Appendix D

Ecological assessments

Appendix D1

EMM, Proposed Georges Cove Marina – terrestrial ecological assessments, April 2015

30 April 2015

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Re: Proposed Georges Cove Marina - terrestrial ecological assessments

Dear Ernest,

1 Introduction

EMGA Mitchell McLennan (EMM) has been engaged to review and update the ecological assessment for a proposed marina development at No 146 Newbridge Road Moorebank. The review aims to identify and fill information gaps and provide an updated assessment of the potential ecological impacts of the proposal.

The project area is approximately 13 ha of a 22 ha site in the Liverpool Local Government Area (LGA). The site is a sand and gravel extraction quarry, operated by Benedict Industries. Benedict Industries is proposing to stabilise the bank of the Georges River on the eastern boundary of the site.

1.1 Background

A previous application was made to Liverpool City Council for development consent for the marina. Director General's Environment Assessment Requirements (DGR 563) were received on 29 July 2011. The environmental impact statement (EIS) addressing these DGRs and supporting the marina application was submitted to Liverpool City Council and the Department of Planning in January 2012. The EIS included a flora and fauna assessment report by Total Earth Care (2006 and 2011). The aquatic assessment by Marine Pollution Research (2010) has been considered elsewhere.

Consent for the Georges Cove Marina was granted to Tanlane Pty Ltd by the Sydney West Joint Region Planning Panel (JRPP) as the Consent Authority on 22 August 2014 with support from Liverpool City Council. The validity of the Consent was challenged by the proposal's sole objector, Moorebank Recycling Pty Ltd in the NSW Land and Environment Court. The court ruled in favour of the objector, declaring that the Consent was invalid and that Tanlane should commission a Preliminary Contamination Investigation, reapply for a consent and supply the Preliminary Contamination Investigation to the JRPP as part of the application.

Benedict is therefore re-applying for consent for the proposed Georges Cove Marina.

This letter reviews the Total Earth Care (2006 and 2011) ecological assessments and provides additional information to ensure that the Secretary's Environmental Assessment Requirements (SEARs), issued on 24 April 2015, have been addressed. This included updated database searches to ensure that none of the species identified at the site, or that have the potential to occur, have been listed under the *Threatened Species Conservation Act 1995* (TSC Act), *Fisheries Management Act 1994* (FM Act) or *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or EPBC Act since the previous reports were completed.

2 Review

2.1 Previous ecological assessments

2.1.1 Flora and fauna assessment 2006

A flora and fauna assessment was completed to support a rezoning application (Total Earth Care 2006). The assessment included site surveys and classification of ecological constraints within the project area.

Desktop searches were completed for a 5 km radius of the project area in 2004, followed by two days of survey (23 August 2004 and 11 January 2005) including:

- identification of plant species;
- mapping and classification of plant communities;
- targeted searches for plant species of conservation significance;
- diurnal observation of fauna;
- searches for fauna evidence; and
- targeted searches for habitat types of threatened fauna.

A total of 99 plant species were recorded, including 58 introduced species. Three plant communities were identified:

- Riparian Woodland;
- Riparian Scrub; and
- Cleared and Disturbed vegetation.

Three plant species of regional significance were identified: Blue Box (*Eucalyptus baueriana*), River Peppermint (*Eucalyptus elata*) and Fringed Wattle (*Acacia fimbrata*) along the western and southern drainage channels (in the south-west and west of the site). None of these are listed as Rare or Threatened Australian Plants (ROTAP) species or threatened under the TSC Act or the EPBC Act.

The assessment concluded that biodiversity values present only provided low to moderate constraints to development. This report was used as the basis for the 2011 flora and fauna assessment.

2.1.2 Flora and fauna assessment 2011

An updated flora and fauna assessment was completed to support the development application for the Georges Cove Marina (Total Earth Care 2011). The assessment assessed the conservation significance of biodiversity values at the site and provided an indication of the potential constraints to the development of the marina.

Updated database searches (5 km) were completed prior to a field survey on 5 September 2011. The survey included:

- identification of plant species;
- mapping and classification of plant communities;

- targeted searches for plant species of conservation significance;
- diurnal observation of fauna including aural and visual detection of birds and frogs;
- searches for fauna evidence; and
- targeted searches for habitat types of threatened fauna.

A total of 87 plant species were recorded, including 49 introduced species. Four plant communities were identified:

- River Flat Eucalypt Forest (previously identified as Riparian Woodland);
- Swamp Oak Floodplain Forest;
- Reconstructed Vegetation (previously identified as Riparian Scrub); and
- Cleared and Disturbed vegetation.

Both the River Flat Eucalypt Forest and Swamp Oak Floodplain Forest meet the description of endangered ecological communities (EECs) listed under the TSC Act. An assessment of significance under Section 5A of the *Environmental Planning and Assessment Act 1979* (EP&A) Act was not completed for the EECs as only a small area of each occurs within the project area and the areas are degraded.

Four plant species of regional significance were identified (Blue Box, River Peppermint, Fringed Wattle and Gosford Wattle (*Acacia prominens*)) along the western and southern drainage channels. None of these are listed as ROTAP or threatened species under the TSC Act or the EPBC Act.

No threatened fauna species were identified during the surveys. However, the riparian woodland along the Georges River was considered to provide potential habitat for the Cumberland Plain Land Snail (*Meridolum corneovirens*), threatened microbats (Eastern Bentwing Bat (*Miniopterus schreibersii oceansis*), Southern Myotis (*Myotis macropus*), Eastern Freetial-bat (*Mormopterus norfolkensis*), Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*)) and the Grey-headed Flying Fox (*Pteropus poliocephalus*) which were recorded in the adjacent Boral site (ERM 2002). An assessment of significance under Section 5A of the EP&A Act was completed for potential impacts on the Eastern Freetail-bat and Yellow-bellied Sheathtail Bat. The assessment concluded that potential impacts would not be significant on these species.

The assessment concluded that the proposed marina is unlikely to significantly impact on native flora and fauna in the project area. However, a number of recommendations were made to reduce the potential impacts of the proposal.

2.2 Database searches and assessment of gaps

2.2.1 Database searches results

Updated searches were undertaken on 8 April 2015 of the following databases:

- NSW Wildlife Atlas (10 km radius);
- Fisheries threatened and protected species record viewer (Liverpool LGA); and
- SPRAT database (10 km radius).

An additional eight threatened species were identified during the searches, which had not considered in the previous ecological assessments (Table 1). Of these, five have a low potential for impacts from the

proposed marina development; Australasian Bittern, Eastern Osprey, Koala, Scarlet Robin and Spotted Harrier. While impacts to the other three species are unlikely.

Table 1 Threatened species not considered in the previous assessments

Species	Status		Number of records[1]	Habitat requirements present?	Potential for impacts from the proposal
	TSC Act	EPBC Act			
Australasian Bittern (*Botaurus poiciloptilus*)	E	E	1	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha spp*.) and spikerushes (*Eleocharis spp*.). Some potential habitat occurs, however there are few records of the species in the area.	Low potential
Eastern Osprey (*Pandion cristatus*)	V		4	Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Some potential habitat occurs along the Georges River and in the ponds.	Low potential given large home ranges and availability of similar habitat in the locality
Koala (*Phascolarctos cinereus*)	V	V	6	Primary food trees have been recorded in the project area including Forest red gum (*E. tereticornis*), Cabbage gum (*E. amplifolia*) and Swamp mahogany (*E. robusta*). A number of known secondary food trees were also recorded. Potential habitat occurs, though records are sparse in the locality.	Low potential and restoration works will improve habitat values along the Georges River
Marsdenia viridiflora R. Br. subsp. *viridiflora* population	E		326	Grows in vine thickets and open shale woodland. No suitable habitat in the project area.	Unlikely
Netted Bottle Brush (*Callistemon linearifolius*)	V		11	Grows in dry sclerophyll forest on the coast and adjacent ranges. Suitable habitat is not considered to occur in the project area.	Unlikely
Scarlet Robin (*Petroica boodang*)	V		1	Dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. Some marginal potential habitat occurs.	Low potential
Spotted Harrier (*Circus assimilis*)	V		5	Occurs in grassy open woodland including Acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. Some potential habitat occurs.	Low potential given large home ranges and availability of similar habitat in the locality
Tadgell's Bluebell (*Wahlenbergia multicaulis*) population	E		3	Most sites are closely aligned with the Villawood Soil Series. The bluebell is found in disturbed sites and grows in a variety of habitats including forest, woodland, scrub, grassland and the edges of watercourses and wetlands. No suitable habitat in the project area.	Unlikely

Notes: 1.Records since 1 January 1990 within a 10 km radius.

Recent records also occur in proximity to the site for the following species:

- Little Lorikeet – recorded adjacent to the site;
- Varied Sittella – recorded across the Georges River; and
- Little Eagle – recorded adjacent to the site.

Given the highly mobile nature of these species and the availability of habitat in adjacent areas where these have been recorded, the impacts of the proposed marina will be minimal to such species should they use the area. Further, the proposed restoration work along the Georges River, which forms part of the project, will improve habitat quality for such species into the future.

2.2.2 Identified gaps

Site surveys completed for the previous assessments were not adequate to identify a range of threatened flora and fauna species that could occur. However, targeted flora surveys would have identified most of the threatened flora species at the site, if they do occur. To compensate for this, and as no nocturnal surveys were completed, the assessment assumed that threatened microbats would occur at the site. It is considered that all threatened species that have the potential to occur at the site have now been adequately assessed and impacts are unlikely to be significant.

In the absence of an appropriate design or controls, there is the potential for the two EECs identified in the project area to be impacted directly and indirectly from the proposed marina development. The previous studies did not assess the impacts of any such activities under Section 5A of the EP&A Act. This has been identified as a gap and as such, an assessment has been completed below.

i Assessment of significance for EECs

Section 5A of the EP&A Act provides the criteria that must be considered in the assessment of the significance of potential impacts on all threatened species listed under the TSC Act. This assessment of significance has been undertaken in accordance with *Threatened Species Assessment Guidelines: The Assessment of Significance* (DECC 2007).

1. *In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;*

This question is not relevant as River-flat Eucalypt Forest and Swamp Oak Floodplain Forest are communities rather than individual species.

2. *In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;*

This question is not relevant as River-flat Eucalypt Forest and Swamp Oak Floodplain Forest are communities.

3. *In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:*

    a) *is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction;*

    b) *is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;*

The local occurrence of River-flat Eucalypt Forest (ie within a 5 km radius of the site) covers approximately 270 ha, while Swamp Oak Floodplain Forest covers approximately 95 ha (OEH 2013). The local occurrence contains some larger patches of the two floodplain communities, but mostly occurs in a highly fragmented state along the Georges River and its tributaries, surrounded by residential and industrial land.

It is not anticipated that any components of the floodplain EECs will be removed for the proposed marina. The previous assessment assumes that up to 0.2% of River Flat Eucalypt Forest and 0.3% of Swamp Oak Floodplain Forest occurring at the site will be removed by the project. This is a very small proportion of the community within the site and the locality.

All works will be undertaken in a manner that minimises any impacts to remnant trees or to the few (if any), characteristic understorey species. However, the works may require machinery to work around remnant trees, to install rock armouring along the bank, which may result in compaction, erosion and/or sedimentation in the EEC areas.

It is important to note that the proposal includes the restoration of the River-flat Eucalypt Forest and Swamp Oak Floodplain Forest areas along the Georges River under the Voluntary Planning Agreement (VPA) and associated Vegetation Management Plan. This will increase the amount and condition of the EECs at the site and in the locality.

4. *In relation to the habitat of a threatened species, population or ecological community:*

    a) *the extent to which habitat is likely to be removed or modified as a result of the action proposed;*

    b) *whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action;*

    c) *the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;*

Only small areas of the EECs (up to 0.2% of River Flat Eucalypt Forest and 0.3% of Swamp Oak Floodplain Forest occurring at the site) may be removed (eg for temporary access tracks to allow riverbank stabilisation works) or indirectly impacted by the construction of the proposed marina (eg by construction noise). The work will require an opening along the western bank of the Georges River which will result in fragmentation of habitat for the community. However, there is already existing gaps along the bank between areas of floodplain EEC at the site.

The modification will not isolate any remnants of River Flat Eucalypt Forest, Swamp Oak Floodplain Forest or their habitat.

The small areas of River Flat Eucalypt Forest and Swamp Oak Floodplain Forest to be removed are not considered important for the long-term survival of the communities in the locality. The floodplain vegetation patch is only small and already isolated from other remnants.

5. *Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);*

Critical habitat has not been declared for River Flat Eucalypt Forest and Swamp Oak Floodplain Forest. Therefore, the proposed development will not have an adverse effect on critical habitat.

6. *Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and*

River Flat Eucalypt Forest and Swamp Oak Floodplain Forest do not have recovery plans. Management objectives for the communities aim to maximise the extent of occurrence and condition across NSW. Any removal of small patches of EEC required will not reduce the occurrence or condition of the ecological community in the locality.

7. *Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.*

A key threatening process relevant to the removal of the trees is 'the clearing of native vegetation'. The removal of the small areas of River Flat Eucalypt Forest and Swamp Oak Floodplain Forest classifies as the

clearing of native vegetation, as the works will remove parts of one or more strata layers of vegetation in these areas.

Conclusion: The removal of up to 0.2% of River Flat Eucalypt Forest and 0.3% of Swamp Oak Floodplain Forest within the project area will not have a significant impact on the EEC in the locality as:

- the proposed clearing is minor;
- the remnant patch of floodplain EECs is not considered to be important;
- the modification will not isolate the communities; and
- remaining areas at the site will be retained, protected and enhanced by the proposed marina.

3 Conclusion

The previous ecological assessments for the proposed Georges Cove Marina have been reviewed. Updated searches have been completed and information gaps have been identified and filled.

No significant impacts to threatened species, populations and communities are anticipated from the construction and operation of the marina. Therefore a species impact statement is not required.

While the proposal will require the removal and modification of some areas of aquatic and terrestrial habitat, it will result in an overall improvement in the quality and amount of available habitat within the site.

Yours sincerely

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References

Department of Environment and Climate Change (DECC) 2007, *Threatened Species Assessment Guidelines: The Assessment of Significance,* Department of Environment and Climate Change NSW

Environmental Resource Management (ERM) 2002, *Boral Moorebank Flora and Fauna Assessment – Technical Report*, Environmental Resource Management Australia

Marine Pollution Research Pty Ltd 2010, Georges *River Marina, Moorebank: Aquatic Ecology Aspects and Environmental Assessment of Marina Concept Design*, prepared for Benedict Industries Pty Ltd

Office of Environment and Heritage (OEH) 2013, *The Native Vegetation of the Sydney Metropolitan Area*.

Total Earth Care 2011, *Flora and Fauna Assessment: No. 146 Newbridge Road, Moorebank*, prepared for Benedict Industries Pty Ltd

Total Earth Care 2006, *Flora and Fauna Assessment: Proposed Rezoning of the Benedict Site No. 146 Newbridge Road, Moorebank,* prepared for Benedict Industries Pty Ltd

Appendix D2

Total Earth Care, Flora and Fauna Assessment, November 2011

total earth care

Flora and Fauna Assessment

Proposed Marina Construction
No.146 Newbridge Road, Moorebank

November, 2011

total earth care

Flora and Fauna Assessment

No.146 Newbridge Road, Moorebank

Quality Control	© Total Earth Care Pty Ltd 2011		
Revision/Version No.	Final REV 0	Date of revision	25 October, 2011
Prepared by:	L Laurie, R Musgrave		
Prepared for:	Benedict Industries		
TEC Job No.	C2473-BI		

No.146 Newbridge Road, Moorebank
Proposed Marina Construction

Flora & Fauna Assessment

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1 INTRODUCTION

1.1 Background

Benedict Industries is proposing the development of the Georges Cove Marina to replace the existing sand extraction/dredging/recycling operations located at No.146 Newbridge Road, Moorebank (referred to herein as the 'subject site' and shown in Map 1, Appendix A). The site is approximately 22 hectares (ha) and is within Liverpool Local Government Area (LGA).

In 2006, a rezoning application was lodged with Liverpool Council to amend the zoning under the then proposed *Liverpool Local Environmental Plan 2008* (LEP). A Rezoning Structure Plan was prepared to accompany the application, which proposed that the land be rezoned from 'Non-urban' to a combination of commercial, residential and open space uses. This application was subsequently approved, and as a consequence the subject site was rezoned as Public Recreation, and Medium Density Residential (See Map 2). Total Earth Care Pty Ltd (TEC) was engaged to prepare a Flora and Fauna Assessment that accompanied the rezoning application to provide information on the suite of native biota (including threatened species) occupying or utilising the site, their conservation significance and the constraints they might impose on future development of the site.

Under the current conditions of approval, the site must be remediated by Benedict Industries upon the cessation of sand and gravel extraction on the subject site. Benedict Industries is proposing the development of the Georges Cove Marina, and restoration of the river foreshore, as a alternative to the required remediation processes.

On 22nd June 2011, the Office of Environment & Heritage issued Director General Requirements for a environmental impact statement required as part of the development application for the Georges Cove Marina. TEC has been engaged to conduct a Flora and Fauna Assessment as part of the biodiversity requirements outlined in the DGRs.

1.2 Current Proposal

The current proposal involves the construction of a marina to replace the existing sand extraction/dredging/recycling operations currently occurring on the subject site (Map 3). The marina basin will be approximately 150m by 350m in size and will use the dredging basins currently onsite as it its basis. The marina will open on to the Georges River via a constructed entry channel approximately 40-50m wide. The marina will consist of, a maritime building (dry berth facility, function room, kiosk, private and public marina club house, retail store, small craft sales show room, and a work shop), a wet berth facility, and floating berth and walkways. Along the river foreshore, fill along the riverbank will be removed, and public recreation facilities such as a bike path, shelters, and BBQ facilities will be constructed. The foreshore will be revegetated in accordance with a Voluntary Planning Agreement and Vegetation Management Plan (to be submitted to Council). Three car parks providing parking facilities for up to 490 vehicles will be constructed to the west and south of the marina and maritime building.

Construction is scheduled to commence once the quarrying activities onsite are completed. It is estimated that the duration of construction activities would be 22 weeks, during which piling would take place over a period of 10 weeks. Construction would be restricted to the hours of 0700 to 1700 Monday to Friday, and 0700 to 1300 Saturday.

1.3 Aims & Objectives

The general aim of this assessment is to describe and assess the existing flora and fauna of the site, with particular regard for biota of conservation significance. Specifically, the objectives of the report are:

- to describe the existing flora and fauna of the site, and their habitats;
- to assess the relevance of the site to biota of conservation significance, particularly the presence or likely occurrence of "endangered" and "vulnerable" species, "endangered populations" and "endangered ecological communities" listed under the *NSW Threatened Species Conservation Act 1995* (TSC Act) and the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC ACT); and
- to provide an indication of the potential constraints pertaining to the proposed marina development.

2 PREVIOUS STUDIES

As stated previously, TEC undertook a Flora & Fauna Assessment of the subject site in 2004. This survey described the plant communities occurring on site, and assessed and mapped potential constraints to development on site. No threatened flora or fauna species were observed during the survey. It was noted in the study that *Sydney Coastal River Flat Forest* (SCRFF) was mapped by NPWS (2003b) and AES (2002) as occurring south of the subject site along the Georges River. It was also mapped as occurring along the eastern boundary of the subject site (also along the Georges River), however, the vegetation was deemed to be structurally and floristically depauperate, and sufficiently disturbed as to no longer qualify as SCRFF. At the time the study was undertaken, *Sydney Coastal River Flat Forest* was listed as an Endangered Ecological Community under the TSC Act (1995). Since 2004, SCRRF has been removed from Part 3 Schedule 1 of the TSA, and replaced with more encompassing *River Flat Eucalypt Forest on coastal floodplains of the NSW North Coast, Sydney Basin, and South-East Bioregions*.

Additionally, several other similar studies have been conducted on the adjacent properties. Studies undertaken on adjacent land include:

- a Flora and Fauna Assessment for Boral Moorebank (ERM 2002), which is located adjacent to the subject site. One threatened plant species (*Acacia pubescens*), three threatened fauna species :(i.e. Cumberland Land Snail *Meridolum corneovirens*, Eastern Freetail Bat *Mormopterus norfolkensis* and Yellow-bellied Sheathtail Bat *Saccolaimus flaviventris*) and remnants of two endangered ecological communities (Cumberland Plain Woodland and Castlereagh Ironbark Forest) were recorded.
- an Assessment of Impacts of a Proposed Service Road at Moorebank (ERM 2003), also undertaken for the Boral site. Eight part tests of significance were conducted on the above mentioned threatened species. The report concludes that provision of the service road is likely to significantly impact on Castlereagh Ironbark Forest, Cumberland Plain Land Snail and *Acacia pubescens* within the Boral site.
- a Flora and Fauna Assessment for the proposed rezoning of Lot 1 DP 336613, Newbridge Road, Moorebank (AES 2002). This assessment was undertaken for land located south of the subject site. Two endangered ecological communities, Sydney Coastal River-flat Forest and Cooks River/Castlereagh Ironbark Forest, occur along the north-eastern and eastern boundaries of the site.

Other studies undertaken within the Liverpool LGA include:

- the Urban Bushland Biodiversity Survey of Western Sydney (NPWS 1997). This survey describes the plant communities and flora and fauna within western Sydney, and identifies regionally significant species.
- A Biodiversity Study of the Liverpool LGA by Eco Logical Consultants (2003). The study examined the threatened species, endangered populations and ecological communities that are known to occur within Liverpool LGA. The results of this study, together with

recommended actions and strategies for conserving biodiversity, have been included in the Liverpool City Council Biodiversity Strategy.

- Mapping of the native vegetation of the Cumberland Plain, Western Sydney. Native vegetation has been presented on a 1:100,000 map sheet (NPWS 2003b) and described by Tozer (2003) in *Cunninghamia*. The subject site is mapped as containing Sydney Coastal River Flat Forest.

3 METHODS

3.1 Desktop Research

Prior to field surveys, records of all threatened species, populations and endangered ecological communities previously recorded within 5km of the subject site were obtained from the OEH Wildlife Atlas database. Records of threatened species from the adjoining sites (mentioned above) were also compiled to generate a list of species to be targeted during field surveys.

3.2 Flora

A general botanical survey was conducted on the site on September 5, 2011 involving:

- the identification of plant species according to the *Flora of NSW* (Harden 1992, 1993, 2000, 2002), with reference to recent taxonomic changes;
- the identification and mapping of plant communities according to the structural definitions of Specht & Specht (1999), and to previous broad-scale mapping of the Cumberland Plain by NPWS (2003b), Tozer (2003), and vegetation mapped by Sydney Metro Catchment Management Authority (2009); and
- targeted searches for plant species of conservation significance in areas of potentially suitable habitat according to the "random meander" method of Cropper (1993).

3.3 Fauna

A general fauna survey, involving diurnal techniques, was conducted on the site on September 5, 2011. Weather conditions during the day were between 19-24^{0}C, with a light north-easterly breeze and minimum cloud cover (~5%).

The diurnal survey involved observations of animal activity, habitat identification and searches for indirect evidence of fauna (such as scats, nests, burrows, hollows, tracks and diggings). Surveys for avifauna and amphibians involved visual detection and aural recognition of bird and frog calls.

Targeted searches were also undertaken for the habitat types of threatened fauna previously recorded in the area, as identified on the DEC Wildlife Atlas database and *Boral Moorebank Flora and Fauna Assessment – Technical Report* (ERM, 2002).

All records of fauna were recorded throughout the survey period and an inventory of species was compiled.

The conservation significance of fauna species and populations was determined according to:

- the UBBS (NPWS 1997) at a regional level;
- the TSC Act at a State level; and
- the EPBC Act at a national level.

3.4 Limitations

Field surveys were conducted over one full day during spring 2011. While the subject site is very degraded, with a long history of disturbance, the brevity of the survey and its timing mean that the full spectrum of flora and fauna species and ecological processes likely to occur on the site cannot be fully quantified or described in this report. These limitations have been addressed by identifying potential habitats for such species and assessing the potential for these species to occur on the site based on previous records, the type and condition of habitats present, the land use of the site and its landscape context.

4 RESULTS

4.1 Site Description

4.1.1 General

The subject site, known as Lot 7 DP 1065574, is located at No.146 Newbridge Road, Moorebank, within Liverpool LGA. It is bounded to the north by Newbridge Road, to the east by the Flower Power Nursery and the Georges River, to the south by Moorebank Recyclers and to the west by the Moorebank Recyclers access road (Map 1).

The site is zoned RE1 (Public Recreation), RE2 (Private Recreation), R3 (Medium Density Residential), and B6 (Enterprise Corridor) under Liverpool LEP 2008 (see Map 2); the eastern section of the study site is also zoned as Environmental Significant Land (Map 4). As stated previously, the site is currently being used for sand and gravel extraction and as a glass recycling facility.

4.1.2 Soils

The site is mapped as occurring within the Richmond Soil Landscape Group (Hazelton *et al.* 1989). Soils of this group are poorly structured orange to red clay loams, clays and sands. Ironstone nodules may be present. Plastic clays occur in drainage lines and krasnozems, red earths and red podzolic soils, occur on terrace surfaces, with earthy sands on terrace edges. Soil limitations include high erosion hazard on terrace edges and minor localised flooding (Hazelton *et al.* 1989).

The site has been largely disturbed by past and current land use practices, including filling and sand and gravel extraction.

4.1.3 Topography

The natural topography of the site has been altered by past filling and current sand and gravel extraction activities, creating a series of small mounds and hills. The largest hill on site has been formed by the temporary stockpiling of unconsolidated fill material. The topography of the surrounding area is typical of an alluvial floodplain and is relatively flat but gently undulating in some areas.

4.1.4 Drainage

The site falls within the Georges River catchment, with the River forming the eastern boundary of the site. A constructed open drainage channel flows along the western boundary of the site, it originates from the Chipping Norton industrial area, north of Newbridge Road. The channel has been constructed to link up with a tributary which runs along the southern boundary. Another small drainage line flows in a west/east direction from the eastern section of the site to the Georges River. A number of constructed dams are located within the southern part of site.

4.1.5 Vegetation

Most of the subject site is devoid of vegetation, with the original native vegetation having apparently been removed during current and past land use practices. The only remaining stands of vegetation border the Georges River, the western and southern aligned drainage line and the northern boundary of the site. The vegetation consists mostly of regenerating plants with a few remnant trees occurring in the far south-eastern corner of the site. Several large infestations of weed species are also present in various places.

4.2 Flora

4.2.1 Plant Species

A total of 87 plant species were recorded on the site during the current flora field survey, including 38 native species and 49 introduced species (Appendix B). A total of 199 plant species have been observed on site if the previous flora study (TEC 2006) is taken into account.

Of the 49 introduced species, nine are listed as noxious for Liverpool LGA, pursuant to the *NSW Noxious Weeds Act 1993* (Order No. 28, 2011) (Table 1).

Any noxious weed species present on the site must be either controlled or removed (and disposed of appropriately) by the landowner, according to the requirements of the Act.

