

APPENDIX H: EIGHT PART TESTS FOR THE OPENING OF EIGHT FLOODGATES

Introduction

This Appendix addresses potential impacts to species listed under the NSW *Threatened Species Conservation Act 1995* that could occur as a result of the proposed opening of floodgates on Ironbark Creek as part of the Hexham Swamp Rehabilitation. This assessment is a response to the requirements of Section 5A of the *Environmental Planning and Assessment Act 1979*.

Section 5A assessment

Under the terms of the *EP & A* and *TSC* Acts, the most critical issues for this assessment are (i) the definition of the local population, and (ii) the definition of "region". The Act regards a "local population" as that inhabiting the study area, unless there is contiguous or proximate occupied habitat, movement of individuals beyond the area boundaries, and genetic exchange across the boundaries. Furthermore, consideration of a "population" for the purpose of assessing its conservation status requires it to be a recognisable entity, disjunct or genetically distinct.

Species that may potentially use the wetland areas in question are likely to be part of a wider population with undefinable boundaries, and unlikely to be genetically distinct from other coastal NSW populations, as most are highly mobile species (e.g. waterbirds, microbats). "Region" means a defined bioregion, in this case the North Coast Bioregion, from the Queensland border to the Hunter Valley and inland to the escarpment of the Dividing Range.

References cited in these tests are listed in Section 8 of the EIS.

Species Assessed

Discussions with NSW NPWS and the assessment undertaken in Section 3.8 of the EIS, have highlighted 13 species that are either known to, or considered potentially likely to occur in habitats associated with Hexham Swamp. These species potentially may be affected by the proposed opening of all eight tidal floodgates on Ironbark Creek. Eight part tests are required for these species which are listed in Table 1 below. A summary of their habitat preferences and likely occurrence in Hexham Swamp is presented in Section 3.8 of the EIS.

Table 1: Threatened Species Evaluated for Eight Part Tests

Scientific Name	Common Name	TSC Act Status	Species potentially affected by maintaining <i>status quo</i>		Opening of 8 floodgates
			Short term	Long term	
FLORA					
<i>Zannichellia palustris</i>	Horned Pondweed	Endangered		✓	✓
FAUNA					
<i>Miniopterus australis</i>	Little Bentwing bat	Vulnerable		✓	✓
<i>Miniopterus schreibersii</i>	Common Bentwing bat	Vulnerable		✓	✓

Scientific Name	Common Name	TSC Act Status	Species potentially affected by maintaining <i>status quo</i>		Opening of 8 floodgates
			Short term	Long term	
<i>Scoteanax rueppelli</i>	Greater Broad-nosed Bat	Vulnerable		✓	✓
<i>Anseranas semipalmata</i>	Magpie Goose	Vulnerable		✓	✓
<i>Stictonetta naevosa</i>	Freckled Duck	Vulnerable		✓	✓
<i>Ixobrychus flavicollis</i>	Black Bittern	Vulnerable		✓	✓
<i>Botaurus poiciloptilus</i>	Australasian Bittern	Vulnerable		✓	✓
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	Endangered		✓	✓
<i>Pandion haliaetus</i>	Osprey	Vulnerable		✓	✓
<i>Rostratula benghalensis</i>	Painted Snipe	Vulnerable		✓	✓
<i>Tyto capensis</i>	Grass Owl	Vulnerable		✓	✓
<i>Litoria aurea</i>	Green and Golden Bell Frog	Endangered		✓	✓

Flora

The annual aquatic halophyte, *Zannichellia palustris* is considered endangered within NSW. *Z. palustris* is a submerged, weakly rhizomatous aquatic annual or perennial plant species. The literature on *Z. palustris* in Australia is scant, therefore, most of the key observations for the purpose of this Eight Part Test are sourced from unpublished reports, personal communications, and surveys conducted for this EIS.

Z. palustris has a worldwide distribution and occurs in eutrophic lakes, rivers, and estuarine habitats in Europe and North America, where it occasionally requires control. *Z. palustris* was first recorded in Australia in 1887 near Murray Bridge in South Australia (Black 1965). Since 1971 it has also been recorded in NSW at;

- Ash Island;
- Ironbark Creek and its tributaries;
- Black Creek and Cessnock;
- Ponds at Kooragang Island; and
- Near Belmont.

