Australia Pacific LNG Project
Supplemental information to the EIS
Aquatic Ecology - Gasfields Wet Season Survey

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Australia Pacific LNG Project

Results of the post-wet season survey

August 2010

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EXECUTIVE SUMMARY

This report presents the results of the post-wet season water quality and aquatic ecology surveys and provides a seasonal comparison between the dry season and post-wet season surveys for the Australia Pacific LNG Project. The purpose of the report is to provide additional information to support the Aquatic Ecology, Water Quality and Geomorphology Impact Assessment for the gas fields provided in Volume 5, Attachment 17 of the EIS.

Post-wet season water quality, fish and macroinvertebrate surveys were conducted during April and May, 2010. Water quality was generally found to be poor to moderate throughout the study area and the majority of sites recorded high turbidity and suspended sediment, high nutrient concentrations and high concentration of aluminium and copper.

The total number of fish species caught was similar between the dry and post-wet season surveys (12 and 11, respectively), although only seven species were caught during both surveys. Three species of conservation significance (Agassiz's glassfish, Hyrtl's tandan and Silver perch) were caught in the Condamine-Balonne catchment during the post-wet season survey, that were not caught during the dry season. These species were considered as part of the impact assessment for the EIS (refer to Volume 5, Attachment 17), so their presence does not alter the outcomes of the assessment.

Macroinvertebrate community structure was found to be similar between dry and post-wet season surveys, although taxa richness was generally lower during the post-wet season survey. With the exception of site HPE2 (Dawson River), the composition of the macroinvertebrate community generally indicated moderately degraded conditions, including high nutrients, high turbidity and poor aquatic habitat.

Overall, while the post-wet season sampling provided additional data to support the characterisation of the existing environment, nothing was observed or collected that resulted in any required amendments to the impact assessment undertaken for the EIS (refer to Volume 5, Attachment 17).

Given the dynamic nature of river systems throughout the survey region, these results only provide a snapshot of water quality and biological community structure at the time of sampling, particularly considering the seasonal extremes encountered during the survey periods. Further surveys would be required to confidently establish any seasonal and or inter-annual trends.

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1 INTRODUCTION

1.1 Background

The Environmental Impact Statement (EIS) for the Australia Pacific LNG Project was released for public comment and examination by government advisory agencies on March 29, 2010. The closing date for submissions was May 4, 2010. A technical report providing a detailed aquatic ecology, water quality, aquatic habitat and geomorphic impact assessment for the gas fields development area was submitted as Volume 5, Attachment 17 of the EIS.

Water quality and aquatic ecology data for both dry and wet season were proposed to be included as part of the EIS. However, no significant rainfall events occurred prior to submission of the EIS, so only the dry season data were reported. Australia Pacific LNG was committed to undertaking additional wet season surveys, should a sufficient rainfall event occur.

Widespread rainfall and flooding occurred throughout the Project Area in early February 2010 and then again in early March 2010. To ensure suitable site access was available and to provide sufficient time for post-flooding species recruitment, the post-wet season surveys commenced in mid April 2010.

This addendum report presents the results of the post-wet season water quality and aquatic ecology surveys and provides a seasonal comparison between the dry season and post-wet season surveys.

This report should be read in conjunction with the Aquatic Ecology, Water Quality and Geomorphology Impact Assessment for the gas fields provided in Volume 5, Attachment 17 of the EIS.

2 WET SEASON SAMPLING METHODS

2.1 Field Surveys

Post-wet season field surveys were undertaken between April 13, 2010 and May 5, 2010. A total of 19 sites were sampled, although not all variables could be sampled at each site due to different water levels and / or habitat availability. Sampling site locations are shown in Figure 2-1.

An additional six sites were dry during the sampling period. These sites were all located on the smaller (sandy bed) tributaries of the upper Border Rivers and Dawson River catchments, resulting in higher rates of infiltration than mid catchment reaches. Refer to EIS Volume 5, Chapter 17 for a detailed geomorphic description of these sites.

A summary of sampling dates and survey type for each site is provided in Table 2-1.

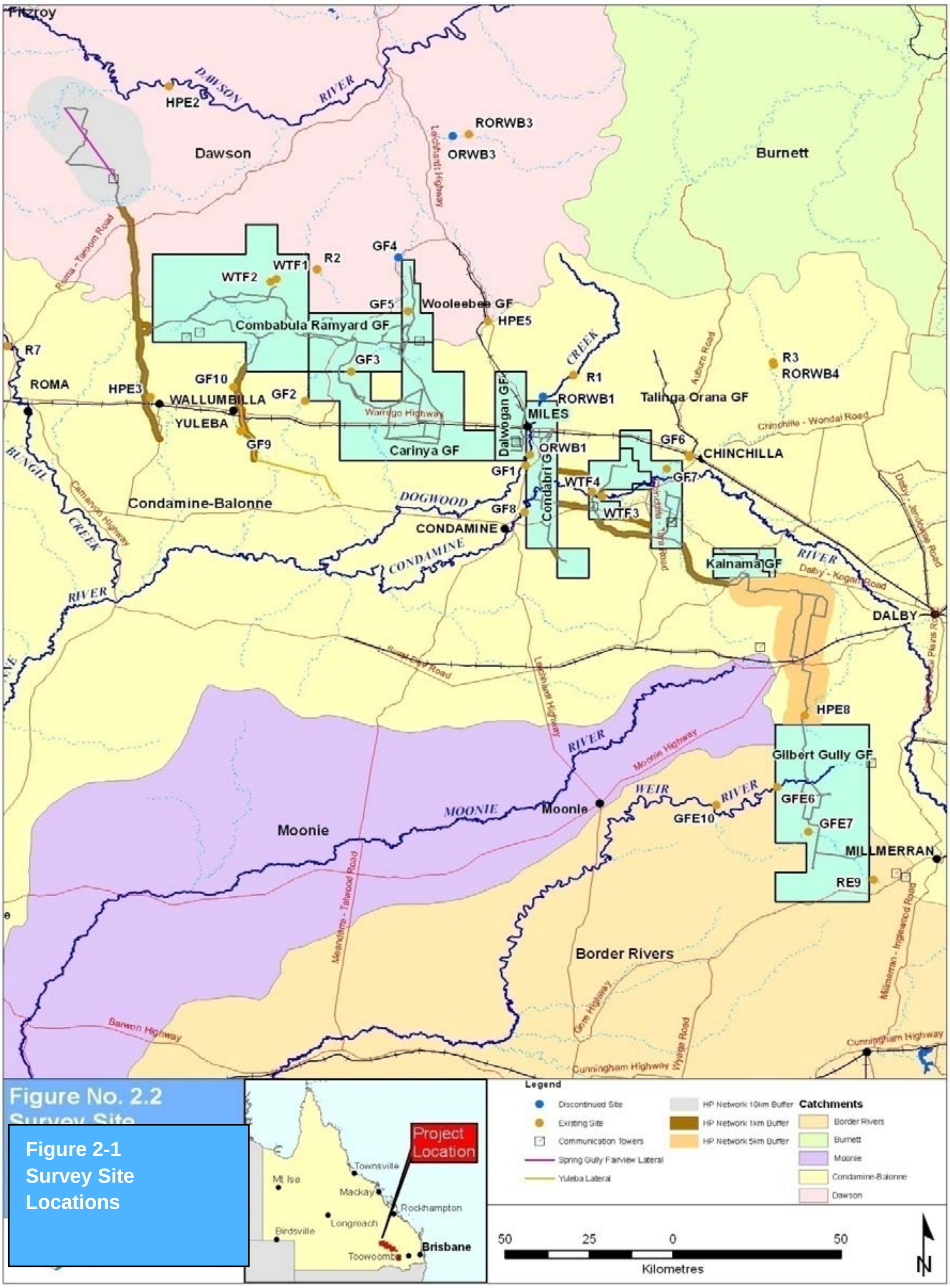

Figure 2-1 Survey Site Locations

Table 2-1 Overview of sample collection dates and survey type

Site	Waterway	Date sampled	WQ	Fish	Macro (edge)	Macro (Bed)	Comments
Border Rivers Catchment							
RE9	Western Creek	13/04/2010	Y	Y	No	Y	Electrofisher and bait traps
GFE6	Weir River	14/04/2010	No	No	No	No	Dry site
GFE7	Western Creek	14/04/2010	No	No	No	No	Dry site
GFE10	Weir River	14/04/2010	Y	Y	Y	Y	Electrofisher and bait traps
Condamine Balonne Catchment							
R3	Charleys Creek	16/04/2010	Y	Y	Y	N	Electrofisher and bait traps
RORWB4	Adjacent to Charleys Creek	16/04/2010	Y	Y	Y	Y	Eectrofisher and bait traps
GF7	Charleys Creek	17/04/2010	Y	Y	Y	No	Gill nets (15, 25, 40, 100mm), fyke net, bait traps
WTF4	Condamine River	18/04/2010	Y	Y	Y	Y	Electrofisher, fyke net, seine net, bait traps
WTF3	Condamine River	18/04/2010 and 21/04/2010	Y	Y	Y	Y	Electrofisher and bait traps on 18/04/2010, additional sampling (gill nets 25, 40, 100mm) and fyke net on 21/4
GF6	Charleys Creek	17/04/2010 and 20/04/2010	Y	Y	Y	Y	Bait traps, gill nets (15, 30mm)
ORWB1	Adjacent to Dogwood Creek	22/04/2010	Y	N	Y	No	Too shallow for fish sampling
GF1	Dogwood Creek	22/04/2010 and 23/04/2010	Y	Y	Y	No	Gill nets (25, 30, 40mm)
R7	Bungil Creek	24/04/2010	Y	Y	Y	No	Electrofisher and bait traps
GF8	Condamine River	24/04/2010 and 25/04/2010	Y	Y	Y	No	Gill nets (25, 30, 40, 50mm)
GF3	Tchanning Creek	25/04/2010	Y	Y	Y	No	Gill nets (25, 30, 50mm), bait traps
GF10	Yuleba Creek	27/04/2010	Y	Y	Y	No	Gill nets (25, 30, 50mm), bait traps
GF2	Tchanning Creek	28/04/2010	Y	Y	Y	No	Gill nets (25, 30, 50mm)
GF9	Yuleba Creek	28/04/2010	Y	Y	Y	No	Gill nets (25, 30, 35, 50mm), bait traps
R1	Dogwood Creek	29/04/2010	Y	Y	Y	No	Gill nets (30, 35, 75mm), bait traps
HPE3	Wallumbilla Creek	30/04/2010	Y	Y	Y	Y	Gill nets (25, 35mm), bait traps
Dawson Catchment							
HPE5	Juandah Creek	30/04/2010	No	No	No	No	Dry site
GF5	Wooleebee Creek	1/05/2010	No	No	No	No	Dry site
R2	Horse Creek	1/05/2010	No	No	No	No	Dry site
WTF1/2	Horse Creek	1/05/2010	No	No	No	No	Dry site
HPE2	Dawson River	5/05/2010	Y	Y	Y	Y	Gill nets (40, 75mm), bait traps, fyke net, seine net

2.2 Sample Collection, Storage and Preservation

Volume 5, Attachment 17 of the EIS contains a detailed description of sample collection, storage and preservation methods. Post-wet season sampling consisted of water quality, fish and macroinvertebrate surveys. No additional fluvial geomorphology or aquatic habitat assessments were undertaken during the post-wet season surveys. However, AUSRIVAS water quality and habitat field sheets were completed and site observations noted to provide additional information to support the water quality and aquatic ecology data collected.

In accordance with the methods used during the dry season surveys, fish sampling methods varied depending on the availability of suitable habitat at each site. Water levels were substantially higher than in 2009 at the majority of sites throughout the Condamine catchment and a canoe was frequently required to facilitate sampling. The elevated water levels precluded the use of the backpack electrofisher at most sites, so other methods such as gill netting, fyke netting and seine netting were employed, where necessary.

At some sites (e.g. WTF 3 and 4) the higher water levels enabled more habitat to be sampled, using a wider range of sampling methods. This resulted in substantially higher catches and contributed to initial delays in the field program. Subsequently, sampling techniques were adjusted (e.g. reduced set times for bait traps and nets) to ensure sampling could be completed within schedule, while still producing sufficient catches to effectively characterise fish and macrocrustacean populations.

2.3 QA/QC

A detailed description of field and laboratory QA / QC methods is provided in EIS Volume 5, Attachment 17.

A summary of QA / QC issues encountered during the post-wet season surveys is provided below.

2.3.1 Water Quality

Inter and intra-lab duplicates were collected at 10% of sites. Field blanks and trip blanks were also collected. Normal laboratory duplicates, method blanks, single control spikes and duplicate control spikes were run for each analysis batch. All laboratory quality control measures were checked against the certificate of analysis to ensure data were within certified limits.

Some QA / QC issues encountered were easily resolved by re-analysis of retained samples. However, a number of issues were encountered for the post-wet season survey that were unable to be resolved.

A number of samples breached laboratory holding times. The reasons for these breaches are summarised below. Results that exceeded laboratory holding times are highlighted in red in Appendix 1.

- Samples collected for the analysis of TDS and TSS breached laboratory holding times for a number of sites (refer to Appendix 1). Australian Laboratory Services (ALS) requires samples to be delivered with at least 50 % of the holding time remaining. ALS was responsible for the breach of holding time on six sites. However, due to delays in transit between site and laboratory, a number of samples were received with <50 % of the holding time remaining.

- Samples collected for sites GF8, R1, GF1, ORWB1, GF3, GF2, and R7 spent considerable time in transit and were not received by the laboratory in sufficient time to analyse some parameters (i.e. TDS, TSS, major ions, FRP, pesticides and hydrocarbons) within recommended laboratory holding times. Given the scale of the holding time breach (8 sites), the data have not been discarded. However, data should be interpreted with caution.

- A number of holding time breaches for FRP were recorded by the laboratory, which was based on a 48 hour holding time. All nutrient samples were frozen in the field and delivered to the laboratory in eskies packed with ice. The majority of samples were delivered to the laboratory within 24 hours of despatch, so were presumed to be within the required holding times. However, one batch of samples was considerably delayed in transit (see above) and FRP samples had defrosted more than 48 hours prior to delivery.

- The conductivity readings for R7 and GF10 recorded during the post-wet season survey were more than double those recorded in the dry season surveys. It was suspected that these may have been recorded incorrectly in the field.

Similarly to the dry season survey, a number of sites recorded elevated TPH concentrations in the post-wet season survey. However, as with the dry season survey, all TPH results were less than detection following an additional silica gel cleanup in the laboratory, again indicating that any TPH present was likely to have resulted from natural, biogenic sources.

2.3.2 Macroinvertebrates

Laboratory QA / QC checks were undertaken on 10 % of field collected residues. In accordance with the Queensland sampling and monitoring manual (DERM 2009), error rates in intra-laboratory QA / QC of greater than 10% are considered unacceptable. However, there is no guideline on the acceptability of error rates in residue samples compared to those live picked in the field. There were between 2 and 12 additional taxa in residue samples compared to their associated live-pick sample. Some of the taxa are small and/or cryptic (e.g. Nematoda, Oligochaeta, Acarina, Tipulidae and Ephydridae) and are more difficult to collect in live picked samples. Others (such as Simuliidae and Glossiphoniidae) were present at low abundance and consequently had a very low probability of them being detected in the field. Anisoptera juveniles were present in two residues, but this was of little consequence as immature stages are excluded from most analyses, including AUSRIVAS.

For two of the three samples evaluated, the effectiveness of live-picking was judged to have little potential to influence the assessment of macroinvertebrate condition at the site. However, for site WTF4, the whole sample estimate contained an additional eight families to the live-pick sample. Given that the additional families have differing environmental requirements, this could result in the site being assessed as being in poorer condition than it actually was. Therefore, the wet season results for site WTF4 should be interpreted with caution.

3 WET SEASON SAMPLING RESULTS

This section provides the results obtained during the post-wet season field surveys as compared to the dry season surveys for water quality, fish and macrocrustaceans and macroinvertebrates.

3.1 Water Quality

3.1.1 Overview

Water quality samples were collected at 19 sites during the post-wet season survey. Raw water quality data[1] and column charts comparing the two dry season (Dry 1 and Dry 2) and single post-wet season (Wet) surveys are provided in Appendix 1.

Data were compared to relevant ANZECC / ARMCANZ (2000) and Queensland Water Quality Guidelines (QWQG) (EPA 2009) (Appendix 1). Further details are provided in EIS Volume 5, Attachment 17.

In general, water quality was similar between sampling occasions with the majority of sites recording high turbidity and suspended solids, high total nitrogen and phosphorus, low to moderate conductivity and low dissolved oxygen. Dissolved copper and aluminium concentrations were also elevated, with most sites exceeding the ANZECC / ARMCANZ (2000) 95 % Protection Limit guidelines. Dissolved manganese and boron concentrations were within the 95 % protection levels at all sites.

Temperature was higher at all sites during the post-wet season survey. This is likely to be a reflection of the ambient air temperatures at the time of sampling (i.e. early autumn 2010, compared to winter and early spring in 2009).

Pesticides were less than detection at all sites on all sampling occasions. A number of sites recorded TPH concentrations in both dry and post-wet season surveys. However, these were all found to be less than detection following a silica gel cleanup carried out in the laboratory. This indicates that any TPH present was likely to have resulted from natural biogenic sources (refer to EIS Volume 5, Attachment 17 for additional information).

Given the presence of intensive agriculture throughout the catchments, concentrations of pesticides would be expected to be higher immediately following runoff events. The lack of detectable concentrations of pesticides in the post-wet season survey is possibly a reflection of the lag time between the flooding events and sampling (approximately one month) and associated physical and chemical pesticides degradation processes (e.g. volatilisation, adsorption to soil particles, photodegradation etc).

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[1] Note: no data are presented for hydrocarbons or pesticides as all were below laboratory detection limits.

3.1.2 Condamine-Balonne

Conductivity was within the ANZECC / ARMCANZ (2000) for the majority of sites within the Condamine-Balonne catchment during the post-wet season survey. As mentioned previously, conductivity at sites R7 (Bungil Creek), GF10 and GF9 (Yuleba Creek) exceeded the ANZECC / ARMCANZ (2000) (1028, 752 and 440 µs/cm, respectively). It is suspected that the conductivity readings for R7 and GF10 may have been recorded incorrectly in the field as these were more than double those recorded in both dry season surveys.

pH marginally exceeded the ANZECC / ARMCANZ (2000) guideline at a number of sites in the Condamine-Balonne catchment (GF6- Charleys Creek, WTF3 and WTF4 – both on Condamine River and GF9 – Yuleba Creek) and was high (>8 units) at sites GF8 and HPE3. These sites recorded similarly elevated pH levels during the dry season surveys. The off river waterbody RORWB4 (adjacent to Charleys Creek) recorded the lowest pH level (6.02) of any site sampled during the post-wet season survey, which was considerably lower than the pH recorded in the dry season surveys. This may be because of reduced concentrations of phytoplankton and / or the addition of humic material following recent inflows.