Table 1 Plant species recorded on the site listed under the *NSW Noxious Weeds Act 1993* for Liverpool LGA (Order No.28).

Common Name	Scientific Name	Control Category
Alligator Weed	*Alternanthera philoxeroides*	3
Castor Oil Plant	*Ricinus communis*	4
Green Cestrum	*Cestrum parqui*	3
Lantana	*Lantana camara*	4
Ludwigia	*Ludwigia peruviana*	3
Privet (Broad-leaf)	*Ligustrum lucidum*	3
Privet (Small-leaf)	*Ligustrum sinense*	3
Pampas Grass	*Cortaderia selloana*	3
Pellitory of the Wall	*Parietaria judaica*	4

4.2.2 Plant Communities

Four plant communities were identified on the subject site at Moorebank during the current investigations:

- River Flat Eucalypt Forest;
- Swamp Oak Floodplain Forest;
- Reconstructed Vegetation; and
- Cleared and Disturbed

River Flat Eucalypt Forest and Swamp Oak Floodplain Forest were mapped on site by SMCMA vegetation mapping, and their extent ground truthed by TEC. The distribution of plant communities within the site is shown on Maps 5 & 6 and described below.

River Flat Eucalypt Forest

River Flat Eucalypt Forest occurs adjacent to the Georges River from the south-western corner of the site, east along the southern boundary, and north approximately one third of the subject site's eastern boundary (Map 6).

The community on site is characterised by a canopy of Swamp She-oak *Casuarina glauca*, Cabbage Gum *Eucalyptus amplifolia,* Forest Red Gum *Eucalyptus tereticornis,* Broad-leaved Apple *Angophora subvelutina,* River Peppermint *Eucalyptus elata,* Blue Box *Eucalyptus bauerana* and Sydney Green Wattle *Acacia decurrens.*

There are no significant understorey plants other then a few individuals of Blackthorn *Bursaria spinosa* and Castor Oil Plant *Ricinus communis.* The groundcover layer is dominated by native and exotic grasses and herbs including: Kikuyu *Pennisetum clandestinum,* Common Couch *Cynodon dactylon*, Paspalum *Paspalum dilatatum,* Weeping Grass *Microlaena stipoides,* Verbena *Verbena bonariensis,* and New Zealand Spinach *Tetragonia tetragonioides,* Balloon Vine *Cardiospermum grandiflorum* and *Tradescantia albiflora*.

The banks of the Georges River contain stands of River Mangrove *Aegiceras corniculatum* and Native Reed *Phragmites australis*, with some infestations of Alligator Weed *Alternanthera philoxeroides*.

Swamp Oak Floodplain Forest

Swamp Oak Floodplain Forest occurs along the eastern boundary of the site, adjacent to the Georges River, and in the south-eastern corner of the site near the tributary (Map 6). Swamp She-oak *Casuarina glauca* is dominant in this community; consequently, it is distinguished from River Flat Eucalypt Forest by the absence of eucalypt species where it occurs.

The community contains few understorey plants with the exception of Sydney Green Wattle *Acacia decurrens* and Blackthorn *Bursaria spinosa.* The groundcover layer is dominated by native and exotic grasses and herbs including Kikuyu *Pennisetum clandestinum,* Common Couch *Cynodon dactylon*, Paspalum *Paspalum dilatatum,* Weeping Grass *Microlaena stipoides,* Verbena *Verbena bonariensis,* and New Zealand Spinach *Tetragonia tetragonioides.* Balloon Vine *Cardiospermum grandiflorum* and *Tradescantia albiflora*.

Reconstructed Vegetation

The Riparian Scrub vegetation occurs along the drainage line that runs along the western and southern boundary of the site (Map 6). This community is devoid of structured native vegetation and is comprised of a mixture of native and exotic species.

The canopy is composed of Swamp She-Oak, River She-Oak *Casuarina cunninghamiana, Acacia decurrens* Sydney Green Wattle and the invasive weed Golden Wreath Wattle *Acacia saligna.* There are also sporadic occurrences of White Feather Honeymyrtle *Melaleuca decora,* Blue Box and Cabbage Gum.

The understorey contains a range of exotic species that commonly colonise disturbed ground, including Castor Oil Plant *Ricinus communis,* Boneseed *Chrysanthemoides monilifera* subsp *monilifera,* Montpellier Broom *Genista monspessulana,* Senna *Senna pendula* and Common Verbena. Scattered individuals of Sydney Golden Wattle *Acacia longifolia* subsp. *longifolia* occur, forming the only representation of native shrubs in the area. Large stands of Fennel *Foeniculum vulgare* exist along the banks of the western channel.

The groundcover is largely dominated by weed species such as Bridal Creeper *Myrsiphyllum asparagoides,* Spear Thistle, Cobbler's Peg's *Bidens pilosa*, Crofton Weed *Ageratina adenophora,* Common Vetch *Vicia sativa*, Kikuyu, Common Couch, Turkey Rhubarb *Acetosa sagittata*, Balloon Vine, and the native Spotted Knotweed *Persicaria decipiens*.

The drainage line contains a significant infestation of the aquatic noxious species Alligator Weed. Common native rushes are growing on the banks of the watercourse and in terrestrial areas immediately adjacent to the watercourse, including Cumbungi *Typha orientalis*, Native Reed, and aquatics such as Common Rush *Juncus usitatus,* Sea Rush *Juncus kraussii* and Water Ribbons *Triglochin procera.*

Cleared and Disturbed

Cleared and disturbed land occurs over most of the site, in areas where sand and gravel extraction and recycling have taken place, and associated infrastructure is located (Map 6). This community exhibits high levels of disturbance and is dominated by weed species.

The vegetation structure within the centre of the site primarily consists of a groundcover layer composed of common exotic species such as Kikuyu *Pennisetum clandestinum,* Common Couch *Cynodon dactylon*, Panic Veldt Grass *Ehrharta erecta,* Cleavers *Galium aparine,* Common Verbena *Verbena officinalis,* Spear Thistle *Cirsium vulgare,* Redflower Mallow *Modiola caroliniana*, Flaxleaf Fleabane *Conyza bonariensis* and Paddy's Lucerne *Sida rhombifolia.*

The understorey comprises exotic shrubs and vines, including Broad-leaf Privet *Ligustrum lucidum*, Boneseed *Chrysanthemoides monilifera* subsp. *rotundata*, Asthma Weed *Parietaria judaica*, Blue Morning Glory *Ipomoea indica* and Coastal Morning Glory *Ipomoea cairica.* The groundcover stratum consists of Nasturtium *Tropaeolum majus,* Centella *Centella asiatica* and Buffalo Grass *Stenotaphrum secundatum.*

4.2.3 Significant Plant Species

Four plant species of regional significance, as listed in the UBBS (NPWS 1997), were recorded on site: *Eucalyptus baueriana* Blue Box, *Eucalyptus elata* River Peppermint, Gosford Wattle *Acacia prominens*, and Fringed Wattle *Acacia fimbriata* (Appendix B). These species were recorded along the western and southern drainage channels in low numbers.

4.2.4 Threatened Species

No threatened plant species were recorded on the site during the current investigations.

A search of the DEC Wildlife Atlas identified 17 threatened plant species occurring within 5km of the site(Table 2). However, examination of their habitat requirements indicates that the likelihood of these species occurring on the site is low due to the absence of suitable soil types, habitat and plant communities.

Table 2 Threatened flora species previously recorded within the locality (5km of the site) on the NSW Atlas of Wildlife.

Scientific Name	Common Name	TSC Act Status[1]	EPBC Act Status[2]
Acacia pubescens	Downy Wattle	V	V
Allocasuarina glareicola	-	E1	-
Caesia parviflora. var minor	Small Pale Grass-lily	E1	
Diuris aequalis	-	E1	V
Epacris purpurascens var purpurascens	-	V	-
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	-
Grevillea parviflora var parviflora	Small-flower Grevillea	V	V
Hibbertia sp. Bankstown	-	E4A	Critically Endangered
Leucopogon exolasius	Woronora Beard-heath	V	
Melaleuca deanei	Deane's Paperbark	V	V
Persoonia nutans	Nodding Geebung	E1	E
Pimelea spicata	-	E1	E
Pomaderris prunifolia	P. prunifolia in the Parramatta, Auburn, Strathfield, and Bankstown LGAs	E2	-
Pterostylis saxicola	-	E1	E
Pultenaea parviflora	-	E1	
Pultenaea pedunculata	-	E1	-
WIlsonia backhousei	Narrow-leafed Wilsonia	V	-

1 E1 – endangered (Schedule 1 of the TSC Act); E2 – Endangered population; E4 – presumed extinct; E4A – Critically Endangered (Schedule 1A of the TSC Act) V – vulnerable (Schedule 2 of the TSC Act).
2 E – endangered, V – vulnerable, Ex- Extinct

Of the above listed threatened flora species *Acacia pubescens* and *Pimelea spicata* have been recorded within 2km of the site. *Acacia pubescens* has been recorded approximately 1km east of the site in Milperra and eight specimens of this species were recorded in a 25m^2 area in the northern arm of bushland (Precinct A) of the adjacent Boral site (ERM 2002). In addition to locating a population of *Acacia pubescens*, the flora and fauna assessment report for the Boral site identifies suitable habitat for this plant species in the southern section of the Boral site (Precinct B). *Pimelea spicata* has been recorded approximately 1.5km northeast of the site in Riverwood Golf Course and Bankstown Airport.

Pterostylis saxicola and *Diuris aequalis* are orchids that do not have above ground parts at all times of the year. Both species flower from October to November, however, the timing of when the species emerge and wilt is unknown. It, therefore, may be possible that these species were not emergent at

the time of the flora survey. Nevertheless, it is unlikely that either species occurs on the subject site as suitable habitat is not present.

No evidence of the above species, or their habitats, was recorded during the field investigations, despite targeted searches. Moreover, no individuals are considered likely to occur on the site, owing to the absence of suitable soil types and habitat types, and to the level of disturbance on the site as a result of current land and previous use practices.

4.2.5 Endangered Ecological Communities

At the end of 2004, listings of Endangered Ecological Communities (EEC) under the TSC Act were changed. As part of the changes, *Sydney Coastal River Flat Forest* (SCRFF) was removed from Part 3 Schedule 1 of the TSC Act, and replaced by the more encompassing *River Flat Eucalypt Forest on coastal floodplains of the NSW North Coast, Sydney Basin, and South-East Bioregions.* Also at the end of 2004, *Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions* was listed as an EEC. The newly listed communities have different eligibility criteria to the formally listed SCRRF.

As a result of the changes to the threatened species listings, two endangered ecological communities as listed under the TSC Act were recorded on the site during the current field investigations.

River Flat Eucalypt Forest has been mapped by SMCMA as occurring along the southern boundary and the southern half of the eastern boundary of the site, while Swamp Oak Floodplain Forest has been mapped as occurring along the northern half of the eastern boundary of the site (Map 5). The vegetation communities and their extents were ground truthed by TEC and shown in Map 6

The vegetation on the site has been almost entirely modified, with only a few canopy tree, shrub, and understorey species present. In addition, the soils of the site and within the area containing the EECs have been disturbed, thereby reducing the natural resilience of the community. The area of River Flat Eucalypt Forest and Swamp Oak Flood Plain Forest comprise approximately 0.2% and 0.3% respectively of the total area of these EECs within the locality (within a 5km radius of the subject site).

Remnants of the endangered ecological communities Castlereagh Ironbark Forest and Cumberland Plain Woodland were identified on the adjacent Boral site during field investigations by ERM (2002). Remnants of Cooks River/Castlereagh Ironbark Forest were also identified within the Moorebank Recyclers site, to the south of the subject site (AES 2002). There is no evidence, however, of these communities within the subject site. SMCMA has also mapped Shale Gravel Transition Forest as occurring immediately west of the subject site. This community was also mapped along the northern boundary of the subject site, however this area was not surveyed by TEC during the current survey effort.

4.3 Fauna

4.3.1 Fauna Species

A total of 22 vertebrate fauna species were recorded during the current field survey, including 19 bird species, two native reptile species, and one amphibian species (Appendix B). Of the total suite of species recorded, one species is listed as Marine/Migratory on the *Environmental Protection and Biodiversity Conservation Act* (1999), and three birds are introduced species.

Although nocturnal and ANABAT surveys were not undertaken, it is likely that common introduced ground mammals (e.g. European Rabbit *Oryctolagus cuniculus*, Red Fox *Vulpes vulpes* and Feral Cat *Felis catus*), common arboreal species (eg Common Brushtail Possum *Trichosurus vulpecula* and Common Ringtail Possum *Pseudocheirus peregrinus*), common native amphibians (e.g. Common Eastern Froglet *Crinia signifera*, Peron's Tree Frog *Litoria peronii* and the Striped Marsh Frog *Limnodynastes peronii*), and microchiropteran bat species occur on the site. The large dams on site and riparian zones if the Georges River provide suitable habitat for species such as the Grey-headed Flying Fox *Pteropus poliocephalus* and some microchiropteran bat ('micro-bat') species. A number of threatened micro-bat species were observed at the adjacent Boral site during the Flora & Fauna

Assessment in 2002 (ERM, 2002), and it has been assumed that those species utilise the subject site as forging, and potentially roosting and nesting habitat.

The majority of species recorded, or expected to occur on the site, are typical of urban bushland sites in residential areas within the Sydney Basin region and are widespread in distribution and common to abundant within their ranges.

4.3.2 Fauna Habitats

The main habitat types occurring across the site include:

- Aquatic/Riparian;
- Riparian Woodland; and
- Cleared and Disturbed.

Aquatic/Riparian

A number of large constructed dams exist within the southern portion of the site. The banks of the dams are generally devoid of vegetation although scattered patches of vegetation containing weed species, such as Common Verbena and the common native Sydney Green Wattle do exist. There are few semi-aquatic plants (reeds, sedges, etc) or aquatic plants within the dams. The aquatic environment of the dam and associated tributaries is highly disturbed, as it is used as part of the gravel and sand extraction works The lack of fringing reeds, the high turbidity levels and the ongoing disturbance would render the dam as unsuitable to all but the most opportunistic and disturbance tolerant amphibian species. The aquatic habitat of the dam is not suitable for the endangered Green & Golden Bell Frog *Litoria aurea,* although the species can tolerate high levels of disturbance, due primarily to the absence of fringing vegetation.

Several common waterfowl were recorded using the dam, including the Pacific Black Duck *Anas superciliosa*, White Faced Heron *Ardea novaehollandiae*, Chestnut Teal *Anas castanea*, and Australian White Ibis *Threskiornis molucca.*

Aquatic and riparian habitat occurs within the drainage line along the western and southern boundaries of the site and along the Georges River. These watercourses constitute a potential wildlife corridor connecting bushland north and south of the site. The watercourses provide habitat and resources for native and introduced fauna. The native reeds and aquatic plants in the tributary provide habitat and foraging resources for birds such as the Pacific Black Duck and Dusky Moorhen *Gallinula tenebrosa* whilst the open water contains potential prey species (ie dragonflies, small birds) for the Australian Hobby *Falco longipennis* and other raptors such as the White-bellied Sea Eagle (*Haliaeetus leucogaster*).

Striped Marsh Frogs were heard calling in the water course at the southwest corner of the site; however, no other frogs were heard calling on the site. Nevertheless, the dams would be suitable habitat for other disturbance tolerant species of frog.

Riparian Woodland

The canopy and understorey vegetation along the tributaries and the Georges River provides shelter, nectar, blossom and seed for small birds such as the Superb Fairy-wren *Malurus splendens,* Silvereye *Zosterops lateralis* and the Scarlet Honeyeater *Myzomela sanguinolenta*. The small tree hollows, particularly in the more established eucalypts in the southeastern corner of the site, could provide nesting opportunities for small forest birds (e.g. Rainbow Lorikeet *Triglossus haematodus,* Sulphur-crested Cockatoo *Cacatua galerita*) arboreal mammals (e.g. Brushtail Possum) and tree-dwelling micro-bats. Two White-bellied Sea Eagles *Haliaeetus leucogaster* were observed roosting in this area. It is likely that the Sea Eagles are a nesting pair; subsequent investigations found records of two Sea Eagle nest sites within 10km of where the pair of Sea Eagles were observed. The closest known nesting site is located approximately 2kms away at Warwick Farm. No Sea Eagle nests were

observed from within the subject site, and it is unlikely that a nest exists within the immediate vicinity of the subject site.

There is a large *Eucalyptus tereticornis* located on the eastern boundary of the site between the Georges River and the dredging dams which would provide suitable roosting and potentially nesting habitat for microchiropteran bats species. This tree contains a large split down the trunk and a number of hollows along the branches. Benedict has advised that this tree will be retained as part of the proposal. The tree's location is shown in Map 7.

The groundcover of herbs and grasses are likely to provide foraging habitat for common native ground-dwelling mammals (e.g. Bush Rat *Rattus fuscipes*), macropods, and introduced feral pests (e.g. European Rabbit, Red Fox, Black Rat, and Feral Cat). Several tracks of an unidentified macropod were observed on the boundary of the Riparian Woodland and Clear and Disturbed habitats. It is likely that various macropod species use both habitats for foraging.

The leaf litter, rocks and logs that are present within the ground layer are also likely to provide habitat for a number of invertebrates. In this regard, it is possible that the less disturbed parts of the riparian habitat adjoining the Georges River provide potential habitat for the endangered Cumberland Land Snail, although no live snails or shells were detected during the current field investigations.

Cleared and Disturbed

The cleared and disturbed habitat type favours ecological generalists that are capable of utilising a wide range of habitats for foraging, as well as disturbance-tolerant species that are ubiquitous in modified urban habitats throughout the region. Some generalist bird species that were recorded within this habitat include Common Mynas *Acridotheres tristis*, and native Pied Currawongs *Strepera graculina*. Australian White Ibises *Threskiornis molucca* and Little Ravens *Corvus mellori* are observed in abundance within the subject site. The species observed within this habitat are all likely to forage over the cleared parts of the site and throughout the locality in general.

4.3.3 Threatened Species

A total of 25 threatened fauna species listed under the TSC Act or EPBC Act have been recorded within 5km of the site over the last 20 years. The OEH Wildlife Atlas records of these species are summarised below in Table 3.

Table 3 Threatened fauna species previously recorded within the locality (5km of the site) on the NSW Atlas of Wildlife and during previous field surveys of the adjacent Boral site (ERM, 2002).

Scientific Name	Common Name	TSC Act Status[1]	EPBC Act Status[2]	Recorded on Boral site
Burhinus grallarius	Bush Stone-curlew	E1	-	
Callocephalon fimbriatum	Gang Gang Cockatoo	V	-	
Cercartetus nanus	Eastern Pygmy-possum	V		
Daphoenositta chrysoptera	Varied Sittella	V		
Dasyurus maculatus	Spotted-tailed Quoll	V	V	
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	
Glossopsitta pisilla	Little Lorikeet	V		
Hieraaetus morphoides	Little Eagle	V		
Lathamus discolor	Swift Parrot	E1	E	
Litoria aurea	Green and Golden Bell Frog	E1	V	
Lophoictinia isura	Square-tailed Kite	V		
Melithreptus gularis gularis	Black-chinned Honeyeater	V	-	
Meridolum corneovirens	Cumberland Plain Land Snail	E1	-	✓
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V	-	
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	✓
Myotis macropus	Southern Myotis	V		
Ninox connivens	Barking Owl	V	-	
Ninox strenua	Powerful Owl	V	-	
Petaurus norfolcensis	Squirrel Glider	V		
Petroica phoenicea	Flame robin	V		
Pseudophryne australis	Red-crowned Todlet	V		
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	✓
Saccolaimus flaviventris	Yellow–bellied Sheathtail Bat	V	-	✓
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	
Xanthomyza phrygia	Regent Honeyeater	E1	E	

[1] E1 – endangered (Schedule 1 of the TSC Act); V – vulnerable (Schedule 2 of the TSC Act).
[2] E – 'endangered, V – vulnerable (EPBC Act)

Table 4 summarises the habitat potential of the subject site for the threatened fauna species previously recorded as occurring within 5 km radius of the site.

Table 4 Habitat potential for threatened fauna species previously recorded within the locality (5km of the site) on the OEH NSW Atlas of Wildlife.

Scientific name	Species distribution and Habitat Preference	Likelihood of Species to Occur on Subject Site
Burhinus grallarius	Bush Stone-curlew stands approximately 50-60cm high, and has long gangly legs, large yellow eyes, and grey-streaked feathers. It colouring makes it difficult to see in its habitat. The Bush Stone-curlew is confined to grassy woodlands and farmlands within the southeastern states. This is a large contraction from its former distribution of all mainland states; it is sparsely distributed within its range. The Bush Stone-curlew prefers grassy woodlands with little understorey, where it can see predators approaching. It nests next to fallen logs, where the branches are essential for its camouflage.	Nil. The native vegetation around the edges of the subject site contains a dense understorey and is therefore not suitable habitat.
Callocephalon fimbriatum	The Gang Gang Cockatoo is a relatively small, dark grey cockatoo. Feathers are distinctively squarish on the ends. Males have a bright red head and crest. Females have a grey head and crest and the females breast feathers are reddish – pink. The species is listed as Vulnerable in NSW and the population found in the Ku-ring-gai and Hornsby LGA's is listed as Endangered. This population is believed to be largely confined to an area bounded by Thornleigh and Wahroonga in the north, Epping and North Epping in the south, Beecroft and Cheltenham in the west and Turramurra/South Turramurra to the east. It is known to inhabit areas of Lane Cove National Park, Pennant Hills Park and other forested gullies in the area. It occurs within a variety of forest and woodland types and usually frequents forested areas with old growth attributes required for nesting and roosting purposes. Also utilises less heavily timbered woodlands and urban fringe areas to forage, but appears to favour well timbered country through which it habitually flies as it moves about. Individuals of this population are likely to move outside the 'defined' population boundary in the general area and should still be considered of this population.	Nil-Low. Limited suitable foraging habitat is located along the southern and south-east & south-west boundaries of the subject site.
Cercartetus nanus	Adult Eastern Pygmy-possums have a head and body length of between 70 - 110 mm and are active climbers with prehensile tails. The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extends from the coast inland as far as the Pillaga and to Wagga Wagga on the western slopes. Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes and insects. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum dreys or thickets of vegetation, (eg. grass-tree skirts) and are generally nocturnal.	Nil-Low. Limited suitable foraging habitat is located along the southern and south-east & south-west boundaries of the subject site.
Daphoenositta chrysoptera	The Varied Sittella is a small songbird with a sharp, upturned bill, short tail, and yellow eyes and feet. It is sedentary and inhabits most of mainland Australia except treeless deserts and open grassland. It has an almost continuous distribution from the coast to far west NSW. It prefers eucalypt forests with woodlands, especially rough-barked species and mature smooth-gum with dead branches, mallee and *Acacia* woodland.	Nil. The subject site does not support any foraging habitat for this species.

Table 4 cont' Habitat potential for threatened fauna species previously recorded within the locality (5km of the site) on the OEH NSW Atlas of Wildlife.

Dasyurus maculatus	The Spotted-tailed Quoll is about the size of a domestic cat with rust to dark-brown fur above, with irregular white spots on the back and tail, and a pale belly. The range has contracted and is now found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland. Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Mostly nocturnal, it spends most of the time on the ground, but may also climb to raid possum and glider dens and prey on roosting birds. Prey includes gliders, possums, small wallabies, rats, birds, bandicoots, rabbits and insects and also eats carrion and takes domestic fowl. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares and usually traverse their ranges along densely vegetated creek lines.	Nil. The subject site does not support any foraging habitat for this species.
Falsistrellus tasmaniensis	The Eastern False Pipistrelle is a relatively large microbat which is approximately 65mm long and weighs up to 28 grams. It is dark to red-brown on top and a pale grey on the underside; it has long slender ears and sparse hair on the nose. Eastern False Pipistrelle's range extends from southern Queensland to Victoria and Tasmania. It prefers moist habitats with trees taller than 20m and roosts in eucalypt hollows as well as under loose bark and in buildings. It forages on beetles, moths, and other flying insects just above the canopy.	Nil-Low The subject site supports limited foraging habitat for this species.
Glossopsitta pisilla	The Little Lorikeet is the smallest of the Australian Lorikeets. The species is distributed from Cairns in QLD to Adelaide in SA. In New South Wales Little Lorikeets are occur in forests and woodlands from the coast to the western slopes of the Great Dividing Range, extending west to Albury, Parkes, Dubbo and Narrabri. The species predominately forages for nectar and pollen in the tree canopy as well as melaleucas and mistletoes.	Nil-low. Subject site does not support preferred foraging habitat.
Hieraaetus morphoides	The Little Eagle is medium size bird of prey which is found throughout Australia. It has two colour forms: pale brown with an obscure underwing pattern, and dark brown above and pale brown underneath. Both forms have a black-streaked head with a slight crest, a pale shoulder band on the upperwings, a short square-tipped tail, and feathered legs. It occupies open eucalypt forests, woodland or open woodland, and preys on birds, reptiles, mammals, and occasionally insects.	Low. Potential habitat on adjacent land. Some foraging habitat on site.
Lathamus discolor	Migrating from breeding grounds in Tasmania to the Australian mainland in winter Swift Parrot ranges from south-eastern South Australia across inland and coastal areas to southeast Queensland. The preferred habitat on mainland Australia is woodlands and riparian vegetation where there are winter flowering eucalypts such as the Swamp Mahogany, *Eucalyptus robusta* in coastal areas (NPWS 2002a). Breeding in Tasmania between September and February sometimes in small colonies the nest is an unlined tree hollow with three to five eggs laid. The species feeds mainly on nectar but also pollen and insects (NPWS 2003).	Nil-Low. Limited suitable foraging habitat is located along the southern and south-east & south-west boundaries of the subject site.

Table 4 cont' Habitat potential for threatened fauna species previously recorded within the locality (5km of the site) on the OEH NSW Atlas of Wildlife.

