# 13 AQUATIC ECOLOGY

## 13.1 Introduction

This Chapter discusses the aquatic flora (submerged, emergent, rooted or free floating) and fauna (fish, macroinvertebrates, turtles and others) present or likely to be present in the Glebe Option area. Potential impacts are determined for the construction and operation phases and mitigation measures are identified.

## 13.2 Methodology

The physical habitat, macrophytes, macro-invertebrates, fish and turtles in the vicinity of Glebe Weir were described through literature review and field survey. Surveys of the Dawson River and its tributaries were undertaken at the end of the dry season in November 2007 (frc environmental 2008a) and in June after the 2007 / 2008 wet season (Ecowise 2008).

Sixteen sites were chosen for survey, representing habitats in the main Dawson River channel, tributaries, and floodplain wetlands, above, below and within the inundation area and along the pipeline route (Figure 13-1). Sites used in previous surveys (NRW long term monitoring, State of the Rivers, university research) were re-used where possible. The pre-wet survey was interrupted by low level flooding such that a number of sites were initially dry and others could not be accessed because of the floods. Water quality samples were captured from some sites both before and during the flood. During the post-wet survey some tributary sties could not be sampled as they were already dry.

### 13.2.1 Aquatic habitat

At each site, whether it was wet or dry, habitat descriptions and observations were recorded using the State of the Rivers method (Anderson 1993a & b). The State of the Rivers method was used to allow for comparison with earlier assessments completed in the region (Telfer 1995, Anderson and Howland 1997). This was supplemented with a project specific datasheet.

### 13.2.2 Water quality

Measurement of in situ water quality included:

- water temperature (°C);
- electrical conductivity (μS/cm);
- pH;
- dissolved oxygen (mg/L and % saturation); and
- turbidity (NTU).

Water quality samples were obtained from 7 sites pre-wet and 11 post-wet. In pre-wet samples, four sites were sampled pre-flood and five, with two overlapping, were sampled during the flood.


Figure 13-1. Survey sites

### 13.2.3 Aquatic flora

The description of flora included:

- submerged, floating (free-floating or rooted) and emergent aquatic macrophytes;
- macroscopic algae; and
- the presence of any introduced or pest plants.

When water was present (four sites pre-wet and 11 sites post-wet), aquatic flora was assessed along a 10 m wide x 100 m long transect. Transects were positioned along one bank and included at least half the wetted channel width, with no more than 2 m of the transect width running along the lower bank. To ensure that observations were accurate, the belt transect was divided into 10 quadrats of equal size (10 x 10 m). The following were recorded for each quadrat:

- the presence of all native and exotic aquatic macrophytes, and their form; and
- the percent cover of each species in the quadrat.

### 13.2.4 Macroinvertebrates

A standard triangular-framed macroinvertebrate net with a cone shaped net of 250 µm mesh was used to sample the macroinvertebrate communities in discrete habitat types such as within aquatic macrophyte beds and around tree roots. Samples were standardised to 20 seconds in duration, and two samples were collected where possible. The same equipment was used to sample macroinvertebrates in riffle and soft sediment bed habitats, although a kick-netting style of sampling (square foot samples) was used. Five replicate samples were collected at each site.

A Surber sampler was used to collect five replicate samples from edge habitats adjacent to deep pools at each site. The area enclosed by the Surber approximated that sampled by kick-netting.

Macroinvertebrate samples were collected from 4 sites pre-wet and 11 post-wet. Collected samples were preserved and transported to the laboratory where invertebrates were sorted, counted and identified. Identification was to the level used by the NRW for ambient monitoring, i.e. family-level for macro-crustaceans, molluscs and insects (except for Chironomidae, which was taken to sub-family) and higher levels for other groups such as micro-crustacea, oligochaetes, nematodes and acarina.

### 13.2.5 Fish and macrocrustaceans

Fish and macro-crustacean surveys were carried out using gear types including:

- boat-mounted electrofisher at deep sites with access;
- backpack electrofisher at shallow sites;
- seine nets, gill nets; and
- bait traps.

Gear types appropriate to the characteristics of sites were used; hence, not all gear types were deployed at each site.

For each gear type, fish caught were identified, counted, and the presence of any wounds, lesions or deformities was recorded. At each site, up to 20 individuals of each species were measured (fork length, or total lengths for species with convex or truncate caudal fins). Almost all fish were released alive, but some specimens that were difficult to identify were euthanased and returned to the laboratory for confirmation of field identifications. Catches from each gear type and trap were recorded separately.

Any prawns, shrimp, or crayfish captured or observed were identified to the lowest practical taxonomic level, and the number of each taxon was estimated and recorded.

#### 13.2.6 Turtles

At sites where water depths were suitable, five large baited turtle traps were set along the bank and adjacent to cover (e.g. vegetation, snags) for standard 2 hour periods. At each site attempts were made to deploy the traps within a variety of habitats present. Turtles observed during other activities were recorded. Turtles captured or observed were identified to species and a photographic record was kept.

## 13.3 Existing environment values

### 13.3.1 Aquatic habitat

Habitat descriptions were undertaken at 7 sites pre-wet and at 11 sites post-wet. Overall, the reach environs of the watercourses in the vicinity of Glebe Weir are moderately impacted by human activity. Regionally, disturbances to the riparian zone have led to a reduction in the cover and diversity of in-stream habitat such as that provided by large woody debris (Telfer 1995). This is not the case in Glebe Weir itself where the riparian trees were not all originally removed so now stand as skeletons, or have fallen to provide large woody debris in the pool.

Riparian zone condition in the vicinity of the Glebe Weir was variable and typical of the region (frc environmental 2008a, Hyder Environmental 1997, Telfer 1995). Riparian zones were generally < 20 m wide and dominated by native grasses and herbs, but included exotic species also and often included various native tree and shrub species. Erosion was evident in the vicinity of the Glebe Weir (frc environmental 2008a, Hyder Environmental 1997) and was a feature of many regional waterways (Telfer 1995).

Streambeds were relatively stable although there was some scouring at bends or downstream of obstructions, and some deposition in pools or upstream of obstructions (particularly Glebe Weir). Channel diversity was generally low across the survey area; isolated pools were the dominant habitat. Regionally, channel diversity was low to moderate (Telfer 1995).

Limited aquatic habitat for fauna was found at most of the sites surveyed. In-stream habitat was typically submerged or exposed tree roots, large woody debris and overhanging vegetation. In the current weir pool, the dominant aquatic habitat upstream was dead tree trunks, fallen trees and logs. Site 2 on the Dawson River upstream from the current or proposed inundation area was the only site surveyed with a variety of aquatic habitat (Ecowise 2008), including riffle.

In the vicinity of Glebe Weir, and regionally, in-stream habitat was most diverse at sites with an extensive riparian zone and overhanging vegetation. Regionally, aquatic habitat was most commonly leaves and twigs, branches, tree roots, logs and boulders (Telfer 1995).

Plates 13-1 and 13-2 depict the range of watercourse crossings along the pipeline route. Cockatoo Creek is the largest watercourse and is similar to Bungaban Creek, Bullock, Roche and Juandah creeks while Price Creek at Cracow Rd is similar in form to many of the smaller (Order 1 or 2) ephemeral watercourses on the route.

Plate 13-1. Cockatoo Creek crossing on Nathan Road

Plate 13-2. Price Creek at Taroom-Cracow Road crossing

The Cockatoo Creek / Sandy Creek sand extraction area is comprised of low profile creek beds which are strongly dominated by sand (Plate 13-3). Sandy Creek is ephemeral at its junction with Cockatoo Creek while

Cockatoo Creek in this area is less ephemeral and appears to hold near permanent water in a pool upstream. There is also a small offstream water body between the two creeks.

Plate 13-3. Cockatoo / Sandy Creek sand extraction site

### 13.3.2 Water quality

The main changes during flooding that were observed in the pre-wet sampling were significantly increased turbidity (doubling from about 600NTU) and lowered conductivity presumably as the incoming dirty water flushed the remaining pools that had been evaporating or increasingly influenced by groundwater. Water quality data is presented in Chapter 8. At the time of the pre- and post-wet season surveys, dissolved oxygen (DO) concentrations were variable and generally not compliant with the EPA's (2006a) Queensland Water Quality Guidelines (QWQG). DO concentrations were lowest downstream of the weir on the main channel (sites 5 and 6). DO, or any other parameter, showed some decrease with depth but overnight logging did not show any significant diurnal change (Ecowise 2008).

Low DO concentrations appeared to reflect the high biochemical oxygen demand (BOD) and low mixing of the waters and this reflected site specific characteristics. The wider Fitzroy River catchment is characterised by fluctuating and often low DO concentrations (Berghuis and Long 1999).

Turbidity levels were mostly not compliant with QWQG during the pre-wet season survey (frc environmental 2008a) but mostly compliant during the post-wet season survey (Ecowise 2008). Turbidity was higher at the downstream extremity of the weir pool on the main channel (site 4) and Cockatoo Creek (site 12), than most sites, during both surveys. High turbidity apparently reflects clearing of riparian vegetation and land generally, sloped / steep banks and flow events, together with water levels. The wider Fitzroy River catchment was characterised by high turbidity (Meecham 2003).

