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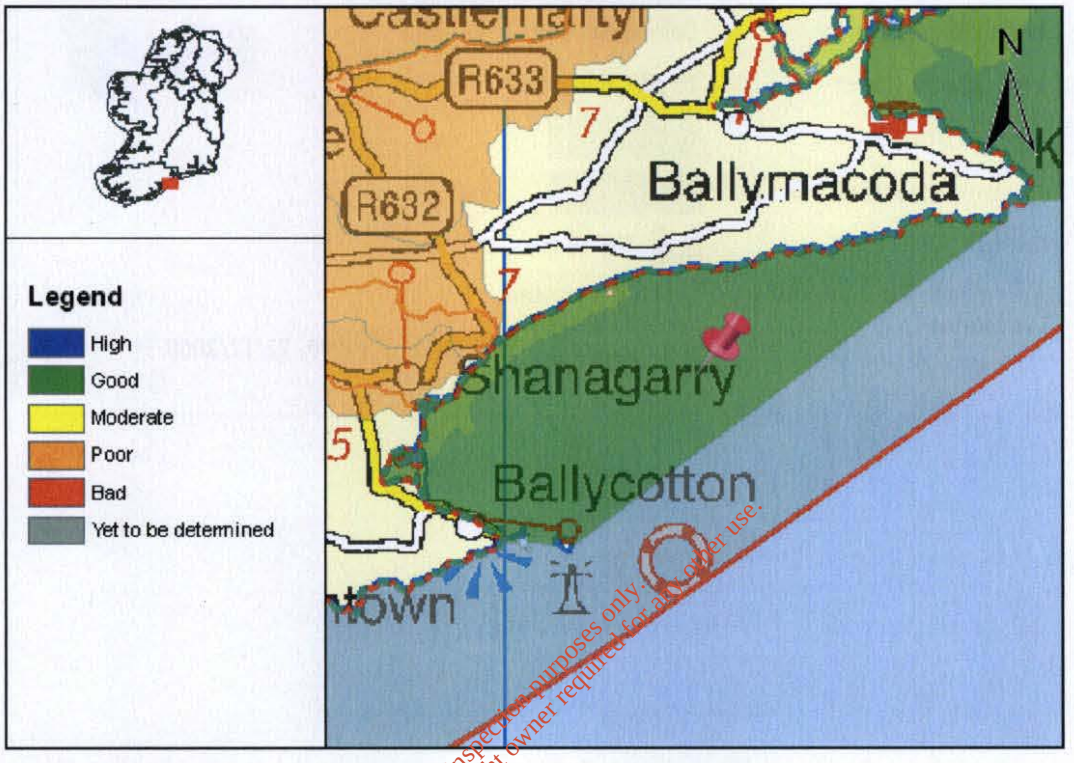
Full Report for Waterbody Ballycotton Bay



Date Reported to Europe: 22/12/2008

Date Report Created 25/08/2009

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Summary Information:

WaterBody Category:	Coastal Waterbody
WaterBody Name:	Ballycotton Bay
WaterBody Code:	IE_SW_040_0000
Overall Status:	Good
Overall Objective:	Protect
Overall Risk:	2b Not At Risk
Applicable Supplementary Measures:	Urban & Industrial;

Report data based upon Draft RBMP, 22/12/2008.

south western river basin district

Date Reported to Europe: 22/12/2008

Date Report Created 25/08/2009

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Status Report

WaterBody Category: Coastal Waterbody

WaterBody Name: Ballycotton Bay

WaterBody Code: IE_SW_040_0000

Overall Status Result: Good

south western river basin district

	Status Element Description	Result
EX	Status from Monitored or Extrapolated Waterbody	Extrapolated
	General Conditions	
DIN	Dissolved Inorganic Nitrogen	
MRP	Molybdate Reactive Phosphorus	
DO	Dissolved Oxygen as percent saturation	
BOD	Biochemical Oxygen Demand	
T	Temperature	
	Biological Elements	
PB	Phytoplankton - Phytoblooms	
PBC	Phytoplankton - PhytoBiomass (Chlorophyll)	
MA	Macroalgae	
RSL	Reduced Species List	
SG	Angiosperms - Seagrass and Saltmarsh	
BE	Benthic Invertebrates	
FI	Fish	
	HydroMorphology	
HY	Hydrology	
MO	Morphology	
	Specific Pollutants	
SP	Specific Relevant Pollutants (Annex VII)	
	Conservation Status	
CN	Conservation Status (Expert Judgement)	
	Protected Area Status	
PA	Overall Protected Area Status	

Date Reported to Europe: 22/12/2008

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	Overall Status	
ES	Ecological Status	
CS	Chemical Status	
O	Overall Ecological Status	Good

Date Reported to Europe: 22/12/2008

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Risk Report

WaterBody Category: Coastal Waterbody

WaterBody Name: Ballycotton Bay

WaterBody Code: IE_SW_040_0000

Overall Risk Result: 2b Not At Risk

south western river basin district

	Risk Test Description	Risk
	Point Risk Sources	
CP1	WWTPs (2008)	2b Not At Risk
CP2	CSOs	
CP3	IPPCs (2008)	2b Not At Risk
CP4	Section 4s (2008)	2b Not At Risk
CPO	Overall Risk from Point Sources - Worst Case (2008)	
	Morphological Risk Sources	
MOR	Overall Morphological Risk - Worst Case	2b Not At Risk
	Marine Direct Impacts	
MDI1	Dangerous Substances	
MDI2	OSPAR	
MDI3	UWWT Regs Designations	
MDIO	Marine Direct Impacts Overall - Worst Case	
	Overall Risk	
CP	Worst case of Point and Marine Direct Impacts Overall (2008)	2b Not At Risk
RA	Coastal Risk Overall - Worst case (2008)	2b Not At Risk

Date Reported to Europe: 22/12/2008

Date Report Created 25/08/2009

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Objectives Report

WaterBody Category: Coastal Waterbody

WaterBody Name: Ballycotton Bay

WaterBody Code: IE_SW_040_0000

Overall Objective: Protect

south western river basin district

	Objectives Description	Result
	Objectives	
OB1	Objective 1 - Protected Areas	Protect
OB2	Objective 2 - Protect High and Good Status	Not Applicable
OB3	Objective 3 - Restore Less Than Good Status	Not Applicable
OB4	Objective 4 - Reduce Chemical Pollution	Not Applicable
OBO	Overall Objective	Protect
	Deadline	
YR	Default Year by which the objective must be met	2015
OBO	Overall Objective and Deadline	Protect

Date Reported to Europe: 22/12/2008

Date Report Created 25/08/2009

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Basic Measures Report

WaterBody Category: Coastal Waterbody

WaterBody Name: Ballycotton Bay

WaterBody Code: IE_SW_040_0000

south western river basin district

	Basic Measures Description	Applicable
	Key Directives	
BA	Bathing Waters Directive	Yes
BI	Birds Directive	Yes
HA	Habitats Directive	No
DW	Drinking Waters Directive	No
SEV	Major Accidents and Emergencies (Seveso) Directive	Yes
EIA	Environmental Impact Assessment Directive	Yes
SE	Sewage Sludge Directive	Yes
UW	Urban Waste Water Treatment Directive	No
PL	Plant Protection Products Directive	Yes
NI	Nitrates Directive	Yes
IP	Integrated Pollution Prevention Control Directive	Yes
	Other Stipulated Measures	
CR	Cost recovery for water use	Yes
SU	Promotion of efficient and sustainable water use	No
DWS	Protection of drinking water sources	No
AB	Control of abstraction and impoundments	No
PT	Control of point source discharges	Yes
DI	Control of diffuse source discharges	Yes
GWD	Authorisation of discharges to groundwater	No
PS	Control of priority substances	Yes
MOR	Control of physical modifications to surface waters	Yes
OA	Controls on other activities impacting on water status	Yes
AP	Prevention or reduction of the impact of accidental pollution incidents	Yes

Date Reported to Europe: 22/12/2008

Date Report Created 25/08/2009

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Urban and Industrial Discharges Supplementary Measures Report

WaterBody Category: Coastal Waterbody

WaterBody Name: Ballycotton Bay

WaterBody Code: IE_SW_040_0000

south western river basin district

	Point discharges to waters from municipal and industrial sources	Result
PINDDIS	Is there one or more industrial discharge (Section 4 licence issued by the local authority or IPPC licence issued by the EPA) contained within the water body?	No
PINDDISR	Are there industrial discharges (Section 4 licence issued by the local authority or IPPC licence issued by the EPA) that cause the receiving water to be 'At Risk' within the water body?	No
PB1	Basic Measure 1 - Measures for improved management.	No
PB2	Basic Measure 2 - Optimise the performance of the waste water treatment plant by the implementation of a performance management system.	No
PB3	Basic Measure 3 - Revise existing Section 4 license conditions and reduce allowable pollution load.	No
PB4	Basic Measure 4 - Review existing IPPC license conditions and reduce allowable pollution load.	No
PB5	Basic Measure 5 - Investigate contributions to the collection system from unlicensed discharges.	No
PB6	Basic Measure 6 - Investigate contributions to the collection system of specific substances known to impact ecological status.	No
PB7	Basic Measure 7 - Upgrade WWTP to increase capacity.	No
PB8	Basic Measure 8 - Upgrade WWTP to provide nutrient removal treatment.	No
PS1	Supplementary Measure 1 - Measures intended to reduce loading to the treatment plant.	No
PS2	Supplementary Measure 2 - Impose development controls where there is, or is likely to be in the future, insufficient capacity at treatment plants.	No
PS3	Supplementary Measure 3 - Initiate investigations into characteristics of treated wastewater for parameters not presently required to be monitored under the urban wastewater treatment directive.	No
PS4	Supplementary Measure 4 - Initiate research to verify risk assessment results and determine the impact of the discharge.	No
PS5	Supplementary Measure 5 - Use decision making tools in point source discharge management.	No
PS6	Supplementary Measure 6 - Install secondary treatment at plants where this level of treatment is not required under the urban wastewater treatment directive.	No
PS7	Supplementary Measure 7 - Apply a higher standard of treatment (stricter emission controls) where necessary.	No

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PS8	Supplementary Measure 8 - Upgrade the plant to remove specific substances known to impact on water quality status.	No
PS9	Supplementary Measure 9 - Install ultra-violet or similar type treatment.	No
PS10	Supplementary Measure 10 - Relocate the point of discharge.	No

Date Reported to Europe: 22/12/2008

Date Report Created 25/08/2009

SITE SYNOPSIS

SITE NAME: BALLYCOTTON BAY SPA

SITE CODE: 004022

Situated on the south coast of Co. Cork, Ballycotton Bay is an east-facing coastal complex, which stretches northwards from Ballycotton to Ballynamona, a distance of *c.* 2 km. The site comprises two sheltered inlets which receive the flows of several small rivers. The southern inlet had formerly been lagoonal (Ballycotton Lake) but breaching of the shingle barrier in recent times has resulted in the area reverting to an estuarine system.

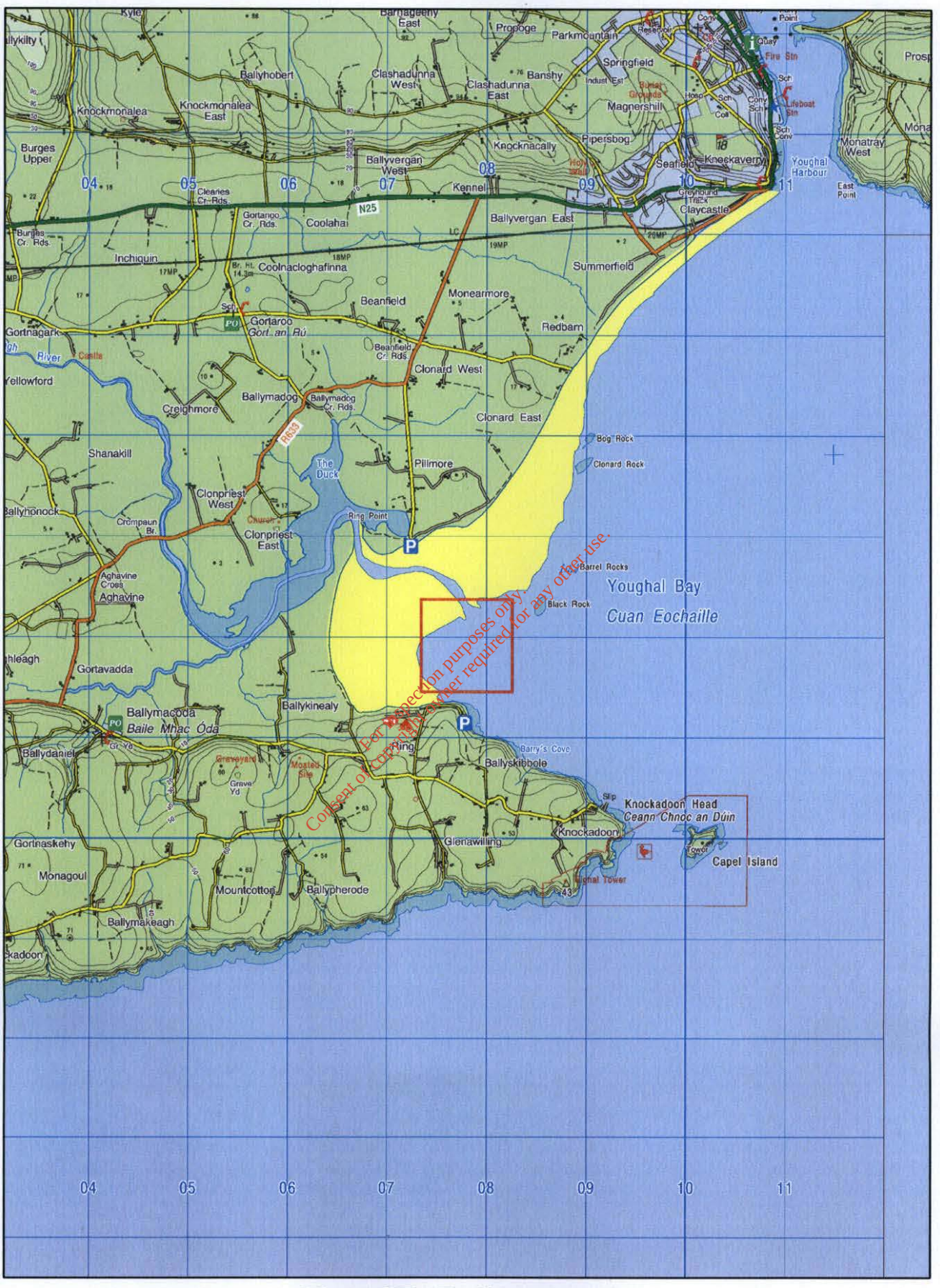
The principal habitat within the site is inter-tidal sand and mudflats. These are mostly well-exposed and the sediments are predominantly firm sands. In the more sheltered conditions of the inlets, sediments contain a higher silt fraction. The inter-tidal flats provide the main feeding habitat for the wintering birds. Sandy beaches are well represented. The shingle beach is mobile and is influenced by storms, which create open conditions that favour a particular suite of species. Species found here include Grass-leaved Orache (*Atriplex littoralis*), Black Mustard (*Brassica nigra*), Sand Couch (*Elymus farctus*) and Lyme-grass (*Leymus arenarius*). Also growing on the shingle beach is Sea-kale (*Crambe maritima*), a rare species that is listed in the Red Data Book. Salt marshes fringe the flats in the sheltered inlets and these provide high tides roosts. A small area of shallow marine water is also included.

Ballycotton Bay supports an excellent diversity of wintering waterfowl species, and has nationally important populations of nine species as follows (all figures are average peaks for the 5 winters 1995/96-1999/00): Teal (1,296), Ringed Plover (248), Golden Plover (4,284), Grey Plover (187), Lapwing (4,371), Sanderling (79), Bar-tailed Godwit (261), Curlew (1,254) and Turnstone (288). Other species which occur in important numbers, and at times exceed the threshold for national importance, include Shelduck (137), Wigeon (757), Mallard (366), Oystercatcher (362), Dunlin (812), Black-tailed Godwit (168), Redshank (149) and Greenshank (17). The population of Golden Plover is of particular note as it represents 2.8% of the national total, while the Grey Plover and Lapwing populations each represent 2.5% of their respective national totals. Ballycotton Bay was formerly of importance for Bewick's Swan but the birds have abandoned the site since the reversion of the lagoonal habitat to estuarine conditions. The site is also important for wintering gulls, especially Lesser Black-backed Gulls (1,606) in autumn and early winter. Common Gull (310) and Great Black-backed Gull (324) are well represented in winter.

The site is a well-known location for passage waders, especially in autumn. Species such as Ruff, Little Stint, Curlew Sandpiper, Green Sandpiper and Spotted Redshank occur annually though in variable numbers. Small numbers of Ruff may also be seen in late winter and spring. Rarer waders, such as Wood Sandpiper and Pectoral Sandpiper, have also been recorded.

While relatively small in area, Ballycotton Bay supports an excellent diversity of wintering waterfowl and has nationally important populations of nine species, of which two, Golden Plover and Bar-tailed Godwit, are listed on Annex I of the E.U. Birds Directive. Bird populations have been well-monitored in recent years.

6.10.2004



Map 37: Ballymacoda

1:50,000

Designated Shellfish Water

Date: December 2008

LIMOSA ENVIRONMENTAL
ECOLOGICAL AND ENVIRONMENTAL CONSULTANCY

Ecological Report for the proposed Shanagarry, Garryvoe, Ballycotton Sewerage Scheme, Co Cork.

Report for

White Young Green (Ireland) Ltd

April 2006

Report Reference:	RP06-GW004-03-0
Draft:	Final Report
Prepared by:	Dr Lesley J. Lewis.
Date:	April 2006.

Signature:

TABLE OF CONTENTS

1.0 INTRODUCTION

Limosa Environmental was commissioned to undertake ecological surveys and assessment in relation to the proposed Shanagarry, Garryvoe and Ballycotton Sewerage Scheme, Co Cork (Figure 1).

