Gales-Kingscliff Pty Ltd
ABN: 75 093 540 080

Cudgen Lakes Sand Extraction Project

Aquatic Ecology Assessment

Prepared by

The Ecology Lab Pty Ltd

April 2008

Specialist Consultant Studies Compendium

Part 6

Gales-Kingscliff Pty Ltd

ABN: 75 093 540 080

Cudgen Lakes Sand Extraction Project

Aquatic Ecology Assessment

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EXECUTIVE SUMMARY

Gales-Kingscliff Pty Ltd is seeking project approval to extend an existing approved sand extraction operation near Cudgen, on the far north coast of NSW. The Project would extend the depth and area of extraction to produce fine-grained sand suitable for raising the level of nearby low-lying land and for use as a raw material in the local construction industry. Gales-Kingscliff currently has approval to extract 400 000m^3 of sand over a six-month period to raise the elevation of part of its land at Cudgen. The proposed Project includes two extraction sites (northern and southern) of which the southern extraction site is proposed to be landscaped into a 37ha freshwater lake with fringing wetlands. The northern extraction site would be backfilled to create land suitable for sporting fields and recreational facilities.

The extraction sites are located within the Tweed floodplain. A network of artificial drainage channels occurs on the floodplain between the Tweed River and the Cudgen plateau. These drainage channels effectively act as small tidal creeks that have been physically modified and straightened. Most of these drains are generally regulated by floodgates (such as the floodgates on the river side of Chinderah Bay Drive) and as a consequence have a limited ecological function. A drainage channel traverses the southern extraction site and others run along the northern and southern boundaries of the Project Site and available evidence suggests they contain freshwater and would be Class 3 watercourses (minimal fish habitat).

Under a separate approval, the western drainage channel traversing the southern extraction site adjacent to Altona Drive is to be redirected around the proposed freshwater lake prior to extraction reaching the existing channel alignment. There is potential for such an alteration to cause key threatening processes as listed under the *Threatened Species Conservation Act 1995* and *Fisheries Management Act 1994* and it is recommended that local Department of Primary Industries and Department of Environment and Climate Change officers be consulted prior to the relocation of this channel. It is also recommended that care should be taken when redirecting the drainage channel so as to maintain or enhance any habitat that it may have afforded fish, and to maintain its original connection to other upstream and downstream drainage channels. Where other drainage channels are to be crossed for any reason, fish passage should be maintained. If any permanent crossings are to be made as part of the Project, DPI guidelines (Fairfull and Witheridge 2003) require that a culvert or ford is built that would allow fish passage.

In terms of aquatic ecology, the benefits of creating an artificial freshwater lake would outweigh any potentially adverse impacts associated with redirecting the western drainage channel traversing the southern extraction site. The creation of the freshwater lake would potentially provide habitat for, birds, fish and aquatic plants, and help to balance the degradation of natural, coastal wetland habitat in the region. Despite its artificial nature, the lake could potentially be recognised as the endangered ecological community, *Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions*, listed under the *Threatened Species Conservation Act 1995*. Consequently, the lake (when completed) would be afforded a high conservation status.

There is potential for some acidic runoff to be produced as a consequence of exposure of potential acid sulfate soils and sediments during sand extraction and redirection of the western drainage channel traversing the southern extraction site. Although soil profiles indicate very little existing acidity, it is understood that best practice safeguards for minimising the potential for damage to aquatic ecology from either contaminated drainage or groundwater are proposed during excavation. It is recommended that water quality in the extraction ponds, any drainage from the extraction sites and groundwater be monitored to ensure acidity does not occur. It is recommended that redirected drainage channels are kept as shallow as practicable, so as to avoid exposure of acid sulfate soils and sediments below the surface layers of soil, and/or lined with non-permeable material.

It is also recommended that a management plan for minimising the potential for, and occurrence of, blooms of blue-green algae in the dredge pond and final lake is developed that involves ongoing monitoring of water quality. Although there are no practical treatments for blooms once they have developed, the proposed establishment of wetlands around the edge of the lake would be an important factor in minimising the potential for blooms of blue-green algae occurring.

No Threatened species or existing areas of conservation significance would be affected by the Project.

1 INTRODUCTION

1.1 Background and Aims

Gales-Kingscliff Pty Ltd ("the Proponent") is seeking approval to extend an approved existing sand extraction operation near Cudgen, on the far north coast of NSW. The Project would extend the depth and area of extraction to produce fine-grained sand suitable for raising the level of nearby low-lying land and for use as a raw material in the local construction industry. Sand extraction has been an approved activity in the area and Gales-Kingscliff Pty Ltd currently has approval to extract 400 000m^3 of sand within a 7ha area over a six-month period to raise the elevation of its land at Cudgen. The proposed extraction would result in the creation of a freshwater lake of a size of approximately 37ha.

R. W. Corkery Pty Ltd has commissioned The Ecology Lab Pty Ltd on behalf of Gales-Kingscliff Pty Ltd to assist in:

- describing the aquatic ecology, commercial and recreational fishing of the potentially affected area;
- identifying any environmental constraints and impacts that could potentially occur;
- proposing mitigation measures; and
- addressing relevant issues raised by Government Agencies.

This report describes the existing aquatic ecology of the Project Site and nearby areas, potentially affected areas and species of conservation significance, potential impacts to aquatic ecology that would result from the Project and suggested operational safeguards and mitigation measures for minimising such impacts.

1.2 Project Description

The Proponent proposes to develop and operate a sand extraction operation to supply fill sand to a number of nominated fill sites via two pipeline corridors and to produce a range of sand products for sale to the local construction industry. The Project would also be appropriately licensed to accept virgin excavated natural material (VENM) which would be used in production of saleable sand products, used to backfill the northern extraction pond or interned at or near the base of the southern extraction pond. The Project would involve the removal of approximately 5 000 000m^3 of sand over a period of 15 to 20 years. The Project Site covers a total area of 67ha which includes:

- a 37ha extraction site south of Altona Drive ('southern extraction site');
- a 9ha extraction site north of Altona Drive ('northern extraction site'); and
- a processing area north of Altona Drive covering an area of 3.7ha.