Litoria aurea	The Green and Golden Bell Frog is distributed along the NSW and eastern Victorian coasts and some isolated locations west of the Great Dividing Range in NSW, this species inhabits wetlands such as marshes, dams and stream verges. Preferred habitat includes unshaded water bodies with adjacent grassy areas and suitable diurnal sheltering sites such as emergent vegetation and rocks and is known to inhabit highly disturbed sites within the Greater Sydney region (NPWS 1999). Frequently active by day. Adults prey on invertebrates and other amphibians. Tadpoles feed on algae or other vegetative material (NPWS 1999). Breeding usually occurs in summer when conditions are warm and wet (Cogger 1992) and water-bodies used for breeding usually have a substrate of sand, rock or clay, are still and shallow and are free of predatory fish eg Mosquito Fish.	Nil. The waterbodies onsite do not contain vegetation for sheltering or breeding.
Lophoictinia isura	The Square-tailed Kite is a medium sized, long-winged raptor. Adults have a white face with thick black streaks on the crown, and the rump and central uppertail is blackish with grey-brown barring. The Square-tailed Kites range extends from coastal and sub-coastal south-western to northern Australia, Queensland, NSW, and Victoria. It is also found along major west-flowing river systems. The Square-tailed kite occurs in a variety of timbered habitats including dry woodlands and open forests. It also shows a particular preference for timbered watercourses. It forages above the canopy, preying on passerines, particularly nestings, and insects.	Nil-Low. Potential habitat on adjacent land.
Melithreptus gularis gularis	The Black-chinned Honeyeater is approximately 17cm long and has a black cap, a white crescent above the nape and a black chin beneath its bill which extends down its white throat. The eastern subspecies of Black-chinned Honeyeaters is distributed from central Queensland to South-Eastern South Australia mostly east of the Great Dividing Range. It occupies the upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts such as E. tereticornis, E. albens, and E. melliodora. It is usually found in large woodland patched as it has a hone range of up to 5 hectares. The species is gregarious and is usually seen in small groups which can contain up to 12 individuals.	Nil-Low. Limited foraging habitat exists along the boundaries of the subject site, however, the size of the area may be inadequate.
Meridolum corneovirens	The Cumberland Plain Land Snail is a small snail which is restricted to a small section of the Cumberland Plain west of Sydney. It is distributed from Richmond and Windsor south to Picton and Liverpool west to the base of the Blue Mountains. Its shell is 25-30mm in diameter, thin and fragile, and appears flattened compared to the common Garden Snail. It is uniform in colour and can be almost any colour brown. Its core habitat primarily consists of the ecotone between Cumberland Plain Woodland (CPL) and Sydney Coastal River Flat Forest (SCRFF); however, it can be found in modified remnants of CPL and SCRFF as well as disturbed habitats. It shelters under leaf litter, logs, loose clumps of soil, and can bury underground to escape drought. They can also be found sheltering in and under rubbish in disturbed environments. It is a fungal specialist and does not eat green leaf matter unlike the common garden snail. Very little is known about its life history and breeding biology.	Low to Medium. Potential habitat would is limited to the Riparian Woodland Habitat along the boundaries of the subject site. This species was found at the Boral site adjacent to the subject site.

Table 4 cont' Habitat potential for threatened fauna species previously recorded within the locality (5km of the site) on the OEH NSW Atlas of Wildlife.

Miniopterus schreibersii oceanensis	The Eastern Bent-wing Bat has chocolate to reddish-brown fur on its back and slightly lighter coloured fur on its belly. The species occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat but also use man-made structures. Form discrete populations centered on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Maternity caves have very specific temperature and humidity regimes and cold caves are used for hibernation in southern Australia. At other times of the year, populations disperse within about 300 km range of maternity caves. Forage in forested areas, catching moths and other flying insects above the tree tops.	Low to medium. Some potential foraging habitat on site.
Mormopterus norfolkensis	The Eastern Freetail-bat has dark brown to reddish brown fur on the back and is slightly paler below and is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest and woodland east of the Great Dividing Range and roost mainly in tree hollows but will also roost under bark or in man-made structures. Solitary and probably insectivorous.	Medium. Potential foraging and roosting habitat on site.
Myotis macropus	The Southern Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. It is rarely found more than 100 km inland, except along major rivers. Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Forage over streams and pools catching insects and small fish by raking their feet across the water surface. In NSW females have one young each year usually in November or December.	Medium. Potential foraging and roosting habitat on site and over adjacent bushland areas.
Ninox connivens	The Barking Owl is a typical hawk-owl with no facial-disc and males may be up to 45 cm. The Barking Owl is found throughout Australia except for the central arid regions and Tasmania. It is quite common in parts of northern Australia, but is generally considered uncommon in southern Australia. It has declined across much of its distribution across NSW and now occurs only sparsely. It is most frequently recorded on the western slopes and plains. It is rarely recorded in the far west or in coastal and escarpment forests. Inhabits eucalypt woodland, open forest, swamp woodlands and timber along watercourses. Dense vegetation is used occasionally for roosting. Roost during the day they roost along creek lines, usually in tall understorey trees with dense foliage. Feeds on a variety of prey including insects, birds and mammals such as smaller gliders, possums, rodents and rabbits becoming important during breeding. Territories range from 30 to 200 hectares and birds are present all year. Nests are made in hollows of large, old eucalypts.	Nil-Low. This species prefers tall eucalypt forests and woodland, however, limited foraging habitat exists in the clear and disturbed areas.
Ninox strenua	The Powerful Owl is the largest owl in Australasia. It is a typical hawk-owl with no facial-disc. Adults reach 60 cm in length. The Powerful Owl is endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW, it is widely distributed throughout the eastern forests from the coast inland to tablelands. Now uncommon throughout its range where it occurs at low densities. Inhabits a range of vegetation types, from woodland and open sclerophyll forest to tall open wet forest and rainforest and requires large tracts of forest or woodland habitat but can occur in fragmented landscapes as well. The species breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally in open habitats. It roosts by day in dense. Preys on medium-sized arboreal mammals particularly the Greater Glider, Common Ringtail Possum, Sugar Glider and flying foxes. Have high fidelity to a small number of hollow-bearing nest trees.	Nil-Low. This species prefers tall eucalypt forests and woodland, however, limited foraging habitat exists in the clear and disturbed areas.

Table 4 cont' Habitat potential for threatened fauna species previously recorded within the locality (5km of the site) on the OEH NSW Atlas of Wildlife.

Petaurus norfolcensis	Squirrel Gliders are a small marsupial with a head and body length of approximately 20cm. they have grey fur above and are white below. They have a dark marke between the eyes which extends down to the mid-back, and a long bushy tail. Squirrel Gliders show tree species preferences of Grey Box (*Eucalyptus microcarpa*), River Red Gum (*Eucalyptus camaldulensis*), Forest Red Gum (*Eucalyptus tereticornis*) and Red Ironbark (*Eucalyptus sideroxylon*) as well as banksias, acacias and xanthorrhoeas. They also prefer mixed stands with Acacia or shrub understorey.	Low. Potential foraging and roosting habitat on site.
Petroica phoenicea	The Flame Robin is a small songbird which reached 14cm in length. The male has a dark grey head and upperparts, a small white forehead patch, white wing stripes and tail edges, and a bright orange breast, throat, and upper belly. Females are brown with whiteist throats and lower bellies. The Flame Robin ranges from near the Queensland boarder to south-east South Australia and Tasmania. The species breeds in tall moist eucalypt forests and woodlands, which are dominated in native grasses, often on ridges and slopes. The prefer clearings or areas with an open understorey for foraging.	Nil. The subject site does not support any breeding or foraging habitat for this species.
Phascolarctos cinereus	The Koala is an arboreal marsupial with fur ranging from grey to brown above, and is white below. The Koala has a fragmented distribution throughout eastern Australia from north-east Queensland to the Eyre Peninsula in South Australia. In NSW it mainly occurs on the central and north coast with some populations in the western region and in sparse and possibly disjunct populations along the south coast. Inhabit eucalypt woodlands and forests and feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. Spend most of their time in trees, but will descend and traverse open ground to move between trees.	Nil-Low. Limited suitable foraging habitat is located along the southern and south-east & south-west boundaries of the subject site.
Pteropus poliocephalus	The Grey-headed Flying-fox is the largest Australian bat. Grey-headed Flying-foxes are found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria. Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. Travel up to 50 km to forage and feed on the nectar and pollen of native trees, in particular Eucalyptus, Melaleuca and Banksias, and fruits of rainforest trees and vines.	Medium. Species occupies a large home range, potential foraging habitat on site and potenial roosting habitat along within the Riparian Woodland.
Pseudophryne australis	The Red-crowned Toadlet is an unmistakable small frog, usually measuring less than 30 mm long with distinctive reddish-orange patches, one between the eyes and one along the rump. The species has a restricted distribution and it is confined to the Sydney Basin, from Pokolbin in the north, the Nowra area to the south, and west to Mt Victoria in the Blue Mountains. Occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones inhabiting periodically wet drainage lines below sandstone ridges that often have shale lenses or cappings. Shelters under rocks and amongst masses of dense vegetation or thick piles of leaf litter. Disperses outside the breeding period, when they are found under rocks and logs on sandstone ridges and forage amongst leaf-litter.	Nil. No Suitable habitat is located on the subject site.

Table 4 cont' Habitat potential for threatened fauna species previously recorded within the locality (5km of the site) on the OEH NSW Atlas of Wildlife.

Saccolaimus flaviventris	The Yellow-bellied Sheathtail-bat is a wide-ranging species found across northern and eastern Australia. In the most southerly part of its range - most of Victoria, south-western NSW and adjacent South Australia - it is a rare visitor in late summer and autumn. There are scattered records of this species across the New England Tablelands and North West Slopes. Roosts singly or in groups of up to six, in tree hollows and buildings, however in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees. This species appears to defend an aerial territory. Breeding has been recorded from December to mid-March, when a single young is born. Seasonal movements are unknown.	Medium. Potential foraging and roosting habitat on site.
Scoteanax rueppellii	The Greater Broad-nosed Bat is a large powerful micro bat. The Greater Broad-nosed Bat is found mainly in the gullies and river systems that drain the Great Dividing Range, from north-eastern Victoria to the Atherton Tableland. It extends to the coast over much of its range. In NSW it is widespread on the New England Tablelands. Utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. The species usually roosts in tree hollows, but it has also been found in buildings. Open woodland habitat and dry open forest suits the direct flight of this species as it searches for beetles and other large, slow-flying insects; this species has been known to eat other bat species. Females congregate at maternity sites located in suitable trees.	Nil-Low. Limited suitable foraging habitat is located along the southern and south-east & south-west boundaries of the subject site.
Xanthomyza phrygia	The Regent Honeyeater is a medium-sized, black and yellow honeyeater with a curved bill and mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. Its range has contracted to between north-eastern Victoria and south-eastern Queensland and in NSW the distribution is very patchy and mainly confined to the two main breeding areas although in some years non-breeding flocks converge on flowering coastal woodlands and forests. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River She-oak with large numbers of mature trees, high canopy cover and abundance of mistletoes. Non-breeding flocks are known to forage in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast. The species is a generalist forager and mainly feeds on the nectar from a wide range of eucalypts and mistletoes.	Nil-Low. Limited suitable foraging habitat is located along the southern and south-east & south-west boundaries of the subject site.

Given the above considerations, the highly disturbed nature of the site and the small area of habitat available, it is unlikely that the majority of the above threatened fauna previously recorded in the locality on the OEH Wildlife Atlas would occur on the site, on other than a transient basis. Mobile, wide ranging and nomadic species (ie some bat and bird species) could occur on the site temporarily or transiently during foraging excursions.

Although no threatened fauna species were recorded on the site during the current investigations, microchiropteran bat survey was not undertaken as part of the works. Instead, it was assumed that the following species would occur on site due to their presence on the adjacent Boral site, and the suitable foraging and potential roosting and nesting habitat located on the subject site:

- Eastern Freetail-bat (*Mormopterus norfolkensis)*
- Yellow–bellied Sheathtail Bat (*Saccolaimus flaviventris)*

4.3.4 Endangered Populations

There are no endangered populations, as listed under Schedule 1 (Part 2) of the TSC Act, of relevance to the site.

4.3.5 EPBC Act Listed Species

Two White-bellied Sea Eagles *Haliaeetus leucogaster* were observed roosting in a *Eucalyptus tereticornis* at the south-eastern corner of the subject site (Map 7). This species is listed as Marine and Migratory under the *Environmental Protection and Biodiversity Conservation Act 1999*. It is likely that the Sea Eagles are a nesting pair; subsequent investigations found two known Sea Eagle nest sites within 10km (as the crow flies) of where the pair of Sea Eagles were observed. The closest known nesting site is located approximately 2kms away at Warwick Farm. No Sea Eagle nests were observed within the subject site, and it is unlikely that a nest exists within the immediate vicinity of the subject site.

TEC has considered the Matters of National Significance Guidelines and believes that it is not necessary to complete an assessment of significance for the following reasons:

- The While-bellied Sea Eagle has a home range of 100km^2; the subject site encompasses a very small proportion of the species home range. Moreover the proposed marina will not substantially modify, destroy, or isolate the limited habitat on site;
- The works will not result in an invasive species being established in the available habitat;
- As stated previously, it is unlikely that a nest exists within the immediate vicinity of the subject site. Therefore, it is highly unlikely that the proposed works will significantly disrupt the breeding cycle of the species.

5 STATUTORY CONSIDERATIONS

5.1 Federal Government Legislation

5.1.1 Environmental Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the EPBC Act as matters of national environmental significance. Matters of national environmental significance identified in the Act are:

- world heritage properties;
- national heritage places;
- Ramsar wetlands;
- nationally threatened species and communities;
- migratory species protected under international agreements;
- the Commonwealth marine environment; and
- Nuclear actions.

Two White-bellied Sea Eagles *Haliaeetus leucogaster,* listed as Marine/Migratory in the EPBC Act, were observed roosting within the subject site. Additionally, it is likely that Grey Headed Flying Foxes *(Pteropus poliocephalus)* use the site as foraging and potentially roosting habitat.

5.2 State Legislation

5.2.1 Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* (*TSC Act*) aims to conserve threatened species, populations, ecological communities and their habitats to promote their recovery, and to manage the processes that threaten or endanger them. The *Act* has lists of threatened flora, fauna and ecological communities, for which consideration must be given for proposed development and actions. The following threatened species or communities occur or have been assumed to occur on site:

- Microchiropteran bats
- Swamp Oak Floodplain Forest
- River Flat Eucalypt Forest

5.2.2 Section 5A of EP&A Act

Section 5A (s.5A) of the *Environmental Planning & Assessment Act 1979* (the so called '7-part test') lists seven factors that "must be taken into account" by a consent or determining authority in the administration of Sections 78A, 79C and 112 of the Act when considering a development proposal or development application. The aim of s.5A is to determine "whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats", as listed under Schedules 1 and 2 of the TSC Act, and hence whether a *Species Impact Statement* (SIS) is required for the development application.

It is has been assumed that threatened micro-bat species occur on site, therefore a 7-part test has been completed for these species and included below. The River Flat Eucalypt Forest and Swamp Oak Floodplain Forest which occur within the subject site constitute a very small proportion (0.2% and 0.3% respectively) of the respective EECs within the locality. Moreover, these areas of EEC are degraded due to past land use practices and as a consequence, are likely to be poorly resilient. As such, due to the nature of these areas of EECs in terms of size and quality, their removal as part of the construction process would not have a significant impact on the EECs within the locality. Therefore, a 7-part test has not been completed for these endangered communities.

5.2.4 Water Management Act 2000

The Water Management Act 2000 stipulates that a controlled activity approval is required for certain types of developments and activities which are carried out within 40m of a river, lake, creek, or estuary. Under the WMA a controlled activity is defined as:

- The erection of a building or the carrying out of work (within the meaning of the EP&A Act);
- The removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise;
- The deposition of material (whether or not extractive material) on land, whether by way of excavation or otherwise; and
- The carrying out of any other activity that affects the quantity or flow of water in a water source.

On this basis, development activities that are proposed to occur within 40m of any waterway that qualifies as a "river" under the Act within the site will require controlled activities approval from the Office of Water. The Georges River and western and southern drainage lines would qualify as a river within the meaning of the Act.

5.2.3 NSW Fisheries Management Act 1994

The *NSW Fisheries Management Act 1994* (FM Act) provides for the protection, conservation and recovery of marine and aquatic fish species. It also makes provision for the management of threats to threatened species, populations and ecological communities, as well as the protection of fish and fish habitat in general.

A number of activities require consultation and approval from NSW Fisheries under the FM Act. Construction as part of the proposed works may require consent from NSW Fisheries for the harming of marine vegetation, such as seagrass, macroalgae and mangroves. This will require a permit under Part 7 of the FM Act.

5.3 State Environmental Planning Policy

5.3.1 SEPP 44 – Koala Habitat Protection

State Environmental Planning Policy No.44 - Koala Habitat Protection (SEPP 44) aims to protect the Koala and its habitat by incorporating prescriptions for consent authorities to consider during the assessment of development applications. SEPP 44 contains prescriptions for the consideration of "potential koala habitat" and "core koala habitat" for developments within Local Government Areas listed on Schedule 1 of the Policy. Liverpool LGA is listed on Schedule 1 as an area to which SEPP 44 applies.

"Potential koala habitat" is defined by SEPP 44 as "areas of native vegetation where the trees of types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component". One tree species recorded on-site, Forest Red Gum, is listed under Schedule 2 of the Policy as a Koala "feed tree species". This species however does not constitute more than 15% of the total number of trees in the canopy stratum and as such the site does not contain "potential koala habitat", as defined under SEPP 44.

"Core koala habitat" is defined under SEPP 44 as areas of land that contain "a resident population of koalas, evidenced by attributes such as breeding females and recent sightings of and historical records of a population". There is no evidence (such as sightings, calls, scats and fur) that the site supports a resident population of the Koala and there is no evidence in general of koala activity. Hence, the site does not constitute "core koala habitat", within the meaning of SEPP 44.

On this basis, the provisions of SEPP 44 do not apply to the proposed activity. A *Koala Plan of Management* is not required to be prepared as part of the proposal.

5.3.2 SEPP 19 – Bushland in Urban Areas

State Environmental Planning Policy No.19 - Bushland in Urban Areas (SEPP 19) aims to, amongst other things, "protect and preserve bushland" within the urban areas of Sydney (Department of Planning 1986). Liverpool is listed under SEPP 19 as a Council area to which the Policy applies.

Clauses 6, 7 and 8 of the Policy outline requirements for development consent to be considered by a consent authority (in this case, Liverpool Council), when assessing development applications that involve disturbance to bushland "zoned or reserved for public open space". Since the eastern section of the site is zoned "for public open space" pursuant to Liverpool LEP, Clauses 6, 7 and 8 of SEPP 19 are applicable to the proposal.

Clause 9 of SEPP 19 sets out requirements for development on "land adjoining land zoned or reserved for public open space". The RE2 zoned land on the subject site adjoins land zoned or reserved for public space, and therefore Clause 9 of SEPP 19 applies to this proposal.

Clause 10 of the Policy requires that, when preparing a draft local environmental plan, Council must consider the "general and specific aims of the Policy" and "give priority to retaining bushland". Accordingly, SEPP 19 applies to the proposed marina. The vegetation along the eastern boundary could be considered marginal 'SEPP 19' bushland. With appropriate restoration works, including

weed removal and supplementary planting, the area proposed for retention within the riparian buffer could be regenerated to be more representative of the original vegetation. The retention of what is a substantial proportion of this bushland, as proposed, is consistent with the aims of SEPP 19, with particular reference to Clause 10.

5.4 Regional Environment Plan

5.4.1 REP No.2 - Georges River Catchment

The *Greater Metropolitan Regional Environmental Plan No.2 Georges River Catchment* (GM REP No.2) aims to protect the environmental and water quality of the Georges River and its tributaries and the catchment as a whole. The REP refers to coordinated land use planning and development control and establishes a framework within which local, state and federal agencies will consult so that there is a consistent approach to planning and development within the catchment.

The requirements of the REP that are to be considered when assessing a development application include:

- landfill, which is prohibited on flood liable land (as defined in Council's Flood Liable Land Map);
- housing, which must consider adequate servicing, stormwater management and the incorporation of vegetated buffer areas along watercourses and other environmentally sensitive areas;
- extractive industry, which must consider flood behaviour, vegetation, water quality, noise and vibration levels; and
- industry, which must consider stormwater controls, remnant vegetation, water quality and wastewater disposal.

The consent authority, Liverpool Council, have specified that a 40m wide vegetated buffer be maintained along the top of the banks of the Georges River in order to meet the aims and objectives of the Greater Metropolitan REP No.2.

5.5 Local Government Policy

5.5.1 Liverpool Local Environmental Plan 2008

The proposed marina will be constructed on land zoned as RE1, RE2 as outlined in Part 2 of the LLEP 2008, and Environmentally Significant Land as outlined in Clause 7.6 of the LLEP 2008.

The aims of zone RE1 is:

- to enable land to be used for public open space or recreational purposes;
- to provide a range of recreational settings and activities and compatible land uses;
- to protect and enhance the natural environment for recreational purposes;
- to provide sufficient and equitable distribution of public open space to meet the needs of residences; and
- to ensure the suitable preservation and maintenance of environmentally significant or environmentally sensitive land.

The aims of zone RE2 is:

- to enable land to be used for private open space or recreational purposes;
- to provide a range of recreational settings and activities and compatible land uses;

- to protect and enhance the natural environment for recreational purposes; and
- to enable land uses that are compatible with, and complimentary to, recreational uses.

Approximately 2ha of the Benedict site has been classified as "Environmentally Significant Land", under clause 7.6 of the LEP. The area includes a strip of land parallel with the eastern site boundary, along the Georges River, and continues towards the south-west corner of the site (see Map 4).

The objectives of Clause 7.6 are as follows:

- to maintain bushland, wetlands, and wildlife corridors of high conservation value;
- to identify areas of significance for revegetation to connect to or buffer bushland, wetlands, and wildlife corridors;
- to protect rare and threatened flora and fauna; and
- to ensure the consideration of the significance of vegetation, the sensitivity of the land and the impact of development on the environment prior to the giving of any development consent.

The LEP stipulates that when determining an application to carry out development on land shown as "Environmentally Significant Land" Council must consider whether:

- the condition and significance of the vegetation on the land and whether is should be substantially retained in that area;
- the importance of that vegetation in that particular location to native fauna;
- the sensitivity of the land and the effect of clearing vegetation;
- the relative stability of the bed and banks of any waterbody that may be affected by the development, whether on the site, upstream, or downstream;
- the effect of the development on water quality, stream flow, and the functions of aquatic ecosystems (such as habitat and connectivity); and
- the effect of the development on public access to, and use of, any waterbody and its foreshores.

6 IMPACT ASSESSMENT

The current proposal involves the construction of a marina at 146 Newbridge Road, Moorebank. Present land use on the subject site includes sand and gravel extraction, and glass recycling; the construction of the marina is being proposed as form of site rehabilitation.

The marina will be constructed in the location of the existing dams and be approximately 150m x 350m in size. Access to the Georges River will be via a channel approximately 40m - 50m wide. The fill material along the riverbank will be removed and the bank reconstructed. Car parking facilities will be built to the west and south of the marina. These works will require the removal of vegetation along the western and southern boundary of the site, and the majority of vegetation along the eastern boundary of the site.

Due to the past and present land use on the subject site, the area is substantially altered from its natural form and significantly degraded. Considerable soil disturbance has occurred across much of the subject site, although to a less of an extent along the southern and eastern boundaries. As a result, a large proportion of the subject site does not support a fully structured vegetation community, and the vegetation that does occur in this area primarily consists of invasive weed species.

The proposal will also require the removal of two very small areas of EECs listed on Schedule 1 of the TSC Act (River Flat Eucalypt Forest and Swamp Oak Floodplain Forest). These vegetation communities occur along the southern and eastern boundaries of the subject site. As stated previously, this vegetation has low levels of species diversity and is poorly resilient due to previous soil

disturbance. As these disturbed vegetation remnants comprise only a very small proportion of the EECs within the locality their removal is not considered to have a significant affect on the survival of the EECs within the locality. Any vegetation that is retained will be remediated and the area revegetated in accordance with a Voluntary Planning Agreement and Vegetation Management Plan which is to be submitted to Council. As this VMP covers the foreshore vegetation only, the restoration of the vegetation along the southern and western boundaries of the subject site would be subject to the recommendations of the landscape plan. It should be noted that the EECs do contain a number of species considered to be of conservation significance for Western Sydney.

Many of the canopy species which occur along the river foreshore are remnant and contain hollows which would be suitable habitat for a number of threatened micro-bat species which have been assumed to be present onsite, and hollow dependent birds and marsupials. The clear and disturbed community on site provides suitable foraging habitat for a number of migratory and wading bird species, including raptors like the observed White-bellied Sea Eagle, and this is unlikely to change with the construction of the proposed marina.

The Assessment of Significance (7-part test) has concluded that the potential impact to micro-bats located within the subject site from the proposed development is not significant, and therefore a Species Impact Statement is not required.

In relation to the current proposal for the Subject Site this report concludes that:

- No threatened flora species were recorded onsite;
- There is unlikely to be a significant impact on the general native flora and fauna occurring on the Subject Site as a result of the proposal;
- There is unlikely to be a significant impact on native flora and fauna habitats as a result of the proposal;
- The 7-part test (Assessment of Significance) prepared under part 5A of the EP&A Act has concluded that there is unlikely to be a significant impact on the micro-bat species occurring on the subject site.

7 CONCLUSION & RECOMENDATIONS

This assessment has concluded that the current proposal is unlikely to significantly impact on the native flora and fauna of the study area. In order to minimise or control the potential impacts of the current proposal on the native flora and fauna of the subject site, this report recommends the following:

- Wherever practical and feasible, the degraded areas of vegetation mapped as EECs should be retained as part of the construction process. Retained vegetation should be remediated through weed removal and revegetation; and this process should be outlined within the VMP to be submitted to Council;

- The large hollow bearing tree (marked in Map 7) should be retained. It should be protected by a Tree Protection Zone during construction works. This zone should be clearly delineated, marked, and signposted prior to works commencing.

- Where possible, hollow bearing trees along the eastern and southern boundaries of the subject site should be retained. The critical root zone of the retain trees should be protected by a Tree Protection Zone, and these zones should be clearly delineated, marked, and signposted prior to works commencing;

- During the removal of hollow-bearing trees they should be pre-cleared for native fauna, and removal/relocation should be overseen by a qualified wildlife handler vaccinated for Australian Bat Lyssavirus.

- Where possible, hollows that are removed should be retained and installed into existing trees as nest boxes. If not, constructed nest boxes should be installed as compensation for the hollows being removed at a rate of 2 nest boxes per hollow removed;

- Removal of vegetation within the degraded EECs should be compensated for during the rehabilitation of the foreshore. This should be done via revegetation works to be undertaken along the eastern and southern boundaries in accordance with the VMP; and

- Revegetation in accordance with the VMP and any landscaping or revegetation works within the subject site are to incorporate locally indigenous native plant species characteristic of the *River Flat Eucalypt Forest* and *Swamp Oak Floodplain Forest* communities.