This proposed sewerage scheme comprises collection systems in the villages of Garryvoe, Shanagarry and Ballycotton, all connected to a single wastewater treatment plant (WWTP) which will discharge treated effluent through an outfall pipeline to Ballycotton Bay. Two proposed WWTP sites were assessed during the ecological study (Figure 2).

Ballycotton Bay lies approximately 25 miles south-east of Cork City and is a wide, shallow and sandy bay that stretches from Garryvoe in the north to Ballycotton in the south, a distance of approximately 3km. The bay exhibits a range of coastal and wetland habitats including sand flats, shingle beach, salt marsh, reed beds, rocky shore and sand dunes. A large proportion of these coastal habitats are protected for nature conservation under designations such as a National Heritage Area (Wildlife Amendment (2000) Act) and Ballycotton Bay Special Protection Area (SPA) (EU Birds Directive 79/409/EEC).

This report details the methods used for ecological surveys and assessment and presents survey results together with a description of the existing environment for each of the survey components. A key aim of the ecological survey and Ecological Impact Assessment (EcIA) process is to assess sites that are likely to be affected by the proposed development and to determine which ecological resources are of sufficient value that an impact upon them may be considered significant (IEEM, 2005). Ecological evaluation is therefore carried out prior to the potential impacts of the proposed development being defined. Finally, the report describes potential mitigation measures that aim to avoid, reduce or compensate for any impacts.

2.0 METHODS

2.1 Terrestrial habitat survey

A habitat survey was conducted on the 14th February 2006. The survey area consisted of the two proposed wastewater treatment sites (Sites 1 and 2) and their immediate adjacent area. Habitats along the route of the proposed sewage pipeline were also assessed (but not mapped).

Terrestrial habitats were recorded and mapped following standard methodology (Heritage Council, 2002; JNCC 2003) and classified according to Fossitt (2000). A list of vascular plant species was drawn up for each habitat. Vascular plant names follow Stace (1997) and their frequency of occurrence within Ireland follows Webb *et al.* (1996). Throughout the text Latin names are given at first mention.

2.2 Terrestrial Bird Survey

A terrestrial bird survey was carried out on 22nd February 2006 using standard line transect methodology (Bibby *et al.*, 2000).

The survey commenced at 0730 hours and continued to 1100 hours and was conducted in dry and calm weather conditions. Transects were undertaken across the two proposed WWTP sites and within the adjacent habitats.

Transect 1 commenced in the top north-eastern corner of the agricultural field within which Site 1 is proposed (GPS grid reference 98182 64541) and ran in a southerly direction until a point directly west of Site 2 (GPS grid reference 98173 64170). Transect 2, directly south of Site 2, followed an east to west direction and aimed to record bird species within the proposed site and within its boundary hedgerows.

Transects were walked at a steady pace and all birds that were either observed or heard (i.e. bird songs or calls) were recorded together with a note of the habitat type.

2.3 Mammal Survey

Dr Paddy Sleeman carried out a mammal survey on the 16th and 17th of February 2006. The survey area was searched on foot for any signs of mammals e.g. droppings, burrows etc. The survey area comprised the two proposed wastewater treatment sites and their immediate surrounding environs and the shoreline adjacent to the proposed WWTP outfall. The proposed sewage pipeline will cross unnamed streams at grid references W 996678 and W 978 648. An area upstream and downstream of these streams was also surveyed for signs of mammals, especially Otter (*Lutra lutra*).

2.4 Littoral (Intertidal) Survey

The aim of this survey was to record, classify and map the intertidal habitats of Ballycotton Bay within the vicinity of the proposed outfall. The intertidal (or littoral) zone is defined as the part of the coastline that extends from the lowest point uncovered by the tides to the highest point on the shore that is washed or splashed by waves at high tides.

Survey methodology follows Wyn & Brazier (2001) in that the extent and distribution of intertidal biotopes were identified and mapped within the survey area. A biotope is defined as the physical habitat together with its characteristic community of plants and/or animals. The marine biotope

classification was developed by the Marine Nature Conservation Review (MNCR) (Connor *et al.*, 1997 a, b). The earlier classification has now been updated and this report uses the updated version 04.05 (Connor *et al.*, 2004).

The survey was undertaken on the 27th February during the spring tide period. A survey area was defined that extended approximately 250m either side of the proposed outfall location within Ballycotton Bay. This area was then surveyed and the different biotopes were identified and drawn onto field maps. A species list was compiled for each biotope. Where species could not be identified in the field, a sample was taken back to the laboratory for identification. Only biotopes covering areas greater than 5m x 5m were mapped; other small biotopes and features of interest were recorded as target notes.

2.5 Coastal and Shorebird Survey and assessment

Shore-based observations were made of coastal and shorebirds within two survey zones that extended either side of the proposed outfall location. Zone 1 encompassed the area approximately 300m to the north-west of the proposed outfall location. At low water this intertidal habitat was rocky in nature. Further north-west, the intertidal area extends into sandflats which are part of the Ballycotton Bay SPA. Zone 2 encompassed the area approximately 200m to the south-east of the proposed outfall location. The intertidal habitat at low water was also rocky in nature.

Bird surveys were undertaken on the 14th, 22nd and 27th February 2006 covering both low tide and high tide periods. On each occasion, each survey zone was continuously observed for a 30-minute period. All bird species were recorded within the two survey zones and a record made as to their behaviour (e.g. feeding) and habitat (e.g. rocky shore or water column).

In addition to bird surveys, the avian fauna of Ballycotton Bay was assessed following a review of data from the Irish Wetland Bird Survey (I-WeBS).

2.6 Ecological Evaluation and Impact Assessment

Ecological evaluation and impact assessment is based on criteria outlined in Appendix 1. Evaluation may apply at different levels and may refer to, for example, a site, a habitat, a species or a population. This will be clarified within the text.

3.0 RESULTS

3.1 Site Description

This proposed sewerage scheme comprises collection systems in the villages of Garryvoe, Shanagarry and Ballycotton, all connected to a single wastewater treatment plant (WWTP) which will discharge treated effluent through an outfall pipeline to Ballycotton Bay.

Two possible sites were considered for the location of the WWTP. For clarity the two proposed WWTP sites are called Site 1 and Site 2 within this report. Site 1 is located within an agricultural field just south of the R629 as it approaches Ballycotton Village (Figure 2). An access road is proposed leading from the R629 to the site. Site 2 is located approximately 250m to the south-east of Site 1 and is also situated within an agricultural field. An access road is proposed to extend from this site to the third class road to the east.

The proposed treated effluent outfall is located in Ballycotton Village, close to the southern extent of Ballycotton Bay. The proposed outfall location is just east of a slipway and will lie adjacent to an existing outfall pipe (Figure 2).

The proposed network of sewage pipes will extend from Garryvoe in the north to Ballycotton in the south and will follow existing roads (R632 and R629) and not cross any agricultural land.

3.2 Designated Areas in the vicinity of the site

Designated areas for conservation are areas that are designated under national and/or European laws in order to conserve habitats and species of national or international conservation importance. These include the following examples:

- **Natural Heritage Areas (NHA)**: a national designation given legal status by the Wildlife Amendment (2000) Act.
- **Special Areas of Conservation** (SAC): areas considered of European and national importance whose legal basis is the EU Habitats Directive (92/43/EEC), transposed into Irish law through the European Union (Natural Habitats) Regulations, 1997.
- **Special Protection Areas** (SPA): sites of conservation importance for birds whose legal basis is the EU Birds Directive (79/409/EEC).
- **Wildfowl Sanctuary**: designated under the 1976 Wildlife Act.
- **Ramsar Site**: European designation based on the Ramsar Convention, 1984.

The proposed development lies within 5km of Ballycotton Bay. A number of wetland habitats associated with Ballycotton Bay are afforded protection by their designation as a proposed Natural Heritage Area (pNHA). Ballycotton, Ballynamona and Shanagarry pNHA (Site Code 0076) stretches from just north of Ballycotton towards Garryvoe and includes coastal/intertidal habitats as well as wetland habitats that stretch further inland (Figure 3). The pNHA site synopsis (National Parks and Wildlife Service) is shown in Appendix 2.

The Ballycotton Bay wetland complex is of particular importance for wetland birds, especially wintering wading birds and wildfowl. A proportion of the area covered by the NHA is also designated as a candidate Special Protection Area. Ballycotton Bay Special Protection Area (SPA) (Site Code 4022) covers 92 ha and is noted for supporting the Annex I species Golden Plover (*Pluvialis apricaria*) and Bar-tailed Godwit (*Limosa lapponica*) as well as supporting nationally important populations of several other wintering waterbird species. Ballycotton Bay SPA site synopsis (National Parks and Wildlife Service) is given in Appendix 2.

A similar area to the SPA is also designated as a Ramsar Site (Site Code 3IE022) under the Ramsar Convention Bureau (1984) (Appendix 2). Ballycotton Bay is also a Wildfowl Sanctuary.

Allen's Pool (Grid Ref W 989667) is a brackish pool covering 8.1 ha within the Ballycotton wetland complex. This pool is a BirdWatch Ireland Reserve.

3.3 Terrestrial habitats and flora within the existing environment

3.3.1 Habitats within the proposed wastewater treatment sites

Terrestrial habitats are classified according to Fossitt (2000). Vascular plant names follow Stace (1997) and their frequency of occurrence within Ireland follows Webb *et al.* (1996). A terrestrial habitat map is shown in Figure 4.

Site 1

Site 1 is located within an agricultural field just south of the R629 as it approaches Ballycotton Village (Figure 2). An access road is proposed leading from the R629 to the site. The area of the site (including access road) is 0.279 ha.

The site consists predominantly of the habitat improved agricultural grassland (GA1). Hedgerows (WL1) and scrub (WS1) border the site to the south and east.

Improved agricultural grassland (GA1)

This classification is used for intensively managed or modified agricultural grassland that has been reseeded and/or regularly fertilised and is either grazed or used for silage making (Fossitt, 2000). This habitat is typically species poor and comprises a mixture of grass species (e.g. Rye grasses *Lolium* spp) with a few herbaceous plants or 'weeds' occurring to various degrees.

Species List:

Latin Name	Common Name	Frequency of occurrence in Ireland
Dactylis glomerata	Cock's-foot	Abundant
Festuca spp.	Fescue spp.	Abundant
Holcus lanatus	Yorkshire Fog	Abundant
Lolium perenne	Perennial rye-grass	Abundant
Rumex obtusifolius	Broad-leaved Dock	Abundant
Taraxacum officinale	Dandelion	Abundant

Hedgerows (WL1)

A hedgerow borders the field within which the proposed site is located. The thickness and composition of the hedgerow is variable with, for example, sparse patches and gaps occurring within the southern hedge and an earth bank also occurring in places. Hedgerows can be very species-rich and support a diversity of tree, shrub and herbaceous plant species. The results of a survey conducted in the month of February are unlikely to produce a fully representative species list for this habitat.

Species List:

Latin Name	Common Name	Frequency of occurrence in Ireland
Alnus glutinosa	Alder	Abundant
Cirsium spp.	Thistle spp.	Abundant
Crataegus monogyna	Hawthorn	Locally frequent
Digitalis purpurea	Foxglove	Very frequent
Galium aparine	Cleavers	Widespread and abundant
Geranium robertianum	Herb Robert	Abundant
Hedera helix	Ivy	Widespread and abundant
Heracleum sphondylium	Hogweed	Abundant
Hieracium sp.	Hawkweed spp.	Frequent
Phyllitis scolopendrium	Hart's-tongue fern	Very frequent
Prunus spinosa	Blackthorn	Very frequent
Rumex obtusifolius	Broad-leaved Dock	Abundant
Salix sp.	Willow	Frequent
Sambucus nigra	Elder	Frequent
Taraxacum officinale	Dandelion	Abundant
Urtica dioica	Common Nettle	Abundant
Vicia cracca	Tufted Vetch	Abundant
Ulex europaeus	Gorse	Abundant

Site 2

Site 2 is located approximately 250m to the south-east of Site 1 and is also situated within an agricultural field. An access road is proposed to extend from this site to the third class road to the east. The area of the site (including access road) is 0.329 ha.

The site comprises predominantly of the habitat improved agricultural grassland (GA1) (Figure 4). Hedgerow (WL1) borders the site to the south. Hedgerow and scrub (WS1) border the site to the west. Some rubble has been tipped along the western boundary of the site which equates to the habitat spoil and bare ground (ED2) (not mapped).

Improved agricultural grassland (GA1)

This agricultural grassland is currently grazed by cattle. Species diversity is typically poor. The sward was dominated by Rye grass. White Clover (*Trifolium repens*) was present and is also typical of this habitat.

Species List:

Latin Name	Common Name	Frequency of occurrence in Ireland
Agrostis stolonifera	Creeping bent	Abundant
Dactylis glomerata	Cock's-foot	Abundant
Lolium perenne	Perennial rye-grass	Abundant
Ranunculus spp.	Buttercup spp.	abundant
Rumex obtusifolius	Broad-leaved Dock	Abundant
Taraxacum officinale	Dandelion	Abundant
Trifolium repens	White Clover	Abundant

Hedgerows (WL1)

A hedgerow borders the site to the south and west consisting predominantly of Hawthorn (*Crataegus monogyna*). The hedgerow also exhibits an earth bank. The hedgerow is well managed (trimmed) and is very sparse in places, many plants not yet in leaf at the time of survey.

Latin Name	Common Name	Frequency of occurrence in Ireland
Bellis perennis	Daisy	Abundant
Chamaerion angustifolium	Rosebay Willowherb	Locally frequent
Crataegus monogyna	Hawthorn	Locally frequent
Galium aparine	Cleavers	Widespread and abundant
Ranunculus spp.	Buttercup spp.	Abundant
Rubus fruticosus agg.	Bramble	Abundant
Rumex obtusifolius	Broad-leaved Dock	Abundant

3.3.2 Habitats beyond the boundaries of the two wastewater treatment plants

Agricultural grassland lies directly to the south and west of Site 1; individual agricultural fields mostly separated by hedgerows (Figure 4).

The eastern boundary of the field within which Site 1 is located is marked by a hedgerow (as described above). Directly beyond this hedgerow is Scrub habitat (WS1) dominated by Bramble (*Rubus fruticosus* agg) and Hawthorn *(Crataegus monogyna*) and a small stream (*c* 1m wide) classified as a Depositing/lowland river (FW2).

Depositing/lowland river (FW2).

View east across Site 1 to the scrub habitat beyond.

Species associated with the stream (within the water column) included *Ranunculus* sp. and Water-cress (*Rorippa nasturtium-aquaticum* agg). Lesser Celendine (*Ranunculus ficaria*), Cow Parsley (*Anthriscus sylvestris*), Herb Robert (*Geranium robertianum*) and Hart's–tongue fern (*Phyllitis scolopendrium*) were dominant riparian (stream-side) plants. As hedgerow and scrub overhang the stream it is heavily shaded in parts.

Beyond the stream to the east and lying between the agricultural field and built surfaces (houses) is a small area of Wet Grassland (GS4).

This habitat exhibits dense tussocky grassland with frequent rushes (*Juncus* spp). Other species include: Cock's-foot (*Dactylis glomerata*), Common Nettle (*Urtica dioica*), Hogweed (*Heracleum sphondylium*), Knapweed spp. (*Centaura nigra*), Self Heal (*Prunella vulgaris*), Thistle spp (*Cirsium spp.*) and Tufted Vetch (*Vicia cracca*).

To the east of Site 1, lying between the wet grassland habitat and scrub habitat is a stand of Japanese Knotweed (*Fallopia japonica*).

To the south of the wet grassland and running in a strip between the south-eastern corner of Site 1 and the western boundary of Site 2 is an extensive area of Scrub habitat (WS1) dominated almost entirely by Gorse (*Ulex europaeus*) (Figure 4).

To the north and east of site 2 is agricultural grassland (GA1) habitat. To the south of Site 2 is Arable land (BC1).

3.3.3 Evaluation of terrestrial habitats

Habitats are evaluated following the criteria set out in Appendix 1. Given that the habitat survey was carried out in February and that many flowering plants are not visible at this time (e.g. annual plants), a comprehensive evaluation of the habitats was not possible. The evaluation given below should therefore be considered as indicative.

Habitats within the site boundaries

Agricultural grassland is a modified and managed habitat and is of relatively low ecological value in comparison with natural habitats. Agricultural grassland is typically species-poor in terms of flora and supports relatively little wildlife, the exceptions being for example rabbits (*Oryctolagus cunniculus*), rats, mice, some invertebrates and some foraging bird species. This habitat is widespread and abundant in the locality and is overall considered of low local ecological importance.

Hedgerows are widespread and abundant in the locality, forming the major boundary type between agricultural fields. Hedgerows form an important network of corridors between the agricultural landscape facilitating animal movement, while also providing feeding, resting and breeding sites for a range of invertebrate, mammal and bird species. For example, two-thirds of Ireland's breeding birds nest in hedgerows. Under Article 10 of the EC Habitats Directive, member states are required to encourage the management of hedges and other linear features in their land use and development policies, with a view to improving their ecological coherence.

Hedgerows can vary in their ecological value, depending on factors such as age, structure, shape, height and management procedures, amongst others. The most valuable are often of mature age with a rich diversity of plant life and a range of vegetation heights (e.g. trees and under storey) and may be in association with wet ditch/earth bank habitats. Hedgerows within the study area therefore vary in terms of their ecological importance. The hedgerow and associated scrub to the east of Site 1 (in association with the stream) is considered the most valuable following the current study. This hedgerow and scrub also act as to buffer the freshwater stream from nutrient runoff and siltation. In terms of the ecological values set out in Appendix 1, hedgerows are considered of low - moderate local ecological importance.