Figure 1 shows the location of the Project Site while **Figure 2** shows the layout of the Project Site**.**

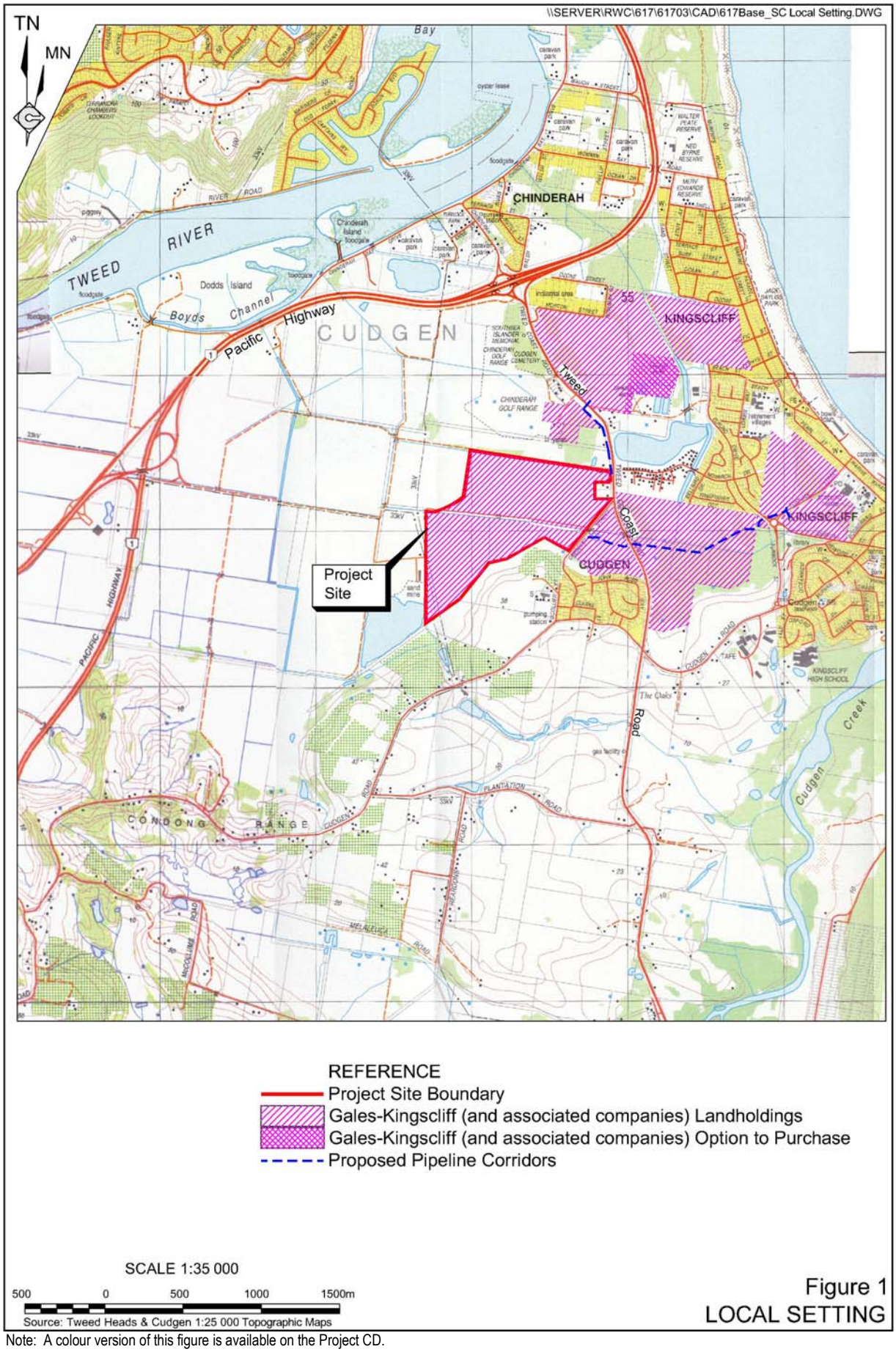

Figure 1
LOCAL SETTING

Note: A colour version of this figure is available on the Project CD.

