Description of the ecological character of the Edithvale-Seaford Wetlands Ramsar Site

Department of Sustainability and Environment
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Australian Government Introductory Notes and Disclaimer

Introductory notes

There may be differences in the type of information contained in this ECD Publication to those of other Ramsar Wetlands as this project preceded agreement by the Natural Resources Management Ministerial Council to the National Framework and Guidance for Describing the Ecological Character of Australian Wetlands (Department of the Environment, Water, Heritage and the Arts, 2008).

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) prohibits actions that are likely to have a significant impact on the ecological character of a Ramsar wetland unless the Commonwealth Environment Minister has approved the taking of the action, or some other provision in the EPBC Act allows the action to be taken. The information in this ECD Publication does not indicate any commitment to a particular course of action, policy position or decision. Further, it does not provide assessment of any particular action within the meaning of the Environment Protection and Biodiversity Conservation Act 1999 (Cth), nor replace the role of the Minister or his delegate in making an informed decision to approve an action.

The Water Act 2007 requires that in preparing the [Murray-Darling] Basin Plan, the Murray Darling Basin Authority (MDBA) must take into account Ecological Character Descriptions of declared Ramsar wetlands prepared in accordance with the National Framework.

This ECD Publication is provided without prejudice to any final decision by the Administrative Authority for Ramsar in Australia on change in ecological character in accordance with the requirements of Article 3.2 of the Ramsar Convention.

Disclaimer

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Note: There may be differences in the type of information contained in this ECD publication, to those of other Ramsar wetlands.

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Contents

Abbreviations

DSE	Victorian Department of Sustainability and Environment
DEWHA	Australian Government Department of the Environment, Water, Heritage and the Arts
ECD	Ecological character description
EPBC Act	*Environment Protection and Biodiversity Conservation Act* 1999
IUCN	International Union for the Conservation of Nature
RIS	Ramsar Information Sheet
FFG Act	Victorian *Flora and Fauna Guarantee Act* 1988.
EVC	Ecological vegetation class
ARI	Average recurrence interval
AHD	Australian Height Datum

Executive summary

A description of the ecological character of the Edithvale–Seaford Wetlands Ramsar Site was prepared using the "Framework for describing the ecological character of Ramsar wetlands" (DSE, 2005). The ecological character description is designed to provide a benchmark for monitoring the ecological character of the Ramsar site. This will facilitate the implementation of Australia's obligations under the Ramsar Convention to maintain the ecological character of Ramsar sites and inform members of the public who are interested in a Ramsar wetland to understand and value the wetland.

The Edithvale-Seaford Wetlands Ramsar Site consists of two separate wetland areas (Edithvale Wetland and Seaford Wetland) which are remnants of the once much more extensive Carrum Carrum Swamp. The Ramsar site also includes predominantly dryland areas surrounding the main wetlands. The area of the Edithvale Wetland segment is 103 hectares (wetland extent is 39 hectares) and the Seaford Wetland segment is 158 hectares (wetland extent is 93 hectares). The wetlands are located in the south eastern Melbourne suburbs of Edithvale and Seaford. They are in the Bunyip River Basin in the Southeast Drainage Division and in the western urban part of the Gippsland Plain Bioregion which lies within the Victorian and South-eastern Coastal Plain Biogeographic Region described in the Interim Biogeographic Regionalisation for Australia (IBRA).

Carrum Carrum Swamp was a shallow freshwater marsh which was extensively drained in the nineteenth century. The wetlands are now surrounded by urban land much of which has been reclaimed. The wetland remnants within the Ramsar site consisted of somewhat degraded shallow freshwater marsh (116 hectares) and permanent open freshwater (16 hectares) wetland types prior to 1987. In 1987-1988, excavations in parts of the wetlands broke through the natural peat layer allowing the inflow of saline groundwater and some of the wetland cells had become brackish or saline by the time of Ramsar listing in 2001. The Ramsar site is used for flood control, conservation, recreation and education. It provides important open space that is highly valued by the local communities.

The Edithvale-Seaford Wetlands were listed as a Ramsar Site in 2001 on the basis of meeting the Ramsar site Criteria 1, 2 and 6 in 2001. In addition the site regularly supports a high diversity of waterbird species and native vegetation typical of the Gippsland Plain Bioregion, meeting Criterion 3.

The ecosystem services that have been used as the basis for the ecological character description are that the wetlands within the Ramsar site:

- are the last remaining representative example of the Carrum Carrum Swamp and are representative of the depleted shallow freshwater wetland type in the Gippsland Plain bioregion;
- assist in the natural control of flooding;
- support threatened waterbird species, particularly the Australasian Bittern *Botaurus poiciloptilus*;
- regularly support 1% of the East Asian-Australasian Flyway population for Sharp-tailed Sandpipers *Calidris acuminata*;
- support threatened ecological vegetation communities characteristic of the Gippsland Plains Bioregion; and
- support a high diversity of waterbird species.

The ecological character description focused on the ecosystem services related to the Ramsar criteria. Additional ecosystem services within the Ramsar site identified but not further described are as follows.

- The wetlands are an essential component of the regional drainage system in receiving, retaining and diverting stormwater and other surface runoff.
- The wetlands contribute to protecting the water quality of Port Phillip Bay by retaining and naturally "treating" stormwater and other surface runoff at limited cost.
- The wetlands are a significant regional resource for passive and nature-based recreation.
- The wetlands offer unparalleled environmental education opportunities for local schools, tertiary institutions and the community.

- The wetlands are of great significance for environmental research, in fields relevant to both the water industry and ecology.
- The wetlands are, and will continue to be an example of a managed wetland system.

The most important wetland ecosystem components and processes that support the ecosystem services at the Ramsar site are:

- hydrology;
- sedimentation;
- salinity;
- connectivity;
- productivity;
- climate;
- catchment land use;
- soil type;
- wetland topography; and
- waterbird habitat.

Detailed information was available to describe the ecosystem services related to the Ramsar criteria and most of the wetland components that support these services, although data were limited for hydrological inflow and outflow volumes, flood storage capacity, vegetation condition and soil type. Information was not available on wetland bathymetry, non-avian vertebrate fauna or for aquatic invertebrates. Information on water quality parameters is limited and relates mainly to salinity with some information on pH. There is no information on nutrients in the wetlands. While catchment land use has been mapped, there is no quantitative information on the nutrient and sediment loads that enter the wetlands from the catchment and no water quality monitoring program within the wetlands. It is recommended that these data gaps be addressed.

The description of ecosystem services, components and processes provides a benchmark against which to evaluate ecological character in the future. Programs are in place to monitor some aspects of ecological character, particularly services related to waterbirds, but additional programs are required to monitor other services, components and processes. Recommendations on monitoring programs are provided.

The wetlands in the Edithvale-Seaford Ramsar Site had a history of degradation since European settlement until around 1988. Since 1989, a new management approach has aimed to retain and restore the site's natural values while maintaining its value for flood control, regional drainage, recreation and education. From that time till the present, significant investigations and monitoring programs have led to a greater understanding of the ecosystem services, components and processes at the wetlands and the threats to the values for which it was listed.

The wetland is now actively managed and it is expected that the detailed management prescriptions in place for hydrology and vegetation, in particular, will continue the restoration process. More data is required on some ecosystem services, components and processes and a more comprehensive monitoring program is recommended to monitor ecological character. Since listing as a Ramsar Site, there is no evidence of adverse change in ecological character. As restoration proceeds, it is expected that positive changes will result. Therefore, consideration should be given to reviewing the ecological character description in ten years time and deciding if the benchmarks in this description are still relevant for continued monitoring of ecological character.

1 Introduction

This ecological character description (ECD) has been prepared for the Edithvale-Seaford Wetlands for the purposes outlined below.

1. To assist, generally, with implementing Australia's obligations under the Ramsar Convention, as stated in Schedule 6 (Managing wetlands of international importance) of the Commonwealth *Environmental Protection and Biodiversity Conservation Regulations 2000:*

(a) to describe and maintain the ecological character of declared Ramsar wetlands in Australia; and

(b) to formulate and implement planning that promotes:

(i) conservation of the wetland; and

(ii) wise and sustainable use of the wetland for the benefit of humanity in a way that is compatible with the maintenance of the natural properties of the ecosystem.

2. To assist, in particular, in fulfilling Australia's obligation under the Ramsar Convention to arrange to be informed at the earliest possible time if the ecological character of any wetland in its territory and included in the Ramsar List has changed, is changing or is likely to change as a result of technological developments, pollution or other human interference.

3. To supplement the description of the ecological character contained in the Ramsar Information Sheet (RIS) submitted under the Ramsar Convention.

4. To assist the administration of the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999 (*EPBC Act), particularly:

(a) to determine whether an action has, will have or is likely to have a significant impact on a Ramsar wetland in contravention of sections 16 and 17B of the EPBC Act; or

(b) to assess the impacts that actions referred to the Minister administering the EPBC Act under Part 7 of the Act have had, will have or are likely to have on a declared Ramsar wetland.

5. To assist any person considering taking an action that may impact on a Ramsar wetland as to whether they need to refer the action to the Minister under Part 7 of the EPBC Act for assessment and approval.

6. To inform members of the public who are interested in the Ramsar wetland to understand and value the wetlands.

This ECD was prepared using the 'Framework for describing the ecological character of Ramsar Wetlands' (DSE, 2005) which preceded the 'National Framework and Guidance for Describing the Ecological Character of Australian Ramsar Wetlands' (DEWHA 2008). The ECD uses the approach recommended in the 2005 Framework and consists of a series of steps (Table 1).

Table 1 Steps in the framework for describing ecological character for a Ramsar Site.

Step No.	Framework description
1	Document introductory details about the ECD
2	List the ecosystem services at the Ramsar Site
3	Select ecosystem services to be described in the ECD
4	Define the selected ecosystem services in specific terms
5	Link the selected ecosystem services with the critical ecological components and processes that support them and select those components and processes to be further specified
6	Specify the critical components and processes that support each of the selected ecosystem services
7	Compile the description of ecological character

2 Ecological character description details

Table 2 provides introductory details regarding the ECD for the Edithvale-Seaford Wetlands Ramsar Site.

Table 2 Details of the ECD for Edithvale-Seaford Wetlands Ramsar Site.

Site name	**Edithvale-Seaford Wetlands**
Location (coordinates)	Edithvale Wetland: 38^0 01' 55" S, 145^0 07' 31'' E Seaford Wetland: 38^0 05' 40" S, 145^0 08' 21'' E
General location of the site	The Edithvale-Seaford Wetlands are located 25km south east of Melbourne, Victoria, in the suburbs of Edithvale and Seaford (Figure 1).
Area (to the nearest hectare)	Edithvale Wetlands: 103 hectares Seaford Wetlands: 158 hectares Source: (DSE Corporate Geospatial Data Library RAMSAR100 layer)
Date of listing as a Ramsar site	The Edithvale-Seaford Wetlands were designated as a Ramsar site on the 29th August 2001
Date for which the description of ecological character applies	The description is for the Ramsar Site at time of listing in 2001.
Management Authorities	Melbourne Water Frankston City Council
Status of description	This is the first formal ECD of the Edithvale Seaford Wetlands site. Lane et al. (2000) in the Edithvale-Seaford Wetlands Ramsar Management Plan describe the attributes, values and significance of the Ramsar Site pre listing. This Management Plan (Lane et al, 2000) was prepared to accompany documentation seeking nomination of the wetlands to the list of wetlands of international importance under the Ramsar Convention.
Name of compilers	Shelley Heron Principal Consultant Heron Environmental Consulting 312 High Street Northcote, Victoria, 3070. Janet Holmes Principal Policy Officer, Biodiversity and Ecosystem Services Department of Sustainability and Environment 8 Nicholson Street East Melbourne, Victoria, 3002 Richard Boekel Senior Flora and Fauna Officer Department of Sustainability and Environment Cnr Lt Malop and Fenwick Streets Geelong, Victoria, 3220.

Table 2 continued

Site name	Edithvale-Seaford Wetlands
Date of Completion	31 May 2008
Reference for RIS	Edithvale-Seaford Wetlands Ramsar Information Sheet, July 2001. The RIS is currently being updated. Available on Department of Sustainability and Environment website: http://www.dse.vic.gov.au/conservation-and-environment/biodiversity/wetlands/ramsar-wetlands/ramsar-wetlands-edithvale-seaford-wetland.
Reference for Management Plan	Various management plans have been prepared for the Edithvale-Seaford Wetlands Ramsar Site. These include: Lane et al. (2000) GHD (2005) Melbourne Water (2004) TBLD (2005) Walters (1994 The reports listed above are not available via the web, they are available from Melbourne Water. William Steele, Senior Biodiversity Scientist, Catchments Melbourne Water PO Box 4342 Melbourne VIC 3001 melbournewater.com.au

2.1 General description of the site

The Edithvale-Seaford Wetlands Ramsar Site consists of two separate wetland areas which are remnants of the once much more extensive Carrum Carrum Swamp (Figure 1). The Ramsar site also includes predominantly dryland areas surrounding the main wetlands. The area of the Edithvale Wetland segment is 103 hectares and the Seaford Wetland segment is 158 hectares.

Carrum Carrum Swamp was extensively drained in the nineteenth century and the wetlands are now surrounded by urban land much of which has been reclaimed. Edithvale Wetland is located in the Melbourne suburb of Edithvale (Figure 2) and Seaford Wetland in the suburb of Seaford (Figure 3). The wetland remnants within the Ramsar site consisted of the shallow freshwater marsh (104 hectares) and permanent open freshwater wetland types (16 hectares), when classified under Victoria's wetland classification system in 1993 (Corrick and Norman, 1980) (Appendix 1). The classification was based on air photography from the late 1980s (Martin O'Brien, DSE, personal communication). In 1987-1988, excavations in parts of the wetlands broke through the natural peat layer allowing the inflow of saline groundwater (GHD, 2005) and some of the wetland cells had become brackish or saline at the time of listing in 2001. The classification by Corrick and Norman (1980) did not reflect these changes.

The Ramsar site is used for flood control, conservation, recreation and education.

The Ramsar site boundaries are defined by land parcels (allotments). Edithvale Wetland consists of freehold land which is owned and managed by Melbourne Water (Table 3, Figure 4). Seaford Wetland consists of freehold land owned by Melbourne Water and a Crown land conservation reserve for which Melbourne Water has formal management responsibility (Table 3, Figure 5). However, by informal agreement with Melbourne Water, Frankston City Council assumes responsibility for the management of some of the drier northern parts of the Seaford Wetland.

Frankston City Council has recently discontinued road reserves at the Seaford Wetland and is in the process of consolidating parcels within the Seaford Wetland. However, the process is not yet finalised and the updated information is not yet available. The discontinued road reserves are managed as part of

the Ramsar site, even though technically, they are not included. When the consolidation process is complete, the parcel list (Table 3) will be revised.

The area has a temperate climate with an average annual rainfall of 719 mm. The wettest month is May with an average of 72 mm, and the driest month is February with an average of 45 mm. The average maximum temperature ranges from 25 ^{0}C in February to 13 ^{0}C in July. The average minimum temperature ranges from 16 ^{0}C in February to 7 ^{0}C in July (BoM, 2008).

The Edithvale-Seaford Wetlands are located in the Bunyip River Basin in the Southeast Drainage Division. The hydrology of the area has been highly altered. The Edithvale Wetland is fed primarily by drains from developed catchments to the northwest. It discharges via the Secondary Drain to Mordialloc Creek and then to Port Phillip Bay. Seaford Wetland has been cut off from the natural catchment of Boggy Creek and no longer receives the seasonal inundation from the former Carrum Swamp (now Patterson Lakes). Seaford Wetland is now fed from a pump in Wadsley Road Drain and also has increased groundwater inputs from local drainage systems (GHD, 2005). The Seaford Wetland discharges to the Weatherston Road Drain at the southern end of the wetland but can also be subject to tidal inflows from Kananook Creek via this drain if failure of a flood gate and pump system occur (GHD 2005). The hydrology of the wetland catchment is shown in Figure 6.

The Ramsar site is located in the urban western part of the Gippsland Plain Bioregion (Figure 7). The Gippsland Plain Bioregion covers 1,226,707 hectares. It stretches from the Melbourne Central Business District in the west to Lakes Entrance in the east and from Moe in the north to Foster in the south (DSE, 2003). The bioregion includes lowland coastal and alluvial plains characterised by generally flat to gently undulating terrain, vegetated in parts with open forest with a grassy and herbaceous ground layer with areas of Swamp Scrub (DSE, 2003). Immediately east of Melbourne the landscape is mainly farmland with cattle grazing. The industrialised Latrobe Valley lies in the centre. There is an extensive irrigation area in the Macalister district, and more forested country to the east (DSE, 2003).

Due to past disturbance, the Edithvale-Seaford Wetlands now consist of a largely altered complex of wetlands supporting a range of indigenous and introduced vegetation that has colonised opportunistically (Lane et al., 2000). Lane et al. (2000) states that many of the native vegetation communities and species presently occurring in the area are considered likely to have evolved from previous native communities that once occupied the greater Carrum Carrum Swamp. TBLD (2005) described and mapped nine ecological vegetation classes (EVCs) in 2003. The main fauna groups utilising the wetlands are waterbirds including seasonal populations of migratory waders (Lane et al., 2000). There are also a variety of other native bird, mammal, frog, reptile, fish and invertebrate species but, with the exception of the avifauna, these taxa are poorly documented (Lane et al., 2000).

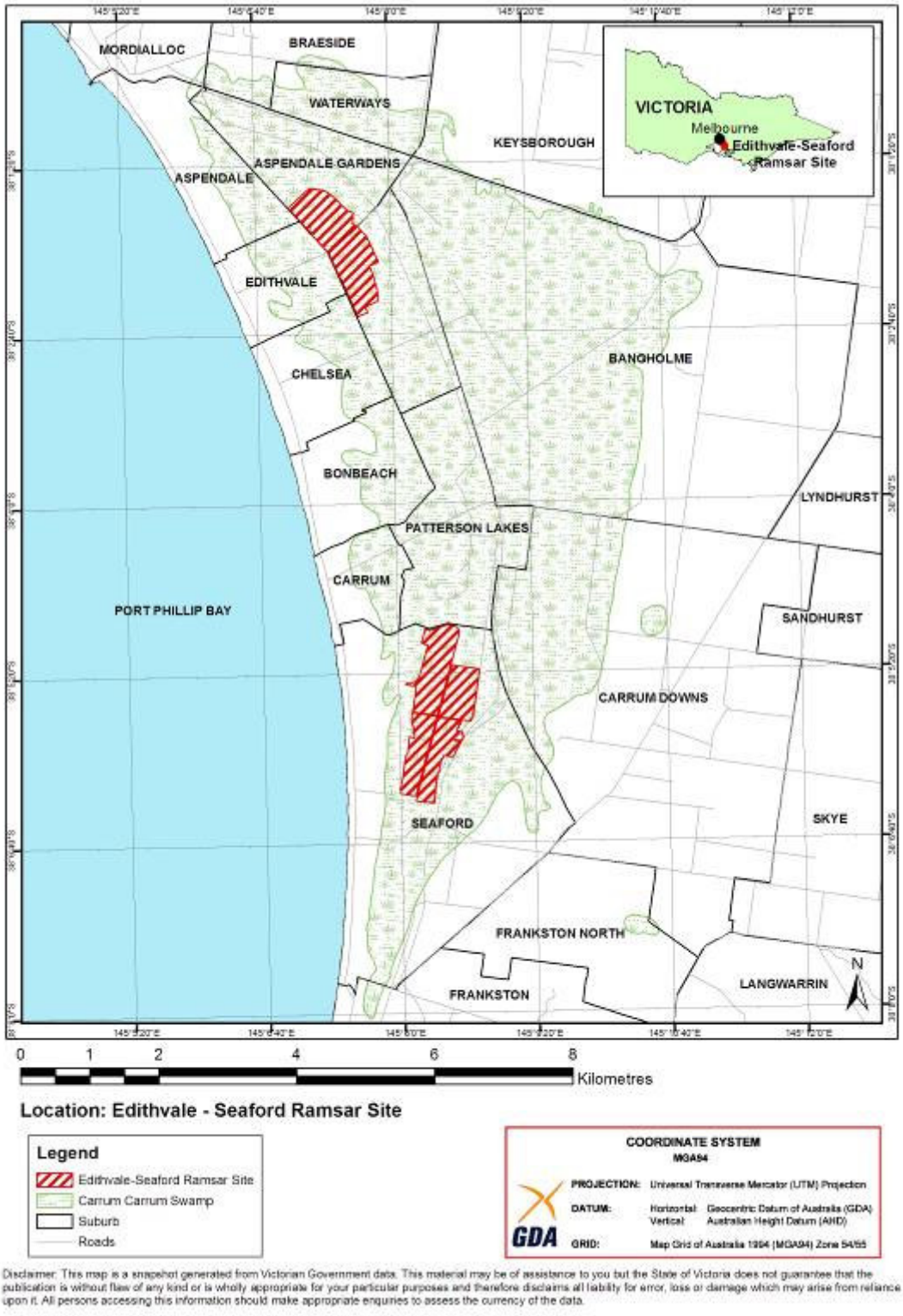

Figure 1. Location of the Edithvale-Seaford Wetlands and the former extent of Carrum Carrum Swamp.

Figure 2. 2005 aerial photography of the Edithvale section of Edithvale-Seaford Wetlands Ramsar Site.

Figure 3. 2005 aerial photography of the Seaford section of Edithvale-Seaford Wetlands Ramsar Site.

Table 3 Land parcels in the Edithvale-Seaford Wetlands Ramsar Site.

Wetland	Land parcels (allotments) (Parish of Lyndhurst)	Land status	Owner/formally assigned land manager	Land manager (on-ground)
Edithvale Wetland	Lot 1 TP131999 Lot 2 TP225777 Lot 1 TP82835 Lot 1 TP414444 Lot 1 TP83139 Lot 1 TP820840 Lot 1 TP370109 Lot 1 TP95924 Lot 1 TP132070 Lot 1 TP366503 Lot 1 TP138507	Freehold	Melbourne Water	Melbourne Water
Seaford Wetland	Lots 16, 26-31, 50-54 LP10032 Lots 183, 206-207, 213-225, 239-245, 281-290 LP11717 Lots 1, 3 TP169027 Lot 76 LP13210 Lot 1 TP872266 Lot 1 TP169722 Lot 52 LP11828 Lots 1-11 TP146701 Lots 1-5 TP820882 Lot 2 LP138935 Lot 1P XX Lot 1 TP382307	Freehold	Melbourne Water	Melbourne Water and Frankston City Council
	P363328	Crown land reserved for conservation of area of natural interest	Melbourne Water appointed as Committee of Management under the *Crown Land (Reserves) Act 1978*, Victoria.	

Figure 4. Land ownership and parcels, Edithvale Wetland.

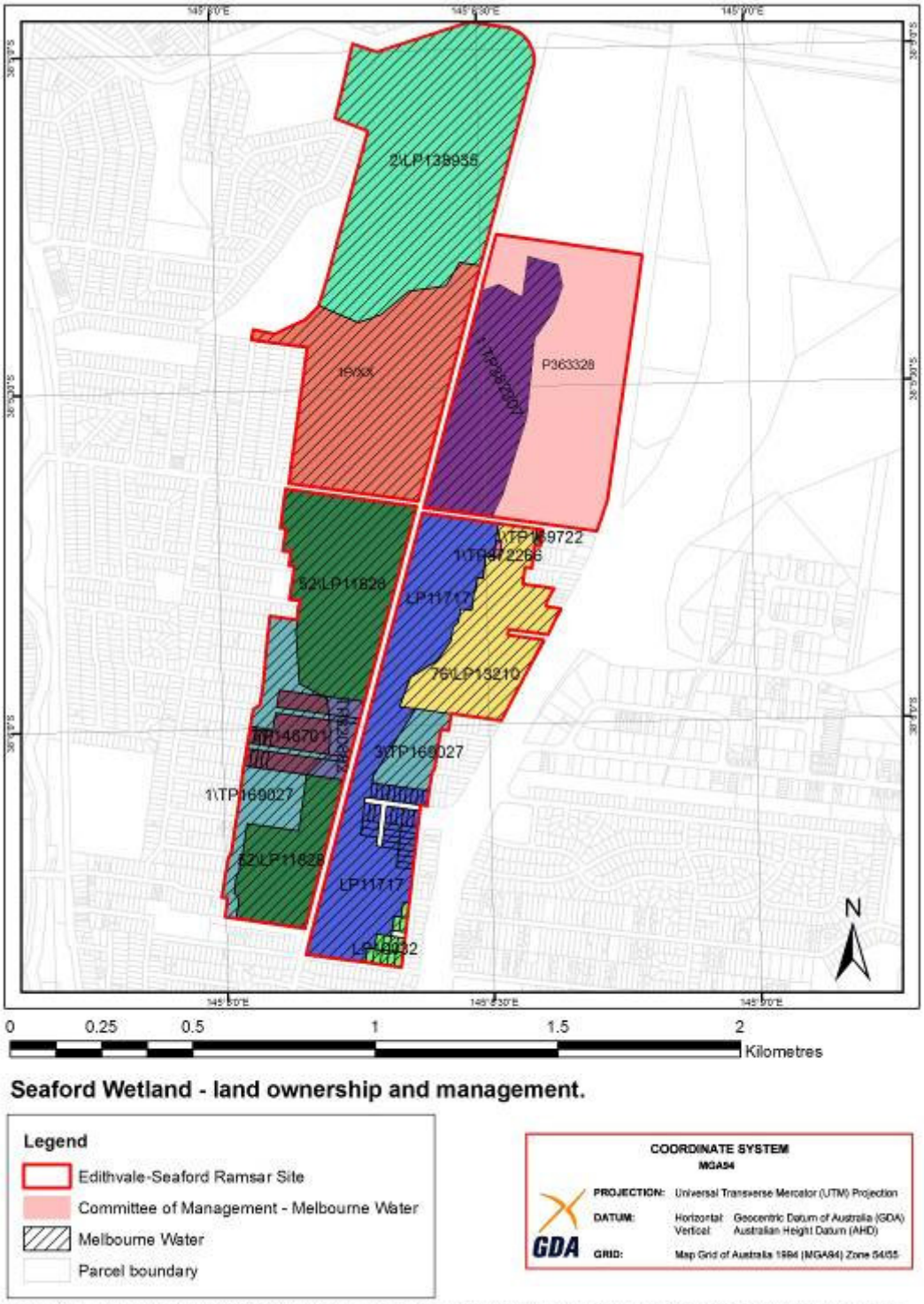

Figure 5. Land ownership and parcels, Seaford Wetland.