Habitats beyond the site boundaries

Scrub habitat to the east of Site 1 and in association with the stream, provides cover, feeding and roosting habitats for a range of wildlife. Hawthorn can be rich in insects and thus attract foraging birds. Insects will also be associated with the stream. The extensive and dense area of scrub running in a north-south direction between the two proposed sites is dominated by Gorse. Although this habitat lacks the species diversity of perhaps an earlier stage of succession (the gradual process of ecological change) it is important for breeding birds while also affording good cover for roosting birds. Gorse is also important for invertebrates as it is in flower for long periods and is a valuable feeding habitat when little else is in flower. Scrub habitat is considered of moderate local ecological value.

The stream to the east of the site is relatively small (< 1m across) and shallow with a silty substratum. It is heavily shaded by hedgerow/scrub habitat and is likely to be covered by impenetrable vegetation for a major part of the year. The stream generally lacks the characteristics that would make it suitable habitat for many fish species (e.g. salmonids) and it is also not suitable habitat for birds associated with water such as the Annex I species Kingfisher (*Alcedo atthis*). On the other hand, the stream adds to the habitat complexity of the area and provides habitat for insects which are in turn prey for other species such as birds.

The stream runs northwards into a wetland that is part of the Ballycotton Bay wetland complex. The stream therefore flows into an area designated for nature conservation. Of more significance is that this stream is the only freshwater inflow to a reedbed habitat within this wetland area to the north (Smiddy & O'Halloran, 2006). Freshwater input is considered very important in maintaining the growth of reeds (*Phragmites australis*) (Burgess *et al.*, 1995) and saline incursion in other parts of the wetland has most likely led to the reduction of reedbed habitat in some areas (P.

Smiddy; pers. comm.). This reedbed also supports a breeding population of the Reed Warbler (*Acrocephalus scirpaceus*, a rare breeding bird within Ireland. The small stream in question therefore supports a reedbed habitat and the Reed Warbler, thus increasing its significance considerably. The stream is therefore considered of high local ecological value.

The wet grassland habitat is relatively small and is abundant within the locality (given the wetland habitats around Ballycotton Bay). It is potentially grazed or managed at some time during the year and is being invaded by Japanese Knotweed. This area is considered of low local ecological value.

The stand of Japanese Knotweed that lies between the wet grassland and scrub habitat is of concern to ecology. This plant species is an alien, invasive species, defined as a species that has become established in natural or semi-natural ecosystems or habitats and is an agent of change, therefore constituting a threat to native biological diversity (SSG, 2000). Japanese Knotweed successfully out-competes native plants, restricts ground flora and damages natural habitats.

None of the plant species recorded during the survey are listed as Red Data species (Curtis & McGough, 1988) or are listed on the Flora (Protection) Order, 1999. The majority of plant species recorded are considered abundant and widespread throughout Ireland. Using the *New Atlas of the British and Irish Flora* (Preston *et al.*, 2002) it is possible to identify rare or protected plant species within the 10-km grid square W96, within which the proposed sites are located (Table 1). Of five recorded rare or protected species, two have a potential to occur within the proposed development sites (*Mentha pulegium* and *Scandix pectin-veneris*) based on their habitat requirements, although this does not imply that they will or have occurred and no evidence was found of them during the habitat survey.

Table 1. Rare or protected plant species within 10-km grid square W96.

Species	Common Name	Habitat within which plant is generally found (after Preston *et al.*, 2002)
Flora (Protection) Order, 1999		
Menthe pulegium	Penny Royal	Seasonally inundated grassland, damp pastures, lake shores, coastal grassland.
Red Data Species		
Ophrys apifera	Bee orchid	Calcareous, well drained soils: grasslands, scrub, roadsides amongst others.
Crambe maritima	Sea-Kale	Shingle and boulder beaches.
Menthe pulegium	Penny Royal	Seasonally inundated grassland, damp pastures, lake shores, coastal grassland.
Geranium purpureum	Little Robin	Stony or rocky places near the sea; earth and stone banksides.
Scandix pectin-veneris	Shepherd's Needle	Range of habitats from waste ground to road sides.

3.4 Terrestrial birds within the existing environment

3.4.1 Wintering birds within the existing environment

Table 2 shows the bird species recorded during the terrestrial bird survey. Birds were recorded as present either within the site or site boundaries or within adjacent habitats (mainly hedgerow and scrub habitat).

Twelve birds of seven species were recorded within the hedgerow to the east and north of Site 1. A greater number of birds were associated with the scrub habitat beyond to the east and south-east. Within the agricultural field within which Site 1 is proposed, four Curlew (*Numenius arquata*)

were also observed feeding. This wading bird species is likely to utilise a number of coastal grassland habitats for feeding during winter.

The hedgerow to the south of Site 2 is well trimmed at present and supported few birds during the survey; only a single Wren (*Troglodytes troglodytes*) and Blackbird (*Turdus merula*) were recorded here.

Table 2. Bird species recorded during the terrestrial bird survey.

SPECIES	Transect 1 South through Site 1 to west of Site 2		Transect 2 East to west along boundary of Site 2	
	Within Site 1 boundaries (hedgerow)	Within adjacent habitats	Within Site boundaries (hedgerow)	Within adjacent habitats
Curlew *Numenius arquata*		4		
Wood Pigeon *Columba palumbus*	4	1		
Wren *Troglodytes troglodytes*	1	4	1	
Dunnock *Prunella modularis*		2		
Robin *Erithacus rubecula*	1	2		
Stonechat *Saxicola torquata*		1		
Pied Wagtail *Motacilla alba*				1
Blackbird *Turdus merula*	1	4	1	
Great Tit *Parus major*	2			
Blue Tit *Parus caeruleus*		3		
Magpie *Pica pica*		1		
Linnet *Carduelis cannabina*				4
Greenfinch *Carduelis chloris*	2	4		
Bullfinch *Pyrrhula pyrrhula*	1	1		

3.4.2 Evaluation of terrestrial birds

The conservation importance of a bird species relates largely to its population status either within its breeding and/or wintering range. Bird species of conservation importance may be listed on either or both of the following:

Council Directive of 2 April 1979 on the Conservation of Wild Birds (79/409/EEC) ('Birds Directive')
This directive relates to the conservation of all species of naturally occurring birds in the wild. The directive lays down protection, management and control of these species and lays down rules for their exploitation. The directive applies to the birds, their eggs, nests and habitats.

Birds of Conservation Concern in Ireland (Newton *et al.*, 1999).
This document set out by BirdWatch Ireland and RSPB Northern Ireland, presents a priority list of bird species within Ireland. The list is divided into Red List Species of high conservation concern e.g. species that have undergone significant population declines (>50%) since 1900. Amber List Species are defined as having medium conservation concern e.g. species whose breeding population has declined by 25% - 50% in the past 25 years. Green List Species are species whose conservation status is presently considered as favourable.

None of the birds recorded during the terrestrial bird survey are listed on Annex I of the EU Bird's Directive. One Red-listed species was recorded (Curlew) and one amber-listed species (Stonechat). Curlew are red-listed due to their declining Irish breeding population. Habitats within the proposed development site would not support breeding Curlews (breeding habitats including upland moors, bogs and wet grassland). Stonechats are amber-listed due to their

unfavourable conservation status within Europe. Stonechats are likely to breed within the hedgerow and gorse scrub habitat adjacent to the development sites.

3.4.3 Habitat potential for breeding birds within the existing environment

Further to the Curlew and Stonechat above, and given knowledge of the habitats present within and adjacent to the proposed development sites, it is possible to predict other bird species that may potentially breed within these habitats. This must not be taken as an exhaustive list and cannot replace a breeding bird survey undertaken at the correct time of year but likewise this prediction does not imply that all of these species will breed within this area.

Table 3 shows the bird species that may potentially breed within the habitats and adjacent habitats of the proposed WWTP sites. The conservation status of each species is given in terms of species listed on 'birds of conservation concern in Ireland' (Newton *et al.*, 1999). All species are recorded as breeding within the 10-km square (W96) that covers the site within the *New Atlas of Breeding Birds in Britain and Ireland* (Gibbons *et al.*, 1993).

Table 3. Bird species that may potentially breed within the habitats and adjacent habitats of the proposed WWTP sites (not an exhaustive list).

Habitat	Species	Conservation Status	Population Movements
Hedgerows	Wren *Troglodytes troglodytes*		Resident
	Dunnock *Prunella modularis*		Resident
	Robin *Erithacus rubecula*		Resident
	Blackbird *Turdus merula*		Resident & short distance migrant
	Blue Tit *Parus caeruleus*		Resident
	Great Tit *Parus major*		Resident
	Wood Pigeon *Columba palumbus*		Resident
	Song Thrush *Turdus philomelos*		Resident & short distance migrant
	Greenfinch *Carduelis chloris*		Resident
	Linnet *Carduelis cannabina*		Resident & long distance migrant
	Chiffchaff *Phylloscopus collybita*		Long distance migrant (Summer Visitor)
	Willow Warbler *Phylloscopus trochilus*		Long distance migrant (Summer Visitor)
	Yellowhammer *Emberiza citrinella*	Red List	Resident
	Bullfinch *Pyrrhula pyrrhula*		Resident
Scrub (including wet scrub in association with stream and gorse scrub)	Stonechat *Saxicola torquata*	Amber List	Resident & migrant
	Linnet *Carduelis cannabina*		Resident & long distance migrant
	Wren *Troglodytes troglodytes*		Resident
	Dunnock *Prunella modularis*		Resident
	Robin *Erithacus rubecula*		Resident
	Mistlethrush *Turdus viscivorus*		Resident & short distance migrant
	Blue Tit *Parus caeruleus*		Resident
	Song Thrush *Turdus philomelos*		Resident & short distance migrant
	Whitethroat *Sylvia communis*		Long distance migrant (Summer Visitor)
	Blackcap *Sylvia atricapilla*		Long distance migrant (Summer Visitor)
	Yellowhammer *Emberiza citrinella*	Red List	Resident
	Bullfinch *Pyrrhula pyrrhula*		Resident
	Reed Bunting *Emberiza schoeniclus*		Resident
Stream	Grey Wagtail *Motacilla cinerea*		Resident & Short distance migrant

3.5 Mammals within the existing environment

3.5.1 Mammals recorded within the survey area

The location of mammal signs are shown in Figure 5.

Mammal signs recorded within and adjacent to the proposed WWTP sites

Feeding signs of Rabbit (*Oryctolagus cuniculus*) and Badger (*Meles meles*) were found within Site 1 and both species therefore visit the area. Rabbits were directly observed within the gorse scrub habitat to the south of Site 1 (LJL pers. obs.). There is an abundance of badger feeding signs within the agricultural grassland field directly to the south of Site 1.

A number of mammal signs were recorded in association with Site 2 (Figure 5). In particular, the hedgerow that separates the agricultural grassland field of Site 2 and the arable crops to the south has a high density of Brown (Common) Rats (*Rattus norvegicus*) evident from the large number of rat holes within the earth bank of the hedgerow. The sugar beet crop within the arable field is likely to attract the rats. This crop is also being fed on by badgers and Fox (*Vulpes vulpes*) and there is evidence that the foxes are also feeding on the rats.

There are badger latrines (toilet areas) at the east end of this hedge and further signs that badger bedding is being collected at the west end of the hedge. This bedding will be destined for a badger sett (burrow) which is most likely located between the two WWTP sites within the dense gorse scrub habitat.

Mammal signs recorded in relation to streams that will be crossed by the proposed sewage pipeline

The proposed pipeline will cross a stream in the Garryvoe Lower area (W 996678). No signs of mammals were recorded at this stream. Further south at approximately W 978648, two small streams enter what was once Ballycotton Lake (now a tidal inlet and part of Ballycotton Bay). Otter (*Lutra lutra*) activity was recorded here in the form of spraint (droppings) and trails.

Mammal signs recorded in relation to the proposed sewage outfall location in Ballycotton Bay

No mammal signs were recorded in the vicinity of the proposed outfall. Three otter sprainting sites were recorded along the shoreline to the north-west of the location as indicated by Figure 5.

Mammals within the wider environment

Apart from the species recorded, the wider environment has suitable habitat for a number of other mammal species including wood mouse (*Apodemus sylvaticus*), bank vole (*Clethrionomys galarolus*), pygmy shrew (*Sorex minutus*) and hedgehogs (*Erinaceus europaeus*). Pygmy shrews and hedgehogs are protected under the Wildlife Act 1976 (amended 2000), the latter also protected under Appendix III of the Berne Convention. One bat (Chiroptera) record exists from the Ballycotton wetland area, a Natterer's Bat (*Myotis nattereri*) recorded in 1987 (Smiddy, 1987).

3.5.2 Evaluation of mammals

The survey identified a total of five mammal species. Three of these (Rat, Fox and Rabbit) are widespread and commonly found in Ireland and are often considered as pest species. They therefore have little conservation value. Badgers and otters are afforded protection under various measures (Table 4).

Table 4. Mammal species whose signs were observed during the survey together with their protection status.

Mammal Species	Protection Status
Rabbit	-
Badger	Wildlife Act 1976, (amended 2000), Appendix III Berne Convention.
Fox	-
Otter	Annex II and IV Habitats Directive, Wildlife Act 1976, (amended 2000), Appendix II Berne Convention.
Brown Rat	-

Both badgers and otters are strictly protected by national and international legislation (Table 4). This protection is based predominantly on low densities and former population declines within Europe. In Ireland however, badgers and otters are considered widespread, indeed in the case of the otter, Ireland is considered to be the European stronghold for the species (Lunnon, 1996). Therefore, both badgers and otters are considered of international and national importance and populations within a specific area are considered of high local importance and must be protected as such.

3.6 The littoral (intertidal) habitats of the proposed outfall location at Ballycotton

3.6.1 Site Description

Ballycotton Bay is described as a composite coastal site exhibiting a variety of coastal and wetland habitats. The southerly region of the bay is rocky in nature extending from the relatively narrow rocky shore at approximately W 992644 to the headland southeast of Ballycotton Pier where rocky reefs extend out to small islands off shore. The rocky shore is backed by rocky cliffs and the substrate is mixed red sandstone and jointed stratified shale/slate layers (Picton & Costello, 1998).

The proposed outfall is located at approximately W 994643 and this report describes the rocky littoral (intertidal) habitats that extend for approximately 250m either side of this location.

Littoral Zones (terminology used in the text)

The intertidal (littoral) shore is divided into biological sub zones as defined below:

Supralittoral – the 'splash zone'; the area that remains exposed for the longest period
Eulittoral – The marine intertidal zone subject to wave action; the area between high and low water marks; can be split into upper, mid and lower eulittoral.
Infralittoral – the lowest zone on the shore that is only exposed on the lowest tides (could also be called the sublittoral fringe).

3.6.2 Littoral biotopes within the survey area

Figure 6 shows the intertidal biotope map for the survey area within Ballycotton Bay. The following biotopes were identified during the survey (following Connor *et al.* 2004). Biotope descriptions are given in Appendix 3.

Shingle (pebble) and gravel shores (LS.LCS.Sh)
Occurs predominantly along the upper shore. Subject to a large degree of drying between the tides and is largely barren in terms of fauna.

Yellow and grey lichens on supralittoral rock (LR.FLR.Lic.YG)

Occurs within the supralittoral zone (splash zone) just above the level of the highest tides. This biotope occurs upon large rocks and is largely unmapped due to the relative small areas in which it occurs. This biotope is not confined to the upper shore zone, rather its distribution is determined by vertical height and lichens can therefore occur upon the upper vertical reaches of large rocks in the midshore area. Lichen species include: *Xanthoria* sp., *Caloplaca marina*, *Lecanora atra* and *Ramalina* sp..

***Verrucaria maura* on littoral fringe rock (LR.FLR.Lic.Ver) (not mapped)**
This biotope describes rock surfaces that are covered in the black lichen *Verrucaria maura*. It forms a black band in the upper littoral fringe upon rocks and occurs immediately below the yellow and grey lichen zone (see photo above)

***Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock (LR.MLR.BF.PelB)**
A zone of Channel Wrack *Pelvetia canaliculata* can occur below the lichen zones. This can form a very narrow band and is therefore unmapped in places.

***Fucus spiralis* on moderately exposed to very sheltered upper eulittoral rock (LR.LLR.F.Fspi)**
This narrow zone is largely unmapped but occurs within the upper eulittoral zone and is characterised by a band of the Spiral Wrack *Fucus spiralis* overlying the black lichen *Verrucaria maura*. Channel Wrack *Pelvetia canaliculata* occurs occasionally. Other species found include the green alga *Enteromorpha intestinalis*, Common Limpet *Patella vulgata* and the periwinkles *Littorina saxatilis*, *L. littorea* and *L. obtusata*.

Barnacles and fucoids on moderately exposed rock (LR.MLR.BF)

This higher biotope code is used to describe and map a very mixed zone to the north-west of the proposed outfall location that does not fit easily into any single biotope code. The zonation in this area approximates to (1) ***Fucus spiralis* on moderately exposed to very sheltered upper eulittoral rock (LR.LLR.F.Fspi)** (2) ***Fucus vesiculosis* and barnacle mosaics on moderately exposed mid eulittoral rock (LR.MLR.BF.FvesB)** and (3) ***Fucus serratus* on**

moderately exposed lower eulittoral rock (LR.MLR.BF.Fser). However, the three zones are intermixed. In some patches the red alga *Osmundea pinnatifida* dominates and these patches could be assigned to '***Osmundea pinnatifida* on moderately exposed mid eulittoral rock' (LR.HLR.FR.Osm)** although these areas are not mapped.

To the south-east of the proposed outfall, LR.MLR.BF occurs below a zone of *Ascophyllum nodosum*. In this location the biotope is more diverse and a lower zone of *Fucus serratus* occurs with red algae species *Mastocarpus stellatus* and *Lomentaria articulata*.