Turbidity was generally lower throughout the Condamine-Balonne catchment during the post-wet season survey than in the dry season, although the majority of sites still had very high turbidity levels. Sites GF10 and GF2 (Tchanning Creek) recorded the highest turbidity (341 and 370 NTU, respectively).

There was a reasonably well-balanced mix of cations and anions throughout the Condamine-Balonne catchment with a slight predominance of bicarbonate over chloride. Similar results were recorded for the dry and post-wet season surveys (Figure A1-8 in Appendix 1).

Dissolved oxygen concentrations were less than the ANZECC / ARMCANZ value of 90 % at all sites in the Condamine – Balonne catchment with the exception of GF6 (Charleys Creek), GF8 (Condamine River) and HPE3 (Wallumbilla Creek). The additional inputs of sediment and organic matter from recent inflows and elevated antecedent temperatures may have led to increased oxygen demand and reduced solubility. This is likely to have contributed to the reduced dissolved oxygen concentrations recorded during the post-wet season survey.

Total nitrogen and total phosphorus exceeded the ANZECC / ARMCANZ guideline at all sites during the post wet season survey. However, all nutrient components were, in general, recorded in lower concentrations than those recorded during the dry season. A higher proportion of phosphorus was present as FRP at the majority of sites during the post-wet season survey. This is surprising given the recent inflows as it would be expected that the majority of phosphorus in surface runoff would be present in particulate form attached to soil particles. This indicates that internal processes were responsible for the release of dissolved phosphorus from sediments and were contributing substantially to the phosphorus pool during the warmer months.

Concentrations of dissolved aluminium and copper exceeded ANZECC / ARMCANZ (2000) 95 % protection limits for most sites within the Condamine-Balonne catchment, and there did not appear to be a seasonal pattern. Site GF7, located on Charleys Creek recorded the highest concentrations of total metals of all sites sampled, although only a small proportion of these were present in dissolved form. This was consistent with data recorded during the dry season surveys.

3.1.3 Dawson

Two gasfield sites, HPE2 (Dawson River) and GF5 (Wooleebee Creek), were sampled in the dry season survey, while only HPE2 was sampled in the post-wet season survey (as GF5 was dry). Conductivity marginally exceeded QWQG at site HPE2 (358 µs/cm). pH, turbidity and dissolved oxygen were also slightly outside QWQG. HPE2 is a spring fed site and the relatively low conductivity and TDS (and low concentrations of other dissolved constituents) recorded at HPE2 during the dry and wet season surveys may indicate that the water is associated with shallow aquifers.

The concentration of total nitrogen was considerably lower during the post-wet season survey and was within QWQG. A higher proportion of dissolved inorganic nitrogen (ammonia, nitrate + nitrite) was present during the post-wet season survey, in comparison with the dry season survey. Total phosphorus exceeded QWQG, although the majority was present in particulate form suggesting that catchment runoff (as opposed to groundwater) was the main nutrient contributor during the post-wet season survey.

Samples were not collected for metals analysis at site HPE2 during any surveys as this site was selected to assess potential impacts associated with the high pressure pipeline connecting Spring Gully to Fairview. Metals were only analysed at sites that could be potentially impacted by other gasfields operations.

3.1.4 Border-Rivers

No Border Rivers sites were sampled in the dry season as all sites were dry. Two sites (RE9-Western Creek and GFE10 – Weir River) were sampled in the wet season. Conductivity was within ANZECC / ARMCANZ guidelines at both sites (RE9 and GFE10) sampled during the post-wet season survey. pH exceeded QWQG at RE9 (8.71). The reason for the elevated pH at this site is not apparent.

Turbidity was high at GFE10 on the Weir River (234 NTU). There was evidence of the recent very high flood flows with debris deposited at a height of 5-6m in trees. The site was still flowing at the time of sampling which may be contributing to sediment resuspension at this site.

Dissolved oxygen was slightly less than the ANZECC / ARMCANZ guideline at GFE10 (86.3 %). The additional inputs of sediment and organic matter from recent inflows and elevated temperatures may have contributed to the slightly reduced dissolved oxygen concentrations recorded at this site.

Nutrient concentrations were generally low at site RE9. Total phosphorus exceeded the ANZECC / ARMCANZ guideline at this site, but all other nutrient parameters were within the guideline values. Ammonia, total nitrogen and total phosphorus exceeded the ANZECC / ARMCANZ guideline at site GFE10, although were generally present in lower concentrations than those recorded in the Condamine-Balonne catchment.

Dissolved aluminium exceeded the 95 % protection limits at both sites during the post-wet season survey. Dissolved copper exceeded the 95 % protection limit at RE9. All other metal concentrations were low.

3.2 Fish and Macrocrustaceans

3.2.1 Fish

3.2.1.1 Overview

A total of 13 native and three non-native fish species were collected from gasfield sites during the dry season and post-wet season survey periods. While the total number of species collected during the dry season and wet season were similar (12 and 11, respectively), only seven species were in catches from both surveys (Table 3-1). Raw catch data for each site are included in Appendix 2.

Native fishes were the dominant component in both dry season and wet season catches, representing 88 % and 93 % of the total catches respectively (Appendix 2).

Table 3-1 Summary of fish catch data for post-wet season and dry season surveys from gasfield sites

		Condamine		Border Rivers		Dawson	
	number of sites surveyed	14		2		2 dry/1wet	
native species	common name	dry	wet	dry	wet	dry	wet
Nematolosa erebi	Bony bream	147	482	x	1		
Hypseleotris spp.	Gudgeon species	1333	423	x		2	
Hypseleotris sp. 1	Midgeley's carp gudgeon			x	1		
Philypnodon grandiceps	Flathead gudgeon	2		x			
Melanotaenia fluviatilis	Crimson-spotted rainbowfish	3	11	x			9
Macquaria amb. ambigua	Yellowbelly perch	15	1	x		1	
Retropinna semoni	Australian smelt	139		x			
Leiopotherapon unicolor	Spangled perch	23	161	x	56		6
Ambassis agassizii	Agassiz's glassfish		18	x			
Neosilurus hyrtlii	Hyrtl's tandan		22	x			
Tandanus tandanus	Freshwater tandan			x		1	
Bidyanus bidyanus	Silver perch		4	x			
Pseudomugil signifer	Pacific blue-eye			x		1	
non-native species				x			
Carassius auratus	Goldfish	94		x	1		
Cyprinus carpio	Common carp	4		x			
Gambusia holbrooki	Eastern gambusia	133	83	x	5		

Note: x sites not sampled in dry season

The high numbers of gudgeons collected during the dry season survey (mostly from an off river water body (RORWB4- adjacent to Charleys Creek) reflects the value of these sites as refugia and, in part, the seasonal concentration of fishes in a drying habitat. In the dry season surveys, 1272 fish from four species were collected from this site, of which 93 % were gudgeons. In the post-wet season surveys only 124 fish from two species were collected, of which 85 % were gudgeons.

The increased representation in catches of Bony bream (*N. erebi)* and Spangled perch (*L. unicolor)* in wet season catches compared to those of dry season catches may reflect wet season recruitment, as the majority of these fishes were juveniles. Spangled perch recruitment, as opposed to spawning, is much greater in years with a significant wet season flood due to the increase in habitat and food availability during such events (Pusey *et al.* 2004). Bony bream are also capable of rapid population recovery after flood dispersal. In the Burdekin River in 1991, after cyclonic rains, Bony bream populations recovered almost to pre-flood levels within 12 months through immigration and primarily by production (Pusey *et al.* 2004).

3.2.1.2 Condamine-Balonne

A total of 10 native species were collected from 14 sites in the Condamine-Balonne catchment during the dry season and post-wet season surveys. Five species were collected during each survey. Two species (Flathead gudgeon and Australian smelt) were collected only during the dry season survey, while three species of conservation significance (Agassiz's glassfish, Hyrtl's tandan and Silver perch) were only collected during the wet season survey (Table 3-1-). EIS Volume 5, Attachment 17 provides a description of the habitat requirements, sensitivity and conservation significance of these species. No Murray cod were caught during any of the surveys.

Agassiz's glassfish were collected during the wet season survey in low numbers from two sites (GF7 and R3, both on Charleys Creek). Hyrtl's tandan were also caught in low numbers from sites GF1 (Dogwood Creek), WTF4 (Condamine River) and GF7 (Charleys Creek). Two specimens of Silver perch were collected from each of two sites (GF9- Yuleba Creek and GF1). These species are relatively uncommon, or occur in only a few sites where habitat may be suitable. The presence of these species in the post-wet season surveys is likely to, in part, reflect the different sampling methods used compared to the dry season surveys. However, in view of the highly variable nature of the flow regimes of these river systems, longer term monitoring is required to provide a fuller appreciation of the status of these populations.

Gudgeons were the dominant native species (70 %) in dry season catches, while Bony bream (40 %), Gudgeon species (35 %) and Spangled perch (13 %) were dominant native species in the post-wet season catches.

The native Australian smelt (*R. semoni)* was collected from seven sites in the Condamine-Balonne catchment in the dry season surveys, but none were collected during the post-wet season surveys. The absence of smelt from all gasfield sites in the post-wet season surveys may be due to a combination of factors, including downstream flushing and impacts of increased wet season turbidity. According to Pusey *et al*. (2004), the species is generally very common in south-eastern Queensland rivers and occurs in a wide range of stream habitats and flow regimes, but is more common in deeper, slow moving or intermittent pools. The species can tolerate a wide range of water quality conditions (Hume *et al*. 1983; Harris and

Gehrke 1997), although Tunbridge, in Doeg and Koehn (1994) reported mortalities in the Thomson River following elevated levels of suspended sediments.

Three non-native species (Goldfish (*C. auratus*), Common carp (*C. carpio*) and Eastern gambusia (*G. holbrooki*)) were collected from 14 gasfield sites within the Condamine catchment during both the dry and post-wet season surveys. In the dry season surveys, Goldfish were a dominant catch component at sites GF10 and R1 (Dogwood Creek) (40% and 47%, respectively) and Eastern gambusia were a dominant catch component at sites GF8 and WTF4 both located on the Condamine River (23% and 32%, respectively). No Goldfish were collected during the post-wet season surveys. Common carp were collected in very low numbers from two sites (GF3 – Tchanning Creek and GF7 – Charleys Creek) in the dry season, while none were collected during the post-wet season surveys.

3.2.1.3 Border Rivers

No Border Rivers sites were sampled in the dry season as all sites were dry. Two sites (RE9 – Western creek and GFE10 – Weir River) were sampled in the wet season with low species richness (two and four species, respectively) and abundance (25 and 39, respectively) recorded. The dominant species as a proportion of catches at both sites in the wet season survey was Spangled perch (96 % and 82 %, respectively).

Non-native species were a minor catch component from site GFE10 with one Common carp and five Eastern gambusia collected. No non-native fish were collected from site RE9. The low numbers of species and small catch sizes in the wet season surveys probably reflect a slow recovery rate in fish populations with the absence of intermittent pools in the dry season to act as refuges for resident populations. No listed species known from the Murray-Darling system were collected from the two sites surveyed in the wet season.

3.2.1.4 Dawson River

Two gasfield sites, HPE2 (Dawson River) and GF5 (Wooleebee Creek), were surveyed in the dry season and only the HPE2 site was surveyed in the wet season (as GF5 was dry). Four native species (Gudgeon species, Fitzroy yellowbelly (*M. ambigua oriens*), Freshwater catfish (*T. tandanus*) and Pacific blue-eye (*P. signifer*)) were collected from HPE2 during the dry season surveys, but all were collected in low numbers (≤2). No fish were collected from GF5 during the dry season surveys.

Three native species (Bony bream, Crimson-spotted rainbowfish and Spangled perch) were collected from HPE2 in the wet season surveys, but all were collected in low numbers (≤9). No non-native fishes were collected from this site during any of the surveys.

The only species of conservation significance known from the Dawson River system and collected from HPE2 were the Fitzroy yellowbelly (dry season) and the Crimson-spotted rainbowfish (wet season). EIS Volume 5, Attachment 17 provides a description of the habitat requirements, sensitivity and conservation significance of the Fitzroy yellowbelly.Recent, as yet unpublished, DNA studies of Queensland rainbowfishes indicate that the Dawson River rainbowfish population, previously classified as the more-widely distributed eastern rainbowfish, *Melanotaenia splendida splendida*, is *M. fluviatilis,* the Crimson-spotted rainbowfish, but with some introgression from *M. splendida.* (P. Unmack, Brigham Young

University, *pers. comm.*). *M. fluviatilis* was previously considered to occur only in the Murray-Darling system (Lintermans 2009). While its final taxonomic status is yet to be confirmed, the Dawson River population represents a locally distinct genotype of a regional endemic and has therefore been included as a species of conservation significance.

3.2.2 Macrocrustaceans

A total of four macrocrustacean species[2] (freshwater prawns and yabbies) were collected during the dry season and post-wet season surveys (Table 3-2). *Macrobrachium* prawns were the dominant total catch component compared with crayfish in both dry season and wet season surveys (68% and 82% respectively). Raw catch data for each site sampled are included in Appendix 2.

Table 3-2 Summary of macrocrustacean species and catch sizes for post-wet season and dry season surveys from gasfield sites

Species		Condamine		Border Rivers		Dawson	
	Number of sites surveyed	14	14	x	2	2	1
	Common name	Dry	Wet	Dry	Wet	Dry	Wet
Macrobrachium sp.	prawn sp.			x		65	
Macrobrachium australiense	Australian river prawn		93	x	15		27
Cherax sp.	crayfish sp.	5		x			
Cherax quadricarinatus	redclaw	15		x		10	
Cherax destructor	yabby		22	x	8		

Note: x = no sites surveyed in dry season

The total catch of *Macrobrachium* prawns and freshwater crayfish for the wet season surveys was markedly higher than that for the dry season surveys. All of the *Macrobrachium* in the dry season surveys were collected from the Dawson River (site HPE2) with no specimens collected from Condamine-Balonne sites. The absence of prawns from Condamine-Balonne sites during the dry season surveys may reflect reduced activity during the winter months or dispersal away from drying pools. The presence of prawns during the wet season surveys is likely to be a result of reproductive recruitment during spring and summer months (Lee and Fielder 1982, 1984; Cook *et al*. 2002).

Crayfish were collected in similar numbers between survey periods, but from more sites during the wet season surveys compared with the dry season. In drying habitat and lower water temperatures, crayfish can survive within their burrows for extended periods and, under extreme conditions, enter a state of dormancy (Jones and Obst 2000). Therefore, crayfish may not have been available for trapping at the majority of sites during the dry season survey.

[2] Note: *Macrobrachium* spp. And *Macrobrachium australiense* have been included as one species.

3.3 Macroinvertebrates

3.3.1 Overview

Macroinvertebrate samples were collected from 19 sites during the post-wet season survey. Edge samples were collected from 18 sites, while composite bed samples were collected from only eight sites (due to variable water depths and habitat availability) (Table 2-1). Raw macroinvertebrate data and supporting figures are provided in Appendix 3. Comparisons between dry season and post-wet season surveys are provided for the following: functional feeding groups and SIGNAL2 scores (edge data only) and flow and substrate preference groups (composite bed data only). Further details are provided in EIS Volume 5, Attachment 17.

Taxa richness ranged between 12 and 29 across all sites from edge samples collected during the post-wet season surveys, compared to 13 and 35 during the dry season surveys. Comparisons between dry and post-wet season surveys were difficult, as a large number of sites that were sampled during the post-wet season, were dry or had insufficient habitat to sample during the dry season. For sites that were able to be compared, taxa richness was lower at most sites during the post-wet season surveys (Table 3-3), which is possibly a result of increased macroinvertebrate flushing /drift following the recent floods and lack of time for post-flooding recruitment.

Plecoptera-Ephemeroptera-Trichoptera (PET) richness was similar between the dry and post-wet season surveys, ranging between zero and four taxa across all sites. A higher number of sites recorded between two and four PET taxa during the post-wet season survey.

Table 3-3 Comparison of macroinvertebrate species richness and PET richness between dry and post-wet season surveys (edge samples only)

Catchment	Site	Taxa richness		PET richness	
		Wet	Dry	Wet	Dry
Border Rivers	**GFE10**	20	-	3	-
Condamine-Balonne	**R7**	15	16	4	1
	GF10	15	-	2	-
	GF9	18	24	2	1
	GF3	12	15	2	3
	GF2	15	35	3	3
	GF1	-	15	-	0
	GF8	12	23	2	4
	WTF4	20	30	4	4
	WTF3	25	13	4	2
	GF7	25	24	3	2
	GF6	29	-	2	-
	GF5	-	28	-	3

	RORWB4	28		2	-
	RORWB3	20		2	-
	ORWB1	15		2	-
	R3	14		0	-
	R1				
	HPE3	18		3	-
Dawson	**HPE2**	23		4	-

SIGNAL 2 scores were low for all sites, ranging from 2.77 to 4.27 (with no abundance weighting) during the post-wet season surveys, which was consistent with the results of the dry season surveys. All sites in the Condamine-Balonne and Border Rivers catchments fell within either quadrant 2 or quadrant 4 (descriptions of quadrants are provided in EIS Vol. 5 Attachment 17). Only one site was sampled in the Dawson catchment, which fell in quadrant 1. The SIGNAL2 scores reflected the high nutrients and turbidity recorded throughout the Condamine-Balonne and Border Rivers catchments. The elevated turbidity and nutrients were likely to be a combination of natural sources (e.g. regional geology and soils), riparian habitat degradation and landuse practices.

The relative proportion of macroinvertebrate functional feeding groups (in edge samples) for sites sampled during the post-wet season varied considerably between sites and no strong seasonal trends in feeding guild composition were evident. Most sites were dominated by non-specific feeders, such as predators and gatherer / collectors.

All sites throughout the Condamine-Balonne and Border Rivers catchments were dominated by taxa with a weak preference for fine substrate (sand/silt) or taxa that showed no preference (composite bed samples). The post-wet season results were generally consistent with the results of the dry season surveys and reflected the dominance of sandy/silty substrates throughout the region.

Although the majority of sites were dominated by taxa with either no flow preference or a preference for low/no flow during the post-wet season surveys, a number of post-wet season sites (e.g. WTF4 – Condamine River, GFE10 – Weir River and HPE2 – Dawson River) had a substantial proportion (20-35 %) of taxa preferring high flows. Despite the recent flooding, the majority of sites had either ceased to flow or were experiencing low flows at the time of sampling. Sites WTF4, GFE10 and HPE2 were all flowing at the time of sampling. Also, these sites had more variable bed habitat (e.g. sand, gravel, riffle) compared to other sites which supported the presence of taxa with preference for higher flows at these sites.