Nutrient concentrations exceeded QWQG at most sites on the main channel (sites 1, 3, 4, 5 and 6) during the post-wet season survey (Ecowise 2008). Concentrations were lower in the one tributary site sampled (Bentley

Creek, site 13). There were no observations of significance with regard to the weir. Nutrient concentrations vary across the Dawson River catchment (EPA 2001). The wider Fitzroy River catchment is characterised by relatively high inputs of nutrients, compared to other Australian catchments (Meecham 2003, Moss *et al*. 1992).

The post-wet season survey did not detect elevated pesticide concentrations (Ecowise 2008).

### 13.3.3 Aquatic flora

Fifteen species of aquatic macrophyte were recorded from the field survey program, ten from the pre-wet season survey (noting 3 sites were dry when assessed so contained no aquatic flora) and seven from the post-wet (Table 13-1). All species were native (Queensland Herbarium 2007); and none were listed as rare or threatened under the *Nature Conservation (Wildlife) Regulation 2006*. No declared pest or weed species of macrophyte have been recorded from the study area. As part of a separate investigation, the endangered (NC Act and EPBC Act) aquatic macrophyte *Myriophyllum artesium* was found associated with a boggomoss on Sandy Creek upstream from the sand extraction area.

Table 13-1. Presence / absence of all aquatic macrophytes at each site, listed by growth form

| Family | Latin name | Common name | Growth Form[1] | Native / Exotic | Sites upstream of the weir pool | | | | | | | | Sites in the weir pool | | | Sites downstream of the weir pool | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1[2] | 2 | | 3 | 8 | 10 | 11 | 15 | 4 | | 12 | 13 | 5 | 6 | 7 | 9 | 14 | | 16 |
| | | | | | b | a | b | b | b | b | b | b | a | b | a | b | b | b | b | b | a | b | b |
| Amaranthaceae | *Alternanthera denticulata* | lesser joyweed | E | N | | X | | | | | | | | | X | | | | | | | | |
| Azollaceae | *Azolla pinnata* | | F | N | | | | | | | | | | | | | | | X | | | | |
| Cyperaceae | *Cyperus difformis* | dirty Dora | E | N | | X | | | | | | | X | | | | | | | X | | | |
| | *Schoenoplectus mucronatus* | sedge | E | N | | | X | | | | | | | X | | | | | | | X | | |
| Gramineae | *Echinochloa inundata* | awnless barnyard | E | N | | | | | | | | | X | | | | | | | | | | |

[1] E = emergent; F = floating; S= submerged

[2] a = Pre; b = Post

| Family | Latin name | Common name | Growth Form[1] | Native / Exotic | Sites upstream of the weir pool | | | | | | | | Sites in the weir pool | | | Sites downstream of the weir pool | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1[2] | 2 | | 3 | 8 | 10 | 11 | 15 | 4 | | 12 | 13 | 5 | 6 | 7 | 9 | 14 | | 16 |
| | | | | | b | a | b | b | b | b | b | b | a | b | a | b | b | b | b | b | a | b | b |
| | *Eleocharis sp.* | | E | N | X | | | | | | | | | X | | | X | X | | X | | | |
| Juncaceae | *Juncus prismatocarpus* | rush | E | N | | | | | | | | | | | | | | | | | | | |
| | *Juncus usitatus* | common rush | E | N | | X | | | | | | | X | | | | | | | | | | |
| Lemnaceae | *Lemna sp.* | | F | N | | | | | | | | | | | | | | | X | | | | |
| Lomandraceae | *Lomandra hystrix* | creek mat rush | E | N | | X | | | | | | | X | | | | | | | | | | |
| | *Lomandra sp* | creek mat rush | E | N | X | | X | | | | | | | | | | | | | | | | |
| Ploygonaceae | *Persicaria attenuata* | knot weed | E | N | X | | X | | | | | | | X | | | X | | X | | | | |
| | *Persicaria decipiens* | slender knot weed | E | N | | X | | | | | | | X | | X | | | | | | | | |

| Family | Latin name | Common name | Growth Form[1] | Native / Exotic | Sites upstream of the weir pool | | | | | | | | Sites in the weir pool | | | Sites downstream of the weir pool | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1[2] | 2 | | 3 | 8 | 10 | 11 | 15 | 4 | | 12 | 13 | 5 | 6 | 7 | 9 | 14 | | 16 |
| | | | | | b | a | b | b | b | b | b | b | a | b | a | b | b | b | b | b | a | b | b |
| | *Persicaria orientalis* | princes's feather | E | N | | | | | | | | | X | | X | | | | | | | | |
| Typhaceae | *Typha domingensis* | cumbungi | E | N | | | | | | | | | X | | | | | | | | | | |

Most aquatic macrophytes had an emergent growth form; floating species were only observed post-wet season and only on Gyranda Weir pool. Knotweeds were the most abundant aquatic macrophytes. Macro-algae was sparse.

Richness (Figure 13-2) was variable, although generally lower at tributary sites (including zero counts), which is likely due to a lack of permanent water. Cover was low across the survey area, except at the downstream extremity of the Glebe weir pool (site 4) during the pre-wet survey (Figure 13-3); richness was also relatively high at this site and comprised emergent species that had germinated when the weir pool was lowered. At this time *Persicaria* sp. (knot weeds) covered most of the (dry) bed and banks, and sedges grew over moist areas of the downstream bank. Following the wet season both diversity and cover at this site were significantly reduced as a result of drowning. Knot weeds, *Typha domingensis* (cumbungi) and *Echinochloa inundata* (awnless barnyard grass) grew in the weir pool only. Floating macrophytes were observed at the Gyranda Weir pool site (site 7) only.

Regional surveys have reflected the dynamic spatial and temporal nature of aquatic macrophytes in the area (Duivenvoorden 1995, Noble *et al*.1995, Telfer 1995, Duivenvoorden 1992, 1990, Mackey 1988); richness was higher during the recent pre-west season survey (frc environmental 2008a) than the post-wet season survey (Ecowise 2008).

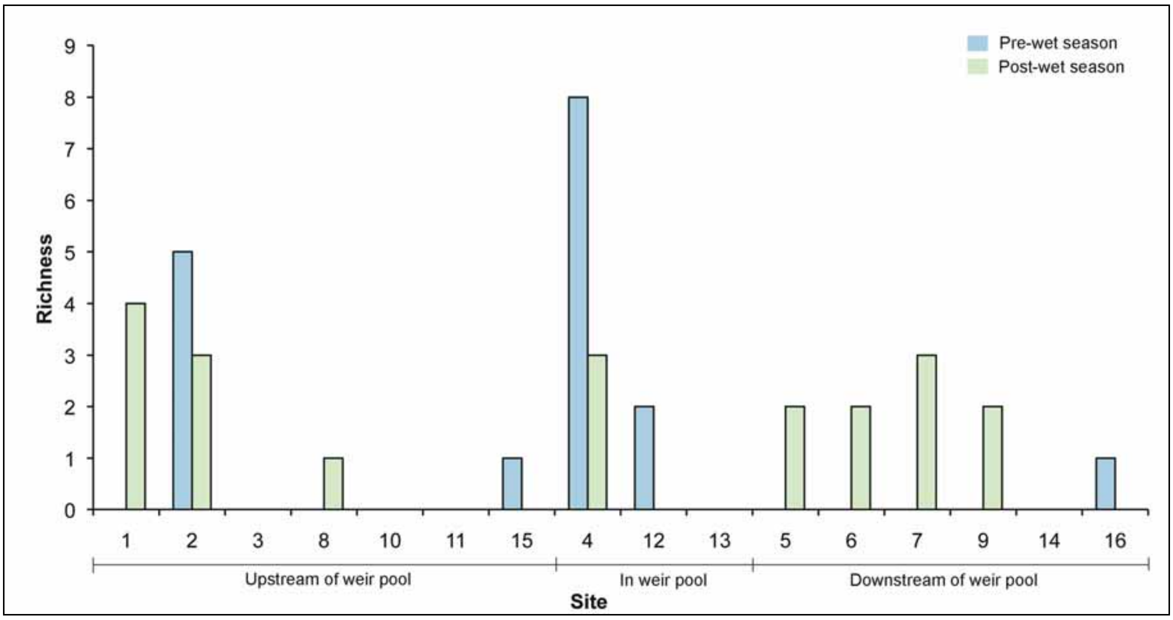


Figure 13-2. Aquatic macrophyte richness at each site surveyed.