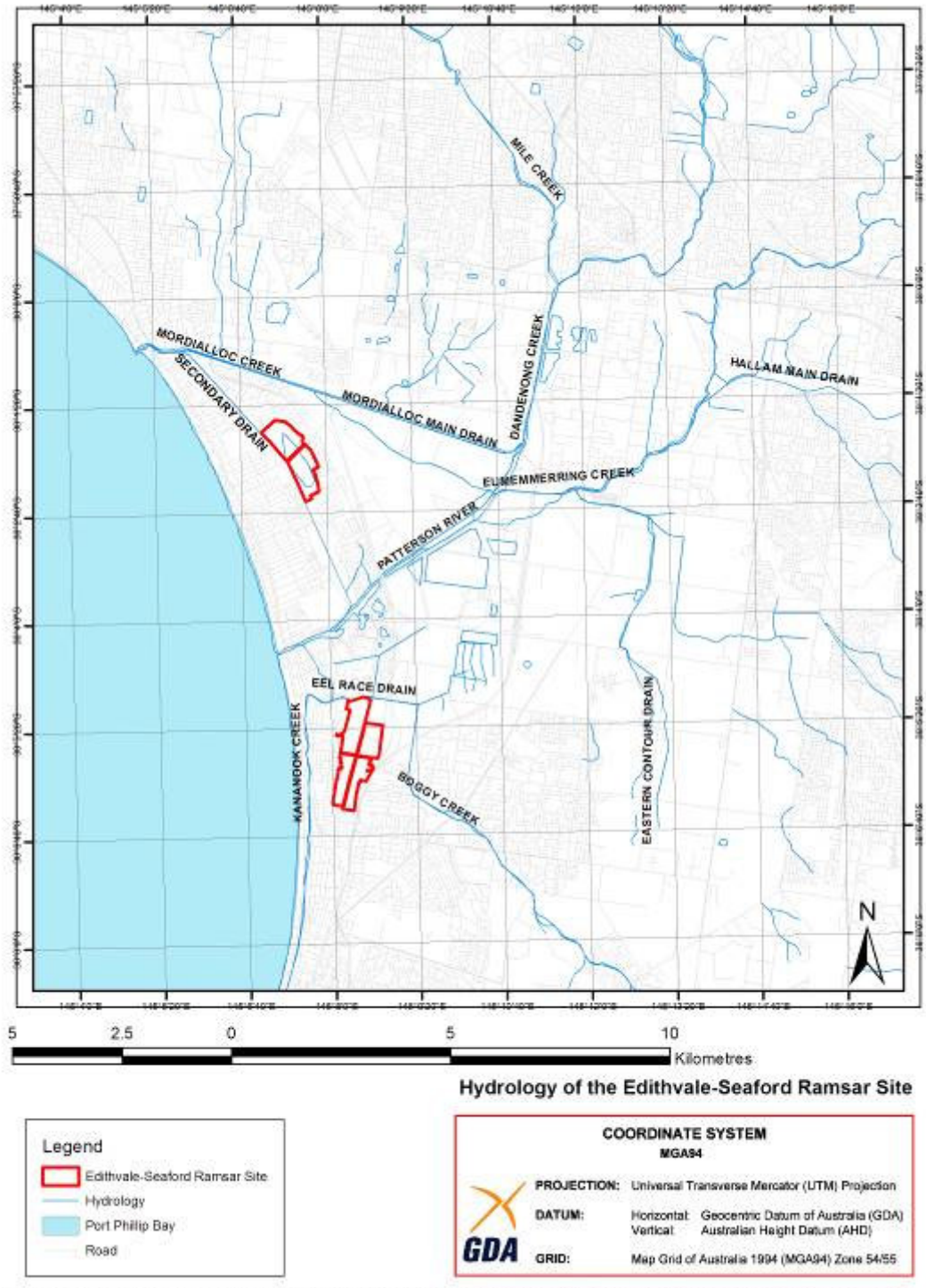

Figure 6. Edithvale-Seaford Wetlands Ramsar Site, regional hydrology.

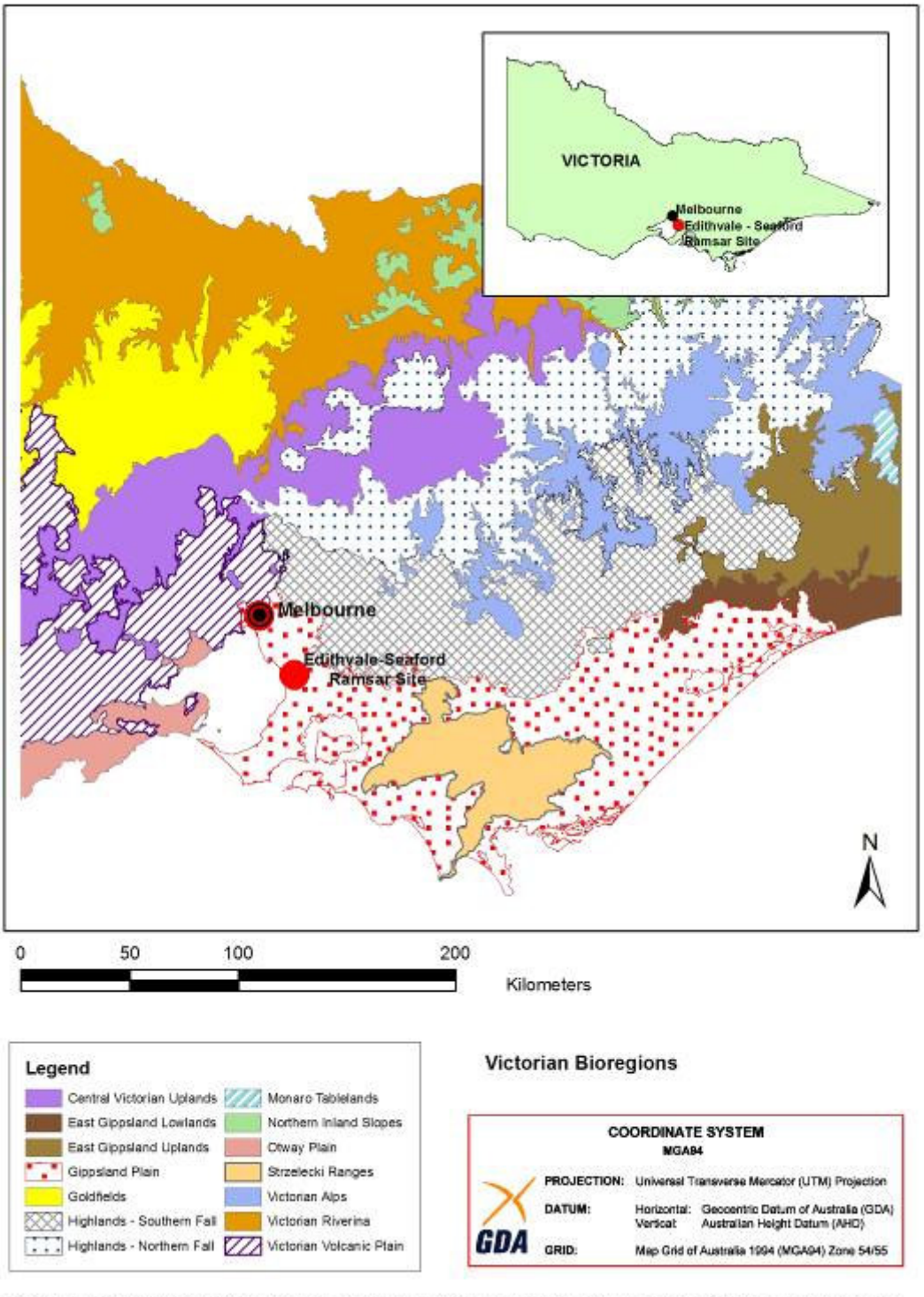

Figure 7. Gippsland Plain Bioregion.

2.2 Ramsar criteria

The Edithvale-Seaford Wetlands were listed in 2001 as meeting the Ramsar site Criteria 1, 2 and 6 (RIS, published 2001). In addition the site regularly supports a high diversity of waterbird species and native vegetation typical of the bioregion, meeting Criterion 3. The criteria and the specific features of the site that meet these Ramsar criteria are detailed below. There is no evidence that the other Ramsar criteria are met or were met at the time of listing.

Criterion 1: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.

The site contains the last remaining representative examples of the Carrum Carrum Swamp, a large southern Australian freshwater wetland, largely drained in the late 19th century (GHD 2005). This includes the shallow freshwater marsh wetland type (Corrick and Norman, 1980) which has been depleted in the Gippsland Plain Bioregion by 70%.

The wetlands are an essential component of the regional drainage system in receiving, retaining and diverting stormwater and other surface runoff. They have critical flood storage capacity that protects surrounding and downstream properties from inundation and assists in the natural control of flooding.

Criterion 2: A wetland should be considered internationally important if it supports vulnerable, endangered or critically endangered species or threatened ecological communities.

The site supports populations of the Australasian Bittern *Botaurus poiciloptilus*, as well as foraging and potential breeding habitat. The Australasian Bittern is listed as endangered on the 'The 2008 IUCN Red List of Threatened Species' (www.iucnredlist.org). The species has been repeatedly recorded for the Edithvale-Seaford Wetlands from 1989 when the surveys began. One percent of the SE Australian population is 20 birds (Wetlands International 2006). The maximum count in individual month surveys from 1989 to 2007 for both wetlands ranges between 0 and 14 (source: Melbourne Water Waterways Biodiversity Database)

Criterion 3: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.

Seventy five different native waterbird species were recorded in the period 1989 – 2007. This represents 85% of the waterbird species recorded in the Gippsland Plains bioregion for this period. Forty eight of these species were recorded in at least ten of the years in this survey period with the remainder being recorded less frequently.

The Ramsar site supports ecological vegetation communities (EVCs) characteristic of (TBLD 2005) the Gippsland Plain Bioregion, many of which are threatened.

Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

The site regularly supports more than 1% of the East Asian-Australasian Flyway population of Sharp-tailed Sandpiper *Calidris acuminata*. A waterfowl count in summer 1987 recorded 3000 Sharp-tailed Sandpipers at Seaford Swamp (Watkins, 1993). Regular monthly counts at Edithvale and Seaford Wetlands, since 1990, indicate that the 1% population estimate for Sharp-tailed Sandpiper (Wetlands International, 2006) was exceeded six times in the period 1991 - 2005.

Sharp-tailed Sandpipers use a wide variety of coastal and inland habitats in Australia. Population fluctuations at coastal sites, such as the Edithvale-Seaford Wetlands, are significantly influenced by the availability of suitable inland habitat. The availability of inland habitat is marked by a high degree of rainfall variability associated with long term climatic variability. In addition, the habitat suitability for the species at the Edithvale-Seaford Wetlands also varies, depending on rainfall. Within this context, the counts and observations outlined above indicate that the site regularly supports this species.

3 Ecosystem services for the Edithvale-Seaford Wetlands Ramsar Site

The ecosystem benefits or services for the Edithvale-Seaford Wetlands Ramsar Site are listed in Table 4. The primary source of the information for each ecosystem service is indicated.

Table 4 Ecosystem services for the Edithvale-Seaford Wetlands Ramsar Site.

Ecosystem Service	Source
The wetlands have critical flood storage capacity that protects surrounding and downstream properties from inundation and assists in the natural control of flooding.	Lane et al. 2000
The wetlands are an essential component of the regional drainage system in receiving, retaining and diverting stormwater and other surface runoff.	Lane et al. 2000
The wetlands contribute to protecting the water quality of Port Phillip Bay by retaining and naturally "treating" stormwater and other surface runoff at limited cost.	Lane et al. 2000
The wetlands are the last remaining representative example of the Carrum Carrum Swamp (a once extensive wetland system) and of the depleted, shallow freshwater wetland type in the Gippsland Plain Bioregion which lies within the South-eastern Coastal Plain Biogeographic Region.	Lane et al. 2000
The wetlands support very rich biodiversity which includes 75 waterbird species and populations of international importance.	Lane et al. 2000
The wetlands are a significant regional resource for passive and nature-based recreation.	Lane et al. 2000
The wetlands offer environmental education opportunities for local schools, tertiary institutions and the community.	Lane et al. 2000
The wetlands are of great significance for environmental research, in fields relevant to both the water industry and ecology.	Lane et al. 2000
The wetlands are an example of a managed wetland system.	Lane et al. 2000
The wetlands support threatened EVCs characteristic of the Gippsland Plain Bioregion.	TBLD (2005)
The wetlands support the endangered Australiasian Bittern and other nationally threatened species.	Lane et al. 2000 RIS (2001)
The wetlands regularly support 1% of the East Asian-Australasian Flyway population for Sharp-tailed Sandpipers.	RIS (2001)

4 Ecosystem services to be used for the ecological character description

The ecosystem services listed in Table 5 will be used as the basis for the ECD for the Edithvale-Seaford Wetlands Ramsar Site. These services relate to the Ramsar criteria for which the wetlands were listed but are also directly related to the value of the wetland as an essential part of the regional drainage system and for recreation, education and research.

Table 5 Ecosystem services to be used for the ECD.

Ecosystem services that relate to the Ramsar criteria for listing Edithvale-Seaford as a Ramsar Site	**Ramsar Criteria**
Last remaining representative example of the Carrum Carrum Swamp. Representative of the depleted shallow freshwater wetland type in the Gippsland Plain Bioregion.	1
Assists in the natural control of flooding	1
Supports threatened species, particularly the Australasian Bittern	2
Regularly supports 1% of the East Asian-Australasian Flyway population for Sharp-tailed Sandpipers	6
The wetlands support threatened ecological vegetation communities characteristic of the Gippsland Plains Bioregion	3*
Ecosystem services that relate to the Ramsar criteria for which the site was not originally listed	
Supports a high diversity of waterbird species	3*

***Criterion 3 was added after the site was listed in 2001.**

Water quality in the wetlands is significantly influenced by stormwater runoff from adjacent urban areas containing sediment, nutrients and toxicants (Lane et al., 2000). Lane et al. (2000) reported that the Edithvale-Seaford Wetlands "contribute to protecting the water quality of Port Phillip Bay by retaining and naturally "treating" stormwater and other surface runoff at limited cost". Although this is likely to be the case and would contribute to the Ramsar site meeting Ramsar criterion 1, data are not available to quantify the service provided by the Edithvale-Seaford Wetlands to assist in maintaining the water quality of Port Phillip Bay. The service is not included for the ECD. A water quality monitoring program at the wetlands is identified as a data gap.

The value of the wetlands as an example of a managed wetland system are based on significant research, investigation and monitoring activities by the land managers. These include a review of hydrological operations (GHD, 2005), revegetation prescriptions (TBLD, 2005) and bird survey and management (Tzaros et al., 2005, Silocks et al., 2006).

5 Description of ecosystem services and identification of related ecological components and processes

This section describes, in specific terms, each of the ecosystem services selected as the basis for the ECD. It also identifies the ecological components and processes that are critical in supporting each service.

Ecosystem services are specified as they were as close as possible to the time of listing in 2001. Where more recent data have been collected for the same ecosystem service, the findings of 2001 and the more recent surveys are both provided. The most recent surveys tend to be more detailed and systematic than those conducted in 2001. For services subject to natural variability data collected over several years have been used to quantify the ecosystem service.

5.1 Wetland representativeness

The wetlands in the Ramsar site were mapped and recorded on the DSE geospatial data layer (WETLAND_1994) in 1993 based on interpretation of air photographs taken in the late 1980s (Martin O'Brien pers. comm.). Changes in salinity associated with excavation of parts of the wetlands were not detected at the time of mapping (Martin O'Brien pers. comm.).

The classification used at the time of listing was the Victorian classification of Corrick and Norman (1980). The wetlands meet the Ramsar types:

- P – seasonal /intermittent freshwater lakes (over 8 ha)
- R – seasonal/intermittent saline/brackish/alkaline lakes and flats
- Q – permanent saline/brackish/alkaline lakes

Wetlands within the Ramsar site were mapped in WETLAND_1994 as consisting of the permanent open freshwater (16 hectares) and shallow freshwater marsh wetland types (104 hectares) (Table 6, Figures 8 and 9). Permanent open freshwater wetlands retain water for longer than 12 months. However, they can have periods of drying. Shallow freshwater marshes are less than 0.5 metres in depth and inundated for less than eight months of the year (Corrick and Norman, 1980).

In 1987-88 excavation of some areas within the Ramsar site resulted in increases in salinity and, in some parts, a more permanent water regime. In 1988, the southern section of the Seaford Wetland was excavated to create additional wetland and lake areas. The excavation broke through the peat layer, allowing saline groundwater to enter this part of the wetland (Lane et al., 2000). This was exacerbated by increased groundwater inputs from the local drainage systems and connectivity to marine waters of Kananook Creek via drainage systems (GHD, 2005). These conditions existed at the time of listing and works were initiated to manage salinity.

Excavation of wetland depressions in the Edithvale North Wetlands into underlying sands commenced in 1987-88. These excavations proved to be too deep and allowed saline groundwater to enter, resulting in high salinity levels which are less suitable for certain waterbirds and native vegetation (GHD 2005).

Recognition of the salinity issue and steps to manage it and restore the freshwater regime as much as possible were begun in the early 1990s. By the time of listing, adverse effects had been somewhat ameliorated. In 2005, Melbourne Water commissioned a review of the hydrological operation of the Edithvale-Seaford Wetlands to 'ensure that the hydrological infrastructure and processes in the wetlands maintain and enhance biodiversity, including enhanced water quality and filling, drying and drawdown in synergy with natural processes, consistent with the regional drainage system and flood storage needs" (GHD, 2005). This resulted in hydrological objectives and specific hydrological operations being recommended (GHD, 2005). These are now being implemented.

The Edithvale-Seaford Wetlands Ramsar Site supports the service of wetland representativeness for two reasons.

Firstly, the Edithvale-Seaford Wetlands are the last remaining significant representative example of the Carrum Carrum Swamp, a once extensive wetland system. The Carrum Carrum Swamp, pre-European settlement, extended almost from Mordialloc to Frankston (GHD, 2005) (Table 6, Figure 1). A DSE geospatial layer that estimates the original extent and classification of wetlands at the time of European settlement (WETLAND_1788) shows the area of the Carrum Carrum Swamp pre-European settlement was 4319 hectares and that it was classified as a shallow freshwater marsh (Table 6). The wetlands in the Ramsar site largely retain basic characteristics (including vegetation and fauna communities) of the former system although their catchments, water flows and, in some cases, depth and salinity were altered before the time of listing and their water regime and vegetation is now actively managed to maintain and restore the original wetland types as far as possible.

Secondly, the remaining areas of shallow freshwater marsh are representative of a depleted wetland type in the Gippsland Plains Bioregion. Within this Bioregion shallow freshwater marshes have been reduced in area by 70%. The Edithvale-Seaford Wetlands did not originally support the permanent open freshwater wetland type. The area of this wetland category has increased in the Ramsar site as a result of wetland excavation and in the Bioregion as a result of the construction of deeper artificial impoundments (Table 6) since European settlement.

Table 6. Change in extent of wetland type (Corrick and Norman 1980) between the time of European Settlement and the period prior to 1994 in the Gippsland Plains Bioregion (source: WETLAND_1994 and WETLAND_1788 layers, DSE GIS Corporate Geospatial Data Library).

Wetland category		**Permanent Open Freshwater**	**Shallow Freshwater Marsh**	**Freshwater Meadow**	**Permanent Saline Wetland**
WETLAND_1994 area within Ramsar site (ha)		16*	116	0	0
Carrum Carrum Swamp	Pre-European settlement (WETLAND_1788) area (ha)	0	4319	0	0
	WETLAND_1994 area (ha)	33**	119	52***	58***
	% change in area	-	97% decrease	-	-
Gippsland Plain Bioregion	Pre-European settlement (WETLAND_1788) area (ha)	230	6665	-	-
	WETLAND_1994 area (ha)	346	1922	-	-
	% change in area	150% increase*	70% decrease	-	-

*** deeper excavated areas,**

**** mainly artificially created wetlands,**

***** areas outside the Ramsar site that were formerly shallow freshwater marsh.**

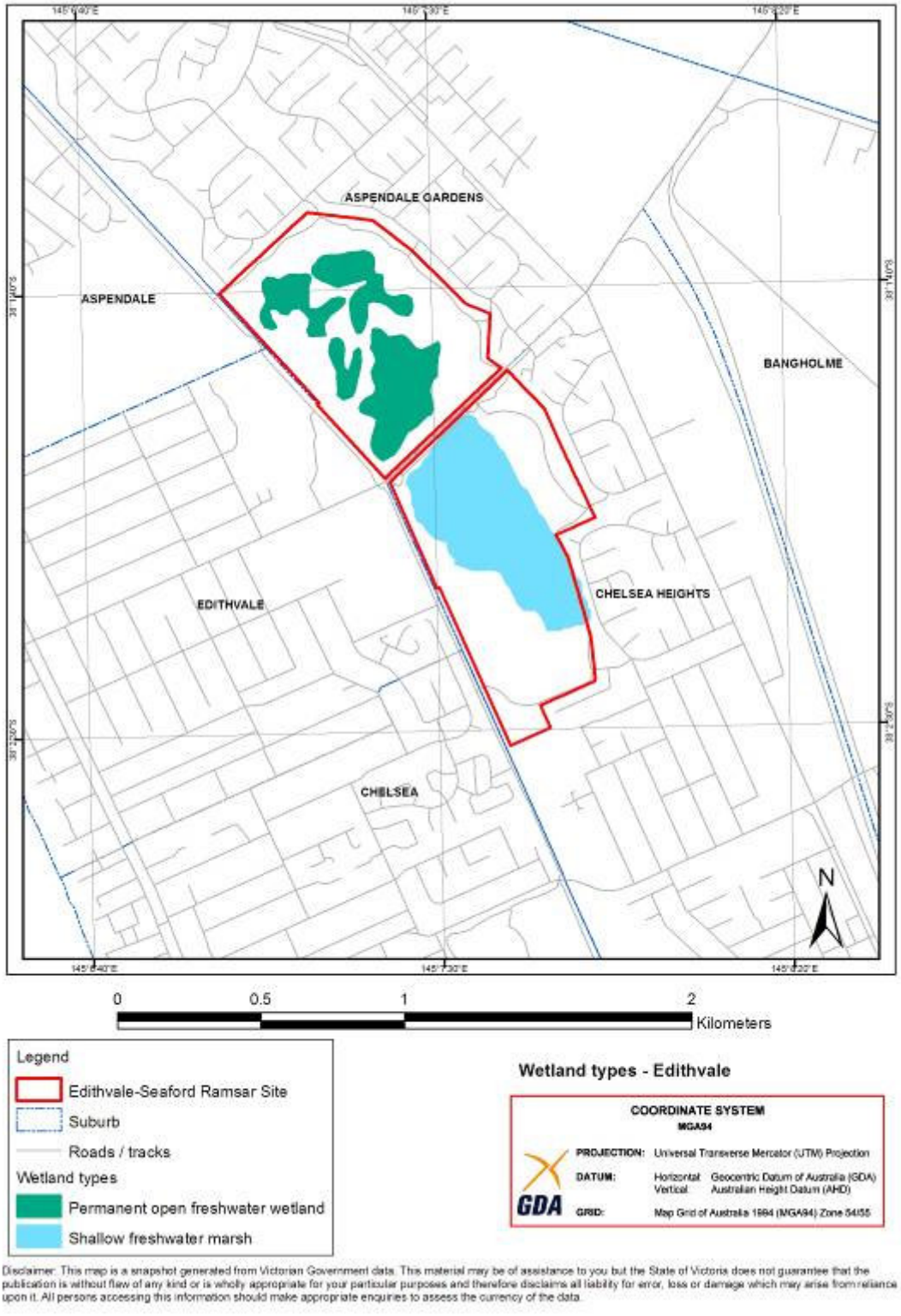

Figure 8. Wetland types in the Edithvale wetland as recorded on the DSE geospatial layer WETLAND_1994.