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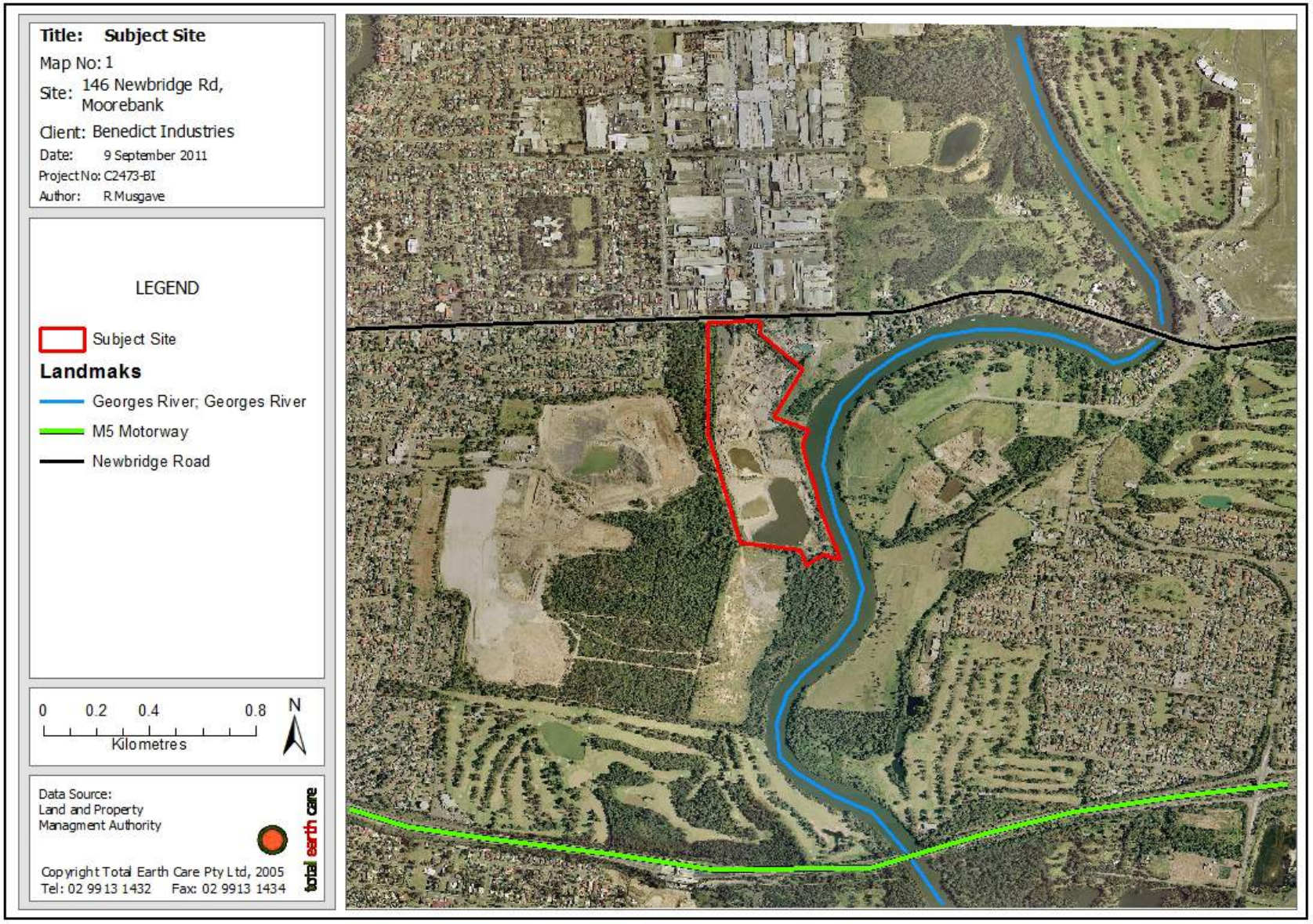
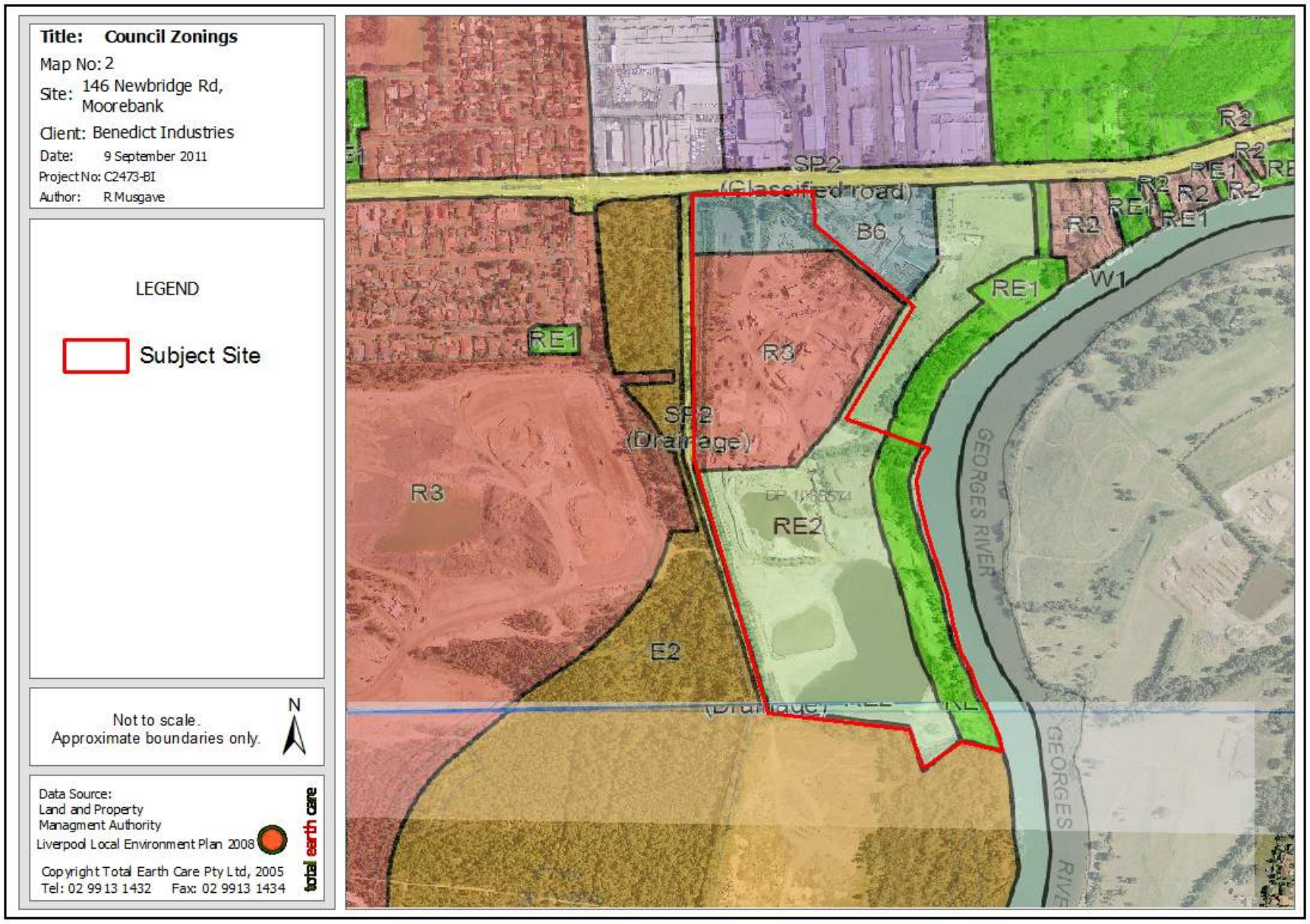
Appendix A

Maps

Flora and Fauna Assessment

Proposed Marina Construction
Benedict Site, Moorebank


Title: Subject Site
Map No: 1
Site: 146 Newbridge Rd, Moorebank
Client: Benedict Industries
Date: 9 September 2011
Project No: C2473-BI
Author: R Musgave
LEGEND
Subject Site
Landmaks
Georges River; Georges River
M5 Motorway
Newbridge Road
0 0.2 0.4 0.8
Kilometres
N
Data Source:
Land and Property
Managment Authority
Copyright Total Earth Care Pty Ltd, 2005
Tel: 02 9913 1432 Fax: 02 9913 1434
total earth care


Title: Council Zonings
Map No: 2
Site: 146 Newbridge Rd, Moorebank
Client: Benedict Industries
Date: 9 September 2011
Project No: C2473-BI
Author: R Musgave
LEGEND
Subject Site
Not to scale.
Approximate boundaries only.
N
Data Source:
Land and Property
Managment Authority
Liverpool Local Environment Plan 2008
Copyright Total Earth Care Pty Ltd, 2005
Tel: 02 9913 1432 Fax: 02 9913 1434
total earth care
SP2
(Classified road)
B6
R2
RE1
W1
R3
SP2
(Drainage)
E2
RE2
GEORGES RIVER

Title: Proposed Marina Location

Map No: 3

Site: 146 Newbridge Rd, Moorebank

Client: Benedict Industries

Date: 9 September 2011

Project No: C2473-BI

Author: R Musgave

LEGEND

Subject Site

Not to scale.
Approximate boundaries only.

N

Data Source:
Land and Property
Managment Authority
Benedict Industries SIS

Tel: 02 9913 1432 Fax: 02 9913 1434

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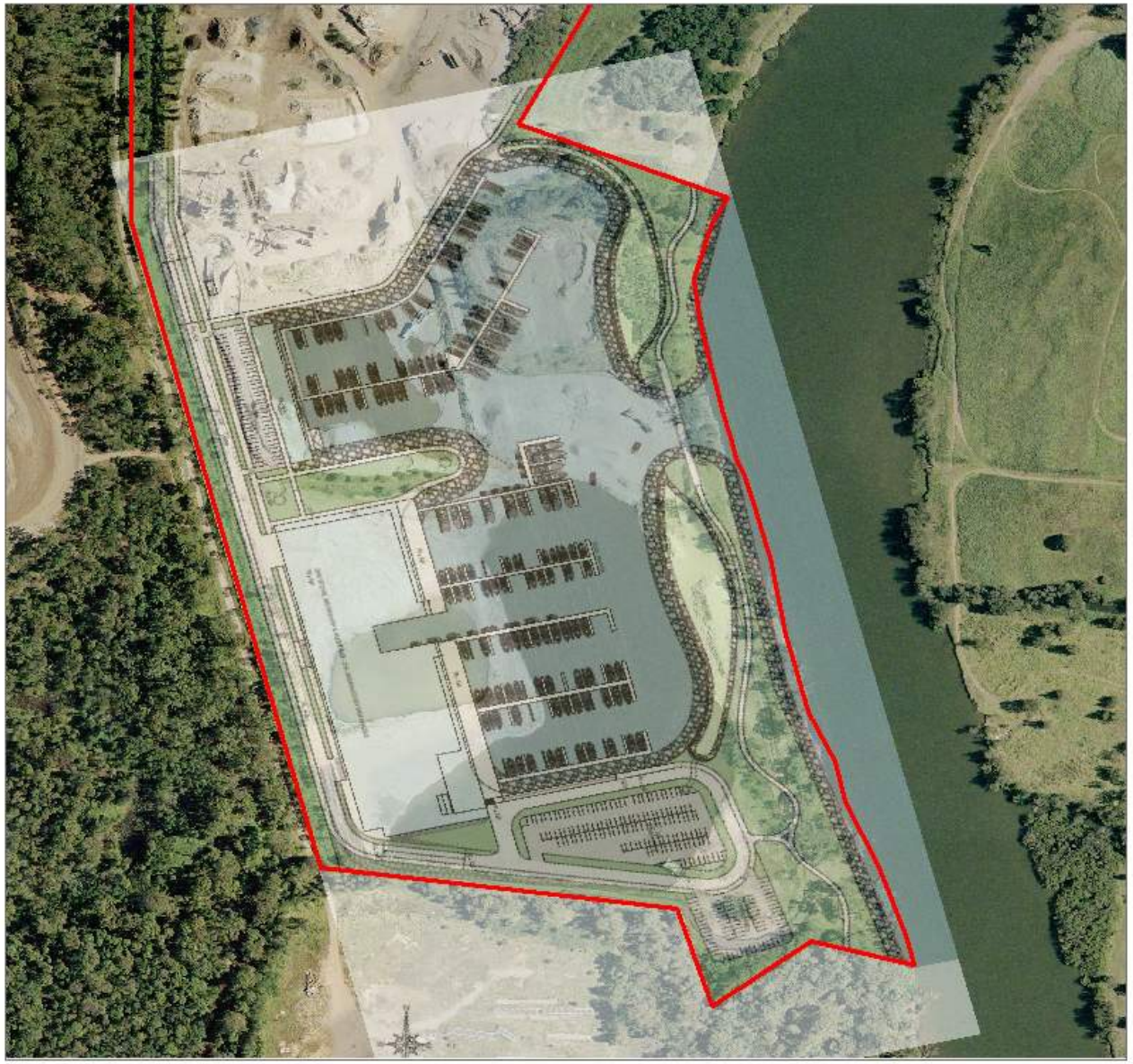

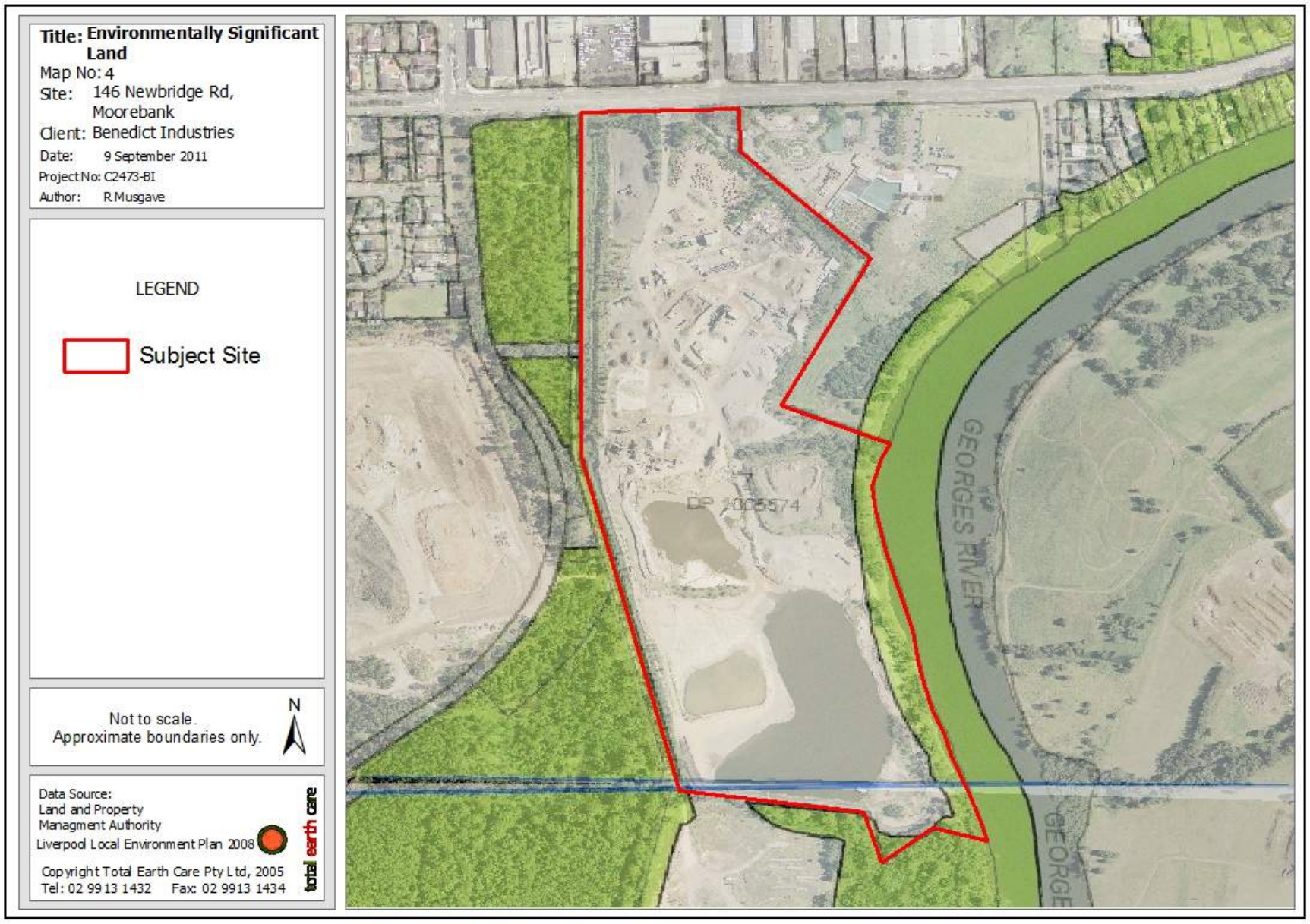
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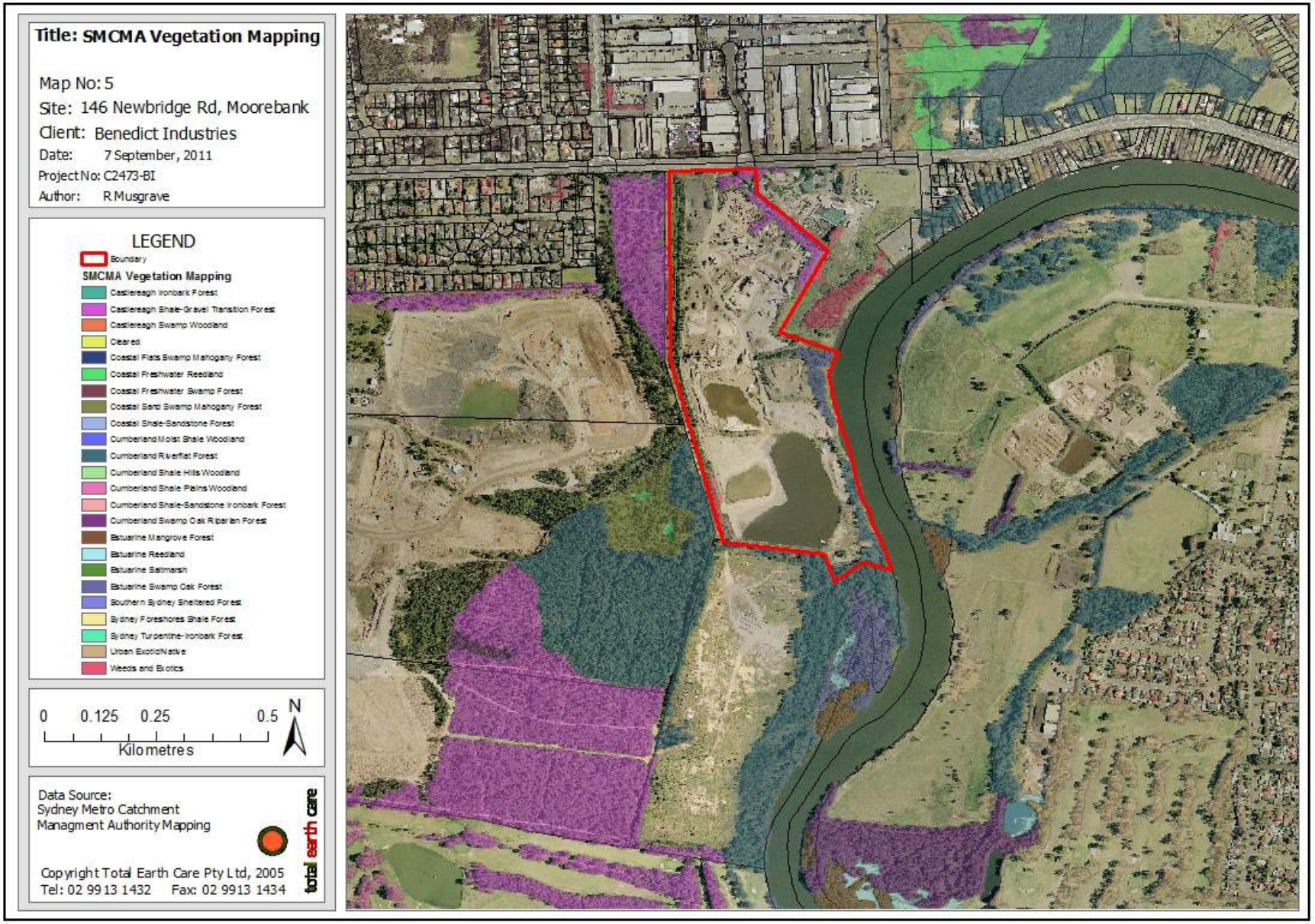
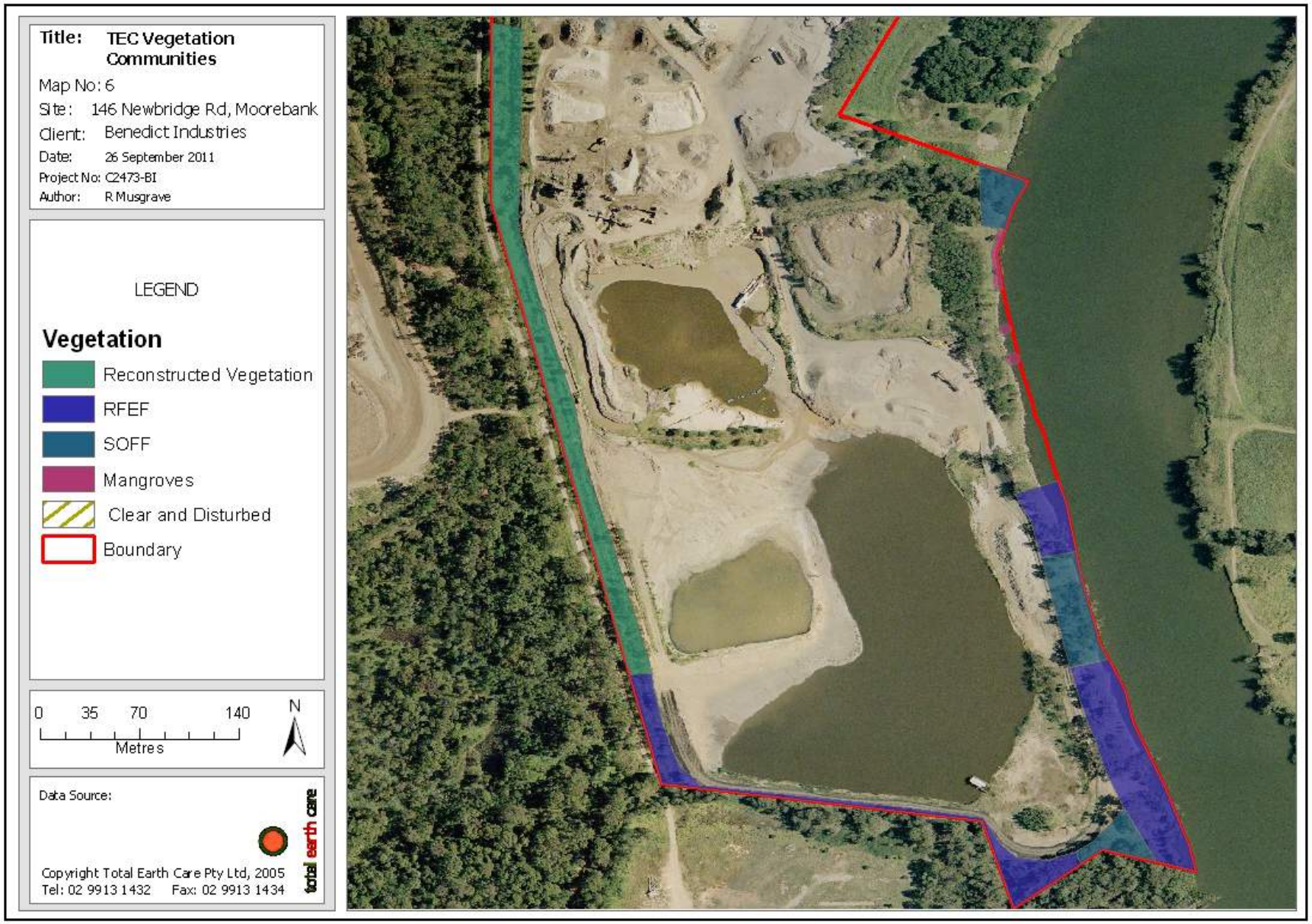
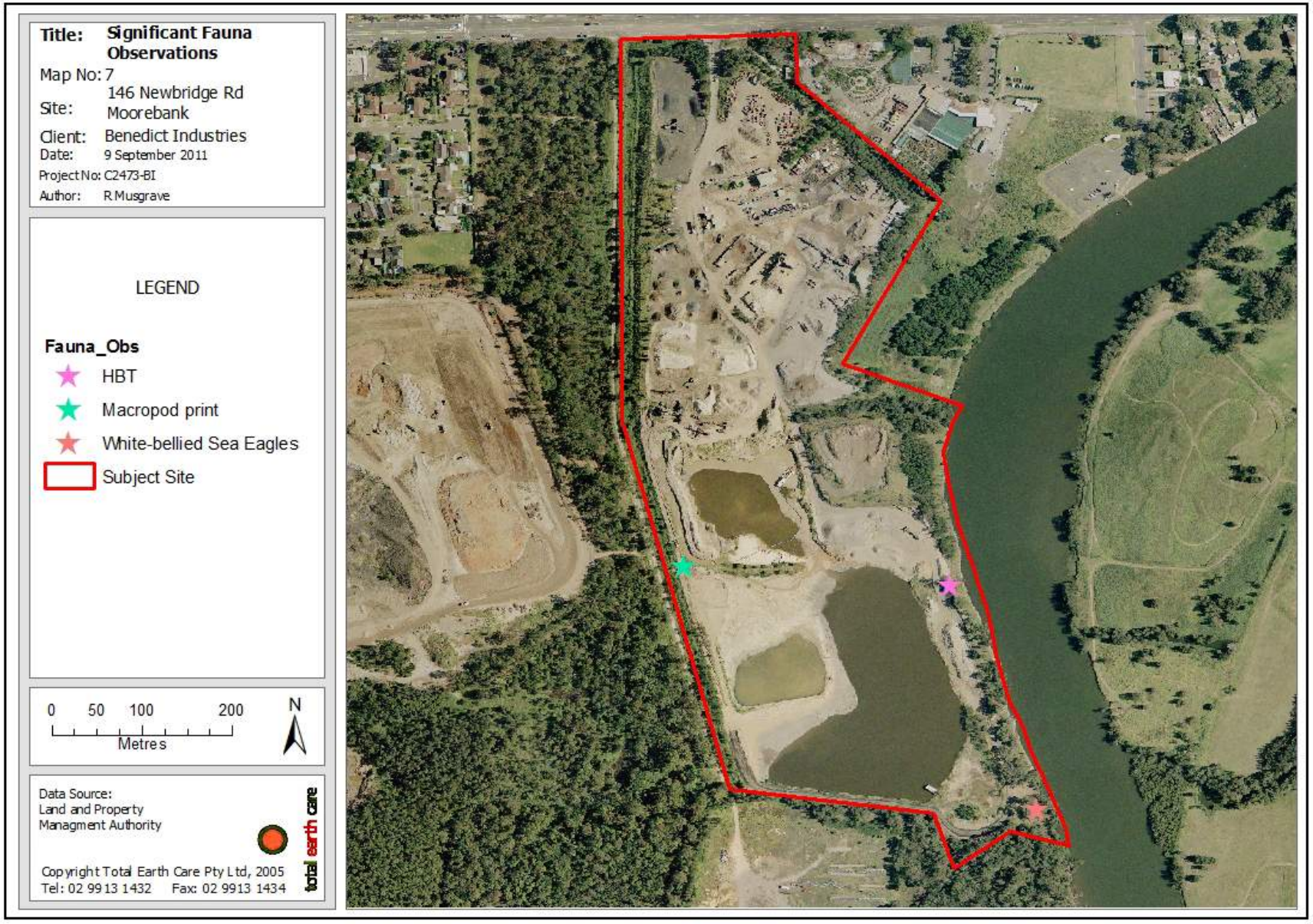
Map No: 4
Site: 146 Newbridge Rd, Moorebank
Client: Benedict Industries
Date: 9 September 2011
Project No: C2473-BI
Author: R Musgave
LEGEND
Subject Site
Not to scale.
Approximate boundaries only.
N
Data Source:
Land and Property
Managment Authority
Liverpool Local Environment Plan 2008
Copyright Total Earth Care Pty Ltd, 2005
Tel: 02 9913 1432 Fax: 02 9913 1434
total earth care
DP 1005574
GEORGES RIVER
GEORGE