Species recorded:
Barnacles (Phylum Crustacea): *Chthamalus montagui, Semibalanus balanoides.*
Brown Algae (Class Phaeophyceae): Bladder Wrack (*Fucus vesiculosis*), Spiral Wrack (*Fucus spiralis*), Serrated Wrack (*Fucus serratus*), Egg Wrack (*Ascophyllum nodosum*) (occasional).
Red Algae (Class Rhodophyceae): *Chondrus crispus* (occasional), Coral weed (*Corallina officinalis*), Pepper Dulse (*Osmundea pinnatifida*) (frequent), *Gelidium* sp.
Molluscs (Phylum Mollusca): Toothed Top Shell (*Monodonta lineata*), Common Periwinkle *Littorina littorea* (occasional), Rough Periwinkle (*Littorina saxatilis*) (occasional), Common Limpet (*Patella vulgata*) (frequent), Flat top shell (*Gibbula umbilicalis*).

***Fucus vesiculosis* on mid eulittoral mixed substrata (LR.LLR.F.Fves.X)**
To the north-west of the proposed outfall and below the very mixed zone of fucoids and barnacles, the shore substratum becomes very mixed. Although rock still occurs it is intermixed with expanses of cobbles, shingle and coarse sand. The green alga *Fucus vesiculosis* dominates although the red algae *Chondrus crispus* may dominate discrete patches. Some patches of sand exhibit the polychaete worm *Lanice conchilega* and therefore form the biotope ***Lanice conchilega* in littoral sand (LS.LSa.MuSa.Lan)** (not mapped). Within this area biogenic reefs formed by the polychaete worm *Sabellaria alveolata* are also common which are described by the biotope **Littoral *Sabellaria* honeycomb worm reefs (LS.LBR.Sab).** Biogenic reefs are defined as (Holt *et al.*, 1998):

"Solid, massive structures which are created by accumulations of organisms, usually rising from the seabed, or at least clearly forming a substantial, discrete community or habitat which is very different from the surrounding seabed. The structure of the reef may be composed almost entirely of the reef building organism and its tubes or shells, or it may to some degree be composed of sediments, stones and shells bound together by the organisms."

***Fucus serratus* on full salinity lower eulittoral mixed substrata (LR.LLR.F.Fserr.X)**

To the north-west of the proposed outfall the mixed substrata continues down the lower shore and the dominant fucoid algae species changes to *Fucus serratus*. *Sabellaria alveolata* does not occur within this lower zone. Patches of sand contain the polychaete worm *Lanice conchilega*.

Species recorded:
Brown Algae (Class Phaeophyceae): Bladder Wrack (*Fucus vesiculosis*) (occasional), Serrated Wrack (*Fucus serratus*) (dominant).
Red Algae (Class Rhodophyceae): *Chondrus crispus* (occasional), Coral weed (*Corallina officinalis*), *Gelidium* sp., *Lithothamnion* spp., *Mastocarpus stellatus.*

Molluscs (Phylum Mollusca): Common Periwinkle (*Littorina littorea*), Common Limpet (*Patella vulgata*).
Worms (Phylum Annelida): Coiled Tube Worm (*Spirorbis* sp), Keelworm (*Pomatoceros triqueter*).
Sea Anenomes (Order Actiniaria): Beadlet Anenome (*Actinia equina*), Snakelocks Anenome (*Anenemonia viridis*).

Laminaria digitata on moderately exposed sublittoral fringe rock (IR.MIR.KR.Ldig.Ldig)

This zone occurs on the very lower shore (infralittoral) that is only exposed on the lowest tides. The kelp species *Laminaria digitata* occurs together with red seaweeds that are dominated by *Mastocarpus stellatus*. The Snakelocks Anenome *Anenemonia viridis* was also recorded in this zone. The kelp *Laminaria saccharina* was recorded occasionally.

Fucus serratus on moderately exposed lower eulittoral rock (LR.MLR.BF.Fser)
This biotope was found on lower eulittoral rock and was characterised by a canopy of the Serrated Wrack *Fucus serratus* and an associated fauna including the Common Limpet *Patella vulgata*, the barnacle *Semibalanus balanoides*, the Dog Whelk *Nucella lapillus* and the Beadlet Anemone *Actinia equina*.

Semibalanus balanoides, _Fucus vesiculosis_ and red seaweeds on exposed to moderately exposed eulittoral rock (LR.HLR.MusB.Sem.FvesR)

Larger rocks to the south-east of the slip were dominated by barnacles *Semibalanus balanoides*. The red alga *Osmundea pinnatifida* occurred within cracks and crevices. Other species included Coral Weed *Corallina officinalis*, Beadlet Anenome *Actinia equina*, Snakelocks Anenome *Anenemonia viridis*, Common Periwinkle *Littorina littorea* and Common Limpet *Patella vulgata*.

Fucus vesiculosis on moderately exposed to sheltered mid eulittoral rock (LR.LLR.F.Fves)
Bladder Wrack *Fucus vesiculosis* dominates a rock substratum. This biotope is found to the south-east of the slip. Above is a narrow zone of Channel wrack *Pelvetia canaliculata* (LR.MLR.BF.PelB).

***Ascophyllum nodosum* on full salinity mid eulittoral rock (LR.LLR.F.Asc.FS)**

This biotope is found to the south-east of the proposed outfall location and is characterised by a canopy of Egg Wrack *Ascophyllum nodosum* upon the mid shore area. Vertical slopes of large rocks within this zone support barnacles and limpets. The brown algae *Cystoseira tamariscifolia* occurs within rockpools within this zone; these are not mapped but are assigned to the biotope ***Cystoseira* sp. in eulittoral Rockpools (LR.FLR.Rkp.Cor.Cys).**

Species recorded:
Brown Algae (Class Phaeophyceae): Bladder Wrack (*Fucus vesiculosis*) (occasional), Serrated Wrack (*Fucus serratus*) (occasional towards the lower part of zone), *Cystoseira tamariscifolia*.
Red Algae (Class Rhodophyceae): *Chondrus crispus* (occasional), Coral weed (*Corallina officinalis*), *Gelidium* sp., *Lithothamnion* spp., *Mastocarpus stellatus*, Pepper Dulse (*Osmundea pinnatifida*).
Green Algae (Chlorophyceae): *Cladophera* sp.
Molluscs (Phylum Mollusca): Common Periwinkle (*Littorina littorea*), *Monodonata lineata*, Common Limpet (*Patella vulgata*).

Robust fucoid and/or red seaweed communities (LR.HLR.FR)
A red algae zone occurs below the zone of *Ascophyllus nodosum* to the south-east of the proposed outfall. The seaweed species are dominated by *Mastocarpus stellatus* together with *Lomentaria articulata*, *Ceramium* spp, *Chondrus crispus* and *Corallina officinalis*. In places the domination of *Mastocarpus stellatus* could allow the biotope '***Mastocarpus stellatus* and Chondrus crispus on very exposed to moderately exposed lower eulittoral rock' (LR.HLR.FR.Mas)** to be assigned, although this biotope is not mapped.
Species recorded:
Red Algae (Class Rhodophyceae): *Chondrus crispus* (occasional), Coral weed (*Corallina officinalis*), *Gelidium* sp., *Lithothamnion* spp., *Mastocarpus stellatus, Calliblepharis jubata, Cystoclonium purpureum, Furcellaria lumbricalis.*

3.6.3 Evaluation of littoral habitats

Within the vicinity of the proposed WWTP outfall, the shoreline of Ballycotton Bay is classified predominantly as a rocky shore (reef) although some sediment/mixed substrata were recorded. A rocky shore or reef is defined as:

Submarine, or exposed at low tide, rocky substrates and biogenic concretions, which arise from the seafloor in the sublittoral zone but may extend into the littoral zone where there is an uninterrupted zonation of plant and animal communities (Davies *et al.*, 2001).

The majority of biotopes and species recorded during the survey are considered common within similar habitats and are not considered of any significant conservation importance although they have important biological roles. The survey area and biotopes therein is considered a good example of a moderately exposed rocky shore and is, at minimum, of moderate local importance. Of note was the occurrence of biogenic reefs (defined above) of the polychaete worm *Sabellaria alveolata*. These reefs take the form of hummocks or mounds consisting of the honeycomb like-masses of the worm tubes. They often have a rich associated flora and fauna and are

consequently considered of high ecological importance (Holt *et al.*, 1998). Biogenic reefs have no separate conservation classification and are included within the EU Natura Code 1170: Reefs.

Sabellaria alveolata

Prime examples of reefs may be selected as Annex I habitats under the EU Habitats Directive (Reefs: Natura Code 1170) and subsequently designated as Special Areas of Conservation. The rocky shore of Ballycotton Bay is not included within the Ballycotton, Ballynamona and Shanagarry pNHA and this habitat is not listed on the NGO Special Areas of Conservation Shadow List (Dwyer, 2000).

The rocky shore at Ballycotton Bay is subject to some local harvesting of the Common Periwinkle *Littorina littorea* although the current amount of harvesting is unknown.

3.7 Coastal and shorebirds of Ballycotton Bay

3.7.1 Birds recorded within the location of the proposed outfall

Shorebirds and coastal birds were recorded on four separate occasions within two zones to the north-west and south-east of the proposed outfall location (as described in Section 2.5). The results are presented in Table 5.

Relatively few birds were observed within the survey zones. Within Zone 1 at low tide, birds such as Oystercatcher (*Haematopus ostralegus*) and gull species were observed foraging within the algae upon the rocky shore. A number of birds were observed just beyond Zone 1 (to the north) within the shingle/sand shore habitat (species dominated by gulls). Zone 2 at low tide also supported a few bird species that were foraging within the algae-dominated shore e.g. Turnstone (*Arenaria interpres*) and Curlew.

During high tide periods, Zone 1 supported very few birds; six roosting Oystercatchers being the most observed on any one occasion. Oystercatchers also roosted upon the shore within Zone 2, just adjacent to the existing outfall pipe.

The birds observed are considered common and widespread within coastal habitats during winter. Although it appears that a small Oystercatcher roost occurs near to the existing outfall pipe, this would not be considered a major roost site and similar habitat (rocky shore) occurs along the shoreline of Ballycotton Bay. The area of shoreline surveyed within the current report is not included within counts undertaken for the Irish Wetland Bird Survey (I-WeBS) and this area is not considered a major roost or feeding site for wintering shorebirds or seabirds (P. Smiddy pers. comm., NPWS and I-WeBS counter).

Zone 1

Zone 2

Table 5. Shorebirds and seabirds recorded during the shorebird survey.

Bird Species	Zone 1	Zone 1	Zone1	Zone1	Zone 2	Zone 2	Zone 2	Zone 2
	14/02/06 13:00 hrs	22/02/06 10:30 hrs	22/02/06 12:00 hrs	27/02/06 07:45	14/02/06 13:30 hrs	22/02/06 11:00 hrs	22/02/06 12:30 hrs	27/02/06 08:15
	Low water count	High water count	High water count	Low water count	Low water count	High water count	High water count	Low water count
	LT @ 12:50	HT @ 11:28	HT @ 11:28	LT @ 11:30	LT @ 12:50	HT @ 11:28	HT @ 11:28	Lt @ 11:30
Hooded Crow *Corvus corone cornix*	1				1			
Cormorant *Phalacrocorax carbo*	1				1			
Wigeon *Anas penelope*	4							
Herring Gull *Larus argentatus*	12			1	3			3
Lesser black-backed gull *Larus fuscus*		No birds			1			
Black-headed Gull *Larus ridibundus*					1			1
Redshank *Tringa totanus*	1							
Curlew *Numenius arquata*			1	1		1	2	1
Turnstone *Arenaria interpres*						2		
Greenshank *Tringa nebularia*	1							
Oystercatcher *Haematopus ostralegus*	2		6	2	1	16	7	1

3.7.2 An assessment of the avian fauna of Ballycotton Bay

Ballycotton Bay is a shallow, sandy bay that stretches from Ballycotton to Garryvoe in the north. It is described as a composite coastal site exhibiting rocky reef, sandy shore, reedbed, salt marsh and dune habitat amongst others. Historically, a large area was a tidal inlet until 1930 when a portion was cut off from the sea by the natural development of a shingle bar (Hutchinson, 1979). This formed a large wetland area called Ballycotton Lake (or alternative name Ballynamona Lake) which supported the Annex I species Bewick's Swan (*Cygnus columbianus*) during winter (Smiddy & O'Halloran, 2006). The shingle bar has since been breached and this area is tidal again. However, the shingle shoreline around the edge of the tidal inlet remains the most important roost area for birds (P. Smiddy pers. comm.).

Ballycotton Bay is considered of national importance for wintering waterbirds (wading birds and waterfowl). A bird species that occurs in nationally important numbers has a wintering population that exceeds 1% of the national wintering population estimate. Ballycotton Bay supports nationally important numbers of Teal (*Anas crecca*), Ringed Plover (*Charadrius hiaticula*), the Annex I species Golden Plover, Grey Plover (*Pluvialis squatarola*), Lapwing (*Vanellus vanellus*), Curlew and Turnstone (Crowe, 2005). Ballycotton Bay is also considered important for Common

Gulls (*Larus canus*), Lesser black-backed Gulls (*Larus fuscus*) and Great black-backed gulls (*Larus marinus*).

Total waterbird numbers for Ballycotton Bay are shown in Table 6. The five-year average shows that over 11,000 waterbirds are regularly supported during winter.

Table 6. Total waterbird numbers for Ballycotton Bay (1999/00 – 2003/04) (Birdwatch Ireland)

	1999/00	2000/01	2001/02	2002/03	2003/04	Average (1999/00 – 2003/04)
Total Waterbirds	8,784	12,354	11,503	14,044	10,920	11,521

Appendix 4 shows the most recently available data from the Irish Wetland Bird Survey (I-WeBS). This shows seven bird species that occur in nationally important numbers: Teal, Grey Plover, Lapwing, Sanderling (*Calidris alba*), Black-tailed godwit (*Limosa limosa*), Curlew and Turnstone. The five-year average for the Annex I species Golden Plover falls just below the national threshold. In addition, Annex I species Bar-tailed godwit, Little Egret (*Egretta garzetta*) and Light-bellied Brent Geese (*Branta bernicla hrota*) also occur. In total, Ballycotton Bay supports 34 regularly-occurring wintering waterbird species.

Given its significant ornithological importance, 92 ha of Ballycotton Bay has been designated as a candidate Special Protection Area under the EU Bird's Directive (also see Section 3.2). A similar area is also designated as a Ramsar Site under the Ramsar Convention Bureau (1984) (Appendix 2). Ballycotton Bay is also a Wildfowl Sanctuary and a brackish pool called Allen's Pool is a BirdWatch Ireland Reserve. Anon (1972) described Ballycotton Bay as 'a wildlife habitat of outstanding merit' and the area has been a popular birdwatching site since the 1960's (Smiddy & O'Halloran, 2006).

4.0 ECOLOGICAL IMPACT ASSESSMENT

4.1 Potential impacts of the proposed development on designated sites

It is considered unlikely that the development of a wastewater treatment plant at either of the two proposed locations will impact upon designated sites given their distance from designated areas. Marine/coastal impacts will be dealt with in Section 4.4.

4.2 Potential impacts of the proposed development on terrestrial habitats and fauna

Habitat Loss

The proposed WWTP development will necessitate removal (habitat loss) of 0.279 ha of habitat for Site 1 or 0.329 ha habitat for Site 2 (these areas include both the sites and their proposed access routes).

Agricultural grassland is abundant in the general locality and considered a modified habitat of low local ecological value. Although this habitat is used by a variety of fauna (e.g. birds and mammals), the loss of the predicted area of agricultural grassland habitat is not considered to constitute a significant negative impact upon fauna. Loss of improved agricultural grassland habitat is considered an imperceptible impact. In the case of badgers that use this habitat for foraging, the survey found that the greatest activity was outside of the proposed site boundaries. Development of the sites should not prevent badger use of other similar habitat in the vicinity of the sites.

It is intended to retain existing hedgerows as much as possible. The predicted loss of 10m of hedgerow is not considered to constitute a significant negative impact upon habitats or species in the local area.

Disturbance

Disturbance is likely to occur during the construction and operation phases of the wastewater treatment sites. Disturbance will be greatest during the construction phase when some birds may be frightened away from habitats on the site boundaries (i.e. hedgerows) or from habitats adjacent to the sites. This will have more significance for Site 1 in terms of the dense scrub habitat and its associated fauna beyond the eastern boundary. Disturbance is predicted to have a short-term minor (slight) negative impact upon wildlife in habitats adjacent to the proposed wastewater treatment sites during the construction phase. Under this prediction, some change in species distribution may be noticeable (e.g. nesting birds move away from habitats adjacent to the site) but overall the impact is predicted to not significantly alter species local distribution or abundance. Once construction is complete and the site is operational, the long-term impact upon wildlife in the adjacent habitats is predicted to be imperceptible – minor (slight).

Badgers are known to be highly territorial and can be sensitive to disturbance, particularly if it occurs close to their setts. The majority of badger activity was recorded outside (but adjacent) to the two proposed WWTP sites. Development of the sites may result in some disturbance to badgers, for example, they may be disturbed away from regularly used trails that are close to the development site(s). However, direct disturbance is likely to be minimal as badgers are most active after dusk (and therefore outside of normal working hours) and construction works will not directly affect their setts. If the development results in a change in the local movement of badgers then this is likely to be temporary and confined to the construction period. Once the site is operational, badgers may well resume their movements quite close to the site boundary as they will be most active when the site is inactive at night.

Impacts caused by laying the sewage pipeline from Garryvoe to Ballycotton

It is proposed to lay the pipeline within the road or road verge. Some indirect damage may occur to hedgerows along the pipeline route which can be minimised if mitigation measures are followed.

Pipeline crossings of watercourses

Correct construction procedures and site-based environmental management that take due consideration of the surrounding habitats should mean that physical impacts upon adjacent habitats (e.g. stream or scrub) will be minimised.

The coastal and wetland habitats of Ballycotton Bay provide ideal habitats for otters. The current survey found that streams running into what was once called Ballycotton Lake (and now the tidal inlet of Ballycotton Bay), are used regularly by otters, evidenced by spraint sites and otter trails. Some form of disturbance may therefore occur when the sewage pipeline is laid along the road that crosses these streams although this is not thought to impact upon otters significantly. Field evidence has found that otters are more tolerant of disturbance than previously thought (Sleeman & Moore, 2005). The disturbance impact upon otters is predicted to be imperceptible-minor (slight) and of a temporary nature.