Within the study area, *Z. palustris* has been recorded in the Canoe Channel between the Shortland Wetland Centre and Ironbark Creek, where it was first observed in 1986 (pers. comm.. G. Winning, HWR, 2004), as well as near the Minmi Road bridge across Ironbark Creek (Winning 1996). *Z. palustris* has also been observed in several ephemeral ponds throughout Hexham Swamp, though it has not been detected every year in these ponds (Winning & King, 2002).

As habitat conditions within the Ironbark Creek catchment have been subject to considerable change in the last 30 years, the occurrence of *Z. palustris* within the catchment may be relatively recent. Factors which may have favoured its establishment and spread in the area include, generally still, eutrophic waters with stable and relatively low salinities, and a lack of competition. The main requirement for the plant appears to be shallow water and limited competition (Greenwood 2001). However, during this survey extensive areas of the species were recorded in moderately deep (0.5m-0.7m) permanent channels with little or no other plant growth.

Given its worldwide occurrence it is not clear whether *Z. palustris* is of native origin with a limited distribution or is a recent introduction to parts of Australia (*Z. palustris* was first recorded in Australia in 1887 - Aston 1977). Greenwood (2001) suggested that the species arrived in Australia via ship ballast water, but this was at a time when most ships evidently used solid ballast. Both the *Flora of New South Wales* (Harden, 1993) and the *Flora of South Australia* (Jessop & Toelken, 1986), the two States where the species has been recorded, list *Z. palustris* as native. While more detailed studies (e.g. DNA studies) may confirm the status of *Z. palustris*, it is presently considered native to Australia and is listed as endangered in New South Wales.

Regardless of its origin or conservation significance, the following assessment can be made regarding potential impacts of the proposal on the distribution of the species within the study area.

- a) ***In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.***

Retain floodgates

Although data on the physiological and ecological requirements of the species is scarce, it appears its main habitat requirements are shallow water and limited competition (Greenwood 2001). Stable and low salinities also seem to be important. Given its specific habitat requirements, the long term viability of *Z. palustris* may be affected by the loss of shallow open waterbodies to the spread of common reed and other perennial species.

Open floodgates

Opening the floodgates would inundate *Z. palustris* habitat. Given the scarcity of data on the physiological and ecological requirements of the species under Australian conditions, it is unclear how this will affect the current population extent and distribution.

Recent Australian studies indicate that the growth and development of *Z. palustris* is retarded at all NaCl concentrations but that it can survive and set fruit in salinities up to 10 ppt (Greenwood, 2001). It was found that the species inhabits fresh or slightly saline waters but that its main habitat requirement appeared to be shallow water and limited competition, suggesting that the species may not be able to tolerate inundation of its habitat. It is likely that any waterbodies which presently support *Z. palustris* that are subject to tidal inundation subsequent to opening the floodgates, will become unsuitable as habitat for *Z. palustris*. It is probable that some of the existing ponds within Hexham Swamp will remain above tidal influence.

With increased tidal inundation into Ironbark Creek, environmental conditions currently suited to *Z. palustris* may develop further upstream. Provided competition is low, and physical conditions are suitable for its growth, development and dispersal, opening the floodgates may provide alternative habitat for the species elsewhere within the catchment.

Zannichellia palustris is an annual that typically occurs in ephemeral ponds, often different ponds each year. This makes it difficult to quantify the local population size or distribution. However, it is likely that all of the plants recorded in the lower Hunter are part of the same local population. Apart from a small number of outlier locations, the majority of records are for Hexham Swamp and Kooragang Island. Based on empirical observations of abundance in various ponds, Kooragang Island is the core habitat for *Zannichellia palustris* in the lower Hunter. There are two ponds on Kooragang Island which have been recorded to support *Zannichellia palustris*. One of these ponds was surveyed in October 1998 and approximately 15,000m² of the ponds approximately 18,000m² supported *Zannichellia palustris* (G. Winning, unpublished data). No other quantitative surveys have been undertaken.

While the abundance of *Zannichellia palustris* in any pond may vary from year to year, observations in Hexham Swamp generally comprise isolated plants or small clusters (pers comm.. G. Winning, HWR, 2004), compared with the sometimes dense stands in ponds on Kooragang Island.

The tidal inundation of Hexham Swamp would affect at least some ponds where *Zannichellia palustris* has been recorded, reducing the area of available habitat for this species. However, it would be unlikely to affect the survival of the local population of this species which would continue on Kooragang Island (assuming continuation of existing conditions on the island), as well as possibly in some ponds in Hexham Swamp.

b) *In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.*

No endangered populations or ecological communities are recorded from this locality.

c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

Z. palustris was first recorded in Australia in 1887 near Murray Bridge in South Australia and since 1971 it has also been recorded in the Hunter region in NSW at;

- Ash Island;
- Ironbark Creek and its tributaries;
- Black Creek and Cessnock;
- Ponds at Kooragang Island; and
- Near Belmont.