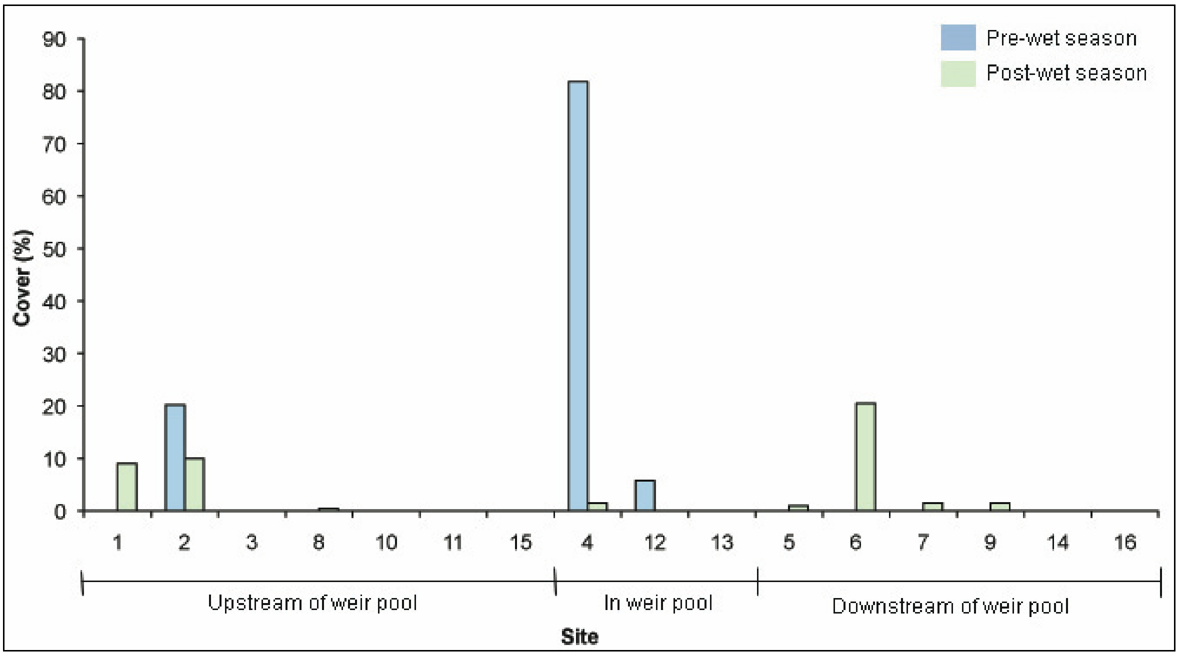


Figure 13-3. Percent cover of aquatic macrophytes at each site surveyed.

### 13.3.4 Aquatic fauna

#### *13.3.4.1 Aquatic macroinvertebrates*

- Richness and abundance

During recent surveys, richness in edge habitats was lowest at sites in the Glebe weir pool (3.4 – 10) but that in Gyranda Weir pool (site 7) was similar to riverine sites (Figure 13-4). The site nearest the weir wall (Site 4) experiences the greatest water level fluctuation and the pre-wet survey was undertaken when the pool was at its lowest. The edge was recolonised rapidly after filling so that the fauna post-wet showed greater similarities with non-weir pool fauna, including more leptocerid caddisflies, presumably associated with the leaf litter derived from riparian trees. Site 12 in Cockatoo Creek is also close to the weir wall but a shorter distance from riparian vegetation. Site 12 and site 13, at the upper extremity of the weir pool, showed results more similar to non-weir pool sites. Upstream and downstream of the weir pool, richness in edge habitats was lower for tributaries (11 – 12) than on the main channel (13 – 17), likely related to the more ephemeral nature of the tributaries. Richness of edge habitats in the main channel was comparable between upstream and downstream sites. The limited number of samples collected prevents statistical analysis of bed, tree root and macrophyte habitats but it can be said that the bed commonly showed lower diversity while macrophyte and tree root was often the most diverse, at times very much so.

In the vicinity of Glebe Weir, aquatic macroinvertebrate communities varied spatially and temporally with richness of 2 – 33 families at any one site (Ecowise 2008, frc environmental 2008a, Duivenvoorden *et al* 2003, DNRW long-term macroinvertebrate monitoring site at Taroom).

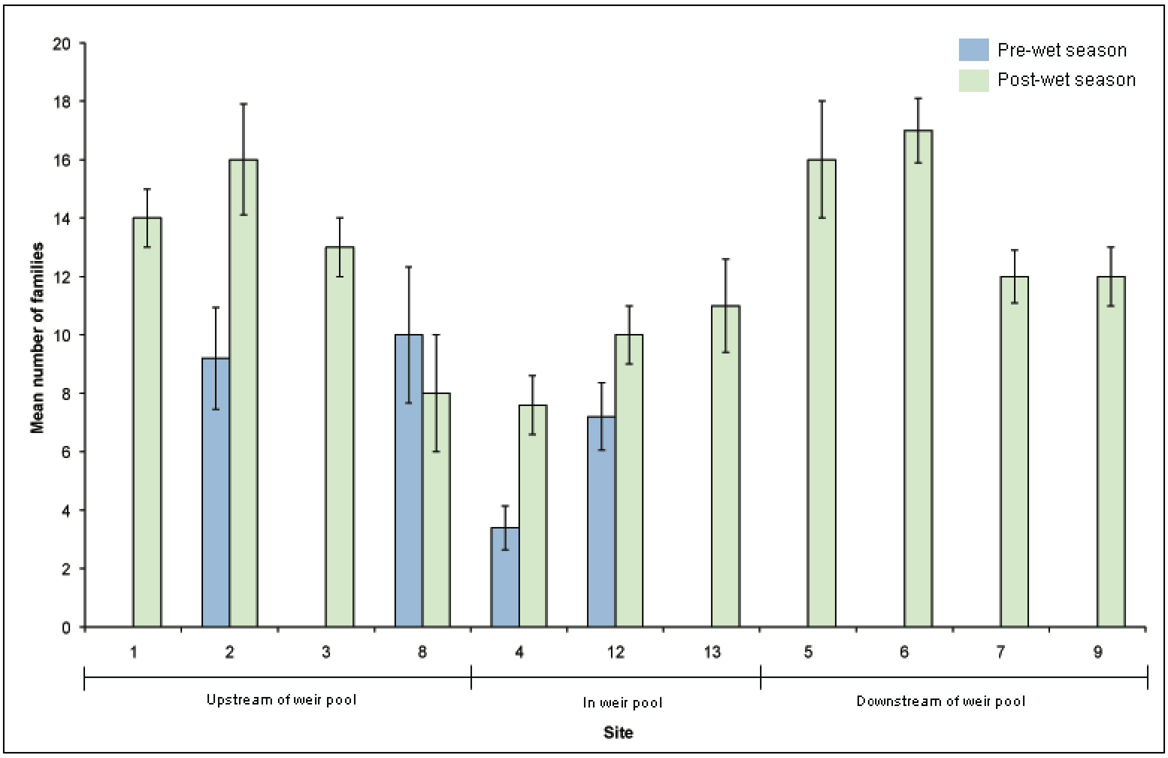


Figure 13-4. Mean number of macroinvertebrate families (richness) in edge habitat at each site surveyed

Total abundance was variable across sites; for example, it was relatively low at the downstream extremity of the Glebe weir pool (site 4) but relatively high at the upstream extremity of the weir pool on Bentley Creek (site 13) (Figure 13-4).

Macroinvertebrate richness and abundance generally increase post-wet season (Ecowise 2008, frc environmental 2008a, Duivenvoorden *et al* 2003), though this depended on the severity of the floods and the time since they occurred. Recent surveys reported 11 – 31 families post-wet season (Ecowise 2008) compared to 2 – 19 pre-wet season (frc environmental 2008a). From September 2002 – May 2003, richness ranged from 5 – 33 at sites surveyed in association with the Dawson Valley irrigation area, with higher richness post-wet season (Duivenvoorden *et al* 2003). This probably relates to the creation of new habitat and redistribution of the fauna.

Table 13-2. Total abundance (for all replicates and habitats sampled) of each macro-invertebrate taxon sampled from the sites that held water.

| Order | Family / Sub-family | Sites upstream of the weir pool | | | | | | Sites in the weir pool | | | | | Sites downstream of the weir pool | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | | 3 | 8 | | 4 | | 12 | | 13 | 5 | 6 | 7 | 9 |
| | | Post | Pre | Post | Post | Pre | Post | Pre | Post | Pre | Post | Post | Post | Post | Post | Post |
| Acarina | Acarina | | | | | 1 | | | | 1 | | | | | | |
| Aranea | | | | | | 7 | | | | 3 | | | | | | |
| Bivalvia | Corbiculidae | 17 | 82 | | 12 | | | | | | | | 80 | 34 | | |
| Bivalvia | Hyriidae | 2 | 1 | | | | | | | 1 | | | | | | 1 |
| Bivalvia | Sphaeriidae | 45 | | 8 | 3 | | | | | | | | 33 | 25 | | |
| Bivalvia | Sphaeriidae/ Corbiculidae immature | 3 | | 0 | 3 | | | | | | | | | 3 | | |
| Coleoptera | Chrysomeliidae | | | | | 1 | | 1 | | 21 | | | | | | |
| Coleoptera | Dytiscidae | 2 | | 35 | | | 5 | | 22 | | 8 | 2 | 8 | 20 | | 2 |
| Coleoptera | Elmidae | | | 15 | | | | 2 | | 5 | | | | | 1 | |
| Coleoptera | Heteroceridae | | | | | 1 | | | | | | | | | | |

| Order | Family / Sub-family | Sites upstream of the weir pool | | | | | | Sites in the weir pool | | | | | Sites downstream of the weir pool | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | | 3 | 8 | | 4 | | 12 | | 13 | 5 | 6 | 7 | 9 |
| | | Post | Pre | Post | Post | Pre | Post | Pre | Post | Pre | Post | Post | Post | Post | Post | Post |
| Coleoptera | Hydraenidae | | | 5 | | 14 | | | 2 | 5 | 2 | 1 | 13 | 4 | 2 | |
| Coleoptera | Hydrochidae | | | | | 2 | | | | 2 | | 6 | 2 | | | |
| Coleoptera | Hydrophilidae | | | 1 | | 2 | | 2 | | 18 | | 1 | 48 | 4 | | |
| Coleoptera | Limnichidae | | | | | | | | | 17 | | | | | | |
| Coleoptera | Ptiliidae | | 1 | | | | | | | | | | | | | |
| Coleoptera | Scirtidae | | | | | 6 | | | | | | 1 | 1 | | | |
| Coleoptera | Staphylinidae | | | | | | | | | 4 | | | 14 | | | |
| Conchostraca | | | | | | 1 | | | | | | | | | | |
| Crustacea | Cladocera | 3 | | | | 32 | | | 137 | 2 | 3 | 1 | 1140 | 40 | 1 | 10 |
| Crustacea | Copepoda | 20 | | 132 | 24 | 26 | 888 | | 92 | 2 | 31 | 17 | 86 | 253 | 350 | 590 |
| Crustacea | Ostracoda | 30 | | 27 | 31 | | | | 3 | | 24 | | 88 | 30 | 75 | 41 |
| Crustacea | unidentified | | | | | | | | | | | 3 | | | | |