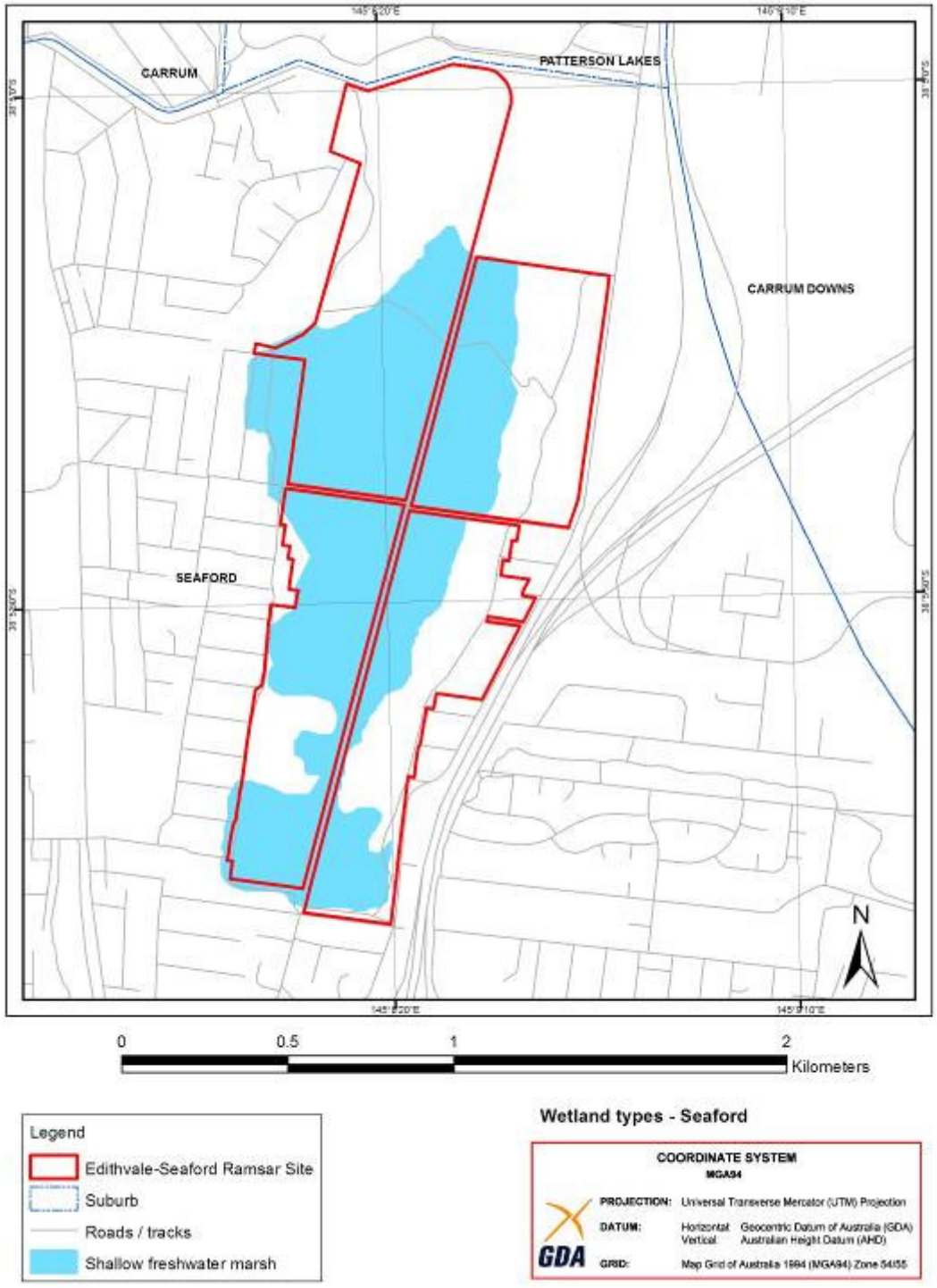

Figure 9. Wetland types in the Seaford wetland as recorded on the DSE geospatial layer WETLAND_1994.

The benchmark used for assessing change to the ecosystem service of wetland representativeness is the success of the hydrological objectives and specific hydrological operations recommended by GHD (2005) (see Section 6.1) and the revegetation prescriptions recommended by TBLD (2005) (see Sections 5.5 and 6.3). A monitoring program should be established to monitor the achievement of these outcomes.

The ecosystem components considered to be most important in maintaining and restoring the representative shallow freshwater wetland type are outlined in Table 7.

Table 7. Ecosystem components important in maintaining wetland representativeness.

Component	How the component maintains the service
Hydrology	The status of the wetlands as permanent or temporary, deep or shallow, depends on the frequency and duration of flooding, which is governed by active management of wetland hydrology as outlined in Section 6.1.
Wetland topography	The topography of the wetlands determines the potential depth of inundation of wetland areas. Water depth also influences duration of inundation with deep wetlands taking longer to dry than shallow ones after filling. Although topography is not proposed to change, water levels are managed as outlined in Section 6.1.
Salinity	Wetlands are classed as saline if salinity exceeds 3,000 mg/L (5,000 EC) throughout the year (Appendix 1). Wetlands in the Edithvale-Seaford Wetlands Ramsar Site were originally fresh but some wetland cells had become saline or brackish before the time of listing. Active management has been put in place to manage salinity.
Connectivity	Artificial connectivity of wetlands now plays a key part in maintaining wetland type e.g. some wetlands only remain permanent because the infrastructure is in place to deliver and discharge water. The surrounding environment is highly modified and the wetlands have been largely cut off from their natural source of water. Wetlands have been connected to accept stormwater and catchment runoff from artificial drains. Excavation has created connectivity to the groundwater.

5.2 Flood control and catchment drainage

The Edithvale-Seaford Wetlands were once part of an extensive wetland system but now are a small remnant of this system lying within a highly modified urban catchment (Figure 10).

The flood storage values of the Edithvale-Seaford Wetlands were recognised prior to listing on the Ramsar Convention. Lane et al. (2000) reports that the wetlands are an essential component of the regional drainage system in receiving, retaining and diverting stormwater and other surface runoff. The wetlands have a flood storage capacity that prevents serious flooding of surrounding properties (Lane et al., 2000). This value and community action to protect the wetlands from development prompted the former Dandenong Valley Authority (now Melbourne Water) to acquire 125 hectares of the floodplain in 1974, including Edithvale South Wetland and part of Edithvale North Wetland (Lane et al., 2000). Seaford Wetland is a critical component of the floodplain storage for the region. Both the Frankston City Council and the Dandenong Valley Authority progressively purchased the area between 1973 and 1987 (GHD, 2005).

The flood control service consists of accepting floodwater from the surrounding catchments, storing floodwater in the wetlands and preventing water levels from rising within the Ramsar site to a level where neighbouring land would be inundated. This involves discharging excess floodwaters from the wetlands when threshold wetland flood levels have been reached. The hydrological management of the wetlands outlined in Section 6.1 addresses both flood control and ecological objectives. Catchment drainage characteristics are described in GHD (2005). They have not changed significantly since listing of the Ramsar site in 2001 but would need to be reviewed if catchment land use or climate change resulted in changes to the regional drainage regime.

A change in the ecological character of the Ramsar site with respect to this service would be indicated by change in flood storage capacity or a change in catchment runoff characteristics or groundwater inflows that resulted in failure to achieve target winter/spring and summer/autumn target water levels outlined in Section 6.1.

Wetland ecosystem components that are important for overall maintenance of flood control and catchment drainage at the Edithvale-Seaford Wetlands Ramsar Site are provided in Table 8.

Table 8 Ecosystem components important in maintaining flood control and catchment drainage.

Component	How the component maintains the service
Wetland topography	The topography of the wetlands determines the amount of flow the wetlands can pond. If for some reason the topography of the wetlands changed in such a way that their capacity decreased (e.g. they became shallower), water may not be confined in the wetlands and create flooding issues for surrounding landholders.
Vegetation	Vegetation may influence the rate of flooding by slowing flood waters and releasing them more slowly into outlet drains reducing downstream flooding.
Connectivity	Upstream connectivity (regulators, structures, drains that regulate the amount of flow to the wetlands) and downstream connectivity (control of water that leaves the wetlands) control the amount of water entering and leaving the wetland and the rate at which it flows in and out.
Sedimentation	Sedimentation from catchment runoff may make the wetlands shallower over time, reducing flood capacity.
Catchment land use	Changes in catchment land use may change water yield and runoff characteristics.
Climate	Change in frequency and intensity of rainfall events are possible with climate change and may change catchment water yield.

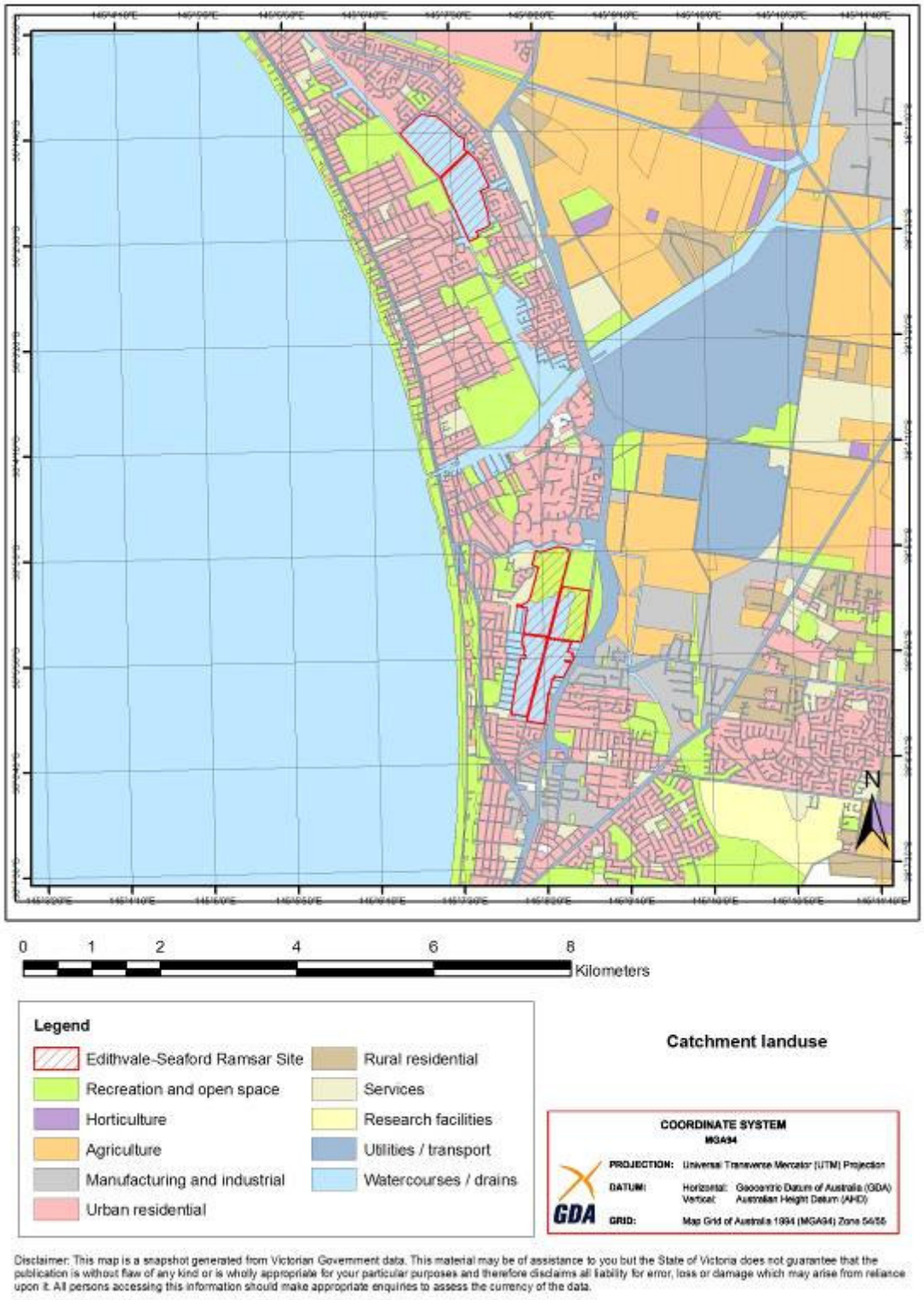

Figure 10. Land use in the catchment and surrounding areas of the Edithvale-Seaford Wetlands Ramsar Site. Data source: DSE Corporate Geospatial Data Library LANDUSE100_PP layer, based on data captured 1970-2002.

5.3 Supports threatened species, particularly waterbirds

Important to this ECD is the occurrence of the Australasian Bittern *Botaurus poiciloptilus* which is globally endangered as determined by the IUCN Red list of threatened species (http://www.iucnredlist.org) and listed as endangered under the EPBC Act. The Ramsar site provides good habitat for the species and they are regularly recorded. The ECD for this service focuses on the Australasian Bittern.

The Swift Parrot *Lathamus discolor* and Orange-bellied Parrot *Neophema chrysogaster* have also been recorded at the Ramsar site. These species are threatened at the national level and listed under the EPBC Act. In the DSE Victorian Fauna Database there is a record of the Swift Parrot within two kilometres of Seaford Wetland from 1984. The parrot was sighted at the Seaford Wetland in August 2004 with a single bird flying through the eucalypt woodlands adjoining the wetland and again in April 2005 with a single bird flying high over the wetland (Tzaros et al., 2005).

The Orange-bellied Parrot uses saltmarsh habitats along the southern coastline of Victoria and South Australia including Port Phillip Bay. It was recorded by Lane et al. (2000) as using the Ramsar Site, however, these appear to be historical records, one record is from Seaford from 1964 and the second is from Edithvale South and was in 1977 (DSE Victorian Fauna Database). The wetlands do not appear to provide critical habitat for these species and they are not discussed further.

In addition to these species there a number of bird species that are threatened in Victoria (but not nationally or internationally) that have been recorded at the Ramsar site. No listed flora taxa have been recorded in the wetlands (Lane et al., 2000). Lane et al. (2000) reported bird species listed under the *Flora and Fauna Guarantee Act 1988 (Vic.*) (FFG Act) in the Edithvale–Seaford Wetlands prior to listing on the Ramsar Convention. Since then further bird surveys have been conducted at the Edithvale-Seaford Wetlands Ramsar Site. Table 9 lists species of State and National significance that were recoded by Lane et al. (2000) and Tzaros et al. (2005). Table 10 summarises data for these species in the period 1989-2007. Silocks et al. (2006) has analysed trends for these species where sufficient data existed (records in six or more years). Statistically significant trends were not found at either Seaford or Edithvale Wetland. Trends should continue to be monitored.

Table 9 Threatened species recorded for the Edithvale-Seaford Wetlands Ramsar Site.

Species	Recorded by Lane et al (2000)	Recorded by Tzaros et al (2005)	Conservation status		FFG Act listed
			National	Victoria	
Blue-billed Duck	X	X		E	L
Musk Duck	X	X		V	
Freckled Duck	X	X		E	L
Australasian Shoveler		X		V	
Hardhead	X	X		V	
Great Egret	X	X		V	L
Cattle Egret	X	X		V	L
Australasian Bittern*	X	X		E	L
Royal Spoonbill	X	X		V	
White-bellied Sea Eagle	X			V	L
Lewin's Rail	X	X		V	L
Ballion's Crake	X	X		V	L

Table 9 continued.

Species	Recorded by Lane et al (2000)	Recorded by Tzaros et al (2005)	Conservation status		FFG Act listed
			National	Victoria	
Wood Sandpiper	X	X		V	
Swift Parrot*	X	X	E	E	L
Orange-bellied Parrot*	X		E	E	L

E - Endangered, V - Vulnerable, L - Listed on FFG Act, * - IUCN, Red list of threatened species

Table 10 Summary of survey data for threatened species for Edithvale Wetland and Seaford Wetland from monthly counts 1989 - 2007 (Source: Melbourne Water Waterways Biodiversity Database). n.r. = not recorded.

Species	% surveys where species recorded		Average count (when recorded)		Maximum count in individual survey	
	Edithvale Wetland	Seaford Wetland	Edithvale Wetland	Seaford Wetland	Edithvale Wetland	Seaford Wetland
Blue-billed Duck	75.4	19.1	8.21	6.46	36	20
Musk Duck	76.3	1.5	3.29	1.00	10	1
Freckled Duck	1.9	n.r.	3.50	n.r.	9	n.r.
Australasian Shoveler	n.r.	11.0	n.r.	5.67	n.r.	12
Hardhead	64.7	33.8	11.48	9.96	82	65
Great Egret	26.1	39.0	1.39	1.28	4	4
Cattle Egret						
Australasian Bittern	38.6	15.4	2.98	1.19	12	2
Royal Spoonbill	31.4	46.3	2.14	2.33	8	9
White-bellied Sea Eagle	n.r.	0.7	n.r.	1.00	n.r.	1
Lewin's Rail	1.4	0.7	1.33	1.00	2	1
Ballion's Crake	20.8	7.4	2.98	1.30	17	2
Wood Sandpiper	22.7	0.7	2.32	1.00	9	1
Swift Parrot	n.r.	1.5	n.r.	1.00	n.r.	1
Orange-bellied Parrot	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.

Wetlands International (2006) indicates that there are four populations of the Australasian Bittern in the world. One is possibly extinct (New Caledonia), the New Zealand population is estimated at less than 750, the south west Australian population as 500 and the south east (SE) Australian population as 2000. The species is reported to favour freshwater wetlands with tall, dense vegetation. This allows it to hide during the day amongst dense reeds or rushes and feed mainly at night.

The Australasian Bitten has been repeatedly recorded for the Edithvale-Seaford Wetlands from 1989 when surveys began (Table 11). It is thought that these birds benefit from the high water levels of the

wetland over the winter-spring period (Tzaros et al., 2005) and the dense vegetation in the wetlands. Silocks et al. (2006) suggest that the species could potentially breed at the site if areas of Phragmites *Phragmites australis* and Cumbungi *Typha* spp. increase. In surveys from the period May 2005 and April 2006, Australasian Bittern were recorded in small numbers from May to October at Edithvale Wetland (Silocks et al., 2006.). One per cent of the SE Australian population is 20 birds. The maximum count in individual monthly surveys from 1989 to 2007 for both wetlands ranges between 0 and 14 (Table 11).

The change in ecological character for this ecosystem service would be indicated by a sustained decline in the number of Australasian Bittern (recorded over five years using a five-year rolling average of the maximum count in each year from monthly surveys). The survey methods used by Tzaros et al. (2005) are adequate to detect changes in Australasian Bittern numbers. If such a trend was detected, further investigation would be warranted to determine if it was likely to be caused by habitat changes in the Ramsar Site or external factors.

Table 11 Australasian Bittern records for Edithvale Wetland and Seaford Wetland from 1989 to 2007. Data are from 207 monthly counts at Edithvale Wetland September 1989 – June 2007 and 114 monthly counts from Seaford wetland June 1994 – October 2006 (source: Melbourne Water Waterways Biodiversity Database accessed on 28 April 2008). n.s. = no monthly survey.

Year	% surveys when species was recorded		Average count (when recorded)		Maximum count in individual survey	
	Edithvale Wetland	Seaford Wetland	Edithvale Wetland	Seaford Wetland	Edithvale Wetland	Seaford Wetland
1989	0.0	n.s.	0.00	n.s.	0	n.s.
1990	0.0	n.s.	0.00	n.s.	0	n.s.
1991	0.0	n.s.	0.00	n.s.	0	n.s.
1992	50.0	n.s.	1.17	n.s.	4	n.s.
1993	8.3	n.s.	0.08	n.s.	1	n.s.
1994	16.7	42.9	1.17	0.43	1	1
1995	41.7	8.3	0.92	0.08	3	1
1996	50.0	25.0	1.25	0.25	3	1
1997	83.3	41.7	3.42	0.50	12	2
1998	58.3	41.7	2.17	0.58	8	2
1999	41.7	8.3	1.67	0.08	6	1
2000	16.7	0.0	0.25	0.00	2	0
2001	50.0	9.1	2.58	0.18	9	2
2002	50.0	20.0	1.33	0.20	5	1
2003	20,0	0.0	0.40	0.00	3	0
2004	58.3	0.0	1.67	0.00	8	0
2005	50.0	0.0	1.33	0.00	4	0
2006	60.0	0.0	1.40	0.00	6	0
2007	100.0	0.0	1.33	0.00	2	0

Wetland ecosystem components and processes that are important for overall maintenance of threatened species at the Edithvale-Seaford Wetlands Ramsar Site are provided in Table 12. These also apply to the ecosystem services: 'diversity of waterbird species' (Section 5.4); and 'regularly supports 1% of the flyway population of Sharp-tailed Sandpipers' (Section 5.5).

Table 12 Ecosystem components and processes important in maintaining threatened fauna.

Component	How the component maintains the service
Wetland topography	The wetlands provide habitat for several of threatened bird species, many of which have different habitat requirements. The topography of the wetlands determines the potential depth of inundation of wetland areas. Water depth also influences duration of inundation with deep wetlands taking longer to dry than shallow ones after filling.
Hydrology	The hydrology of the wetlands (seasonality, frequency, duration and magnitude) is a determinant of habitat availability for threatened bird species.
Waterbird habitat	Hydrology and topography influence give rise to different habitat types that are required by different waterbird species. For example, the Australasian Bittern requires dense vegetation like reeds or rushes but the Blue-billed Duck require open water habitats surrounded by vegetation to enable feeding in open water areas and protection from dense vegetation. The habitat provides suitable areas for waterbird species, including threatened species, to roost, breed and forage. In addition suitable habitat provides shelter from predators and, in some cases, a buffer from human disturbance.
Productivity	The productivity of the wetlands determines food (plant and invertebrate) abundance for waterbirds.

5.4 Diversity of waterbird species

The definition of waterbirds used by the Ramsar Convention is as "birds ecologically dependent on wetlands" (Article 1.2). For the Edithvale-Seaford Wetlands these include the following broad groups: grebes, the Australian pelican *Pelecanus conspicillatus*, cormorants, darters, herons, bitterns, ibises and spoonbills, ducks and allies, wetland dependent raptors, wetland dependent rails, shorebirds, gulls, and terns.

The Edithvale-Seaford Wetlands provide habitat for a high diversity of waterbird species. Table 13 lists the 75 native waterbird species that have been recorded in the period 1989 – 2007. More detailed count data for waterbird species is presented in Appendix 2. Bird survey methods are described in Tzaros et al. (2004) and Tzaros et al. (2005).

Table 13 Number of years in which waterbird species have been recorded at the Edithvale Seaford Wetlands. Data is from 207 monthly counts over 19 years (1989-2007) at Edithvale Wetland and 136 monthly counts over 14 years (1994-2007) at Seaford Wetland (source: Melbourne Water Waterways Biodiversity Database accessed on 28 April 2008).

Species	No. years species recorded		Species	No. years species recorded	
	Edith-vale	Sea-ford		Edith-vale	Sea-ford
Australasian Bittern	16	8	Lewin's Rail	3	1
Australasian Darter	4	3	Little Bittern	1	1
Australasian Grebe	19	13	Little Black Cormorant	10	14
Australasian Shoveler	19	8	Little Curlew	1	0
Australian Pelican	18	13	Little Egret	1	0
Australian Reed-Warbler	19	13	Little Pied Cormorant	19	12
Australian Shelduck	10	10	Long-toed Stint	2	0
Australian Spotted Crake	17	6	Magpie Goose	7	0
Australian White Ibis	19	12	Marsh Sandpiper	13	4
Australian Wood Duck	13	9	Masked Lapwing	19	14

Table 13 continued

Species	No. years species recorded		Species	No. years species recorded	
	Edith-vale	Sea-ford		Edith-vale	Sea-ford
Baillon's Crake	16	7	Musk Duck	18	1
Black Swan	19	14	Nankeen Night Heron	4	0
Black-fronted Dotterel	19	14	Pacific Black Duck	19	14
Black-tailed Godwit	0	1	Pacific Gull	19	7
Black-tailed Native-hen	1	1	Pectoral Sandpiper	9	1
Black-winged Stilt	18	13	Pied Cormorant	3	1
Blue-billed Duck	19	8	Pink-eared Duck	8	3
Buff-banded Rail	12	0	Purple Swamphen	19	14
Cape Barren Goose	1	2	Red Knot	1	0
Caspian Tern	4	2	Red-capped Plover	4	9
Cattle Egret	11	3	Red-kneed Dotterel	14	4
Chestnut Teal	19	14	Red-necked Avocet	3	5
Common Greenshank	15	13	Red-necked Phalarope	0	1
Common Tern	1	1	Red-necked Stint	10	6
Curlew Sandpiper	13	4	Royal Spoonbill	18	13
Double-banded Plover	2	2	Sharp-tailed Sandpiper	18	12
Dusky Moorhen	19	11	Silver Gull	19	14
Eastern Great Egret	17	14	Spotless Crake	13	4
Eurasian Coot	19	12	Straw-necked Ibis	18	12
Freckled Duck	2	1	Swamp Harrier	19	14
Glossy Ibis	5	0	Whiskered Tern	16	7
Great Cormorant	18	12	White-bellied Sea-Eagle	1	1
Great Crested Grebe	5	2	White-faced Heron	19	13
Grey Teal	18	14	White-necked Heron	10	2
Hardhead	19	12	White-winged Black Tern	5	0
Hoary-headed Grebe	19	14	Wood Sandpiper	17	1
Intermediate Egret	4	0	Yellow-billed Spoonbill	15	11
Latham's Snipe	19	13			

The limits of acceptable change for this ecosystem service are difficult to define, given the variety of species and the many factors that influence waterbird distribution and abundance at local and regional scales. Monitoring of trends for significant species as undertaken by Silocks et al. (2006) should be continued. In addition, monthly waterbird counts should be analysed regularly to detect any change which might signal a change in ecological character for this service. A significant decline in numbers for significant species and/or a 10% change in the number of years in which a species was recorded over a rolling twenty year period at Edithvale-Seaford Wetlands should trigger an investigation into the cause of such a change.

Wetland ecosystem components and processes that are important for overall maintenance of the number of species at the Edithvale-Seaford Wetlands Ramsar Site are the same as those listed in Table 12 (Section 5.3).

5.4 Regularly supports 1% of the East Asian-Australasian Flyway population of Sharp-tailed Sandpipers

The East Asian-Australasian Flyway (the Flyway) stretches from the Russian Far East and Alaska, southwards through East Asia and South-east Asia, to Australia and New Zealand and encompasses 22 countries. The flyway population of Sharp-tailed Sandpipers is reported as 160,000 and hence the 1% flyway population is 1600 (Wetland International, 2006).