The study area supports approximately 1-2ha of habitat for the species. There is no available data on the extent of *Z. palustris* within the remainder of the Hunter region. Accordingly, an assessment of

the regional significance of the study areas habitat cannot be determined. In addition, given its relatively recent discovery the species may occur elsewhere within the region. Although little is known about the habitat requirements of the species, shallow water, limited competition, and fresh to low saline waters appear important, so potential habitat for the species may occur throughout coastal areas of the bioregion.

Opening the floodgates in the study area would inundate all known habitat of the species within Ironbark Creek (approximately 1-2ha). As discussed above, it is unclear how this will affect the current population extent and distribution and there is no available data to place this in a regional context.

- d) *whether an area of known habitat is likely to become isolated from currently interconnecting or proximate area of habitat for a threatened species, population or ecological community.***

Opening the floodgates would not result in the isolation of the species. At present, the permanently lowered floodgates may be containing *Z. palustris* within the Ironbark Creek system. Provided competition is low, and physical conditions are suitable, opening the floodgates may facilitate dispersal of the population through the Hunter River and may result in genetic exchange with other populations in the region (Kooragang Island and Black Creek).

- e) *Whether critical habitat will be affected.***

A critical habitat for an endangered species is defined as the whole or part of an area comprising its habitat that is critical for its survival. Ironbark Creek is one of six known habitats for *Z. palustris* within the Hunter region. Provided that populations at Ash Island, Black Creek, Cessnock, Kooragang Island and Belmont are protected, the study area could not be considered a critical habitat.

- f) *Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.***

None of the known occurrences of *Z. palustris* within the Sydney Basin bioregion are currently within a conservation reserve of similarly protected area.

- g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.***

Under Schedule 3 of the TSC Act, the “alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands” is listed as a threatening process. The natural flows of the study area were modified by the installation of floodgates. Opening the floodgates may help reinstate the natural flows.

- h) *Whether any threatened species population or ecological community is at the limit of its known distribution.***

In Australia, the Lower Hunter Region is the only area outside South Australia where *Z. palustris* occurs. It does, however, occur extensively elsewhere within the world, as noted under a).

Fauna

- a) *In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.*

This test requires an assessment of status of the local population for each threatened species, and what effect the proposed rehabilitation works would have on the life cycle of that local population.

Water-associated Avifauna

Seven water-associated threatened species have been recorded in the vicinity of Hexham Swamp. These are the Australasian Bittern, Black Bittern, Osprey, Black-necked Stork, Freckled Duck, Magpie Goose and Painted Snipe.

The Australasian Bittern is known to be a nomadic species (Serventy 1987) and as a consequence of this habit, there are difficulties in defining a local population within a geographical context. Australasian Bittern has been observed regularly in Hexham Swamp during the ecological baseline study (Winning & King, 2002; Winning & King, 2003). While the observations are opportunistic and no systematic studies have yet been undertaken, the observations suggest that Australasian Bittern is present in Hexham Swamp at any time of year that there is sufficient standing water. The birds have consistently been flushed during the day from open patches within common reed and from the edge of stands of common reed. The available information does not permit an estimation of the numbers within Hexham Swamp, but it can be said from the observations that at least 6 individuals were present during one survey (June 2002), and given that only a relatively small part of the swamp is accessed during each survey, there are likely to have been many more than these 6 individuals at that time.

While Australasian Bittern are also known to occur in other wetlands in the lower Hunter, such as Tomago (Winning & King, 2002; Winning & King, 2003) and Kooragang Island (Kooragang Wetland Rehabilitation Project unpublished records), there are no reliable data on which to base an estimate of the numbers in the lower Hunter at any time. The local numbers of Australasian Bittern are likely to vary considerable in response to changing habitat conditions. In any case, the local populations, as interpreted for the eight-part test, would be much larger than the birds present in the lower Hunter from time to time. Given the nomadic habit of Australasian Bittern, individuals in Hexham Swamp in winter of one year could be present in a swamp 100 or more kilometres away the following summer.