| Order | Family / Sub-family | Sites upstream of the weir pool | | | | | | Sites in the weir pool | | | | | Sites downstream of the weir pool | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | | 3 | 8 | | 4 | | 12 | | 13 | 5 | 6 | 7 | 9 |
| | | Post | Pre | Post | Post | Pre | Post | Pre | Post | Pre | Post | Post | Post | Post | Post | Post |
| Decapoda | Atyidae | 6 | 20 | 5 | 5 | | | 1 | | 8 | | 5 | | | | 3 |
| Decapoda | Palaemonidae | 5 | 47 | 24 | 11 | | 4 | | | | | 15 | | 4 | | 3 |
| Decapoda | Parastacidae | | 12 | | | 1 | | | | | | | | 1 | | 1 |
| Diptera | Ceratopogonidae | 159 | 15 | 1067 | 863 | 2 | 38 | | 125 | 5 | 269 | 406 | 686 | 237 | 132 | 496 |
| Diptera | Chaoboridae | | | | | | 1 | | | 1 | | | | | | |
| Diptera | Culicidae | | | 1 | | | | 5 | | 1 | | 1 | 12 | 6 | | 3 |
| Diptera | Dixidae | | | | | | | | | | | | 5 | | | |
| Diptera | Dolichopodidae | | | 2 | | 1 | | | | | 1 | 13 | | | | |
| Diptera | Empididae | | | 2 | | | | | | | | | | | | |
| Diptera | Muscidae | | | 4 | | | | | | | | | | | | |
| Diptera | Psychodidae | | | | | | | | 3 | | | 1 | | 1 | | |
| Diptera | s-f Chironominae | 34 | 25 | 581 | 218 | | 2 | | 30 | | 1631 | 168 | 1348 | 1035 | 542 | 966 |

| Order | Family / Sub-family | Sites upstream of the weir pool | | | | | | Sites in the weir pool | | | | | Sites downstream of the weir pool | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | | 3 | 8 | | 4 | | 12 | | 13 | 5 | 6 | 7 | 9 |
| | | Post | Pre | Post | Post | Pre | Post | Pre | Post | Pre | Post | Post | Post | Post | Post | Post |
| Diptera | s-f Orthocladiinae | | | 1285 | 5 | | | | 2 | | 19 | 4 | 2 | 44 | 11 | 2 |
| Diptera | s-f Tanypodinae | 51 | 89 | 97 | 125 | 55 | | 10 | 14 | 17 | 188 | 18 | 276 | 92 | 124 | 26 |
| Diptera | Chironomidae | | 52 | 5 | 3 | 7 | | 4 | | 8 | | | | | 33 | 1 |
| Diptera | Simuliidae | | 518 | 1113 | | | | | | | | | | | | |
| Diptera | Tabanidae | | 5 | 1 | | 4 | | | 1 | 8 | | 1 | 5 | | | 5 |
| Diptera | Tipulidae | | | 2 | | 2 | | | | | 2 | 16 | | | 1 | 1 |
| Diptera | Unidentified | | 2 | 5 | | 2 | | | 7 | 1 | | 3 | | | 3 | |
| Ephemeroptera | Baetidae | 3 | 244 | 16 | 4 | 19 | | 1 | | 14 | | 2 | 4 | 45 | 17 | 2 |
| Ephemeroptera | Caenidae | 28 | 102 | 247 | 10 | | 1 | | 5 | | 42 | | 90 | 955 | 18 | 32 |
| Ephemeroptera | Leptophlebiidae | | 8 | | 8 | | | | | | | | | 6 | | |
| Ephemeroptera | immature/damaged | | | 20 | 3 | | | | | | | | 12 | 8 | 5 | |
| Gastropoda | Ancylidae | 5 | | 2 | | | | | | | | | | 1 | | 4 |

| Order | Family / Sub-family | Sites upstream of the weir pool | | | | | | Sites in the weir pool | | | | | Sites downstream of the weir pool | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | | 3 | 8 | | 4 | | 12 | | 13 | 5 | 6 | 7 | 9 |
| | | Post | Pre | Post | Post | Pre | Post | Pre | Post | Pre | Post | Post | Post | Post | Post | Post |
| Gastropoda | Hydrobiidae | 28 | | | | | | | | | | | | 49 | | |
| Gastropoda | Physidae | | 11 | | | 7 | | | | 11 | | | | | | |
| Gastropoda | Planorbidae | | | | | 5 | | | | | | | | | | |
| Gastropoda | Physidae/Planorbidae immature | | | | | | | | | | | | 4 | | | |
| Gastropoda | Thiaridae | 56 | 6 | 20 | | | | | | | | | 32 | | | |
| Gastropoda | Viviparidae | 3 | 1 | | | | | 7 | | | | | 2 | | | |
| Gastropoda | Unidentified | | | | | 1 | | | | | | | | | | |
| Hemiptera | Belostomatidae | | | | | | | | | 1 | | | | | | |
| Hemiptera | Corixidae | | 17 | 4 | 21 | 41 | | 116 | 5 | 125 | 12 | 4 | 10 | | 9 | |
| Hemiptera | Gerridae | | 6 | | | 4 | | | | | | 2 | | | 4 | |
| Hemiptera | Hydrometridae | | | | | 1 | | | | 32 | | 4 | 8 | | | |
| Hemiptera | Mesoveliidae | | 1 | | | | | 10 | | 127 | | | | | | |

| Order | Family / Sub-family | Sites upstream of the weir pool | | | | | | Sites in the weir pool | | | | | Sites downstream of the weir pool | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | | 3 | 8 | | 4 | | 12 | | 13 | 5 | 6 | 7 | 9 |
| | | Post | Pre | Post | Post | Pre | Post | Pre | Post | Pre | Post | Post | Post | Post | Post | Post |
| Hemiptera | Naucoridae | | | | | | | | | | | | | | 4 | |
| Hemiptera | Nepidae | | | | | | | | 1 | | | | | | | |
| Hemiptera | Notonectidae | | | | | 28 | 2 | 2 | 1 | 35 | | | | | | |
| Hemiptera | Ochteridae | | | | | | | 1 | | | | | | | | |
| Hemiptera | Pleidae | | | | | | | 1 | | | | 1 | 5 | | | |
| Hemiptera | Saldidae | | | | | | | | | 2 | | | | | | |
| Hemiptera | Veliidae | | 16 | | | 71 | | | | 3 | | 33 | 24 | 3 | | |
| Hirudinea | Erpobdellidae | | 6 | | | | | | | | | | | | | |
| Hirudinea | Richardsonianidae | | | | 1 | | | | | | | | | | | |
| Lepidoptera | Pyralidae | | | | | | | 1 | | 3 | | | | | | |
| Isopoda | Cirolanidae | | | 1 | | | | | | | | | 1 | | | |
| Isopoda | immature/damaged | 3 | | | | | | | | | | | | | | |

| Order | Family / Sub-family | Sites upstream of the weir pool | | | | | | Sites in the weir pool | | | | | Sites downstream of the weir pool | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | | 3 | 8 | | 4 | | 12 | | 13 | 5 | 6 | 7 | 9 |
| | | Post | Pre | Post | Post | Pre | Post | Pre | Post | Pre | Post | Post | Post | Post | Post | Post |
| Nematoda | unidentified | | | 5 | 5 | | | | | | 14 | | 8 | | 7 | 4 |
| Nematomorpha | Gordiidae | | | | | | | | | | | | 2 | | | |
| Nemertia | | | 4 | | | | | | | | | | | | | |
| Odonata | Aeshnidae | | | | | | | | | | | | | | 8 | |
| Odonata | Coenagrionidae | | | 3 | 1 | | | | | 1 | | | | | | |
| Odonata | Epiproctophora | | | | 4 | | | | | | 7 | 2 | 2 | 3 | 23 | |
| Odonata | Gomphidae | 15 | | 40 | 4 | | 1 | | 1 | | | | 24 | 25 | 7 | 4 |
| Odonata | Isostictidae | | | | | | | | | | | | | | 1 | |
| Odonata | Lestidae | | | | | 5 | | | | | | | | | | |
| Odonata | Libellulidae | | | | 2 | 1 | | 1 | | 7 | 2 | 1 | | 3 | | |
| Odonata | Macromiidae | | | | | 4 | | | | | | | | | | |
| Odonata | Protoneuridae | | | | | | | | | | | | | 6 | | |

| Order | Family / Sub-family | Sites upstream of the weir pool | | | | | | Sites in the weir pool | | | | | Sites downstream of the weir pool | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | | 3 | 8 | | 4 | | 12 | | 13 | 5 | 6 | 7 | 9 |
| | | Post | Pre | Post | Post | Pre | Post | Pre | Post | Pre | Post | Post | Post | Post | Post | Post |
| Odonata | Synthemistidae | | 1 | | | | | | | | | | | | | |
| Odonata | Zygoptera immature | 3 | | 6 | | | | | | | | 1 | | 3 | 20 | |
| Oligochaeta | Oligochaeta | 38 | | 176 | 10 | | | | 5 | | 1 | 8 | 33 | 166 | 17 | 34 |
| Trichoptera | Calamoceratidae | 2 | 2 | | 2 | | | | | | | | 6 | | | |
| Trichoptera | Ecnomidae | 4 | 58 | 19 | | 2 | | | | | | | | 2 | 7 | |
| Trichoptera | Hydropsychidae | | 14 | 195 | | | | | | | | | | | | |
| Trichoptera | Hydroptilidae | | | 3 | | | | | | | | | | 1 | | |
| Trichoptera | Leptoceridae | 7 | 93 | 26 | 12 | 9 | 1 | | 10 | 3 | 34 | 16 | 129 | 112 | 179 | 1 |
| Trichoptera | immature/damaged | 5 | | 15 | | | | | 1 | | | 2 | | 18 | 20 | |
| Turbellaria | Dugesiidae | | | | | | | | | | | | | 1 | | |

- Community composition

The recorded fauna was representative of the region, with a diverse fauna of coleopteran scavengers, surface bugs, micro-crustaceans and a range of dipteran (fly and midge) species. No species of recognised conservation significance were recorded.