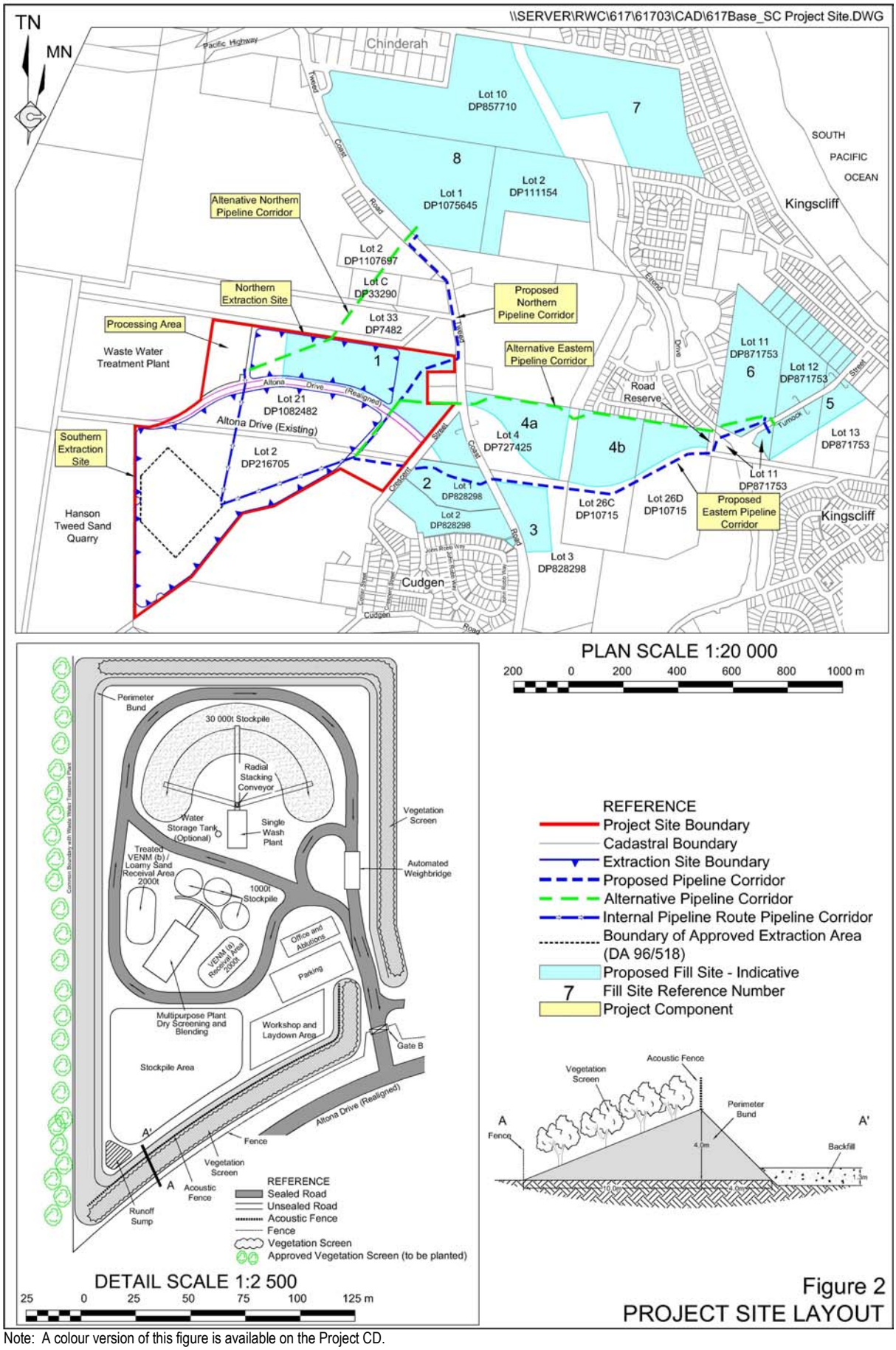

Figure 2
PROJECT SITE LAYOUT

Note: A colour version of this figure is available on the Project CD.

Two pipeline corridors are also proposed extending north and east from the southern extraction site (see **Figure 2**). These are referred to as the "northern pipeline corridor" (0.8km in length) and the "eastern pipeline corridor" (1.5km in length). The proposed northern pipeline corridor would be located within the road reserve on the western side of Tweed Coast Road. The proposed eastern pipeline corridor would be located within the road reserve for a proposed subdivision road within land owned by the Proponent. It is acknowledged that the proposed road has not yet been approved. Therefore, an alternative eastern pipeline corridor (see **Figure 2**) has been proposed in the event that the proposed road is not approved within a suitable timeframe. An alternative northern pipeline has also been proposed in the event that suitable agreements are reached with an adjoining landholder.

The operation has been designed to optimise the recovery of sand whilst at the same time addressing and managing the environmental constraints within and surrounding the Project Site. As the Project proceeds, the northern extraction pond would be progressively backfilled to form sporting fields and recreational facilities and finalised sections of the southern extraction pond would be progressively rehabilitated in order to form a recreational lake and surrounding parklands.

The extraction sequence would involve: stripping of topsoil; formation of bunds; and extraction of the sand resource (loamy sand and fine grained sand). Extraction of all material within the northern extraction site would be undertaken over four stages progressing east to west to a depth of approximately 5m using excavator and trucks. Within the southern extraction site, extraction would occur over 10 stages, generally progressing west to east. Extraction would occur to the depth of the resource, typically 20m below current ground level with the upper loamy sand material extracted using an excavator and the remaining fine grained sand material extracted using a cutter-suction dredge.

The upper loamy sand material would be treated using alkaline amendments, such as agricultural lime, prior to being transferred to the processing area for production of various construction materials, such as mortar sand. The fine grained sand material would either be trucked or pumped to the processing area and washed to remove oversize and undersize materials, producing construction grade sand, or be pumped to a nominated fill site for use as fill material. All fines separated during processing or returned from the fill sites would be returned to near the base of either the northern or southern extraction pond.

Both non-acid generating VENM - VENM(a) and acid producing VENM – VENM(b) would be received at the Project Site via road trucks, appropriate details recorded and the material classification verified. VENM(a) would either: be processed to produce saleable products or used to backfill the northern extraction pond or finalised edges of the southern extraction pond. VENM(b) which is suitable for processing would be placed adjacent to the southern extraction pond for treatment, as for the loamy sand material, prior to processing. VENM(b) not suitable for processing would be either used to backfill the northern extraction pond or interned near the base of finalised sections of the southern extraction pond.

All VENM delivered to the Project Site and processed materials despatched from the processing area would be transported via Altona Drive, Crescent Street and Tweed Coast Road. Access to the Project Site would be provided via three entrances off Altona Drive, one to the processing area and northern extraction site and two to the southern extraction site.

The Proponent would adopt a progressive approach to site landscaping and rehabilitation to ensure that, wherever possible, disturbed areas are either temporarily or permanently stabilised to limit erosion and adverse visual impacts. An important component of the rehabilitation of the Project Site would be the progressive backfilling of selected finalised sections of the shore of the southern extraction pond and introduction of native vegetation to create wetland areas and parklands. The construction of recreational facilities such as walking and equestrian / cycling tracks would occur following completion of sand extraction activities. The final lake would have a depth of up to 20m and cover an area of approximately 37ha.

2 STUDY METHODS

2.1 Review of Existing Information

Information about aquatic habitats, aquatic fauna species, commercial and recreational fishing, water quality and acid sulfate soils and sediments in the local area was obtained from available inventories (including The Ecology Lab database), and published studies and specific studies conducted by other specialist consultants for the Project.

2.2 Interpretation of Topographic Maps and Project Site Plan

Plans of the proposed development, including aerial photography, were reviewed in conjunction with the Tweed Heads and Cudgen 1:25 000 topographic maps (Land and Property Information NSW) to identify aquatic habitats at the Project Site and in the nearby area.

2.3 Species and Areas of Conservation Significance

There are provisions under both State and Commonwealth legislation to ensure that the effects of proposed developments on Threatened species, populations and communities and threatening processes are considered. It is understood that the Project will be assessed under Part 3A of the *Environmental Planning and Assessment Act 1979*. Under the guidelines for such assessments, it is a requirement that a preliminary (desktop) assessment of Threatened species is made to determine whether any species are likely to be affected by the Project. If Threatened species are considered likely to be affected, then more intensive assessments (including field surveys are required). The following legislation lists aquatic Threatened species and communities: *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*), *Threatened Species Conservation Act 1995* (*TSC Act*), *Fisheries Management Act 1994* (*FM Act*) and the *Fisheries Management Amendment Act 1997* (*FMA Act*). Threatened species, populations, ecological communities and threatening processes listed in these legislative documents that are likely to occur in the vicinity of the Study Area were identified from searches of relevant databases.