During the pipe laying process there is a potential that some construction or other materials may enter watercourses. This could cause pollution and/or an increase in siltation ('worst-case' impact). Provided that measures are taken to minimise pollution and siltation of watercourses during development, there should be no negative impacts upon water quality.

4.3 WWTP site choice: most suitable site based on ecological resources

In terms of existing environment and aiming to minimise ecological impacts, Site 2 would appear to be the most suitable site for WWTP development. This is due to the more sensitive/valuable ecological resources adjacent to Site 1 such as the stream and the hedgerow/scrub habitats (See Section 3.3.3).

4.4 Potential impacts of the proposed development on the intertidal (littoral) habitats and fauna

Potential impacts of the proposed development include physical damage/habitat loss (e.g. due to the construction of the outfall pipe on the shore) and ecological disturbance (i.e. due to the effects of organic loading to the coastal environment).

Habitat loss and habitat degradation

The outfall pipe will extend 322 m into Ballycotton Bay and will therefore be a subtidal outfall. The outfall pipe consists of a 300mm diameter pipe that will be laid within a trench. This will necessitate the excavation of a trench and its back-filling once the pipe is laid. The impact zone is deemed to be the area directly affected by the route of the pipeline, the area either side of the pipeline route (construction corridor) and areas of the shore that are disturbed or impacted by the movement of construction vehicles/machinery during construction.

Construction of the pipeline will involve some physical habitat loss and damage (habitat degradation) of intertidal reef (rock) habitat and its associated fauna within the impact zone. The biotopes and species recorded within the impact zone are relatively common within similar habitats and are not considered to be of special conservation importance. Intertidal biotopes that will be directly affected by the pipeline construction are as follows:

- Yellow and grey lichens on supralittoral rock (LR.FLR.Lic.YG)
- *Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock (LR.MLR.BF.PelB).
- *Semibalanus balanoides*, *Fucus vesiculosis* and red seaweeds on exposed to moderately exposed eulittoral rock (LR.HLR.MusB.Sem.FvesR).
- *Fucus serratus* on moderately exposed lower eulittoral rock (LR.MLR.BF.Fser)
- *Laminaria digitata* on moderately exposed sublittoral fringe rock (IR.MIR.KR.Ldig.Ldig)

Appendix 5 gives the relative sensitivity of these biotopes to a range of physical factors. This information is based on the previous biotope codes (Connor *et al.*, 1997a) and is taken from the Marine Life Information Network (*MarLIN*) (www.marlin.ac.uk). Apart from yellow and grey lichens (LR.FLR.Lic.YG), sensitivity to four physical factors (substratum loss, smothering, increase in suspended solids and abrasion & physical disturbance) ranges from moderate to low and recoverability is deemed to be high. While lichens are sensitive to physical disturbance and are extremely slow-growing, therefore making recoverability low (Dobson, 1979), the species found are common and widespread along similar shores.

Subtidal biotopes that will be impacted by the construction are undetermined at present.

Removal of rock during trench excavation will mean the physical loss of reef habitat and this impact will be of a permanent nature. Once the construction has finished and given sensitive reinstatement of the shoreline, the shore will gradually return to a natural state although this may take several years. Flora and fauna will recolonise over time, although recolonisation times will vary for different faunal groups and depend on the dispersion, recruitment and growth rates of invertebrate and plant species. During the recolonisation process, species diversity and zonation are likely to differ from the pre-construction state as the intertidal communities undergo natural ecological processes of succession, competition etc.

The physical habitat loss and disturbance caused by the construction of the outfall pipeline is considered to be a moderate negative impact in that it will cause noticeable ecological consequences within the impact zone.

In terms of the impact upon Ballycotton Bay as a whole, construction of the proposed outfall is considered unlikely to have a significant negative effect on the distribution and abundance of habitats and species within Ballycotton Bay. The development is predicted to have a minor (slight) impact on the physical nature of the shore as long as careful engineering procedures are followed and care is taken to limit physical disturbance to the smallest area possible.

Additional physical impacts upon shore habitats may occur due to the movement of construction vehicles and erosion of features and habitats. Some of this ancillary impact can be avoided if construction personnel are made aware of the sensitivity of the habitats in question.

In addition to physical disturbance, impacts upon water quality may occur during the construction phase as sediments and materials become mobilised within the water column. Suspended sediment will reduce water clarity which will have knock-on effects for flora and fauna. The subsequent deposition of suspended sediment may also smother fauna with negative ecological consequences for the most sensitive species such as filter-feeding invertebrate species (species that filter particles from the water column) (e.g. *Sabellaria alveolata*). These impacts will occur over the short-term during the period of construction although the ecological effects may last for much longer.

Ecological disturbance due to organic loading

The effects of organic loading to coastal environments are well documented (e.g. Pearson & Rosenberg, 1978) although a greater amount of attention has focused on effects within shallow estuarine areas. The greatest negative effects of organic loading on local ecology are observed where large quantities of raw effluent are discharged. Effects are also generally greater within estuarine soft sediment environments as wave action (and increased dissipation and dispersion) within rocky shore environments may potentially reduce negative effects upon rocky shore communities (Underwood & Chapman, 1997).

At present, primary-treated effluent (from septic tanks) and untreated raw sewage enter Ballycotton Bay. The supplied figures show that the current peak load discharged is 109.3 kg BOD/day (from 2,713 PE), and of this, 62.9 kg BOD/day is discharged to sea without any treatment. The proposed WWTP development has a design capacity of 4,300 PE and will have Secondary Treatment with the discharged effluent meeting the standards of the Urban Wastewater Treatment Directive of 25 mg/l BOD, 35 mg/l SS and 125 mg/l COD. Proposed future loads are estimated at 19.4 kg BOD/day that are discharged to sea.

The proposed WWTP development is therefore predicted to have a positive impact on the local coastal environment due to the decrease in BOD loadings. Although the volume discharged is likely to increase as the population in the area expands, effluent that meets the UWWTD standards will have a more positive impact on the coastal environment than if no development occurred. The 'Do-Nothing Impact' would result in future increases in the volume of untreated effluent discharged to the bay which could have negative impacts upon ecology.

Biogenic reefs

Biogenic reefs are sensitive to a range of both natural and anthropogenic events such as large natural movements of sand, blanketing by sediment as a result of coastal construction and physical damage due to trampling. There is little evidence of sensitivity to chemical (e.g. sewage) contaminants (Holt *et al.*, 1998). The main *Sabellaria alveolata* reefs recorded during the current survey were located over 200m to the north-west of the proposed outfall location. Physical disturbance caused by the pipeline construction is therefore considered unlikely to affect them. These reefs are considered to be at minor risk from impacts due to suspended sediments and increased turbidity of the water column.

Shore and coastal birds

Noise and other disturbance have the potential to adversely affect fish, mammals and birds during the construction phase. This will be a short-term impact.

Although otters are known to use the shoreline of Ballycotton Bay, the current studies found no evidence of major otter activity within the impact zone (i.e. no evidence of an otter holt or resting place within the impact zone). The construction of the outfall pipe is considered to have an imperceptible impact upon otters.

The shore and coastal birds observed during the current surveys are considered common and widespread within coastal habitats during winter. Although it appears that a small Oystercatcher roost occurs near to the existing outfall pipe, this would not be considered a major roost site and similar habitat (rocky shore) occurs along the shoreline of Ballycotton Bay. Although some disturbance will occur during the construction phase, birds may continue to roost close to the outfall pipe once the disturbance has finished.

Some bird species are known to be associated with sewage outfalls. Gulls, for example, are known as opportunistic feeders and may feed directly on waste matter from outfalls (Cramp & Simmons, 1983; Ferns & Mudge, 2000). The current surveys found no indication of increased numbers of birds in the vicinity of the outfall and the proposed new outfall is unlikely to result in any changes. Overall, the construction of the outfall pipe is considered to have an imperceptible impact upon coastal and shorebirds of Ballycotton Bay.

5.0 PROPOSED MITIGATION MEASURES

5.1 Proposed mitigation measures for terrestrial habitats and fauna

Hedgerows should be retained wherever possible to provide a buffer between the WWTP site and the surrounding environment. At Site 1, the existing hedgerow to the east of the site forms a natural buffer between the proposed site access road and the stream to the east. If this site is chosen, then retention of the hedgerow and associated scrub is recommended so as to buffer the stream. It is not intended to interfere with this stream in any way but given the local importance of this stream, the utmost care should be paid in buffering it from any site development activities.

Site development should be contained within the site boundaries. Special consideration should be given to the scrub habitat (to the south-east of Site 1) and its special significance for badgers – this area should not be encroached upon or disturbed unduly during site development.

Creation and management of site boundary vegetation should follow sound ecological principles and aim to enhance flora and fauna (e.g. the careful use of weed killer and insecticide). Vegetation planting as part of the landscape design should include plant species of value to wildlife (e.g. plants that provide cover; plants that provide food in the form of berries) and reflect native plant species that are present in the local area.

Hedgerow and vegetation management should be carried out with due consideration of the Wildlife (Amendment) Act 2000, Section 46 (amending Section 40 of the Wildlife Act, 1976) in terms of the timing of hedgerow trimming, vegetation removal and habitat destruction with regards to breeding birds.

The spread of Japanese Knotweed is potentially damaging to the ecology of the habitats adjacent to Site 1. Future site management should acknowledge its occurrence and the species should not be used in any boundary planting. Any plants that are found within site boundaries in the future should be managed correctly; simple cutting, for example, only aids in the plant's spread as the plant can regenerate from fragments of stem material (Child *et al.,* 1998). For guidance see Child & Wade (2000).

Fencing of the WWTP development site during construction is advisable to stop mammals entering. This is particularly important in the case of badgers as the mammal survey found that they are very active close to both proposed development sites. Badger-proof fencing or a low-lying electric fence should be used to prevent badgers entering the site during construction. It would be advantageous for a suitably qualified ecologist to undertaken a mammal survey during the construction period to assess mammal (particularly badger) movements both within the development site and in the immediate surrounding area.

Given the very high density of brown rats in the hedgerow adjacent to Site 2, it may be desirable to undertake some form of rodent control prior to the development taking place.

During the laying of the sewage pipeline, due care must be given in relation to stream crossings. Construction and/or polluting materials (including sediment) must not be allowed to enter the watercourse. In the event that the pipeline cannot be paid within the road bridge (which may necessitate works below the bridge), recommendations must be sought from the Southern Regional Fisheries Board and the National Parks and Wildlife Service, the latter particularly in the case of the streams that enter the NHA / SPA.

During the laying of the sewage pipeline, due care must be given to the ecological importance of hedgerows and any physical removal or disturbance should be carried out with due consideration

of the Wildlife (Amendment) Act 2000, Section 46 (amending Section 40 of the Wildlife Act, 1976).

5.2 Proposed mitigation measures for littoral (intertidal) habitats and fauna

Engineering and construction of the proposed outfall pipe should take every possible measure to reduce the physical impacts upon the rocky shore, coastal and marine environment. Care should be taken to reduce ancillary impacts such as pollution (e.g. oil spillages) and siltation. Damage or disturbance to sediment and rocky substratum should be minimised and limited to the route of the pipeline. Construction machinery should be used with due care and consideration of the surrounding shore habitats; special care being required when accessing the site. Refuelling should not take place on the shore.

A method statement should be prepared for the trench excavation and pipe laying procedures taking into account the ecological sensitivity of the shoreline. This should ideally be assessed by a suitably qualified ecologist and statutory authorities prior to the construction.

Excavated material should be transported and stored appropriately and the loss of such material to the water column (and subsequent impacts upon water quality) should be minimised (i.e. do not store such materials within areas that will be inundated by the tide).

The pipe should be made of a material that is non-harmful to fauna (e.g. HDPE/Concrete). As far as possible, the excavation trench should be back-filled with the same material that is removed during trench excavation. If other material is required to supplement existing material then it should be of the same type and nature as the existing material and be non-harmful to shoreline fauna. This will facilitate the return of the shore to its natural state and maximise faunal recolonisation.

Following the completion of pipeline construction, the area of shore within the impact zone of the pipeline should be reinstated to reflect as close to the former natural state as possible.

Further studies will be required to determine the sub-tidal biotopes that may be impacted by the proposed development (i.e. sub-tidal sampling). Monitoring would be advantageous to assess the impact zone of the outfall pipeline e.g. before/after sampling; monitoring of defaunation and recolonisation following the physical disturbance.

The developer should comply with all statutory legislative requirements and national and local guidelines. The developer should consult and comply with the requirements of the Department of Marine and Natural Resources, the Marine Institute, National Parks and Wildlife Service (DEHLG) and the Regional Fisheries Board.

Treated effluent discharges should meet the minimum standards of the Urban Waste Water Treatment Directive of 25 mg/l BOD, 35 mg/l SS and 125 mg/l COD.

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APPENDIX 1

Ecological Evaluation and Ecological Impact Assessment (EcIA)

The significance of an ecological impact is directly correlated with the conservation importance of a particular area being affected. Evaluation of the conservation importance of an area (ecological evaluation) is therefore of critical importance in identifying the significance of an impact.

There are currently no standard guidelines for ecological/conservation evaluation within Ireland. Limosa Environmental has therefore adapted for use, evaluation criteria and techniques based on previously published guidelines (e.g. Ratcliffe 1977; Treweek, 1999; NRA, 2004) following best practice methodology (e.g. IEEM, 2005).

Evaluation methodology consists of evaluating each ecological resource (e.g. habitat, micro-habitat, population, species) within the zone of influence (area to be affected) using the criteria outlined in Table 1a. Each ecological resource is then given an evaluation value (ranking) as described in Table 1b. Table 1b allows for evaluation to be described in a more readily understandable way within the EIA document. As evaluation rankings of local value and below may be deemed to be subjective, these rankings if assigned will, in general, be discussed and explained more fully within the text.

Table 1 a Established criteria for ecological evaluation

Evaluation criteria	Definitions and Notes
Site designations	Designated areas for conservation are areas that are designated under national and/or European laws in order to conserve habitats and species of national or international conservation importance. These include: • Natural Heritage Areas (NHA): a national designation given legal status by the Wildlife Amendment (2000) Act. • Special Areas of Conservation (SAC): areas considered of European and national importance whose legal basis is the EU Habitats Directive (92/43/EEC), transposed into Irish law through the European Union (Natural Habitats) Regulations, 1997. • Special Protection Areas (SPA): sites of conservation importance for birds whose legal basis is the EU Birds Directive (79/409/EEC). • Wildfowl Sanctuary: designated under the 1976 Wildlife Act. • Ramsar Site: European designation based on the Ramsar Convention, 1984.
Species designations/criteria	Certain legislation refers directly to species/populations (e.g. annexed species): • Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora. • Council Directive 79/409/EEC on the Conservation of Wild Birds ('Birds Directive'). • Bern Convention on the Conservation of European Wildlife and Natural Habitats. • The Wildlife Act (1976) and The Wildlife (Amendment) Act (2000). • Birds of Conservation Concern in Ireland (Newton *et al.*, 1999). • Red Data Books of Britain and Ireland (e.g. Curtis & McGough,1988). • Flora (Protection) Order, 1999.
Size	Includes both size of habitats (area) and population size of individual species and is intrinsically linked to other criteria such as rarity and fragility (below). Habitats: considers minimum viable size of habitats, habitat heterogeneity, species/area relationships, home-range size. Populations: considers concept of minimum viable population size (population viability), national and local population trends, extinction risk...
Diversity / Biodiversity	At a minimum species richness (number of species). Biodiversity defined as 'the variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part (Convention on Biological Diversity, 1993). Must be considered in terms of the habitat type - some habitats have low species diversity by nature. Keystone species deserve special attention – defined as a species whose removal would induce significant changes within the food web (Begon *et al.*, 1996).
Rarity	Applies to habitats and to species. The degree to which a habitat or community approximates a natural state. The degree to which the site is a good example of the habitat types. National, county, local scales e.g. within 10-km^2 squares.
Naturalness	The degree of modification by human intervention. Habitats that are least modified are generally regarded more highly (Treweek, 1999). Also considers the extent to which the habitat is free of alien species.
Representativeness/ Typicalness	How well the area represents habitats or vegetation types on a wider scale (Treweek, 1999); 'degree of representativity of the natural habitat type on the area' (Council Directive 92/43/EEC; Habitats Directive).
Fragility	The degree of sensitivity of habitats, communities and species to environmental change.
Stability/Resistance/Resilience	Habitats and species. Stability refers to the ability of an ecosystem to maintain some form of equilibrium in the presence of a disturbance. Resilience is defined as the ability and speed with which a community returns to its former state following a disturbance. Resistance is defined as the ability of a community to avoid displacement by a disturbance (Begon *et al.*, 1996). .
Other criteria include:	
Recorded history (scientific value), Potential value, Educational value, Amenity value.	

Table 1 b Value of resources

Ecological Value	Examples
A International	Sites designated as Special Protection Areas (SPA), Special Areas of Conservation (SAC), Ramsar Sites. Sites meeting criteria for international designation.
B National	Sites designated as Natural Heritage Areas (NHA) or sites qualifying for designation. Undesignated sites containing good examples of Annex I habitats. Undesignated sites containing significant numbers of resident or regularly occurring populations of Annex II species under the EU Habitats Directive or Annex I species under the EU Birds Directive or species protected under the Wildlife (Amendment) Act 2000. Sites supporting viable populations of Red Data Book species (nationally rare species).
C Regional	Undesignated sites that are prime examples of the habitat (natural or semi-natural) type, exhibit high biodiversity or support important communities/assemblages of species within the region. Sites exhibiting habitats that are scarce within the region. Sites that support nationally scarce plant species (recorded from less than 65 10-km^2 squares, unless they are locally abundant). Sites that hold regionally scarce vertebrate species.
D High Local	Sites that are prime examples of the habitat type, exhibit high biodiversity or important communities/assemblages of species within the local area. Habitats that are important in a local context e.g. semi-natural habitats within an urban setting, hedgerows and treelines that serve as important ecological corridors within an otherwise modified landscapes. Sites exhibiting habitats/species that are generally scarce within the local area.
E Moderate Local	Sites that exhibit good quality semi-natural habitats. Hedgerows and treelines.
F Low Local	Artificial or modified habitats considered of low value for wildlife.