The habitat for Australasian Bittern in Hexham Swamp is evidently dependent on a mosaic of more open sedge-dominated ponds within a matrix of taller reeds. While this habitat exists in Hexham Swamp, it was much more abundant in the recent past when there was less common reed, and is continuing to decline as common reed continues its spread into the more open areas. Doing nothing, would result in a gradual decline of habitat for Australasian Bittern. The effects of opening the floodgates is more difficult to predict, however it is likely that the predicted dieback of common reed would be patchy, and this may create additional habitat for Australasian Bittern. In any case, the loss of habitat within Hexham Swamp would not be sufficient to affect the viability of the local population of Australasian Bittern.

The Black Bittern is also regarded as rare in the Hunter Valley region with the last breeding record made in 1994 (HBOC 1997). As is the case with the Australasian Bittern, the Black Bittern is probably a nomadic species for which it is difficult to define a local population in geographical terms. It is recorded from a variety of wetlands with dense vegetation, often trees, adjacent to running or still water (Marchant & Higgins, 1990). In a wetland like Hexham Swamp it is most likely to utilise mangroves alongside larger creeks. This habitat type would be enhanced as a result of opening of the floodgates.

Osprey were recorded during 1995/96 by the HBOC (1996, 1997) at a large number of coastal sites within the Hunter region (eg. Tanilba Bay, Tuncurry, Belmont South, Harrington) but not at Hexham Swamp. Surveys undertaken for the 1991 NPWS Osprey Management Plan estimated the breeding population in NSW to be approximately 40 to 50 pairs with the size of the non-breeding population unknown, though probably not contributing a significant number of birds as sightings of unattached birds are uncommon (Clancy 1991). The southern most Osprey nest site identified in that study (1977-1988) was in a large dead tree at Eraring. While Osprey may forage for fish within the adjacent Hunter River, Hexham Swamp provides little foraging habitat and no breeding habitat. Open of the floodgates will, if anything, slightly improve potential foraging habitat in the larger creeks within Hexham Swamp.

The Black-necked Stork was recorded by the HBOC in the eastern portions of the Hunter Region in 1995 (especially in the Foster/Tuncurry area). All records were of solitary birds. The total number of records was an increase over previous years, and it was considered that numbers in the region may be increasing (HBOC). However, considerably fewer birds (five birds) were recorded in the region in surveys conducted in 1996 (HBOC 1997). The species has been recorded in Hexham Swamp, on the edge of the now decommissioned maturation pond of the Shortland wastewater treatment works. The most suitable habitat for this species in Hexham Swamp would be the extensive freshwater swamp community near Minmi. This area is not predicted to be substantially affected by opening of the floodgates, and would be relatively easy to protect by bunding if it was affected.

In NSW, the Freckled Duck is considered to have a widespread distribution, though mostly in the north-west and the Murray-Darling Basin, with erratic vagrants appearing in coastal districts in drought years (Marchant and Higgins 1990, Serventy 1985). Freckled Duck were observed (single birds) at Shortland (Market Swamp) and at Arrowfield (two birds) in 1996, but not recorded in Hexham Swamp (HBOC 1996, 1997). In the Hunter Region it is regarded as "accidental" (i.e. species recorded less than once per year, over a 10 year average) with no breeding records previously confirmed (HBOC 1997). The most suitable habitat for this species in Hexham Swamp would be the extensive freshwater swamp community near Minmi. This area is not predicted to be substantially affected by opening of the floodgates, and would be relatively easy to protect by bunding if it was affected.

The Magpie Goose is considered a rare visitor to NSW. Juveniles were introduced to the Shortland Wetland Centre in the late 1980's. In 1996, a count of 93 birds was recorded at the Shortland Wetland Centre (with evidence of breeding: 11 chicks). In Hexham Swamp, seven to ten birds were recorded and two birds recorded from Ash Island (HBOC 1996). The Magpie Goose is now regarded by HBOC as a locally resident species. The Magpie Goose usually establishes a nest site on elevated ground, often up to a kilometre away from water to avoid flooding (Marchant and Higgins 1990). A large proportion of the area that is likely to be affected by opening all eight floodgates is regarded as

unsuitable breeding habitat for the species, as it has often been subjected to inundation during local storm events that have resulted in the area being flooded. This localised flooding and inundation of the wetland is a factor which greatly reduces the potential value of the area to be used as a breeding resource by this species (Marchant and Higgins 1990). The most suitable habitat for this species in Hexham Swamp would be the extensive freshwater swamp community near Minmi. This area is not predicted to be substantially affected by opening of the floodgates, and would be relatively easy to protect by bunding if it was affected.