3.3.2 Condamine-Balonne

Macroinvertebrate samples were collected from 16 sites (16 edge and five composite bed samples) in the Condamine-Balonne catchment during the post-wet season surveys. The highest taxa richness was recorded at site GF9 (Yuleba Creek). This site was dry during the dry season surveys so no seasonal comparison is available. Taxa richness was generally lower during the post-wet season surveys (for those sites where a comparison is available), with the exception of sites WTF3 (Condamine River) and GF7 (Charleys Creek), which recorded an additional 12 and one taxa, respectively. WTF4 on the Condamine River recorded 10 less taxa in the post-wet season surveys than in the dry season surveys. However, as noted in Section 2.3.2, QA / QC checks undertaken in the laboratory found an additional eight families in the whole residue sample compared to the live-pick sample for this site. Therefore, the taxa richness reported is likely to underestimate not only the total taxa richness at this site, but also results of other indices, particularly SIGNAL2 scores.

While PET richness was similar between the post-wet and dry season surveys for most sites in the Condamine-Balonne catchment, PET richness was considerably higher at R7 (Bungil Creek) and WTF3, which both recorded four taxa. Given only two surveys have been undertaken, it is difficult to determine if there are any seasonal or interannual trends in macroinvertebrate richness.

3.3.3 Dawson

Two gasfield sites, HPE2 (Dawson River) and GF5 (Wooleebee Creek), were sampled in the dry season surveys and only the HPE2 site was surveyed in the post-wet season surveys. No edge data were available from this site for the dry season surveys.

The edge sample collected during the post-wet season surveys had moderate to good taxa richness and good representation of PET taxa (four species). HPE2 recorded the highest SIGNAL2 score compared to all sites and was the only site to fall within quadrant one on the SIGNAL bi-plot. This indicates a diversity of physical habitats, low turbidity, salinity and nutrient concentrations and the absence of toxic chemicals or harsh physical environments (Chessman 2003).

The functional groupings were dominated by generalist feeders such as predators and gatherer/collectors. However, the more specialist scraper and shredder groups were also present at this site.

Approximately 50 % of the taxa collected at HPE2 preferred either strong coarse or weak coarse substrate, with approximately 25 % preferring high flows. The remainder showed either no preference or were not classified.

HPE2 is a spring fed site located on the upper Dawson River. Water quality at the site was found to be generally good, with low turbidity, conductivity and low to moderate nutrient concentrations. The site also has a variable aquatic habitat (riffle-run-pool) and good riparian habitat, which was reflected in the macroinvertebrate community.

3.3.4 Border Rivers

No Border Rivers sites were sampled in the dry season as all sites were dry. Two sites (RE9 – bed and GFE10 – edge and bed) were sampled during the post-wet season surveys.

Site GFE10 located on the upper Weir River recorded moderate taxa richness and moderate PET richness (20 and 3, respectively) during the post-wet season surveys. A high proportion of filter feeders were recorded, possibly linked to the flowing conditions at the site. The remainder of the feeding guild composition comprised the non-specialist feeders (predators and gatherer/collectors), with a small proportion (<10 %) of shredders present.

The macroinvertebrate community in composite bed samples collected from site GFE10 was dominated by taxa with no flow or substrate preference. Approximately 20 % favoured higher flows and coarse substrate, which is a reflection of the nature of the site at the time of sampling. It was clear that the site had experienced substantial recent flooding, but had receded to a shallow, slow-moderate flowing stream by the time sampling was undertaken. The macroinvertebrate community at site RE9 located on Wester Creek was dominated by taxa with no flow or substrate preference. A small proportion of the macroinvertebrate community favoured low/no flow and weak fine substrate. At the time of sampling, despite recent floods, water levels at RE9 had receded to a series of small, non-flowing, sandy pools.

3.4 Data limitations

Given the dynamic nature of river systems throughout the survey region, water quality and biological communities are likely to be highly variable both seasonally and interannually. Two or three surveys within a 12-month period can only provide a snapshot of the health of these systems at the time of sampling. This is particularly relevant given the seasonal extremes encountered during the survey periods (i.e. extended drought period followed by one of the wettest summers on record[3]). Therefore, data presented in this report need to be interpreted with caution.

Changes in catch composition and species abundances between surveys reflect, in part, differences in species' responses to seasonal changes in flow regimes and sampling methods employed at each site. For example, fish are more concentrated and accessible to capture in shallow, intermittent pools (predominant in the dry season surveys) compared with post-flood streams (encountered in wet season surveys), where fish are more dispersed.

It was not possible to maintain standardised biological sampling methods between dry and wet season surveys (e.g. net selection and soak times varied due to time constraints, water depth and channel width; macroinvertebrate sampling varied depending on water depth and available edge habitat etc.). In particular, this may have affected fish catch composition, with some species more amenable to capture by particular sampling methods. For example, small elongate species such as hardyheads and relatively sedentary species such as gudgeons are more easily collected by electrofishing than by gill nets, while plotosid catfish are more easily collected by gill netting than by electrofishing. In the dry season surveys, the predominant sampling methods were electrofishing and small traps, while in the post-wet season surveys, the majority of sites were sampled using gillnets and small traps. Fyke netting and seine netting were also undertaken at some sites during the post-wet season survey.

[3] http://www.abc.net.au/news/stories/2010/03/06/2838439.htm

4 SUMMARY AND CONCLUSIONS

Water quality, fish and macroinvertebrate surveys were conducted during April and May, 2010, following two significant flooding events in February and March. Data collected during the post-wet season survey were compared to those collected during the dry season surveys.

Water quality was generally found to be similar between the dry and post-wet season surveys, with the majority of sites recording high turbidity and suspended solids, high nutrients, low dissolved oxygen and elevated concentrations of aluminium and copper. No pesticides or hydrocarbons were detected in any of the dry or post-wet season samples. Dissolved manganese and dissolved boron concentrations were less than the ANZECC / ARMCANZ (2000) 95 % protection limits for all sites on all sampling occasions.

A total of 13 native and three non-native fish species were collected from gasfields sites during both the dry and post-wet season surveys. All catches were dominated by native species. While overall species richness was similar between dry and post-wet season surveys, only seven species were recorded from both surveys. Three species of conservation significance (Agassiz's glassfish, Hyrtl's tandan and Silver perch) were caught in the Condamine-Balonne catchment during the post-wet season survey, that were not caught during the dry season. It should be noted that although these species are of conservation significance, they are not formally protected under Queensland or Commonwealth legislation. The difference in species caught between survey periods is likely to have resulted from a combination of wet-season recruitment and different sampling methods used. The presence of these species did not alter the impact assessment provided in EIS Volume 5, Attachment 17, as this assessment was based on the assumption that all significant species known to occur throughout the region were present, regardless of whether they were caught or not.

Macroinvertebrate taxa richness was generally lower during the post-wet season survey, compared to the dry season survey. This is likely to be a result of delayed post-flooding recruitment. Results for PET richness, SIGNAL2 scores and functional group structure were similar between dry and post-wet season surveys. The composition of the macroinvertebrate community generally indicated moderately degraded conditions, including high nutrients, high turbidity and poor aquatic habitat. Site HPE2, located on the Upper Dawson River was the only site that fell within quadrant one on the SIGNAL2 bi-plot, which is indicative of favourable habitat and water quality conditions. This site also had more variable proportions of feeding groups and flow and substrate preferences, indicating a more diverse aquatic habitat. The majority of sites were dominated by taxa with generalist food preferences and tolerating a range of flow and substrate conditions.

Overall, while the post-wet season sampling provided additional data to support the characterisation of the existing environment, nothing was observed or collected that resulted in any required amendments to the impact assessment undertaken for the EIS (refer to Volume 5, Attachment 17).

Given the dynamic nature of river systems throughout the survey region, these results only provide a snapshot of water quality and biological community structure at the time of sampling, particularly considering the seasonal extremes encountered during the survey periods. Further surveys would be required to confidently establish any seasonal and or inter-annual trends.

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Appendix 1. Raw Water Quality Data

Table A1-1 Physico-chemical data for dry season and post-wet season surveys

		RE9	GFE10	RORWB4	R7	GF6	GF7	R3	GF8	WTF3	WTF4	GF1	R1	GF2	GF3	ORWB1	HPE3	GF10	GF9	GF5	HPE2
Dry 1	Temp (°C)			15.5	11.72	15.3		11.1	12.9	16.3	14.4	15.6	12		12.7			9.82	12		22.85
Dry 2	Temp (°C)			22.93	16.86	18.98	16.4	18.68	22.29	17.69	15.09	17.61	19.13		17.35					19.55	19.04
Wet	Temp (°C)	22.5	22.68	20.36	18.57	25.65	21.09	20.73	25.09	22.35	21.45	20.36	22.55	18.74	21.37	24.13	21.86	17.46	22.02		
Dry 1	Conductivity (µS/cm)			133	149	157	220	203	158	292	168	77	179	114	149			251	145	160	266
Dry 2	Conductivity (µS/cm)			114	268	151	269	212	168	378	212	78	213	119	159			273	147	196.6	358
Wet	Conductivity (µS/cm)	235	218	100	1028	164	205	155	216	196	203	157	107	251	139	115	201	752	440		
Dry 1	pH			8.2	7.45	7.9	5.59	7.5	8.4	7.5	7.77	7.76	7.48	6.16	7.16			7.52	7	7.12	8.14
Dry 2	pH			7.52	7.66	7.2	6.91	6.88	7.49	7.47	7.42	6.72	5.38		6.93					7.32	7.77
Wet	pH	8.71	7.15	6.02	7.96	7.59	7.1	6.43	7.97	7.54	7.66	6.35	7.13	7.25	7.35	6.95	8.08	7.32	7.72		
Dry 1	Turbidity (NTU)			42.8	411	63.1	1195	2	203	221.4	1.5	350	65.9	390.8	286			78.9	71.3	632.3	13.5
Dry 2	Turbidity (NTU)			27.6	126.5	188.9	1197.5	21.9	340.6	264.1	932	635.6	298.4	395.1	646.2			177	150.6	3.5	34.2
Wet	Turbidity (NTU)	23.9	234.2	7.5	0	25.2	22.9	76.2	197.4	175.6	196	135.1	119.8	370.9	295.4	68	47.2	341	23		
Dry 1	DO (% sat)			34.9	52	85.6	38	43.5	72.6	79.1	80	69.1	65.9	70.9	63.5			59.4	56	71.7	103.6
Dry 2	DO (% sat)			123.3	52.8	59	28.6	53.5	94	65.6	70.7	60.2	108.6		61.5					100.2	76.3
Wet	DO (% sat)	110.3	86.3	20.2	85.5	105.1	29.4	52.4	97.1	79.6	80.6	36.4	76.5	62.3	44.3	70.7	95.8	47.9	88.4		
Dry 1	TDS (mg/L)			137	176	189	3150	289	344	407	627	602	186	535	248			122	158	1140	253
Dry 2	TDS (mg/L)			97	166	217	2720	244	522	434	1400	924	112	513	902			184	199	1600	218
Wet	TDS (mg/L)	246	535	154	653	229	244	260	346	434	455	283	232	349	418	183	141	436	268		
Dry 1	TSS (mg/L)			28	284	32	476	15	69	107	67	47	137	50	41			110	32	108	14
Dry 2	TSS (mg/L)			23	125	66	1290	5	85	70	106	145	1220	57	139			252	75	166	4
Wet	TSS (mg/L)	32	40	19	6	21	17	57	108	60	40	55	13	189	32	44	28	40	24		

Guideline

	cond	pH	Turb	DO
upland	30-350	6.5-7.5	2-25	90-110
condamine	340		25	

no guideline value
exceeds guideline
Exceeded lab holding time

Note: All parameters measured in mg/L

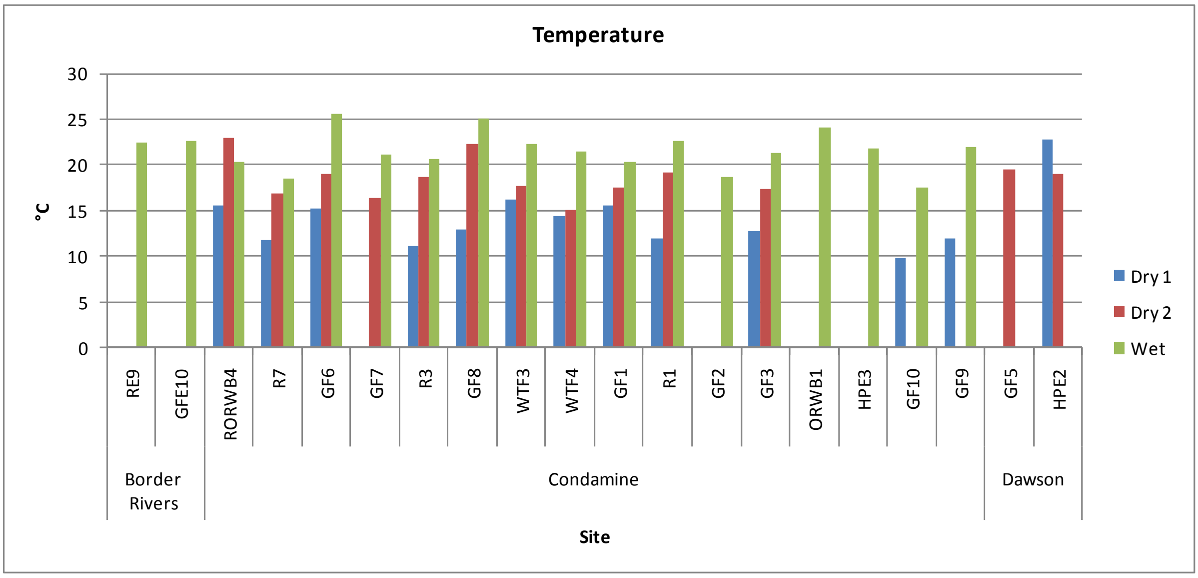
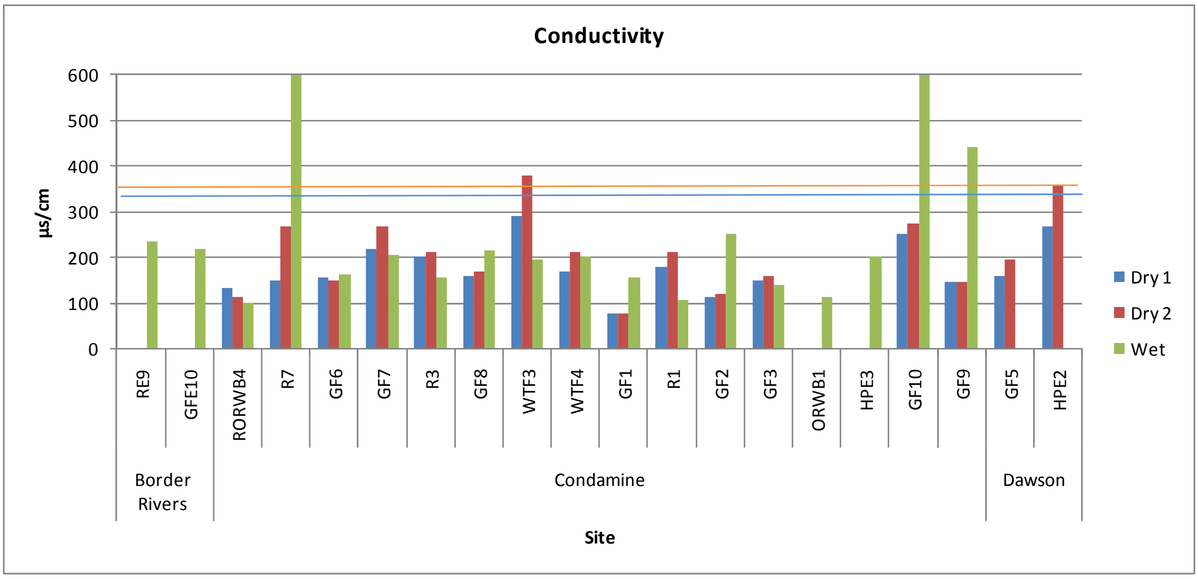
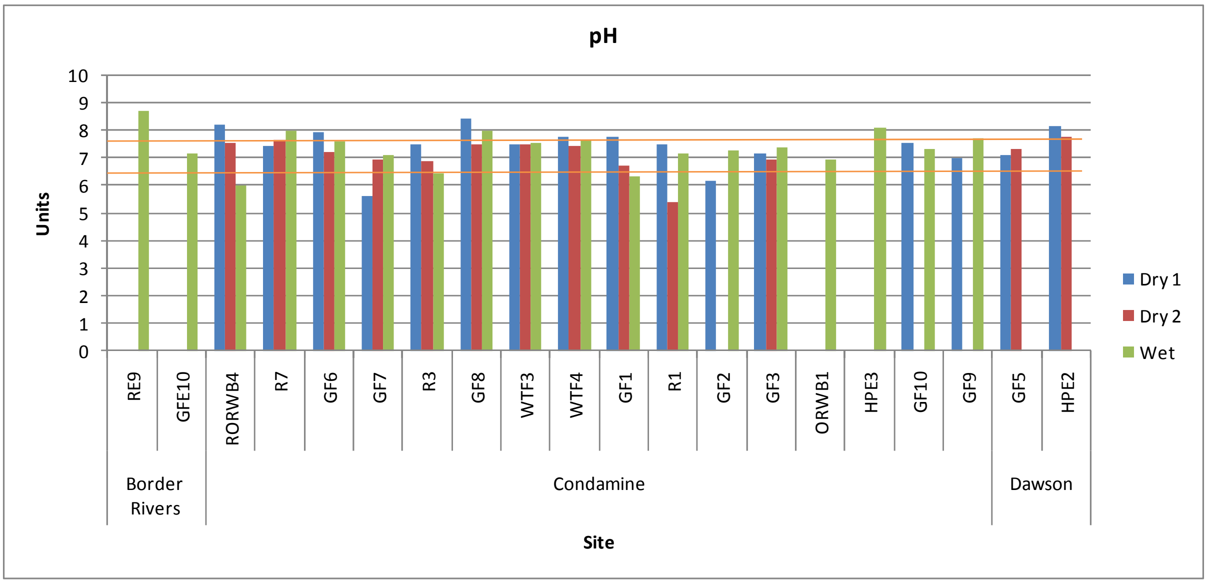