State Environmental Planning Policy No. 14 (SEPP 14), which aims to preserve and protect wetlands in coastal areas, is also pertinent. A search was made of the SEPP 14 database (DUAP 1995) to determine whether there are any areas that have potential to be affected by the Project.

3 RESULTS

3.1 Review of Existing Information

3.1.1 Aquatic Habitat and Biota at the Project Site

The Project Site is located on part of the Tweed floodplain. A network of artificial drainage channels occurs on the floodplain between the Tweed River and the Cudgen plateau. These drainage channels (originally excavated to lower the water table and discharge the water to the Tweed River) effectively operate as small tidal creeks that have been physically modified and straightened (as occurs at the Project Site). Further, most are generally regulated by floodgates. As a consequence, their ecological function is often degraded.

Unregulated, small tidal creeks and channels on coastal floodplains can be vital habitat areas, important for the reproduction, recruitment and early growth of many fish and prawn species. Research on various coastal rivers in NSW has shown that juveniles of commercially and recreationally significant species such as yellowfin bream (*Acanthropagrus australis*) and school prawn (*Metapenaeus macleayi*) can occur in small creeks and channels in high numbers (eg. McGregor 1980; cited in Copeland 1993). However, where floodgates are in place, the ecological function of such creeks or channels is often degraded and as a result many species of fish and invertebrates that are common in un-gated systems are scarce, because the floodgates act as a physical barrier to migration.

Plans of the proposed development and local topographic maps indicate a single drainage channel runs east-west through the southern extraction site on the southern side of the existing alignment of Altona Drive, with others along its northern and southern borders (**Figure 3**, **Plate 1)**. There is also a drainage channel connecting the east-west drainage channel traversing the southern extraction site with the channel on its southern border but it is understood that the connecting channel is of higher elevation, often dry, and hence of limited aquatic value. The northern extraction site does not overlap with any drainage channels. The drainage channels on and adjacent to the Project Site are part of a network of straight and narrow drains connected to the Tweed River. Information sourced from Idyll Spaces (2008) indicates that aquatic vegetation along the western drainage channel at the southern extraction site is dominated by the native sedge, *Schoenoplectus validus*, with mats of *Bacopa monniera* on exposed mud and occasional water lillies, *Nymphaea capensis,* in deeper areas of water. It is understood that parts of the drainage channels on the Project Site do not always contain standing water. Some of the drainage channels are lined with Swamp Oak, *Casuarina glauca*. The presence of water lilies in the drainage channels within the Project Site indicates a dominance of freshwater. The presence of water lilies also suggests that there is very little flow in the drainage channels and that they are shallow. The drainage channels could, however, potentially hold deeper water after rain periods.

The types of freshwater fish that are likely to be found in the western drainage channel that currently traverses the southern extraction site are indicated in the records of The Australian Museum and NSW Department of Primary Industries (Fisheries)(Web Reference 1) and other studies of freshwater sections of small creeks flowing into the lower Tweed River (The Ecology Lab 2004). These species are presented in **Table 1**. There is also potential for some estuarine fish and prawns (particularly juveniles) to migrate up the drainage channels from the Tweed River to the Project Site during a flood or when floodgates are opened. Estuarine species sampled in a previous study (The Ecology Lab 1990) of the section of the Tweed River where the drainage channels from the floodplain connect to the river are also included in **Table 1**.

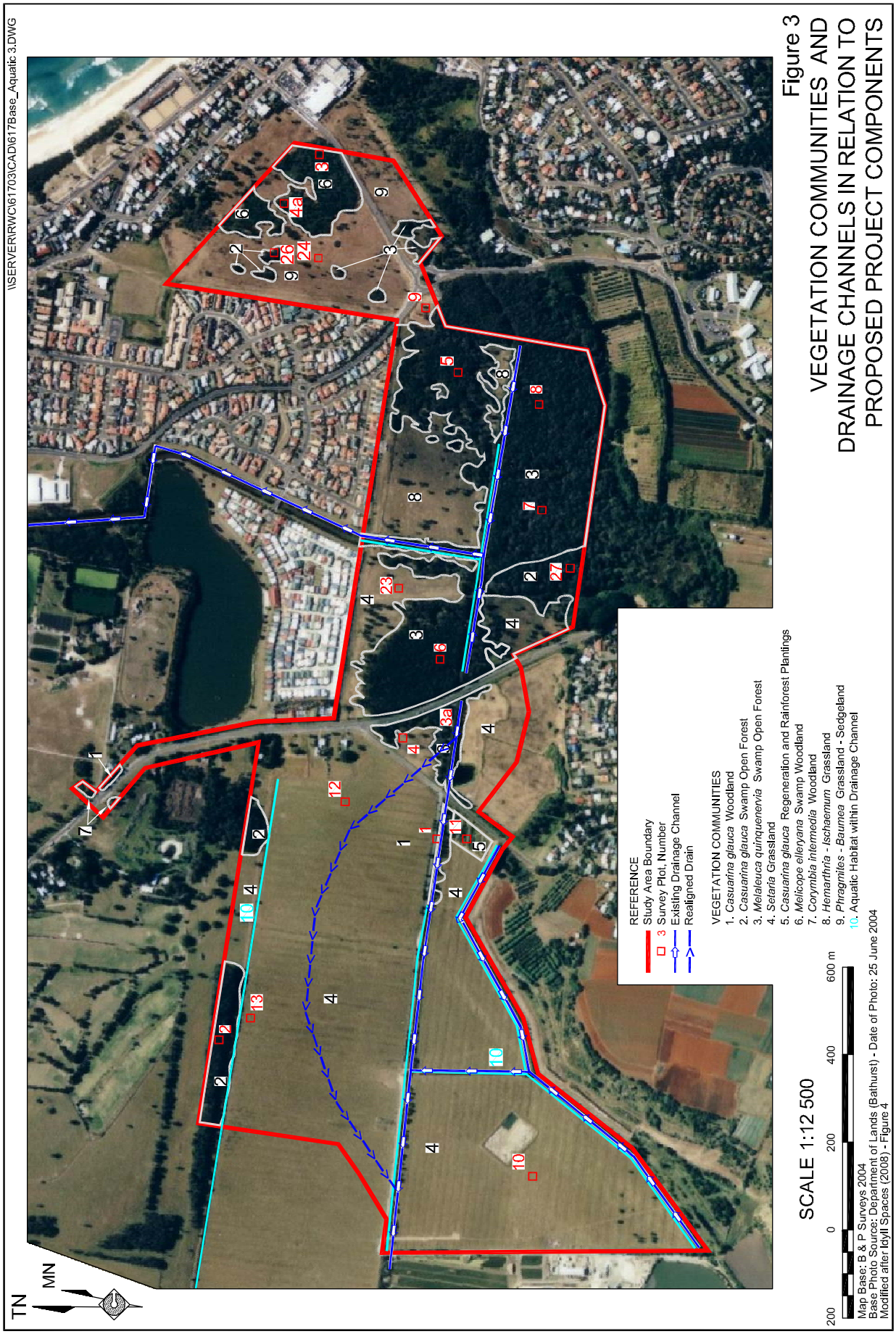
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Figure 3
VEGETATION COMMUNITIES AND
DRAINAGE CHANNELS IN RELATION TO
PROPOSED PROJECT COMPONENTS
REFERENCE
Study Area Boundary
3 Survey Plot, Number
Existing Drainage Channel
Realigned Drain
VEGETATION COMMUNITIES
1. Casuarina glauca Woodland
2. Casuarina glauca Swamp Open Forest
3. Melaleuca quinquenervia Swamp Open Forest
4. Setaria Grassland
5. Casuarina glauca Regeneration and Rainforest Plantings
6. Melicope elleryana Swamp Woodland
7. Corymbia intermedia Woodland
8. Hemarthria - Ischaemum Grassland
9. Phragmites - Baumea Grassland - Sedgeland
10. Aquatic Habitat within Drainage Channel
SCALE 1:12 500
200 0 200 400 600 m
Map Base: B & P Surveys 2004
Base Photo Source: Department of Lands (Bathurst) - Date of Photo: 25 June 2004
Modified after Idyll Spaces (2008) - Figure 4
TN
MN