The Painted Snipe is sparsely distributed and highly nomadic, apparently seldom remaining long in any locality (Pringle 1987, Marchant and Higgins 1993). Rarely recorded in the Hunter region, a single bird in 1992 and another in 1996 at Ash Island (HBOC 1997) have been recorded. In the Hunter region its occurrence is regarded as “accidental” (HBOC 1997). The nomadic behaviour of the species makes it difficult to define a local population in geographical terms.

In summary, opening the floodgates is not considered likely to cause significant impacts to the local/regional populations of identified water-associated avifauna, as it is considered:

- that the wetlands currently do not, nor are likely in the future (under the status quo), to support a substantial proportion of the local population of these species; and
- that suitable habitat will remain within the rehabilitated wetland, as well as in other wetland in the lower Hunter.

Grass Owl

The Grass Owl occurs on the NSW coast and regularly south to the Hunter River, and occasionally beyond to the Sydney region. To the end of 1996 there were approximately 100 published records for the state, with a further 30 added for the far north coast by Maciejewski (1997) as a result of a targeted survey. Local records include a historical (1970s) breeding record for Harrington, several recent records between Harrington and Newcastle, and records for Crowdy Bay National Park. The owl is known to occur in most major coastal reserves and *de facto* reserves in NSW south to the Hunter mouth, including Broadwater, Bundjalung and Yuraygir National Parks, Billinudgel, Tyagarah and Limeburners Creek Nature Reserves, and military land at Williamtown. It is likely to occur in Hat Head, Booti Booti and Myall Lakes National Parks and in Kattang Nature Reserve (S. Debus *pers. comm.*). The known southern breeding limit is Harrington, but it is likely that the owl breeds in suitable habitat south to Port Stephens or the Hunter River (S. Debus *pers. comm.*).

On the NSW coast, the Grass Owl uses mid-high to very tall (0.6-2 m), closed (90-100% foliage cover) wet heathland, sedgeland and tussock grassland associated with surface water and moist soil. This species is also known to occasionally use fallow croplands supporting tall reeds *Phragmites*, and fallow pastures with tall grass.

There have been no recorded sightings of the Grass Owl in the Hunter Region (HBOC 1996, 1997). Hexham Swamp is located well south of the recognised geographic breeding range limit of this species which has been identified as north-eastern NSW around Kempsey (Pizzey and Knight 1998, Hollands 1991, Blakers *et al.* 1984). If this species does exist in the Hunter region, local populations are likely to be very small with unknown status regarding breeding capacity.

Opening the floodgates is not considered to cause significant impacts to the local/regional populations of Grass owl, as suitable habitat is well represented within the remaining wetland complexes of the area and in the region.

Microchiropterans

Three microbat species, Little Bentwing Bat, Common Bentwing Bat and Greater Broad-nosed Bat are reported to use the Hexham Swamp area (NPWS Wildlife Atlas). No information is available on local population sizes.

Hoye (1995) considers the Little Bentwing Bat as rare in the Morisset Forestry District (30-40 km to the west of Hexham Swamp) and PPK (1998) considered it a rare, occasional visitor to the Beresfield area nearby. Typically, this species inhabits lowland rainforest, both wet and dry sclerophyll forest and paperbark wetlands (Churchill 1998, Menkhorst and Knight 2001).

The Common Bentwing bat inhabits well timbered valleys and requires caves or similar suitable environments for roosting and as maternity sites (Dwyer 1995, Menkhorst and Knight 2001). Regionally, this species is regarded as widespread and moderately common (Hoye 1995), though uncommon within the Beresfield area to the near north (PPK 1998).

The local population size of the Great Broad-nosed Bat is unknown but is likely to be small. Hoye (1995) considered the species widespread but uncommon in more suitable habitats of the Morisset Forest District (30-40 km west of Hexham Swamp). This species roosts in tree hollows, and typically inhabits tall, wet forests and margins into drier forests in gully lines (Menkhorst and Knight 2001, Churchill 1998).

Neither preferred foraging or roosting/maternity resources and habitats are adequately represented within Hexham Swamp for any of these species.