Title: SMCMA Vegetation Mapping
Map No: 5
Site: 146 Newbridge Rd, Moorebank
Client: Benedict Industries
Date: 7 September, 2011
Project No: C2473-BI
Author: R Musgrave
LEGEND
Boundary
SMCMA Vegetation Mapping
Castlereagh Ironbark Forest
Castlereagh Shale-Gravel Transition Forest
Castlereagh Swamp Woodland
Cleared
Coastal Flats Swamp Mahogany Forest
Coastal Freshwater Reedland
Coastal Freshwater Swamp Forest
Coastal Sand Swamp Mahogany Forest
Coastal Shale-Sandstone Forest
Cumberland Moist Shale Woodland
Cumberland Riverflat Forest
Cumberland Shale Hills Woodland
Cumberland Shale Plains Woodland
Cumberland Shale-Sandstone Ironbark Forest
Cumberland Swamp Oak Riparian Forest
Estuarine Mangrove Forest
Estuarine Reedland
Estuarine Saltmarsh
Estuarine Swamp Oak Forest
Southern Sydney Sheltered Forest
Sydney Foreshores Shale Forest
Sydney Turpentine-Ironbark Forest
Urban Exotic/Native
Weeds and Exotics
0 0.125 0.25 0.5
Kilometres
N
Data Source:
Sydney Metro Catchment
Managment Authority Mapping
Copyright Total Earth Care Pty Ltd, 2005
Tel: 02 9913 1432 Fax: 02 9913 1434
total earth care


Title: TEC Vegetation Communities
Map No: 6
Site: 146 Newbridge Rd, Moorebank
Client: Benedict Industries
Date: 26 September 2011
Project No: C2473-BI
Author: R Musgrave
LEGEND
Vegetation
Reconstructed Vegetation
RFEF
SOFF
Mangroves
Clear and Disturbed
Boundary
0 35 70 140
Metres
N
Data Source:
Copyright Total Earth Care Pty Ltd, 2005
Tel: 02 9913 1432 Fax: 02 9913 1434
total earth care


Title: Significant Fauna Observations
Map No: 7
Site: 146 Newbridge Rd Moorebank
Client: Benedict Industries
Date: 9 September 2011
Project No: C2473-BI
Author: R Musgrave
LEGEND
Fauna_Obs
HBT
Macropod print
White-bellied Sea Eagles
Subject Site
0 50 100 200
Metres
N
Data Source:
Land and Property
Managment Authority
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Tel: 02 9913 1432 Fax: 02 9913 1434
total earth care

Appendix B

Flora and Fauna Inventories

Flora and Fauna Assessment

Proposed Marina Construction
Benedict Site, Moorebank

Flora Inventory

General Status

*	Exotic (not native to Australia)
N( )	Noxious weeds and 'Control Class' as listed on the NSW Noxious Weeds Act 1993 for the Campbelltown LGA
ni	Non - indigenous native species (does not naturally occur at this locality)
(?)	Uncertain identification

Conservation Status

CE	Critically Endangered - listed under Schedule 1A of the TSC Act
E	Endangered - listed under Schedule 1 of the TSC Act
V	Vulnerable - listed under Schedule 2 of the TSC Act

Abundance

c	Common, species occur all over the site
o	Occasional, species occur over the survey area but not in large numbers at any occurrence
uc	Uncommon, species occur only once or twice during the survey

Status	Family	Genus species	Common Name	Abundance
	Acanthaceae	*Avicennia marina ssp*	Grey Mangrove	o
	Aizoaceae	*Tetragonia tetragonioides*	New Zealand Spinach	o
*	Amaranthaceae	*Alternanthera philoxeroides*	Alligator Weed	u
*	Apiaceae	*Foeniculum vulgare*	Fennel	o
*	Apocynaceae	*Araujia sericifera*	Moth Vine	c
*	Apocynaceae	*Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush	u
*	Arecaceae	*Phoenix sp.*	Date Palm	u
*	Asparagaceae	*Asparagus asparagoides*	Bridal Creeper	u
*	Asteraceae	*Arctotheca calendula*	Capeweed	u
*	Asteraceae	*Bidens pilosa*	Cobblers Pegs	c
*	Asteraceae	*Cirsium vulgare*	Spear Thistle	c
*	Asteraceae	*Conyza sp*	Fleabane	c
	Asteraceae	*Cotula australis*	Common Cotula	u
*	Asteraceae	*Helianthus annuus*	Common Sunflower	u
*	Asteraceae	*Hypochaeris radicata*	Catsear	o
*	Asteraceae	*Senecio madagascariensis*	Fireweed	o
*	Asteraceae	*Silybum marianum*	Variegated Thistle	u
*	Asteraceae	*Sonchus oleraceus*	Common Sowthistle	c
*	Basellaceae	*Anredera cordifolia*	Madeira Vine	o
*	Boraginaceae	*Echium vulgare*	Vipers Bugloss	u
*	Brassicaceae	*Brassica juncea*	Indian Mustard	o
*	Cactaceae	*Opuntia monacantha*	Drooping Pear	u
	Casuarinaceae	*Casuarina glauca*	Swamp Oak	c
	Chenopodiaceae	*Atriplex semibaccata*	Creeping Saltbush	u
	Chenopodiaceae	*Einadia hastata*	Berry Saltbush	o
	Chenopodiaceae	*Einadia polygonoides*		o
	Commelinaceae	*Commelina cyanea*	Scurvy Weed	u
*	Commelinaceae	*Tradescantia fluminensis*	Wandering Jew	o
	Convolvulaceae	*Dichondra repens*	Kidney Weed	o
	Dennstaedtiaceae	*Pteridium esculentum*	Common Bracken	o
	Euphorbiaceae	*Breynia oblongifolia*	Coffee Bush	o
*	Euphorbiaceae	*Ricinus communis*	Castor Oil Plant	o
*	Fabaceae - Caesalpinioideae	*Gleditsia triacanthos*	Honey Locust	u
*	Fabaceae -	*Senna pendula var glabrata*		o

	Caesalpinioideae			
*	Fabaceae - Faboideae	*Genista monspessulana*	Montpellier Broom	o
	Fabaceae - Faboideae	*Kennedia rubicunda*	Dusky Coral Pea	o
*	Fabaceae - Faboideae	*Lathyrus odorata*	Sweet Pea	u
*	Fabaceae - Faboideae	*Vicia sp*	Vetch	o
*	Fabaceae - Faboideae	*Viminaria juncea*	Golden spray	o
	Fabaceae - Mimosoideae	*Acacia baileyana*	Cootamundra Wattle	u
	Fabaceae - Mimosoideae	*Acacia binervia*	Coast Myall	u
	Fabaceae - Mimosoideae	*Acacia decurrens*	Black Wattle	c
	Fabaceae - Mimosoideae	*Acacia fimbriata*	Fringed Wattle	u
	Fabaceae - Mimosoideae	*Acacia longifolia ssp longifolia*	Sydney Golden Wattle	o
	Fabaceae - Mimosoideae	*Acacia longifolia ssp sophorae*	Coastal Wattle	u
	Fabaceae - Mimosoideae	*Acacia prominens*	Gosford Wattle	u
	Fabaceae - Mimosoideae	*Acacia saligna*	Golden Wreath Wattle	o
*	Iridaceae	*Watsonia meriana*	Wild Watsonia	u
	Juncaginaceae	*Triglochin procerum*	Water Ribbons	u
	Lauraceae	*Cassytha pubescens*		u
	Lauraceae	*Cinnamomum camphora*	Camphor Laurel	u
	Lomandraceae	*Lomandra longifolia*	Spiny-headed Mat-rush	c
	Loranthaceae	*Muellerina eucalyptoides*		u
*	Malvaceae	*Modiola caroliniana*	Red-flowered Mallow	o
*	Malvaceae	*Pavonia hastata*		u
*	Malvaceae	*Sida rhombifolia*	Paddy's Lucerne	c
	Meliaceae	*Melia azedarach*	White Cedar	u
*	Moraceae	*Morus alba*	White Mulberry	u
	Myrsinaceae	*Aegiceras corniculatum*	River Mangrove	o
	Myrtaceae	*Angophora floribunda*	Apple	o
	Myrtaceae	*Angophora subvelutina*	Broad-leaved Apple	c
	Myrtaceae	*Callistemon citrinus*	Crimson Bottlebrush	u
	Myrtaceae	*Corymbia maculata*	Spotted Gum	u
	Myrtaceae	*Eucalyptus amplifolia ssp amplifolia*	Cabbage Gum	u
	Myrtaceae	*Eucalyptus baueriana*	Blue Box	c
	Myrtaceae	*Eucalyptus elata*	River Peppermint	o
	Myrtaceae	*Eucalyptus moluccana*	Grey Box	uc
	Myrtaceae	*Eucalyptus robusta*	Swamp Mahogany	u
	Myrtaceae	*Eucalyptus saligna*	Sydney Blue Gum	o
	Myrtaceae	*Eucalyptus tereticornis*	Forest Red Gum	c
	Myrtaceae	*Melaleuca decora*		o
	Myrtaceae	*Melaleuca ericifolia*	Swamp Paperbark	u
	Myrtaceae	*Melaleuca linariifolia*	Flax-leaved Paperbark	u
	Myrtaceae	*Melaleuca sieberi*		u
	Myrtaceae	*Melaleuca styphelioides*	Prickly-leaved Tea Tree	u
*	Oleaceae	*Ligustrum lucidum*	Large Leaved Privet	u
*	Oleaceae	*Ligustrum sinense*	Small Leaved Privet	o
*	Onagraceae	*Ludwigia peruviana*		o
*	Papaveraceae	*Papaver somniferum ssp*	Opium Poppy	u
	Phytolaccaceae	*Phytolacca octandra*	Inkweed	o
	Pittosporaceae	*Bursaria spinosa*	Blackthorn	o
*	Plantaginaceae	*Plantago lanceolata*	Lamb's Tongues	c
*	Poaceae	*Arundo donax*	Spanish Reed	u
*	Poaceae	*Avena fatua*	Wild Oats	u
*	Poaceae	*Bromus catharticus*	Praire Grass	u

*	Poaceae	*Chloris gayana*	Rhodes Grass	c
*	Poaceae	*Cortaderia selloana*	Pampas Grass	u
*	Poaceae	*Cynodon dactylon*	Couch	c
*	Poaceae	*Ehrharta erecta*	Panic Veldtgrass	c
	Poaceae	*Entolasia stricta*	Wiry Panic	c
*	Poaceae	*Eragrostis curvula*	African Lovegrass	c
	Poaceae	*Microlaena stipoides var stipoides*	Weeping Grass	c
*	Poaceae	*Paspalum dilatatum*	Paspalum	o
*	Poaceae	*Pennisetum clandestinum*	Kikuyu Grass	c
*	Poaceae	*Phalaris aquatica*	Phalaris	u
*	Poaceae	*Phragmites australis*	Common Reed	o
*	Poaceae	*Setaria gracilis*	Slender Pigeon Grass	o
*	Poaceae	*Setaria palmifolia*	Palm Grass	u
*	Poaceae	*Stenotaphrum secundatum*	Buffalo Grass	c
*	Poaceae	*Triticum aestivum*	Common Wheat	u
*	Poaceae	*Zea mays*	Corn	u
*	Polygonaceae	*Acetosa sagittata*	Rambling Dock	o
	Polygonaceae	*Persicaria decipiens*	Slender knotweed	o
*	Polygonaceae	*Rumex brownii*	Swamp Dock	u
*	Polygonaceae	*Rumex crispus*	Curled Dock	o
*	Rubiaceae	*Galium aparine*	Cleavers	o
	Santalaceae	*Exocarpos cupressiformis*	Cherry Ballart	u
*	Sapindaceae	*Cardiospermum grandiflorum*	Balloon Vine	c
	Sapindaceae	*Dodonaea triquetra*	Large-leaf Hop-bush	u
*	Scrophulariaceae	*Verbascum virgatum*	Green Mullein	u
*	Solanaceae	*Cestrum parqui*	Green Poisonberry	o
*	Solanaceae	*Solanum nigrum*	Black-berry Nightshade	c
*	Tropaeolaceae	*Tropaeolum majus*	Nasturtium	u
	Typhaceae	*Typha orientalis*	Broadleaf Cumbungi	o
*	Urticaceae	*Parietaria judaica*	Asthma Weed	u
	Verbenaceae	*Clerodendrum tomentosum*	Hairy Clerodendrum	o
*	Verbenaceae	*Lantana camara*	Lantana	o
*	Verbenaceae	*Verbena bonariensis*	Purpletop	o
*	Verbenaceae	*Verbena officinalis*	Vervain	c

Fauna Inventory

General Status

*	Exotic/introduced species
(?)	Uncertain identification
P	Protected
U	Unprotected

Conservation Status

CE	Critically Endangered - listed under Schedule 1A of the TSC Act
E	Endangered - listed under Schedule 1 of the TSC Act
V	Vulnerable - listed under Schedule 2 of the TSC Act

Record Type

O Observed	B Burnt
F Tracks/scratchings	T Trapped or netted
H Hair, feathers, or skin	Y Bone or teeth
R Road kill	P Scat
D Dog kill	W Heard call
C Cat kill	Z In raptor/owl pellet
V Fox kill	E Nest/roost
K Dead	M Miscellaneous
S Shot	N Not located
X In scat	A Stranding/Beached
U Anabat	

Certainty (anabat analysis only)

D Definite

Pr Probable

Po Possible

Status	Family	Scientific Name	Common Name	Obs Type
P	Anura	*Limnodynastes peronii*	Brown-striped Frog	au
P	Falconiformes	*Elanus axillaris*	Black-shouldered Kite	vi
P	Falconiformes	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	vi
P	Anseriformes	*Anas castanea*	Chestnut Teal	vi
U	Anseriformes	*Anas platyrhynchos*	Mallard	vi
P	Anseriformes	*Anas superciliosa*	Pacific Black Duck	vi
P	Pelecaniformes	*Anhinga melanogaster*	Darter	vi
P		*Ardea novahollandiae*	White faced heron	vi
P	Ciconiiformes	*Ardea/Egretta sp.*	Unidentified Egret	vi
P	Passeriformes	*Strepera graculina*	Pied Currawong	vi
P	Psittaciformes	*Cacatua galerita*	Sulphur-crested Cockatoo	vi
P	Psittaciformes	*Cacatua sanguinea*	Little Corella	au
V	Passeriformes	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	vi
P	Passeriformes	*Corvus mellori*	Little Raven	vi
P	Falconiformes	*Falco longipennis*	Australian Hobby	vi
vi	Passeriformes	*Hirundo neoxena*	Welcome Swallow	vi
U	Charadriiformes	*Larus novaehollandiae*	Silver Gull	vi
U	Passeriformes	*Malurus cyaneus*	Superb Fairy-wren	vi
P	Passeriformes	*Anthochaera carunculata*	Red Wattlebird	au
P	Passeriformes	*Myzomela sanguinolenta*	Scarlet Honeyeater	vi
P	Passeriformes	*Pardalotus sp.*	Unidentified Pardalote	au

P	Gruiformes	*Gallinula tenebrosa*	Dusky Moorhen	vi
U	Passeriformes	*Acridotheres tristis*	Common Myna	vi
U	Passeriformes	*Sturnus vulgaris*	Common Starling	vi
P	Ciconiiformes	*Threskiornis molucca*	Australian White Ibis	vi
P	Squamata	*Lampropholis delicata*	Dark-flecked Garden Sunskink	vi
P	Squamata	*Pseudechis porphyriacus*	Red-bellied Black Snake	vi

Appendix C

Assessment of Significance

Flora and Fauna Assessment

Proposed Marina Construction
Benedict Site, Moorebank

1 7-part Test – Microchiropteran Bat Species

Microchiropteran bat species (micro-bats) are small bats, with wingspans up to 30cm and with up to 170g. The majority of species in the suborder are insectivorous and feed upon moths and flying insects, although some catch fish and aquatic insects (Strahan 1995). All micro-bats hunt and navigate by echolocation. The Sydney Basin supports at least 19 species of micro-bats and of these four are predominantly cave-roosting; sheltering during the day in caves, mines, tunnels, culverts and stone basements. The remaining species roost during the day in tree hollows, under bark and in buildings (KBCS 2009). Preferred roost sites are species-specific (DIPNR 2004).

Two species of micro-bats, Yellow-bellied Sheathtail Bat *Saccolaimus flaventris* and Eastern Freetail Bat *Mormopters norfolkensis*, were observed on the adjacent Boral site in 2002 (ERM 2002). No micro-bats surveying was conducted for this study; however, as the aforementioned species were observed on the adjacent site, and suitable foraging habitat is present on the subject site, it has been assumed, for the purposes of this study, that these species do occur on the subject site.

The other species considered further in this assessment are considered to have suitable habitat within the Links Creek site, and appeared as part of the fauna database searches.

Species	Status under *Threatened Species Conservation Act 1995*	Preferred foraging Habitat	Preferred roosting Habitat	Habitat features located within the subject site
Miniopterus schreibersii oceanensis Eastern Bentwing Bat	Vulnerable	Hunts in forested areas, catching moths and other flying insects above the canopy (DECC 2005b).	Caves are the primary roosting habitat for this species; however they also use derelict mines, storm-water tunnels, buildings and other man-made structures (DECC 2005a). Specific maternity caves that provide constant high temperate and humidity are used annually in spring and summer for the birth and rearing of young	Preferred foraging habitat may be present south-east of the subject site. No preferred roosting habitat (site does not contain caves or other suitable man-made structures).
Mormopterus norfolkensis Eastern Freetail-bat	Vulnerable	Forages above the forest canopy or at forest edges (Environment Australia 1999).	Roosts mainly in tree hollows but is known to also roost under bark or in man-made structures (DECC 2005b)	Preferred foraging habitat may be present south-east of the subject site. Preferred roosting habitat offered by small hollows and bark of trees

Saccolaimus flaventris Yellow-bellied Sheathtail bat	Vulnerable	Forages for fast-flying insects high over forest canopy or lower over more open habitats, including those with few trees (DECC 2005c)	Typically roost in tree hollows, in abandoned sugar gliders nests, buildings and occasionally animal burrows (Churchill 1998, DECC 2005c).	Preferred foraging habitat offered by canopy of trees and dams. Potential preferred roosting habitat offered by hollows in trees
Scoteanax rueppellii Greater Broad-nosed Bat	Vulnerable	Forage slowly for large moths and beetles and possibly other bats within 20m of the ground, in riparian areas and woodland margins (Churchill 1998, DECC 2005e)	Usually tree hollows but has also been found to roost in cracks in the boughs of stags, exfoliating bark roofs of building (Churchill 1998, Environment Australia 2999, DECC 2005e)	Marginal foraging habitat offered by degraded riparian zone and woodland margin. Potential preferred roosting habitat offered by small hollows and bark of trees
Myotis macropus Southern Myotis	Vulnerable	Forages over streams and pools catching insects and small fish by raking their feet across the water surface.	Generally roots in groups of 10-15 close to water in caves, mine shafts, hollow bearing trees, storm water channels, buildings, under bridges, and in dense foliage.	Preferred foraging habitat offered by the dredging dams and the Georges River. Preferred roosting habitat offered by hollow bearing trees, buildings, and dense foliage close to water.
Falsistrellus tasmaniensis Eastern False Pipistrelle	Vulnerable	Forages just above or below the canopy hunting flying insects, moths and beetles. Prefers moist habitats with trees taller than 20m.	Roosts in live or dead hollow-bearing trees, under bark, caves, and buildings.	Preferred foraging habitat may be present south-east of the subject site. Potential preferred roosting habitat offered by small hollows and bark of trees.

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The proposed action may require the removal of vegetation along the eastern, southern, and western boundaries of the subject site. The trees proposed to be removed do not comprise a significant area of canopy within the locality and consequently do not comprise a significant area of foraging habitat within the locality. As part of the proposed works, the current dredging dams will be retained to form the marina. Moreover, the area of water onsite is likely to increase once the proposed marina is complete. Consequently, the proposed action is unlikely to have an adverse effect on the foraging activities of the bat species.

Five of the six micro-bat species (with the exception of the Eastern Bent-wing Bat) may roost under the bark or within the few small hollows contained in some of the larger eucalypts on the subject site. Comparable roosting habitat may be found within the vegetated area to the south-east of the subject site and smaller parks and reserves in the locality. There is a large remnant hollow bearing tree on the bank of the Georges River within subject site, which would be appropriate roosting or breeding habitat for a number of the micro-bat species listed above. Liverpool Council has stipulated that this tree remain as part of the proposal. As a result, the trees proposed to be removed do not comprise a

significant area of roosting habitat for the four tree-roosting micro-bats species within the locality. The subject site does not support preferred roosting habitat for the Eastern Bent-wing Bat.

As a result, the proposed actions are highly unlikely to have an adverse effect on the life cycle of these five micro-bat species such that a viable local population of any species is likely to be placed at risk of extinction.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.

The TSC Act defines an 'endangered population' as 'a population specified in Part 2 of Schedule 1' of the Act. The aforementioned bat species are not listed as an 'endangered population', as defined under the TSC Act.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

- **(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

The TSC Act defines an 'endangered ecological community' as an 'ecological community specified in Part 3 of Schedule 1' of the Act. The aforementioned species are not an 'endangered ecological community', as defined under the TSC Act.

(d) In relation to a habitat of a threatened species, population or ecological community:

- **(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**
- **(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**
- **(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.**

As mentioned previously, the proposed action may include the removal trees and native vegetation along the eastern, southern, and western boundaries of the subject site. The trees occurring within the subject site are contiguous to a canopy stratum which extends to the south-east. As a result, the trees proposed to be removed do not comprise a significant area of canopy within the locality and consequently do not comprise a significant area of foraging habitat within the locality. The proposed action is highly unlikely to have an adverse effect on the foraging activities of the five micro-bat species.

Five of the six micro-bat species (with the exception of the Eastern Bent-wing Bat) may roost under the bark or within the few small hollows contained in some of the larger eucalypts on the subject site. Comparable roosting habitat may be found within the vegetated area to the south-east of the subject site and smaller parks and reserves in the locality. There is a large remnant hollow bearing tree on the bank of the Georges River within subject site, which would be appropriate roosting or breeding habitat for a number of the micro-bat species listed above. Liverpool Council has stipulated that this tree remain as part of the proposal. As a result, the trees proposed to be removed do not comprise a significant area of roosting habitat for the four tree-roosting micro-bats species within the locality. The subject site does not support preferred roosting habitat for the Eastern Bent-wing Bat.

The removal of vegetation including tree species from the subject site will not remove, modify, fragment or isolate a significant area of potential foraging or roosting habitat for the five micro-bat species in the locality. As a result, the long-term survival of the micro-bat species in the locality is unlikely to be affected as a result of the proposed action.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

No area has been designated as 'critical habitat' under Part 3 of the TSC Act 1995 for the Eastern Bentwing Bat, Eastern Freetail-bat, Yellow-bellied Sheathtail-bat, Southern Myotis, Eastern False Pipistrelle, or Greater Broad-nosed Bat.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.

There is currently no Recovery Plan on Threat Abatement Plan in place for the Eastern Bentwing-bat, Eastern Freetail-bat, Yellow-bellied Sheathtail-bat, Greater Broad-nosed Bat, Southern Myotis, or Eastern False Pipistrelle. Recovery strategies include actions such as retaining stands of native vegetation, especially those with hollow-bearing trees (including dead trees), and retain other structures containing bats, retain a buffer of vegetation around roost sites in vegetated areas and protect hollow-bearing trees for breeding sites and younger mature trees should also be retained to provide replacements for the older trees as they die and fall over.

(g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The TSC Act defines a 'key threatening process' as 'a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities'. Schedule 3 of the TSC Act provides a list of the 'key threatening processes' (KTP). Of the KTP's listed in Schedule 3 of the TSC Act the following will occur as a result of the proposed action and may impact the micro-bat species:

- *Clearing of native vegetation*. The destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation. This may result in habitat degradation of loss, population fragmentation and habitat disturbance facilitating the establishment of weeds. Clearing of native vegetation has been identified as a threat to micro-bat species.

As mentioned previously, the proposed action includes the removal of trees (comprising both native and exotic species) occurring within the subject site. The trees proposed to be removed do not comprise "sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation". The removal of these trees is unlikely to result in significant habitat degradation or loss, population fragmentation or habitat disturbance.

Conclusion

In light of the consideration of the above seven factors (1 -7), the proposed activity on the subject site is not likely to have "a significant effect" on the either the Eastern Bentwing-bat, Eastern Freetail-bat, Yellow-bellied Sheathtail-bat, Eastern False Pipistrelle, Southern Myotis, or Greater Broad-nosed Bat on the subject site or wider locality as a result of the current proposal, as:

- The proposal will not adversely affect the lifecycle of the species;
- The proposal will not remove, modify or further fragment or isolate a significant area of habitat for the species; and
- The proposal does not significantly contribute to any KTP threatening the community.

Consequently, a Species Impact Statement is not required to be prepared for the Eastern Bentwing-bat, Eastern Freetail-bat, Yellow-bellied Sheathtail-bat, Southern Myotis, Eastern False Pipistrelle or Greater Broad-nosed Bat.

Appendix D3

Marine Pollution Research, Aquatic ecology aspects & environmental assessment of marina concept design, March 2010

GEORGES RIVER MARINA, MOOREBANK

AQUATIC ECOLOGY ASPECTS &
ENVIRONMENTAL ASSESSMENT
OF MARINA CONCEPT DESIGN

Frontis: Portion of existing quarry, proposed to be adaptively re-used as a marina basin

REPORT PREPARED FOR
BENEDICT INDUSTRIES PTY LTD

MARINE POLLUTION RESEARCH PTY LTD
MARCH 2010

MARINE POLLUTION RESEARCH PTY LTD

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REPORT TITLE:	GEORGES RIVER MARINA, MOOREBANK AQUATIC ECOLOGY ASPECTS & ENVIRONMENTAL ASSESSMENT OF MARINA CONCEPT DESIGN
MPR REPORT NUMBER:	MPR 510
DRAFT REPORT FOR COMMENT:	PDF Version 2 Sent to WP 8 March 2010 PDF Ver 2 Sent to Benedict Industries 9 March 2010 PDF Ver
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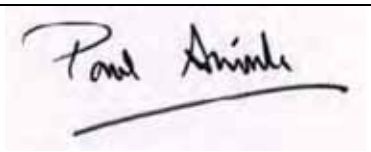
FINAL REPORT:	PDF Ver 5 sent to Benedict Industries 25 June 2010
MPR APPROVAL: PAUL ANINK	 25 June 2010

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FIGURES

1 INTRODUCTION

Benedict Industries Pty Ltd own and operate a sand and gravel quarry at Moorebank, south of Newbridge Road and immediately adjacent to the Georges River. The use of the site for this purpose is nearing completion and the company now propose to redevelop the site to incorporate a marina, using the remaining quarry excavation as the basis for a marina basin. The remainder of the site would be developed for residential and commercial purposes and the foreshore would be remediated as riparian public parkland.