The RIS (2001) reports that:

> "The site regularly supports more than 1% of the flyway population of Sharp-tailed Sandpiper (*Calidris acuminata*). A waterfowl count in summer 1987 recorded 3000 Sharp-tailed Sandpipers at Seaford Swamp (Watkins 1993). Regular monthly counts at Edithvale and Seaford Wetlands, since 1990, show 2007 Sharp-tailed Sandpipers were recorded at the Edithvale Wetland in December 1991. Other data collected by experienced bird watchers at both wetlands is not readily available but discussions indicate that the 1% population estimate for Sharp-tailed Sandpiper is probably exceeded about one year in three, on average.
>
> Sharp-tailed Sandpipers use a wide variety of coastal and inland habitats in Australia. Population fluctuations at coastal sites, such as Edithvale-Seaford, are significantly influenced by the availability of suitable inland habitat. The availability of inland habitat is marked by a high degree of rainfall variability associated with long term climatic cycles. In addition, the habitat suitability for the species at the Edithvale-Seaford Wetlands also varies, depending on rainfall. Within this context, the counts and observations outlined above indicate that the site regularly supports this species."

The results of more recent monthly bird counts of the Edithvale-Seaford Wetlands Ramsar Site support the original justification for listing under the Ramsar Criteria 6. Table 14 shows that the Ramsar Criteria of 1% flyway population for Sharp-tailed Sandpipers has been recorded six times at the Edithvale-Seaford Wetlands Ramsar Site between 1989 and 2006.

Table 14 Sharp-tailed Sandpiper numbers exceeding 1% of the flyway population recorded for Edithvale-Seaford Wetlands Ramsar Site during annual counts in summer, September 1989 to February 2006. Survey identifiers and data are from the Melbourne Water Waterways Biodiversity Database.

Management Area	Survey ID	Date	No. of Sharp-tailed Sandpipers recorded
Edithvale South	F0214	8-Dec-91	2000
Edithvale South	F0310	20-Dec-99	2000
Edithvale South	F0311	15-Jan-00	2000
Edithvale South	F0312	6-Feb-00	3000
Edithvale South	F0317	13-Nov-02	2800
Edithvale South	K0065	8-Jan-05	5000

A change in the ecological character for this ecosystem service would be signalled by a sustained decline over 5 years in the frequency with which species meet the 1% criterion over the previous 18 year period, compared to the benchmark period (1989 – 2006).

If this was to occur, the following factors should be investigated:

- habitat availability in the Ramsar site; and
- external factors such as flyway population changes or wetland availability in Australia which may explain the change.

Wetland ecosystem components and processes that are important in maintaining Sharp-tailed Sandpiper numbers at the Edithvale-Seaford Wetlands Ramsar Site are the same as those in listed in Table 12 (Section 5.3).

5.5 Supports vegetation characteristic of the bioregion

During the preparation of the Edithvale-Seaford Ramsar Management Plan (Lane et al., 2000) the vegetation of the Edithvale-Seaford Wetlands was surveyed and described in terms of vegetation communities. It was recognised by Lane et al. (2000) that the Edithvale-Seaford Wetlands had undergone a high degree of disturbance from past land use activities. A total of 202 plant taxa were recorded for the Edithvale-Seaford Wetlands, 103 of which were indigenous (Lane et al., 2000). These records came from taxa recorded during the preparation of the Management Plan in 2000 and previously by other workers (Lane et al., 2000).

Lane et al. (2000) considered the flora to be of high regional conservation significance. TBLD (2005) mapped and described the vegetation in spring 2003 using EVCs (Table 15, Figures 11 and 12). These are different and somewhat more detailed than the vegetation communities described by Lane et al. (2000). DSE has prepared benchmark descriptions of each EVC (available on the DSE website) and has determined bioregional conservation status for most of the EVCs recorded by TBLD (2005). TBLD (2005) provided more specific descriptions and species lists for the EVCs within the Ramsar site and also described their local, regional and State significance (Table 16).

The vegetation of the Edithvale-Seaford Wetlands Ramsar Site has been greatly altered since European settlement. Change in flow regimes, weed invasion, changes to water quality and past grazing activities and wetland excavation have impacted on the vegetation condition. However, many significant EVCs exist and the area is rich in remnant vegetation. TBLD (2005) states that the vegetation communities in the Edithvale-Seaford Wetlands, while altered, are still recognisable as EVCs. Some remnant communities (e.g. Brackish Aquatic Herbland) now have different distributions to those they originally had as they have recolonised suitable habitats as environmental conditions changed due to disturbances. Others such as Damp Sands Herb-rich Woodland remain in the original location (TBLD, 2005).

TBLD (2005) provides the following overview of vegetation in the Edithvale-Seaford Wetlands.

> "Edithvale Wetlands occurs in what was the deepest part of the Carrum Carrum Swamp. A much larger proportion of this wetland is inundated for a greater part of the year than at Seaford, and this is reflected by patterns of vegetation distribution. Vegetation communities are zoned in concentric rings, which correlate with the maximum water depth that the component plant species can grow in. The pattern of vegetation distribution at Seaford is rather complex, being influenced by the location of major drains and other earthworks which have altered natural soil profiles. Parts of eastern section of this site have been affected by secondary salinity. A decrease in inundation by fresh water has allowed saline groundwater to reach the surface. A consequence of this has been the invasion of native plant communities by a number of weeds which are favoured by an increase in salinity, including **Juncus acutus*".

Table 15 EVC descriptions of wetland vegetation in the Edithvale Seaford Wetlands Ramsar Site in spring 2003 (TBLD, 2005).

EVC (name in bold)	Description and notes
Damp Sands Herb-rich Woodland	This community has a canopy of *Eucalyptus camaldulensis, Eucalyptus pryoriana* and *Banksia integrifolia*, with an open shrub-layer of *Acacia melanoxylon* and *Acacia mearnsii*. Non-local trees and shrubs that have invaded include *Pinus radiata* and the native *Eucalyptus botryoides* and *Leptospermum laevigatum*. The once diverse herb-rich field-layer has been heavily invaded by weeds, though still contains *Hemarthria uncinata*, *Pteridium esculentum*, *Lomandra longifolia*, *Ficinia nodosa*, *Senecio hispidulus*, *Austrodanthonia setacea*, *Austrodanthonia geniculata* and *Crassula sieberiana ssp. Tetramera*. This community is associated with quaternary dunes that flank the swamp deposits of the former Carrum Carrum Swamp. Remnants occur at Seaford Wetland.
Plains Grassland/Grassy Woodland	Scattered areas of degraded native grassland along the eastern side of both Edithvale and Seaford Wetlands are remnants of a grassland/grassy woodland community which occurred on the heavy soils formed by swamp deposits, in areas which were infrequently inundated. This community was either naturally treeless or may have supported a sparse canopy of *Eucalyptus camaldulensis*. Remnant components of this community include *Austrodanthonia laevis*, *A. setacea*, *A. racemosa*, *Poa labillardieri*, *Juncus subsecundus*, *Oxalis perrenans*, *Microtis unifolia* and *Thelymitra pauciflora*. This community is associated with quaternary dunes that flank the swamp deposits of the former Carrum Carrum Swamp. Remnants occur at Seaford Wetland.
Swamp Scrub	This community is dominated by dense *Melaleuca ericifolia*. Some areas have a scattered overstorey of *Eucalyptus ovata*. The field-layer varies with depth and duration of inundation from introduced grasses and blackberry in drier areas, to *Triglochin procerum* and *Phragmites australis* in Shallow Marsh areas (inundated by <40 cm for <6 months). This community occurs as scattered stands at Edithvale Wetlands, with an isolated occurrence at Seaford.
Brackish Wetland (Sea Rush Rushland)	This community is dominated by *Juncus krausii*, with associated species including *Triglochin striatum*, *Lobelia anceps*, *Selliera radicans*, *Sarcocoria quinquiflora*, *Mimulus repens*, *Isolepis inundata* and *Isolepis cernua*. It occurs in areas that are seasonally waterlogged or inundated by up to 20 cm of water, with spring EC 2,000 to 15,000 µS/cm. This community occurs in a localized area at Edithvale North and extensively at Seaford.
Brackish Wetland (Herbland/Sedgeland)	Dominants of this community vary from sedgeland of *Bolboschoenus caldwellii* (areas remaining moist into summer), *Eleocharis acuta* or *Baumea arthrophylla* to herbland with *Mimulus repens*, *Lilaeopsis polyantha*, *Triglochin striatum*, *Selleria radicans*, *Sarcocornia quinquiflora*, *Senecio glomeratus*, *Senecio linearifolius*, *Crassula helmsii* and *Persicaria decipiens* (species composition varying with local salinity levels and depth of inundation). It occurs in areas inundated by up to 30 cm of water for up to 6 months, with spring EC 2200 to 7,400 µS/cm, increasing into summer and autumn. This community occurs at both Edithvale and Seaford wetlands.
Plains Sedgy Wetland	Dominants of this community include *Eleocharis acuta* and *Baumea arthrophylla*, with associated species including *Centella cordifolia*, *Selliera radicans*, *Juncus holoschoenus*, *Juncus planifolius*, *Myriophyllum crispatum*, *Myriophyllum simulans*, *Neopaxia australasica*, *Lilaeopsis polyantha*, *Triglochin striatum*, *Crassula helmsii*, *Persicaria decipiens*, *Centrolepis strigosa* and at one site the rare *Ranunculus papulentis*. Inundated by up to 30 cm of water for up to 6 months, with spring EC 800 to 1,000 µS/cm. This community occurs at Edithvale and Seaford wetlands. It provides important habitat for Snipe, Crakes, Rails and cryptic marshland passerines. This habitat is also utilized by Spoonbills, Herons, Egrets and Australasian Bitterns.

Table 15 continued

EVC (name in bold)	Description and notes
Tall Marsh (Common Reed Dominated)	Dominated by dense *Phragmites australis*, which in some areas is up to 3.5 metres tall. Associated species vary with depth and duration of inundation. In areas of shallow marsh (inundated by <40 cm for <6 months) this community includes *Triglochin procerum*, *Lemna minor*, *Crassula helmsii*, *Ranunculus amphitrichus* and *Juncus pallidus*. In localised areas the native vine *Calystegia sepium* is common. This community provides important habitat for Bitterns, Crakes, Rails and cryptic marshland passerines, such as the Clamorous Reed Warbler and Little Grassbird. In areas which have become drier due to changes in hydrology this community is invaded to varying degrees by a range of environmental weeds. These include *Phalaris aquatica*, *Lolium rigidum* and *Galium aperine*. Extensive areas of this community occcur at both Edithvale and Seaford.
Tall Marsh (Cumbungi Dominated)	Dominated by *Typha domingensis* and *Typha orientalis*, this community occurs in water 0.2 to 1 metre deep around areas of permanent fresh to brackish water. Extensive areas of this community occur at Edithvale, with isolated occurrences at Seaford. It provides important habitat for Bitterns, Crakes, Rails and cryptic marshland passerines, such as the Clamorous Reed Warbler and Little Grassbird.
Brackish Aquatic Herbland	Dominated by *Myriophyllum salsuginium*, *Nitella sp.*, *Potamogeton pectinatus* and *Triglochin procerum* with associated species including *Ruppia polycarpa*, *Ranunculus amphitrichus*, *Mimulus repens*, *Lilaeopsis polyantha*, *Batrachium trichophyllum* and *Agrostis avenacea*. In this community at Edithvale there are localised occurances of *Potamogeton ochreatus* and *P. crispus*. Occurs in areas inundated by water 0.5 to 1.5 metres deep, with spring EC values 2200 to 2300 µS/cm (in summer/autumn salinity may reach 8000 µS/cm). In shallower areas as water levels recede in summer *Bolboschoenus caldwellii* sprouts from dormant corms and becomes dominant. This community provides important habitat for Swans, Coots and diving ducks such as the Musk Duck.
Saline Aquatic Meadow (Saline Aquatic Submerged Meadow)	In this community *Ruppia polycarpa* and *Nitella sp.* form a dense submerged meadow. This community occurs in water 0.5 to 1.5 metres deep with spring EC values from 12,000 to 15,000 µS/cm. Occurs extensively at Seaford with a small occurrence at Edithvale at the Dog Pond. Provides food for Coots, Swans and some Ducks.
Aquatic Herbland Aquatic Sedgeland (Aquatic Herbland/Sedgeland)	This community is dominated by *Eleocharis sphacelata* and *Triglochin procerum* associated with *Myriophyllum simulans*, *Isolepis inundatus* and *Lilaeopsis polyantha*. It occurs in water 0.5 to 1 metre deep with a spring EC of 1000 µS/cm. This community occurs in the east of Seaford Wetland, near the end of Rossiter Crt. It provides an important habitat for frogs because of the availability of permanent fresh water.
Open Water/Mudflats	Areas that at the time of the survey did not support any emergent or submerged aquatic vegetation. In the middle section of Seaford these areas are fringed by *Sarcocornia quinquiflora*, *Mimulus repens* and *Triglochin striatum* and *Cotula coronopifolia*.

Table 16 Conservation significance (TBLD, 2005) and DSE bioregional conservation status (BCS) (Fiona Ferwerda pers. comm.) of wetland EVCs in the Edithvale Seaford Wetlands Ramsar Site.

EVC	Conservation significance	Notes on significance	DSE BCS
Damp Sands Herb-rich Woodland	High Regional	Uncommon community Maturity of canopy trees Poorly reserved Heavy weed invasion	Vulnerable

Table 16 continued

EVC	Conservation significance	Notes on significance	DSE BCS
Plains Grassland/Grassy Woodland	High Local	Threatened community Poorly reserved Small and fragmented remnants Low diversity	Endangered
Swamp Scrub†	High Local	Depleted community Small remnant	Endangered
Brackish Wetland† Sea Rush Rushland	High Regional	Uncommon community Extensive occurrence in study Few weeds	Endangered
Brackish Wetland * Herbland/Sedgeland	High Regional	Uncommon community Extensive occurrence in study High diversity Few weeds	
Plains Sedgy Wetland*	State	Uncommon community Moderately extensive Supports species of state significance High diversity	Not available
Tall Marsh* Common Reed Dominated	State	Uncommon community Extensive occurrence in study area Few weeds Poorly reserved	Not available
Tall Marsh* Cumbungi Dominated	High Regional	Extensive occurrence in study area Few weeds Poorly reserved	Not available
Brackish Aquatic Herbland*	State	Rare and depleted community Uncommon character species Extensive occurrence in study area High diversity Few weeds	Vulnerable
Saline Aquatic Submerged Meadow * Saline Aquatic Meadow	High Regional	Uncommon community Uncommon character species Few weeds	Rare
Aquatic Herbland/Sedgeland* Aquatic Herbland Aquatic Sedgeland	High Regional	Uncommon community Poorly reserved Few weeds	 Endangered Vulnerable

* **Wetland EVC, † Terrestrial and wetland EVC**

TBLD (2005) states that “the boundaries of wetland vegetation communities are quite fluid, changing in response to environmental factors including rainfall, evaporation and seasonal variation or in response to management regimes. It is likely that vegetation community boundaries will change over time”. TBLD (2005) also states that “aquatic vegetation communities are dynamic in nature and require adaptive management. The most important issues in managing existing areas of native wetland vegetation include maintaining appropriate hydrological regimes and controlling environmental weeds”.

Some of the EVCs recorded by TBLD (2005) are associated with brackish or saline habitats that have occurred since changes to the wetlands in the late 1980s (Table 15). The long term management objective is to restore freshwater habitats as far as possible. This is likely to result in a decline in EVCs that prefer saline conditions and would not be regarded as an adverse change in ecological character. TBLD (2005) has defined landscape zones in the Ramsar site (Appendices 4 and 5) and has prepared revegetation prescriptions for each zone. These are aimed at maintaining the full range of values in the Ramsar site. The prescriptions are presented in Section 6.3. TBLD (2005) recommends monitoring wetland vegetation by establishing permanent quadrats in each of the EVCs at Edithvale and Seaford Wetlands.

A change in ecological character would occur if there was a 5% reduction in the area of EVCs associated with freshwater habitats and a decline in condition of these EVCs. This would be subject to accurate measurement of the EVC areas depicted in Figures 11 and 12, which is not yet available. To assess condition a habitat hectares or Index of Wetland Condition vegetation condition assessment (DSE, 2004) of EVCs should be undertaken, with ongoing monitoring of condition and EVC distribution occurring approximately every five years.

Wetland ecosystem components that are important for the overall maintenance of wetland EVCs at the Edithvale-Seaford Wetlands Ramsar Site are listed in Table 17.

Table 17 Ecosystem components important in maintaining vegetation communities.

Component	How the component maintains the service
Wetland topography	The topography of the wetlands determine the potential depth of inundation of wetland areas. Water depth also influences duration of inundation with deep wetlands taking longer to dry than shallow ones after filling. The depth and duration of inundation in turn influences vegetation composition.
Hydrology	The hydrology of the wetlands (seasonality, frequency, duration and magnitude) is a determinant of vegetation species and community composition.
Soil type	Soil type is a determinant of vegetation species and vegetation distribution throughout the wetlands.
Salinity	Different vegetation communities are adapted to various salinity levels. If salinity increases or decreases, the vegetation community will respond with salt tolerant species thriving in more saline conditions and intolerant species being replaced. Shifts in species composition will occur with changes to salinity levels.

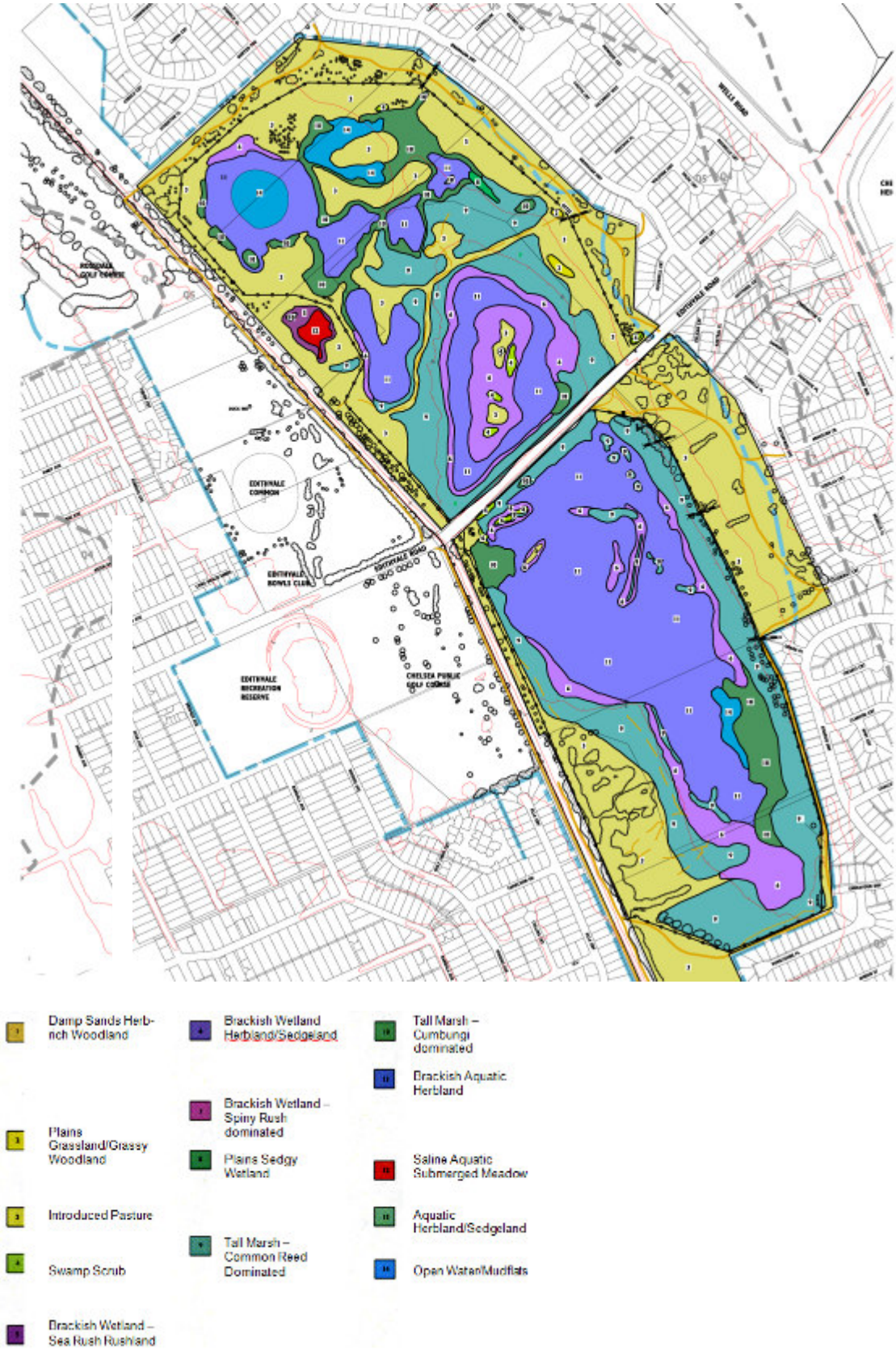

Figure 11. Ecological Vegetation Classes in the Edithvale Wetland (reproduced from TBLD 2005).

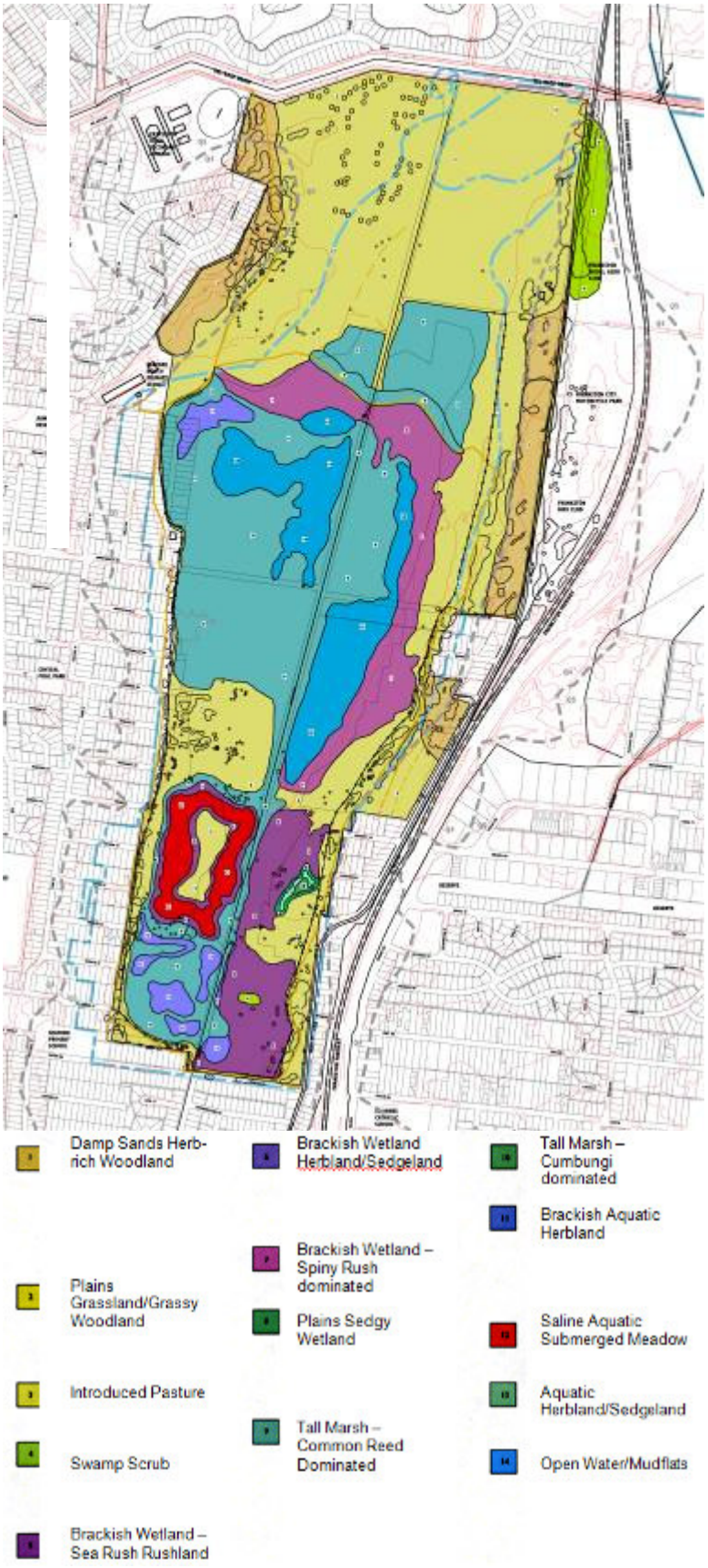

Figure 12. Ecological Vegetation Classes in the Seaford Wetland (reproduced from TBLD 2005).

6 Ecosystem components and processes that maintain ecosystem services

This section provides a description of those ecosystem components that are critical in maintaining the ecosystem services in the Edithvale-Seaford Wetlands Ramsar Site for which data are available. A summary of the components that are critical in maintaining the ecosystem services as the basis of the ECD is presented in Table 18.

Some ecosystem components and processes are not specified in the ECD (see notes in Table 18). The vegetation in the wetlands is described in Section 5.6 and is not further specified in this section except as it relates to waterbird habitat. Basic climate data is summarised in Section 2.1 and is monitored by the Bureau of Meteorology. It is not further specified. Wetland typography and connectivity are discussed together with wetland hydrology as these components are closely linked. Catchment land use is mapped in Figure 10 but not further specified. Sedimentation and productivity are not specified due to lack of data. The limited information on soil type in the wetlands is presented in this section.

Table 18 Ecosystem components and processes critical in maintaining the ecosystem services (shaded). S - specified in the ECD, NS – not specified in the ECD.