Figure A1-1 Water temperature results for dry season and post-wet season surveys



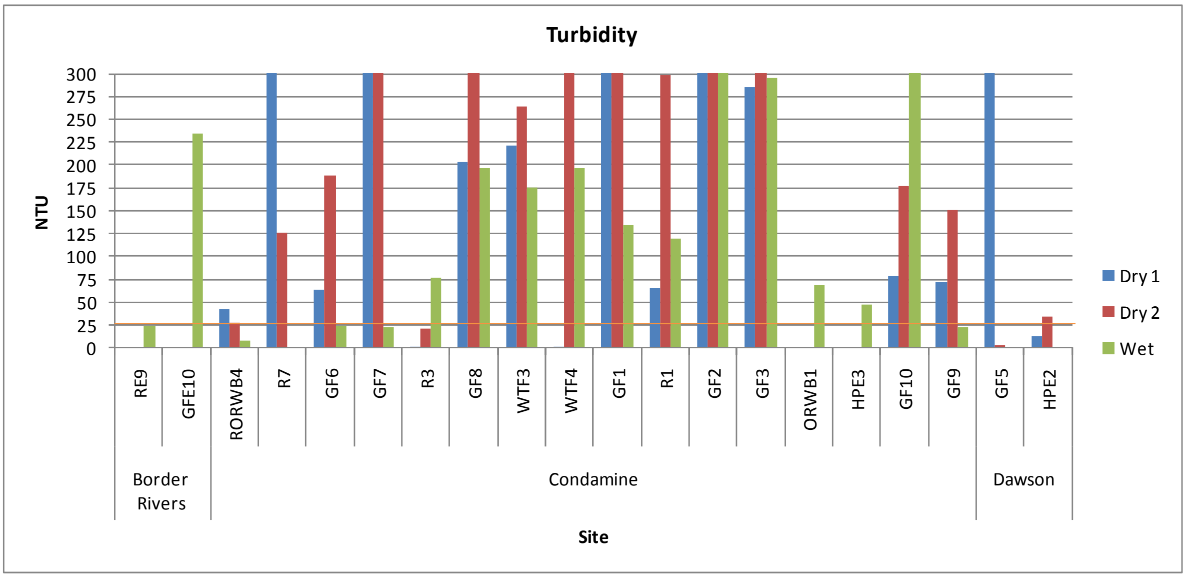
Note: Orange line indicates upland guideline; Blue line indicates Condamine guideline

Figure A1-2 Specific conductivity results for dry season and post-wet season surveys



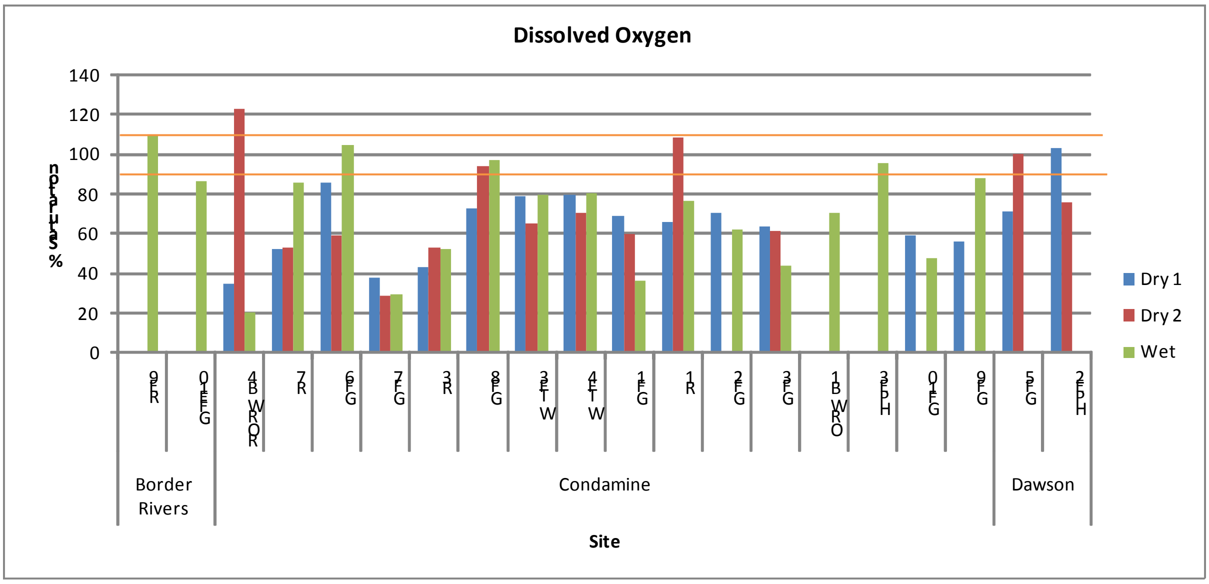
Note: Orange line indicates upland guideline

Figure A1-3 pH results for dry season and post-wet season surveys



Note: Orange line indicates upland guideline; Blue line indicates Condamine guideline

Figure A1-4 Turbidity results for dry season and post-wet season surveys



Note: Orange line indicates upland guideline

Figure A1-5 Dissolved oxygen results for dry season and post-wet season surveys

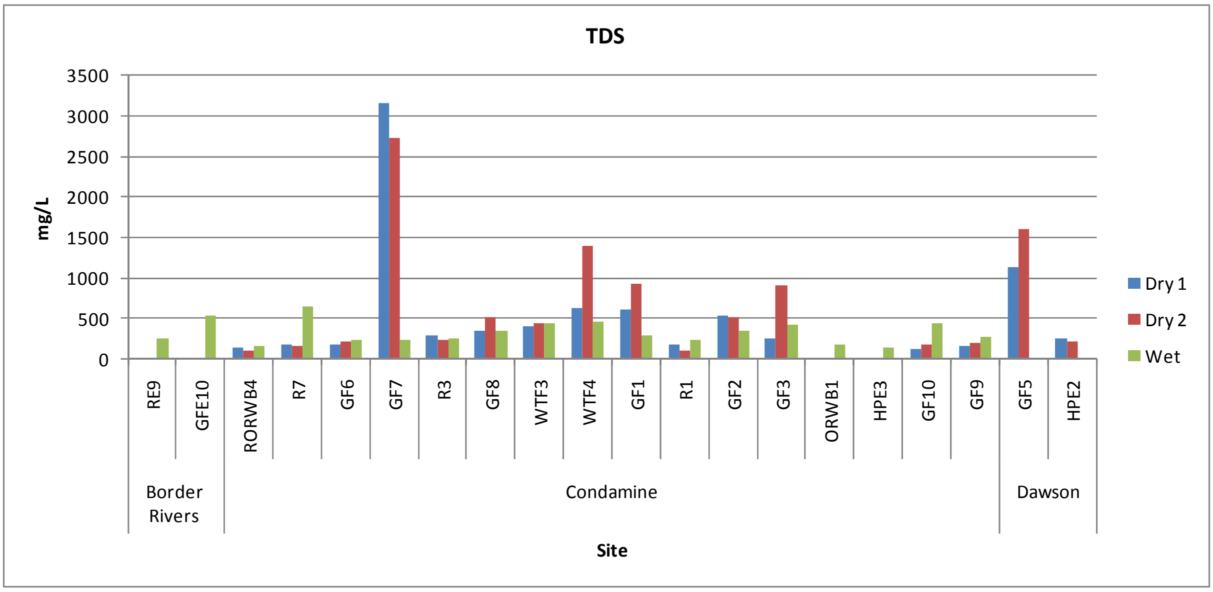


Figure A1-6 TDS results for dry season and post-wet season surveys

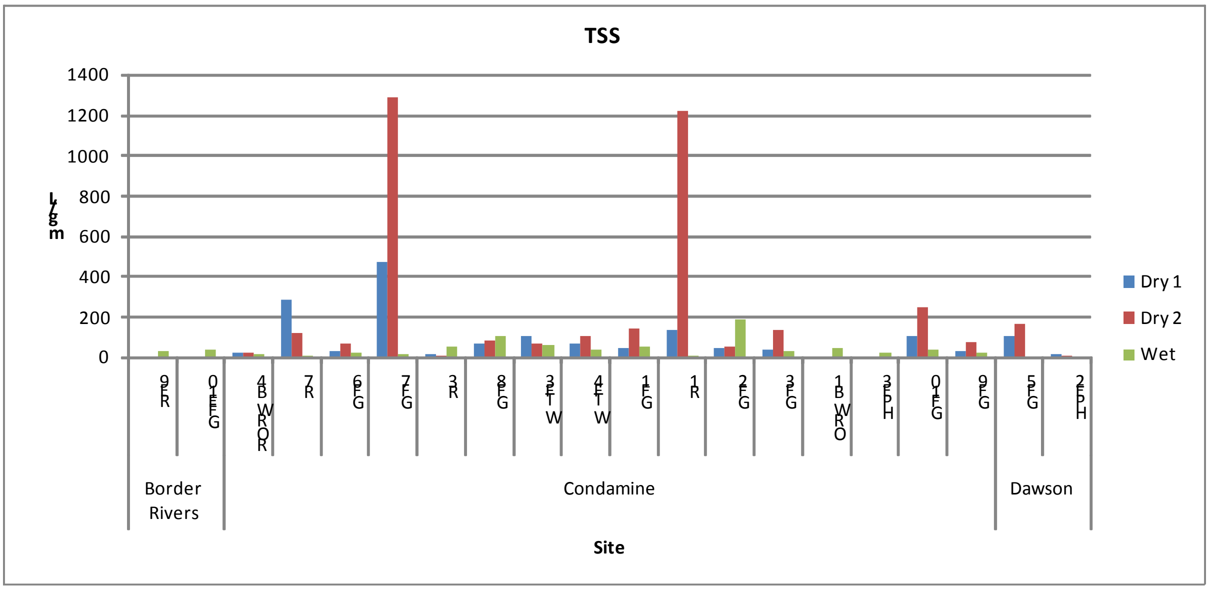


Figure A1-7 TSS results for dry season and post-wet season surveys

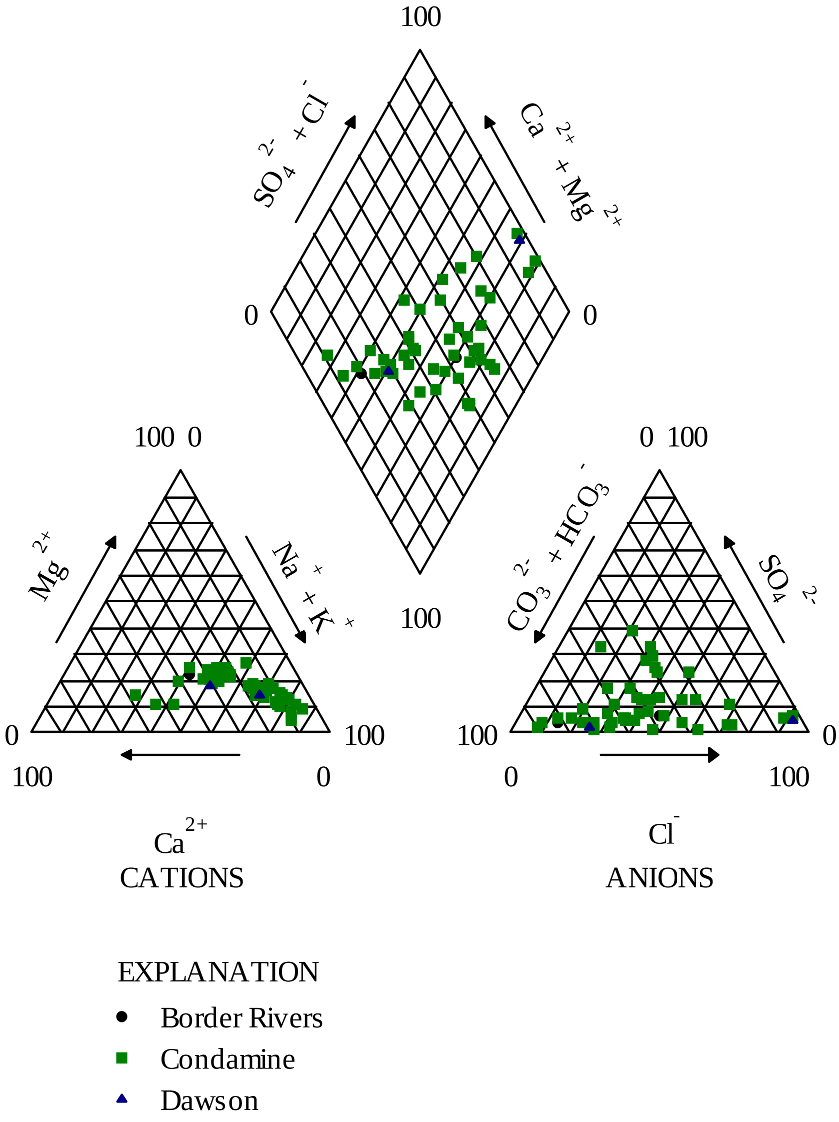


Figure A1-8 Piper plot for dry season and post-wet season surveys showing anions against cations

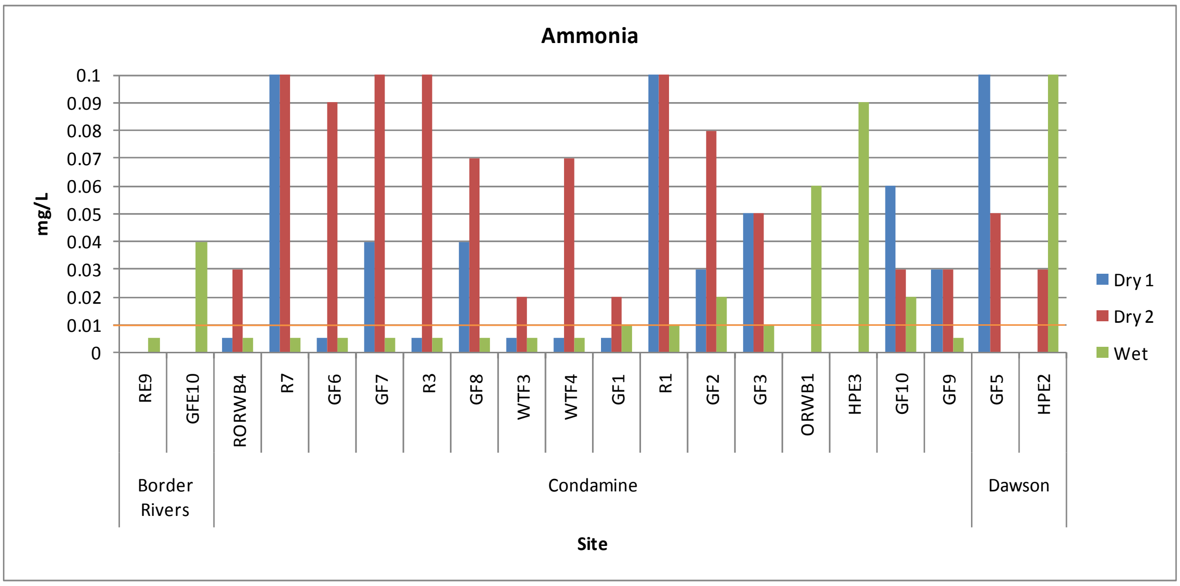
Table A1-2 Nutrient data for dry season and post-wet season surveys

		RE9	GFE10	RORWB4	R7	GF6	GF7	R3	GF8	WTF3	WTF4	GF1	R1	GF2	GF3	ORWB1	HPE3	GF10	GF9	GF5	HPE2
Dry 1	NH4			0.005	0.11	0.005	0.04	0.005	0.04	0.005	0.005	0.005	0.46	0.03	0.05			0.06	0.03	0.12	
Dry 2	NH4			0.03	0.31	0.09	0.2	0.12	0.07	0.02	0.07	0.02	0.47	0.08	0.05			0.03	0.03	0.05	0.03
Wet	NH4	0.005	0.04	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.01	0.01	0.02	0.01	0.06	0.09	0.02	0.005		0.11
Dry 1	Nox			0.005	0.05	0.005	0.29	0.04	0.19	0.2	0.16	0.37	0.06	0.59	1.47			0.03	0.53	0.1	
Dry 2	Nox			0.005	0.14	0.52	0.04	0.18	0.17	0.04	0.08	0.32	0.005	0.31	0.18			0.16	0.08	6.78	0.04
Wet	Nox	0.005	0.005	0.005	0.04	0.005	0.005	0.005	0.005	0.005	0.02	0.04	0.02	0.07	0.01	0.005	0.63	0.02	0.09		0.05
Dry 1	TKN			3.7	1	1.9	1.6	2.5	1.2	3.1	3	1.6	1.5	0.6	1.2			1	0.8	2.2	
Dry 2	TKN			2.1	1	1.6	6.2	1.6	1.2	1.6	2.4	2.2	6.4	1.5	1.8			3	0.8	3.4	1.5
Wet	TKN	0.2	0.7	1.2	0.5	1	1	1.3	0.9	1	0.8	0.6	1	1.2	0.7	2.1	0.8	0.9	0.9		0.2
Dry 1	TN			3.7	1	1.9	1.9	2.6	1.4	3.3	3.1	2	1.6	1.2	2.7			1	1.4	2.3	
Dry 2	TN			2.1	1.2	2.1	6.2	1.8	1.4	1.6	2.5	2.5	6.4	1.8	2			3.2	0.9	10.1	1.5
Wet	TN	0.2	0.7	1.2	0.5	1	1	1.3	0.9	1	0.8	0.6	1	1.3	0.7	2.1	1.4	0.9	1		0.2
Dry 1	TP			0.15	0.27	0.09	0.66	0.5	0.26	0.26	0.23	0.27	0.005	0.51	0.22			0.12	0.005	0.42	
Dry 2	TP			0.09	0.08	0.16	2.25	0.14	0.32	0.27	0.67	0.41	0.67	0.28	0.48			0.44	0.2	1.99	0.04
Wet	TP	0.05	0.09	0.18	0.11	0.15	0.42	0.74	0.17	0.2	0.17	0.07	0.04	0.22	0.17	0.21	0.05	0.12	0.1		0.05
Dry 1	FRP			0.02	0.005	0.02	0.005	0.03	0.02	0.04	0.02	0.02	0.005	0.005	0.005			0.005	0.005	0.11	
Dry 2	FRP			0.005	0.005	0.07	0.005	0.005	0.005	0.02	0.005	0.005	0.005	0.005	0.005			0.01	0.005	0.05	0.01
Wet	FRP	0.005	0.005	0.005	0.03	0.04	0.02	0.005	0.07	0.04	0.04	0.02	0.005	0.01	0.01	0.03	0.005	0.005	0.005		0.005

	Guidelines				
upland	NH4	Nox	TN	TP	FRP
condamine	0.01	0.015	0.25	0.02	0.015
				0.03	