Communities of the Glebe weir pool were generally similar to those upstream and downstream of the weir, on the main channel and tributaries. Weir pool communities often included slightly fewer copepods, baetids, caenids and several fly subfamilies. The Gyranda weir pool contained more dragonflies and leptocerid caddisflies but less beetles than either Glebe weir or many of the riverine sites.

Immediately downstream of the weir (site 5) and (to a lesser extent) at the downstream extremity of the weir pool (site 4) there were more water fleas (order Cladocera) than other sites. Cladoceran eggs are long lived, tolerant of harsh conditions and often distributed by the wind or larger animals moving between water bodies (Gooderham and Tsyrlin 2002). They also reproduce very quickly in response to food (algae, bacteria and detritus) availability (Gooderham and Tsyrlin 2002). High abundance may reflect accumulation of food availability and eggs.
Site 2 contained the only riffle surveyed and this was the only site to record simuliid blackflies or hydropsychid caddisflies, both flowing water specialists. Mayflies, particularly *Baetis*, were also more common at this site.

- Macrocrustaceans

frc environmental (2008a) positively identified four macro-crustacean species across the survey area; *Macrobrachium australiense* (prawn), *Paratya australiensis* and *Caradina* sp (shrimps) and *Cherax depressus* (yabby). Hyder Environmental (1997) reported a comparable richness of three species. All species were more common upstream of the weir inundation area.

#### *13.3.4.2 Fish*

- Richness and abundance

Pre- and post-wet season surveys captured 18 species, with abundance at any one site ranging from 32 – 173 fish pre-wet season (frc environmental 2008a) to 1–113 fish post-wet season (Ecowise 2008 Table 13-3). Care should be exercised when interpreting the data as the sampling effort varied considerably between sites depending on the habitat available. There were no obvious patterns in richness or abundance, related to the weir pool Figure 13-5. The highest diversity was found in the Gyranda weir pool.

- Community composition

*Nematalosa erebi* (bony bream) was the most abundant and widely distributed species followed by *Leiopotherapon unicolor* (spangled perch). Other species were usually in low numbers and patchily distributed, though Yellowbelly occurred at most sites and some species were occasionally found in higher numbers, such as *Hypseleotris* species 1 (Midgley's carp gudgeon), *Melanotaenia splendida* (eastern rainbowfish), *Neosilurus hyrtlii* (Hyrtl's tandan) and Mosquitofish (*Gambusia holbrooki*). Exotic species were limited to *Gambusia holbrooki* (mosquitofish) and *Carassius auratus* (goldfish). The least common species were Rendahls tandan (1), Fly specked hardyhead (2), Agassizi's glassfish (3), Flathead gudgeon (3), Purple spotted gudgeon (8 individuals at one site). Other species were captured at a number of sites but in low numbers e.g. Saratoga was captured as single specimens at 4 sites. These low numbers of fish and the currently limited degree of replication through time preclude any further analysis of the data. It is encouraging though that native species dominate and the expected range of native species was encountered.

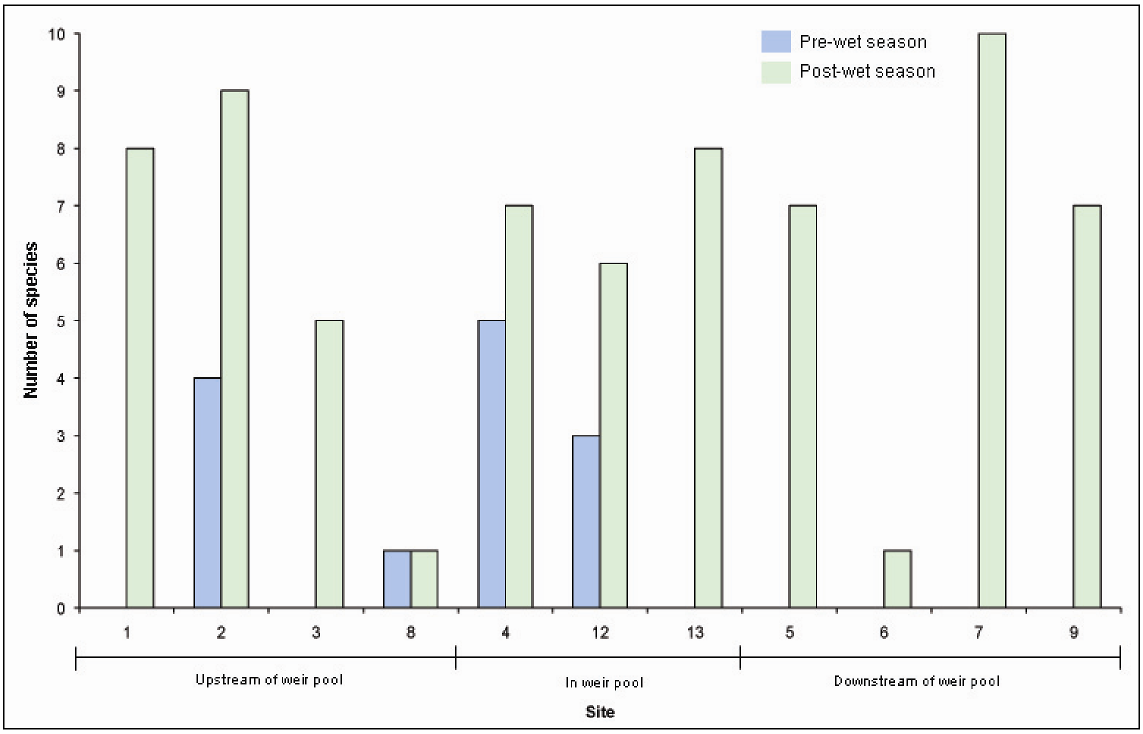


**Figure 13-5.** Number of fish species (richness) captured at each site surveyed during the pre- and post-wet survey.

Table 13-3. Total abundance of fish species captured at each of the sites that held water during the pre- and post-wet season surveys.

| Family | Latin name | Common name | Native / exotic | Sites upstream of the weir pool | | | | | | Sites in the weir pool | | | | | Sites downstream of the weir pool | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | | 3 | 8 | | 4 | | 12 | | 13 | 5 | 6 | 7 | 9 |
| | | | | post | pre | post | post | pre | post | pre | post | pre | post | post | post | post | post | post |
| Ambassidae | *Ambassis agassizii* | Agassiz's glassfish | N | 2 | | | | | | | | | | | | | 1 | |
| Antherinidae | *Craterocephalus stercusmuscarum* | fly-specked hardyhead | N | | | | | | | | | | | | | | 2 | |
| Clupeidae | *Nematalosa erebi* | bony bream | N | 5 | | | 51 | | | 106 | 18 | 35 | 31 | 91 | 1 | | 9 | 10 |
| Cyprinidae | *Carassius auratus* | goldfish | E | | | | | | | 1 | | | | | 3 | | 1 | |
| Eleotridae | *Hypseleotris* species 1 | Midgley's carp gudgeon | N | | 5 | | | 1 | | 1 | | 1 | | | | | | |
| | *Hypseleotris klunzingeri* | western carp gudgeon | N | 2 | | 3 | | | | | | | | | | | | 15 |
| | *Hypseleotris* sp. | unidentified gudgeon | N | | | | 3 | | | | | | | | | | | |
| | *Mogurnda adspersa* | purple-spotted gudgeon | N | | | | | | | | | | | | | | | 8 |
| | *Oxyeleotris lineolata* | sleepy cod | N | | | | 1 | | | 4 | | | 4 | 1 | 1 | | 1 | |

| Family | Latin name | Common name | Native / exotic | Sites upstream of the weir pool | | | | | | Sites in the weir pool | | | | | Sites downstream of the weir pool | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | | 3 | 8 | | 4 | | 12 | | 13 | 5 | 6 | 7 | 9 |
| | | | | post | pre | post | post | pre | post | pre | post | pre | post | post | post | post | post | post |
| | *Philypnodon grandiceps* | flathead gudgeon | N | | | 3 | | | | | | | | | | | | |
| Melanotaeniidae | *Melanotaenia splendida* | eastern rainbowfish | N | 2 | | | | | | | | 3 | 1 | 1 | 5 | | 1 | 16 |
| Osteoglossidae | *Scleropages leichardti* | saratoga | N | | | | 1 | | | | | | | 1 | 1 | | 1 | |
| Percichthyidae | *Macquaria ambigua* | golden perch | N | 8 | | 1 | | | | | 5 | | 1 | 2 | 2 | | 1 | |
| Plotosidae | *Neosilurus hyrtlii* | Hyrtl's tandan | N | | 2 | 19 | | | | 6 | 2 | | | | | | | 1 |
| | *Porochilus rendahli* | Rendahl's catfish | N | | | 1 | | | | | | | | | | | | |
| | *Tandanus tandanus* | freshwater catfish | N | | | 9 | | | | 1 | | | | | | | | |
| Poecillidae | *Gambusia holbrooki* | mosquitofish | E | | 16 | | | | | | 4 | | 2 | 15 | 3 | | 8 | |
| Terapontidae | *Leiopotherapon unicolor* | spangled perch | N | 9 | | 27 | 2 | 31 | 1 | | 22 | | 6 | 5 | | | 1 | 3 |
| | *Scortum hillii* | leathery grunter | N | 3 | 8 | | | | | | 2 | | | | | | | |