Plate 1 Drainage channel running east-west through the Project Site.
(Source: R.W. Corkery & Co. Pty Ltd)

Table 1
Fish and Invertebrates known to occur in Freshwater Tributaries of the Tweed River and in the Estuarine Section of the lower Tweed River near the Project Site

Family	Species	Common Name	BIONET Search	Sampled by The Ecology Lab (2004)	Sampled by The Ecology Lab (1990)
Freshwater					
Eleotridae	*Hypseleotris compressa*	Empire gudgeon	x	x	
	Hypseleotris galii	Firetailed gudgeon	x	x	
	Gobiomorphus australis	Striped gudgeon	x	x	
	Butis butis	Flathead gudgeon	x		
	Gobiomorphus coxii	Cox's gudgeon	x		
	Hypseleotris klunzingeri	Western carp gudgeon	x		
	Philypnodon grandiceps	Big-headed gudgeon	x		
Poeciliidae	*Gambusia holbrooki*	Mosquitofish	x	x	
Ambassidae	*Ambassis jacksoniensis*		x		
	Ambassis marianus	Silver perchlet	x		
Retropinnidae	*Retropinna semoni*	Australian smelt	x		
Mugilidae	*Trachystoma petardi*	Fresh water mullet	x		
Pseudomugilidae	*Pseudomugil signifer*	Southern blue-eye	x		
Melanotaeniidae	*Melanotaenia duboulayi*	Duboulay's rainbowfish	x		
	Melanotaenia fluviatilis	Crimson-spotted rainbowfish	x		
	Rhadinocentrus ornatus	Soft-spined rainbowfish	x		
Plotosidae	*Tansanus tandanus*	Freshwater catfish	x		
Perichthyidae	*Macquaria novemaculeata*	Australian bass	x		
Estuarine					
Clupeidae	*Harrengula abbreviata*	Southern herring			x
	Hyperlophus vittatus	Sandy Sprat			x
Engraulidae	*Engraulis australis*	Australian anchovy			x
Hemiramphidae	*Arrhamphus sclerolepis*	Snubnosed garfish			x
Scorpaenidae	*Centropogon australis*	Fortescue			x
Platycephalidae	*Platycephalus fuscus*	Dusky flathead			x
Ambassidae	*Priopidichthys marianus*	Ramsay's perchlet			x
	Vellambassis jacksoniensis	Port Jackson perchlet			x
Teraponidae	*Pelates quadrilineatus*	Trumpeter			x
Sillaginidae	*Sillago ciliata*	Sand whiting			x
Pomatomidae	*Pomatomus saltator*	Tailor			x
Gerridae	*Gerres ovatus*	Silver biddy			x
Sparidae	*Acanthropagrus australis*	Yellowfin bream			x
	Rhabdosargus sarba	Tarwhine			x
Monodactylidae	*Monodactylus argenteus*	Silver batfish			x
Scorpipidae	*Microcanthus strigatus*	Stripey			x
Mugilidae	*Liza argentea*	Flat-tail mullet			x
	Mugil cephalus	Sea mullet			x
	Myxus elongatus	Sand mullet			x
Sphyraenidae	*Sphyraena* sp.				x
Blenniidae	*Petroscirtes lupus*	Brown sabertooth blenny			x
Gobiidae	*Arenigobius bifrenatus*	Bridled goby			x
	Arenigobius frenatus				x
	Bathygobius kreffti	Kreft's goby			x
	Callogobius dpressus				x
	Favonigobius exquisitus	Exquisite goby			x
	Parkraemaria cf. ornata				x
	Pseudogobius olorum	Swan River goby			x
	Redigobius macrostoma	Large-mouth goby			x
Eleotridae	*Philypnodon grandiceps*	Flathead gudgeon			x
	Philypnodon sp.				x
Monocanthidae	*Meuschenia trachylepis*	Yellowfinned leatherjacket			x
Bothidae	*Pseudorhombus* sp.				x
Soleidae	*Achlyopa nigra*	Black sole			x
	Aseraggodes macleayanus	Macleay's sole			x
Tetradontidae	Unidentified species	Toad fish			x

Despite the potential for some freshwater fish to occur in the drainage channel traversing or bordering the Project Site and, occasionally, some estuarine species, the drainage channels are only Class 3 (Minimal fish habitat) waterways. According to the classification by Fairfull and Witheridge (2003), Class 3 waterways are named or unnamed waterways with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (eg. fish, yabbies). In addition, semi-permanent pools form within the waterway after a rain event.