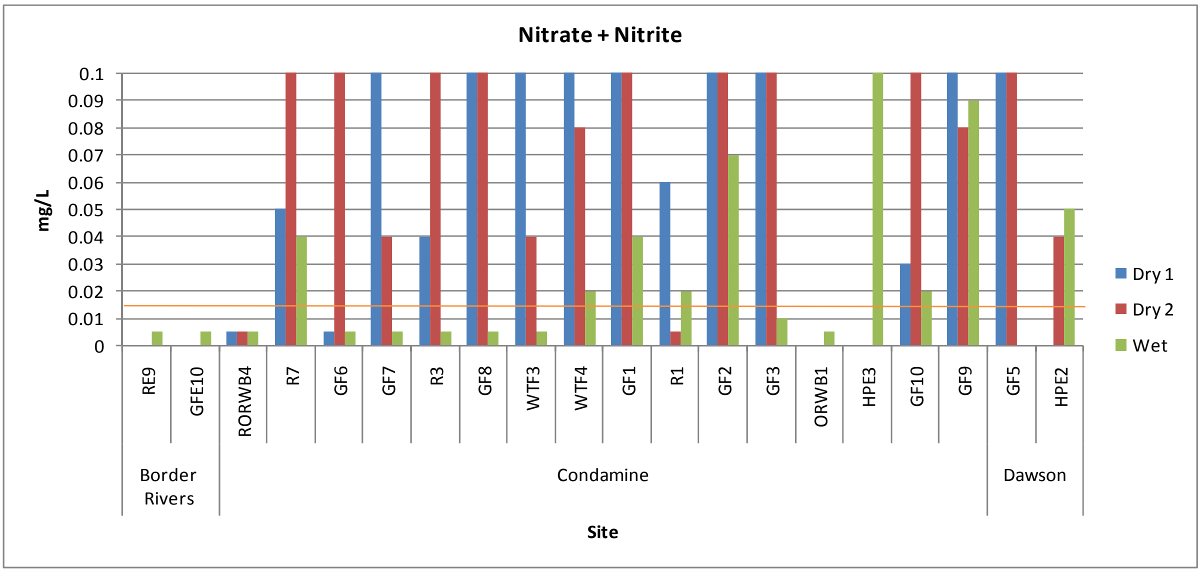
no guideline value
exceeds guideline
Exceeded lab holding time

Note: All parameters measured in mg/L



Note: Orange line indicates upland guideline

Figure A1-9 Ammonia results for dry season and post-wet season surveys



Note: Orange line indicates upland guideline

Figure A1-10 Nitrate and nitrite results for dry season and post-wet season surveys

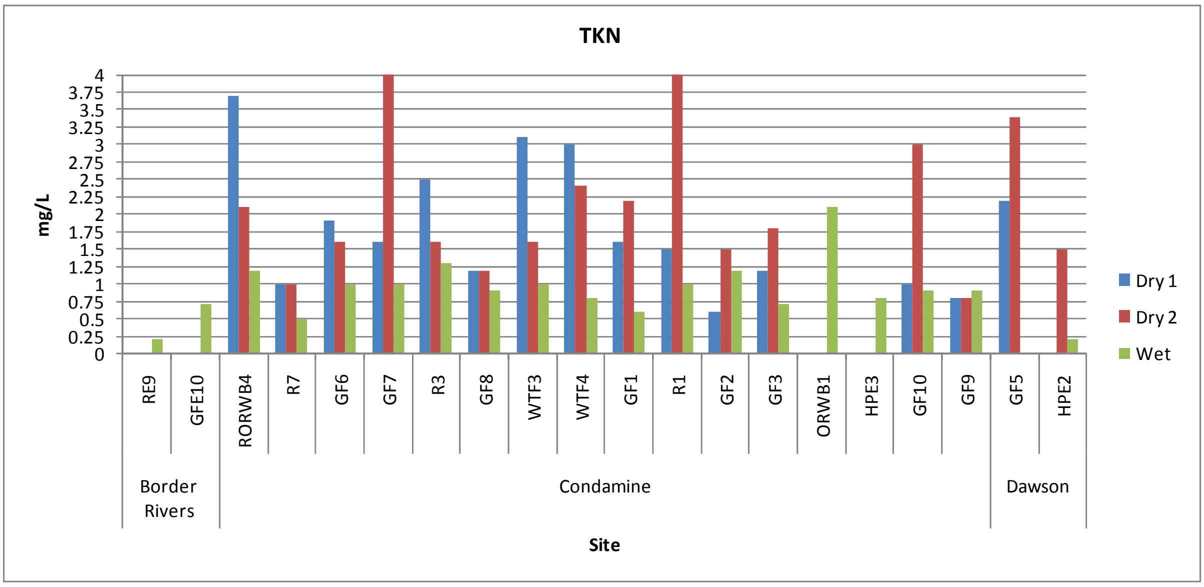
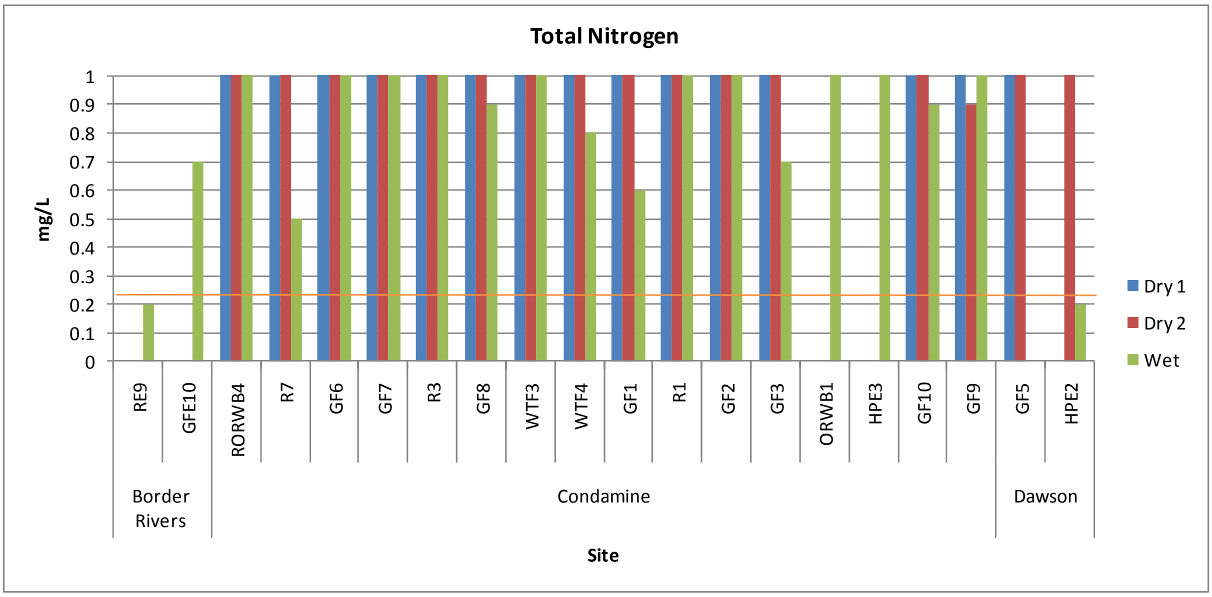
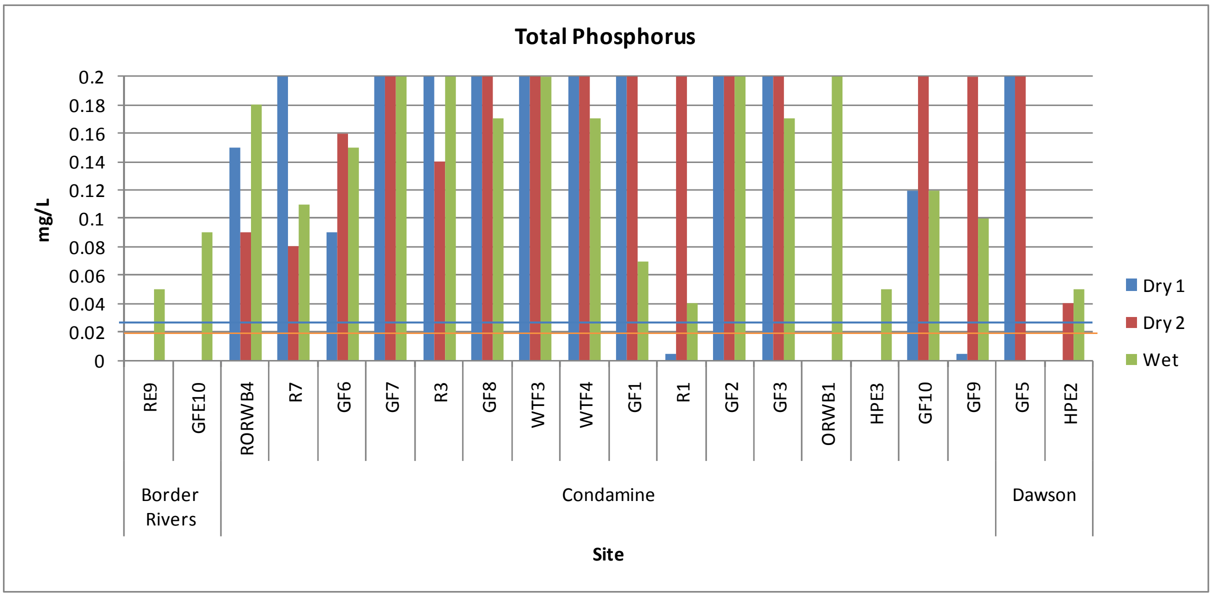


Figure A1-11 TKN results for dry season and post-wet season surveys



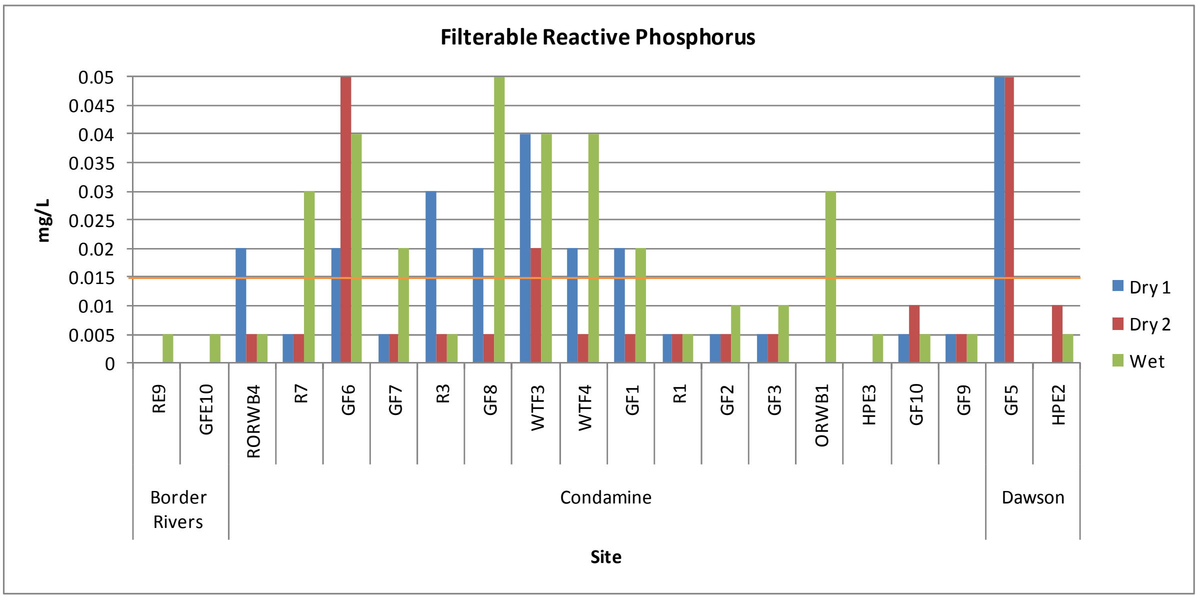
Note: Orange line indicates upland guideline

Figure A1-12 Total nitrogen results for dry season and post-wet season surveys



Note: Orange line indicates upland guideline; Blue line indicates Condamine guideline

Figure A1-13 Total phosphorous results for dry season and post-wet season surveys



Note: Orange line indicates upland guideline.

Figure A1-14 Filterable reactive phosphorous results for dry season and post-wet season surveys

Table A1-3 Total and dissolved metals data for dry season and post-wet season surveys

Dissolved		RE9	GFE10	RORWB4	R7	GF6	GF7	R3	GF8	WTF3	WTF4	GF1	R1	GF2	GF3	ORWB1	HPE3	GF10
Dry 1	Al			0.05	0.05	0.1	0.76	0.49	0.28	0.01	0.75	0.92	0.05	1.78	0.72			0.005
Dry 2	Al			0.005	0.005	0.16	0.06	0.24	0.09	0.005	0.13	0.2	0.02	0.24	0.38			0.005
Wet	Al	0.14	0.17	0.17	0.01	0.22	0.08	0.16	0.24	0.13	0.04	0.53	1.72	0.04	0.57	0.86	0.02	0.005
Dry 1	Cu			0.0005	0.001	0.0005	0.002	0.001	0.002	0.002	0.002	0.001	0.0005	0.001	0.002			0.003
Dry 2	Cu			0.001	0.0005	0.001	0.002	0.003	0.005	0.002	0.003	0.002	0.003	0.001	0.002			0.003
Wet	Cu	0.002	0.001	0.0005	0.0005	0.0005	0.001	0.0005	0.002	0.002	0.002	0.004	0.003	0.001	0.001	0.011	0.002	0.005
Dry 1	Mn			0.005	0.007	0.004	0.034	0.083	0.003	0.052	0.006	0.017	0.078	0.004	0.006			0.239
Dry 2	Mn			0.002	0.164	0.009	0.465	0.084	0.003	0.03	0.003	0.022	0.193	0.008	0.024			0.811
Wet	Mn	0.015	0.063	0.116	0.216	0.159	0.566	0.459	0.009	0.02	0.013	0.221	0.026	0.011	0.012	0.051	0.003	0.594
Dry 1	B			0.06	0.025	0.05	0.025	0.06	0.025	0.025	0.025	0.025	0.08	0.025	0.0025			0.0025
Dry 2	B			0.06	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.1	0.025	0.0025			0.0025
Wet	B	0.025	0.12	0.09	0.08	0.06	0.06	0.08	0.09	0.08	0.09	0.07	0.09	0.07	0.11	0.09	0.06	0.07
Dry 1	Fe			0.0005	0.09	0.06	0.5	2.8	0.23	<0.05	0.47	0.64	0.11	1.35	0.57			0.0025
Dry 2	Fe			0.025	0.025	0.15	0.05	3.8	0.1	0.12	0.25	0.32	0.06	0.26	0.4			0.0025
Wet	Fe	0.11	0.38	1.03	0.025	0.56	1.1	2.53	0.58	0.59	0.43	1.28	2.01	0.12	0.82	1.6	0.06	0.0025
Total		**RE9**	**GFE10**	**RORWB4**	**R7**	**GF6**	**GF7**	**R3**	**GF8**	**WTF3**	**WTF4**	**GF1**	**R1**	**GF2**	**GF3**	**ORWB1**	**HPE3**	**GF10**
Dry 1	Al			0.22	17.4	1.38	83.3	2.32	8.71	12.1	15.8	12.3	2.19	15	13.2			2.66
Dry 2	Al			0.06	3.74	2.53	107	1.6	12.8	10.4	37.4	19.4	3.24	16.8	25.3			3.89
Wet	Al	1.14	9.14	0.62	0.03	1.05	0.34	1.87	6.76	6.32	6.94	3.33	0.57	8.09	9.4	1.25	1.62	0.52
Dry 1	Cu			0.0005	0.008	0.001	0.053	0.002	0.006	0.007	0.006	0.006	0.002	0.008	0.006			0.002
Dry 2	Cu			0.002	0.003	0.002	0.065	0.001	0.007	0.006	0.014	0.008	0.004	0.006	0.01			0.004
Wet	Cu	0.003	0.004	0.004	0.0005	0.005	0.005	0.007	0.006	0.006	0.011	0.003	0.003	0.006	0.005	0.022	0.002	0.001
Dry 1	Mn			0.036	0.236	0.037	2.46	0.111	0.073	0.152	0.139	0.146	0.112	0.098	0.076			0.387
Dry 2	Mn			0.015	0.355	0.08	4.22	0.107	0.113	0.198	0.366	0.242	0.245	0.119	0.164			1
Wet	Mn	0.019	0.164	0.149	0.276	0.28	0.675	0.787	0.115	0.122	0.114	0.25	0.029	0.134	0.065	0.119	0.052	0.535
Dry 1	B			0.06	0.0025	0.0025	0.06	0.0025	0.0025	0.0025	0.0025	0.0025	0.08	0.0025	0.0025			0.0025
Dry 2	B			0.06	0.0025	0.0025	0.08	0.0025	0.0025	0.0025	0.0025	0.0025	0.09	0.0025	0.0025			0.06
Wet	B	0.0025	0.0025	0.0025	0.07	0.0025	0.0025	0.06	0.0025	0.0025	0.0025	0.0025	0.08	0.0025	0.0025	0.0025	0.0025	0.06
Dry 1	Fe			0.99	18.3	2.5	109	7.17	10.1	14.2	16.7	19.5	6.13	18.3	14.4			5.01
Dry 2	Fe			0.28	4.24	4.37	143	6.61	13.4	11.6	29.2	24.4	5.97	16.8	23.8			6.45
Wet	Fe	1.15	12.1	2.63	0.13	3.23	3.06	15.6	10.6	10.2	10.9	8.73	1.92	14.4	16.3	7.04	1.94	1.94

95% protection levels (dissolved metals)