Adapted from IEEM, 2005; NRA, 2004; Regini, 2000; RPS Group, 2001.

Impact Terminology

Impacts may be defined as per the EPA (2003):

Positive Impact:	A change which improves the quality of the environment.
Negative Impact:	A change which reduces the quality of the environment.
Neutral Impact:	A change which does not affect the quality of the environment.
Cumulative Impact	The addition of many small impacts to create one larger, more significant, impact.
Do-Nothing Impact:	The environment as it would be in the future if no development was carried out.
Indeterminable Impact	When the full consequences of a change in the environment cannot be described.
Irreversible Impact	When the character, distinctiveness, diversity or reproductive capacity of an environment is permanently lost.
Residual Impact:	The degree of environmental change that will occur after the proposed mitigation measures have taken effect.
Synergistic Impact	Where the resultant impact is of greater significance than the sum of its constituents.
Worst case Impact	The impacts arising from a development in the case where mitigation measures substantially fail.

Impact magnitude refers to the 'size' or 'amount' of an impact (IEEM, 2005). Impact Assessment takes into account not only the impact magnitude, but also the extent (e.g. proportion of the site to be affected), timing and frequency, duration (e.g. temporary or permanent), reversibility and cumulative effects of the impact(s) (IEEM, 2005).

The criteria for assessing impact magnitude are given in Table 1 c.

Table 1 c Criteria for assessing impact magnitude

Impact Magnitude	Definition
No change	No observable impact in either direction (negative or positive).
Imperceptible Impact	An impact without noticeable consequences in either direction (negative or positive).
Minor (Slight) Impact	An impact (negative or positive) that has noticeable ecological consequences that are not considered to significantly affect the distribution and/or abundance of species or habitats within the defined site.
Moderate Impact	An impact that has noticeable ecological consequences that are considered to significantly affect the distribution and/or abundance of species or habitats within the defined site.
Major (Significant) Impact	An impact that has noticeable ecological consequences that are considered to significantly affect species or habitats of high conservation importance and to potentially affect the overall viability of those species or habitats within the wider area.
Profound Impact	An impact considered to significantly affect species or habitats of high conservation importance to such a degree that their viability in the wider area is under a very high degree of threat (negative impact) or is likely to increase markedly (positive impact).

Based on RPS Group, 2001.

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APPENDIX 2

NHA SITE SYNOPSIS

SITE NAME: BALLYCOTTON, BALLYNAMONA AND SHANAGARRY

SITE CODE: 000076

This is a composite coastal site stretching northwards from Ballycotton towards Garryvoe. Much of the area was a tidal inlet until 1930 when it was cut off from the sea by the development of a shingle storm beach. This created a series of three wetlands, only the middle of which remained tidal. Recently, however, the shingle bar at the southern end of the site was breached destroying Ballycotton Lake and rendering this inlet tidal also.

The site is important for its wetlands, which have, however, been damaged by drainage, land reclamation and a breach in the shingle bar in recent years. Wetlands on the site include reedswamp with Common Reed (*Phragmites australis*) and marshes near Garryvoe with Greater Pond-sedge (*Carex riparia*), Water Dock (*Rumex hydrolapathum*) and Pink Water-speedwell (*Veronica catenata*), amongst others.

The shingle beach on the site is mobile and is influenced by storms, which create open conditions that favour a particular suite of species. Species found here include Grass-leaved Orache (*Atriplex littoralis*), Black Mustard (*Brassica nigra*), Sea Radish (*Raphanus raphanistrum* subsp. *maritimum*), Sand Couch (*Elymus farctus*) and Lyme-grass (*Leymus arenarius*). Also growing on the shingle beach is Sea-kale (*Crambe maritima*), a rare species listed in the Red Data Book.

The site is also of ornithological importance. It contains nationally important numbers of eight species of waterfowl, i.e. Bewick's Swan (100), Gadwall (70), Shoveler (93), Coot (311), Ringed Plover (122), Grey Plover (60), Sanderling (93) and Turnstone (112) - all counts are the average of 19 counts over three seasons between 1984/85 and 1986/87. A further thirteen species occur in regionally or locally important numbers. The site is also notable for its use by rare migrant species. Reed Warblers, rare in Ireland, breed in the Common Reed beds.

Land use within the site is varied, but grazing is dominant. The site has been much damaged by land reclamation, drainage and breaching of the shingle bar, the latter leading to the loss of a brackish lake (Ballycotton Lake) and the almost total disappearance of the many wildfowl, including the Swan species that used it. The site is a Wildfowl Sanctuary, and part of it is a Special Protection Area.

The site has some geological interest, with the eroding cliffy shoreline at Garryvoe revealing two glacial tills, one being produced by the local mountain glacier and the other by the Irish Sea ice sheet.

Several habitats that are listed on Annex I of the EU Habitats Directive occur on the site and it is of considerable ornithological importance, particularly for the waterfowl that use it. The presence of breeding Reed Warblers is also of interest. The occurrence of the rare, Sea-kale adds to the interest of the site. Despite the damage to some of the habitats on the site, it remains a very diverse site of considerable ecological and conservation importance.

SPA SITE SYNOPSIS

Ballycotton Bay SPA (Site Code 4022)

Situated on the south coast of Co. Cork, Ballycotton Bay is an east-facing coastal complex, which stretches northwards from Ballycotton to Ballynamona, a distance of *c.* 2 km. The site comprises two sheltered inlets which receive the flows of several small rivers. The southern inlet had formerly been lagoonal (Ballycotton Lake) but breaching of the shingle barrier in recent times has resulted in the area reverting to an estuarine system.

The principal habitat within the site is inter-tidal sand and mudflats. These are mostly well-exposed and the sediments are predominantly firm sands. In the more sheltered conditions of the inlets, sediments contain a higher silt fraction. The inter-tidal flats provide the main feeding habitat for the wintering birds. Sandy beaches are well represented. The shingle beach is mobile and is influenced by storms, which create open conditions that favour a particular suite of species. Species found here include Grass-leaved Orache (*Atriplex littoralis*), Black Mustard (*Brassica nigra*), Sand Couch (*Elymus farctus*) and Lyme-grass (*Leymus arenarius*). Also growing on the shingle beach is Sea-kale (*Crambe maritima*), a rare species that is listed in the Red Data Book. Salt marshes fringe the flats in the sheltered inlets and these provide high tides roosts. A small area of shallow marine water is also included.

Ballycotton Bay supports an excellent diversity of wintering waterfowl species, and has nationally important populations of nine species as follows (all figures are average peaks for the 5 winters 1995/96-1999/00): Teal (1,296), Ringed Plover (248), Golden Plover (4,284), Grey Plover (187), Lapwing (4,371), Sanderling (79), Bar-tailed Godwit (261), Curlew (1,254) and Turnstone (288). Other species which occur in important numbers, and at times exceed the threshold for national importance, include Shelduck (137), Wigeon (757), Mallard (366), Oystercatcher (362), Dunlin (812), Black-tailed Godwit (168), Redshank (149) and Greenshank (17). The population of Golden Plover is of particular note as it represents 2.8% of the national total, while the Grey Plover and Lapwing populations each represent 2.5% of their respective national totals. Ballycotton Bay was formerly of importance for Bewick?s Swan but the birds have abandoned the site since the reversion of the lagoonal habitat to estuarine conditions. The site is also important for wintering gulls, especially Lesser Black-backed Gulls (1,606) in autumn and early winter. Common Gull (310) and Great Black-backed Gull (324) are well represented in winter.

The site is a well-known location for passage waders, especially in autumn. Species such as Ruff, Little Stint, Curlew Sandpiper, Green Sandpiper and Spotted Redshank occur annually though in variable numbers. Small numbers of Ruff may also be seen in late winter and spring. Rarer waders, such as Wood Sandpiper and Pectoral Sandpiper, have also been recorded.

While relatively small in area, Ballycotton Bay supports an excellent diversity of wintering waterfowl and has nationally important populations of nine species, of which two, Golden Plover and Bar-tailed Godwit, are listed on Annex I of the E.U. Birds Directive. Bird populations have been well-monitored in recent years.

6.10.2004

RAMSAR SITE CODE: IRELAND 3IE022

Site: Ballycotton Bay	**Designation date:** 11-06-1996	
Coordinates: 51°50'N 008°00'W	**Elevation:** 0 m	**Area:** 92 ha
Location: The site is situated approximately 35 km east of the town Cork in South Ireland. It stretches northwards from Ballycotton towards Garryvoe.		
Criteria: no information available		
Importance: Ballycotton Bay regularly supports internationally important numbers of *Cygnus columbianus bewickii* and *Anas strepera*. The site also supports a notable assemblage of other wetland birds.		
Wetland Types: K ,J ,H ,G ,E (dominant types shown in bold) Ballycotton Bay is a composite coastal site consisting of brackish and freshwater lagoons, wet meadow, reed beds and saltmarsh with a sandy beach and intertidal sand and mudflats.		
Biological/Ecological notes: The habitats are dominated by common reed *Phragmites australis*, with some marshes below Garryvoe containing interesting plant species such as *Carex riparia*, *Rumex hydrolaphatum* and *Veronica cateniata*. The shingle beach still exists and is mobile and influenced by storms. This creates open conditions that favour several unusual plant species, including two local species *Atriplex littoralis* and *Brassica nigra*. *Raphanus raphanistrum maritiumus* is very noticeable in this community and there are some *Elymus farctus* and *Leymus arenarius*. The shingle beach also supports *Crambe maritima*, a scarce species listed in the Irish Red Data Book. The site contains nationally important numbers (from average peaks in 1984/85 - 1986/87) of eight species of waterbirds including *Anas clypeata* and turnstone *Arenaria interpres*. A further thirteen species occur in regionally or locally important numbers. The site is also notable for its records of rare migrants. Reed warblers, rare in Ireland, breed in the *Phragmites*.		
Hydrological/Physical notes: Much of the area was a tidal inlet until 1930 when it was cut off from the sea by the development of a shingle storm beach. This created a series of 3 wetlands, only the middle of which remained tidal. The shingle bar at the southern end of the site was however breached, destroying Ballycotton Lake and rendering this inlet tidal. This site contains some geological interest, with the eroding "cliffy" shoreline at Garryvoe revealing two glacial tills, one being produced by the local mountain glacier and the other by the Irish Sea ice-sheet.		
Human Uses: Land use within this site is varied, but grazing is dominant. The site is used for recreation purposes. The site is of considerable scientific interest, most notably for its bird life. The site's proximity to Cork allows easy access to a large number of bird-watchers.		
Conservation Measures: The site is a Wildfowl refuge, while the open shore part is a European Union Special Protection Area for birds.		
Adverse Factors: Land reclamation and drainage have caused the greatest extent of damage in the area. However, the character of the site changed in 1990-91 when the shingle bar breached, leading to the loss of the brackish Ballycotton Lake and the almost total disappearance of the many wildfowl, especially all three swan species that used it. Still, it is likely that elements of the former habitats exist.		
Site Management: No information provided.		
Based on the 1995 Ramsar Site information provided.		

APPENDIX 3

Biotope Descriptions. Following Connor *et al.* (2004).

LS.LCS.Sh (Shingle (pebble) and gravel shores)

Habitat (physical) description
Salinity: Full (30-35ppt)
Wave exposure: Exposed, Moderately exposed
Substratum: Shingle; gravel; coarse sand
Height band: Upper shore, Mid shore, Lower shore
Biotope description
Littoral shingle and gravel shores include shores of mobile pebbles and gravel, sometimes with varying amounts of coarse sand. The sediment is highly mobile and subject to high degrees of drying between tides. As a result, few species are able to survive in this environment. Beaches of mobile shingle tend to be devoid of macroinfauna, while gravelly shores may support limited numbers of crustaceans such as *Pectenogammarus planicrurus*.
Situation
Littoral gravels and shingles are found along relatively exposed open shores, where wave action prevents finer sediments from settling. Gravel and shingle may also be present on the upper parts of shores where there are more stable, sandy biotopes on the lower and mid shore.
Temporal variation
The sediment particle size structure may vary seasonally, with relatively finer sediments able to settle during calmer conditions in summer.

LR.FLR.Lic.YG (Yellow and grey lichens on supralittoral rock)

Habitat (physical) description
Salinity: Full (30-35ppt), Variable (18-35ppt)
Wave exposure: Very exposed, Exposed, Moderately exposed, Sheltered, Very sheltered
Substratum: Bedrock; stable boulders
Zone: Supralittoral
Biotope description
Vertical to gently sloping bedrock and stable boulders in the supralittoral (or splash zone) of the majority of rocky shores are typically characterised by a diverse maritime community of yellow and grey lichens, such as *Xanthoria parietina*, *Caloplaca marina*, *Lecanora atra* and *Ramalina* spp. The black lichen *Verrucaria maura* is also present, but usually in lower abundance than in the littoral fringe zone. In wave exposed conditions, where the effects of sea-spray extend further up the shore, the lichens generally form a wide and distinct band. This band then becomes less distinct as wave exposure decreases, and in sheltered locations, cobbles and pebbles may also support the biotope. Pools, damp pits and crevices in the rock are occasionally occupied by winkles such as *Littorina saxatilis* and halacarid mites may also be present.
Situation
This biotope is usually found at the top of the shore, immediately above a zone of the black lichen *V. maura* (Ver.Ver; Ver.B). Above the band of YG, and occasionally in crevices in the rock alongside the lichens, terrestrial plants such as the thrift *Armeria maritima* and other angiosperms often occur. In sheltered areas the transition from YG to Ver.Ver is often indistinct and a mixed zone of YG and Ver.Ver may occur. In estuaries, this biotope is often restricted to artificial substrata such as sea defences.

LR.FLR.Lic.Ver (*Verrucaria maura* on littoral fringe rock)

Habitat (physical) description
Salinity: Full (30-35ppt), Variable (18-35ppt)
Wave exposure: Very exposed, Exposed, Moderately exposed, Sheltered, Very sheltered, Extremely sheltered
Substratum: Bedrock; stable boulders and cobbles
Zone: Littoral fringe
Biotope description
Bedrock or stable boulders and cobbles in the littoral fringe which is covered by the black lichen *Verrucaria maura*. This lichen typically covers the entire rock surface giving a distinct black band in the upper littoral fringe. The winkle *Littorina saxatilis* is usually present. Two variants are defined which both occur in a wide range of wave exposures. On exposed shores *V. maura* may occur with sparse barnacles such as *Chthamalus* spp. or *Semibalanus balanoides* and may be covered by a band of ephemeral seaweeds such as *Porphyra umbilicalis* or *Enteromorpha* spp. (Ver.B). Above Ver.B or on more sheltered shores is a species poor community consisting mainly of *V. maura* and *L. saxatilis* (Ver.Ver).
Situation
This biotope occurs below the yellow and grey lichen zone (YG) and above eulittoral communities of barnacles and fuciod algae.

Temporal variation
Distinct band of red or green ephemeral algae may obscure the black lichen band at certain times of the year.

LR.MLR.BF.PelB (*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock)

Habitat (physical) description
Salinity: Full (30-35ppt)
Wave exposure: Exposed, Moderately exposed
Substratum: Bedrock; boulders; cobbles
Zone: Littoral fringe - lower
Height band: Upper shore
Other features: Also on steep sheltered bedrock
Biotope description
Exposed to moderately exposed steep, lower littoral fringe rock and mixed substrata characterised by the wrack *Pelvetia canaliculata* and sparse barnacles *Chthamalus montagui* and *Semibalanus balanoides*. On sheltered shores the biotope is restricted to vertical faces. The limpet *Patella vulgate* and the wrack *Fucus spiralis* are usually present as well. *P. canaliculata* typically overgrows a crust of the black lichen *Verrucaria maura* or on occasion *Verrucaria mucosa*, in contrast to the red crust *Hildenbrandia rubra* on very sheltered shores. The winkle *Littorina saxatilis* is frequently present underneath the fronds of *P. canaliculata*. Some geographical variation are present and southern and western shores are typically characterised by the barnacle *C. montagui* or *Chthamalus stellatus* while *S. balanoides* dominates on northern and eastern shores. On mixed substrata the barnacle *Elminius modestus* may be present.
Situation
PelB is generally found below the *V. maura* and barnacle zone (Ver.B; Ver.Ver). On exposed shores PelB is found above the biotope dominated by *F. spiralis* (Fspi) or the mussel *Mytilus edulis* and barnacles biotope (MytB) or the barnacles and *P. vulgata* biotopes (Sem). In addition, patches of lichen *Lichina pygmaea* with the barnacle *Chthamalus montagui* (Cht.Lpyg) may also occur at the same level or above this biotope, particularly on southern shores. On sheltered to extremely sheltered shores this biotope is limited to very steep or vertical faces.
Temporal variation
Unknown.