Ecosystem Service	Hydrology	Sedimentation	Salinity	Vegetation	Connectivity	Productivity	Climate	Catchment land use	Soil type	Wetland topography	Waterbird habitat
Wetland representativeness	S		S		S					S	
Assists in flood control and catchment drainage		NS[1]		S[2]	S		S[3]	S[4]		S	
Supports threatened species, particularly Australiasian Bittern	S					NS[1]				S	S
Supports high diversity of waterbird species	S					NS[1]				S	S
Regularly supports 1% of the flyway population of Sharp-tailed Sandpipers	S					NS[1]				S	S
Supports vegetation characteristic of the Gippsland Plain Bioregion	S		S						S	S	

Notes

1. Not specified because data are not available, 2. Summarised in Section 2.1, 3. Described in Section 5.6, 4. See Figure 10.

6.1 Hydrology, wetland topography and connectivity

For this ECD, hydrology is the term used that encompasses all water related components of the wetlands. Period of inundation, season of flooding, amount of flow and frequency of inundation are all components of the hydrology. Wetland topography is the term used to describe the geomorphology of the wetlands, particularly depth. Connectivity describes the water sources, discharges and flow through the wetland system. These three ecosystem components are closely linked and described together here.

History and conditions at time of Ramsar listing

The hydrology of the Edithvale-Seaford Wetlands has been significantly altered since European settlement in the nineteenth century. The conditions at the time of listing were influenced by topographical changes within some of the wetlands (excavations), and changed catchment conditions as land use changed from natural to farming and then urban settlement. Black (1957) provides an early history of their reclamation and settlement. The input of groundwater has progressively increased with urban settlement and wetland excavation, and this has led to salinisation of some parts of the Ramsar site. By the time of listing, the hydrology was largely artificial and actively managed.

GHD (2005) describe the original geomorphology of the Carrum Carrum Swamp, focusing on the Edithvale-Seaford Wetlands, and the changes since European settlement. The following description of the geomorphological history of the wetlands is summarised from this report.

> Since the last ice-age, (5,000 – 7,000 years ago) the current coastal dune system established and a new set of inter-dunal lagoons was created. Over time, seasonal inundation established a pattern of anastomosing channels and fresh to brackish lagoons which established a mud and peat layer from the growth of *Bolboschoenus* species. Following European settlement, as the land began to be used for agriculture, Carrum Carrum Swamp was extensively drained. The Edithvale and Seaford Wetlands remained as remnants which from the 1970s came to be valued for flood control and, more recently conservation, recreation, research and education.
>
> The morphology of the Edithvale Wetland basin, with its peat layer intact, was the last and deepest remnant of the Carrum Carrum Swamp. However, excavations of wetland depressions in Edithvale North Wetland which commenced in 1987 broke through the peat layer in the northern part of the Edithvale North Wetland into the underlying sands, resulting in saline groundwater entering the system and a subsequent rise in salinity. In the southern part of the wetland excavations were shallower, the peaty base was retained and the southern wetland cells have remained fresh to brackish.
>
> In 1973, the Seaford Wetland consisted of agricultural land on which there was some excavation to assist drainage. In 1988, excavation of the southern section of the swamp was undertaken to create lake areas. The excavation broke through the peat layer allowing saline and acid-sulfate groundwater to enter this part of the wetland. Additional saline groundwater entered from drainage systems for residential land to the west and north west. Saltwater inflow also came from Eel Race Drain during higher tides and from the marine waters of Kananook Creek via drains at the southern end of the wetland.
>
> By 1989 these problems were recognised and started to be addressed by diversion of saline water from stormwater drains and creation of a fresh-brackish area in the south eastern part of the wetland by isolating the area from salt water areas using low intervention earthworks. In 1991-92 a low embankment was constructed to isolate the northern part of the swamp from saline areas to assist it to become a fresh-brackish system. In 1989-90 the inlet from Eel Race Drain was modified to prevent intrusion of saline water and allow freshwater to enter the wetlands.

The catchment of the Edithvale-Seaford Wetland is now highly urbanised. Connectivity of flow has been progressively disrupted since European settlement due to drainage of natural water courses, and a high degree of modification of surface water flows. At the time of Ramsar listing in 2001 and now, surface inflows to the wetlands are primarily from drains, many of which are controlled. Groundwater inflows are now much more significant due to wetland excavations in the late 1980s and drainage from residential areas at Seaford Wetland. Outflows are also controlled as are flows between wetland cells.

Each wetland has very complex hydrological conditions, which are fully described in GHD (2005). The hydrology, wetland morphology and connectivity in 2005 (four years after Ramsar listing) are summarised in Tables 19-21 and the connectivity is shown in Figures 13 and 14. The information, summarised from GHD (2005), describes the hydrological zones in the wetlands (Edithvale South Wetlands, Edithvale North Wetlands and Seaford Wetlands) and the cells within each zone.

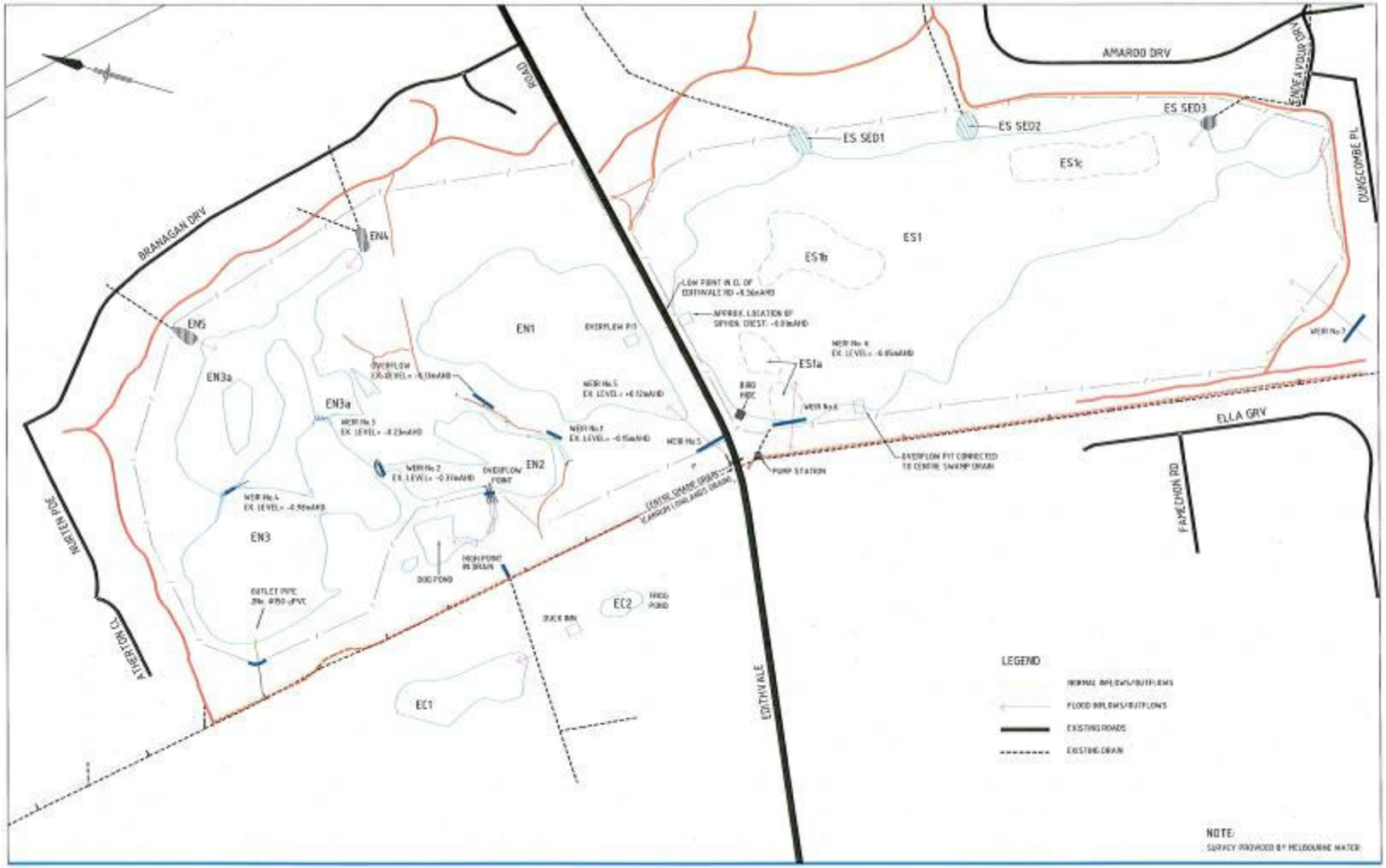

Figure 13. Hydrological cells in the Edithvale Wetland (reproduced from GHD 2005).

Table 19 Hydrology, morphology, connectivity and wetland habitat at the Edithvale South Wetland in 2005 (summarised from GHD 2005)

Hydrological cell	Water sources and discharges	Morphology	Seasonality of inundation	Wetland habitat
ES1 Main wetland	Water sources: three drains (via sediment ponds) from developed catchments to the northwest; overland flows; and overflows from Centre Swamp Drain during storms with 1 in 2 year annual return interval (ARI). Discharges: To Edithvale north via the siphon under Edithvale Road or into the Centre Swamp Drain floodway at 0.2 m Australian Height Datum (AHD). Generally flood overflows from the Centre Swamp Drain are controlled by the inflows into the Edithvale North Wetland cell downstream of Edithvale Road.	Natural 'dish'-shaped cross-section underlain by a thick layer of peat which thins towards the edges. Depth: normally 0.5 m (deepest part 0.3 m below sea level, water level usually 0.2 m AHD at peak flood level but up to 1.55 m AHD in a 1 in 100 year average recrrence interval (ARI)I event).	Inundated in winter and spring (standing water level generally at 0.00 m AHD). Drawdown and drying in summer and autumn (below 0.00 AHD). Maximum drying by late January. Unseasonable event flows may rewet the area totally or partially.	Shallow and deep fresh – brackish marsh system in most of the wetland. Summer drawdown creates critical mud flat habitat for migratory waders.
ES1a, ES1b, ES1c Drought refuge areas	Water sources: ES1c: Groundwater in addition to main wetland source. ES1a, ES1b Pumping from Centre Swamp Drain in extended dry periods in addition to main wetland source. Discharges: None.	Excavated pools deeper than main wetland ES1.	Permanent except in drought.	Drought refuge.

Table 20 Hydrology, morphology, connectivity and wetland habitat at the Edithvale North Wetland in 2005 (summarised from GHD 2005)

Hydrological cell	Water sources	Discharges	Morphology	Seasonality of inundation	Wetland habitat
EN1 Adjacent to Edithvale Road	Via Weir 5 from Centre Swamp Drain at 0.2m AHD and Siphon crest in ES1 at -0.01m AHD. Leakage from groundwater.	To EN2 at Weir 1 at -0.15m AHD and overflow at -0.13m AHD.	Constructed within the former floodplain. Shallow peat-lined cell with concentric marsh zones with an island in the centre.	Inundated in winter and spring. Drying in summer and autumn. Generally desiccates every year- some wet summers will leave residual pool in autumn. Moist area maintained in dry periods (due to groundwater leakage).	Fresh – brackish. Supports a heavy growth of Bolboschoenus caldwellii. Management intent is to provide habitat for wader, dabbling and filter feeding waterbirds.
EN2	From EN1 at Weir 1 at -0.15m AHD and overflow at -0.13m AHD.	To EN3 at Weir 2 at -0.37m AHD. To Dog Pond via a high level overflow channel at about -0.4m AHD.	Constructed within the former floodplain. A series of weirs between EN3, EN3a and EN2 limit total draw down under prolonged dry conditions. Deep, reaching into sandy substrates that underlie the area.	Generally draws down to about -0.5m in average year but can go down to -1.2m in dry times.	Fresh-brackish EN3: main open water pond. EN3 and EN3a water levels are responsive to groundwater. Levels can be -1.2m AHD in drought years with salinity (10,000-12,000 micro-siemens/cm) and -0.2- -0.4m AHD in wetter sequences with salinity 4,000-5,000 micro-siemens/cm.
EN3	From EN2 at Weir 2 at -0.37m AHD. From EN3a via Weir 3 at -0.23m AHD and Weir 4 at -0.98m AHD.	To Centre swamp Drain via two outlet pipes and a high level overflow channel to the adjacent floodway.		Generally draws down to about -0.5m in average year but can go down to -1.2 in dry times. System responds to groundwater in summer – which is controlled by area saturation and drawdown.	

Table 20 continued

Hydrological cell	Water sources	Discharges	Morphology	Seasonality of inundation	Wetland habitat
EN3a	Stormwater from stormwater drains to the north and overland flow via EN4 and EN5.	To EN3 via Weir 3 at -0.23m AHD and Weir 4 at -0.98m AHD.	Constructed within the former floodplain. A series of weirs between EN3, EN3a and EN2 limit total draw down under prolonged dry conditions. Deep, reaching into sandy substrates that underlie the area.	Filling of pond to full supply generally only achieved in July - October. Drawdown via groundwater and evaporation response. Higher water levels can occur in wet summers.	
Dog Pond	Water level in the Dog Pond is controlled by groundwater but it can receive water from EN2 via a high level overflow channel at about -0.4m AHD.	None.	Constructed within the former floodplain. Deep, reaching into sandy substrates that underlie the area.	Generally dry by end of January.	
EN4	Stormwater from stormwater drains to the north and overland flow.	To EN3a.		Will draw down to weir at -0.2m AHD, then evaporation and inflows control the level.	Deep pool with fresher water quality providing habitat for Blue-billed Duck, Musk Duck and Australasian Bittern.
EN5				Generally dries out by late December.	

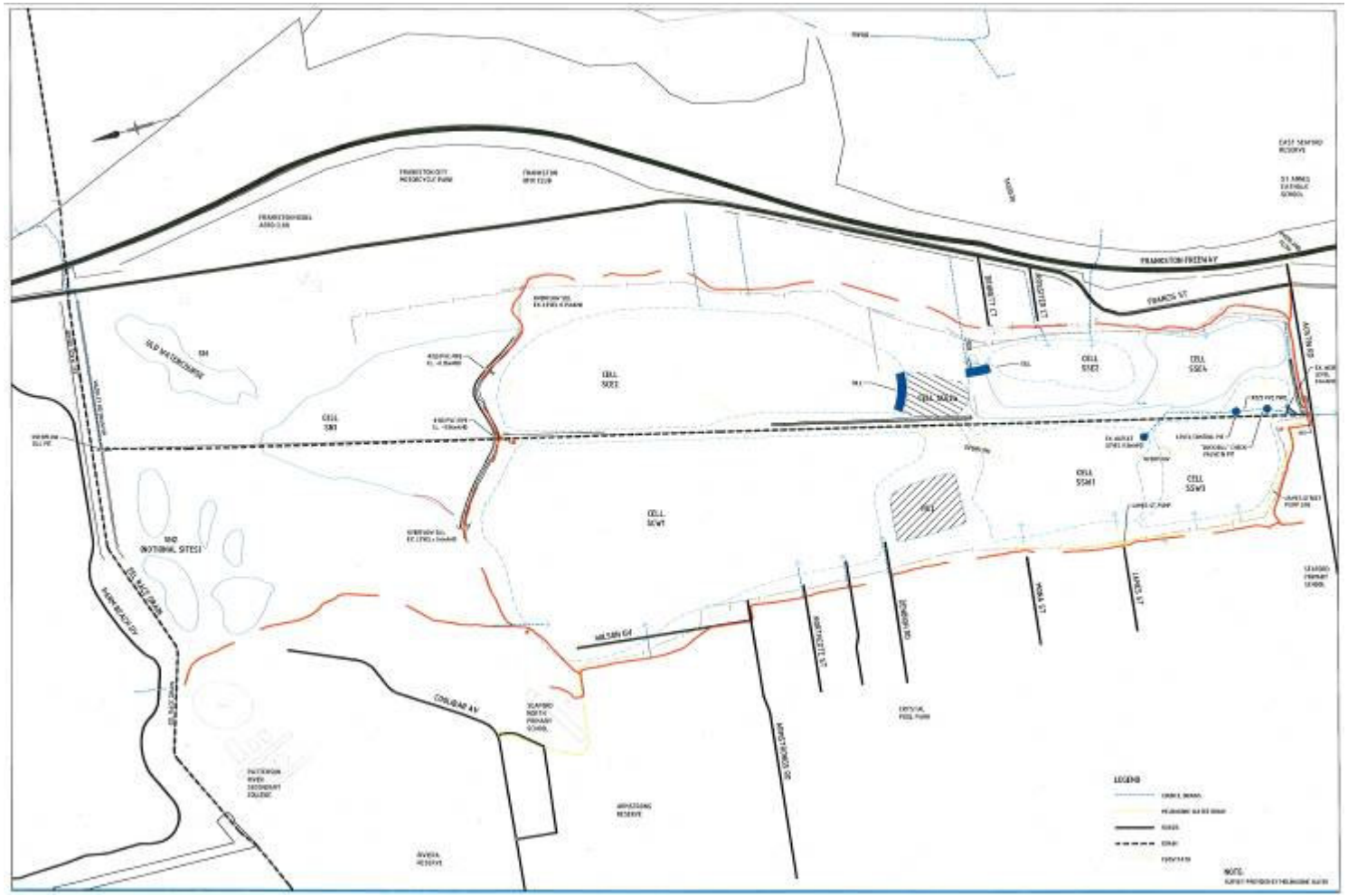

Figure 14. Hydrological cells in the Seaford Wetland (reproduced from GHD 2005).

Table 21 Hydrology, morphology, connectivity and wetland habitat at the Seaford Wetland in 2005 (summarised from GHD 2005)

Hydrological cell	Water sources	Discharges	Morphology and depth	Seasonality of inundation	Wetland habitat
SN1 Main header pool	Rising main which transfers the base flow from Wadsleys Drain and freshwater surcharges that enter via high level weir, with a crest level of 1.25m AHD, from Eel Race Drain. The centre drain (old Seaford Drain) runs from north to south and carries inflows to the northern pool through higher ground.	Two controlled pipe discharge points to SCW1 and SCE2. Overflows to SCW1 and SCE2. Redirection of the flows from Cell SN1 to the centre drain after November.	Standing winter spring water level at 0.6m AHD. Overflow level 0.75m AHD. Summer levels tend to be lower at about 0.45m AHD.	Depth reduced during summer.	Fresh-brackish
SCW1	Drainage inputs from undiverted stormwater drains to the west in Seaford North. Overflow sill from SN1 at 0.6m AHD. Groundwater.		Water level at 0.4m AHD but will pond higher in flood events. Disturbed deeper substrate (probably due to historical cropping) under shallow peat. Western margin filled.	Wetter than originally with long-term running of freshwater through the cell in summer.	Water during summer has exacerbated growth of Typha, Phragmites and Sharp Rush.

Table 21 continued

Hydrological cell	Water sources	Discharges	Morphology and depth	Seasonality of inundation	Wetland habitat
SCE2	Orifice from SN1 till late October (when closed). Overflow from SN1 at 0.75m AHD.		Ponds to 0.45m AHD. Original morphology. Peat layers mainly intact.	Management regime mimics natural wetting and drying cycles. Closure of flows from SN1 in late October allows drying unless major unseasonable event occurs.	Fresh-brackish wetland. Important for waders with productive mudflat available September – December.
SCE2a		Overflow to SSE4 and SSW1.	Part of SCE2 but separated from main cell by low level weir on northern edge.	Minor ponding to 0.55m AHD in winter. Dries in late spring. Generally dry in summer and autumn except for some residual pool areas in natural terrain.	Shallow brackish wetland.
SSW1	Numerous inlets in form of high level surcharges from local drains to the west. Most smaller events do not surcharge as they are intercepted by the James Street pump Station.	Via Austin Road outlet. Higher level overflow to SSW3 at 0.18m - 0.35m AHD. Overflows to SSW3 via weir at 0.5m AHD.	Excavated in 1989. Lowest cell within Seaford wetland complex. Ponds to 0.35m AHD and drains to 0.1m AHD.	Water maintained at 0.25-0.3m by base flows.	Strongly saline with some acid sulfate oxidation and low pH. Limited productivity and less diverse flora and fauna. Used by a range of diving duck species.
SSE2	Fed by local drains to the east.	Overflow to SSE4. Overflow via sill in NE corner of cell to SCE2a at 0.7m AHD approx.	Perched cell that has been leveed off from the rest of the wetland to attain a fresher regime. Winter spring levels can get to 0.7- 0.8 m AHD.	Generally dries to one or two residual pools at about 0.3m AHD.	Semi-permanent wetland colonised by Typha sp. Generally about 3,000 micro-siemens/cm but may be lower following runoff from drains.

Table 21 continued

Hydrological cell	Water sources	Discharges	Morphology and depth	Seasonality of inundation	Wetland habitat
SSW3	From SSW1 via higher level overflow at 0.18m - 0.35m AHD and overflows via weir at 0.5m AHD. Can be subject to tidal intrusion from Kananook Creek via the Bardia Avenue and Weatherstone Road Drain if failure of the flood gate and pump system occurs (as was the case in 2005).	Earthen weir and outlet control at Austin Road to Weatherstone Road Drain (not functioning in 2005).	Modified cell.	Operates at about 0.45m AHD or lower depending on event inflows and tidal back flooding.	Dominated by Phragmites.
SSE4	Overflow from SCE2a. Receives major flood inflows from Austin Road.	Drains to SW corner of cell.	Will hold to 0.45/0.5m AHD in winter but responds to SSW3 height.	Generally dry except in wet winter periods or flooding events.	Ephemeral wetland dominated by Halophytes.
SN Downes Land	Local rainfall.	-	Old watercourses.	Only fill in a wet winter.	Ephemeral wetland with potential to be managed for late winter – early spring wader habitat with hydrological management.
SN2	Local rainfall.	-	Original morphology.	Dry in summer/autumn.	Ephemeral wetlands providing habitat in late spring for waders.

Hydrological management objectives

Efforts to largely restore the characteristics of the original wetland type (shallow freshwater marsh) led the review of hydrological arrangements by GHD (2005) and setting of hydrological objectives. The objectives are achieved by dividing each of the main wetlands into cells according to various physical characteristics. These are managed according to detailed hydrological prescriptions (Appendix 3) which are designed to achieve the hydrological objectives. The key hydrological management objectives are reproduced from GHD (2005).

Edithvale South Wetlands

The management objectives for Edithvale South Wetlands are:

- to mimic natural seasonal wetting and drying cycles as much as possible so as to retain the high productivity and provide critical seasonal habitats for a range of bird species, in a fresh brackish regime;
- in mimicking the wetting and drying cycles limit the invasion of *Typha* spp. into the wetlands through controlling saturation levels;
- to maintain normal water levels at or near 0.00m AHD during winter and early spring;
- to manage the transfer of stormwater to Edithvale North Wetlands via the siphon under Edithvale Road using head developed or retained by the side cast weirs;
- to limit the artificial filling of the wetland to autumn only in order to discourage the growth of *Phragmites* and *Typha* spp. and manage the *Typha* spp. by aggressive removal, spraying and replacement with a strongly competitive species;
- to manage the drought refuge transfer pumping to provide water in periods of extended dry weather; and
- to manage the flooding of the site as per the Carrum Lowlands Flood Management Strategy.

Edithvale North Wetlands

The management objectives for Edithvale North Wetlands are to:

- manage the peat wetland of cell EN1 in order to mimic natural seasonal wetting and drying cycles as much as possible so as to retain the high productivity and provide critical seasonal habitats for a range of bird species in fresh brackish regime;
- manage the hydrological cycles to limit Phragmites and Typha sp invasion in EN1;
- manage the remainder of the wetland cells as variable habitats with variable water levels within the limitations of the groundwater interactions; and
- allow flood waters to enter the Edithvale North Wetlands cells at an early stage, +0.2m AHD, via Weir 5, in order to provide flood storage during flood events.

Seaford Wetlands

The management objectives for Seaford Wetlands are to:

- ensure that the freshwater inputs from both the Eumemmerring Creek diversion and Boggy Creek are operating to provide the critical freshwater supply for flushing of the system and provision of a predominantly fresh brackish environment to sustain key invertebrate and wader habitats;
- improve the hydrological management of SCW1 over the long term with flexible arrangements to control wetting cycles of the cells for seasonal habitat requirements;
- manage the peat wetland of Cell SCE2 so as to mimic natural seasonal wetting and drying cycles as much as possible, so as to retain the high productivity and provide critical seasonal habitats for a range of bird species in fresh brackish regime;
- manage constant freshwater through flow in SSW1 to mitigate the impacts of acid sulfate soils and salinity inputs;
- manage the saline diversion and inflow mitigation systems to assist in the lowering of salinity levels throughout the wetlands but specifically in the winter/spring period;
- manage the northern area of the wetlands as ephemeral with variable levels within the limitations of the surface and groundwater interactions;

- ensure that hydrological facilities have flexibility to manage for a range of level settings or conditions; and
- to allow flood waters to enter the wetlands from multiple sources.

These objectives will be used as a benchmark for future management of the Edithvale–Seaford Wetlands Ramsar Site, which is likely to see a positive change in ecological conditions. As such, the baseline of the Ramsar site may need to be redefined once a semi-stable ecological state has been reached.

Requirements for specific ecosystem services

Various components of the hydrology (as described by GHD (2005) and outlined in the extracts above) are important in maintaining various ecosystem services, these include hydrological requirements for wetland representativeness, waterbirds and vegetation.

The topography of the wetlands determines the potential depth of inundation of wetland areas. This is important for a variety of reasons as outlined below.

- Holding flood waters assists in preventing flooding of adjacent residential areas.
- Water depth influences duration of inundation with deep wetlands taking longer to dry than shallow ones after filling.
- The depth and duration of inundation in turn influences vegetation composition, which has a direct influence on provision of habitat.

The bathymetry of the wetlands has not been mapped. However, there is detailed understanding of the depths of individual wetland cells (Tables 19-21). Hydrological manipulation is an important part of managing the depths in the Edithvale-Seaford Wetlands.