Marine Pollution Research Pty Ltd (MPR) has been commissioned to provide an aquatic ecology assessment report for the marina proposal. For this purpose MPR has been supplied with a copy of the Michael Fountain Preliminary Marina Concept Design and an Environmental Assessment by WorleyParsons (2010) which provide design details of the marina proposal and evaluates the impacts of the adopted design on river processes, flooding and water quality.

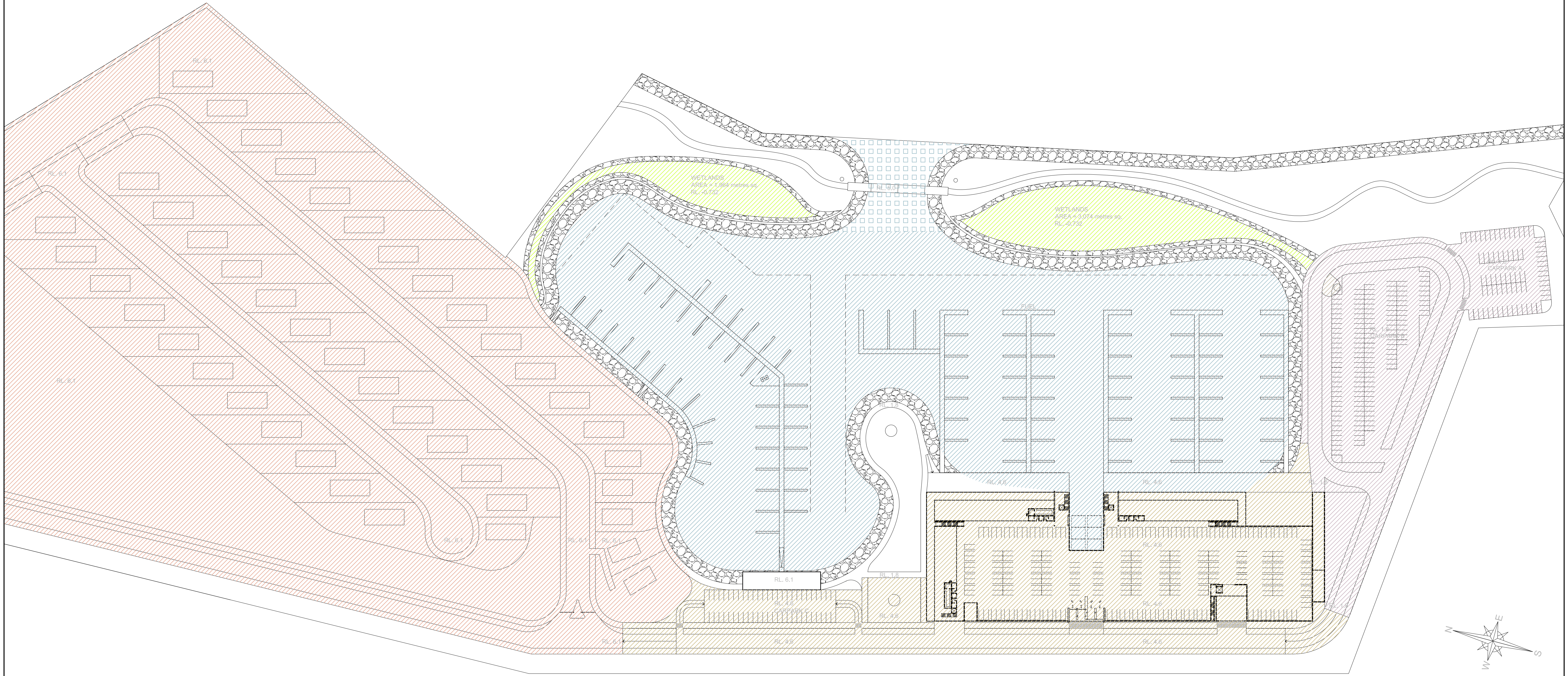
1.1 Site Overview

Figure 1 provides an aerial view of the Benedict Sands site in its locality:

- The site is located along the western bank of the Georges River downstream of the Milperra Bridge.
- There are residential and commercial developments existing, under construction or under consideration to the west of the site at Moorebank, to the north at Chipping Norton and distantly across the river to the east.
- There is a strip of riparian land along the site bank that runs north to the Davy Robinson Park public boat ramp and south down to Harris Creek, almost 2 km downstream.
- There is an unnamed creek draining to Georges River located alongside the site southern boundary and there is a constructed earthen stormwater channel along the western boundary that discharges to the unnamed creek.

Figure 2 provides the Micheal Fountain Architects Site Plan for the marina and adjacent housing development proposed for the Benedict Site. Comparison of the current state of the existing site in Figure 1 with the proposal in Figure 2 indicates that the formation of the proposed marina basin and the hardstand areas for the marina infrastructure will require considerable earthmoving activities, all wholly contained within the existing disturbed site. Construction of the outer part of the entrance channel and Georges River foreshore rock protection will occur in the riparian zone of the Georges River.

FIGURE 1
BENEDICT SANDS SITE SHOWING EXISTING QUARRY EXCAVATION



01 Site Plan - Ground Level
1: 2000

Legend

		Level	Area
	Northern Carpark & Surrounds	RL. 4.6	4,157 m sq
	Dry Store & Surrounds	RL. 4.6	17,714 m sq
	Southern Carpark & Roads	RL. 1.8	12,282 m sq
	Wetlands	RL. -0.732	5,038 m sq
	Marina Basin	RL. -2.932	45,079 m sq
	Entrance to Basin	RL. -2.932	1,853 m sq
	Residential Development	RL. 6.1	

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ISSUE	REV	AMENDMENTS	DATE	ISSUE	REV	AMENDMENTS	DATE
A		Issue to Client	23.02.10				
B		Issue to Client	10.03.10				

CLIENT
Benedict Industries Pty. Ltd.

DRAWING
Site Plan - Diagram
Flood Area Calculations

PROJECT
Moorebank Marina
Newbridge Road
Moorebank NSW 2170

PRINTED: Mar 10, 2010 - 9:14am
P:\MOOREBANK MARINA\Cadwork\Drawings\SK-001- Site Plan- CURRENT.dwg

DRAWN	CHKD	APPROVED
MF		
SCALE	DATE	CAD FILE No
1 : 2000 @ A3	27- 11- 09	

JOB NO	DRAWING NO	ISSUE
0914	SK- 100	B

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2 ASSESSMENT METHODS

In order to assess the possible impact on aquatic ecology of the proposal, the following tasks were undertaken:

- A review of literature regarding the aquatic ecology of the locality including a consideration of the potential for threatened and protected species to utilise the site. The results are incorporated into the aquatic ecology assessment.
- A review of water quality monitoring conducted at the Benedict Sands site and in the Georges River within the locality.
- Field studies of the aquatic ecological attributes of the site and surrounds.

Aquatic ecology field investigations have been undertaken by MPR staff over the following periods:

- A preliminary survey to ascertain the aquatic ecology of the Georges River boundary intertidal zone for a Constraints and Opportunities study was carried out on 11 August 2004.
- Following initial concept design production in early 2007 a further, more detailed survey of the site aquatic ecology habitats was undertaken on 30 April 2007. This survey was undertaken in the company of Surveyor Robert Ward from Matthew Freeburn Surveyors who provided a plan plus bank profiles for the site that indicated the location of intertidal vegetation (mangroves) plus the location of riparian trees (see Appendix A for full survey plans). Figure 3 indicates the locations of mangroves and seagrass patches at the site.
- A follow up aquatic ecology survey of the internal pond at the Benedict Site was undertaken on 30 May 2007. This survey included physical water quality profiles of the pond at various locations. Figure 3 shows the locations of sites where water quality profiles were made and also shows spot depths in the pools.

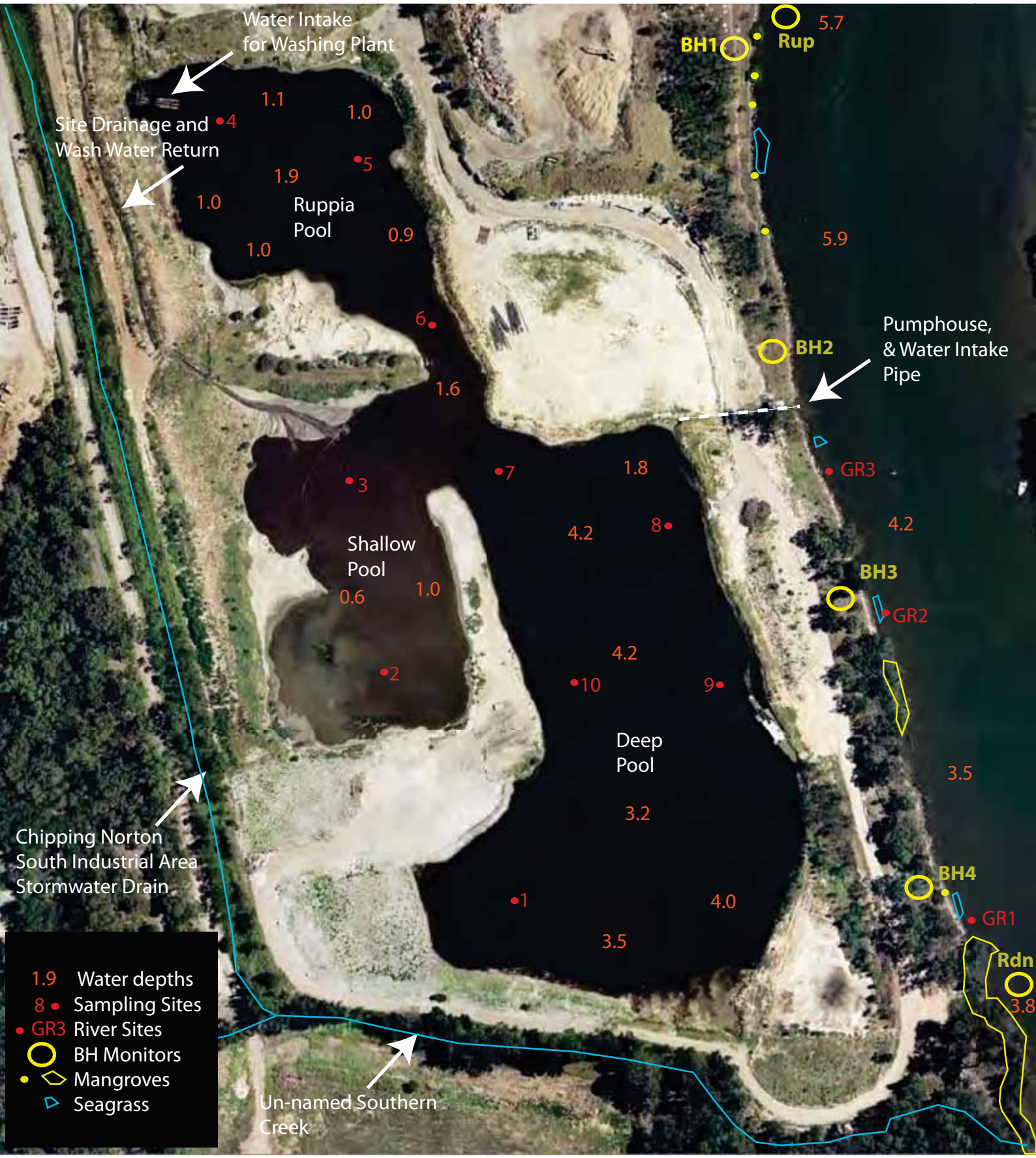

FIGURE 3 GEORGES RIVER MARINA SITE AQUATIC HABITATS & SAMPLING SITES

3 MARINA SITE AQUATIC ECOLOGY

Figure 3 provides an aerial view of the existing proposed marina site and shows details of aquatic habitats/quarry pool features plus the location of sampling sites for water quality profiles.

The aquatic habitats of the site can be separated into three distinct systems:

- The internal quarry pond system that is connected to the Georges River via an overflow pipe.
- The stormwater drain plus un-named southern creek system that drains to Georges River at the south end of the property and has no hydraulic connection to the quarry.
- The Georges River.

The hydrodynamic and water quality features of these systems are presented in Section 3.1 below followed by a consideration of the existing water quality interrelation of the quarry pond and Georges River (Section 3.2). Section 3.3 then provides a description of the resultant aquatic ecology of the system.

3.1 Existing Quarry Pond Hydrodynamics

The existing quarry comprises three pool sections and Figure 3 shows the relative pond depths for each of the pools. The aquatic ecology of the existing quarry is a function of the water volume and quality of the ponds and the water volume and quality are determined to a large degree by the hydraulic relationship between the three ponds and the surface plus groundwater relationships of the quarry to the Georges River.

With regard to groundwater connection between the quarry and the Georges River, Dames and Moore (1994) described the riparian bank of the Georges River at the quarry and between the quarry and the river as “a sequence of silty and sandy alluvial sediments with thin gravels, overlaying shale bedrock. The thickness of the sediments ranged from 11 to 17 m thinning towards the north and west” (p 1).

Dames and Moore (1994) installed six monitoring wells in August 1994, four along the riparian buffer land between the quarry and the river (BH1 to BH4 in Figure 3), one well on the western side of the quarry and one well at the northern end of the quarry 15 m from the tidal channel of a ‘northern creek’ that now no longer exists at the site. The riparian buffer sites (Bores BH1 to BH4) are all located within 10 m of the river. Medium and coarse sands predominate and measured permeability ranged from 12 to 47 m/day averaging 30

m/day. Groundwater levels in the wells were closely correlated with, and slightly above, the river tidal levels. Dames and Moore (1994) inferred that there was an overall flow of groundwater in a south-easterly direction towards the Georges River and the un-named Southern Creek. They concluded that groundwater flows in the zone adjacent to the river were likely to be influenced by intrusion of brackish/saline river water at depth in the aquifer with fresh water flows towards the river concentrated in the shallow zone above approximately 5 to 6 m depth (p5).

Hydraulic relationships are described as follows:

- There is a water uptake pump located in the north-west corner of the 'Ruppia' Pool that extracts water from the quarry ponds, to be used for the Benedict sand wash plant (see Figures 1 and 3).
- Site runoff water and return water from the sand/gravel washing plant is drained into the north-west corner of the "Shallow Pool" (see Figure 3). Floating material in the return water is constrained to some degree by a surface boom across the shallow pool, whilst the remaining return water flows under the boom and drains/mixes into the other two pools. The 'Deep Pool' acts as a stilling basin and vertical mixing would be facilitated by local wind action.
- There is a pump-house on the riparian shore near the northeast corner of the Deep Pool that extracts water from the Georges River to 'top up' the water in the quarry ponds (See Figure 3).

The requirement for top up water from the river varies, depending on a number of factors including:

- Evaporative losses from on-site water usage (for dust suppression and in the washing plant).
- Climate variation, which balances natural evaporative losses against rainwater gains.
- Water loss via infiltration from the pools to the sandy sediments of the surrounding land, with a net groundwater drainage to Georges River (as described above).

As a result of the dynamic mixing of runoff, direct rainfall and Georges River waters, the quarry waters are brackish and the level of the waters in the ponds is variable but not in any regular way.

3.2 Water Quality Relationships Georges River and Quarry Ponds

As noted in Section 3.1 above, there are no direct hydraulic connections between the Chipping Norton stormwater drain to the west of the Benedict Sands site and the quarry and the only connection between the quarry and the Georges River is the makeup water pump for pumping Georges River water into the quarry when the quarry water level is low.

3.2.1 Georges River

The Benedict site is located towards the top of the estuarine portion of the Georges River and the river at this location carries stormwater runoff from highly urbanised sub-catchments upstream including wet weather sewage discharges from three Sewage Treatment Plants (STPs) ; Glenfield, Liverpool and Fairfield STPs.

Sydney Water (2007) provided a summary of sewage overflow volumes to the Georges River from key sewage overflow points between 1996 and 2005 (Table 1):

Table 1 Sewage Discharge Volumes to the Georges River from key overflow points above Milperra between 1996 and 2005

Year	Sewage Discharge Volume (ML/yr)			
Discharge Site	Glenfield	Fairfield	Chipping Norton	Total Discharge
96–97	214	486	714	1414
97–98	38	348	362	748
98–99	595	933	1,428	2956
99–00	68	411	902	1381
00–01	24	411	1,924	2359
01–02	230	706	3,051	3987
02–03	70	460	1,699	2229
03–04	0	72	1,001	1073
04–05	92	284	693	1069
Minimum	0	72	362	748
Maximum	595	933	3051	3987
Mean	148	457	1308	1913
Median	70	411	1001	1414

- The lowest total sewage discharges over the period occurred in 1997-1998 and 2003-2004, both dry years, and thus with fewer wet weather sewage overflows.
- Individual discharge volumes at Glenfield and Fairfield were lowest in 2003-2004 and 1997 to 1998 for Chipping Norton.

Sydney Water (1998) stormwater overflow EIS assessed the water and sediment quality of Georges River immediately downstream of the Chipping Norton Effluent Diversion Scheme

overflow. This overflow discharges treated effluent from the NGRS. The river downstream of overflow is tidal and approximately 3-4 m deep. Sediments are predominantly composed of mud and muddy sand. Low dissolved oxygen concentrations during storm events have been observed downstream of this site. During large storm events, this reach of the river changes from saline to freshwater, but this is more likely attributable to stormwater flows, not overflows.

Ecological Risk Assessment for the estuarine section of the Georges River downstream of Chipping Norton sewerage overflow showed that there was potential risk to aquatic life from exposure to chemicals in sewer overflow and stormwater. Twenty-five chemicals were identified as COPCs following chronic exposures and 5 COPCs were identified for acute exposures. Detailed risk evaluation indicated that processes such as degradation and the settling of particle bound chemicals reduced the number of chemicals of potential concern. However risks were still predicted from 3 acute COPCs and 9 chronic COPCs.

Comparing potential risks from all sources (i.e., sewer overflows and stormwater) to potential risks from stormwater only, indicated that the potential risk to aquatic life at this site appeared to come from stormwater. In summary, the Risk Assessment made the following conclusions:

- Ammonia, the only chemical associated with sewerage overflows, posed only negligible risk because it exceeded toxicity thresholds for only a few days of the 10 years modelled.
- The risk evaluation also showed some potential risk to aquatic life from suspended particles, largely brought in by stormwater.
- Potential risks from low dissolved oxygen may occur, although both stormwater and sewer overflows contribute to these risks.
- Localised scouring of benthic habitat from overflows was possible at the overflow site, but this scour was assessed to be minor in comparison to general benthic habitat scour caused by stormwater flows.
- Some loss of intertidal organisms from stormwater inputs is expected since estuaries are dynamic systems that typically experience fluctuations due to salinity changes.

In practice, Sydney Water (1998) found that whilst preliminary sampling of sediments undertaken in 1996 identified arsenic, cadmium, chromium, copper, iron, nickel, lead, zinc, a & b-BHC, endosulphan, DDT, Chlordane, chloropyrifos as chemicals of potential concern, no toxicity was found in a sediment bioassay taken downstream of the overflow.

Table 2 Water Quality data at Chipping Norton Lakes (In River - Channel and in Lakes - Grand Flaneur Beach)

Site/Date	Time	Field Notes	Cond mS/cm	Turb NTU	Tot Phos ppm	DO % sat
		River Channel				
10/03/03	1400		21.0			87.9
21/03/03	0930		13.9			77.6
14/05/03	1130	Heavy rain for 3 previous days	0.5	57	0.03	77.4
13/10/03	1016	100% cloud, recent rain, SE breeze	14.7	8	0.02	90.9
17/12/03	1500	low tide, onshore breeze, choppy water	8.4			87.3
29/04/04	1425	low tide, recent rain, film on water, weed and rubbish present	4.8	23	0.12	82.5
13/05/04	1340	low tide, clear, dry weather, S breeze. No rain recently, slightly oily film	10.0	10	0.08	95.2
3/06/04	0955	high tide, recent light rain, samll amounts of foam & film on water. 90% overcast, little or no wind	17.8	6	0.05	77.3
10/08/04	1430	med/high tide, recent dry waether, fine and clear. Fresh SE breeze, very slight film	26.4	8	0.06	91.3
Minimum			0.5	6	0.02	77.3
Maximum			26.4	57	0.12	95.2
Mean			13.06	18.67	0.06	85.27
Standard Error of Mean			2.70	8.07	0.01	2.27
		Grand Flaneur Beach				
10/03/03	1415		20.7			88.3
21/03/03	0945		13.6			89.8
14/05/03	1140	heavy rain for 3 days previously	0.0	56	0.08	96.4
13/10/03	1039	100% cloud, recent rain, SE breeze	14.5	11	0.02	95.2
17/12/03	1500	low tide, onshore breeze, choppy water	8.3			110.0
29/04/04	1500	low tide, recent rain, weed and rubbish present	4.1	29	0.07	98.1
13/05/04	1400	low tide, clear, dry weather, S breeze. No rain recently, no film	9.5	10	0.06	92.4
3/06/04	1020	high tide, recent light rain, samll amounts of foam & film on water. 90% overcast. Little or no wind	15.9	14	0.02	86.3
10/08/04	1445	med/high tide, recent dry weather, fine and clear, fresh SE breezes	26.1	9	0.04	91.0
Minimum			0.0	9	0.02	86.3
Maximum			26.1	56	0.08	110.0
Mean			12.52	21.50	0.05	94.17
Standard Error of Mean			2.69	7.53	0.01	2.36

Note* Data from Georges River Environmental Education Centre via http://www.georgesriv-e.schools.nsw.edu.au/index.htm

Further, a survey of benthic organisms showed no difference between the aquatic communities upstream and downstream of the overflow discharge (although both communities appeared stressed), which suggested that overflows were not having a significant impact on sediments.

The Georges River Environmental Education Centre had river water quality data available for 2003 to 2004, from the river upstream of Milperra Bridge (in the vicinity of the key sewage discharge overflow point at Chipping Norton (see above). These data are shown in Table 2 above, and the results are summarised as follows:

- Water conductivity was very low during rainfall periods indicating large volumes of freshwater flow. Mean values for the two data sets were around 12 to 13 mS/cm indicating generally brackish waters at other times.
- Total Phosphorus was elevated and variable, with mean values around 0.05 to 0.06 ppm. There was no real correlation with rainfall but there was some correlation with tide (at least during dry weather); concentrations during medium to high tides were lower than concentrations during low tides.
- Dissolved oxygen values (expressed as % saturation) were generally reasonable, meeting the ANZECC (2000) guideline criteria (80 to during dry weather and just under the low criteria during wet weather.
- Turbidity was around 56 NTU during wet weather events. Mean turbidity was around 18 to 21 NTU. These values are generally close to the ANZECC (2000) upper range criteria of 6 to 50 NTU for low-land rivers but well above the criteria for estuaries and marine waters (0.5 to 10 NTU).

With regard to other turbidity criteria for the river in the immediate vicinity of the proposed marina, the SPCC Botany Bay project (SPCC 1979) collected water turbidity data from 0.5 m depth at two sites upper estuary sites over two extended periods, 2 May to 3 June 1977 (21 days) and 30 Nov 77 to Jan 78 (18 samples). The range of results (expressed as NTU) was as follows:

- First period Milperra 1.8 to 42 NTU, East Hills 1.4 to 26 NTU.
- Second period Milperra 1.8 to 13 NTU, East Hills 1.5 to 15 NTU

ANZECC (2000) notes that turbidity expressed as NTU is generally lineally correlated with suspended solids expressed as NFR (or TSS), at least on a local scale, and the relationship can be established by regression (see also SPCC 1979).

Figure 4 shows the regression relationship of NFR to NTU for available Georges River data. The correlation coefficient r^2 value is 0.9, which indicates a good fit.

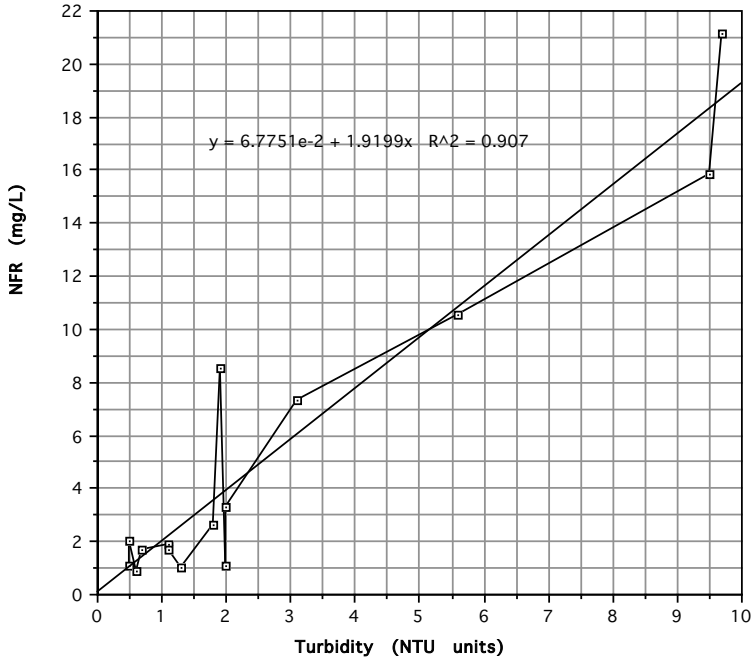

Figure 4 Relationship between Turbidity (NTU) and Suspended Solids Concentrations (TFR) for Georges River data at Milperra (data from SPCC 1979).

Using this correlation, and applying it to the 2003-2004 Milperra data, the turbidity of around 56 NTU during wet weather events would correlate with more than 100 mg/L Total Suspended Solids TSS (or Non Filterable Residue NFR). Mean turbidity around 18 to 21 NTU, relates to around 40 mg/L TSS.

3.2.2 Site Water Quality Data

As described in Section 3.1, Dames and Moore (1994) installed four monitoring wells along the riparian buffer land between the quarry and the river (BH1 to BH4 in Figure 3), all located within 10 m of the river. These sites plus two sites in the Georges River (sites Rup and Rdn in Figure 3) and a site in the Deep Pool (site 8 in Figure 3) were monitored at around monthly intervals for the time that the quarry was active. Table 3 provides summary statistics for the available data collected over the 2006 sampling period. The results are interpreted as follows:

- Acidity, expressed as pH units met ANZECC guideline values for the pond and river samples but was low for the groundwater bore samples possibly indicating some Acid Sulphate Soil activity in the buffer sands.