- Significant species

None of the species captured during the pre- or post-wet season survey is listed under the EPBC Act or the Queensland *Nature Conservation Act 1992* (NC Act), as listed in the *Nature Conservation (Wildlife) Regulation 2006* (NCWR).

*Scleropages leichardti* (southern saratoga) is listed as lower risk – near threatened under the International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species, although this assessment was made in 1996 and needs updating (IUCN 2007). Southern saratoga is endemic to the upper reaches of the Fitzroy river system, including the Dawson River, although it has been translocated to other streams (Allen *et al*. 2002). This species prefers long, deep turbid waterholes with reduced flow, abundant snags, undercut banks and overhanging vegetation (Marsden and Power 2007).

Golden perch, southern saratoga, sleepy cod and eel-tailed catfish are important recreational species (Marsden and Power 2007). The Glebe Weir campground is a popular fishing spot with anglers likely targeting these species. No species of commercial importance were captured during the pre- or post-wet season survey.

The Dawson River has historically been stocked with angling species, including southern saratoga and golden perch.

#### *13.3.4.3 Turtles*

The pre-wet season survey captured *Emydura krefftii* (Krefft's river turtle) in the weir pool only, although no downstream sites were surveyed due to flooding Table 13-4 (frc environmental 2008a). The post-wet season survey did not record any turtles but two decomposing carcasses were observed on the banks of the Dawson River at the Leichhardt Hwy crossing (Ecowise 2008).

Table 13-4. Abundance of each turtle species caught or observed at each site.

| Latin name | Common name | Sites upstream of weir pool | | Sites in the weir pool | |
|---|---|---|---|---|---|
| | | 2 | 8[1] | 4 | 12[2] |
| *Emydura krefftii* | Krefft's river turtle | – | – | 11 | 1 |

1 Dry site

2 Observed during electrofishing, nil captured in bait traps

Three turtle species have been recorded in the vicinity of Glebe Weir, Krefft's river turtle, *Elseya albagula* (white-throated snapping turtle) and *Elseya latisternum* (saw-shelled turtle), although Krefft's river turtle is the most abundant (Hyder Environmental 1997, Ison Environmental Planners 1997, 1996). Considerable numbers of turtles are known to at times be killed on the existing intake structure where they are apparently trapped on the screens and drown.

*Rheodytes leukops* (Fitzroy River turtle) is listed as 'vulnerable' under the Queensland NC Act; the EPBC Act; and the IUCN Red List of Threatened Species (IUCN 2007). It is found over a restricted distribution that includes the Fitzroy River and its tributaries, and the Dawson River up to the Theodore Weir (EPA 2007; Limpus *et al*. 2007).

No Fitzroy river turtles have been recorded in the vicinity of the Glebe Weir. The most upstream records for the Dawson River are from the Theodore Weir, some 100 km downstream of Glebe Weir (Limpus *et al.* 2007). This does not totally preclude the possibility of their presence.

## 13.4 Potential impacts and mitigation measures

### 13.4.1 Construction phase

#### *13.4.1.1 Glebe Weir and associated works*

- Physical disturbance of aquatic habitat and sediment

Work on raising the weir, the construction of a temporary crossing of the river immediately downstream of the existing weir, pump station intake, bridging of Cockatoo Creek to access the pump station and sand extraction from Cockatoo Creek will result in the physical disturbance of aquatic and riparian habitat and elevated turbidity in the nearby area.

The action will remove emergent macrophyte species but as the length of river or creek edge impacted in total is restricted to tens to perhaps a hundred lineal metres, the species involved are common, widespread and likely to recolonise rapidly on completion of works, it is not considered a significant impact.

Works at the pump station intake will occur in an area within the existing weir pool that is characterised by fine sediment and often deep water (Plate 13-4). No flora is expected in this area except when the weir is near dead storage and the exposed bed is colonised by Smart Weed. Works will disturb sediment but the site is within the weir pool so if the weir is not releasing at the time it will have little impact. If the weir is releasing and has been stable for some time, downstream turbidity will be elevated.

**Plate 13-4** Cockatoo Creek near the proposed pump station intake site

Works on the downstream face of the weir and the temporary river crossing will disturb a length of river bed and banks of approximately 50 m. This area was also disturbed during original weir construction and the recent maintenance. As it is immediately below the weir it is subjected to an unnatural flow regime and the poorest water quality, being nearest the point of release.

The bridging of Cockatoo Creek (see **Chapter 5** for description of bridge construction) will take place at the existing crossing so it is a currently disturbed area however the works will disturb both the bed and banks over a creek length of approximately 20 m. This is a shaded pool area with a fine substrate so would be expected to have a fauna similar to other pools in the area, that is, largely common and tolerant species.

Fish and turtles are likely to move away from areas of disturbance unless they are prevented from doing so but as no coffer dams are planned (depending on water levels at the time at the pump intake site) and the temporary crossing below the weir will allow passage, the risk of direct mortality is low. Macroinvertebrates within works footprints will be lost but recolonisation will be rapid upon completion of works and the taxa present are common and widespread. If coffer dams are used in Cockatoo Creek, the impact footprint will be larger (probably an extra 30 lineal metres) but the dams will confine the impact of suspended sediment. This alternative would also not represent any more than a temporary and reversible impact.

Erosion and transport of sediment from construction sites to adjacent waterways may result in elevated turbidity and sediment deposition. Substrates within the study area are characteristically dominated by silt. Faunal communities of the study area are adapted to living in turbid water. Given the background conditions and the management offered by the EMP, the introduction of a relatively small amount of additional sediment is likely to have no more than a local, temporary and reversible impact.

- Obstruction of fish passage

Glebe Weir is not currently fitted with a fishway. It is overtopped annually on average and often for several months a year. The proposed raising of the weir is unlikely to further restrict fish passage because the operation of the bags means they are deflated during floods. The data to date does not indicate any impacts of the existing barrier though this cannot be confirmed because of the limited data and the stocking of angling species that has been undertaken. Also, upstream populations may be sustained but still genetically isolated, hence at long term risk of decline.

It is proposed that a fishway will be installed, at a later date, if construction of the proposed Nathan Dam does not proceed. Design of the structure will be cognisant of the needs of turtles. Initial discussions have been held with DPI&F.

- Waste and contamination from works areas

Fuels and oils required for the operation of construction machinery together with the waste and contaminants associated with mobile work camps, concrete batch plant, materials stockpiles, day camp and offices may adversely impact aquatic flora and fauna.

The likelihood of a direct spill into water is low. Construction during the dry season minimises the risk of spilt contaminants being carried into downstream watercourses. Spills upstream of the weir will be captured by the weir and therefore more easily managed. On-site spill containment facilities and practices are detailed in the Construction EMP (Chapter 21). The volume of spill and river flow at the time will determine the extent of impact. A significant spill during a flow is very unlikely.

Good housekeeping in accordance with the EMP will reduce the risk of impact from litter and other forms of contamination to negligible levels.

Nutrient inputs to waterways could occur via the day works area facilities and from any fertiliser used in revegetation but as native species will be used and they require little if any fertiliser, this represents a very low risk. On-site wastewater systems are planned to be pump-out with some grey water recycling. The maximum workforce for the weir is expected to be approximately 30 people so nutrient loading is likely to be commensurately low. Risks related to nutrient inputs are, therefore, considered to be very low.

- Recreational and commercial fisheries

Recreational fishers fish the weir pool and downstream waters. Access will be restricted during construction works. As the flow regime downstream will not alter during construction, downstream commercial fisheries will not be impacted.

- Mosquito and biting midge

Construction activities that result in pooled water will create potential habitat for mosquito and biting midge breeding. Mosquito eggs are laid in mud or on vegetation associated with shallow pooled water. The larvae and pupae of most species take at least six days to develop. An increase in the population of mosquitoes and biting midge has the potential to impact human health or create a nuisance. Implementation of strategies to limit the availability of standing water (Chapter 21), such as frequently pumping out sediment basins and grading to avoid formation of pools, will substantively reduce opportunities for breeding. Note that few culicids (mosquito larvae) were captured during field surveys.