Wetland topography maintains the following ecosystem services:

- Assists in flood control
- Wetland representativeness
- Supports threatened species, particularly waterbirds
- Supports a high diversity of waterbird species
- Supports 1% of the flyway population for Sharp-tailed Sandpipers
- Supports vegetation characteristic of the Gippsland Plain Bioregion.

Requirements for flood control

Service to which the wetland topography ecosystem component relates
• Assists in flood control

Wetland bathymetry and wetland area together determine the capacity of the wetland cells to hold flood water. While capacity has not been quantified, the hydrological objectives and operational specifications are designed to address flood storage needs (GHD, 2005). A change in the flood storage capacity could result from a significant change in the maximum depth of the wetlands. This could take place over time due to changes in water availability and sedimentation.

Requirements for wetland representativeness

Service to which the hydrology and wetland topography ecosystem components relate
• Wetland representativeness

Using the classification system developed by Corrick and Norman (1980), the Edithvale-Seaford Wetlands were classified as originally being shallow freshwater marshes. The seasonality of inundation is also important and it should mirror natural seasonal rainfall cycle: The hydrological management objectives outlined above are designed to restore the wetlands to their original wetland type as far as possible.

The topography of the wetlands is an integral to achieving these objectives. Any changes in wetland topography would change the depth, period of inundation and hence the habitat provided by the wetlands. A change in the wetland category could result from a significant change in the maximum depth of the wetlands. This could take place over time due to changes in water availability and sedimentation.

Requirements for waterbirds

Services to which the hydrology and wetland topography ecosystem components relate:
• Supports threatened species, particularly waterbirds
• Supports a high diversity of waterbird species
• Regularly supports 1% of the flyway population for Sharp-tailed Sandpipers

Waterbirds use wetlands for a variety of purposes including feeding, roosting and nesting. Birds can be categorised by feeding guilds e.g. fish eaters, deep water foragers, dabbling ducks, grazers, shoreline foragers, large and small waders (Roshier et al., 2002). Even though the precise relationships between birds and water levels are not established (Tzaros, 2005), change in flooding regime could impact on the Sharp-tailed Sandpiper habitat and other waterbird habitat. The timing of floods, duration of floods, magnitude of floods and frequency are thought to be critical elements in creating appropriate habitat conditions for waterbirds. This is partly because these elements or a combination of these elements, can give rise to conditions required to stimulate food production or create conditions for vegetation to flourish and provide appropriate habitat or maintain open water areas or mud flat areas that species rely upon for feeding, roosting, nesting or breeding.

Wetland depth influences the wetland's suitability for use by waterbirds. For example, species may have specific water depth preferences for feeding e.g. waders that seek food in shallow mud flat areas compared to deep water feeders. Provision of shallow mudflat areas are critical to the numbers of Sharp-tailed Sandpipers. If these habitats were not available, the wetlands would not support such high numbers. The variation in depth provides the conditions for habitat diversity enabling the wetlands to support a high species diversity.

The waterbird monitoring program established for the Edithvale-Seaford Wetlands (Tzaros, 2005) will assist in understanding the relationships between waterbird use and the current wetland topography and hydrology.

Requirements for vegetation.

Service to which the hydrology and wetland topography ecosystem components relate:
• Supports vegetation characteristic of the Gippsland Plain Bioregion

The distribution and abundance of wetland vegetation species and communities within the wetlands are dependent upon a complex set of environmental variables often operating in parallel. These include the season, depth and length of inundation, substrate and water salinity levels, competition from other species and the grazing effects of waterfowl (Lane et al., 2000). TBLD (2005) indicates the hydrological, depth (and salinity) conditions for the wetland EVCs in the Edithvale-Seaford Wetlands Ramsar Site (Table 22).

Table 22 Hydrological conditions for EVCs in the Edithvale Seaford Wetlands Ramsar Site (TBLD, 2005)

EVC (name in bold)	Hydrological conditions
Plains Grassland/Grassy Woodland	Not documented.
Swamp Scrub	The field-layer varies with depth and duration of inundation from introduced grasses and blackberry in drier areas, to *Triglochin procerum* and *Phragmites australis* in shallow marsh areas (inundated by <40 cm for <6 months).
Brackish Wetland Sea Rush Rushland	Occurs in areas that are seasonally waterlogged or inundated by up to 20 cm of water.
Brackish Wetland Herbland/Sedgeland	Occurs in areas inundated by up to 30 cm of water for up to 6 months.
Plains Sedgey Wetland	Inundated by up to 30 cm of water for up to 6 months.
Tall Marsh Common Reed Dominated	Species associated with Common Reed vary with depth and duration of inundation. In areas of shallow marsh (inundated by <40 cm for <6 months) this community includes *Triglochin procerum*, *Lemna minor*, *Crassula helmsii*, *Ranunculus amphitrichus* and *Juncus pallidus*. In localised areas the native vine *Calystegia sepium* is common. In areas which have become drier due to changes in hydrology this community is invaded to varying degrees by a range of environmental weeds.
Tall Marsh Cumbungi Dominated	Occurs in water 0.2 to 1 metre deep.
Brackish Aquatic Herbland	Occurs in areas inundated by water 0.5 to 1.5 metres deep. In shallower areas as water levels recede in summer *Bolboschoenus caldwellii* sprouts from dormant corms and becomes dominant.
Saline Aquatic Submerged Meadow.	Occurs in water 0.5 to 1.5 metres deep.
Aquatic Herbland/Sedgeland	Occurs in water 0.5 to 1 metre deep.

6.2 Salinity

Service to which the ecosystem component relates:

- Wetland representativeness
- Supports vegetation communities typical of the Gippsland Plain Bioregion

Using the classification system developed by Corrick and Norman (1980), the Edithvale-Seaford Wetlands were classified as originally being shallow freshwater marshes. Wetlands are classed as saline if salinity exceeds 3,000 mg/L (5,000 µS/cm) throughout the year (Corrick and Norman, 1980). However, GHD (2005) indicates that parts of the system were probably naturally fresh to brackish.

The salinity levels required for the main wetland EVCs are discussed by TBLD (2005) and summarised in Table 23:

As discussed in Section 6.1, the salinity of the northern parts of Edithvale North Wetland and much of Seaford Wetlands had become more brackish or saline by the late 1980s (Tables 19-21) and recent hydrological management prescriptions have been designed to address this (Section 6.1). Given that there has been a history of increasing salinity levels and works undertaken to ameliorate high salinity levels, a salinity monitoring program is suggested.

Table 23 Salinity conditions for EVCs in the Edithvale Seaford Wetlands Ramsar Site (TBLD, 2005)

EVC (name in bold)	Hydrological, salinity and other habitat conditions
Plains Grassland/Grassy Woodland	Not documented.
Swamp Scrub	Not documented.
Brackish Wetland Sea Rush Rushland	EC 2,000 to 15,000 µS/cm.
Brackish Wetland Herbland/Sedgeland	Spring EC 2200 to 7,400 µS/cm, increasing into summer and autumn.
Plains Sedgey Wetland	Spring EC 800 to 1,000 µS/cm.
Tall Marsh Common Reed Dominated	Permanent fresh to brackish water.
Tall Marsh Cumbungi Dominated	Permanent fresh to brackish water.
Brackish Aquatic Herbland	Moderate salinity with spring EC values 2200 to 2300 µS/cm (in summer/autumn salinity may reach 8000 µS/cm).
Saline Aquatic Submerged Meadow.	Spring EC values from 12,000 to 15,000 µS/cm.
Aquatic Herbland/Sedgeland	Relatively freshwater with spring EC of 1000 µS/cm.

6.3 Waterbird habitat

Service to which the ecosystem component relates:

- Supports threatened species, particularly waterbirds
- Supports high diversity of waterbird species
- Regularly supports 1% of the flyway population for Sharp-tailed Sandpipers

Birds Australia (2004) has identified “BA’ landscape zones in the Edithvale-Seaford Wetlands to assist Melbourne Water in increasing understanding of the bird habitat values at the wetlands (Figures 15 and 16). These are adapted from landscape zones identified by TBLD (2005) for revegetation prescriptions and based broadly on amalgamated EVCs (Appendices 4 and 5). From 2005, bird counts have been surveyed and collated for each zone (Silocks et al., 2006). Figure 15 has been adapted to correct apparent errors in the matching of BA and LA zones as reported in Silocks et al. (2006). Table 25 been adapted to correct apparent errors in the matching of BA and LA zones as reported in Birds Australia (2004).

Silcocks et al. (2006) make a number of recommendations relevant to the future management of waterbird habitat. These are summarised below.

- Control Blackberry *Rubus fruiticosus* (aggregate) in the drier areas of Common Reed *Phragmites australis* at both Edithvale and Seaford Wetlands.
- Continue control of Spiny Rush *Juncus acutus* especially at Seaford Wetlands where it is especially widespread and invasive to enhance migratory wader habitat.
- Monitor the rate of spread of the dominant wetland plants, such as Common Reed *Phragmites australis* and Cumbungi *Typha spp.* to prevent open water areas becoming overgrown to the

detriment of the bird species which favour open water or open mudflats. If excessive encroachment by these plants is shown, some form of control should be considered.

- Initiate amonitoring program to establish the precise relationship between birds and water levels.
- Control foxes *Vulpes vulpes*, especially at Edithvale Wetlands.
- Consider initiating a cat *Felis catus* owner education program for domestic cat owners at Seaford Wetland.

In addition, TBLD (2005) have specified revegetation prescriptions for each landscape zone. These address the full range of values at the Ramsar site (Table 4). TBLD (2005) state that the aim of the prescriptions is to:

- reinforce the revegetation works that have been undertaken over the years with some changes to establish a relatively natural open woodland character in the terrestrial areas;
- establish some selected areas of fringing Swamp Scrub on the wetland margins whilst retaining extensive areas of open wetland character;
- continue Spiny Rush control program and control of other weeds in the wetlands and undertake species enrichment where required;
- improve the avifauna values with additional vegetation to screen adjoining activities from the wetland and provide a diversity of habitats for a range of birds;
- protect the significant vegetation communities;
- continue to encourage community involvement in revegetation works and recognise the ongoing work and involvement of the Friends of Edithvale-Seaford Wetlands; and
- create an inviting natural setting which reflects the environmental significance of the wetlands and engenders a respect for these values from visitors and local residents.

TBLD (2005) also state that “other works that are to be undertaken to assist vegetation management include minor adjustments to the hydraulic function of Seaford Wetlands to improve the wetting and drying cycles”.

The description of the BA zones and waterbird use is summarised in Tables 24 and 25 based on descriptions in Birds Australia (2004) and TBLD (2005). The revegetation prescriptions of TBLD (2005) are also included in the tables.

The successful management of waterbird habitat at Edithvale-Seaford wetlands will depend on a combination of hydrological, vegetation and salinity management as well as the control of invasive species. Silcocks et al. (2006) state that “it is not presently possible to establish the precise relationship between birds and water levels”. Until further data are collected and relationships investigated it is not possible to define the limits of acceptable change for the waterbird habitat component.

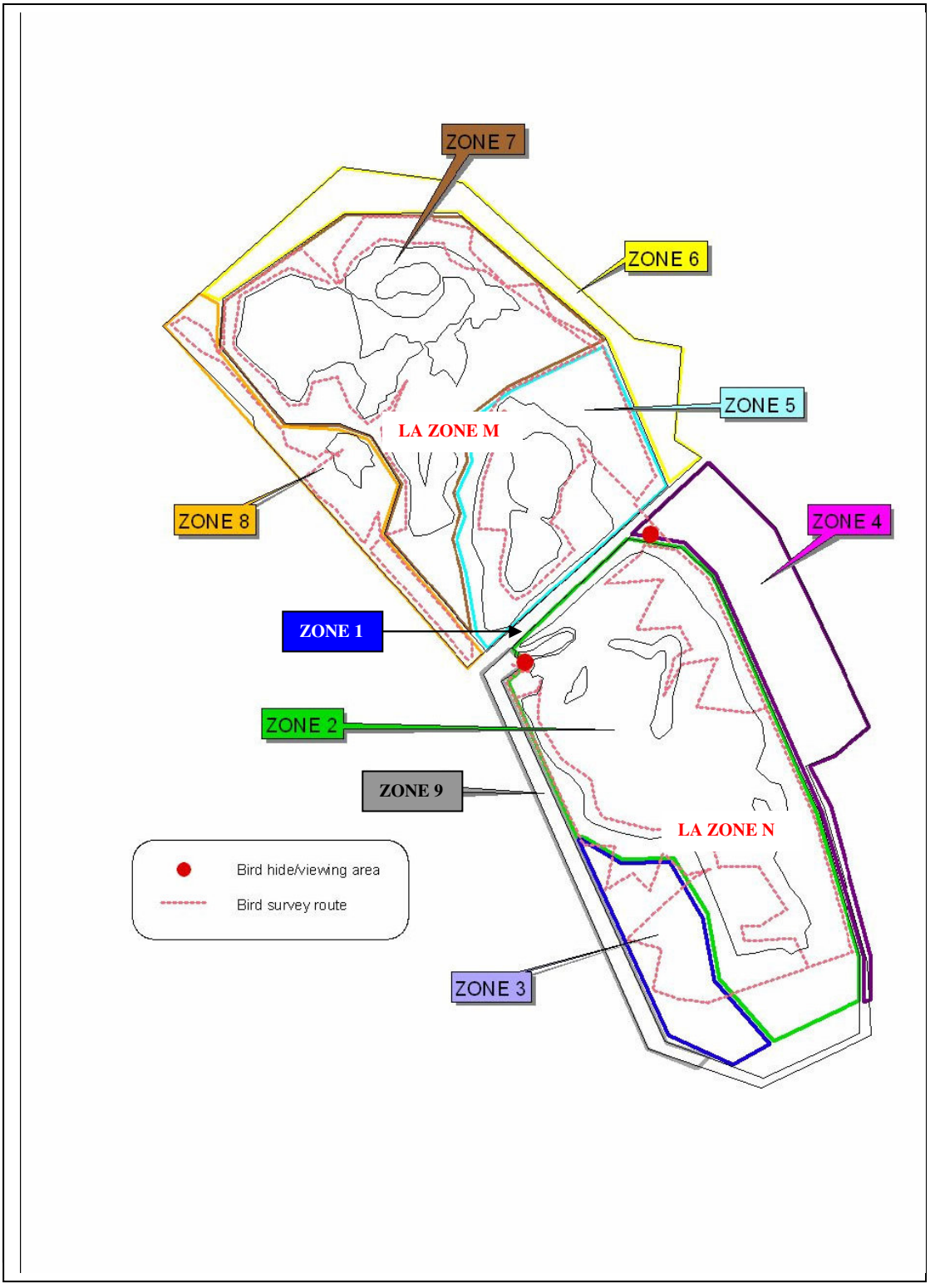

Figure 15. BA Landscape zones at Edithvale Wetland (reproduced from Birds Australia 2004 with corrections and additions to match mapping of LA zones by TBLD, 2005).

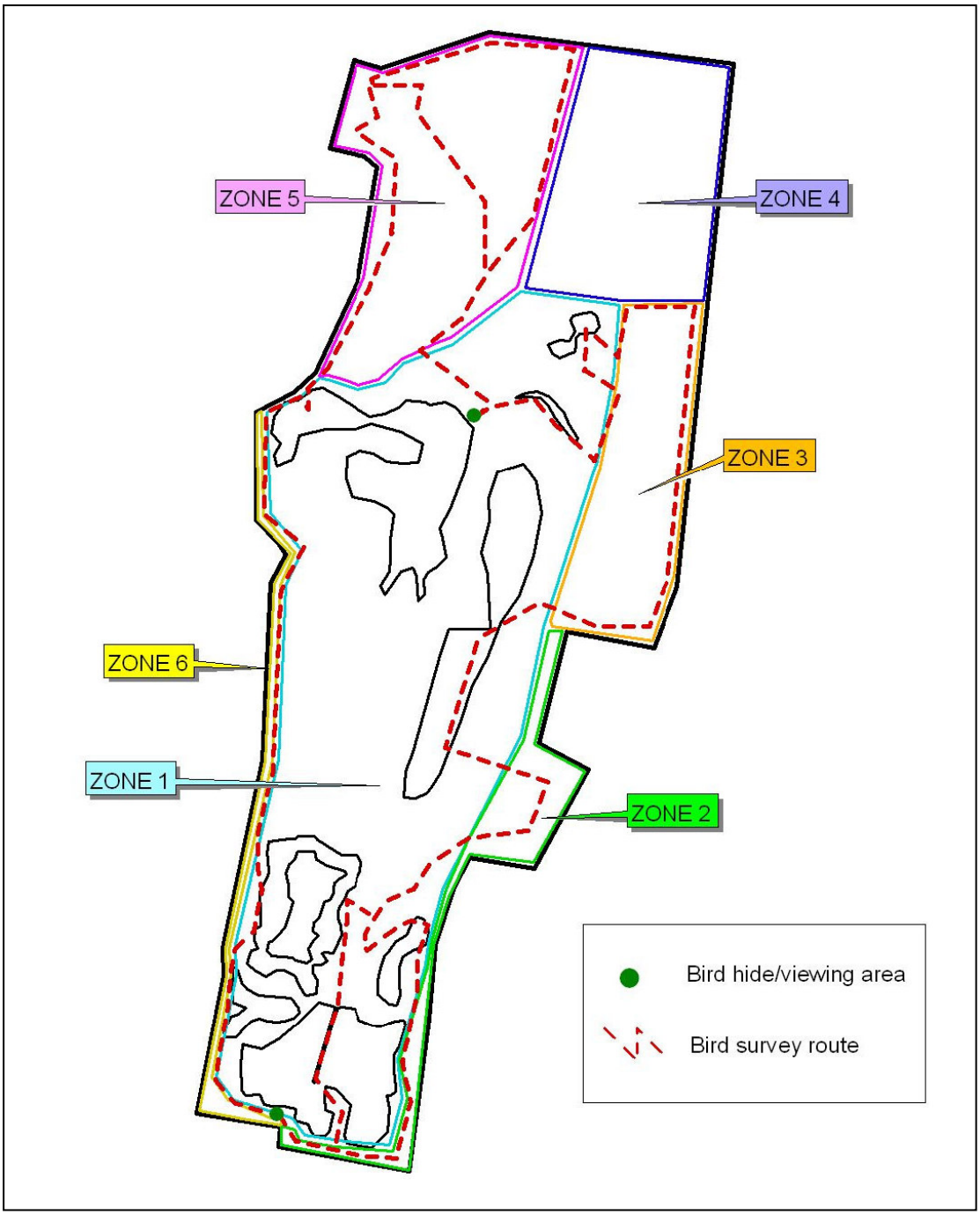

Figure 16. BA Landscape zones at Seaford Wetland (reproduced from Birds Australia 2004).

Table 24 Habitat description, waterbird use and revegetation prescriptions for BA landscape zones and LA landscape zones in Edithvale Wetland (source: Birds Australia 2004 and TBLD (2005)

BA Zone	Habitat description	Waterbird use		LA Zone	Revegetation prescriptions
		Non-threatened species	Threatened species		
1	This zone is dominated by Edithvale Road, which carries a large volume of traffic and does not support any notable bird habitat values. There is an important flight path for birds over the road between Edithvale North and South that is to be kept free of overstorey trees Common Reed on fringe of road form buffer between the road and the wetlands Small stands of Swamp Paperbark Kikuyu grass and other weeds invading wetland edge	Purple Swamphen. Latham's Snipe flies over zone.	None known but Australasian Bittern flies over zone.	A	Retain the function of vegetation in this zone as a buffer between Edithvale Road and the wetlands Reduce the impact of weeds invading the wetland from the road reserve Improve the visual presentation of the wetlands along Edithvale Road in recognition of this as the main visitor entry point to the wetlands.

Table 24 continued

BA Zone	Habitat description	Waterbird use		LA Zone	Revegetation prescriptions
		Non-threatened species	Threatened species		
2	This zone consists of shallow ephemeral wetlands which flood during the early winter and are usually dry by late summer, depending on rainfall. Ephemeral Wetlands Brackish Aquatic Herbland Brackish Aquatic Herbland/Sedgeland grading to Tall Marsh	Extremely important for migratory waders, especially when water levels are receding and damp mud is exposed. All the wader species utilise the whole wetland area, though Latham's Snipe seldom stray from the cover of marshy vegetation. Ducks and other waterbirds are often recorded in large numbers. Crakes are most frequently seen along the waters edge beside the bird hide, though they probably occur around the whole wetland. Swamp Harriers are regularly seen hunting over the swamps throughout the year. • Black Swan • Black-winged Stilt • Chestnut Teal • Latham's Snipe • Eurasian Coot • Pacific Black Duck • Common Greenshank • Magpie Goose • Marsh Sandpiper • Glossy Ibis • Pectoral Sandpiper • Red-necked Stint • Purple Swamphen • Wood Sandpiper	Freckled Ducks, Blue-billed Ducks and Australasian Shovelers can be found anywhere on the wetland, but usually retreat to the deeper southern end when the wetland is drying. Australasian Bitterns occur mainly in winter and may be found hiding in the lower wetland vegetation, foraging for frogs. • Cattle Egret • Royal Spoonbill • Sharp-tailed Sandpiper	N	Maintain seasonal wetting and drying cycle. Monitor water quality in conjunction with vegetation to ensure diversity of vegetation is retained and eutrophic conditions do not occur. Recognise the diversity of frog populations in the wetland, in addition to the avifauna habitat values. Establish Swamp Scrub along some of the wetland margins where it will not impact on wader bird habitat values to improve the diversity of habitat values, and be representative of the former vegetation regime of Carrum Carrum Swamp.

Table 24 continued

BA Zone	Habitat description	Waterbird use		LA Zone	Revegetation prescriptions
		Non-threatened species	Threatened species		
3	This zone includes the best and most extensive area of indigenous trees at the Edithvale Wetlands, including Swamp Gum, River Red Gum and Swamp Paper Bark.	None known	None known	D	Increase the presence of scattered shrubs as understorey to improve avifauna habitat values in this area consistent with kangaroo management objectives. Recognise and protect this area as the largest stand of native/indigenous trees adjacent to Edithvale Wetlands.
				E	Increase and expand the Plains Grassland/Grassy Woodland vegetation community adjacent to Edithvale Wetlands.
4	This zone consists of a narrow strip of grass with isolated plantings of indigenous and non-indigenous eucalypts and melaleucas. Fringing the short grassy areas are tall reed beds of Cumbungi.. Large area of mown grass (mainly exotic) Kikuyu grass and other weeds invading wetland edge Indigenous and non-indigenous eucalypts and melaleucas Tall reed beds of Cumbungi	Small numbers of Straw-necked Ibis are sometimes seen feeding in the open areas	None known	F	Retain the open character of this zone with no overstorey trees for wildfire management purposes. Decrease the impact of weeds from this zone into the wetland, particularly Kikuyu.
				G	Expand the habitat diversity adjacent to the wetland with scattered open woodland vegetation. Improve community interest and ownership of the wetland through appropriate integration of open space and environmental values. Utilise this area for pre-treatment of stormwater inputs to the wetlands.

Table 24 continued

BA Zone	Habitat description	Waterbird use		LA Zone	Revegetation prescriptions
		Non-threatened species	**Threatened species**		
5 7	These zones comprises of a series of permanent ponds fringed by tall reeds and bullrush, separated by grassy banks. Predominately Brackish Aquatic Herbland Perimeter of zone dominated by introduced pasture (slashed) Ponds fringed with Tall Marsh Spiny Rush around wetland perimeter Blackberry and other weeds found particularly amongst the Tall Marsh Swamp Paperbark, Red Gums and Swamp Gums in northern boundary	Common Greenshank along the edges, Crakes and Rails in the vegetation around all the ponds, Spotless Crake regularly seen, amongst the bullrush. Chestnut Teal Pacific Black Duck Hardhead Hoary-headed Grebe Purple Swamphen Eurasian Coot	Important for many species, most notably Blue-billed Duck and Musk Duck which favour the deeper water. Particularly in late summer, these ponds can hold numbers of Australasian Shovelers and Hardheads. Baillon's Crake regularly seen, amongst the bullrush. Royal Spoonbill	M	Increase habitat diversity with species enrichment planting to the wetlands and some revegetation of terrestrial areas with Plains Grassland/Grassy Woodland vegetation. Monitor and continue Spiny Rush control program as required. Monitor water quality in conjunction with vegetation to ensure diversity of vegetation is retained and eutrophic conditions do not occur.
6 8 (part)	These zones which border the Edithvale North Wetland are characterised by open grasslands with scattered plantings dominated by eucalypts and acacias. A drain exists along the western interface, which is only damp following heavy rainfall.	None known	None known	H I	Manage existing, and plant additional, indigenous vegetation to achieve the open woodland character of the Plains Grassland/Grassy Woodland EVC in this zone. Improve the shrub and ground layer species in the existing and new planting areas to improve habitat diversity. Retain selective view sheds over the wetlands from adjoining properties and council open space reserves.