Table 3 Summary Statistics for Water Quality Results from 2006 Sampling Program*

Analyte**	Units	Detect Limit	ANZECC Limit***	Site	N	Min	Max	Mean	SE
pH	pH units		7 - 8.5	Pond	12	6.8	8.7	7.9	0.16
pH				Bank	48	3.2	6.3	5.0	0.14
pH				River	24	6.5	7.6	7.3	0.06
Cond	μS/cm			Pond	4	7200	14800	11250	1571
Cond				Bank	16	5400	14600	10038	695
Cond				River	8	8700	21000	16488	1771
TDS	mg/L			Pond	4	7300	9600	8450	608.96
TDS				Bank	16	4700	10000	7438	441.10
TDS				River	8	9600	14000	11950	562.84
Alkalinity	mg/L	< 0.1		Pond	4	110	140	122.5	7.50
Alkalinity				Bank	16	0.05	150	32.6	11.86
Alkalinity				River	8	65	95	75.1	3.41
TOC	mg/L			Pond	4	16	30	24.3	2.95
TOC				Bank	16	4	29	13.1	1.42
TOC				River	8	2	7	3.8	0.56
NH4-N	mg/L	<0.1	0.015	Pond	4	0.042	0.2	0.086	0.04
NH4-N				Bank	16	0.64	3.8	1.475	0.23
NH4-N				River	8	0.044	0.05	0.049	0.00
NOx	mg/L	<0.005	0.015	Pond	4	0.0025	0.43	0.133	0.10
NOx				Bank	22	0.0025	0.22	0.057	0.01
NOx				River	8	0.031	0.62	0.244	0.07
Al	mg/L	< 0.1	0.055	Pond	2	0.05	0.2	0.13	0.08
Al				Bank	8	0.05	65	17.67	9.84
Al				River	4	0.05	0.05	0.05	0.00
Cu	mg/L	<0.01	0.0014	Pond	3	0.005	0.005	0.005	0.00
Cu				Bank	12	0.005	0.1	0.023	0.01
Cu				River	6	0.005	0.005	0.005	0.00
Fe	mg/L	<0.02		Pond	2	0.05	0.22	0.14	0.09
Fe				Bank	8	22	230	87.38	26.22
Fe				River	4	0.01	0.36	0.12	0.08
Mn	mg/L		1.9	Pond	4	0.04	0.15	0.09	0.02
Mn				Bank	16	0.7	4.4	1.78	0.25
Mn				River	8	0.02	0.06	0.04	0.01
Pb	mg/L	<0.01	0.0044	Pond	3	0.005	0.015	0.012	0.00
Pb				Bank	12	0.005	0.07	0.019	0.00
Pb				River	6	0.005	0.015	0.012	0.00
Zn	mg/L	<0.02	0.015	Pond	0	0	0	0.000	0.00
Zn				Bank	10	0.03	0.3	0.119	0.03
Zn				River	2	0.01	0.01	0.010	0.00

Notes:

* Pond = single dredge pond site, Bank = 4 bore sites on riverbank, and River = two river edge sites

** All other analytes (As, Ba, Cd, Cr, Hg, Se, TPH, OC pesticides, PAH & Phenols) were below detection or non-significant at all sites and at all times (30 Mar, 4 May, 13 Jul and 25 Oct).

*** ANZECC (2000) limits for protection of 95% aquatic biota.

This conclusion is strengthened when the aluminium results are considered, as the river concentrations are below the ANZECC (2000) criteria of 0.08 mg/L for protection of 90% of aquatic species, the pond values are just above the ANZECC values and the bore-waters values are well in excess of the criteria (mean 17.67 mg/L) possibly indicating residual potential acid sulfate soils (PASS) within the land between the river and the quarry. The same trends are shown for the iron data with similar mean values for river and pond waters and highly elevated values for the bore waters.

- The conductivity data indicate that the waters are brackish, with the Georges River marginally more saline than the pond waters and the bore-waters marginally more fresh than the pond waters.
- Whilst there are no TSS or turbidity data there are Total Dissolved Solids (TDS) data. These data indicate that the pond and bore waters are marginally less turbid than the river waters.
- Total organic carbon (TOC) shows a six-fold decrease from pond waters (mean 24.3 mg/L) to river waters (mean 3.8 mg/L). The bore water mean was 13.1 mg/L.
- Mean concentrations of nitrogenous compounds (Nntrogen oxides NOx and ammonia NH4-N) were all elevated with regard to ANZECC (2000) criteria for lowland river and estuarine waters. For both compounds the bore waters had the highest concentrations, with the pond waters just under double the river concentrations.
- For most metal comparisons the bore-waters were elevated with respect to river and pond values and the pond values were generally similar to or marginally higher than the river values. It should also be noted that for most of the metal results the detection limits for analytsis are higher than the ANZECC (2000) criteria for protection of aquatic life:
- Lead, Copper and Zinc concentrations were below or near detection in river and pond waters, with elevated mean values in bore waters; 0.019 mg/L, 0.023 mg/L, 0.119 mg/L respectively.

The pond results from the Benedict Sands monitoring program were based on samples taken from a single depth (generally around 0.5 m depth) and a question remained as to whether the results would be representative of the total pond waters. That is, are the waters of the ponds sufficiently well mixed? Given the size of the pond system and its exposure to wind mixing, the initiative answer was that the waters would be well mixed, and this was tested by undertaking a series of water quality profile measurements throughout the three ponds and in the adjacent river shallows on 28 May 2007. Results are shown in Table 4 below.

Table 4 Benedict Sands Water Quality Profiles 28 May 2007											
Site	Pool	Time	Depth	Bottom	Temp	Cond	Sal	DO	DO	pH	Turb
	Location		m	Depth	C	us/cm	ppt	%sat	mg/l	pH	NTU
4	NW Ruppia	12:45:39	0.1		16.33	7252	7.63	66.7	6.3	7.89	0.1
4		12:46:07	0.5		15.68	7359	7.58	64.5	6.1	7.84	0.5
4		12:46:27	1.0		15.16	7448	7.57	64.0	6.1	7.85	1.5
4		12:46:45	1.6	1.8	15.09	7459	7.58	63.5	6.1	7.85	1.5
5	E Ruppia	12:50:11	0.1		17.02	7139	7.57	47.6	4.4	7.60	3.2
5		12:50:47	0.6	1.3	15.11	7451	7.57	55.7	5.4	7.89	3.2
6	S Ruppia	13:01:53	0.1		16.78	7181	7.59	37.2	3.5	7.49	6.7
6		13:02:28	0.5		15.71	7360	7.57	21.2	2.0	7.35	16.6
6		13:03:07	1.0		15.58	7383	7.56	13.9	1.3	7.32	20.3
6		13:05:16	1.5	1.9	15.57	7388	7.56	15.3	1.5	7.33	151.0
3	N Shallow	12:34:16	0.1		16.59	7208	7.61	26.1	2.4	7.40	15.0
3		12:34:41	0.5		16.07	7296	7.57	22.0	2.1	7.35	87.9
3		12:35:05	1.0		15.67	7363	7.54	21.8	2.1	7.37	286.2
3		12:36:04	1.8	2	15.71	7360	7.54	22.6	2.1	7.37	519.5
2	S Shallow	12:19:36	0.1		15.83	7336	7.49	46.5	4.4	7.57	10.2
2		12:19:52	0.4	0.6	15.61	7370	7.49	47.3	4.5	7.60	17.6
7	N Deep	13:08:52	0.1		16.49	7229	7.57	26.9	2.5	7.44	6.5
7		13:09:21	0.5		15.97	7315	7.57	25.9	2.4	7.45	8.5
7		13:09:55	1.0		15.76	7349	7.56	25.4	2.4	7.46	8.5
7		13:10:17	1.5		15.69	7363	7.56	25.1	2.4	7.44	12.3
7		13:10:49	2.0	2.2	15.67	7367	7.55	24.0	2.3	7.43	10.1
8	NE Deep	13:22:09	0.1		16.69	7191	7.57	29.0	2.7	7.45	6.8
8		13:22:56	1.0		16.18	7279	7.56	27.1	2.5	7.45	9.2
8		13:24:10	2.0		15.67	7369	7.55	22.5	2.1	7.42	12.6
8		13:25:05	2.5	2.8	15.64	7371	7.56	21.6	2.1	7.41	13.0
9	E Deep	13:29:33	0.1		17.04	7140	7.56	29.4	2.7	7.46	4.4
9		13:30:02	1.0		16.44	7235	7.55	27.3	2.5	7.45	4.3
9		13:30:41	2.0		15.67	7363	7.55	22.1	2.1	7.42	5.6
9		13:31:17	3.0		15.61	7374	7.55	22.8	2.2	7.44	8.2
9		13:31:56	3.8	4.1	15.59	7378	7.56	23.4	2.2	7.45	7.5
10	W Deep	13:48:59	0.1		17.05	7135	7.56	31.6	2.9	7.48	4.3
10		13:49:22	1.0		16.12	7284	7.56	29.8	2.8	7.48	6.7
10		13:49:46	2.0		15.66	7363	7.55	26.7	2.5	7.45	9.7
10		13:50:06	3.0		15.60	7375	7.55	25.4	2.4	7.46	10.1
10		13:50:17	3.5	3.8	15.57	7379	7.55	25.3	2.4	7.45	13.8
1	SW Deep	12:04:13	0.1		16.05	7302	7.67	28.6	2.7	7.45	10.1
1		12:05:02	0.5		15.79	7347	7.59	27.7	2.6	7.46	7.8
1		12:05:36	1.0		15.76	7351	7.58	27.5	2.6	7.46	7.8
1		12:06:20	2.0		15.70	7363	7.57	26.6	2.5	7.46	6.5
1		12:06:43	2.5	2.8	15.67	7369	7.56	26.4	2.5	7.45	7.7
GR3	N end	14:28:03	0.1		17.37	7090	5.23	54.8	5.1	7.33	3.1
GR3		14:28:32	0.3		17.30	7104	5.19	54.5	5.1	7.34	5.1
GR1	S end	14:15:20	0.1		17.25	7107	5.25	54.7	5.1	7.17	5.8
GR1		14:16:50	0.3		17.20	7124	5.23	54.2	5.1	7.34	5.1
Minimum					15.09	7090	5.19	13.9	1.3	7.17	0.1
Maximum					17.37	7459	7.67	66.7	6.3	7.89	519.5
Median					15.74	7355	7.56	27.0	2.5	7.45	7.8
Mean					16.04	7304	7.35	33.7	3.2	7.48	31.0
SE of Mean					0.0939	15	0.10	2.2	0.2	0.0239	13.5

Ten Benedict Sands pool sites were profiled (sites 1 to 10 in Figure 3) as well as two adjacent river sites (GR1 and GR3 on Figure 3). At the time of sampling the weather was dry and sunny, the washing plant was operational and therefore the inlet pump at the NW corner of the Ruppia Pool was operational and there was a return wash water stream discharging into the NW corner of the Shallow Pool (see Figure 3 for these locations).

The results of the survey shown in Table 4 have been ordered from north to south, i.e., from Site 4 closest to the wash water intake, to Site 1 in the SW corner of the Deep Pool. Results are summarised as follows:

- Adjacent Georges River waters were less brackish (5.23 ppt salinity) compared to quarry pond waters (median 7.6 ppt). Dissolved oxygen levels were higher than the pond waters (54.5 % saturation compared to Pond median of 27 % sat). Other parameter values (pH, turbidity and temperature) were similar to the quarry water values.
- There were very slight temperature and conductivity gradients for most deeper quarry pool sites but the differences were not sufficiently high to conclude that the quarry waters were uniformly (or deeply) stratified. That is, there would appear to be sufficient mixing available to ensure that no significant stratification takes place.
- The salinity of the three ponds was relatively uniform, both with depth and between pools. The pool waters were brackish (mean 7.56 ppt) and more saline than the corresponding river waters (mean 5.23 ppt).
- Dissolved oxygen (DO) concentrations was generally higher in the surface waters for most sites, corresponding to the observations of algae and debris floating on the surface of the Ruppia and Deep Pools (see Figures 5 and 6). The dissolved oxygen levels in the remaining water column decreased gradually with depth. At Site 6 there was a much larger decrease in DO with depth (surface 37 %sat, bottom 15% sat).
- The Ruppia pond sites had increasingly higher DO concentrations to the north reflecting the proliferation of a submerged aquatic plant (*Ruppia sp.)* growing in this pond (see Figure 7).
- The pH values were relatively uniform (range 7.2 to 7.9 pH units) with generally higher pH values in the surface waters and a very slight depth gradient.
- Turbidity (expressed as NTU) varied from very low (± 1.5 NTU) at site 4 to very high (519 NTU and 151 NTU in bottom waters at sites 3 and 6 respectively). For the remaining sites turbidity generally ranged between 7 and 13 NTU. All sites (bar Site 10) had increasing turbidity with depth.

Figure 5 View of Deep Pool looking north from Dredge showing flocculants and algae floating on surface (Photo 27 April 2007).

Figure 6 Same view of Deep Pool, looking south from Site 7 towards dredge and showing denser floating flocculants plus algae on pool surface (Photo 28 May 2007).

Figure 7 *Ruppia sp*. growing in Ruppia Pool (Photo May 2007).

A pattern of water movement and behaviour through the existing pond system can be inferred from the above data is as follows:

- Wash water intake (Site 4) had reasonable dissolved oxygen (DO) concentrations and low turbidity reflecting the proliferation of *Ruppia* in the pond that both generates oxygen and aids sediment settlement.
- Return waste wash water with very high turbidity and low DO is captured by the floating boom between the shore discharge and Site 3 and the 'dirty' water is forced to the bottom to flow under the boom. Consequently Site 3 profile shows very high turbidity and low DO in the bottom waters.
- Some of the waste water stream is directed to deeper waters east and little is retaining in the Shallow pond. Consequently Site 2 has relatively high DO and relatively low turbidity.
- The sub-surface wastewater stream that is directed into the deep pool, becomes buoyant and generally flows clockwise along the eastern bank of the pool, gradually mixing with the remaining waters (sites 7 to 8 to 9 to 1 to 10). The buoyant scum from the wastewater aid algae growth and there is a gradual increase in DO

concentrations around the pool. This mechanism is also probably mediated by prevailing winds with scum and algae forced towards the southern shore on the sampling day resulting in an inverted turbidity profile at site 1 compared to all other sites.

- Some of the sub-surface waste-water flow is pushed north into the Ruppia pool and the circulation is most probably constrained by both shallow depth and the Ruppia growth. Consequently there is an area of dead water at the mouth of the Ruppia Pool (at Site 6) which has the only distinct DO stratification (73 % surface, 15 % bottom).
- Most probably there is further mixing of the Deep Pool clockwise flowing waters with the wastewaters and a resultant mixed flow into the Ruppia poll, at least when the washing plant is operational and drawing water from the Ruppia Pool.

In summary, the combination of wash water intake and discharge sets up circulatory water currents that mediate water mixing throughout the quarry ponds. Overall quarry water is similar to adjacent river waters in terms of salinity; both are brackish, most probably due to the pumping in of make-up river water. With regard to supporting aquatic life, the quarry waters have relatively low dissolved oxygen concentrations but as the waters are fairly well mixed there are very few areas of 'dead water'. Consequently the quarry could be expected to support a reasonable diverse assemblage of aquatic biota – and generally the assemblage would be more marine than freshwater.

3.3 Aquatic Ecology of the Site

In the following sections the basic aquatic habitats of the study site are described. The site has been considered as three more or less distinct systems; (i) the quarry pond system, (ii) the stormwater drain plus un-named southern creek system bounding the quarry to the west and south, and (iii) the adjacent river and river bank bounding the quarry ponds to the east.

Additional information on the riparian habitats of the Benedict site are available in a flora and fauna report (Total Earth Care 2006).

3.3.1 Existing Quarry Pond Habitats

The three quarry pond habitats comprise the benthic sediment habitat of each of the ponds, the pond water bodies and the pond riparian edges. Figures 8 and 9 provide panoramic views across the Deep Pool and the Shallow Pool, and Figures 10 to 14 provide various views of the quarry pool aquatic habitats (discussed below).

Figure 8 Panorama view of Deep Pool from the bank just north of the Dredge, looking north (along right edge) and south (along edge of dredge). Most of the pool edges are steep. Figure 10 (below) shows the remainder of the deep pond to the south-west (obscured by the dredge).

Figure 9 Panorama view of Shallow Pool in foreground and Deep Pool in background from the west looking south (along right edge) and north (along left edge). The return wash -water drain can be seen in the left hand corner of the Shallow Pool with the floating boom located off-shore from the discharge.

Figure 10 South-west corner of Deep Pool looking west from Dredge, and showing various emergent and bank plants.

Figure 11 Sand spit on west side of Deep pool looking south-west.

Figure 12 Bittou Bush and *Phragmites australis* growing on Deep Pool bank.

At the time of survey, active dredging in the ponds had ceased some 2 years previously (in 2005) and pumping for make up water for evaporative losses only occurs once every 2 to 3 months during prolonged droughts.

Whilst the ponds are brackish, they are not tidal, and the water levels in the ponds vary inconsistently, as a result of the interaction of a variety of climatic mechanisms, (rainfall, air pressure, wind pressure, evaporation due sunshine) and as a result of quarry washing plant operations (wash water draw down and wash water return plus river make up water).

The southern Deep Pool has depths varying from 1.8 m inshore to 4.2 in the centre of the pond. The bottom is firm and is generally sandy to silty sand. Presumably owing to the depth, there was no submerged aquatic vegetation found in the deep pond, but at the time of field studies there was a film of floating flocculants and algae over the surface of the deep pond (see Figures 5 and 6). The edges of the Deep Pool are generally steep (see Figures 8 and 10) and there is minimal slumping. The cleared and disturbed riparian edge vegetation comprises various grass and weed species, with scattered Sydney Green Wattle saplings and, where there is sufficient shallow slumped sediment, there are patches of emergent reeds (*Phragmites australis*).

Figure 13 View of Shallow pond looking north-west from sand spit with quarry wash water runoff in background (behind floating boom). Sand spit supports a variety of saltmarsh species.

Figure 14 Sand spit on east side of Shallow pool looking towards *Ruppia* Pond.

Other than *Phragmites*, there are scattered saltmarsh plants amongst the riparian grasses, mainly New Zealand Spinach. There are also isolated stands of Bittou Bush (see Figure 12).

The Deep pool is separated from the Shallow Pool by a constructed sand spit (see plan view in Figure 3 and various ground views in Figures 11, 13 and 14. The upper half of the sand spit comprises loose coarse sand and supports scattered terrestrial weed species (see Figure 11). The outer portion of the sand spit is much lower to the water and consequently it would be inundated from time to time. As a consequence the lower sand spit supports small and isolated clumps of saltmarsh species (Figures 13 and 14). Plants observed included several species of Atriplex, some Sarcocornia, Austral Seablight and Club Rush. These plants are commonly found on the edges of brackish water ponds and the intermittency of the inundation was evident in that there were also areas of dead saltmarsh plants observed.

The shallow pool (Figure 13) has depths generally less than 1 m. it has a hard sandy bottom with no observable epibenthic fauna, and there were no burrows of benthic organisms observed. It is concluded that the brackish nature of the waters probably preclude many estuarine benthic species. However, a large adult Dusky Flathead was observed in this pond, indicating that the waters are sufficiently brackish to support an adult flathead and that there must be some benthic fauna for the flathead to feed upon.

The Ruppia pool is so called as it supports a vigorous growth of a brackish water submerged plant *Ruppia sp.,* growing to between 1.5 and 2 m height (see Figure 7). The pond has gently sloping sides with 1 m depths around the edges and an open basin to about 2 m depth. Much of the riparian edge supports swathes of *Phragmites*. There were schools of small fish observed amongst the reeds, generally Mosquito Fish, an introduced pest species generally known from freshwaters but also found in brackish water ponds.

Other fish reported anecdotally from the ponds are Mullet and the introduced Carp. No fish have been directly placed into the ponds and the main mechanism for fish to enter the ponds is via the top-up water that is pumped in from time to time from the Georges River.

The ponds support a variety of aquatic bird life including ducks (Black Duck, Wood Duck and Chestnut Teal), Swans, Swamphens and Mooorhens, White faced Heron and White Ibis. There are a variety of fishing birds, Pelicans, Black and Pied Cormorants and the Australian Darter. Silver gulls also visit the site. Some of the ducks and Swans are known to breed in the ponds.

Figure 15 Chipping Norton Stormwater drain at Milperra Road (looking west).

Figure 16 Stormwater drain adjacent Study Site (looking upstream – north) from levee bank. Drain is filled with Cumbungi.

Figure 17 Stormwater Drain upstream of Un-named Creek confluence. Drain supports Alligator weed and Frogs Mouth.

Figure 18 Un-named Creek just downstream of Stormwater Drain confluence (looking east). Alligator Weed is main emergent aquatic plant.

Figure 19. Eastern Long-necked Turtle in Un-named Creek pool.

Figure 20. Un-named Creek just upstream of Georges River confluence (looking west). Grey Mangrove on right, *Phragmites* along north bank and Alligator weed in background.

Figure 21. Georges River bank at the Un-named Creek confluence (site south-east boundary) looking north. Grey and River mangroves with She-oaks on bank.

3.3.2 Stormwater Drain and Creek Habitats

The stormwater drain that runs along the western boundary of the site is separated from the site by a levee running from Milperra Road to the confluence with the un-named southern creek (Figures 1 and 3, and see also Sections 13 to 15 on the survey plan in Appendix A). This is a freshwater system draining stormwater from the Chipping Norton industrial area to the north of Milperra Road. Figures 15 to 17 show parts of the stormwater drain from the culvert pool below Milperra Road to just above the confluence with the un-named southern creek. The upper culvert pool did not appear to support any fish and the shallows lower down the drain supported Mosquito Fish. Much of the drain is filled with Cumbungi and Alligator Weed, a noxious aquatic weed.

The unnamed creek has a more or less intact native riparian cover along the creek from the confluence with the stormwater drain to its confluence with Georges River. The creek is freshwater for most of its length then becomes brackish and estuarine as it approaches the Georges River (Figures 18 to 21). The upper pools have grassy banks and patches of Duck weed, Alligator Weed and Persicaria and there were Mosquito Fish observed, as well as an Eastern Long-Necked Turtle (Figure 19). Another noxious aquatic weed *Ludwigia* is also

reported from the site (Total Earth Care 2006). At the estuarine end of the creek there is a canopy of Swamp She-oak with *Phragmites* and *Juncus krausii* along the creek edge. There are two mangrove species in the lower creek confluence, the Grey Mangrove Avicennia marina, and the River Mangrove Aegicerus corniculatum. There are some mature Grey mangroves with canopy heights between 4 and 6 m at the confluence.

3.3.3 Georges River Habitats

The strip of riparian land between the quarry and the Georges River supports a variety of disturbed and partially intact sections of woodland – see Figures 1 and 3 for plan views and see the survey plan in Appendix A for the location of wooded areas. The vegetation of this riparian strip is described in Total Earth Care (2006).

The rivers' edge between the southern creek confluence and the northern end of the study site has been eroding over time and there have been a number of partially controlled and probably uncontrolled measures taken to check the erosion, ranging from engineered bank works to dumping of masonry. This would appear to have been undertaken over many years as there are mangroves growing out of the dumped materials scattered along the bank.

The survey plan in Appendix A provides location details of bank treatments plus the locations of mangrove stands and of individual mangroves. Grey Mangroves are identified as such and River mangroves are noted as 'mangrove'. Figures 22 to 36 show aquatic habitat aspects of the river bank, (from downstream - south to north):

- There is an engineered treatment along the bank immediately upstream of the mangrove stand at the property southern boundary (the Creek confluence mangrove stand) see Figures 22 to 26. This treatment has failed in several places with slumping of the rocks and exposure of the underlying silt cloth plus active bank erosion behind the treatment resulting in terrestrial trees (mainly She-oaks) falling into the river (Figure 24 and 25).
- Where the silt cloth is exposed in the intertidal it has been covered in a silt/algae matrix that provides food for grazing molluscs (Figure 26).
- Upstream of the rubble and siltcloth bank treatment there is a section where the bank is protected by larger piece of masonry, mainly concrete slab pieces (Figures 23 and 27). There are also dead trees amongst this rubble indicating earlier active bank erosion.
- The mixed masonary bank treatment continues to (and beyond) the northern boundary. This fill has been in place for many years and there are mangroves that have colonised the fill (Figures 31 and 33).

Figure 22 Georges River bank at north end of mangrove stand upstream of un-named creek confluence (looking south). Note engineered rubble bank treatment.

Figure 23 Engineered Rock Rubble embankment looking north of mangrove band with failed and slumped bank in foreground.

Figure 24 showing bank erosion and toppled she-oaks (looking south from Figure 23).

Figure 25. Detail of active bank erosion including exposure of silt-cloth plus slumped rubble fill treatment (looking south from Figure 23).

Figure 26. Littorinid snails grazing silt/algae matrix on exposed silt cloth.

- Although these mangroves are relatively small (up to 1.5 m) they are not young – as indicated by the thick trunks and multi-branching. That is, these are dwarfed forms of mangroves, most likely dwarfed owing to the limited space for lateral peg root development in the intertidal due to the masonry treatment.
- The variety of materials used for the fill ranges from road-base through reinforced concrete to brick masonry (Figures 27, 29, 30, 32).
- Where there has been significant slumping, there are shallow inshore areas along the banks and several of these have been colonised by seagrass patches (*Zostera capricorni*). The location of these patches is indicated on Figure 3, and Figure 36 provides a view of the southern patch, located just upstream of site GR1 in Figure 3.

In summary, the aquatic habitats of the Georges River edge of the property comprise:

- A mixture of earth bank and masonry intertidal bank that supports small stands of Grey and River mangroves and scattered individual mangrove trees, all mature and ranging from 1.5 m dwarf specimens to 4 m tall Grey mangroves at the unrestricted un-named creek confluence immediately downstream of the southern property boundary. There were a few crab holes in the exposed sdiments and littorinid snails on the rock.

- There are a few areas of intermittent shallow sub-tidal bank along the toe of the intertidal bank, generally where there has been active erosion, and several of these support small patches of seagrass, *Zostera capricorni*.

Figure 27. Next upstream bank treatment from engineered rock rubble treatment (Figure 23). This treatment continues up to the site boundary (see following photos).

Figure 28 Continuation of bank treatment looking upstream from Figure 27. Note individual mangroves in background (see Figure 74 below).

Figure 29. Diversity of masonry and road base fill material.

Figure 30. Masonry and concrete fill material.

Figure 31. River mangroves growing between masonry rubble (looking upstream). See Figures 33 and 34 for remaining views beyond the she-oak.

Figure 32. Trapped floating rubbish amongst masonry rubble.

Figure 33. Bank treatment around individual Grey mangroves at north-east end of study site looking downstream (i.e., back south towards Figure 31).

Figure 34. Bank treatment south of mangrove in Figure 33, looking downstream. Note pump-house on bank in middle distance.

Figure 35 Pump House and Inlet pipe for pumping 'make up' river water to Quarry (August 2004 photo).

Figure 36 Seagrass Patch upstream of Un-named Creek Confluence - see Figure 3 for location.

- Beyond these inshore habitats, the river bed comprises generally mobile sediments comprising coarse to finer river sands mixed with silts. There were no burrows or mounds of benthic crustaceans or polychaete worms noted during diving inspections near the bank, and no surface invertebrates (molluscs and prawns) were seen, indicating generally mobile sediments.