#### *13.4.1.2 Pipeline*

- Loss of habitat and impact on water quality

Construction of pipeline crossings will disturb sediments and riparian and instream cover, where it is present. Where the waterway holds water at the time of construction, this may result in localised turbidity and sediment deposition within the pool. It is highly unlikely that such pools will be significantly connected to other water so the impact will remain local. In dry creek beds, impacts on water quality will be absent. Aestivating crustaceans (resting sealed in their burrows), instream vegetation (where it exists) and riparian vegetation within the construction footprint are likely to be lost. The specific location of each creek crossing has been identified in order to minimise disturbance to the riparian zone where possible. Examples of re-using existing clearings at Cockatoo Creek and Roche Creek are shown in Plates 13-5 and 13- 6.

Plate 13-5. Cockatoo Creek showing dozer crossing that can be used for the pipeline

Plate 13- 6 Roche Creek showing cleared preferred pipeline crossing location in foreground

Similarly the sand extraction area at Cockatoo / Sandy Creek was apparently used for the original construction of Glebe weir with cleared areas indicative of former access points. Little direct impact to fauna or flora will occur if extraction occurs in the dry season as planned. More important here is the stabilisation of the remaining habitat upon completion of works. This site will then represent a long pool and will likely develop aquatic habitats characteristic of other pools in the region. It would be recommended that the depth of extraction not exceed 3 m below the baseflow line as the water quality in such a deep pool would likely be poor in extended dry periods.

- Obstruction of Fish Passage

The proposed pipeline crosses Cockatoo, Bungaban, Bullock, Roche and Juandah creeks, and the construction of each crossing has the potential to temporarily inhibit fish passage within the respective sub-catchment. These creeks have an ephemeral flow regime (they only flow following rain) but hold pools of water throughout the year, and the diversity of fish captured from some of these pools suggests they provide important dry season refuge (frc environmental 2008a, 2008b). No pools were observed along the pipeline route but some exist nearby. The catchment area upstream of the pipe crossing becomes less hospitable to fish as it becomes more ephemeral.

Most creek crossings will be completed in the order of just a few days so construction phase impacts of significance are highly unlikely.

- Rare and Threatened Species, waste and spillage

The likelihood of Southern Saratoga or Fitzroy river turtle being in pools along the pipeline route is very low as the near lack of permanent habitat does not suit them hence impacts are not expected. Similarly the risk of spillage of fuels into a watercourse is confined to the period that works will be occurring in that area and this is very restricted. A traffic accident on Nathan Road could result in spillage to a watercourse but this is a low probability event and emergency response to such a situation is addressed in the EMP (Chapter 21).

#### *13.4.1.3 Mitigation Measures*

Appropriate mitigation measures are currently incorporated in the Description of the Project (Chapter 5) or relate to sediment and erosion control issues. Measures that will reduce impact include:

- the area physically disturbed will be kept to the minimum necessary
- works will be undertaken during the dry season.
- a construction Environmental Management Plan (EMP) (Chapter 21) provides for the management and minimisation of construction related erosion and sedimentation
- the EMP also responds to the risks posed by construction-related potential contaminants such as on site re-fuelling of machinery

- the streambed at pipeline crossings will be disturbed for only short periods and will be restored to their initial profile and character on completion
- key habitat features at pipeline crossings to be restored include the sediment profile and the abundance of other physical structure such as logs and boulders which will be stockpiled when first removed then replaced on completion of works
- riparian areas of the weir will be revegetated with endemic native trees, shrubs and grasses in accordance with the process described in Chapter 12; and
- riparian areas along the pipeline route will be revegetated with endemic grasses only because they will be within the maintenance corridor, so trees will not be planted

In summary, during the construction phase:

- physical disturbance of the river or stream beds will result in the death or removal or aquatic plants and animals
- the level of impact is assessed as minor because the area is small, the species are common and widespread and they will recolonise rapidly once construction is completed. No offset is recommended
- impacts related to sediment disturbance are considered minor because of the small area in question, construction during the dry season and likely success of containment strategies. No offset is recommended.
- impacts to fish movement will be no greater than at present but recreational fishing access to the weir will be reduced. The improved boating area on the expanded weir and the potential for fish that utilise floodplains to benefit from the overbank areas is considered an appropriate offset.
- the potential for mosquito and biting midges to breed in temporary construction ponds can be satisfactorily addressed through adherence to the EMP and no further action is necessary.

### 13.4.2 Operation and Maintenance Phase

#### *13.4.2.1 Glebe Weir*

□ Loss and Gain of Aquatic Habitat

Raising of the weir will increase the extent, depth (by approximately 25%) and volume (by approximately 70%) of the inundation area and particularly increase the extent of shallow margins. The length of the weir pool will increase by 4 km up the Dawson River, 1.5 km up Cockatoo Creek and 2.5 km up Boggomoss Creek. The maximum increase in depth, which applies to the area currently inundated, is 2.36m. The further lengths of waterways inundated will represent a tapered reduction from 2.36m to zero at the new FSL. It is highly likely that the raised weir will fill in the first wet season following completion. While much of the 70% increase in the storage volume relates to the increased depth of inundation in the Dawson River and its major tributaries, the bulk of the increased surface area at FSL relates to the right bank area along Cockatoo Creek and to a lesser extent the left bank along Boggomoss Creek where water spreads over low lying areas. In most years the depth of the weir will be drawn down such that these areas largely dry but topography of the base is quite uneven so pools of various sizes will remain. This effect will be less significant as a result of the proposed extraction of topsoil from the Cockatoo Creek area. Current riffle areas upstream of the weir will not be inundated. Operational requirements will result in the weir not being emptied as frequently as it currently is, but nonetheless, the water level is expected to continue to fluctuate considerably.

The initial filling of the weir pool will drown emergent macrophytes currently growing along the margins of the weir pool. These species are expected to recolonise at the new water line. Currently, at the downstream extremity of the weir pool (site 4), macrophyte communities are dominated at low water levels by *Persicaria* sp. a species known to rapidly colonise available suitable habitat. As currently occurs, *Persicaria* particularly will die-off and recolonise in response to fluctuations in water level. The shallow areas of Cockatoo Creek and Boggomoss Creek are likely to encourage *Persicaria* and *Typha domingensis* which is present in the weir pool, and other emergent species.

Whilst no submerged macrophytes have been recorded from the current inundation area or upstream reaches, they may become established within the shallow margins of the enlarged weir pool, particularly in the Cockatoo Creek area. However the turbidity is unlikely to alter given the open nature of these locations and when combined with water level fluctuations, the extent of establishment is likely to be limited.

The expanded and more permanent water in the weir pool will provide increased habitat for some fauna, though the deepest water is likely to be less hospitable than it is now. Southern Saratoga is one likely beneficiary.

The increased extent of shallow margins may also provide suitable habitat for several species, particularly if they are colonised by macrophytes. For example, gudgeons and catfish prefer habitats that include macrophytes (Allen *et al* 2002) and spangled perch is very likely to move to the over-bank areas during floods, as are several other species.

Short lengths of the ephemeral lower reaches of Cockatoo and Boggomoss Creeks and those reaches of the Dawson River where it flows into the existing weir pool will be ‘drowned out’ by the increased water level. The changed depth will be a maximum of 2.36 m so will still suit many species as the depth change is minor.

Overall the weir component of the Glebe Option is expected to provide a greater variety of habitat than the current weir pool, particularly because of the over-bank areas near Cockatoo Creek and Boggomoss Creek.

☐ Pump Station Intake

The risk of aquatic flora and fauna being sucked into the pipeline (particularly entrapment and drowning of turtles) will be minimised through a design that minimises suction and incorporates screens to significantly reduce the risk of plants and animals entering the pipeline.

Planned improvement to the intake screens on the current weir outlet will reduce impacts to turtles and this is viewed as a significant benefit.

☐ First Filling Impact on Water Quality

First filling will drown existing terrestrial vegetation that will decay and release nutrients to the water column. Nutrient enrichment may lead to phytoplankton blooms and unstable water quality impacting fishes and other fauna. Clearing of other than substantial non-commercial trees near FSL will reduce this risk. Filling of the new weir pool will increase the volume of the pool by approximately 70%, providing significant dilution to the area of uncleared vegetation, which is proportionally less (that is, the volume increases by more than the area). Worst case scenario would be filling on only a small flow event with no follow up, such that the organic matter stayed within the weir pool. This is a very unlikely scenario given that the mean annual flow at the site is over 500,000 ML and the volume of the expanded weir pool is just over 30,000 ML (Chapter 8). The annual flushing of the weir pool should minimise the risk of substantial accumulation of toxicants.

☐ Water Quality of the Weir Pool and Downstream Reaches

The increased depth of water, together with an operational regime that retains water for longer, may result in more frequent stratification and 'turn over' of water. Stratification results in the deoxygenation of bottom waters and potentially the reduction of habitat able to support fishes and other biota. Turn over of waters can result in the release of nutrients to the surface waters of the dam, stimulating algal blooms and potentially leading to eutrophication and associated mortality of fishes and other aquatic fauna. Recent surveys of Glebe and Gyranda weirs have not provided evidence of a significant deleterious impact from stratification and turn over. Whilst a reliable prediction of risk is not possible, it is noted that various dams in southern Queensland of similar depth do not experience ecologically or conservationally significant stratification-related impacts. Impacts do occur but are more often due to natural causes (cold snap, inflow of poor water, naturally drying pool, excessive macrophyte growth etc; Lugg 2000, Grace et al 2007).

