	Control	Test	Control
Hylidae (cont.)																		
Litoria citropa	Blue Mountains Tree Frog	2010	4 0	0 0	3 4	0 0	2 0	0 0	0 0	0 0	0 0	1 0	0 0	0 0	9 4	1 0	UC UC	1 0
Litoria dentata	Bleating Tree Frog	2009	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
		2010	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	3 0	3 15	0 0	0 0	6 15	0 0	UC MC
Litoria freycineti	Southern Rocket Frog	2009	0 0	0 0	0 0	0 0	5 0	1 0	0 0	0 0	0 0	2 0	0 0	0 0	6 0	2 0	UC 0	UC 0
		2010	3 0	1 8	2 0	0 0	0 0	0 0	1 0	0 c1000	0 0	4 38	0 0	1 3	6 8	6 c1041	UC UC	UC A
Litoria latopalmata	Broad-palmed Frog	2009	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
		2010	0 0	0 0	0 0	0 0	0 0	0 0	0 c500	0 0	0 0	0 0	0 c500	0 0	0 0	0 c1000	0 0	0 A
LItoria lesueurii	Lesueur's Frog	2009	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
		2010	0 42	2 0	0 10	2 0	0 0	4 0	0 0	0 0	0 0	0 0	0 0	0 0	8 52	0 0	UC A	0 0
Litoria wilcoxii	Stony Creek Frog	2009	0 0	10 0	0 0	0 0	3 0	0 0	0 0	0 0	0 0	4 2	0 0	0 0	13 0	4 2	MC 0	UC UC
		2010	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Litoria peronii	Peron's Tree Frog	2009	0 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	1 0	0 0	1 0	0 0
		2010	0 0	0 0	0 0	0 0	0 0	0 0	3 c1000	0 0	0 0	2 0	0 0	2 0	0 0	7 c1000	0 0	UC A

[1] First line of data refers to the presence or absence of adults, while the second line of data refers to absence or presence of tadpoles.

[2] Relative Abundance: 0 – no sightings, 1 – One sighting of adult or tadpole stage, UC – Uncommon, 2 to 10 individuals (adult or tadpole stage), MC – Moderately common, 11 to 20 individuals (adult or tadpole stage), C – Common, 21 to 40 individuals (adult or tadpole stage), A – Abundant, >40 individuals (adult or tadpole stage).

[V, V] Listed as vulnerable under the NSW *Threatened Species Conservation Act, 1995* and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999*.

[V] Listed as vulnerable under the NSW Threatened Species Conservation Act, 1995.

Table 2 (Continued)
Amphibian Species Diversity and Abundance at Test Sites, Spring/Summer 2009 and 2010

Scientific Name	Common Name	Survey	Sites Above Longwalls 20-22						Control Sites						Total		Relative Abundance[2]	
			1	2	3	4	5	6	7	8	9	10	11	12	Test	Control	Test	Control
Hylidae (cont.)																		
Litoria phyllochroa	Green Stream Frog	2009	0 0	0 0	0 0	2 0	1 0	>5 0	0 0	0 0	0 0	0 0	0 0	0 0	>8 0	0 0	UC 0	0 0
		2010	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Species Diversity at Each Site		2009	**1**	**5**	**2**	**6**	**5**	**5**	**3**	**0**	**1**	**7**	**0**	**0**				
		2010	**4**	**5**	**7**	**3**	**4**	**3**	**4**	**2**	**0**	**6**	**4**	**4**				
Species Diversity in all Control and all Test sites		2009													**9**	**8**		
		2010													**7**	**7**		
Species Diversity across the survey site		2009													**11**			
		2010													**10**			

[1] First line of data refers to the presence or absence of adults, while the second line of data refers to absence or presence of tadpoles.

[2] Relative Abundance: 0 – no sightings, 1 – One sighting of adult or tadpole stage, UC – Uncommon, 2 to 10 individuals (adult or tadpole stage), MC – Moderately common, 11 to 20 individuals (adult or tadpole stage), C – Common, 21 to 40 individuals (adult or tadpole stage), A – Abundant, >40 individuals (adult or tadpole stage).

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