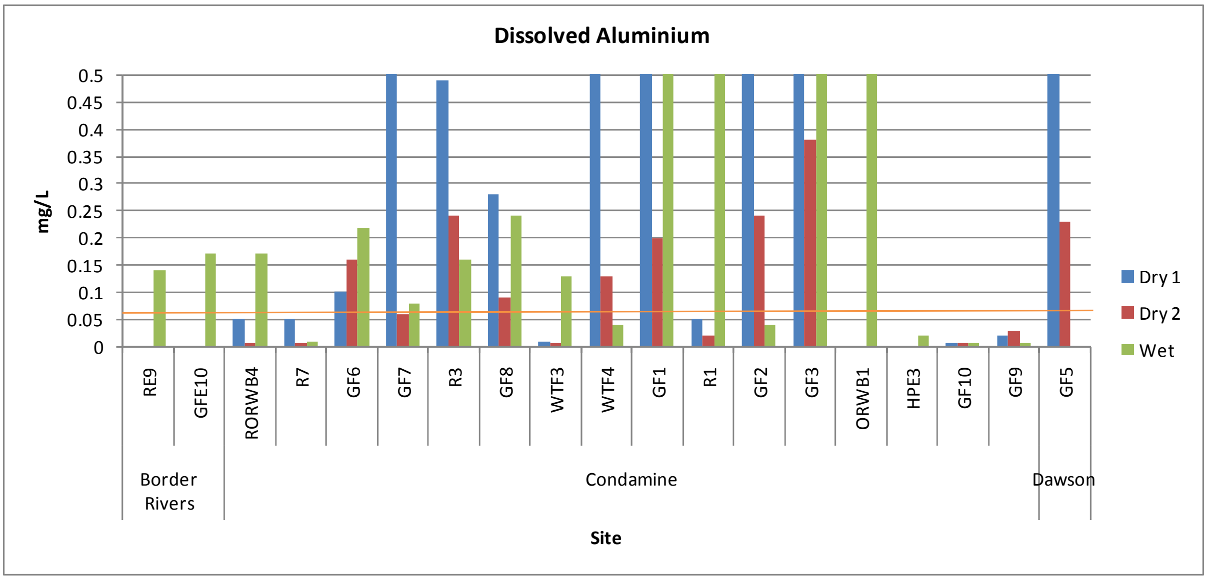
Al	Cu	Mn	B	Fe
0.055	0.0014	1.9	0.37	N/A

no guideline value

exceeds guideline

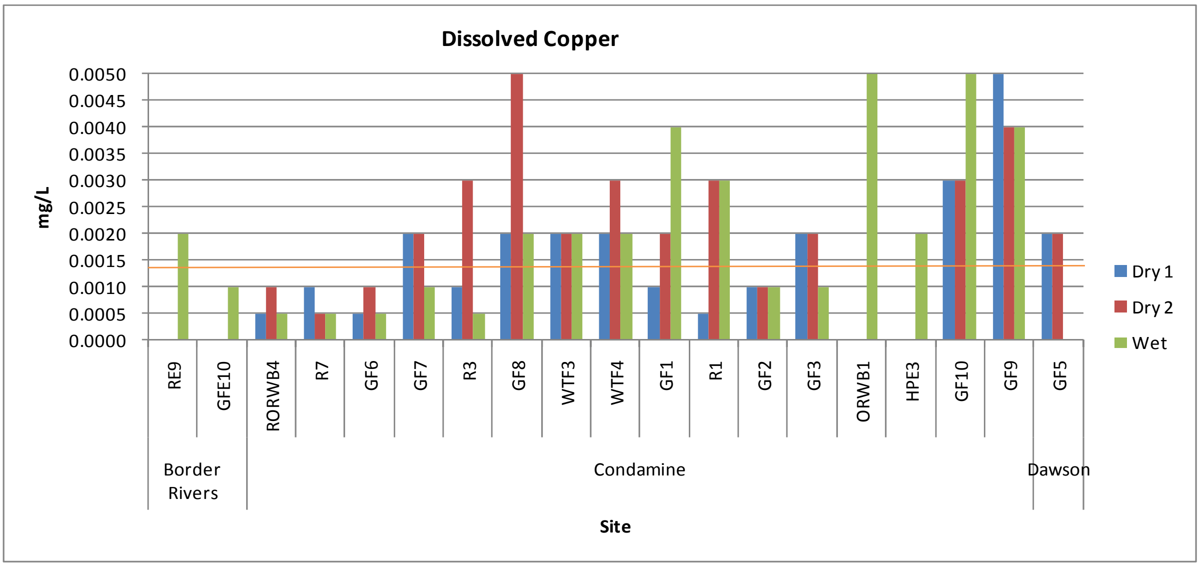
Exceeded lab holding time

Note: All parameters measured in mg/L



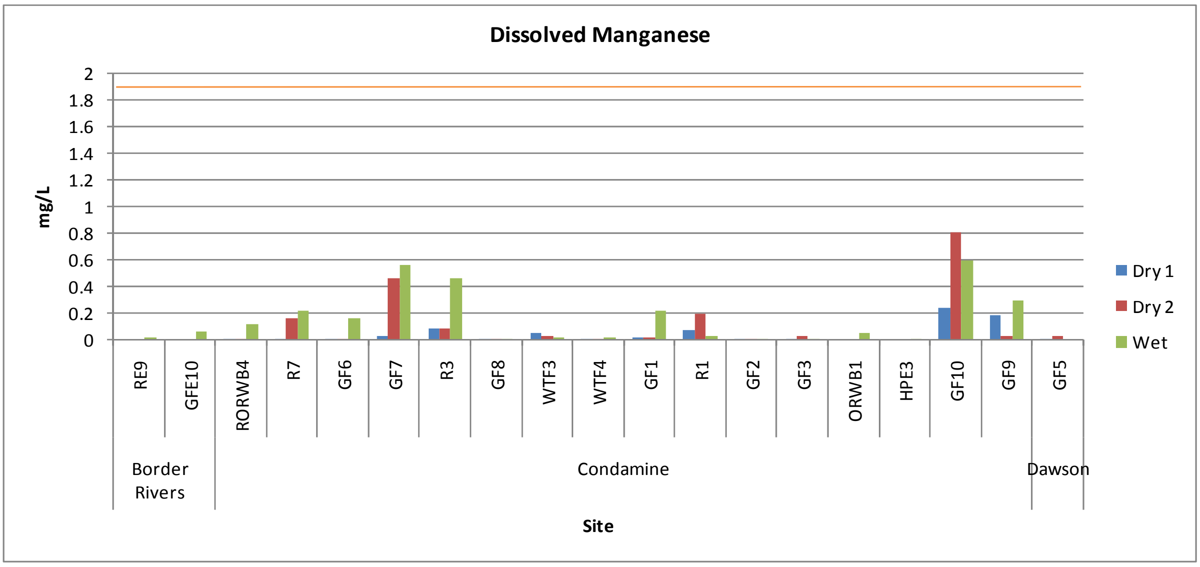
Note: Orange line indicates upland guideline

Figure A1-15 Dissolved aluminium results for dry season and post-wet season surveys



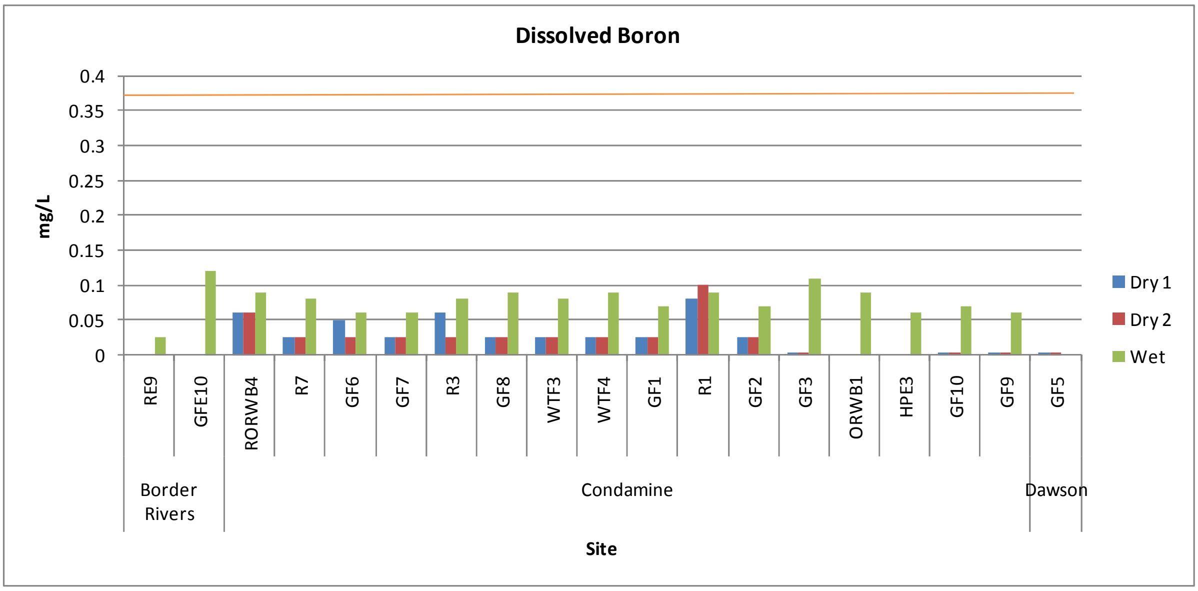
Note: Orange line indicates upland guideline

Figure A1-16 Dissolved copper results for dry season and post-wet season surveys



Note: Orange line indicates upland guideline

Figure A1-17 Dissolved manganese results for dry season and post-wet season surveys



Note: Orange line indicates upland guideline

Figure A1-18 Dissolved boron results for dry season and post-wet season surveys

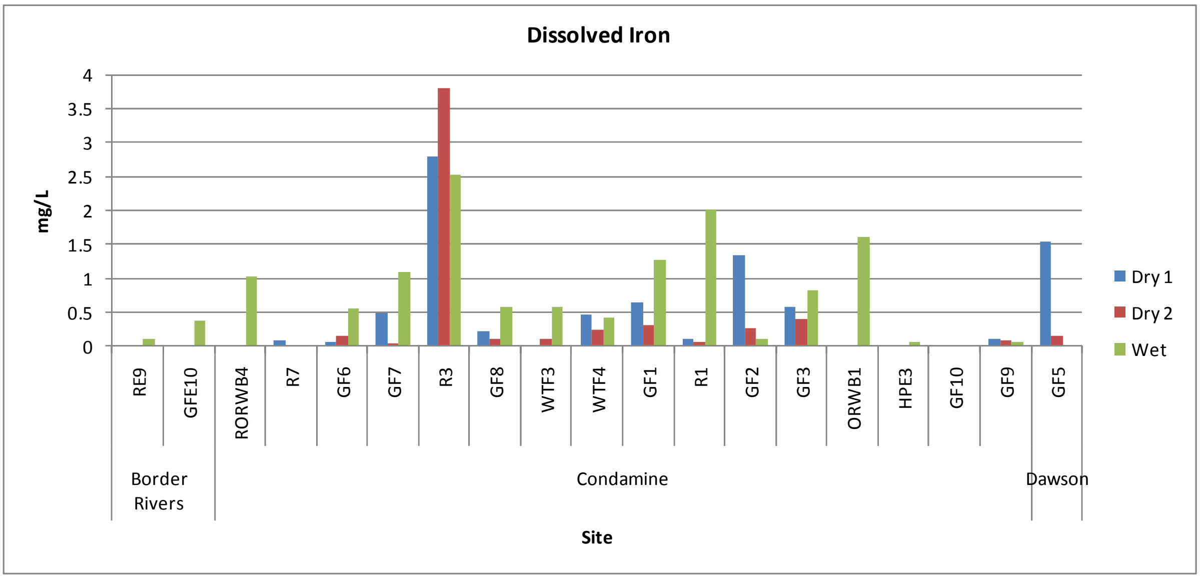


Figure A1-19 Dissolved iron results for dry season and post-wet season surveys

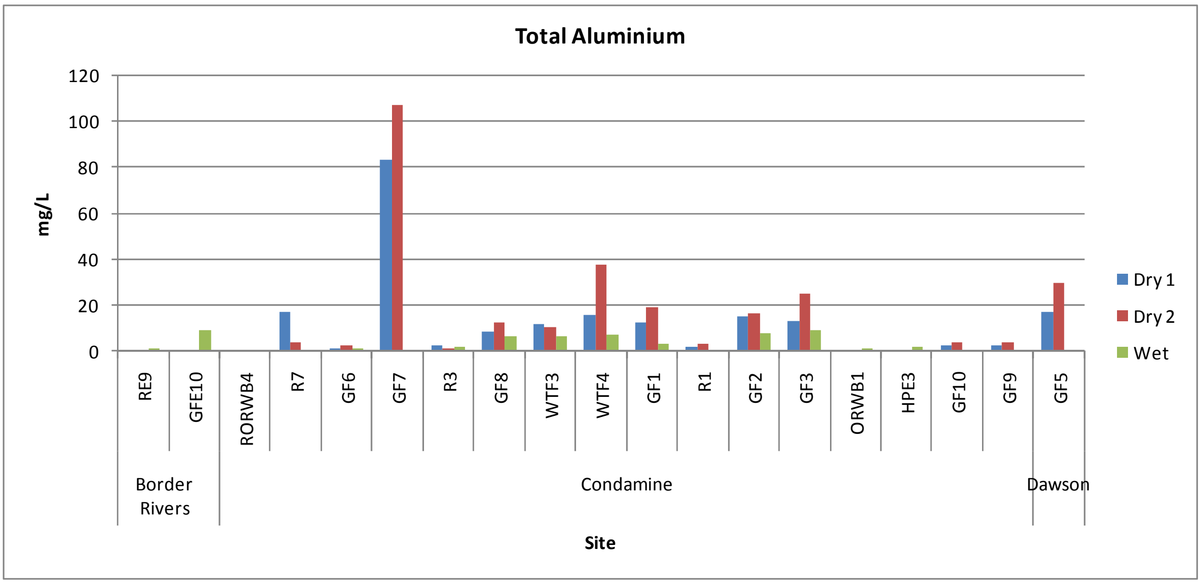


Figure A1-20 Dissolved aluminium results for dry season and post-wet season surveys