LR.LLR.F.Fspi (*Fucus spiralis* on moderately exposed to very sheltered upper eulittoral rock)

Habitat (physical) description
Salinity: Full (30-35ppt), Variable (18-35ppt)
Wave exposure: Moderately exposed, Sheltered, Very sheltered, Extremely sheltered
Substratum: Bedrock; stable boulders; cobbles
Zone: Eulittoral - upper
Biotope description
Moderately exposed to very sheltered upper eulittoral bedrock is typically characterised by a band of the spiral wrack *Fucus spiralis* overlying the black lichen *Verrucaria maura*. Underneath the fronds of *F. spiralis* and the occasional *Pelvetia canaliculata* is a community consisting of the limpet *Patella vulgata*, the winkles *Littorina saxatilis* and *Littorina littorea* and the barnacle *Semibalanus balanoides*. The rock surface can often be covered by the red crust *Hildenbrandia rubra*. During the summer months the ephemeral green seaweed *Enteromorpha intestinalis* can be common. Two variants have been described: Upper eulittoral bedrock characterised by *F. spiralis*, the black lichen *Verrucaria maura* and the olive green lichen *Verrucaria mucosa* (Fspi.FS). Upper eulittoral mixed substrata characterised by *F. spiralis* with occasional clumps of the wrack *Pelvetia canaliculata* (Fspi.X). Please notice that a *F. spiralis* biotope has descriped for variable salinity (FspiVS).
Situation
This zone usually lies below a zone dominated by the wrack *Pelvetia canaliculata* (PelB: Pel), but occasional clumps of *P. canaliculata* may be present (usually less than common) amongst the *F. spiralis*. In areas of extreme shelter, such as in Scottish sea lochs, the *P. canaliculata* and *F. spiralis* zones often merge together forming a very narrow band. Fspi occurs above the wracks *Ascophyllum nodosum* (Asc) and/or *Fucus vesiculosus* (Fves) zones and these two fucoids may also occur, although *F. spiralis* always dominates. Vertical surfaces in this zone, especially on moderately exposed shores, often lack the fucoids and are characterised by a barnacle-limpet dominated community (Sem).
Temporal variation
Unknown.

LR.MLR.BF (Barnacles and fucoids on moderately exposed rock)

Habitat (physical) description
Salinity: Full (30-35ppt)
Wave exposure: Moderately exposed
Substratum: Bedrock; boulders
Zone: Eulittoral
Height band: Upper shore, Mid shore, Lower shore

Biotope description
Moderately exposed rocky shores characterised by a mosaic of fucoids and barnacles on bedrock and boulders, where the extent of the fucoid cover is typically less than the blanket cover associated with sheltered shores. Other species are normally present as well in this habtat including the winkle *Littorina littorea*, the whelk *Nucella lapillus* and the red seaweed *Mastocarpus stellatus*. Beneath the band of yellow and grey lichens at the top of the shore is a zone dominated by the wrack *Pelvetia canaliculata*, scattered barnacles, while the black lichen *Verrucaria maura* covers the rock surface (PelB). Below, on the mid shore the wrack *Fucus vesiculosus* generally forms a mosaic with the barnacle *Semibalanus balanoides* and the limpet *Patella vulgata* (FvesB). Finally, the wrack *Fucus serratus*, dominates the lower shore, while a variety of red seaweeds can be found underneath the *F. serratus* canopy (Fser). A number of variants have been described: lower shore bedrock and boulders characterised by mosaics of *F. serratus* and turf-forming red seaweeds (Fser.R); where the density of *F. serratus* is greater (typically Common - Superabundant) and the abundance of red seaweeds less Fserr.FS should be recorded. The presence of boulders and cobbles on the shore can increase the micro habitat diversity, which often results in a greater species richness. Although the upper surface of the boulders may bear very similar communities to Fserr.FS there is often an increase in fauna (crabs, tube-forming polychaetes, sponges and bryozoans) and Fser.Bo should be recorded. Sand-influenced exposed to moderately exposed lower shore rock can be characterised by dense mats of *Rhodothamniella floridula* (Rho).
Situation
Mid and lower eulittoral moderately exposed bedrock with a lichen zone above and a kelp dominated community below in the sublittoral zone.

LR.MLR.BF.FvesB (*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock)

Habitat (physical) description
Salinity: Full (30-35ppt)
Wave exposure: Exposed, Moderately exposed
Substratum: Bedrock; boulders
Zone: Eulittoral - mid
Biotope description
Exposed to moderately exposed mid eulittoral bedrock and boulders are frequently characterised by a mosaic of the barnacle *Semibalanus balanoides* and the wrack *Fucus vesiculosus*. The limpet *Patella vulgata* and the whelk *Nucella lapillus* are typically present, whilst the anemone *Actinia equina* and small individuals of the mussel *Mytilus edulis* are confined to crevices. Underneath the *F. vesiculosus* is a community of red seaweeds, including *Corallina officinalis, Mastocarpus stellatus* and *Osmundea pinnatifida*, usually with the winkles *Littorina littorea* and *Littorina* spp. present. Opportunistic seaweeds such as *Enteromorpha intestinalis* may occur in patches recently cleared on the rock or growing on the *M. edulis*.
Situation
On exposed shores FvesB is found below the black lichen *Verrucaria maura* and sparse barnacle biotope (Ver.B) and/or below the *Chthamalus* spp. and *P. vulgata* biotopes (Cht.Cht). FvesB is found above the biotope dominated by the wrack *Himanthalia elongata* (Him) or the red seaweed biotopes (Coff; R). FvesB forms an intermediate along the wave exposure gradient between the exposed shore barnacle-*P. vulgata* biotopes (Sem.FvesR) and the sheltered shore *F. vesiculosus* biotope (Fves). Vertical surfaces tend to be dominated by the barnacle-*P. vulgata* biotope (Sem).
Temporal variation
On some shores, particularly those, which are moderately exposed to wave action, temporal fluctuations in the abundance of limpets, barnacles and fucoid seaweeds may occur. As a result, over a number of years, a single shore may cycle between the barnacle-*P. vulgata* dominated biotope (Sem.FvesR), through this mosaic (FvesB) to a *F. vesiculosus*-dominated biotope (Fves).

LR.MLR.BF.Fser (*Fucus serratus* on moderately exposed lower eulittoral rock)

Habitat (physical) description
Salinity: Full (30-35ppt)
Wave exposure: Moderately exposed, Sheltered
Tidal streams: Moderately strong, Weak
Substratum: Bedrock; boulders
Zone: Eulittoral - lower
Biotope description
Lower eulittoral bedrock and stable boulders on moderately exposed to sheltered shores with a canopy of the wrack *Fucus serratus* and an associated fauna consisting of the limpet *Patella vulgata*, the barnacle *Semibalanus balanoides*, the whelk *Nucella lapillus*, the anemone *Actinia equina* and the sponge *Halichondria panicea*. Green seaweeds such as *Enteromorpha intestinalis* and *Ulva lactuca* are usually present among/beneath the *F. serratus* canopy. Three variants of this biotope are described. These are: *F. serratus* with red seaweeds (Fser.R) and *F. serratus* with under-boulder communities (Fser.Bo) with sponges. Lastly, a *F. serratus* and piddocks community on soft rock has been identified (Fser.Pid). Dense *F. serratus* with fewer red seaweeds occurs on more sheltered shores (Fserr).
Situation
Above the *F. serratus* biotope on moderately exposed bedrock shores is the *Fucus vesiculosus* and/or *S. balanoides* and *P. vulgata* dominated biotopes (Sem; Sem.FvesR; FvesB). On more sheltered shores are biotopes dominated by the wracks *F. vesiculosus* and *Ascophyllum nodosum* (Fves; Asc.FS). On moderately exposed shores, the sublittoral fringe

below Fser is dominated by the kelp *Laminaria digitata* and on vertical faces the kelp *Alaria esculenta* may be present (Ldig.LdigBo; Ala.Ldig). On more sheltered shores the kelp *Laminaria saccharina* is found among the *L. digitata* (Lsac.Ldig;Lsac.Ft).

Temporal variation

Unknown.

LR.HLR.FR.Osm (*Osmundea pinnatifida* on moderately exposed mid eulittoral rock)

Habitat (physical) description

Salinity: Full (30-35ppt)
Wave exposure: Exposed, Moderately exposed
Substratum: Bedrock; boulders
Zone: Eulittoral - mid

Biotope description

Exposed to moderately exposed lower eulittoral rock characterised by extensive areas or a distinct band of *Osmundea pinnatifida* and *Gelidium pusillum* (either together or separately). This community usually occurs on shores on which a fucoid canopy is reduced in extent, or even absent. Other turf-forming red seaweeds, such as *Corallina officinalis, Mastocarpus stellatus, Ceramium* spp. And *Callithamnion hookeri* may be present, although *O. pinnatifida* always dominate. On flatter, more sheltered shores, *Osmundea hybrida* may also occur. Small patches of bare rock amongst the algal turf are occupied by barnacles *Semibalanus balanoides*, the limpet *Patella vulgata*, the whelk *Nucella lapillus* and small individuals of the mussel *Mytilus edulis*. The winkles *Littorina littorea* and *Littorina saxatilis* can be present on the rock or among the seaweeds. A variation of this biotope has been described for the chalk platforms in Kent where extensive turfs of *G. pusillum* occur in the mid eulittoral above the main *O. pinnatifida* zone.

Situation

This biotope can be found below barnacles *S. balanoides* or red seaweed dominated community, which includes the species *Palmaria palmata, C. officinalis* or *M. stellatus* (Sem; Coff; Cor). It is found above biotopes dominated by the wrack *Fucus serratus* and red seaweeds (FcdR; MytFR; Fser.R) or above biotopes dominated by the kelp *Laminaria digitata* (Ldig.Ldig).

Temporal variation

Unknown.

LR.LLR.F.Fves.X (*Fucus vesiculosus* on mid eulittoral mixed substrata)

Habitat (physical) description

Salinity: Full (30-35ppt), Variable (18-35ppt)
Wave exposure: Moderately exposed, Sheltered, Very sheltered
Tidal streams: Moderately strong, Weak, Very weak
Substratum: Pebbles and cobbles on sand/mud
Zone: Eulittoral
Other features: Silt and/or variable salinity

Biotope description

Sheltered and very sheltered mid eulittoral pebbles and cobbles lying on sediment in fully marine conditions typically characterised by the wrack *Fucus vesiculosus*. The wrack *Ascophyllum nodosum* can occasionally be found on larger boulders while the barnacle *Semibalanus balanoides* and the limpet *Patella vulgata* also can be present on the cobbles with the whelk *Nucella lapillus* preying on the barnacles and on the mussel *Mytilus edulis*. Winkles, particularly *Littorina littorea* and *Littorina obtusata*, commonly graze the biofilm on the seaweeds, while *Littorina saxatilis* can be found in crevices. Ephemeral seaweeds such as *Enteromorpha intestinalis* may be present in this biotope. The sediment between patches of hard substrata often contains the polychaete *Arenicola marina* or the polychaete *Lanice conchilega*, while a variety of gastropods and the crab *Carcinus maenas* occur on and under cobbles.

Situation

Fves.X can be found below the biotope dominated by the wrack *Fucus spiralis* (Fspi.X) or a community dominated by *S. balanoides, P. vulgata* and *L. littorea* (BLitX). It is found above a community dominated by *M. edulis* beds (Myt.Myt) or the wrack *Fucus serratus* (Fserr.X).

Temporal variation

Some variation in the ephemeral seaweeds and their abundance depending on season is likely.

LS.LSa.MuSa.Lan (*Lanice conchilega* in littoral sand)

Habitat (physical) description

Salinity: Full (30-35ppt), Variable (18-35ppt)
Wave exposure: Moderately exposed, Sheltered, Very sheltered, Extremely sheltered
Tidal streams: Very strong, Strong, Moderately strong, Weak, Very weak
Substratum: Medium to fine muddy sand, mixed sediment
Zone: Height band: Mid shore, Lower shore

Biotope description

This biotope usually occurs on flats of medium fine sand and muddy sand, most often on the lower shore but sometimes also on waterlogged mid shores. The sand may contain a proportion of shell fragments or gravel. Lan can also occur on

the lower part of predominantly rocky or boulder shores, where patches of sand or muddy sand occur between scattered boulders, cobbles and pebbles.
Conditions may be tide-swept, and the sediment may be mobile, but the biotope usually occurs in areas sheltered from strong wave action. The sediment supports dense populations of the sand mason
Lanice conchilega. Other polychaetes present are tolerant of sand scour or mobility of the sediment surface layers and include the polychaetes *Anaitides mucosa*, *Eumida sanguinea*, *Nephtys hombergii*, *Scoloplos armiger*, *Aricidea minuta*, *Tharyx* spp. and *Pygospio elegans*. The mud shrimp *Corophium arenarium* and the cockle *Cerastoderma edule* may be abundant. The baltic tellin *Macoma balthica* may be present. On boulder shores, and where pebbles and cobbles are mixed in with lower shore tideswept sand with dense *L. conchilega* between the cobbles, the infaunal component is rarely sampled. The infaunal community under these circumstances, provided that the cobbles are not packed veryclose together, is likely to be similar to that in areas without the coarse material.

Situation

Lan occurs mainly on the mid and lower shore of moderately exposed sand and muddy sand flats. Higher on the shore, other sand and muddy sand biotopes may be present, such as BarSa and AmSco on the upper shore and the Po communities on the mid shore. Tal may occur where driftlines of wracks and other debris accumulate. Where Lan occurs on areas of scattered boulders and cobbles on the lower shore, there may be broad transition areas with Salv and other boulder shore biotopes.

Temporal variation

Where *Lanice conchilega* becomes very abundant, especially on the low shore, this can lead to the build up of sediment mounds around their tubes, thus leading to a significant alteration in the surface appearance of the biotope.

LS.LBR.Sab (Littoral *Sabellaria* honeycomb worm reefs)

Habitat (physical) description

Salinity: Full (30-35ppt)
Wave exposure: Exposed, Moderately exposed
Substratum: Boulders; cobbles; pebbles; sand; bedrock
Zone: Eulittoral - mid, Eulittoral - lower
Height band: Mid shore, Lower shore

Biotope description

The sedentary polychaete *Sabellaria alveolata* (honeycomb worm) builds tubes from sand and shell. On exposed shores, where there is a plentiful supply of sediment, *S. alveolata* can form honeycomb reefs on boulders and low-lying bedrock on the mid to lower shore. These *S. alveolata* reefs are quite distinct from the mosaic of seaweeds and barnacles or red seaweeds (FK; MB) generally associated with moderately exposed rocky shores though many of the same species are present. These include the anemone *Actinia equina*, the barnacles *Semibalanus balanoides* and *Elminius modestus*, the limpet *Patella vulgata*, the top shell *Gibbula cineraria* and the winkle *Littorina littorea*. The whelk *Nucella lappilus* and the mussel *Mytilus edulis* is also present on the boulders whereas the polychaete *Lanice conchilega* is restricted to the associated sediment areas. Scour resistent red seaweeds including *Palmaria palmata, Corallina ifficinalis, Mastocarpus stellatus, Chondrus crispus, Ceramium nodulosum, Osmundea pinnatifida, Polysiphonia* spp. and coralline crusts can also be present where suitable substrata exsist. Brown and green seaweeds also present include *Fucus serratus, Fucus vesioculosus, Cladostephus spongiosus, Enteromorpha intestinalis* and *Ulva lactuca*.

Situation

Above Salv are biotopes dominated either by ephemeral seaweeds, such as *Enteromorpha* spp. And *Porphyra* spp. or the perennial wrack *Fucus vesiculosus* on mixed substrata (FvesB; Fves.X; EphX; EntPor). Rockpool biotopes dominated by the red seaweed *Corallina officinalis* (Cor), by wracks such as *Fucus* spp. or by kelp such as *Laminaria* spp. (FK) can usually be found above this biotope. Beneath this biotope is a community consisting of mixed scour-tolerant like the kelp *Laminaria digitata* and opportunistic foliose red seaweeds such as *Polyides rotundus* and *Ahnfeltia plicata* (Ldig.Ldig; XKScrR; EphR; PolAhn).

LR.LLR.F.Fserr.X (*Fucus serratus* on full salinity lower eulittoral mixed substrata)

Habitat (physical) description

Salinity: Full (30-35ppt)
Wave exposure: Sheltered, Very sheltered, Extremely sheltered
Substratum: Mixed cobbles, boulders and pebbles on sediment
Zone: Eulittoral - lower

Biotope description

Sheltered to extremely sheltered full salinity lower eulittoral mixed substrata with dense stands of the wrack *Fucus serratus*. The crab *Carcinus maenas* and a large number of winkles such as *Littorina littorea* and *Littorina obtusata/mariae* can be found amongst the pebbles and cobbles as well as large individuals of the mussel *Mytilus edulis*, commonly occurring in clumps. On these mussels and on larger cobbles are the barnacle *Semibalanus balanoides* and the limpet *Patella vulgata*. Red algae such as coralline crusts including *Lithothamnion* spp. and the tube-forming polychaetes *Pomatoceros triqueter* and *Spirorbis* spp. can be found on cobbles and boulders. *Spirorbis* spp. can also be found on the *F. serratus* fronds. Sediment in the spaces between the loose substrata may support infauna including the polychaete *Arenicola marina*. The red seaweed *Mastocarpus stellatus* and the wrack *Ascophyllum nodosum* can occur in patches, while the green seaweeds *Enteromorpha intestinalis* and *Cladophora* spp. can be found among the mussels and underneath the *F. serratus* canopy.

Situation
Fserr.X occurs in the lower eulittoral below the biotopes dominated by the wrack *Fucus vesiculosus* and *A. nodosum* (Fves.X or Asc.X) on mixed substrata shores, or on sediment shores where mixed substrata occurs in discrete patches on the lower shore. Fserr.X occurs above biotopes dominated by the kelp *Laminaria digitata* or *Laminaria saccharina* (Ldig.Ldig; Lsac.Ldig; Lsac.Ft) depending on the substrata.