With regard to general aquatic ecological attributes of the Georges River in this locality the following are relevant:

- Since 2002 there has been a commercial fishing closure placed on the entire Georges River – Botany Bay estuary.
- Whilst Georges River once supported a thriving oyster farming industry there is now no aquaculture activities in Georges River and the closest aquaculture operations are located in Botany Bay; native Sydney Rock and triploid Pacific oyster farming in Woolooware Bay and Mulloway farming off Silver Beach, Botany Bay.
- Marine vegetation (mangroves, saltmarsh and seagrass) are all recognised as significant nursery habitats for estuarine fish (NSW Fisheries 1999) and there have been a number of studies to map the distribution of these fisheries resources in the Georges River catchment. The descriptions of these resources as presented above is consistent with the descriptions provided in West et al (1985) and in the more recent mapping in Williams et al (2004). This confirms that there is a patchy distribution of mangroves fringing the river along the upper river shores below Milperra Bridge with a very scattered distribution of Zostera seagrass, generally occurring in small patches. The report also indicates that there are no significant saltmarsh areas in the locality.

With regard to the possibility of listed threatened aquatic species or communities within the project area, no species as listed under the NSW Fisheries Management Act or under the Commonwealth EPBC Act were noted or observed during the field studies undertaken for this study and, given the aquatic habitats available at the site, none are expected. With regard to fish species, this conclusion is supported by the Williams et al (2004) study, which also reported no threatened fish species.

Whilst individual saltmarsh plants were found scattered or grouped along the margins of the internal waterways, these were not considered to form viable saltmarsh communities (which are listed as threatened under the TSC Act), as they are subjected to inconsistently varying water levels and exhibit dieback due to inundation.

4 IMPACT ASSESSMENT

WorleyParsons (2010) provides a description of the construction and operational aspects of the proposed marina and the following sections provide an assessment of the impacts that could potentially be associated with these aspects.

The proposal includes a marina basin of approximate dimensions of 150 m by 350 m. The depth of the basin will be higher than that of the adjacent river depth to minimise sediment deposition in the marina basin.

The marina would open to the Georges River with a short entrance channel, about 50 m long and 40-50 m wide. The opening has been located so as to avoid existing seagrass patches and mangroves. There would be a high pedestrian bridge over the marina river entrance to allow public pedestrian access along the river foreshore.

Bank edge treatments proposed for the internal marina basin have been selected to meet the combined functions of bank stability and environmental enhancement. There will thus be rock revetment treatments that incorporate complex crevice habitat for intertidal rocky shore species plus a combination of rock revetments and integrated vegetation zones. This latter treatment would incorporate a berm of saltmarsh (or other suitable aquatic habitat treatment).

This rock revetment and integrated vegetation zones treatment will also be used for the Georges River foreshore bank, to replace the existing actively eroding and inappropriate masonry rubble-based bank treatment.

The proposal also includes two constructed freshwater wetlands along the east side of the marina basin to treat runoff from carpark and residential areas (see Figure 2). The wetlands would be vegetated with suitable macrophytes and would enhance the riparian zone by increasing aquatic vegetation and habitat complexity. The riparian bank between the marina and the river would then be planted out with appropriate littoral species.

4.1 Construction Aspects

In order to limit the impact of construction on adjacent river and riverbank aquatic habitats, the marina basin will be formed by filling the existing quarry and shaping it into the final landform using a dredge and land-based earth moving machinery. The dredge would operate as at present, in the water-filled basin. The excavated sand will be used for forming the associated land areas required for the marina. This work would commence at the landward

end forming the basin and land base prior to breakthrough of the banks to the river. In this way, these works would not impact on the river water quality or aquatic habitats.

The breakthrough to the river would be undertaken as the last activity after the water quality in the basin had stabilised and is suitable to discharge to the river once the banks are excavated. Stockpiled excavated sand from forming the marina basin would be used to line the vessel access channel. Connection to the river would be delayed for as long as practicable and would be completed during favourable water level conditions (i.e. at or around slack water) to enable management of the breakthrough with the deployment of an appropriate turbidity curtain.

4.1.1 Possible Impacts on Aquatic Ecology and Habitats

The internal quarry excavation and land forming works will result in the loss of the existing aquatic ecological attributes of the present quarry, including *Ruppia* aquatic vegetation (used by fish and edge saltmarsh plants and emergent reed areas (used by aquatic birds for nesting and roosting). The waters of the internal quarry would be disturbed to an extent that remaining fish would probably not be able to survive the high turbidity arising from the works. Fishing and foraging birds are likely to take advantage of the feeding opportunities arising from this activity over the short-term. Whilst there would not be any threatened species or communities affected by the works there would be a temporary diminution in the available aquatic habitats of the locality.

The formation of an entrance channel through the riparian land between the site and the river would result in the permanent loss of some foreshore riparian land but would provide a small amount of additional water habitat area.

The proposed river bank stabilisation works will potentially impact on individual mangroves currently scattered along the bank and, depending on the detailed engineering design, may require active removal of some or all of these trees to allow for the bank stabilisation works to be completed. Similarly, the small patches of seagrass growing on submerged areas of slumped shallow river-bank could be partially or wholly lost to bank stabilisation works.

From the broad perspective, if the site is not used for the proposed marina it will likely be used for some other land-use requiring filling of the existing quarry. That is, loss of the aquatic ecological attributes of the existing quarry is likely to occur regardless of the proposed end-use of the site. From this perspective, the marina proposal would result in an overall increase in Georges River aquatic habitat area and diversity and the resultant floating marina plus revetment treatments would provide suitable wetted habitat for a diverse

assemblage of aquatic biota. Also, regardless of end-use for the site, riverbank stabilisation works are likely to be required, and thus the potential impacts on existing edge aquatic vegetation (mangroves and seagrass) remains the same. Even under the do-nothing option it is likely that the masonry fill currently used for shore protection would need to be removed, which would still put the adjacent marine vegetation at risk, either from direct loss to rubble removal or indirect loss to natural river bank movement.

From a more focused perspective, the individual impacts described above can be mitigated to some degree by timing the works to avoid or ameliorate particular aspects of the impact. For instance, initial site works could remove the edge vegetation at a time when the possibility of nesting birds is at a minimum. Then, as the vegetation is being removed any resident roosting aquatic birds (e.g., Swamphens and Moorhens) can re-locate to alternate aquatic habitats in the adjacent stormwater/un-named creek, and aquatic birds later seeking suitable nesting sites will by-pass the site for lack of suitable habitat.

There is also scope to harvest saltmarsh soil (with intact seed) from the sand-spit for eventual use in the revetment berms, in order to accelerate the colonisation of the berms, once built. Even individual dwarfed mangroves that are potentially to be lost to river bank works can be harvested for replanting into river revetment berms, if desired. Similar works have been undertaken successfully at Harrington, Manning River.

Creation of the channel connection between the marina and the river will require the removal of the existing soils between the quarry and the river. These soils are likely to be Acid Sulfate and if so, removal without associated remediation works poses a risk of acid discharges to the river. Remediation, if required would entail over-excavation and treatment or replacement of soils immediately adjacent to the proposed channel, to prevent long-term drainage of acid from the adjacent soils.

The final connection of the formed marina basin to the river has the potential to drain turbid water from the basin to the river and could scour the new channel if the levels of the marina and river are not similar. As noted in WorleyParsons (2010), these impacts can be mitigated to insignificance by matching the river and marina waters in level and quality prior to the final entrance connection and by placing a turbidity curtain around the final breakthrough point. This matching of waters could be achieved by use of the existing quarry make-up water pump (or similar).

Finally, the project incorporates a number of habitat enhancement proposals that are designed to achieve an overall diverse and integrated riparian and aquatic ecology for the site to the benefit of the whole river environment.

4.2 Operational Impacts

The main operational impacts of the use of the marina from the aquatic ecological perspective relate to overall water quality within the marina basin, water quality resulting from vessel movements in and out of the basin and resultant water quality in the river:

- Water quality related to direct exchange and mixing with the river waters.
- Stormwater quality and quantity draining to the marina basin.
- Behaviour of vessel antifouling leachate in relation to the above.
- Accidental spillages of fuels and other liquids into the marina waters from fuelling and workshop activities.
- Bilge and sewage discharge control from vessels within the marina.
- Potential for bottom scouring from propeller wash by vessels using the marina.

These matters have been considered in detail in WorleyParsons (2010) and Section 5 provides a summary of avoidance and mitigation measures that have been incorporated into the design of the facility to mitigate or minimise impacts on marina water quality.

4.2.1 ANZECC Water Quality Criteria

ANZECC/ARMCANZ (2000) provides water quality criteria for the protection of aquatic ecosystems and the WorleyParsons (2010) report has assessed the proposal against these criteria. The main pollutant inputs to the river associated with the proposal were determined to be suspended solids and nutrients (from stormwater) and copper, that would be derived from both stormwater and from anti-fouling paint ablation off boats stored in the marina.

Of these, the WorleyParsons (2010) modelling results determined that incorporation of water sensitive urban design including stormwater treatment elements would be sufficient to reduce suspended solids and nutrient loads to acceptable levels. Modelling for copper inputs indicated that the greatest copper load to the marina waters would be from the anti-fouling paints, which cannot be controlled by stormwater treatment. Accordingly, the measures taken to achieve satisfactory copper concentrations in the marina waters have been to design the marina to facilitate sufficient mixing and exchange with river waters plus adjust the mix of vessels to meet the modelled target criteria.

For modelling purposes WorleyParsons (2010) used the ANZECC/ARMCANZ (2000) default copper trigger levels for the protection of 90 % and 95% of estuarine aquatic organisms within the marina waters; being 3 μg/L and 1.3 μg/L respectively. However, the ANZECC guidelines suggest that the default trigger levels (as stated above) should only be used if there are no available water quality data from which a background value can be determined. In this case, Benedict Industries collected additional water samples from Georges River under various tidal and weather conditions that were analysed by CSIRO laboratories - see Section 6.1.4 and Table 6.2 of WorleyParsons (2010) for sampling and analysis details and results. These results have been used to establish a site background level for copper concentrations with the following statistics derived from the river sampling results:

- Mean ± Standard Deviation of the Mean for Dry Weather labile (i.e., bioavailable) copper concentrations in the Georges River is 1.5 ± 0.40 μg/L.
- When both wet weather and dry weather data are combined, the mean ± standard deviation copper concentration is 1.4 ± 0.41 μg/L.

As noted in the WorleyParsons (2010) report, the critical modelling conditions for copper concentrations in the marina are for dry weather. Accordingly, and as per the ANZECC/ARMCANZ (2000) guidelines, the appropriate background river concentration to be adopted for comparison of modelling results is the background dry weather river concentration. The measured background data provide a range (via the standard deviation calculations shown above) of 1.3 to 1.7 μg/L. The adopted design provided a predicted dry weather concentration of 1.46 μg/L, which is below the background mean value and within the range of the adopted dry weather background river copper concentrations for Georges River at this location.

Note also that this modelled value is considered conservative, as the assumption for occupancy rate (95 %) is considered more than would probably be achieved in practice. If a lower occupancy rate of 90 % is adopted, the modelled dry weather concentration reduces to 1.4 μg/L – see Section 6.5.5 in WorleyParsons (2010) for details of their sensitivity analysis.

In conclusion, the conservative modeling undertaken for this project indicates that the proposed development will not have any adverse impact on the levels of labile copper in the river, and the operation of the proposed marina would meet the required thresholds set by the ANZECC/ARMCANZ (2000) guidelines for the protection of aquatic ecosystems.

4.2.2 Operational Impacts – Conclusions

It is concluded that the proposed marina can be constructed and operated without any significant impact on river water quality, and can achieve a suitable water quality within the marina to support a representative assemblage of aquatic biota for this river reach.

With regard to potential water quality impacts on the aquatic biota of the river it should also be noted that the marina is situated in the upper portion of the estuary and is therefore subjected to periodic floods that cause the river waters (and by extension the waters of the marina) to become fresh. Depending on the magnitude of the flood, low salinity conditions can persist for sufficient time to adversely affect the estuarine biota in this portion of the river.

As a consequence, the composition of the aquatic biota community in this part of the river and in the proposed marina can be expected to be dynamic, changing in relation to the frequency and persistence of floods. Under these circumstances, potential impacts arising from copper concentrations - as measured and as modelled above - would also be insignificant (i.e., could not be measured) compared to adverse impacts due to freshwater inundation.

There are other potential off-site operational impacts that relate to the possible increased volume of vessel traffic within the river and the possible effect on river aquatic habitats, principally shallow water and bank habitats, that could be impacted by the increased frequency of vessel wash. As wash impacts are already being experienced along the length of the Georges River as a result of existing vessel traffic in the river, it is considered that any potential increase in river traffic volume that may arise from the use of the marina is unlikely to produce any measurable additional impact over the present wash impact.

Whilst mitigation of existing wash impacts on the Georges River is outside the scope of this project, the commitment by Benedict Industries Pty Ltd to remediate their present wash-impacted shoreline will provide an improvement for river water quality for this section of the river.

5 MITIGATION OF POTENTIAL IMPACTS

The description of the project plus the assessment of potential impacts provides a number of proposed and possible impact mitigation measures that have or can be applied to avoid or off-set significant impacts to the aquatic ecology of the locality. These have been brought together here.

5.1 Avoidance Measures

There are several direct avoidance measures incorporated into the marina design that provide protection for aquatic biota:

- Modelling has been used to design the shape, capacity and use of the marina so that adverse water quality and river hydraulic impacts can be avoided. This includes the incorporation of a significant dry boat storage component in the design.
- The design has incorporated freshwater wetlands to treat stormwater from the site and the wetlands have been sited to form a part of an ecotone grading from sub-tidal to intertidal rock revetment incorporating a reed or saltmarsh berm with enhanced planting out of the adjacent riparian land with suitable native littoral plant species.
- The design has incorporated a depth differential between the basin and the river to ensure that there will be no deep 'dead water' areas in the basin and ensure that there will be no significant accumulation of sediments within the basin.
- The entrance channel has been located to avoid direct loss of existing seagrass patches or of individual mangroves.
- Building the marina basin and marina infrastructure within the confines of the existing quarry site has avoided the possibility of construction water loss to the river.

5.2 Mitigation and Offset Measures

Construction mitigation measures include the following:

- Stage initial quarry construction activities to minimise impacts on the existing biota that currently use the quarry aquatic ecological resources.
- Harvest aquatic plant resources where appropriate for later use in riparian or aquatic remediation or enhancement works.
- Early testing for and remediation where required of possible Acid sulfate soil content to prevent possible discharge to the river from the proposed channel formation and connection works.

- Incorporation of strict vessel management controls within the confines of the marina to minimise the risk of deliberate discharges and of accidental spills related to vessel use.
- Delay and control entrance connection to the river until the basin and river water quality and levels are matched. Use a turbidity curtain to minimise the extent of turbidity arising from the final entrance breakout.
- Incorporate aquatic biota friendly construction methods into the basin and river breakwater designs, by the use of rock revetments and revetments with berms that will be planted with intertidal marine vegetation such as reeds, saltmarsh or mangroves.

Offset measures include the following:

- Provision of additional habitat for marine intertidal vegetation in the form of constructed berms as part of the rock revetment works for the basin and the river, to offset the potential loss of some of the river intertidal seagrass and mangroves that may be necessary as a result of the need to removal masonry fill materials currently placed along the river bank.
- Rehabilitation and enhancement of the existing riparian land between the river foreshore and the proposed marina by the planting of suitable local native littoral species.
- Rehabilitation of the creek bank vegetation between the marina and the un-named southern creek to provide a native vegetated barrier between the marina and creek.
- Rehabilitation of the levee bank vegetation between the marina and western stormwater drain to provide a native vegetated barrier between the marina and drain.

The intent of the these combined mitigation measures with regard to aquatic ecological function is to provide a diversity of natural or near-natural intertidal to riparian zone habitats that support local native terrestrial and marine trees and other vegetation, and link these combined habitats vertically as ecotones, from the water to the land and horizontally as habitat corridors for connecting the up stream and down-stream river corridor habitats to the southern creek habitats and to each other.

With regard to avoidance and mitigation of operational impacts on the aquatic ecology of the locality, the proposal will incorporate a series of measures to avoid and minimise the chances of fuel and other spills (from fuelling and workshop practices) entering the waterway, and will provide proper systems in place to deal with any spills should they occur.

Potential impacts from workshop activities will be minimised by a mix of direct avoidance and mitigation measures. Benedict Industries have advised that there will be no traditional "slipway" activities (which have a much higher potential for wastes and residues to enter the marine environment). All environmentally sensitive maintenance works will be undertaken on a dedicated hardstand area fully under cover and within the marina building. It is intended that all craft will be lifted from the water via an elevator or forklift system and placed within the adjoining maintenance facility, within the enclosed building in cradles for maintenance works. The maintenance facilities will be constructed and operated to comply with industry standards for the Marina workshop management, specifically for the management of all liquid wastes generated from the facility and for management of all potential liquid spills that may be associated with the facility.

With regard to fuelling activities, Benedict Industries have advised that bulk fuel storage will be above the 1:100 flood level. Standard industry practice mandates isolation valves and fail-safes. This means fuel supply from the bulk store can be turned off remotely from suitable points on the marina deck and surrounds. In addition, bunding will be constructed to contain fuel spills in the event of a rupture of the bulk fuel store. Further, AS 3962-2001 notes the need for particular precautions when supplying fuel over water such as the use of double containment lines. All of these precautions will be considered and where necessary integrated in the design, installation and operation of the facilities.

A number of operational features would also be incorporated into the system as required, to reduce and deal with potential hazards associated with the refuelling facilities. These include:

- Drip trays under and around the bowsers. Trays would be of sufficient size to hold any jerry cans being filled;
- A holding tray on site to collect and retain collected wastes from the drip trays;
- Provision would be made for regular emptying and disposal of the holding tray to an approved waste collection system or site;
- Oil/fuel boom kits located at a suitable point for quick deployment to contain any accidental fuel spillage; and
- Oil absorbent kits located at the fuelling point to be used in the event of a spill to absorb petroleum products spilt on the deck or on the water surface.

These mitigation requirements are only useful if undertaken by trained staff. Thus all fuel systems will be secured and operated only by marina staff who have been provided with the appropriate level of training.

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APPENDIX A

SHORELINE SURVEY

OF

BENEDICT INDUSTRIES PTY LTD

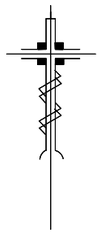
PROPOSE MARINA SITE

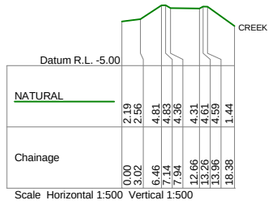
UNDERTAKEN BY

MATHEW FREEBURN SURVEYORS

ON

3 MAY 2007





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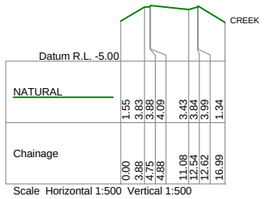

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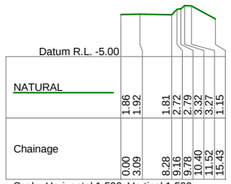

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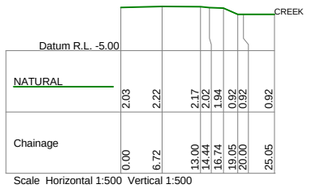

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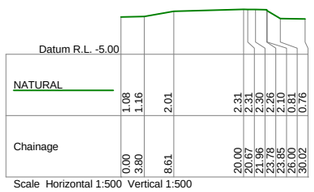

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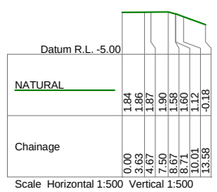

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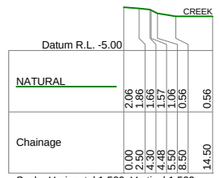

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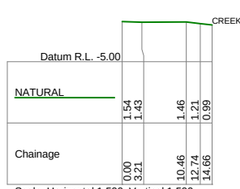

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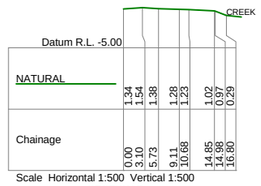

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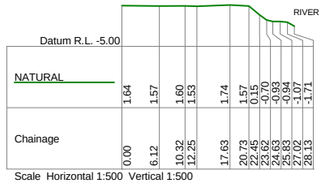

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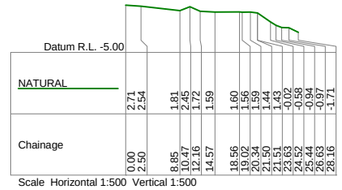

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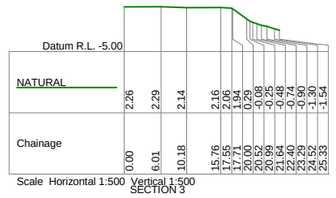

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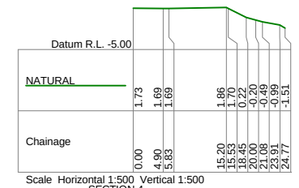

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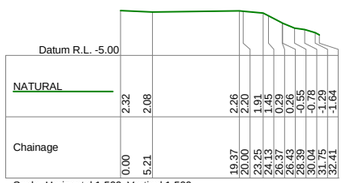
SECTION 4



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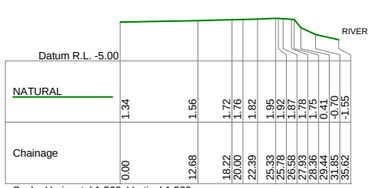
SECTION 5



Scale Horizontal 1:500 Vertical 1:500

SECTION 6

NOTE

ALL SECTIONS RUN FROM LAND TO WATER
THAT IS CH OO IS ALLWAYS ON LAND
AND THE END CH IS ALWAYS AT THE CREEK
OR UNDER WATER IN THE RIVER

SEE 3D DXF FILE FOR POINT HEIGHTS

PLAN SHOWING RIVER & CREEK DETAILS OVER PART LOT 1 DP 515738 NEWBRIDGE RD MOOREBANK

CIVILCAD SOFTWARE

SCALE PLAN 1: 1000 - SECTIONS AS SHOWN

DATUM: AHD

DRAWN BY R.WARD

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DATE: 3.05.07

SEE RW CC6

REFERENCE No:23848-30-04-07-DWG RIVER & CREEK

Appendix D4

Marine Pollution Research, Update of aquatic ecology impact report for Georges Cove Marina, April 2015

MARINE POLLUTION RESEARCH PTY LTD

Marine, Estuarine and Freshwater Ecology, Sediment and Water Quality Dynamics

A.B.N. 64 003 796 576

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PO BOX 279 CHURCH POINT NSW 2105

TELEPHONE (02) 9997 6541 E-MAIL panink@iimetro.com.au

Mr Ernest Dupere
Director
Benedict Industries
PO Box 431
FRENCHS FOREST NSW 1640 17 April 2015

Dear Ernest,

UPDATE OF AQUATIC ECOLOGY IMPACT REPORT FOR GEORGES COVE MARINA

I am writing in regard to your request for me to reconsider my original aquatic impact assessment for the Georges Cove Marina EIS (dated January 2012) in light of the time since I prepared my original impact assessment in 2010 (MPR 2010 which is an appendix of the above EIS).

I have made a short site visit on 14 April 2015 to inspect the current state of the aquatic ecology habitats that I had described in my original report. I made the visit at low tide so that I could see as much of the river intertidal and shallow sub-tidal habitats as possible. The following summarises my finding in relation to my earlier assessment:

In relation to the quarry site ponds as described in Section 3.3.1 in MPR (2010), there have been major changes since the original survey shown in Figures 1 and 3 in MPR (2010), with the two southern pools either filled or much reduced in size and the northern pool reshaped. There is active dredging and excavations underway and the waters are quite turbid as a result:

- As there is no physical connection to the river there are no implication of this change in water quality for the adjacent river ecology.
- The ponds still support fish life as evidenced by small fry observed in the shallows (including plague minnow which is a listed freshwater pest species).
- Sediment mobilisation by bottom feeding fish was also observed, most probably by carp, which is also a listed freshwater pest species.

- Both plague minnow and carp were reported from the internal ponds for the original assessment. They occur in the Georges River and are likely to have been introduced during pumping from the river to the dredge ponds.

In relation to the stormwater drain/creek that borders the site along the western and southern sides, there has been no change to the relationship of the Benedict site to that creek, in that there are no connections between site drainage or the site internal ponds with the stormwater drain. Drainage works from the housing development to the west of the Benedict site would appear to have been completed since the 2010 survey and there would appear to be overflow drainage from that development sedimentation ponds to the creek. In comparison to the habitat descriptions provided in Section 3.3.2 of MPR (2010), the following observations were made:

- The lower estuarine portion of the creek above and at the confluence with the Georges River still supports mature mangroves (both Grey Mangrove *Avicennia marina*, and the River Mangrove *Aegicerus corniculatum)*.
- In contrast to the 2010 survey, where the creek held more water and supported a relatively complete fringing reed habitat, the creek was generally dry and there was little or no *Phragmites* or *Juncus krausii* along the creek edge.

In relation to the Georges River bank river aquatic habitats at the Benedict site, there would not appear to have been any changes to the river riparian bank in that it remains a mélange of engineered bank works and dumped masonry as previously described in Section 3.3.3 with the following minor changes noted:

- The mangrove stand at the creek confluence immediately south of the site remains the same as previously described.
- The bank slumping just up from the southern boundary has provided intertidal habitat for *Phragmites* reeds that were not reported from this site previously.
- There does not appear to have been any change to the next clump of mangroves to the north (between sites GR2 and GR1 on Figure 3 in MPT 2010).
- There are still isolated mangoves along the northern bank as reported previously with at least one undercut and killed leaving only a patch of air roots.
- Whilst several of the *Zostera* seagrass patches reported in 2010 were not noted for the present survey a single patch of *Zostera* was observed.

It is concluded that there have not been any substantial changes to the aquatic ecology of the river or creek along the eastern, southern and western boundaries of the Benedict Site and that the changes in aquatic ecology and water quality observed in the ponds within the site are as expected

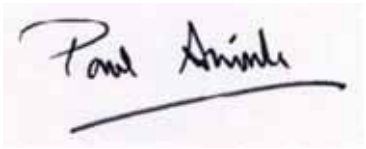
with the site ponds and their banks being actively dredged and shaped, as described in Section 4.1.1 of the MPR (2010) report.

I have also reviewed the discussion of possible listed and threatened species and the original conclusions remain the same in that no species as listed under the NSW *Fisheries Management Act* or under the Commonwealth *EPBC Act* are reported from the locality and none are expected.

On the basis of my April 2015 field inspection and review of the MPR (2010) report, I am satisfied that the descriptions of the aquatic habitats provided in Sections 3 plus the impact assessment and mitigation measures provided in Sections 4 and 5 of the MPR (2010) report remain relevant, and aquatic ecology impact does not require any additional assessment.

I trust that this is sufficient for your needs at this time. Please let me know by return e-mail if you require further clarification.

Yours Sincerely,



Paul Anink
Aquatic Ecologist
Marine Pollution Research Pty Ltd