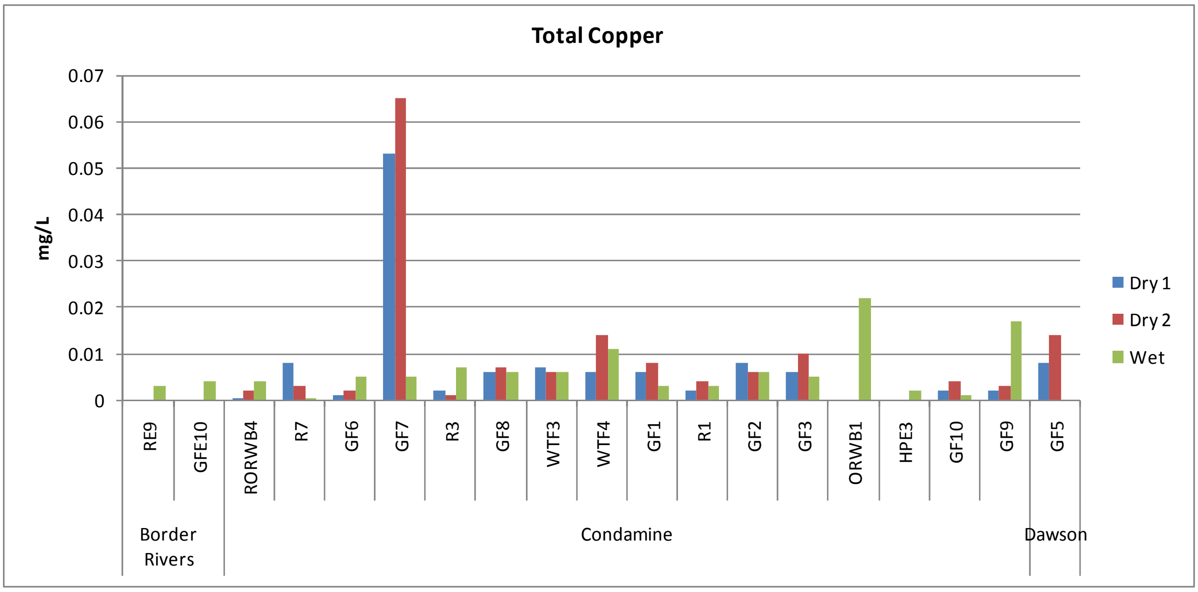


Figure A1-21 Total copper results for dry season and post-wet season surveys

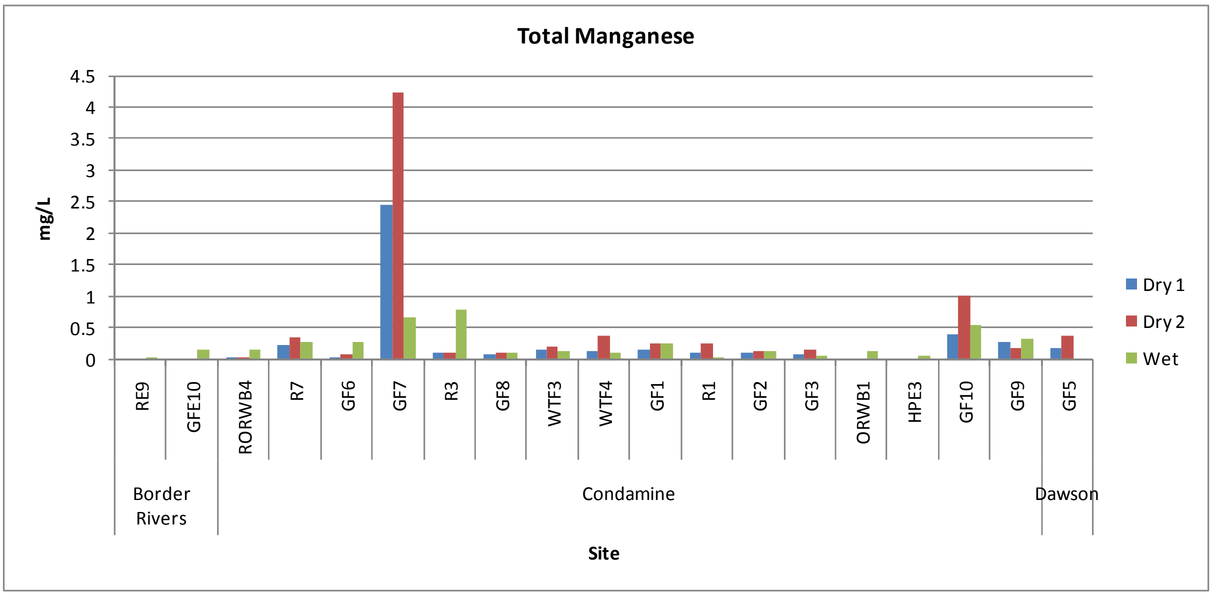


Figure A1-22 Total manganese results for dry season and post-wet season surveys

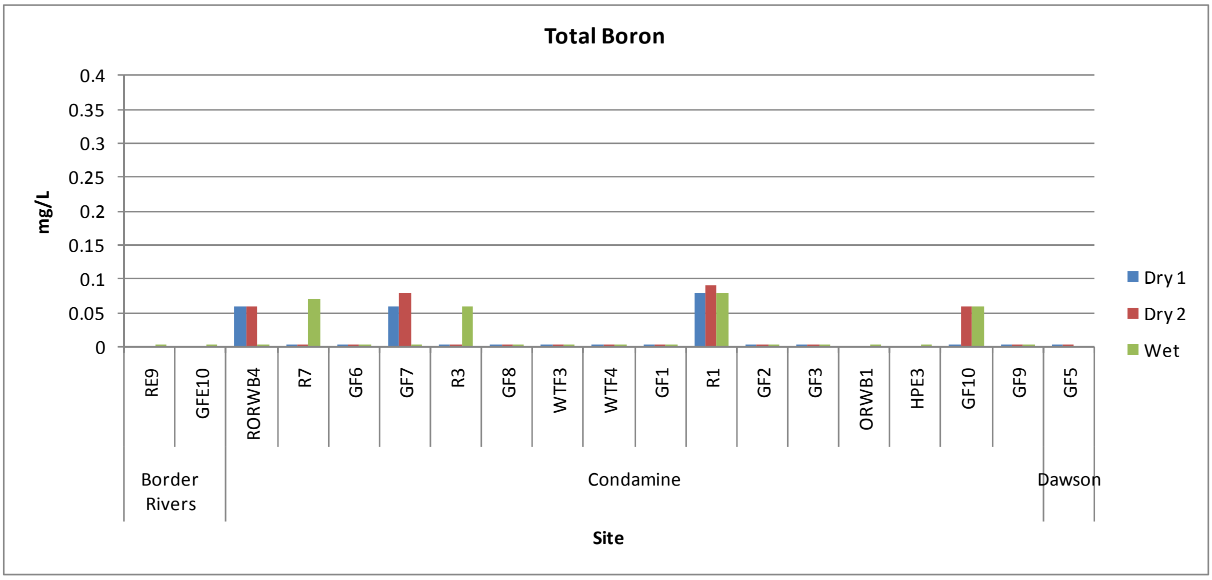


Figure A1-23 Total boron results for dry season and post-wet season surveys

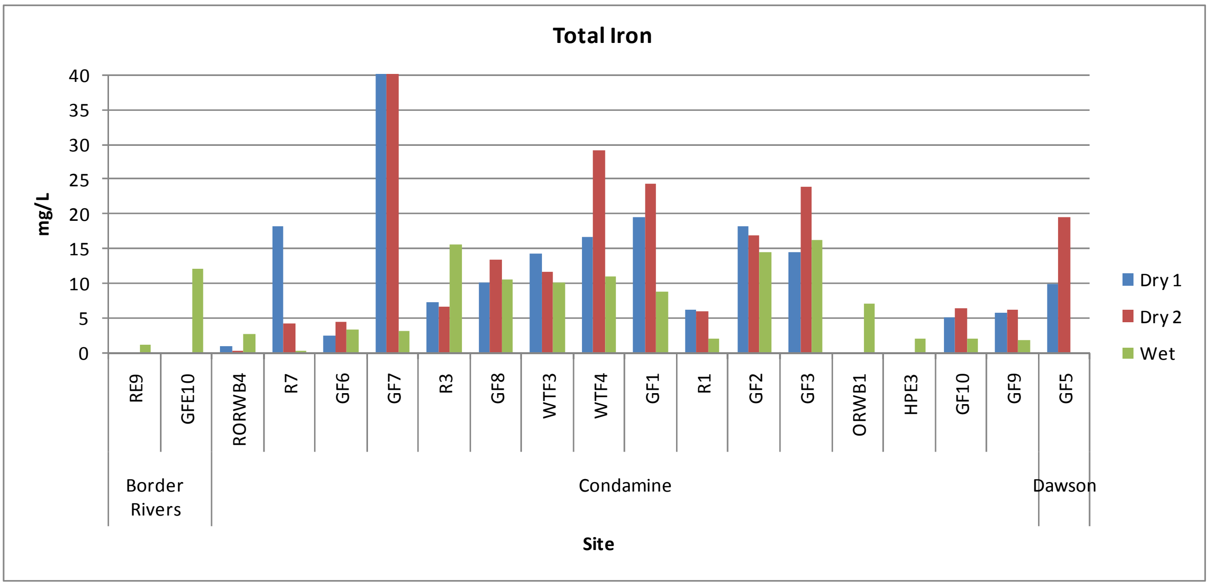


Figure A1-24 Total iron results for dry season and post-wet season surveys

Appendix 2. Raw Fish Data

Table A2-1 Fish diversity and abundance Dry Season – gasfields

Fish Family	Fish Species	Common name	Condamine / Balonne														Dawson	
			R7	GF10	GF9	GF3	GF2	R1	GF1	GF8	WTF4	WTF3	GF7	GF6	RORWB4	R3	HPE2	GF5
Clupeidae	*Nematalosa erebi*	Bony bream	21	12		2	1		1	47	26	2	1		34			
Cyprinidae	*Carassius auratus*	Gold fish	12	47		2	1	26		1			5					
	Cyrinus carpio	Common carp				1							3					
Eleotridae	*Hypseleotris* spp.	Gudgeon species	4	44		4	18	11		31	15	5	11		1187	3	2	
	Philypnodon granidceps	Flathead gudgeon									2							
Melanotaeniidae	*Melanoteania fluviatilis*	Murray river rainbowfish		1						2								
Percichthydidae	*Macquaria ambiqua*	Golden perch / Yellowbelly						5		6	1	1	2				1	
Plotosidae	*Tandanus tandanus*	Freshwater catfish															1	
Poecilidae	*Gambusia holbrooki*	Eastern Mosquitofish		6			3	10		36	28	5	1	6	29	9		
Pseudomugilidae	*Pseudomugil signifer*	Pacific blue-eye															1	
Retropinnidae	*Retropinna semoni*	Australian smelt					3	2		27	6	3		76	22			
Terapontidae	*Leiopotherapon unicolor*	Spangled perch	2	6		1	1	1		3	9							
Crustacean Family	**Crustacean Species**	**Common name**																
Palaemonidae	*Macrobrachium* sp.	Prawn species															65	
Parastacidae	*Cherax quadricarinatus*	Red claw	11			4												10
	Cherax sp.	Crayfish species									3			2				

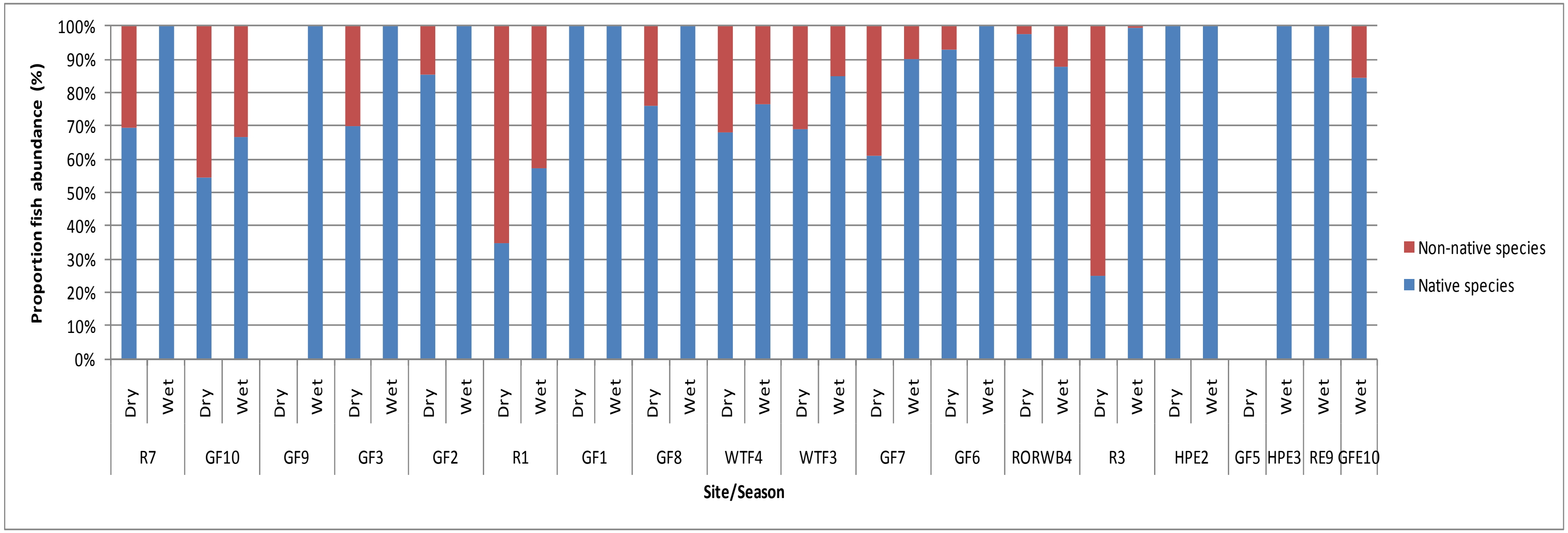
Note: Shaded rows indicate non-native species

Table A2-2 Fish diversity and abundance Wet Season – gas fields

Fish Family	Fish Species	Common name	Condamine / Balonne															Border Rivers		Dawson
			R7	GF10	GF9	GF3	GF2	R1	GF1	GF8	WTF4	WTF3	GF7	GF6	RORWB4	R3	HPE3	RE9	GFE10	HPE2
Ambassidae	*Ambassis agassizii*	Agassiz's Glassfish											17			1				
Clupeidae	*Nematalosa erebi*	Bony Bream		3	30	15	11		229	6	29	67	48	22		13	9		1	9
Cyprinidae	*Carassius auratus*	Gold fish																	1	
	Cyprinus carpio	Common carp																		
Eleotridae	*Hypseleotris sp. 1*	Midgley's Carp Gudgeon																1		
	Hypseleotris spp.	Gudgeon species		1	1			2				51	53	13	109	193				
	Philypnodon granidceps	Flathead gudgeon																		
Melanotaeniidae	*Melanoteania splendida*	Eastern Rainbowfish																		9
	Melanoteania fluviatilis	Murray River Rainbowfish														2	9			
Percichthydidae	*Macquaria ambiqua*	Golden Perch / Yellowbelly														1				
Plotosidae	*Tandanus tandanus*	Freshwater catfish																		
	Neosilurus hyrtlii	Hyrtl's tandan							1		11		10							
Poecilidae	*Gambusia holbrooki*	Eastern Mosquitofish		3				3			22	22	17		15	1			5	
Pseudomugilidae	*Pseudomugil signifer*	Pacific blue-eye																		
Retropinnidae	*Retropinna semoni*	Australian smelt																		
Terapontidae	*Leiopotherapon unicolor*	Spangled perch	53	2	11	2		2	8	2	32	6	26			11	6	24	32	6
	Bidyanus bidyanus	Silver Perch			2				2											
Crustacean Family	**Crustacean Species**	**Common name**																		
Palaemonidae	*Macrobrachium australiens*	Prawn species	2	1	6	2	22	2		1	12	18					27	2	13	27
Parastacidae	*Cherax destructor*	Red claw		4		7		1			6				2	1	1	2	6	

Note: Shaded rows indicate non-native species

Table A2-3 Fish abundance at each site showing the proportion of native vs exotic species for dry season and post-wet season surveys



Appendix 3. Raw Macroinvertebrate Data

Table A3-1 Macroinvertebrate abundances and functional feeding guilds – gas fields (edge data)

Taxon	Functional Feeding Guild	DRY SEASON									WET SEASON																	
		R7	GF9	G3	GF2	GF8	WTF4	WTF3	GF7	GF5	R7	GF9	GF10	GFE10	GF3	GF2	GF8	WTF4	WTF3	GF7	GF6	RORWB4	RORWB3	ORWB1	R3	HPE3	HPE2
Acarina	Predator		1	1		4	14			2				1					1	2	33	6	1		2	10	1
Anisoptera	Predator																					1					
Pisauridae	Predator				4				3	16				1													
Ancylidae	Scraper				1														1	2	1						1
Lymnaeidae	Scraper				2																						
Physidae	Scraper					1																					
Planorbidae	Scraper				3																1	1	10	1			
Bryozoa	Filter-feeder		1		1											1								2			
Thiaridae	Scraper																										16
Coleoptera	Predator				1		1		4																		
Curculionidae	Shredder								1																		
Dytiscidae	Predator	2		10	5		1		2	19	6	3	3	2	10		3	1				8	1		5	7	
Hydraenidae	Gatherer/ collector	1	1		9				5	24		5		5				1	2	5		3	8		6	1	7
Hydrochidae	Shredder													3							1	5			1		
Hydrophilidae	Predator	1			3		2	1	10	2		1									3	1	5		1	2	
Noteridae	Predator											1							1		1	2					
Scirtidae	Filter-feeder			2			1			12											1				1		
Spercheidae	Filter-feeder													1				4	2	4	1	5			2		
Staphylinidae	Predator				2		1			4																	
Collembola	Gatherer/ collector	5				3	2			3																	

Taxon	Functional Feeding Guild	DRY SEASON									WET SEASON																				
		R7	GF9	G3	GF2	GF8	WTF4	WTF3	GF7	GF5	R7	GF9	GF10	GFE10	GF3	GF2	GF8	WTF4	WTF3	GF7	GF6	RORWB4	RORWB3	ORWB1	R3	HPE3	HPE2
Cirolanidae	Gatherer/ collector						1	2																			1
Cladocera	Filter-feeder		77		37	1	9		6	94			3	3	4	18		1	9	11	41	1	7	29	10		
Copepoda	Gatherer/ collector	21	45	17	61	9	6	4	38	78	2		5	2	8	4		8	11	31	136	13		9	9		1
Ostracoda	Filter-feeder	1	2		3	1			4	4					1					1	2		3	3	2		
Atyidae	Gatherer/ collector	1	5		14	5	3	10	3			17			17	15	7		1	3	8	3					
Caridea	Gatherer/ collector																				4						
Palaemonidae	Gatherer/ collector	1	11		3	4	16			5		1			1	45	7		1		1						7
Parastacidae	Shredder			1			1		2	8								2				2				1	
Ceratopogonidae	Predator	3	4		24	1	2		3	2	3			1				1	2	1	4	5	7	4		1	
Chaoboridae	undetermined																									1	
Chironomidae: s-f Chironominae	Filter-feeder		20	4	29	1	8	1	13	8	6	1	1	2		2	1	18	7	21	15	26	25	1	20	23	4
Chironomidae: s-f Orthocladiinae	Gatherer/ collector				1		1				2			1								2			1		5
Chironomidae: s-f Tanypodinae	Predator	1	5		16	3	1	2	1	2	2	1		4				1	2	1		3	3		1	3	
Culicidae	Filter-feeder	8	2		3						7		4	5	1			1	1	1	6	1		1		1	
Psychodidae	Gatherer/ collector		1																								
Sciomyzidae	Predator				6																						
Simuliidae	Filter-feeder										5			5													
Tipulidae	Gatherer/ collector									1	1			1													

Taxon	Functional Feeding Guild	DRY SEASON									WET SEASON																	
		R7	GF9	G3	GF2	GF8	WTF4	WTF3	GF7	GF5	R7	GF9	GF10	GFE10	GF3	GF2	GF8	WTF4	WTF3	GF7	GF6	RORWB4	RORWB3	ORWB1	R3	HPE3	HPE2
Baetidae	Gatherer/ collector			3	4	1	2			2	3	7	1	5	1	1	3	1	3	2	8	7	5	38		2	6
Caenidae	Gatherer/ collector			2		8	4	1							1			4	2							7	8
Leptophlebiidae	Gatherer/ collector																										1
Belostomatidae	Predator												1								4	8					
Corixidae	Predator			1		22	6	7	1	9	3	5	17		7		5	8	9	2		3	7			9	
Gerridae	Predator	1	3									1	2				1			1	2						
Hebridae	Predator																										1
Hydrometridae	Predator	1		2	3	2	4					1	1		1												
Mesoveliidae	Predator																			1							1
Naucoridae	Predator				2															1	3						
Nepidae	Predator		1	2						1																	
Notonectidae	Predator			2				2		4		1	8			1	7				1		7	29			
Ochteridae	Predator					1																					
Pleidae	Predator		1		1		2		14	1									1		15			1			
Veliidae	Predator	2	2	8	23		5		9	15	7	27	6	2	24	43	5	4	5	2	3	1				1	7
Glossiphoniidae	Predator		1																	2							
Hydridae	Predator		1		1															1							
Nematoda	Predator		1		4	1			6	2			1					3			7	6	25				
Aeshnidae	Predator						1																1				
Coenagrionidae	Predator			2	3	7	3	1				1	1						1	1	3			8	1		
Corduliidae	Predator						2															8					

Taxon	Functional Feeding Guild	DRY SEASON									WET SEASON																
		R7	GF9	G3	GF2	GF8	WTF4	WTF3	GF7	GF5	R7	GF9	GF10	GFE10	GF3	GF2	GF8	WTF4	WTF3	GF7	GF6	RORWB4	RORWB3	ORWB1	R3	HPE3	HPE2
Gomphidae	Predator				1	4																				2	13
Hemicorduliidae	Predator				2									1		1							2			1	
Isostictidae	Predator		12		5	2		9	2			1				1		1	1	7	1						
Libellulidae	Predator																						1	3			2
Protoneuridae	Predator																		2								
Teleplebiidae	undetermined																										1
Zygoptera	Predator		1			2			1			1				3			1	1	1	1	3				
Oligochaeta	Gatherer/ collector		3		6		1	1	1	1								1	4			2	3	2		4	2
Temnocephalidea	Predator	1					5		8	3						110	3	17				12					1
Ecnomidae	Predator				1	1	3		3	1						1		1	1	2						1	
Hydropsychidae	Filter-feeder										26			5													
Leptoceridae	Shredder	2	6	1	15	13	31	44	1	4	3	17	4			1	16	4	11	13	8	9	4	2			5
Trichoptera	undetermined										1			1													
Hyriidae	Predator																1										
Corbiculidae	Filter-feeder	3																									1
Corbiculoidea	Filter-feeder																										3

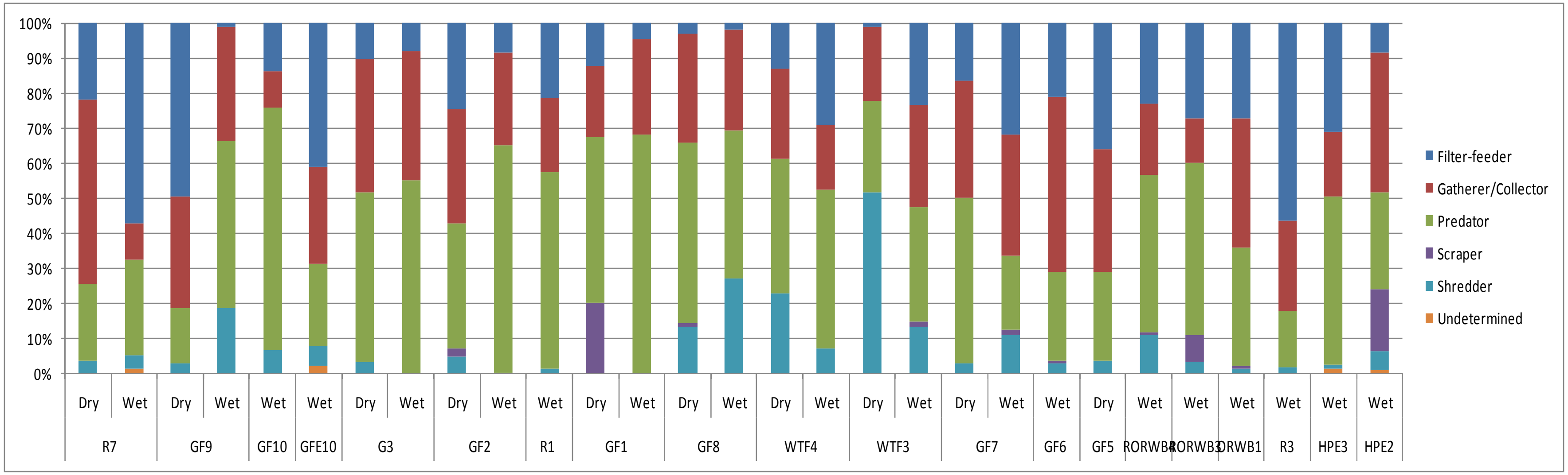


Figure A3-1 Functional feeding groups for dry season and post-wet season surveys

Table A3-2 SIGNAL 2 Scores for dry season and post-wet season surveys

Catchment	Site	SIGNAL2 Score	
		Dry	Wet
Condamine	R7	3.27	4.14
	GF10	-	2.77
	GF9	3.20	3.18
	G3	3.57	3.00
	GF2	3.16	3.83
	GF8	3.42	3.58
	WTF4	3.57	3.33
	WTF3	2.83	3.41
	GF7	3.26	3.14
	GF6	-	3.21
	RORWB4	-	3.33
	ORWB1	-	3.00
	R3	-	3.45
	HPE3	-	3.39
Border Rivers	GFE10	-	4.12
Dawson	RORWB3	-	3.41
	HPE2	-	4.27
	GF5	3.46	-