Table 24 continued

BA Zone	Habitat description	Waterbird use		LA Zone	Revegetation prescriptions
		Non-threatened species	Threatened species		
6 8 (part)	These zones which border the Edithvale North Wetland are characterised by open grasslands with scattered plantings dominated by eucalypts and acacias. A drain exists along the western interface, which is only damp following heavy rainfall.	None known	None known	J	Soften the interface between the housing and the wetlands by planting additional scattered indigenous overstorey trees and selective mid-storey. As part of the new path alignment along the northern boundary, revegetation is to retain selective views of the wetlands.
				K	Plant additional scattered indigenous overstorey trees to establish a link with the remnant vegetation in Rossdale Golf Course. As part of the proposed path connecting the viewing platform to the maintenance track around the north of the wetland, ensure revegetation works retain selected views over the wetland whilst providing a screening function.
8 (part)	A saline pond lies outside the fenced wetland which is regularly disturbed by dogs and their owners. West of the pond, in the open grassy areas and patches of planted woodland, the bird life is very similar to that described in Zone 5.	Masked Lapwing (at times), Black-fronted Dotterel	None known	L	Improve the landscape and community educational values of this zone with additional appropriate scattered overstorey tree planting in the terrestrial zone and additional planting. Retain the community and dog owner use of this zone, however, where possible establish saltmarsh vegetation to the perimeter.
9	The dominant habitat type in this area is introduced pasture dominated by weedy grasses, fringed by reeds and with some scattered eucalypts and melaleucas. Mown exotic pasture grass Scattered eucalypts and melaleucas Tall Marsh around wetland provides a buffer along the inside margins of the wetland Kikuyu and other weeds invading wetland edge	During wet periods, the drain overflows which attracts some waterbirds such as White-faced Herons and Latham's Snipe.	None known	BC	Establish additional indigenous overstorey trees to improve the bird habitat values and the landscape values.
				C	Establish additional indigenous overstorey trees to improve the landscape values and additional screening between residential housing and the wetlands

Table 25 Habitat description, waterbird use and revegetation prescriptions for BA landscape zones and LA landscape zones in Seaford Wetland (source: Birds Australia 2004 and TBLD (2005)

BA Zone	Habitat description	Waterbird use		LA Zone	Revegetation prescriptions
		Non-threatened species	Threatened species		
1	This zone consists of shallow ephemeral wetlands which flood during winter and typically dry out by late summer, depending on spring-summer rainfall. Some sections of deeper water may retain water year-round. All wader species recorded at the Seaford Wetlands use this zone, though most species seem to be restricted to favourite areas. The water bodies that are most saline appear to support a reduced number of species and individuals. Often, the only species seen on the most saline pond are Chestnut Teal, Black Swan and Little Pied Cormorant, which are tolerant of such conditions. Most other aquatic species are found on adjoining water bodies that appear less salt affected. Spiny Rush dominates some areas (particularly north-eastern section of wetland) Tall Marsh dominates in north-eastern section Brackish wetland- Sea Rush Rushland dominates the south western area of this zone Small area of freshwater wetland supports Aquatic Herbland and Plains Sedgy Wetland In south west area the deeper water bodies are saline, whilst shallow wetlands are brackish and support Brackish Aquatic Herbland	These wetlands are extremely important for migratory waders, especially when water levels are receding and damp mud is exposed (usually around December–February). Latham's Snipe are only recorded at Seaford in the south of this zone (in the area marked as Plains Sedgey Wetland and Aquatic Herbland/Sedgeland), while the Spotless Crake has only been recorded from the far south of this zone. This zone is also important habitat for ducks, swans and other waterbirds such as herons, egrets and spoonbills. • Black Swan • Chestnut Teal • Pacific Black Duck • White-faced Heron • Purple Swamphen • Masked Lapwing • Latham's Snipe • Whiskered Tern • Common Greenshank • Red-necked Stintr • Spotless Crake • Red-kneed Dotterel	These wetlands are extremely important for migratory waders, especially when water levels are receding and damp mud is exposed (usually around December–February). Latham's Snipe are only recorded at Seaford in the south of this zone (in the area marked as Plains Sedgey Wetland and Aquatic Herbland/Sedgeland), while the Spotless Crake has only been recorded from the far south of this zone. This zone is also important habitat for ducks, swans and other waterbirds such as herons, egrets and spoonbills. • Black Swan • Chestnut Teal • Pacific Black Duck • White-faced Heron • Purple Swamphen • Masked Lapwing • Latham's Snipe • Whiskered Tern • Common Greenshank • Red-necked Stintr • Spotless Crake • Red-kneed Dotterel	SL	Minor adjustments to hydrological regime to allow seasonal wetting of this area to an approximate depth of 300mm, and active revegetation to establish Brackish Wetland/Herbland which will expand the waterbird habitat. Continue Spiny Rush control program and ongoing monitoring. Establish Swamp Scrub along the east and west margins, leaving the northern extent open for uninhibited avifauna flight path.
				SM	Minor improvements to the hydrology to achieve desired seasonal wetting and drying cycles. Continue Spiny Rush control program and reinstate Brackish Aquatic Herbland fringed by Brackish Wetland/Herbland in the eastern areas of the wetland. Control other high priority weed species and regularly monitor for weed infestations. Increase species diversity in freshwater wetland communities. Provide adequate east west fire breaks to control wildfire and peat fire outbreaks. Control introduced predators, particularly foxes, dogs and cats.

Table 25 continued

BA Zone	Habitat description	Waterbird use		LA Zone	Revegetation prescriptions
		Non-threatened species	Threatened species		
2	The habitats within this zone are structurally and floristically similar to those in Zone 6, though there are more extensive areas of planting, including a large area of mature and regenerating banksias at the far south-east corner of the wetland.	None known	None known	SG	Provide vegetation screen/buffer between the southern end of the wetland and visual and physical movement along the path, whilst retaining some selective views over the wetland from the shared trail..
				SH	Improve vegetation management between existing path and wetland. Protect the low lying depressions outside the wetland perimeter fence. Additional revegetation with Damp Sands Herb-rich Woodland species to achieve an open woodland character.
				SI	Improve the landscape character by selective trimming and removal of some trees, and strengthening the low shrub and ground layer species to establish an open woodland character. Potential seating viewing area over the freshwater meadow, along with interpretation of the localised change in vegetation in this area. Increase wetland habitat diversity and selective screening with planting of Swamp Scrub along the wetland margins.
				SJ	Achieve a scattered open woodland character of the Damp Sands Herb-rich Woodland. Increase wetland habitat diversity and selective screening by planting Swamp Scrub EVC along the wetland margins.
3	This zone supports the best quality and most extensive area of woodland habitat at the Seaford Wetlands.	None known	None known	SK	Restore the Damp Sands Herb-rich Woodland vegetation present along the eastern boundary with progressive removal of existing Pine trees and allowing natural regeneration of indigenous species, in preference to revegetation. Expand the area of Damp Sands Herb-rich Woodland to the wetland perimeter to establish a natural connection between the open woodland and the wetland. North of the levee bank only, reintroduce fringing Swamp Scrub between the wetland margin and the Damp Sands Herb-rich Woodland vegetation. South of the levee bank the wetland margins are to remain free of Swamp Scrub.

Table 25 continued

BA Zone	Habitat description	Waterbird use		LA Zone	Revegetation prescriptions
		Non-threatened species	Threatened species		
4	The dominant habitat type in this area is introduced pasture dominated by weedy grasses. Introduced pasture Pines Scattered remnant vegetation including: Red Gum, Swamp Gum and Banksia Spiny Rush in south eastern area of zone	Species such as the Straw-necked and Australian White Ibis prefer the open conditions for foraging.	Species such as the Straw-necked and Australian White Ibis prefer the open conditions for foraging.	SB	Create freshwater wetlands (ie. Herb-rich Plains Grassy Wetland) in the old creek course depressions through a combination of revegetation and increasing seasonal freshwater flows. Retain the majority of the zone as open slashed pasture with some scattered low shrubs and ground layer species from Swamp Scrub EVC for shelter. Retain and improve the remnant Damp Sands Herb-rich Woodland vegetation along the eastern boundary with progressive removal of Pines.
5	The most valuable habitat attribute in this zone is the mature eucalypts. There are numerous large River Red Gums	None known	None known	SA	Reinstate Damp Sands Herb-rich Woodland reflective of its original distribution pattern and lightly wooded character. Improve bird habitat values by allowing open wet depressions to remain with low shrub and reeds for shelter, and selective removal of recently planted overstorey trees to minimise habitat for raptor bird species.
6	This zone comprises open expanses of short grass interspersed with clump plantings of eucalypts and acacias. Larger eucalypts (trees approximately 20 years old) fringe the boundary of the wetland complex, along the margins of adjacent residential areas.	None known	None known	SC	Increase vegetation between housing and wetland including reinstatement of Swamp Scrub margin. This will also improve wetland habitat and vegetation diversity reflective of the original Carrum Carrum Swamp. Address weed invasion into the Wetland in the northern extent of the zone, particularly Kikuyu.
				SD	Increase planting of overstorey trees to provide additional screening to residential properties and provide shade to shared path. Improve the recreational and landscape character and value of this zone with additional trees for shade and create a natural bushland character. Increase diversity of indigenous species on fill mound over time.

Table 25 continued

BA Zone	Habitat description	Waterbird use		LA Zone	Revegetation prescriptions
		Non-threatened species	Threatened species		
6	This zone comprises open expanses of short grass interspersed with clump plantings of eucalypts and acacias. Larger eucalypts (trees approximately 20 years old) fringe the boundary of the wetland complex, along the margins of adjacent residential areas.	None known	None known	SE	Increase planting of overstorey trees to provide additional screening to residential properties and provide shade to shared path. Improve the recreational and landscape character and value of this zone with additional trees for shade and create a natural bushland character. Improve the environmental and landscape amenity of the viewing mound, including potential for a screened approach and interpretive information about the birds. Improve the environmental and landscape value of grassed overland flow swale on the western side of perimeter fence by planting sedge and rush species.
				SF	Retain established vegetation as a buffer between proposed residences and the wetlands. Screen the path from the wetland to potentially improve bird habitat values in an area of the wetland that currently has low presence of bird species.

6.4 Soil type

Service to which the ecosystem component relates:
• Supports vegetation characteristic of the Gippsland Plain Bioregion

The wetlands in the original Carrum Carrum Swamp, of which Edithvale and Seaford Wetlands are remnants, formed as inter-dunal lagoons in the current dune system after its establishment 5,000 – 7,000 years ago (GHD, 2005). These filled with a mixture of eroded dunal sands and more recent alluvial deposits from streams in the catchment. The lagoons established a mud and peat layer from the growth of *Bolboschoenus* spp. which is generally about 300-400 mm thick but may be as thick as three metres (GHD, 2005).

The soils at both Edithvale and Seaford Wetlands consisted of a peat layer. However, the northern depressions of Edithvale North Wetland were excavated into underlying sands in 1987. In 1988, similar excavations at the southern end of Seaford Swamp broke through the peat layer into acid-sulfate soils which caused salinisation and lowered pH. With the addition of lime and the oxidation process declining with time, pH was 4.8 – 5.0 in 2005 (GHD, 2005). In the remainder of Seaford Wetland the peat layer remains relatively intact (TBLD, 2005).

Lane et al. (2000) briefly described the soil type for most wetland vegetation communities (Table 26). Soil types have not been described for EVCs described by TBLD (2005) in 2003 (Section 5.6).

The lack of detailed information on soil types means that it is not possible to define the limits of acceptable change for this component. However, the most significant changes in soil type would be likely to occur through the longer term re-establishment of peat in previously excavated areas through the careful management of vegetation, hydrology and mitigation of salinity. This would not be considered an adverse change in ecological character. Adverse change could be brought about by further excavation or soil disturbance. This is not proposed by the wetland managers.

Table 26 Soil types for vegetation communities in the Edithvale Seaford Wetlands (Source: Lane et al., 2000). * indicates an introduced species

Wetland community	Soil type
Red Milfoil (*Myriophyllum verrucosum*) Submerged Aquatic Herbfield Submerged/emergent aquatic herbfield characterised by Red Milfoil. Occupies the deep freshwater lagoons in the north of the Edithvale North Wetlands at depths of greater than one metre.	Not documented
Cumbungi (*Typha* spp.) Emergent Aquatic Herbfield Dominated by Cumbungi (*Typha domingensis* and *Typha orientalis*)	Peaty anaerobic substrates
Freshwater Amphibious Herbfield Common species include Waterwort (*Elatine gratioloides*), Floating Club-sedge (*Isolepis fluitans*), Swamp Clubsedge (*Isolepis inundata*), Upright Milfoil (*Myriophyllum crispatum.*), White Purslane (*Neopaxia australasica*), Small River Buttercup (*Ranunculus amphitrichus*) and Marsh Club-sedge (*Bolboschoenus medianus*). Seasonally inundated flats of Edithvale North and South where water depths seldom exceed 40cm.	Not documented
Common Reed (*Phragmites australis*) Grassland Dominated by Common Reed	Silty grey loams
Spiny Rush (**Juncus acutus*) Rushland Anthropogenic vegetation community dominated by the highly invasive Spiny Rush (**Juncus acutus ssp. acutus*). A range of indigenous and introduced species also occur in this community.	Grey sandy/silty loams.

Table 26 continued

Wetland community	Soil type
Sub-saline Herbfield Dominated by Water Buttons (**Cotula coronopifolia*), Shiny Swamp-mat (*Selliera radicans*), Streaked Arrow-grass (*Triglochin striatum* sens. lat.), Beaded Glasswort (*Sarcocornia quinqueflora*) and Creeping Saltbush (**Atriplex prostrata*).	Peaty black silts (salinity levels may be quite high)
Sea Rush (*Juncus kraussii*) Rushland Dominated by Sea Rush.	Sulfate soils in the southern parts of Seaford Wetland
Beaded Glasswort (*Sarcocornia quinqueflora ssp. quinqueflora*) Saltmarsh Characterised by Beaded Glasswort in association with mostly introduced species.	Saline soils in the southern parts of the Edithvale North wetlands

7 Data gaps

Since 1990 there have been a number of investigations, studies and monitoring programs at the Edithvale Seaford Wetlands. Detailed information is available on the hydrology, hydrological connectivity, vegetation classes, bird fauna, and bird habitat. Information is less detailed for hydrological inflow and outflow volumes, flood storage capacity, vegetation condition and soil type. While water levels within hydrological management cells are well understood and documented, bathymetry of the wetlands has not been mapped. It would also be useful to classify each wetland cell using the Corrick and Norman (1980) classification.

The successful management of waterbird habitat at Edithvale-Seaford wetlands will depend on a combination of hydrological, vegetation and salinity management as well as the control of invasive species. The relationship between waterbirds and water levels is needed to define the limits of acceptable change for the waterbird habitat component.

There is very little data available for non-avian vertebrate fauna or for aquatic invertebrates. Lane et al. (2000) states that sampling of benthos and plankton was conducted at Seaford Wetlands in 1985 and there has been no sampling at Edithvale Wetland. Lane et al. (2000) states that “the diversity and status of invertebrates in the Edithvale and Seaford Wetlands requires systematic sampling”. In addition to their indicator value, invertebrates are the primary food source for many waterbirds: knowledge of invertebrate richness and abundance may influence management of the foraging habitat of these species”.

Information on water quality parameters is limited and relates mainly to salinity with some information on pH in the southern part of Seaford Wetland. There is no information on nutrients in the wetlands. Lane et al. (2000) states “water quality in the wetlands is significantly influenced by saline water intrusion from the groundwater and stormwater runoff from adjacent urban areas. The quality of this stormwater, particularly the presence of sediment, nutrients and toxicants, has the potential to significantly affect the diversity and productivity of the wetlands and catchment activities will significantly affect this. The maintenance of a nutrient balance to prevent eutrophication is very important”. While catchment land use has been mapped, there is no quantitative information on the nutrient and sediment loads that enter the wetlands from the catchment and no water quality monitoring program within the wetlands.

It is recommended that these data gaps be addressed, giving highest priority to classifying wetland cells using the Corrick and Norman (1980) classification and to acquiring data on water quality, nutrient and sediment loads, non-avian vertebrate fauna, vegetation condition and aquatic invertebrates.

8 Monitoring

The recommended monitoring programs to evaluate change in ecological character for the Edithvale-Seaford Wetlands Ramsar Site are outlined in Table 27.

Table 27 Recommended monitoring of ecosystem components and processes at the Edithvale-Seaford Wetlands Ramsar Site

Overarching component, process, benefit or service	Specific component, process, benefit or service	Objective of the monitoring	Indicator / measure	Frequency	Priority
Hydrology	Frequency Duration Seasonality Connectivity	Determine the success of the hydrological prescriptions in meeting the hydrological objectives for the wetland cells. Establish benchmarks and limits of acceptable change.	depth gauges inflow / outflow from wetland cells	Seasonal with 5 year evaluation	High
Ecological Productivity	Aquatic invertebrates	Establish productivity benchmarks	to be determined	Seasonal	High
Climate	Climate statistics	Determine climate change effects	as used by the Bureau of Meterology	Every 10 years	Medium
Water quality	Nutrients Sediment loads from wetland catchment	Establish benchmarks for nutrient and sediment loads	to be determined in detailed moniroting program	Every 10 years	High.
	Salinity	Establish benchmarks and limits of acceptable change		Every 10 years	High.
Soils	Soil type	Establish benchmarks for soils types, particularily peat substrate	soil type	Every 10 years	Medium
Wetland topography	Depth	Establish benchmark for flood volume and monitor wetland representativeness.	depth gauges	Every 10 years	Medium
Waterbirds including threatened species	Presence Abundance	Detection of change against benchmarks Evaluate waterbird habitat	methods outlined in Tzaros (2005)	Monthly	High
Vegetation	EVCs	Establish benchmarks and monitor to detect change	extent and condition of EVCs	Every 5 years	High

9 Conclusions

The Edithvale-Seaford Wetlands Ramsar Site consists of two separate wetland areas, Edithvale Wetland and Seaford Wetland that are remnants of Carrum Carrum Swamp, a once extensive shallow freshwater marsh. The wetlands had a history of degradation since European settlement until around 1988. Since 1989, a new management approach has aimed to retain and restore their natural values while maintaining their value for flood control, regional drainage, recreation and education. In 2001, the wetlands supported sufficient values to qualify for Ramsar listing. From that time till the present, significant investigations and monitoring programs have led to a greater understanding of the ecosystem services, components and processes at the wetlands and the threats to the values for which it was listed.

The wetland is now actively managed and it is expected that the detailed management prescriptions in place for hydrology and vegetation, in particular, will continue the restoration process. More data is required on some ecosystem services, components and processes and a more comprehensive monitoring program is recommended to monitor ecological character. Since listing in 2001 as a Ramsar Site, there is no evidence of adverse change in ecological character. As restoration proceeds, it is expected that positive changes will result. Therefore, consideration should be given to reviewing the ECD in ten years time and deciding if the benchmarks in this ECD are still relevant for continued monitoring of ecological character.

10 Glossary

Australian height datum (AHD)	The datum used to determine elevations in Australia. The AHD is based on mean sea level being zero elevation.
East Asian-Australasian Flyway	The East Asian-Australasian Flyway (the Flyway) stretches from the Russian Far East and Alaska, southwards through East Asia and South-east Asia, to Australia and New Zealand and encompasses 22 countries. The EastAsian–Australasian Flyway is home to over 50 million migratory waterbirds from over 250 different populations, including 28 globally threatened species. (DEWHA, not dated).
Benchmark	A standard or point of reference (ANZECC and ARMCANZ 2000b). A predetermined state (based on the values that are sought to be protected) to be achieved or maintained (Lambert and Elix 2006). In this ECD, benchmarks are related to the baseline description at the time of listing of a Ramsar site.
Benefits	Benefits here refer to the economic, social and cultural benefits that people receive from ecosystems (Ramsar Convention 2005a, Resolution IX.1 Annex A). These benefits often rely on the underlying ecological components and processes in the wetland. See also 'Ecosystem services'.
Bioregion or Biogeographic region	A scientifically rigorous determination of regions as established using biological and physical parameters such as climate, soil type, vegetation cover, etc (Ramsar Convention 2005b).
Catchment	The total area draining into a river, reservoir, or other body of water (ANZECC and ARMCANZ 2000a).
Change in ecological character	Human-induced adverse alteration of any ecosystem component, process, and/or ecosystem benefit/service (Ramsar Convention 2005a, Resolution IX.1 Annex A).
Community	An assemblage of organisms characterised by a distinctive combination of species occupying a common environment and interacting with one another (ANZECC and ARMCANZ 2000a).
Diversity (biological)	The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species (genetic diversity), between species (species diversity), of ecosystems (ecosystem diversity), and of ecological processes. This definition is based largely on the one contained in Article 2 of the Convention on Biological Diversity (Ramsar Convention 2005b).
Ecological character	The combination of the ecosystem components, processes, and benefits and services that characterise the wetland at a given point in time. Within this context, ecosystem benefits are defined in accordance with the variety of benefits to people (ecosystem services). The phrase 'at a given point in time' refers to Resolution VI.1 paragraph 2.1, which states that 'It is essential that the ecological character of a site be described by the Contracting Party concerned at the time of designation for the Ramsar List, by completion of the Information Sheet on Ramsar Wetlands (as adopted by Recommendation IV. 7).'

Glossary continued

Ecological communities	Any naturally occurring group of species inhabiting a common environment thatinteracts with each other, especially through food relationships, and that is relatively independent of other groups. Ecological communities may be of varying sizes, and larger ones may contain smaller ones (Ramsar Convention 2005b).
Ecosystems	Within the Millennium Ecosystem Assessment, ecosystems are described as the complex of living communities (including human communities) and nonliving environment (ecosystem components) interacting (through ecological processes) as a functional unit, which provides, inter alia, a variety of benefits to people (ecosystem services) (Ramsar Convention 2005a, Resolution IX.1 Annex A).
Ecosystem components	Include the physical, chemical and biological parts of a wetland (from large scale to very small scale,e.g. habitat, species and genes) (Ramsar Convention 2005a, Resolution IX.1 Annex A).
Ecosystem processes	Dynamic forces within an ecosystem. They include all those processes that occur between organisms and within and between populations and communities, including interactions with the nonliving environment, that result in existing ecosystems and that bring about changes in ecosystems over time (Australian *Heritage Commission 2002)*. They may be physical, chemical or biological.
Ecosystem services See also 'Benefits'	Benefits that people receive or obtain from an ecosystem (Ramsar Convention 2005a, Resolution IX.1 Annex A). The components of ecosystem services include (Millennium Ecosystem Assessment 2005): provisioning services — such as food, fuel and fresh water regulating services — the benefits obtained from the regulation of ecosystem processes such as climate regulation, water regulation and natural hazard regulation cultural services — the benefits people obtain through spiritual enrichment, recreation, education and aesthetics supporting services — the services necessary for the production of all other ecosystem services such as water cycling, nutrient cycling and habitat for biota. These services will generally have an indirect benefit to humans or a direct benefit in the long term.
Ecological vegetation class (EVC)	An EVC is a native vegetation classification based on a combination of its floristics, life form and ecological characteristics, and through an inferred fidelity to particular environment attributes (DSE 2004).
Flyway	Global waterbird migration systems that directly link sites and ecosystems in different countries and continents. The geographical routes that migratory waterbirds traverse on an annual basis are known as 'flyways'. There are eight major flyways around the world (DEWHA not dated)
Limits of acceptable change	Variation that is considered acceptable in a particular component or process of the ecological character of the wetland without indicating change in ecological character that may lead to a reduction or loss of the criteria for which the site was Ramsar listed (modified from definition adopted by Phillips 2006).
Ramsar	City in Iran, on the shores of the Caspian Sea, where the Convention on Wetlands was signed on 2 February 1971; thus the Convention's short title, 'Ramsar Convention on Wetlands' http://www.ramsar.org/about/about_glossary.htm
Ramsar Criteria	Criteria for identifying wetlands of international importance, used by Contracting Parties and advisory bodies to identify wetlands as qualifying for the Ramsar List on the basis of representativeness or uniqueness or of biodiversity values. http://www.ramsar.org/about/about_glossary.htm

Glossary continued

Ramsar Convention	Convention on Wetlands of International Importance especially as Waterfowl Habitat. Ramsar (Iran), 2 February 1971. UN Treaty Series No. 14583. As amended by the Paris Protocol, 3 December 1982, and Regina Amendments, 28 May 1987. The abbreviated names "Convention on Wetlands (Ramsar, Iran, 1971)" or "Ramsar Convention" are used more commonly. http://www.ramsar.org/index_very_key_docs.htm
Ramsar Information Sheet (RIS)	Form upon which Contracting Parties record relevant data on proposed Wetlands of International Importance for inclusion in the Ramsar Database; covers identifying details like geographical coordinates and surface area, criteria for inclusion in the Ramsar List and wetland types present, hydrological, ecological, and socioeconomic issues among others, ownership and jurisdictions, and conservation measures taken and needed. http://www.ramsar.org/about/about_glossary.htm
Waterbirds	The Ramsar Convention defines 'waterfowl' as species of birds that are "ecologically dependent upon wetlands" Wetlands International (2006) defines waterbirds as all such species of the families Gaviidae, Podicipedidae, Pelecanidae, Phalacrocoracidae, Anhingidae, Ardeidae, Balaenicipitidae, Scopidae, Ciconiidae, Threskiornithidae, Phoenicopteridae, Anhimidae, Anatidae, Pedionomidae, Gruidae, Aramidae, Rallidae, Heliornithidae, Eurypygidae, Jacanidae, Rostratulidae, Dromadidae, Haematopodidae, Ibidorhynchidae, Recurvirostridae, Burhinidae, Glareolidae, Charadriidae, Scolopacidae, Thinocoridae, Laridae, Sternidae and Rynchopidae.
Wetlands	Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres (Ramsar Convention 1987).
Wetland types	As defined by the Victorian classification sytem of Corrick and Norman (1980).

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Appendix 1 Victorian wetland categories and sub-categories

Source: Department of Conservation and Environment and Office of the Environment 1992.