These species may potentially use the swamp as part of a much wider foraging area that may include the nearby foothill forests to the west of Hexham Swamp. Suitable roosting and/or maternity sites may occur in these forested foothills, with the principal tree species in Hexham Swamp (*Casuarina glauca*) not providing the necessary hollows for roosting Greater Broad-nosed Bats (Menkhorst and Knight 2001). No caves, potentially used as roosts by both Bentwing species, are known to occur in the area potentially influenced by increased tidal inundation. If tree hollows are present in the area that is likely to become inundated as part of Option 6, these tree hollows are considered likely to persist and continue to provide a potential refuge resource for microbat species in the short term.

Increased tidal inundation resulting from opening of eight gates would therefore not adversely affect the foraging, roosting or breeding of local populations of these three species.

Amphibians

The Green and Golden Bell Frog has been previously recorded within Hexham Swamp. Records primarily relate to the margins of the swamp including areas adjacent to Ironbark Creek (Markwell 1984).

The species is known to forage and breed in a variety of semi-permanent to permanent wetlands and open waterbodies (including waterways) which support dense fringing vegetation, including bull

rushes (*Typha* sp.) and rushes (*Eleocharis* sp., *Juncus* sp. and *Phragmites* sp.) (Barker *et al.* 1997, Tyler 1997, Cogger 2000).

Although the species has a wide range of habitat preferences, it is considered that opening of eight floodgates would result in the loss of a significant proportion of available freshwater habitats, though not all, confined to the area of impact. Areas of preferred freshwater habitats (e.g. reed swamps, Casuarina forest, and grass swamps) would remain located around the periphery of the wetland. Areas suitable for breeding/foraging would diminish, though even under the status quo, the long term viability of the population within Hexham Swamp is uncertain.

However, recent surveys conducted by the University of Newcastle failed to record the Green and Golden Bell Frog in Hexham Swamp (Hamer, 1998) from areas previously known to support this species, indicating that the habitat value of the wetland has declined substantially in the last 15 years. This decline is probably related primarily to the gradual decline in water quality of the wetland as a whole, the simplification of habitats supported, and the infestation by the predator fish *Gambusia holbrooki* in Hexham Swamp, which is a known predator of native fish and frogs (Arthington *et al.* 1983, Arthington and Lloyd 1989, Gillespie and Hero 1999). Predation by *Gambusia holbrooki* has been listed as a key threatening process on Schedule 3 of the TSC Act (NSW NPWS 2002).

It is unlikely that Green and Golden Bell Frog is still present within Hexham Swamp. The potential capacity of the wetland to support this species in the future would be dependant on substantial rehabilitation works required to improve the nature and condition of freshwater habitats and water quality within the wetland. These works would also need to address the management issue of *gambusia* control, as it is listed as a key threatening process under the TSC Act.

b) *In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.*

No endangered populations or ecological communities are recorded from this locality or adjacent lands.

c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

The affected area does not represent a significant area of known habitat. None of the species under consideration have a highly restricted distribution or have highly specific habitat requirements.

Waterbirds

The Australasian Bittern in NSW is regarded as widespread, though only abundant in the Murray-Darling Basin and considered scarce elsewhere with infrequent records from coastal areas (Marchant and Higgins 1990). The species prefers shallow, freshwater or brackish wetlands which support extensive reed beds and/or dense bands of vegetation fringing open water (Marchant and Higgins 1990) and is highly nomadic (Serventy 1985). Whilst detailed data are not available on the distribution of such habitats in the Sydney region, it is reasonable to assume the opening of eight floodgates would not remove a significant proportion of habitat types utilised by the Australasian Bittern within Hexham Swamp as the habitats present following floodgate opening would also be

suitable for utilisation by this species, and potentially provide habitat and food resources of greater extent, diversity and value.

In NSW, the Black Bittern is essentially a coastal species, with occasional inland records and rarely recorded south of Sydney which forms the south-eastern extremity of its range (Garnett 1993, Marchant and Higgins 1990). The Black Bittern is regarded as rare in the Hunter Valley with no confirmed records in 1996 and the last breeding record made in 1994 (HBOC 1997). It typically inhabits dense vegetation associated with terrestrial wetlands, estuarine and littoral habitats with a greater preference for estuarine habitats than the Australasian Bittern. Whilst the opening of eight floodgates would ultimately reduce a significant area of freshwater habitat (common reed areas) which provide for this species, other preferred habitat types affected by this would be improved and increased (mangrove and saltmarsh habitats). The condition and ecological viability of these estuarine and brackish habitats would be significantly rejuvenated and enhanced resulting in an increased and improved potential habitat for this species in Hexham Swamp. It is unlikely that opening of eight floodgates would remove a significant area of habitat for this species and in fact additional preferred habitat may be created.