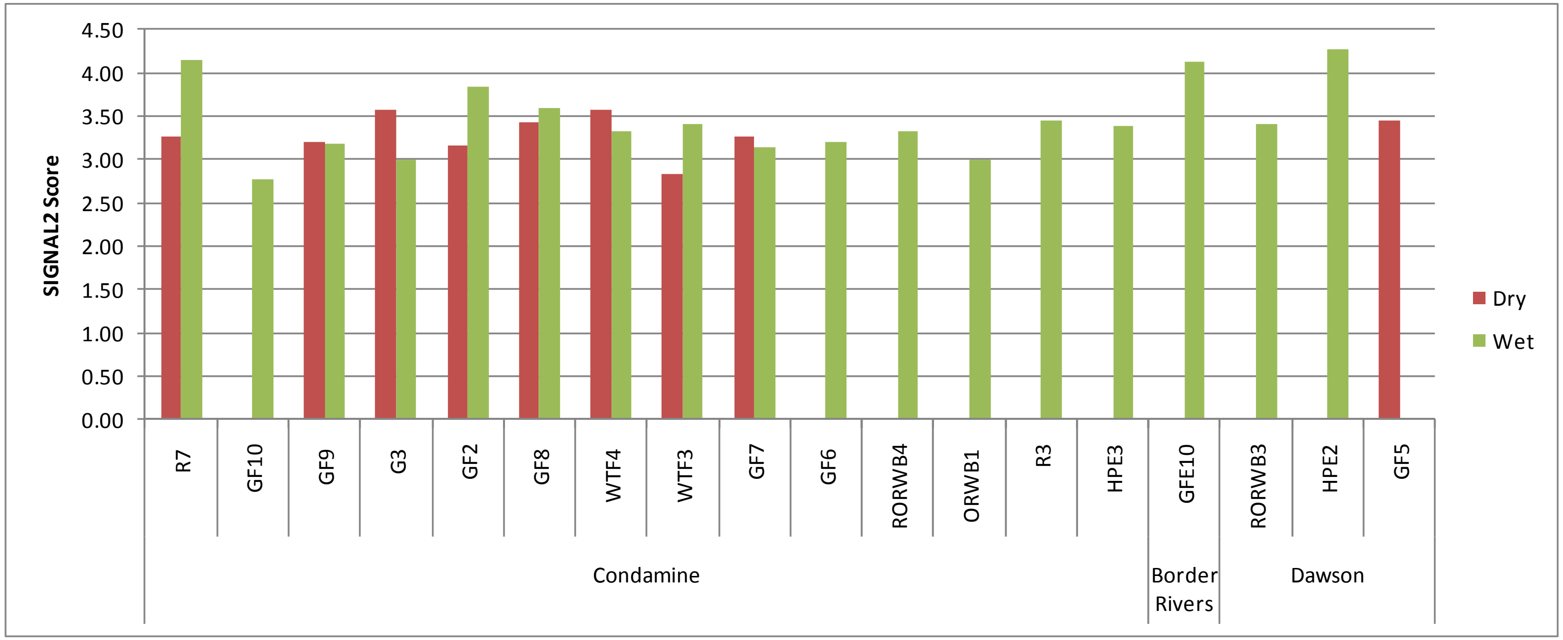


Figure A3-2 SIGNAL 2 Scores

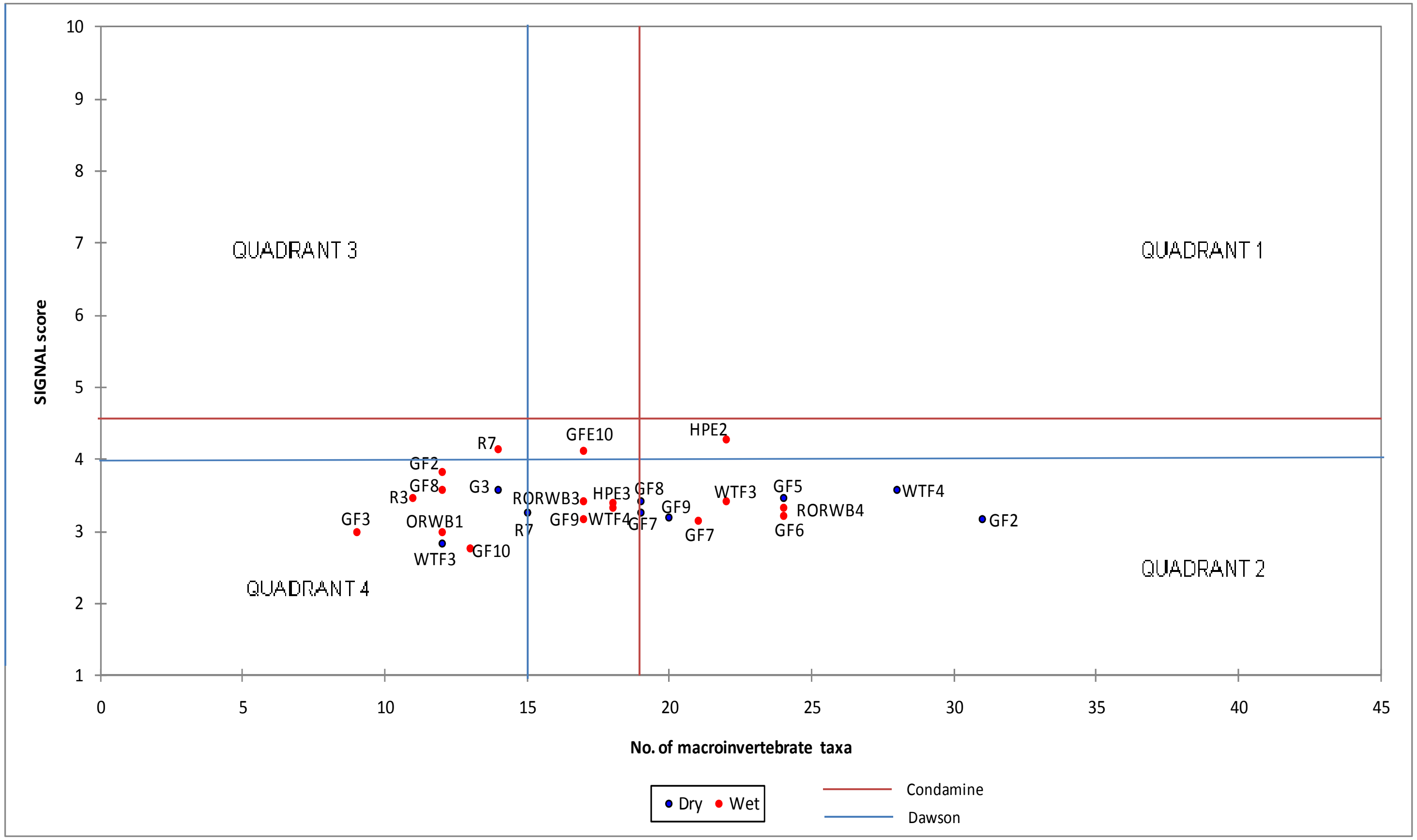


Figure A3-3 Bi-plot of SIGNAL 2 Scores

Table A3-3 Macroinvertebrate flow and substrate data – gas fields (bed data)

Taxon	Flow Pref	Substrate Pref	DRY SEASON														WET SEASON								
			R7	GF10	GF9	GF3	GF2	GF8	WTF4	WTF3	GF7	GF6	RORWB4	R3	HPE2	GF5	WTF4	WTF3	GF6	RORWB4	HPE3	GFE10	RE9	RORWB3	HPE2
Acarina	NP	NP		10				30					80	20	10				70	410	120		190	10	
Ancylidae	L/NF	NC						10		30	1								20						
Anisoptera	NC	NC								10															
Atyidae	L/NF	WF				1	1		1	8	2	10	20					1	10	10					
Baetidae	NP	NP		50						10						10		20	10		10	80	50	40	20
Belostomatidae	L/NF	SF																		1					
Bryozoa	NC	NC								10															
Caenidae	NP	NP				10		30		190		10	220		60		10	110			20	10	20		420
Ceratopogonidae	NP	NP	480	50		40	90	70	30	200	9		240		390	1	70	240	70	170	110	200	70	740	50
Chaoboridae	NC	NC		10																					
s-f Chironominae	NP	NP	280	1260		60	220	150	30	370	29	180	200	150	1400		370	570	430	3990	2880	230	1490	1390	210
s-f Orthocladiinae	NP	WC			60										50		110				10	70	20		340
s-f Tanypodinae	NP	NP		260		20	130	60		190	35	30	20	20	140	1	50	90	30	410	30	20	320	10	70
Cladocera	L/NF	WF		160	430	30	200	10		190	1	60	40	530	10	380			1040	10	160	10	30	70	
Clavidae	NC	NC							10																
Coenagrionidae	L/NF	WF								2															
Collembola	L/NF	SF	10			10																			
Copepoda	L/NF	WF	460	980		2600	1660		280	1970	379	20	160	1600	30	140	60	330	2710	190	100	20	580	60	
Corbiculidae	NP	NP																							1

Taxon	Flow Pref	Substrate Pref	DRY SEASON														WET SEASON										
			R7	GF10	GF9	GF3	GF2	GF8	WTF4	WTF3	GF7	GF6	RORWB4	R3	HPE2	GF5	WTF4	WTF3	GF6	RORWB4	HPE3	GFE10	RE9	RORWB3	HPE2
Corbiculoidea	NC	NC																							80
Corduliidae	L/NF	NP			1														1						
Corixidae	L/NF	WF		130				30	10														70	1	
Culicidae	L/NF	SF			200														10						
Dugesiidae	HF	WC		20																					
Dytiscidae	L/NF	WF		10										10		10							1		
Ecnomidae	NP	WC										2						150							20
Elmidae	HF	WC													20										30
Ephydridae	NC	NC									1														
Gerridae	L/NF	WF													10										
Glossiphoniidae	NP	NP			10																				
Gomphidae	NP	NP		1																	1				10
Hydraenidae	L/NF	SF								10															
Hydrometridae	L/NF	SF			10																				
Hydrophilidae	L/NF	WF																	1					20	
Hydropsychidae	HF	SC			50												330					200			20
Hydroptilidae	NP	WC																							40
Hyriidae	L/NF	SF						10		90															
Isostictidae	L/NF	WF								1															
Leptoceridae	NP	NP		1			1	50	10	70	1		140	10				40	10				20		10
Leptophlebiidae	NP	WC																							20
Libellulidae	NP	NP																		1					

Taxon	Flow Pref	Substrate Pref	DRY SEASON														WET SEASON								
			R7	GF10	GF9	GF3	GF2	GF8	WTF4	WTF3	GF7	GF6	RORWB4	R3	HPE2	GF5	WTF4	WTF3	GF6	RORWB4	HPE3	GFE10	RE9	RORWB3	HPE2
Megapodagrionidae	MF	SF									1														
Mesostigmata	NC	NC			10																				
Naucoridae	NP	NP			40																				
Nematoda	NP	NC	10	1460	110			10	10	20	6	80	400	20	20	10	10		240	70	20	20		3600	10
Noteridae	L/NF	SF			10																				
Notonectidae	L/NF	SF		10										20										40	
Oligochaeta	NP	NP	30	1380	470		200	120		330	79	150	20	40	290	60		110	410	70		280			10
Ostracoda	L/NF	WF		60	320	20	40	30	10	330	3	70	20		10			40	100		560		80	20	
Palaemonidae	NP	NP	40					1	1																
Parasticidae	L/NF	SF										10													
Physidae	L/NF	SF		2						1															
Planorbidae	L/NF	WF		1	30									10					10		10			10	
Ptilodactylidae	HF	SC			10																				
Simuliidae	HF	SC			300												20					90			360
Sphaeriidae	L/NF	SF						1							20										
Tabanidae	HF	SC			10										10										
Temnocephalidea	L/NF	NP	10																						
Veliidae	L/NF	WF					10																		
Zygoptera	NC	NC								40														30	

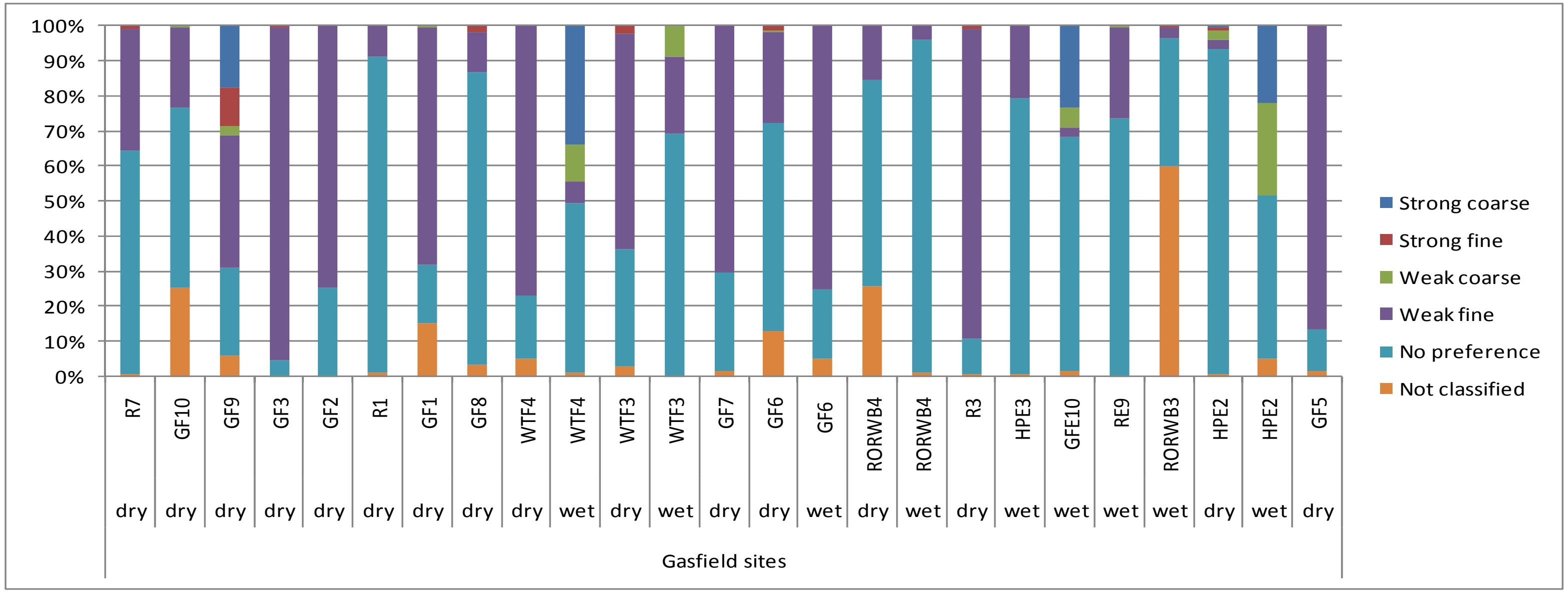


Figure A3-4 Substrate preference groups for dry season and post-wet season surveys

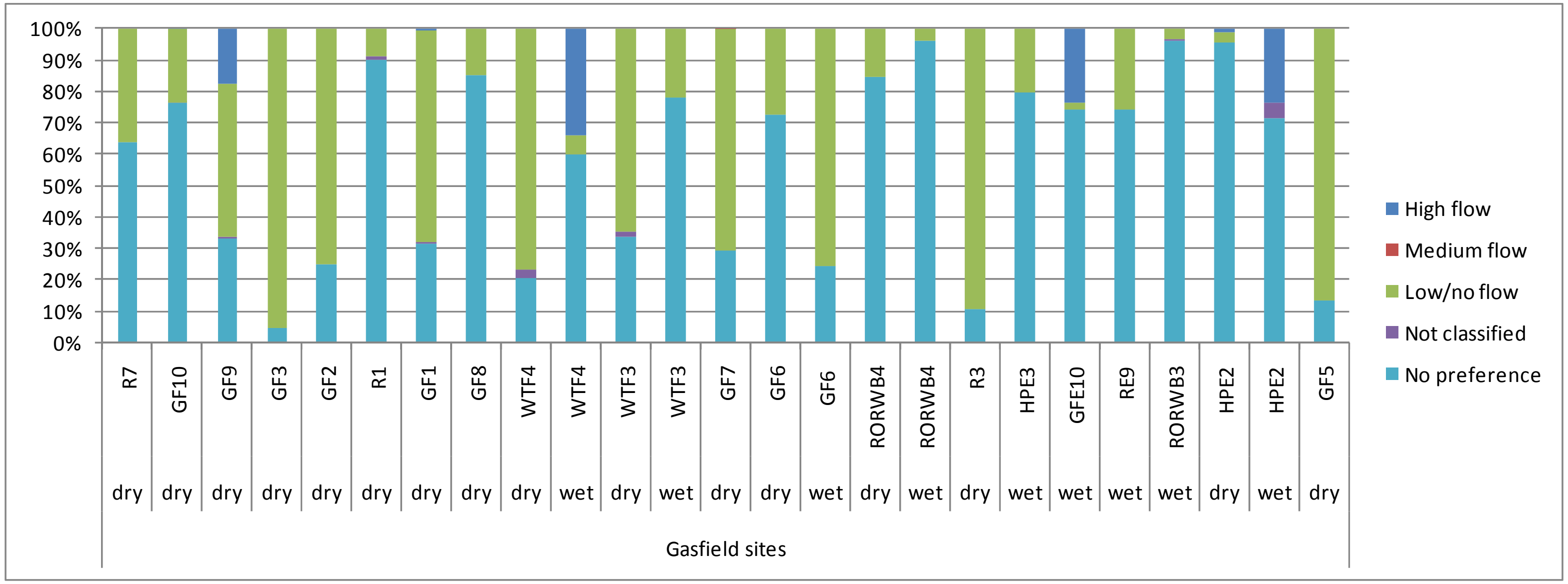


Figure A3-5 Flow preference groups for dry season and post-wet season surveys