3.1.2 Coastal Freshwater Lakes

Significant portions of eastern Australia are fringed by sandy lowlands which may contain freshwater lakes (Timms 1982). Several different types of these so-called dune waterbodies are recognised. They may, for example, exist above the water table, as perched lakes (with organically cemented sandy bases), or as water table windows in lowland areas (Timms Unkn.). The proposed 37ha freshwater lake (expected electrical conductivity of approximately 2 500µS/cm) at the Project Site would probably be of the latter type, as the water table is very close to the surface (see Section 3.1.3). Freshwater dune lakes can have distinctive physicochemical and faunal features, making them unique habitats. Water table window lakes are generally less acidic (pH ~ 6.0) than other types of freshwater dune lakes and have much clearer water because of the much lower levels of coloured organic acids (Timms 1982). Emergent macrophytes characterise the shoreline of most dune lakes. In NSW, the firetail gudgeon, *Hypseleotris galii,* and introduced *Gambusia* sp. are common in this habitat (Timms 1982).

There is potential for some coastal freshwater lakes to be considered an endangered ecological community. *Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions* (referred to as Freshwater Wetlands on Coastal Floodplains) is an endangered ecological community listed under the *Threatened Species Conservation Act 1995*. Freshwater Wetlands on Coastal Floodplains generally occur below 20m elevation on level areas. They are dominated by herbaceous plants and have few woody species. The structure and composition of the community varies both spatially and temporally depending on the water regime. Some lack standing water most of the time, others are subject to regular inundation and drying and others contain standing water that is deeper or more permanent. In these wetlands, floating and submerged aquatic herbs are more abundant than amphibious and emergent plants (Web Reference 2).

Development of coastal lands has destroyed many coastal freshwater wetlands, including coastal dune lakes. Early damage was caused by drainage and sand mining (Timms Unkn). Eutrophication and mosquito fish, which can out-compete small native fish (Arthington 1984, in Timms Unkn) are also problematic to the ecology of coastal dune lakes.

3.1.3 Water Quality

There is limited information about water quality in the drainage channels traversing or bordering the Project Site. It is understood that the flow is poor between rain events and that the drainage channels may only hold isolated pools at times. Hence, water quality in the drainage channels is likely to be poor at times, ie. between rain events, particularly dissolved oxygen levels, any may become slightly brackish as a result of tidal influence.

Sampling by Gilbert and Sutherland (2004) at a nearby sand extraction site and by Australian Groundwater and Environmental Consultants (2008) at the Project Site indicates that the groundwater is essentially freshwater near the surface, but becomes brackish as it gets deeper, particularly at depths below about 15m. The presence of freshwater plants in the drainage channels (see Section 3.1.1), a shallow water table (~1.0m) to freshwater groundwater and barriers to brackish water incursions suggest water in the drainage channels would generally have a very low salinity. Other data collected by Gilbert and Sutherland (2004) indicated groundwater was generally not excessively acidic.

3.1.4 Acid Sulfate Soils and Sediments

Acid sulfate soils and sediments are widespread in NSW estuarine floodplains and coastal lowlands. Before drainage and oxidation, they are termed potential acid sulfate soils and sediments. Actual acid sulfate soils and sediments are formed when the naturally occurring iron sulfides (pyrite) in the soils and sediments become exposed to air (through drainage or excavation) and subsequently oxidise, forming sulphuric acid.

Impacts to aquatic ecology that can result from exposure of acid sulfate soils and sediments include: habitat degradation; fish kills; outbreaks of fish disease; reduced aquatic food resources; reduced migration potential of fish; reduced fish recruitment; altered waterplant communities; weed invasion by acid-tolerant plants; and secondary water quality changes (Stone *et al*. 1998). Other potential impacts include: the release of heavy metals from contaminated sediments; impacts to human and animal health from polluted water; impacts to the arability of land and damage to built structures such as bridges (Web Reference 3). As a result, developments in areas with high risk acid sulfate soils and sediments should consider potential impacts to aquatic ecology in the area of developments and in downstream environments. The NSW Government has issued an Acid Sulfate Soils Manual (ASSMAC 1998) which contains best practice guidelines in planning, assessment and management of activities in areas with potential acid sulfate soils and sediments.

HMC (2008) indicate there are potential acid sulfate soils and sediments beneath the extraction sites in the upper profile (depth of <6m) though there is very little existing acidity. Below 6m, there is considerable calcareous material (in the form of broken shell) that provides for the buffering of any acidic water generated.

3.1.5 Commercial and Recreational Fishing

The drainage channels traversing or bordering the extraction sites are not suitable for commercial or recreational fishing. However, these activities occur in the Tweed River. The latest available published commercial fishing data, an estimated 197t of fish and invertebrates were caught by 33 commercial fishers in the estuarine parts of the Tweed River in 1998/99, worth $721,999 (NSW Fisheries 2000). Oyster farming occurs in the Tweed River, although the majority of farms are not near the Study Area (Oceanics 1991). Recreational fishing is popular in the western channel of the Tweed River. A recent survey of recreational fishing in NSW estimated 50,000 anglers use the Tweed or Richmond rivers each year (NSW Fisheries 2002).

3.2 Species and Areas of Conservation Significance

An assessment of the aquatic habitat in conjunction with desktop searches of databases indicated there are no Threatened species, populations or ecological communities or areas of conservation significance that are likely to be affected by the Project. Although the Threatened eastern freshwater cod, *Maccullochella ikei*, is known to occur in some freshwater areas of the Tweed catchment, it would not occur at the Project Site as the drainage channels do not represent its habitat requirements. The only potential concern to Threatened species is that sand extraction activities on the Project Site would disturb potential acid sulfate soils and sediments. In the event these soils are not correctly managed acidic water could enter the drain and /or groundwater and potentially affect Threatened species living in the Tweed River (see Section 4)

Key Threatening Processes
Two key threatening processes relevant to freshwater ecology as listed under the *Fisheries Management Act 1994* and two listed under the *Threatened Species Conservation Act 1995* could potentially occur as a result of the Project. These are listed below and need to be considered. In the event that the Project is likely to cause one or more key threatening processes, approval will be required from DPI (Fisheries) or the Department of Environment and Climate Change (DECC). The key threatening processes that have potential to occur are:

1. *Degradation of native vegetation along New South Wales water courses. (Fisheries Management Act 1994)*.
   Sections of the banks of the western drainage channel that traverse the Project Site are covered by native vegetation, although some are covered only by common reeds or weeds which are of low conservation value.

2. *Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams* (*Fisheries Management Act 1994*). There is a limited potential for the realignment of the western drainage channel that traverses the southern extraction site to result in permanent changes to the flow of water in the drainage channels connected upstream, if the new drainage channel is not designed appropriately.