Ospreys are known to nest as far south as Eraring through to Cobaki in the extreme north of the state (Clancey 1991). Morris *et al.* (1981) listed the species as “rare” in NSW and regarded it as a local resident in the Hunter Valley (HBOC 1997). The Osprey is predominantly a coastal species using a variety of marine and littoral habitats (bays, estuaries, rivers) and terrestrial wetlands, with observations occasionally made of the species extending inland along larger river systems (Blakers *et al.* 1984, Marchant and Higgins 1993). The species requires extensive areas of clear open water (fresh, brackish or saline) for foraging and tall trees for nesting and as feeding perches (Clancey 1991). Opening of eight floodgates (Option 6) will not remove a significant area of foraging habitat for this species considering its widespread distribution in the Hunter region and variety of preferred habitats. It is highly probable that the opening of eight floodgates will, in fact, increase the quality of habitats available for foraging, considering the anticipated improvement in water quality and resultant increase in the abundance of potential food resources. As noted previously, the swamp does not currently provide suitable nesting habitat for this species.

In New South Wales, the Black-necked Stork is associated with coastal habitats and is regarded as scarce to about Sydney, and as rare through to the southern extremity of its range at about Nowra (Garnett and Crowley 2000, Marchant and Higgins 1990). The species prefers open freshwaters which form shallow flooded grassland habitats, though birds will, to a lesser extent, utilise saline/brackish water habitats (Serventy 1985). The opening of eight floodgates (Option 6) will result in the reduction of a large area of common reed communities within Hexham Swamp. These areas are not considered suitable as foraging habitat for the Black-necked Stork which typically prefers shallow, open water areas with submerged, or short emergent vegetation (Marchant and Higgins 1990). It is expected that the opening of eight floodgates, and the subsequent rejuvenation and expansion of saltmarsh and mangrove communities will provide foraging habitat of greater value, diversity and extent for the Black-necked stork than that which currently exists in the wetland. As assessed previously, changes to nesting habitats for this species is unlikely as Hexham Swamp supports few suitable large trees.

The Painted Snipe prefers a broad range of habitats, including the margins of dams, claypans, lakes, streams and swamps particularly those which include low, dense vegetation such as sedges, rushes

and reeds (Pringle 1987). Although the species has not previously been recorded at Hexham Swamp, some of the freshwater vegetation types within Hexham Swamp apparently provide suitable habitat to varying degrees. Opening of eight floodgates (Options 6) will remove a large area of habitat of varying suitability for this species (98 % of the common reedland). However, it needs to be recognised that this species has not been recorded at Hexham Swamp and the current low/poor diversity and quality of potential habitat significantly reduces the likelihood of potential impact from opening of the floodgates 6 to this species.

In NSW, the Freckled Duck is considered to have a widespread distribution, though mostly in the north-west and the Murray-Darling Basin, and appearing as a vagrant in coastal districts in drought years (Marchant and Higgins 1990). It prefers a range of habitat types including freshwater wetlands and waterways which are densely vegetated with lignin (*Nuehoenbeckia cunninghamii*) or cane grass (*Eiagiostis* sp.) (Garnett and Crowley 2000, Marchant and Higgins 1990) which did not occur in the Hunter region. The dense vegetation cover is required for nesting and is used as a day-time cover for this primarily secretive species (Marchant and Higgins 1990). Considering its preference for freshwater habitats, opening of eight floodgates would remove a significant proportion of the preferred habitat of this species in Hexham Swamp. Consequently, opening of eight floodgates would reduce the capability of the wetland to support this species during drought years when it may migrate to coastal areas.

Magpie Goose prefers shallow, freshwater or brackish wetlands which support extensive reed beds and/or dense bands of vegetation fringing open water (Marchant and Higgins 1990). Considering its preference for freshwater habitats, opening of eight floodgates is likely to remove a significant proportion of the preferred habitat of this species in Hexham Swamp. However, suitable local habitat occurs elsewhere. The Magpie Goose usually establishes a nest site on elevated ground, often up to a kilometre away from water to avoid flooding (Marchant and Higgins 1990). The area that will be affected by opening of the floodgates is already subject to flooding during heavy storm events and may not be currently regarded as suitable breeding habitat.