Category	Sub category	Depth (m)	Duration of inundation
2. Freshwater meadow	Herb-dominated Sedge-dominated Red gum-dominated Lignum dominated	< 0.3	< 4 months/year
3. Shallow freshwater marsh	Herb-dominated Sedge-dominated Cane grass-dominated Lignum dominated Red gum-dominated	< 0.5	< 8 months/year
4. Deep freshwater marsh	Shrub-dominated Reed-dominated Sedge-dominated Rush-dominated Open water Cane grass-dominated Lignum-dominated Red gum-dominated	< 2	Permanent
5. Permanent Open Freshwater	Shallow Deep Impoundment	<0.5* >2	Permanent**

***The literature variously states that permanent open freshwater wetlands in the shallow subcategory may be <2, <3 or <5 metres deep. Andrew Corrick (pers. comm.) advises that 0.5 metres is the most appropriate figure to use.**

**** Permanent Open Freshwater wetlands retain water for longer than 12 months. However, they can have periods of drying (Corrick, pers. comm. August 2004).**

Appendix 2 Waterbird counts

Edithvale Wetland continued

Common Name	Maximum count (Sep 1989 to 2007)	Total count	Average count (n = 207)	No. surveys recorded	Reporting Rate	No. years recorded (n = 19)
Australasian Bittern	12	238	1.15	80	38.6%	16
Australasian Darter	2	5	0.02	4	1.9%	4
Australasian Grebe	106	2164	10.45	195	94.2%	19
Australasian Shoveler	381	4956	23.94	161	77.8%	19
Australian Pelican	14	308	1.49	106	51.2%	18
Australian Reed-Warbler	240	7976	38.53	155	74.9%	19
Australian Shelduck	3	33	0.16	18	8.7%	10
Australian Spotted Crake	24	277	1.34	65	31.4%	17
Australian White Ibis	62	941	4.55	136	65.7%	19
Australian Wood Duck	17	85	0.41	30	14.5%	13
Baillon's Crake	17	128	0.62	43	20.8%	16
Black Swan	278	12411	59.96	206	99.5%	19
Black-fronted Dotterel	40	568	2.74	131	63.3%	19
Black-tailed Godwit	-	0		0		0
Black-tailed Native-hen	1	1	0.00	1	0.5%	1
Black-winged Stilt	423	7199	34.78	129	62.3%	18
Blue-billed Duck	36	1280	6.18	156	75.4%	19
Buff-banded Rail	3	32	0.15	26	12.6%	12

Edithvale Wetland continued

Common Name	Maximum count (Sep 1989 to 2007)	Total count	Average count (n = 207)	No. surveys recorded	Reporting Rate	No. years recorded (n = 19)
Cape Barren Goose	2	2	0.01	1	0.5%	1
Caspian Tern	9	17	0.08	5	2.4%	4
Cattle Egret	14	45	0.22	19	9.2%	11
Chestnut Teal	880	23826	115.10	207	100.0%	19
Common Greenshank	16	144	0.70	47	22.7%	15
Common Tern	1	1	0.00	1	0.5%	1
Curlew Sandpiper	282	512	2.47	22	10.6%	13
Double-banded Plover	1	2	0.01	2	1.0%	2
Dusky Moorhen	74	2368	11.44	203	97.6%	19
Eastern Great Egret	4	75	0.36	54	26.1%	17
Eurasian Coot	1517	53203	257.02	207	100.0%	19
Freckled Duck	9	14	0.07	4	1.9%	2
Glossy Ibis	8	26	0.13	9	4.3%	5
Great Cormorant	48	212	1.02	76	36.7%	18
Great Crested Grebe	1	7	0.03	7	3.4%	5
Grey Teal	575	6537	31.58	167	80.7%	18
Hardhead	82	1538	7.43	124	64.7%	19

Edithvale Wetland continued

Common Name	Maximum count (Sep 1989 to 2007)	Total count	Average count (n = 207)	No. surveys recorded	Reporting Rate	No. years recorded (n = 19)
Hoary-headed Grebe	216	5641	27.25	193	93.2%	19
Intermediate Egret	2	6	0.03	5	2.4%	4
Latham's Snipe	68	915	4.42	89	43.0%	19
Lewin's Rail	2	4	0.02	3	1.4%	3
Little Bittern	2	2	0.01	1	0.5%	1
Little Black Cormorant	450	723	3.49	22	10.6%	10
Little Curlew	1	1	0.00	1	0.5%	1
Little Egret	1	1	0.00	1	0.5%	1
Little Pied Cormorant	30	1150	5.56	166	80.2%	19
Long-toed Stint	1	2	0.01	2	1.0%	2
Magpie Goose	8	40	0.19	31	15.0%	7
Marsh Sandpiper	42	350	1.69	40	19.3%	13
Masked Lapwing	48	1629	7.87	181	87.4%	19
Musk Duck	10	520	2.51	158	76.3%	18
Nankeen Night Heron	2	7	0.03	5	2.4%	4
Pacific Black Duck	1208	13617	65.78	207	100.0%	19
Pacific Gull	7	63	0.30	33	15.9%	19
Pectoral Sandpiper	5	22	0.11	13	6.3%	9
Pied Cormorant	1	4	0.02	4	1.9%	3
Pink-eared Duck	110	191	0.92	11	5.3%	8

Edithvale Wetland continued

Common Name	Maximum count (Sep 1989 to 2007)	Total count	Average count (n = 207)	No. surveys recorded	Reporting Rate	No. years recorded (n = 19)
Purple Swamphen	327	14448	69.80	207	100.0%	19
Red Knot	2	2	0.01	1	0.5%	1
Red-capped Plover	16	62	0.30	10	4.8%	4
Red-kneed Dotterel	50	459	2.22	46	22.2%	14
Red-necked Avocet	30	65	0.31	4	1.9%	3
Red-necked Phalarope	-	0	0.00	0		0
Red-necked Stint	52	122	0.59	19	9.2%	10
Royal Spoonbill	8	139	0.67	65	31.4%	18
Sharp-tailed Sandpiper	5006	38505	186.01	87	42.0%	18
Silver Gull	1170	17779	85.89	207	100.0%	19
Spotless Crake	7	96	0.46	53	25.6%	13
Straw-necked Ibis	90	1282	6.19	108	52.2%	18
Swamp Harrier	6	328	1.58	159	76.8%	19
Whiskered Tern	160	1594	7.70	47	22.7%	16
White-bellied Sea-Eagle	1	1	0.00	1	0.5%	1
White-faced Heron	32	1193	5.76	200	96.6%	19
White-necked Heron	12	59	0.29	21	10.1%	10
White-winged Black Tern	8	28	0.14	6	2.9%	5
Wood Sandpiper	9	109	0.53	47	22.7%	17
Yellow-billed Spoonbill	8	169	0.82	76	36.7%	15

Seaford Wetland

Common Name	Maximum count 1994 to 2007	Total count	Average count (n = 136)	No. surveys recorded	Reporting Rate	No. years recorded (n = 14)
Australasian Bittern	2	25	0.18	21	15.4%	8
Australasian Darter	1	4	0.03	4	2.9%	3
Australasian Grebe	7	70	0.51	37	27.2%	13
Australasian Shoveler	12	85	0.63	15	11.0%	8
Australian Pelican	40	347	2.55	83	61.0%	13
Australian Reed-Warbler	65	1967	14.46	80	58.8%	13
Australian Shelduck	110	177	1.30	19	14.0%	10
Australian Spotted Crake	2	13	0.10	10	7.4%	6
Australian White Ibis	31	415	3.05	55	40.4%	12
Australian Wood Duck	14	52	0.38	14	10.3%	9
Baillon's Crake	2	13	0.10	10	7.4%	7
Black Swan	128	2572	18.91	128	94.1%	14
Black-fronted Dotterel	19	147	1.08	67	49.3%	14
Black-tailed Godwit	1	1	0.01	1	0.7%	1
Black-tailed Native-hen	1	3	0.02	3	2.2%	1
Black-winged Stilt	62	837	6.15	54	39.7%	13
Blue-billed Duck	20	168	1.24	26	19.1%	8
Buff-banded Rail	-	0		0		0
Cape Barren Goose	2	4	0.03	3	2.2%	2
Caspian Tern	1	2	0.01	2	1.5%	2

Seaford Wetland continued

Common Name	Maximum count 1994 to 2007	Total count	Average count (n = 136)	No. surveys recorded	Reporting Rate	No. years recorded (n = 14)
Cattle Egret	2	5	0.04	3	2.2%	3
Chestnut Teal	300	12830	94.34	135	99.3%	14
Common Greenshank	12	151	1.11	49	36.0%	13
Common Tern	1	1	0.01	1	0.7%	1
Curlew Sandpiper	27	60	0.44	9	6.6%	4
Double-banded Plover	1	2	0.01	2	1.5%	2
Dusky Moorhen	16	159	1.17	52	38.2%	11
Eastern Great Egret	4	68	0.50	53	39.0%	14
Eurasian Coot	150	1171	8.61	56	41.2%	12
Freckled Duck	1	1	0.01	1	0.7%	1
Glossy Ibis	-	0		0		0
Great Cormorant	19	142	1.04	47	34.6%	12
Great Crested Grebe	2	3	0.02	2	1.5%	2
Grey Teal	289	3216	23.65	113	83.1%	14
Hardhead	65	458	3.37	46	33.8%	12
Hoary-headed Grebe	117	1195	8.79	109	80.1%	14
Intermediate Egret	-	0		0		0
Latham's Snipe	22	171	1.26	47	34.6%	13
Lewin's Rail	1	1	0.01	1	0.7%	1
Little Bittern	1	1	0.01	1	0.7%	1

Seaford Wetland continued

Common Name	Maximum count 1994 to 2007	Total count	Average count (n = 136)	No. surveys recorded	Reporting Rate	No. years recorded (n = 14)
Little Black Cormorant	14	179	1.32	49	36.0%	14
Little Curlew	-	0		0		0
Little Egret	-	0		0		0
Little Pied Cormorant	8	67	0.49	43	31.6%	12
Long-toed Stint	-	0		0		0
Magpie Goose	-	0		0		0
Marsh Sandpiper	4	13	0.10	5	3.7%	4
Masked Lapwing	27	824	6.06	115	84.6%	14
Musk Duck	1	2	0.01	2	1.5%	1
Nankeen Night Heron	-	0		0		0
Pacific Black Duck	190	5351	39.35	134	98.5%	14
Pacific Gull	5	26	0.19	13	9.6%	7
Pectoral Sandpiper	1	1	0.01	1	0.7%	1
Pied Cormorant	17	18	0.13	2	1.5%	1
Pink-eared Duck	2	4	0.03	3	2.2%	3
Purple Swamphen	50	1305	9.60	132	97.1%	14
Red Knot	-	0		0		0
Red-capped Plover	13	138	1.01	35	25.7%	9
Red-kneed Dotterel	73	111	0.82	10	7.4%	4

Seaford Wetland continued

Common Name	Maximum count 1994 to 2007	Total count	Average count (n = 136)	No. surveys recorded	Reporting Rate	No. years recorded (n = 14)
Red-necked Avocet	91	295	2.17	8	5.9%	5
Red-necked Phalarope	1	1	0.01	1	0.7%	1
Red-necked Stint	65	84	0.62	8	5.9%	6
Royal Spoonbill	9	147	1.08	63	46.3%	13
Sharp-tailed Sandpiper	700	5774	42.46	34	25.0%	12
Silver Gull	440	3853	28.33	130	95.6%	14
Spotless Crake	2	11	0.08	8	5.9%	4
Straw-necked Ibis	95	617	4.54	51	37.5%	12
Swamp Harrier	6	177	1.30	99	72.8%	14
Whiskered Tern	80	344	2.53	14	10.3%	7
White-bellied Sea-Eagle	1	1	0.01	1	0.7%	1
White-faced Heron	16	366	2.69	113	83.1%	13
White-necked Heron	1	2	0.01	2	1.5%	2
White-winged Black Tern	-	0		0		0
Wood Sandpiper	1	1	0.01	1	0.7%	1
Yellow-billed Spoonbill	8	61	0.45	37	27.2%	11

Appendix 3 Summary of hydrological operations for the Edithvale-Seaford Wetlands

Reproduced from GHD (2005)

Area	**Cell Number**	**Winter Spring** **level**	**Summer Autumn** **level**	**Comments**
Edithvale South	ES1 - Main pond	Following onset of rains in late autumn - standing water level at 0.00 AHD but rising to +0.15 m AHD during events	Will normally dry out and desiccate in late December Unseasonable event flows may rewet the area totally or partially.	Drying key to Bolboschoenus growth to maintain peats and nutrient cycling. Also controls Typha invasion Outflows via siphon to cell EN1 and overflows via weir (0.15m) to Centre Swamp Drain Floodway.
	ES1a/b/c - refuge pools	0.00 AHD	Rest at -0.40m AHD or lower depending on the season	Filled by pump off Centre Swamp Drain low flow pipe from January on an as needed basis
	ES Sed 1 and 2 & 3	Will rest at 0.00 AHD	Draw down below 0.00 due to evaporation but may refill under event flows	Sediment ponds obscured by Phragmites growth

Appendix 3 continued

Area	Cell Number	Winter Spring level	Summer Autumn level	Comments
Edithvale North	EN1 Peat	0.00 AHD or below	Generally desiccates every year- some wet summers will leave residual pool in autumn	Overflow at approx 0.00 AHD to EN 2 via weir in bank at 0.00. Relies primarily on siphon from ES1 for flows. Flood flows may enter from floodway at +0.2m AHD.
	EN2 Sands	Will fill from EN1 and lower salinity – level determined by level in EN3 but minimum of -0.4 at weir 2. Primary sill south of boardwalk at Weir No2. Full level controlled via EN3 outlets	Generally draws down to about -0.5m in average year but can go down to -1.2 in dry times. Weir to EN3 set at -0.4m AHD under board walk	System responds to groundwater in summer – which is controlled by area saturation and drawdown to invert of low flow pipe in Centre Swamp Drain floodway to south
	EN3 main open water pond	Will fill to - 0.2-0.3 m AHD in wet year, but may be much lower in a low rainfall year. Outlet via twin 150mm UPVC pipes. Overflows top of outlets to be set at -0.2 - 0.3m AHD. In flood events will overflow to floodway via swale set at +0.12m AHD	Generally draws down to about -0.5m in average year but can go down to -1.2 in dry times. Filled from subdivision stormwater and overflow from EN1/EN2 occasionally.	Filling of pond to full supply generally only achieved in July - October. Drawdown via groundwater and evaporation response. Higher water levels can occur in wet years and summers
	EN 3a Northern end of main pond	As above	Will draw down to submerged weirs to NW -weirs 3 (-0.4 to -0.5 m AHD) and weir 4 (-0 .95 m AHD) by end January and then slowly decrease after that. Weir 3 crest at --0.4 AHD for late autumn vehicle access to island.	Filling of pond to full supply generally only achieved in July - October. Drawdown via groundwater and evaporation response. Higher water levels can occur in wet summers

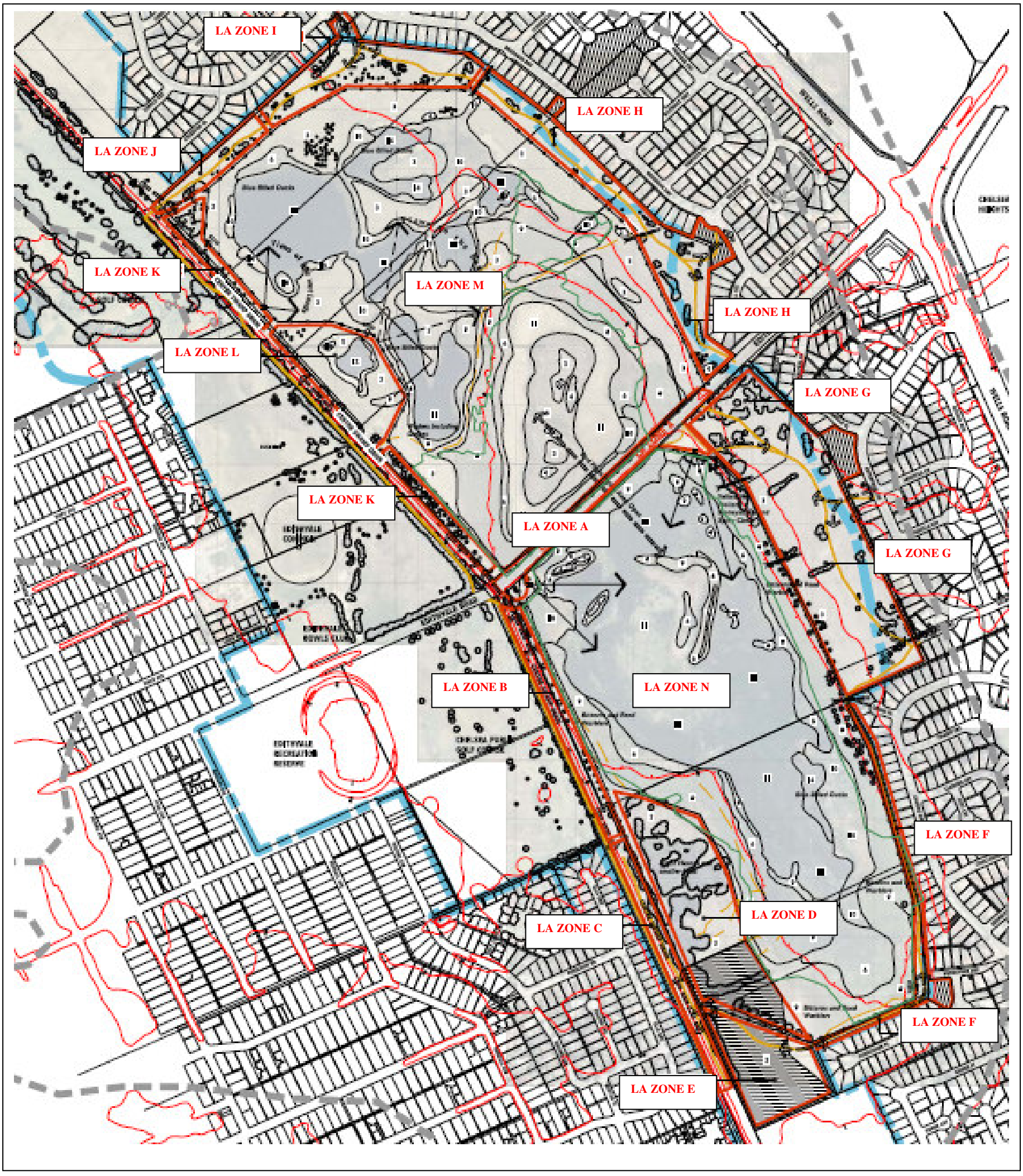
Appendix 3 continued

Area	Cell Number	Winter Spring level	Summer Autumn level	Comments
Edithvale North	EN4 Sedimentation pond	Overflow controlled by sill at approx -0.2m AHD	Will draw down to weir at -0.2 m AHD, then evaporation and inflows control the level	Site known to hold predominantly fresh water and support Blue Bills and Bitterns
	EN5 Sedimentation pond	Responds to main pond height in EN3	Generally dries out by late December	No weir as per EN4
	Dog Pond	Relies on inflows from EN2 to be above the standing seasonal groundwater height. In flow pipe at -0.6m AHD but higher sill at – 0.3m AHD controls surface outflow	Generally dry by end of January	Not lined and is a poor arrangement. Requires a substantial clay liner to retain water and to limit groundwater interaction
Seaford North	SN1 main header pool	To fill and maintain to 0.60m AHD – level to be controlled via weir plates on overflow orifices in earth bund. Side caste overflow around structure to east at 0.75 m AHD and or sag point in the west at 0.75m AHD Filling is generally via side cast weir at Eel Race drain at 0.70m AHD	To draw down via orifices to 0.45 – Summer Autumn maintenance flow via Wadsleys Drain pump and rising main (65mm dia) to header drain. Event flows can enter via overflow weir at north. Close eastern cell SCE2 in late October early November to allow mud flats to form. Leave open orifice to SCW1 – divert to Swamp Drain in late November	Current levee bank severely damaged by fire truck traffic – not designed for vehicle use
	SN2 various ephemeral areas locked by land forms of former swamp cut off by Eel Race Drain	Ephemeral and variable levels dependant on rainfall	Generally dry	Several areas that provide critical habitats
	SN - Downes	Seasonal wetland in old courses	Dry	Important habitat area

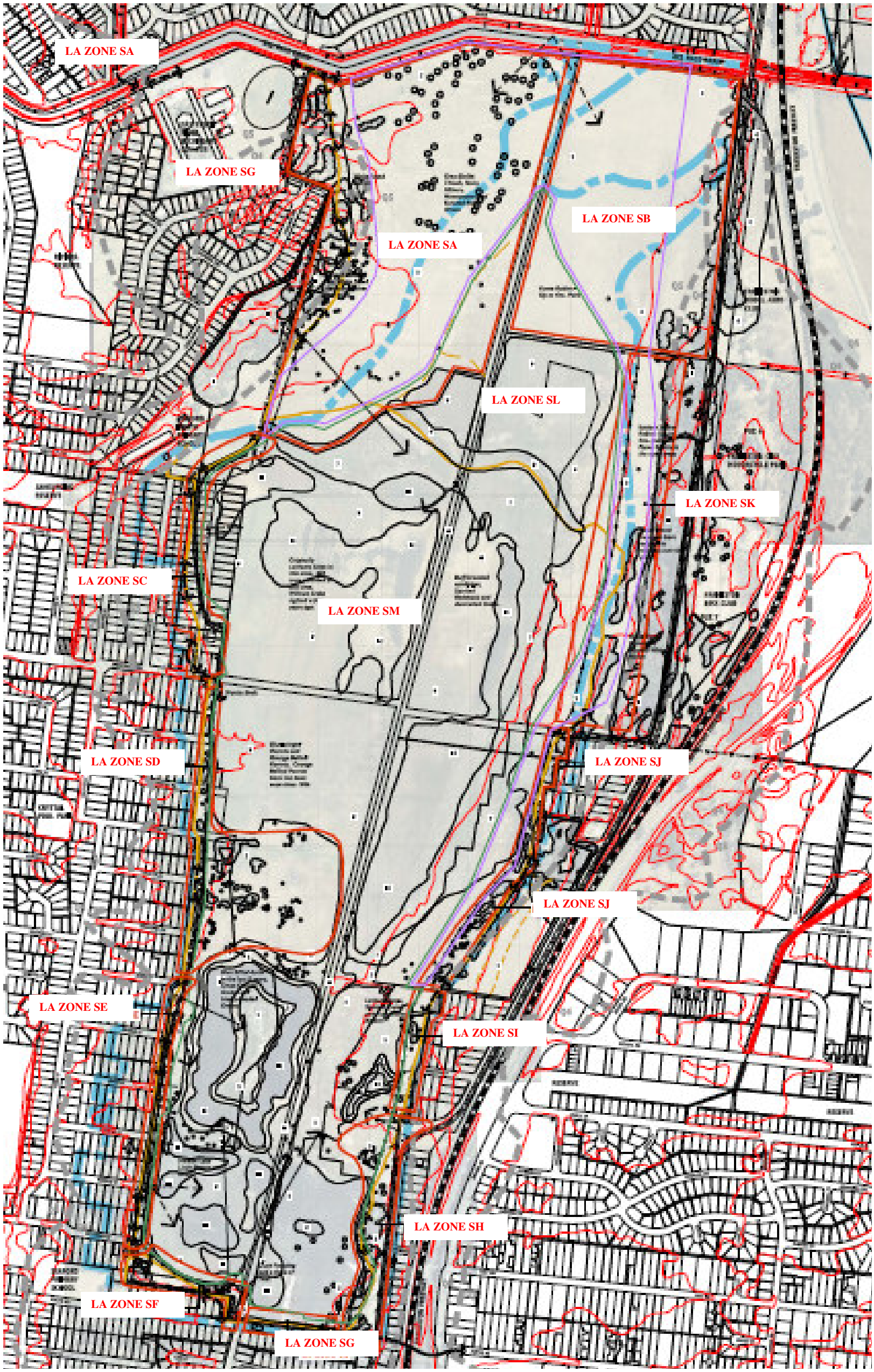
Appendix 3 continued

Area	Cell Number	Winter Spring level	Summer Autumn level	Comments
Seaford Central	SCW1	Should hold to about 0.4m AHD controlled by sills to centre drain at 2 locations. Fed by event and base flows	Will pond higher during events but will draw back to 0.4m AHD or lower if no events. Fed by Seaford North local drainage system as well as low flow pump from Wadsleys Drain via overflow from Cell SN1	Sill controls to centre drain are crude and need formalising but seem to be working Inlet is increasing Phragmites and Typha growth
Seaford Central	SCE2	Should hold to 0.45 m AHD in late spring after which supply is ceased except for major unseasonable event inflows. Level control via sills in SW corner adjacent to central drain	Should desiccate to mud flats by mid December. Inflows from SN1 to cease late October. Some unseasonable flows could refill.	Generally working well
	SCE2a	Minor ponding to 0.55 in winter due to old fill mound of central drain Overflows uncertain but generally to SSE4	Generally dry except for some residual pool areas in natural terrain	OK need to watch for mossies – generally low brackish area
Seaford South	SSW1	Lowest point in system – Generally maintained at 0.0.18 – 0.35m by outlet orifice in SE corner (150mm PVC pipe) with T) that drains to Austin Road outlet via a rubber duck bill flap valve	Will maintain at 0.25-0.3 by base flows	Overflows via sill between SSW1 and SSW3 is at about 0.5m AHD
	SSE2	Winter spring levels can get to 0.7- 0.8 m AHD – overflow via sill in NE corner of cell to SCE2a at 0.7approx	Generally dries to one or two residual pools at about 0.3m AHD	Fed by local drains to the east.
	SSW3	Should hold at +0.45m AHD by overflow to weir on central pipe – been broken off by vandals. Level currently controlled by sill at Austin Road needs re configuring to original intent	Holds to pool height of 0.45 or lower depends of event inflows and tidal back flooding	Outlet control destroyed
	SSE4	Generally only wet in winter – basically ephemeral will hold to 0.45/0.5m AHD in winter but responds to SSW3 height	Generally dry in summer autumn J Krausii area. Will receive major flood inflows from Austin Road	Operating Ok Note future RB wall need along south and east areas.

Appendix 4 LA landscape zones for Edithvale Wetland (reproduced from TBLD, 2005)



Appendix 5 LA landscape zones for Seaford Wetland (reproduced from TBLD, 2005)



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