3. *Alteration of the natural flow regimes of rivers, streams, floodplains and wetlands* (*Threatened Species Conservation Act 1995*). As per No. 2.

4. *Clearing of native vegetation* (*Threatened Species Conservation Act 1995*). As per No. 1, in reference to the riparian zone.

4 ISSUES RELATED TO THE PROJECT

Issues related to the Project in terms of impacts on aquatic habitats and biota and potential mitigation measures are outlined below.

4.1 Impacts of Sand Extraction and Creation of the Artificial Lake

The main component of the Project of direct relevance to aquatic habitats and biota is the creation of an artificial lake south of the proposed realigned Altona Drive. Though the modification of the western drainage channel that traverses the southern extraction site has been approved as part of the realignment of Altona Drive, due to its relationship to the Project, including required access road crossings, it should also be considered as part of this assessment.

The implications of these components in relation to the aquatic environment are discussed below. Although the proposed pipelines for distributing sand would potentially cross the drainage channel adjacent to Altona Drive, it is unlikely that they would affect aquatic ecology. The northern extraction site is not traversed by any drainage channels or riparian vegetation and would be backfilled and hence would not influence aquatic ecology.

4.1.1 The Creation of an Artificial Lake

It is proposed that the 37ha artificial, freshwater lake is to have a comparatively shallow edge, planted with native macrophytes, to provide wetland habitat. Assuming this is done under the advice of experts, the lake could potentially be an important wetland in the region. Wetlands are important habitats for many species (Section 3.1.2). The creation of the freshwater lake could potentially provide habitat for, birds, fish and aquatic plants, many of which are Threatened because of the loss or degradation of natural, coastal wetland habitat.

Despite being artificially created, the lake could potentially have the attributes of other freshwater lakes on coastal floodplains. As these diverse habitats are recognised as endangered ecological communities (*Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions*) under the *Threatened Species Conservation Act 1995*, the proposed lake could potentially be recognised as one of these. Consequently, the lake once completed could be afforded the conservation status of a Threatened ecological community.

Water quality in the lake and depth stratification would be similar to the profile for groundwater at the Project Site. The surface waters of the lake would be freshwater and the bottom waters of the lake (ie. below 15m) would be brackish (Section 3.1.3). A cold, potentially nutrient – accumulating bottom layer, as generally occurs in freshwater lakes deeper than about 10m (Boulton and Brock 1999), may not form in this case because the horizontal flow of groundwater could be sufficient to continuously replace the bottom water of the lake.

Notwithstanding this, some stratification of the water should be expected due to temperature differences between the surface and deeper water, particularly during summer. This, together with the potential for nutrient-rich water runoff from surrounding land, creates the possibility of blue-green (cyanobacterial) algal blooms which proliferate in warm, nutrient-rich water (Robarts and Zohary 1987). Apart from their negative impact on the aesthetic values of

freshwater lakes, these algae produce toxins that may be life-threatening to humans and animals (Bowling and Baker 1996; Falconer 1999). Furthermore, when a bloom dies back, the resulting decomposition of large numbers of cells causes severe oxygen depletion which can adversely affect aquatic wildlife, particularly fish and invertebrates (Bowling 1994). The signs of blue-green algae blooms are green discolouration of the surface waters, unpleasant odour and the formation of surface scums which can be transported around the lake by winds. ANZECC (2000) considers a concentration of 11500 cells / ml (*Microcystis aeruginosa* – one of several species common in Australia) as potentially harmful to livestock.

An additional issue associated with the creation of the lake would be the potential for limited acidic runoff to be produced as a consequence of exposure of potential acid sulfate soils and sediments during sand extraction. Despite soil profiles indicating very little exiting acidity, the safeguards nominated by HMC (2008), in accordance with NSW Government's *Acid Sulfate Soils Manual* (ASSMAC 1998) best practice guidelines in planning, assessment and management of activities in areas with potential acid sulfate soils and sediments, would need to be put in place during sand extraction to minimise the potential for damage to aquatic ecology either from contaminated drainage or through groundwater (sea also Section 4.2).

4.1.2 Modification of Drainage Channels

It is proposed that the western drainage channel that traverses the southern extraction site would be re-aligned around the northern side of the lake as part of the realignment of Altona Drive approved by Tweed Shire Council (DA05/1450). Some of the drainage channels at the Project Site are considered to be Class 3 watercourses (Minimal Fish Habitat). The NSW Department of Primary Industries (Fisheries) provide guidelines as to what is required if fish habitat is potentially affected by a development (Section 4.2). Potentially, the realignment of the western drainage channel could disturb potential acid sulfate soils and sediments and create acidic runoff that could affect aquatic ecology in drainage channels downstream. Care should be taken to minimise the potential for this to occur (see Section 4.2).

Finally, the realignment of the western drainage channel traversing the southern extraction site has some potential to cause key threatening processes (see Section 3.2). Local Department of Primary Industries and Department of Environment and Climate Change officers should be consulted during the approved realignment and construction of access crossings.

4.2 Mitigation Measures

4.2.1 Artificial Lake

It is recommended that water quality in the dredge pond, any drainage from the extraction sites and groundwater be monitored to ensure excessive acidity does not occur. Disturbance of potential acid sulfate soils and sediments during extraction of sand, construction of a new road and realignment of a drainage channel have some potential to create acidic groundwater or runoff that could affect aquatic ecology in drainage channels downstream of the extraction sites. Care must be taken to minimise the potential for this to occur. New sections of the drainage channels should be kept as shallow as practicable, so as to avoid exposure of acid sulfate soils and sediments below the surface layers of soil.

Blue-green Algae
There are no practical treatments for blooms once they have developed. Algicides cause cell disruption, which releases even more toxin into the water and are themselves toxic to wildlife, while filtration is generally impractical except where water must be rendered safe to drink.

While artificial aeration of dams, using compressed air pumped into the deeper areas to disrupt stratification, has been suggested as a prevention stratagem, mitigation is usually based on wider catchment management that is focused on reducing nutrient loads, particularly phosphorus (NSW DPI 2007).

In this context, the establishment of wetlands around the margin of the final lake is recognised as an efficient way to reduce nutrient loads to receiving waters (White *et al*. 1994). Furthermore, the establishment of wetlands would also act to metabolise nutrients in the water. Therefore the establishment of wetlands on the lake edge would be an effective mitigation measure. The width of the wetland fringe, types of species used and maintenance should be carefully considered to achieve the most effective results.