Grass Owl

The Grass Owl primarily occurs in grasslands and marshy thickets of sedges or rushes. These habitats provide both foraging and nesting habitat. Whilst the Grass Owl has not been recorded from Hexham (HBOC 1997), opening of eight floodgates will remove a significant proportion of habitat of potentially marginal value for this species in Hexham Swamp. Within a bioregional context, the area of variable quality habitat at Hexham is insignificant in relation to that existing within the North Coast Bioregion. There are collectively thousands of hectares of habitat within coastal reserves in the region. These areas, unlike the Hunter region, are known to support breeding populations of Grass Owl. The habitat that will be modified by tidal inundation is already disturbed habitat of low/poor quality on the edge of a highly disturbed area.

Amphibians

The Green and Golden Bell frog was formerly known to have a widespread distribution occurring from northern coastal NSW (Byron Bay) to east Gippsland in Victoria and was regarded as a common species of secure status nationally (Tyler 1992) and as common in coastal areas of NSW (Barker and Grigg 1997). Since the 1960's, the species has undergone a significant contraction in geographic range and decline in abundance (Tyler 1997, White and Pyke 1996, Goldingay 1996).

These changes have primarily occurred within NSW and the ACT (Tyler 1997) with no parallel changes in distribution and/or abundance apparent in Victoria (Gillespie 1996). Currently, the species is known from only about 30 locations within NSW with over half of these sites located within the greater Sydney area (White and Pyke 1996). Consequently it can be considered to have a restricted distribution in NSW. Markwell (1984) identified that this species was recorded in Hexham Swamp in the early 1980's, but its abundance has markedly decreased since that time, with recent surveys conducted by the University of Newcastle (Hamer, 1998) failing to record the Green and Golden Bell Frog in Hexham Swamp. This indicates that the habitat value of the Swamp has potentially declined substantially in the last 15 years. This decline is probably related primarily to the gradual reduction in water quality of the wetland as a whole, the simplification of habitats supported and infestation of the predator fish *Gambusia holbrooki* in Hexham Swamp which is a known predator of native fish and frogs (NSW NPWS 2001). Opening of eight floodgates is considered likely to remove a large proportion of a broad range of freshwater habitats of low/poor value (namely common reed communities) though not in areas where this species has previously been recorded (see Markwell 1984). The proposed opening of eight floodgates would not result in the loss of a significant area of quality habitat for this species.

- d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.***

The nature and extent of the impact resulting from opening eight floodgates would not result in the severing of fauna movement corridors, or isolate areas of habitat known or considered likely to support threatened species.

- e) *Whether critical habitat will be affected.***

No critical habitat has been recorded for this location.

- f) *Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.***

"Region" refers to the North Coast Bioregion, within which there are many coastal reserves supporting the threatened species identified for this survey.

Whilst it is difficult to assess whether populations of transient or cryptic species (e.g. Black Bittern, Australasian Bittern and Painted Snipe) are well represented in reserves without targeted, detailed survey work, it is reasonable to assume that their habitats are represented in reserves in the region.

For less mobile species, it is probable that populations are not well represented in conservation reserves within the region. The Green and Golden Bell Frog, in particular, is presently known from a very limited number of sites, all outside conservation reserves (White and Pyke 1996, NPWS Wildlife Atlas).

- g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.***

The proposed opening of tidal floodgates is not recognised as a key threatening process. No other key threatening processes that are applicable to this proposal, are listed in Schedule 3 of the TSC Act.

However, if the final decision is to “do nothing”, i.e. leave the current system in place, a detailed management plan will have to be designed and implemented especially in regard to addressing impacts by gambusia, which is listed as a key threatening process under the *TSC Act*.

h) *Whether any threatened species, population of ecological community is at the limit of its known distribution.*

Excluding Magpie Goose and Grass Owl, none of the threatened species recorded on the subject site are at the limit of their known distribution in this area.

The Magpie Goose is widespread in sub-coastal areas from north-western Australia through to about the Queensland/NSW border and is currently considered to be a rare visitor to NSW (Marchant and Higgins 1990). In NSW, the species occurs in a range from north-east NSW (Macquarie Marshes) through to areas within the lower Hunter Valley (Marchant and Higgins 1990). Juveniles were introduced to Shortland in the late 1980's resulting in resident flocks of over 100 in 1990 (Maddock in Marchant and Higgins 1990). The population associated with the Newcastle area is probably at or near the southern limit of distribution of this species. Most birds have been recorded at the Shortland Wetland Centre where the population is maintained by supplementary feeding.

The Grass Owl is probably at its southern limit of distribution in the Hunter Region.