The release of deoxygenated waters from the weir pool may impact aquatic flora and fauna downstream. The recent data from the weir shows little stratification but oxygen levels can at times reach very low levels. Without a multi-level offtake, as the weir will be deeper at the offtake point, the likelihood of releasing water with a low oxygen content will be higher. Released waters will become reoxygenated as they flow downstream: the extent of downstream habitat affected by deoxygenated waters will be dependent on a variety of factors, including the extent of initial deoxygenation and the degree of mixing affected in the downstream environment. The current weir has no multi-level offtake and the data from the nearest site downstream (site 5) has shown low dissolved oxygen levels but does not indicate any significant impact on fauna as it shows a diverse and relatively abundant macroinvertebrate and fish fauna. It is also likely that, as water is mainly released in spring and summer, remaining pools in the river will be showing reduced oxygen levels in any case and the improved connectivity resulting from the flow will allow mobile fauna to relocate to better habitat. Until the multi-level offtake is fitted, the situation will remain similar to at present but with a higher risk of release of water with a low oxygen content. Fitting of the multi-level offtake will substantially improve dissolved oxygen levels.

Cyanobacterial blooms are common in all of the larger south-east Queensland storages. Impoundments that are particularly problematic are narrow deep storages with small surface areas and low exposure to wind. Flow rates, nutrient status, stratification and river turbidity are the primary determinants of cyanobacterial growth. As the upper Dawson River has variable flow rates and elevated nutrient levels, blooms are a possibility but the high turbidity is a limiting factor. Cyanobacterial blooms occur in impoundments and in rivers during periods of low flow as the turbidity decreases and stratification can occur. Blooms have occasionally occurred but consequences have not been reported as significant possibly because the turbidity takes a considerable time to lower and it is often only a short period between flow events.

The proposed weir pool will generally be relatively long and narrow but with wide sections and large surface areas in the Cockatoo Creek break-out area. This is an area of risk but being relatively shallow and open to wind action, it is expected to stay well mixed in most circumstances. When it doesn't and blooms occur, it will represent a relatively small proportion of the total storage volume and areas will the poorest water quality will be represented by isolated pockets that are not connected to the pool storage. The water quality in these pockets is also likely to be affected by evaporation and macrophyte growth, which will reduce dissolved oxygen levels and increase both pH and conductivity. In summary, whilst occasional blue green algal blooms are expected, ecological consequences are not expected to be significant.

No impact on downstream estuarine and marine environments is possible given the scale of development, the distance and the level of intervening development.

- Barriers to Movement

Twenty-six species from 15 families inhabit the Dawson / lower Fitzroy catchment, most of which undertake freshwater migrations or movements at particular stages of their life cycle associated with reproduction, feeding, escaping predators or dispersing to new habitats (Marsden and Power 2007, Cotterell 1998). Australian rivers are notoriously variable, and fish may also need to move up and downstream to avoid undesirable water quality and the drying out of pools (Kennard 1997, Freshwater Fisheries Advisory Committee 1996). Details of fish migrations in the study area are provided in **Table 13-5**. As can be seen, for most species, very little is known. It should also be noted that eels were not recorded in the most recent surveys.

Table 13-5. Timing of critical movements of fish known to inhabit the region (Marsden & Power 2007).

| MIGRATION GROUP / Family | Latin Name | Common Name | Seasonal movements[3] | | | | Flow-associated movements[1] | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Sum. | Aut. | Win. | Spr. | Low | Mod. | High |
| CATADROMOUS | | | | | | | | | |
| Anguillidae | *Anguilla reinhardti* | long-finned eel | X | X | x | X | x | x | X |
| POTAMODROMOUS | | | | | | | | | |
| Ambassidae | *Ambassis agassizii* | Agassiz's glassfish | x | X | X | X | X | X | – |
| Antherinidae | *Craterocephalus stercusmuscarum* | fly-specked hardyhead | x | – | x | X | x | x | – |
| Clupeidae | *Nematolosa erebi* | bony bream | X | X | X | X | x | X | x |
| Cyprinidae | *Carassius auratus* | Goldfish | ? | ? | ? | ? | ? | ? | ? |
| Eleotridae | *Hypseleotris klunzingeri* | western carp gudgeon | ? | ? | ? | ? | ? | ? | ? |
| | *Oxyeleotris lineolata* | sleepy cod | ? | ? | ? | ? | ? | x | ? |
| | *Mogurnda adspersa* | purple-spotted gudgeon | ? | ? | ? | ? | ? | ? | ? |
| | *Philypnodon grandiceps* | flathead gudgeon | ? | ? | ? | ? | ? | ? | ? |
| Melanotaeniidae | *Melanotaenia splendida* | eastern rainbowfish | x | x | x | X | x | X | x |
| Osteoglossidae | *Scleropages leichardti* | southern Saratoga | x | ? | ? | x | ? | x | ? |
| Poecillidae | *Gambusia holbrooki* | Mosquitofish | ? | ? | ? | ? | ? | ? | ? |
| Plotosidae | *Neosilurus hyrtlii* | Hyrtl's tandan | X | ? | ? | X | ? | ? | X |
| | *Porochilus rendahli* | Rendahl's catfish | X | ? | ? | X | ? | ? | X |
| | *Tandanus tandanus* | freshwater catfish | ? | ? | ? | ? | ? | ? | ? |
| Terapontidae | *Leiopotherapon unicolor* | spangled perch | X | x | x | X | X | X | X |
| | *Macquaria ambigua oriens* | golden perch | X | x | x | X | X | X | x |

[3] X = large number of fish; x = small number of fish; – = none; ? = unknown

The Glebe Option will not alter the seasonality of the flow regime from what currently occurs. The peaks of smaller floods will be reduced (Chapter 8) but as the capacity of the weir is still low relative to common flood volumes, a significant amount of spillage in natural sequence will occur, providing the necessary flow triggers. A fish transfer device will be fitted if the Nathan Dam project does not proceed. While there is no conclusive evidence of impacts to date, the addition of the fishway can only be seen as an improvement on the current situation, particularly as there is a substantial area of catchment upstream of the weir suited to fish habitation which is not impounded or regulated.

- Impacts to Rare and Threatened Species

Southern Saratoga is not expected to be impacted by the Glebe Option and may benefit from the extended pool environment. There are no species listed under State or Federal legislation.

Fitzroy River turtles have not been recorded from the weir pool or within 100km though there is a possibility they may occur in the area. The area of the Fitzroy River in which they currently nest most intensely is the headwaters of the Fitzroy Barrage Weir pool (Limpus *et al* 2007) so their core nesting area is several hundred kilometres downstream. No impact is therefore anticipated.

- Recreational and Commercial Fisheries

While increased stratification and turn over may have increased impact of the weir pool's fish stocks, the greater diversity of habitat offered by the floodplain break-out areas may balance this risk. The Glebe Option design currently includes the re-use of some timber debris as fish habitat within the storage. Fisheries of the river downstream are very unlikely to be significantly impacted. Downstream commercial fisheries will not be impacted.

- Mosquito and biting midge

The increased extent of shallow margins is likely to result in an increase in edge breeding habitat and consequently an occasional increase in the abundance of mosquitoes and biting midges. Opportunities to minimise the breeding of both mosquitoes and biting midge are detailed in the EMP (Chapter 21). Residents in Glebe homestead and campers at the Glebe Weir reserve will need to be aware of this issue and take appropriate precautionary measures. The intention to extract topsoil from the Cockatoo Creek area should attempt to make areas greater than 0.5 m deep as this will restrict the area of suitable mosquito breeding habitat.

### *13.4.2.2 Pipeline*

Physical operational phase impacts are unlikely if the bed and banks at crossings are appropriately stabilised following construction. Scouring and pigging of the pipe may discharge viable seed or algae. If discharged to a dry area they would be unlikely to survive but they may if they reach a wetted area. Few species currently survive in these dry creek beds and they achieve only low levels of cover so no major new growth areas would be expected. All species encountered were native, so this does not represent an invasion threat.

As the pipe will be buried and the stream bed reinstated upon completion, it will not obstruct stream flow or the passage of fish.

- Transfer of Fauna Through the Pipeline

Operation of the pump station and pipeline has the potential to translocate aquatic flora and fauna. That is, organisms may be drawn into the pipeline and transferred along its length to the receiving environment. No exotic species were recorded in the receiving environment (headwaters of the Dawson River near Wandoan) during a recent survey (frc environmental 2008b). During recent surveys in the vicinity of the Glebe Weir, Mosquitofish were captured across the survey area and goldfish were captured in the weir pool and downstream of the weir, on the main channel only. It is possible therefore for these species to be translocated to areas in which they currently may not exist, however both of these areas are headwaters of the Dawson River. Mosquitofish and Goldfish may exist in these other areas but sampling has not detected them. Sampling to date has been limited. It is highly likely they exist in the Dawson River in areas upstream of the weir that have not been sampled (both were recorded within the weir pool and Mosquitofish was recorded upstream in the river), to at least the junction with streams draining the mine area. If there is an area which is currently not populated, it is small.

The translocation of fishes via water supply pipeline may be reduced through use of screens. Consultation with the DPI & F will be undertaken to determine the desirability of fitting the intake with screens. The potential for effective translocation is expected to be low because of the low likelihood of survival through the process of pumping and transport along the 83 km of pipe and the intended use of the water at the mine, that is, it will be stored till it is used primarily in coal washing, a process that is unlikely to allow the survival of any translocated fauna.