Regardless, in view of the health issues associated with blue-green algal blooms, it is recommended that a Blue-Green Algae Management Plan be developed. The plan should have two main elements, namely:

- monitoring of water quality, which would include temperature, oxygen, nutrients, colour and concentrations of blue-green algae; and
- keeping nutrient loads to a minimum.

As algal blooms can develop rapidly, frequent and regular monitoring (i.e. weekly) would be necessary during summer and no longer than monthly monitoring during winter. Samples and readings should be obtained from the upper 0.5m of the water at least at four localities around the periphery and two in the centre of the pond(s).

4.2.2 Drainage Channels

As some of the drainage channels at the Project Site are considered to be Class 3 watercourses (Minimal Fish Habitat), care should be taken during the re-alignment of the western drain traversing the southern extraction site so as to maintain or enhance any habitat that it may have afforded fish, and to maintain the original connection to other upstream and downstream drainage channels. Care should be taken during realignment to avoid stranding native fish and where practicable, to transfer them to other similar habitat. Where watercourses are to be crossed for any reason, fish passage should be maintained. Permanent crossings made as part of the Project should be constructed in accordance with DPI guidelines (Fairfull and Witheridge 2003), which require that a culvert or ford is built that would allow fish passage.

5 CONCLUSIONS

Based on the proposed mitigation measures, it is concluded that:

- the Project would have no significant impacts on existing aquatic habitat or Threatened species; and
- would result in the creation of a coastal freshwater lake which would provide additional aquatic habitat that may be potentially recognised as an endangered ecological community.

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Appendix 1

Coverage of Environmental Assessment Requirements and Environmental Issues in the Aquatic Ecology Assessment

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Coverage of Environmental Assessment Requirements and Environmental Issues in the Aquatic Ecology Assessment

ENVIRONMENTAL REQUIREMENTS RAISED BY THE DIRECTOR-GENERAL RELATING TO AQUATIC ECOLOGY	
	Relevant Section(s)
The Assessment must:	
– be scientifically rigorous, and prepared in accordance with best practice;	
– be certified by the author;	1.1p
– include an executive summary;	Exec. Sum.
– assess the potential impacts of the Project (including any potential cumulative impacts that may arise from the combined operation of the Project with the existing or approved operations at the Bolster Quarry), and describe what measures would be implemented to avoid, minimise, mitigate, offset, manage and/or monitor these impacts:	4.1, 4.2
– Refer to the draft Guidelines for *Threatened Species Assessment* (Department of Environment and Climate Change.	2.3, 3.2
ENVIRONMENTAL ISSUES RAISED BY GOVERNMENT AGENCIES RELATING TO AQUATIC ECOLOGY	
	Relevant Section(s)
DPI (Fisheries)	
Describe/map aquatic habitats within 100m of the boundary of the proposal that could be impacted upon either directly or indirectly by the proposal during its construction, life and decommissioning including:	
• gravel beds;	n/a
• deep pools;	n/a
• rocky reefs;	n/a
• aquatic vegetation (seagrass, mangroves, saltmarsh and emergent vegetation such as reeds);	3.1.1, Fig 1
• riparian vegetation and snags;	3.1.1, Fig 1
• wetlands and floodplains; and	3.1.1-3.1.4
• under cut banks.	n/a
Identify recreational and commercial fishing areas and aquaculture ventures that could be effected by the proposal or works during its construction.	3.1.5
Provide a statement about the presence or absence of Threatened species.	3.2
Detail the potential impacts of the various phases of the proposal.	4.1
Outline ongoing management activities to ensure impacts on biodiversity are minimised.	4.2
Outline the purpose and types of works requiring fish passage to be blocked.	4.1.2
Outline timing, duration and manner of proposed restriction / blockage to fish passage.	4.1.2
Describe methods to be used to avoid stranding fish and any remediation works.	4.2

Coverage of Environmental Assessment Requirements and Environmental Issues in the Aquatic Ecology Assessment

ENVIRONMENTAL ISSUES RAISED BY GOVERNMENT AGENCIES RELATING TO AQUATIC ECOLOGY	
	Relevant Section(s)
DPI (Fisheries) (Cont'd)	
Describe the type(s) of marine vegetation in the vicinity of the proposed works and the distance from the outer boundary of the proposed works.	n/a
Investigate and report on an area extending downstream and / or upstream as far as is necessary to take all potential impacts into account.	3.1, 3.2
Discuss possible indirect effects of the proposal on species / habitats in the area surrounding the subject site.	3.1.1, 4.1
Outline the habitat requirements of Threatened species and species important to commercial or recreational fishing likely to occur in the Study Area.	3.1.5, 3.2
Discuss fish habitat within the Study Area and the nature and extent of habitat removal or modification and potential impact which may result from the proposed action.	3.1.1, 4.1
Describe and discuss in the EIS, other locally occurring populations and the extent, security and viability of remaining habitat in the locality for all species likely to have their lifecycle patterns disrupted by the proposal to the extent that individuals will cease to occupy any location within the subject site.	3.1.1, 4.1
Discuss measures for minimizing impacts on fish and fish habitat, how erosion and run off will be reduced and water quality maintained and other environmental safeguards to be employed.	4.2
Outline how the proposal has been or may be modified and managed to conserve fisheries habitat on the subject site and in the Study Area.	4.1, 4.2
Develop long term management strategies to protect areas within the Study Area which are of particular importance for fish species including proposals to restore or improve habitat.	4.1.1, 4.1.2
Outline any proposed pre-construction monitoring plans or on-going monitoring of the effectiveness of the mitigation measures including the objectives of the monitoring program, method of monitoring, reporting framework, duration and frequency.	4.2
Department of Environment and Climate Change	
Include a rehabilitation plan detailing the location, spatial area, depth and ecology of the wetlands to be created including a comprehensive list of species to be used in the rehabilitation works. Plant species used in the rehabilitation works should be native species indigenous to the local area.	EA Section 2
Investigation of the impacts in the event of a "turnover" of cold water in the pond (cold water inversion).	4.1.1
Department of Planning	
Consider the development with respect to the NSW State Groundwater Quality Protection Policy (1998).	Part 1 of SCSC
Consider the development with respect to the NSW State Groundwater Dependent Ecosystem Policy (2002).	Part 4 of SCSC