IR.MIR.KR.Ldig.Ldig (*Laminaria digitata* on moderately exposed sublittoral fringe rock)

Habitat (physical) description
Salinity: Full (30-35ppt)
Wave exposure: Exposed, Moderately exposed, Sheltered
Tidal streams: Moderately strong, Weak, Very weak
Substratum: Bedrock; boulders
Zone: Sublittoral fringe
Height band: Lower shore
Depth band: 0-5 m
Biotope description
Exposed to sheltered sublittoral fringe bedrock or boulders dominated by a dense canopy of *Laminaria digitata* often with a wide range of filamentous and foliose red seaweeds beneath. The most frequently occurring red seaweeds are *Palmaria palmata*, *Corallina officinalis*, *Mastocarpus stellatus*, *Chondrus crispus*, *Lomentaria articulata* and *Membranoptera alata*. Generally the rocky substratum is covered by encrusting coralline algae, on which occasional limpets *Patella vulgata* and topshells *Gibbula cineraria* graze. A wide variety of fauna occurs, some of the most commonly occurring species being the sponge *Halichondria panicea*, the tube-building polychaete *Pomatoceros triqueter* and occasional. Kelp holdfasts provide a refuge for a varied assemblage of species such as sponges and the limpet *Helcion pellucidum*, while encrusting bryozoans such as *Electra pilosa* more often are found on the fronds of foliose red seaweeds. Solitary ascidians may be locally abundant where overhanging or vertical rock occurs, while the hydroid *Dynamena pumila* can be abundant on *Fucus serratus* and *Laminaria* sp. fronds. On exposed, wave-surged shores, the robust red seaweeds *M. stellatus*, *C. crispus* and *C. officinalis* can form a dense turf beneath the kelp along with the occasional green seaweed *Ulva lactuca*. Similarly on such shores the mussel *Mytilus edulis* can occur in extremely dense aggregations on the rock, beneath the kelp canopy.
Situation
This biotope is usually found on the extreme low shore below the *Fucus serratus* zone (Fser) and above the truly sublittoral *Laminaria hyperborea* zone (Lhyp).

LR.HLR.MusB.Sem.FvesR (*Semibalanus balanoides*, *Fucus vesiculosus* and red seaweeds on exposed to moderately exposed eulittoral rock)

Habitat (physical) description
Salinity: Full (30-35ppt)
Wave exposure: Exposed, Moderately exposed
Substratum: Bedrock
Zone: Eulittoral - upper, Eulittoral - mid
Height band: Mid shore
Other features: The growth form *Fucus vesiculosus* f. *linearis* is often present
Biotope description
Exposed and moderately exposed upper and mid eulittoral bedrock characterised by the barnacle *Semibalanus balanoides*, the limpet *Patella vulgata* and the whelk *Nucella lapillus* with a sparse community of seaweeds. Turfs of the wrack *Fucus vesiculosus* can be present on the more horizontal parts of the shore though usually in low abundance (Occasional). Individuals of *F. vesiculosus* can lack the characteristic twin air bladders due to environmental stress (i.e. wave exposure). A sparse seaweed community consisting of foliose red seaweeds such as *Osmundea pinnatifida* and *Mastocarpus stellatus* are usually present along with the *Corallina officinalis* and the green seaweed *Enteromorpha intestinalis*. The algal community is usually restricted to fissures and cracks in the bedrock surface. Moist cracks and crevices also provide a refuge for small individuals of the mussel *Mytilus edulis* and the winkles *Littorina saxatilis* and *Littorina littorea*. These crevices can also be occupied by encrusting coralline algae and the anemone *Actinia equina*.
Situation
On exposed and moderately exposed shores Sem.FvesR is found below the black lichen *Verrucaria maura* and sparse barnacles biotope (Ver.B) and/or below the *Chthamalus* spp. and *P. vulgate* biotopes (Cht). Sem.FvesR is found above the biotope dominated by the wrack *Himanthalia elongate* (Him) or the red seaweed biotopes (Coff).
Temporal variation
On some shores, particularly those which are moderately exposed to wave action, temporal fluctuations in the abundance of limpets, barnacles and fucoid seaweeds may occur. As a result, over a number of years, a single shore may cycle between the barnacle-*P. vulgata* dominated biotope (Sem.FvesR) and a *F. vesiculosus*-dominated biotope (Fves). Individuals of *F. vesiculosus* growing in stressed environmental conditions (i.e. high wave exposure) do not always develop the characteristic twin air bladders.

LR.LLR.F.Fves (*Fucus vesiculosus* on moderately exposed to sheltered mid eulittoral rock)

Habitat (physical) description
Salinity: Full (30-35ppt), Variable (18-35ppt)
Wave exposure: Moderately exposed, Sheltered, Very sheltered
Substratum: Bedrock; boulders
Zone: Eulittoral - mid
Height band: Mid shore
Biotope description
Moderately exposed to very sheltered mid eulittoral bedrock and large boulders characterised by a dense canopy of the wrack *Fucus vesiculosus* (Abundant to Superabundant). Beneath the seaweed canopy the rock surface has a sparse covering of the barnacle *Semibalanus balanoides* and the limpet *Patella vulgata*. The mussel *Mytilus edulis* is confined to pits and crevices. A variety of winkles including *Littorina littorea* and *Littorina saxatilis* can be found grazing on the fucoid fronds. The whelk *Nucella lapillus* is found beneath the seaweed canopy. In areas of localised shelter the wrack *Ascophyllum nodosum* may occur, though never at high abundance. The crab *Carcinus maenas* may be present in pools or among the boulders. Two variants have been described: Bedrock and large boulders (Fves.FS) and mixed substrata (Fves.X). Please notice that a *F. vesioculosus* biotope subject to variable salinity (FvesVS) has been identified.
Situation
This biotope usually occurs between the wrack *Fucus spiralis* (Fspi) and the *Fucus serratus* (Fserr) zones; both of these fucoids may be present in this biotope, though never at high abundance (typically less than Frequent). In some sheltered areas *F. vesiculosus* forms a narrow zone above the *A. nodosum* zone (Asc). Where freshwater runoff occurs on more gradually sloping shores *F. vesiculosus* may be replaced by the wrack *Fucus ceranoides* (Fcer).
Temporal variation
On some shores, particularly those which are moderately exposed to wave action, temporal fluctuations in the abundance of limpets, barnacles and fucoid seaweeds may occur. As a result, over a number of years, a single shore may cycle between the barnacle-*P. vulgata* dominated biotope (Sem.FvesR), through this mosaic (FvesB) to a *F. vesiculosus*-dominated biotope (Fves).

LR.LLR.F.Asc.FS (*Ascophyllum nodosum* on full salinity mid eulittoral rock)

Habitat (physical) description
Salinity: Full (30-35ppt)
Wave exposure: Sheltered, Very sheltered, Extremely sheltered
Substratum: Bedrock; boulders; cobbles
Zone: Eulittoral - mid
Other features: Disturbance allows *Fucus vesiculosis* to occupy patches in the canopy
Biotope description
Bedrock, stable boulders and cobbles in the mid-eulittoral zone of moderately exposed to extremely sheltered shores, in fully marine conditions, characterised by a dense canopy of the wrack *Ascophyllum nodosum*. Another wrack *Fucus vesiculosus* may in some places co-dominate the canopy. The hydroid *Dynamena pumila* can form colonies on the wracks *F. vesiculosus* and *Fucus serratus*. Variations in the ratio of *A. nodosum* and *F. vesiculosus* in the overlying canopy have little effect on the under-storey species. Beneath the canopy are a diverse array of filamentous and foliose red seaweeds, including *Mastocarpus stellatus, Chondrus crispus, Gelidium pusillum* and coralline crusts. The filamentous red seaweed *Polysiphonia lanosa* is usually present on *A. nodosum* as an epiphyte. A few green seaweeds including *Cladophora rupestris* and *Enteromorpha* spp. are also present in moderate to low densities. On the bedrock and boulders beneath the seaweed canopy is a fauna including the barnacle *Semibalanus balanoides*, the limpet *Patella vulgata*, tube-forming spirorbid polychaetes and the anemone *Actinia equina*. The latter can be present in damp cracks and crevices. On and among the seaweeds are mobile species including the winkles *Littorina littorea* and *Littorina obtusata*, the whelk *Nucella lapillus* or even the crab *Carcinus maenas*. At the top of the *A. nodosum* zone there might be the occasional presence of the olive green lichen *Verrucaria mucosa*.
Situation
This biotope is usually found between the wrack *Fucus spiralis* (Fspi) and *F. serratus* dominated biotopes (Fserr), although on some shores a narrow zone of *F. vesiculosus* (Fves) may occur immediately above the *A. nodosum*. With increasing wave exposure the *A. nodosum* canopy is replaced by *F. vesiculosus* (FvesB; Fves). Asc.FS can occur on more exposed shores, where there is localised shelter.
Temporal variation
A. nodosum can reach an age of 25 years on sheltered shores and the communities are, once established, usually very stable. *F. vesiculosus* or *F. serratus* can occur in patches where the *A. nodosum* has been removed.

LR.FLR.Rkp.Cor.Cys (*Cystoseira* spp. in eulittoral Rockpools)

Habitat (physical) description
Salinity: Full (30-35ppt)
Wave exposure: Very exposed, Exposed, Moderately exposed
Substratum: Bedrock
Zone: Eulittoral
Other features: Rockpool

Biotope description
Eulittoral rockpools on exposed to moderately exposed south-western shores dominated by the brown alga *Cystoseira* spp. (including *Cystoseira tamariscifolia*), coralline crusts and *Corallina officinalis*. These pools generally support dense red algal growth comprising: *Ceramium* spp., *Calliblepharis jubata*, *Chondrus crispus*, *Osmundea pinnatifida* and *Gelidium latifolium*. Wracks such as *Himanthalia elongata* and the epiphytic brown seaweed *Colpomenia peregrina* are present while the kelp *Laminaria digitata* can occupy the deeper parts of the pool. The green seaweeds *Enteromorpha intestinalis* and *Ulva lactuca* are usually present as well. The pools usually contain some sand and pebbles at the base of the pool while spirorbid polychaetes and *Pomatoceros* spp. build their tubes on any small boulders present. In addition, these pools can support high numbers of grazing gastropods including the top shells *Gibbula cineraria* and *Gibbula umbilicalis* but also the limpet *Patella vulgata*, while sponges such *Hymeniacidon perleve* and *Halichondria panicea* can be found overgrowing the small boulders or on and around the seaweeds. The shanny *Lipophrus pholis* is present hiding underneath boulder and cobbles, while the anemone *Actinia equina* is found in cracks and crevices..
number of available records and care should be taken not to interpret this solely as a very high species richness.
Situation
Rockpools throughout the eulittoral zone in bedrock on very exposed to moderately exposed southwestern shores.
Temporal variation
Unknown.

LR.HLR.FR (Robust fucoid and/or red seaweed communities)

Habitat (physical) description
Salinity: Full (30-35ppt)
Wave exposure: Extremely exposed, Very exposed, Exposed
Substratum: Bedrock
Zone: Eulittoral
Height band: Upper shore, Mid shore, Lower shore
Biotope description
This biotope complex encompasses those seaweeds that are able to tolerate the extreme conditions of very exposed to moderately exposed rocky shores. The physical stresses caused by wave action often results in dwarf forms of the individual seaweeds. The strong holdfasts and short tufts structure of the wracks *Fucus distichus* and *Fucus spiralis* f. *nana* allow these fucoids to survive on extremely exposed shores in the north and north-west (Fdis). Another seaweed able to tolerate the wave-wash is the red seaweed *Corallina officinalis*, which can form a dense turf on the mid to lower shore (Coff). The wrack *Himanthalia elongata* occurs on the lower shore and can extend on to moderately exposed shores (Him). The red seaweed *Mastocarpus stellatus* is common on both exposed and moderately exposed shores, where it may form a dense turf (particularly on vertical or overhanging rock faces (Mas). Very exposed to moderately exposed lower eulittoral rock can support a pure stand of the red seaweed *Palmaria palmata*. It is found either as a dense band or in large patches above the main sublittoral fringe (Pal). Exposed to moderately exposed lower eulittoral rock characterised by extensive areas or a distinct band of *Osmundea pinnatifida* (Osm). Outcrops of fossilised peat in the eulittoral are soft enough to allow a variety of piddocks, such as *Barnea candida* and *Petricola pholadiformis*, to bore into them (RPid). This biotope is rare. Other species such as the anemone *Halichondria panicea*, the barnacle *Semibalanus balanoides*, the limpet *Patella vulgata*, the mussel *Mytilus edulis* and the whelk *Nucella lapillus* can be present as well, but they are never dominant as in the MusB-complex. There is also a higher number of seaweeds present including the red *Palmaria palmata*, *Lomentaria articulata*, *Ceramium* spp. and the brown seaweeds *Laminaria digitata* and *Fucus serratus*. *The green seaweeds* Enteromorpha intestinalis, Ulva lactuca *and* Cladophora rupestris *are occasionally present.*
Situation
This biotope complex is present on extremely exposed to moderately exposed upper to lower shores.

LR.HLR.FR.Mas (*Mastocarpus stellatus* and *Chondrus crispus* on very exposed to moderately exposed lower eulittoral rock)

Habitat (physical) description
Salinity: Full (30-35ppt)
Wave exposure: Exposed, Moderately exposed
Substratum: Bedrock; boulders
Zone: Eulittoral - lower
Other features: Vertical faces on very exposed rock
Biotope description
Exposed to moderately exposed lower eulittoral vertical to almost horizontal bedrock characterised by a dense turf of *Mastocarpus stellatus* and *Chondrus crispus* (either together or separately). Beneath these foliose seaweeds the rock surface is covered by encrusting coralline algae and the barnacle *Semibalanus balanoides*, the limpet *Patella vulgata* and spirorbid polychaetes. Other seaweeds including the red *Lomentaria articulata* and *Osmundea pinnatifida*, *Palmaria palmata*, *Corallina officinalis* and coralline crusts. The wrack *Fucus serratus* and the green seaweeds *Enteromorpha intestinalis* and *Ulva lactuca* may also be present though usually at a low abundance. Although both *M. stellatus* and *C. crispus* are widespread in the lower eulittoral and the sublittoral fringe, they occur only infrequently in a distinct band, or in large enough patches, to justify separation from Fser.R. Consequently, where only small patches of these species occur within a larger area of mixed red algal turf, then records should be assigned to more general mixed red algal turf biotope

(Coff; Him). *M. stellatus* can be present in high abundance in a number of biotopes (Coff: Him; Fser.R etc.) found on the shore. At least one other species normally co-dominates and records should be assigned to the appropriate biotope. Caution should be taken regarding the characterising species list due to the low number of records. More information needed to validate this description.

Situation

This biotope can form a band above the main kelp zone, above *Alaria esculenta* (Ala) or the mussel *Mytilus edulis* (MytB) or within a *F. serratus*-red algal mosaic (Fser.R).

Temporal variation

M. stellatus is more resistant to wave action than *C. crispus* and may therefore dominate more exposed shores; it can dominate vertical rock at very exposed sites (e.g. Mingulay, Outer Hebrides). On more sheltered shores, especially in the south-west, *M. stellatus* may give way to *C. crispus* which has a faster growth rate.

APPENDIX 4

I-WeBS

Ballycotton Bay

Species name	1% national	1% international	1999/00	2000/01	2001/02	2002/03	2003/04	Mean	Peak
Red-throated Diver	20	10,000	6	1				1	6
Great Northern Diver	20	50	1				1	0	1
Little Grebe	25	3,400	2					0	2
Great Crested Grebe	55	4,800	1				1	0	1
Cormorant	130	1,200	12	17	9	11	28	15	28
Grey Heron	30	2,700	15	13	9	10	15	12	15
Little Egret	20	1,300	2	3	4	3	7	4	7
Mute Swan	110	110					2	0	2
Pink-footed Goose			1					0	1
Greenland White-fronted Goose	110	330	1					0	1
Canada Goose			34	15	20	8	16	19	34
Barnacle Goose	90	540		1				0	1
Light-bellied Brent Goose	200	200	62	46	26	15	48	39	62
Shelduck	150	3,000	149	81	91	52	91	80	149
Wigeon	820	15,000	454	380	578	735	588	535	735
American Wigeon						1		0	1
Gadwall	20	600	2		2			2	6
Teal	450	4,000	747	751	512	728	509	650	758
Green-winged Teal			1					0	1
Mallard	380	20,000	167	85	159	213	218	167	218
Pintail	20	600				4	2	1	4
Shoveler	25	400				20		4	20
Ring-necked Duck						1		0	1
Scaup	45	3,100	5					1	5
Moorhen		30,000	5	2	2	2	6	3	6
Water Rail			1		1	1	1	1	1
Oystercatcher	680	11,000	184	164	230	267	251	219	267
Ringed Plover	150	730	87	134	105	82	78	97	134
American Golden Plover				1				0	1
Golden Plover	1,500	9,300	123	830	1,850	2,600	2,200	1,481	2,600
Grey Plover	60	2,500	84	96	93	129	104	101	129
Lapwing	3,000	20,000	2,120	1,839	1,868	2,240	1,789	1,971	2,240
Knot	190	4,500	2	8		35	15	12	35
Sanderling	65	1,200	62	114	73	61	92	80	114
Little Stint				1				0	1
Baird's Sandpiper			1					0	1
Curlew Sandpiper			2	10				2	10
Dunlin	880	13,300	363	285	527	475	450	420	527
Buff-breasted Sandpiper				1				0	1
Ruff		10,000	3	8	1	2		3	8
Jack Snipe					1			0	1
Snipe		20,000	75	27	57	57	83	60	83
Black-tailed Godwit	140	350	171	156	188	243	207	193	243
Bar-tailed Godwit	180	1,200	123	99	96	158	101	115	158
Whimbrel			1					0	1
Curlew	530	4,200	744	494	588	676	540	608	744
Spotted Redshank		1,000	2	1	2	1	1	1	2
Redshank	310	1,900	160	154	128	133	214	162	214
Greenshank	20	3,100	13	9	21	19	14	15	21
Green Sandpiper					1			0	1
Turnstone	120	1,000	118	87	126	148	147	126	148
Mediterranean Gull			1		1	1		1	1
Black-headed Gull		20,000	370	848	643	1,033	1,000	779	1,033
Common Gull		16,000	551	2,205	1,300	1,630	364	1,210	2,205
Lesser Black-backed Gull		4,500	983	2,162	1,563	1,352	1,313	1,475	2,162

The counts presented in the table refer to the peak counts of species in each I-WeBS season. Site peak and mean are calculated as the peak and mean of peak counts respectively over the five seasons specified. Blank columns indicate seasons for which no data are available, while blank cells within columns which contain positive values for one or more species constitute zero for those species.

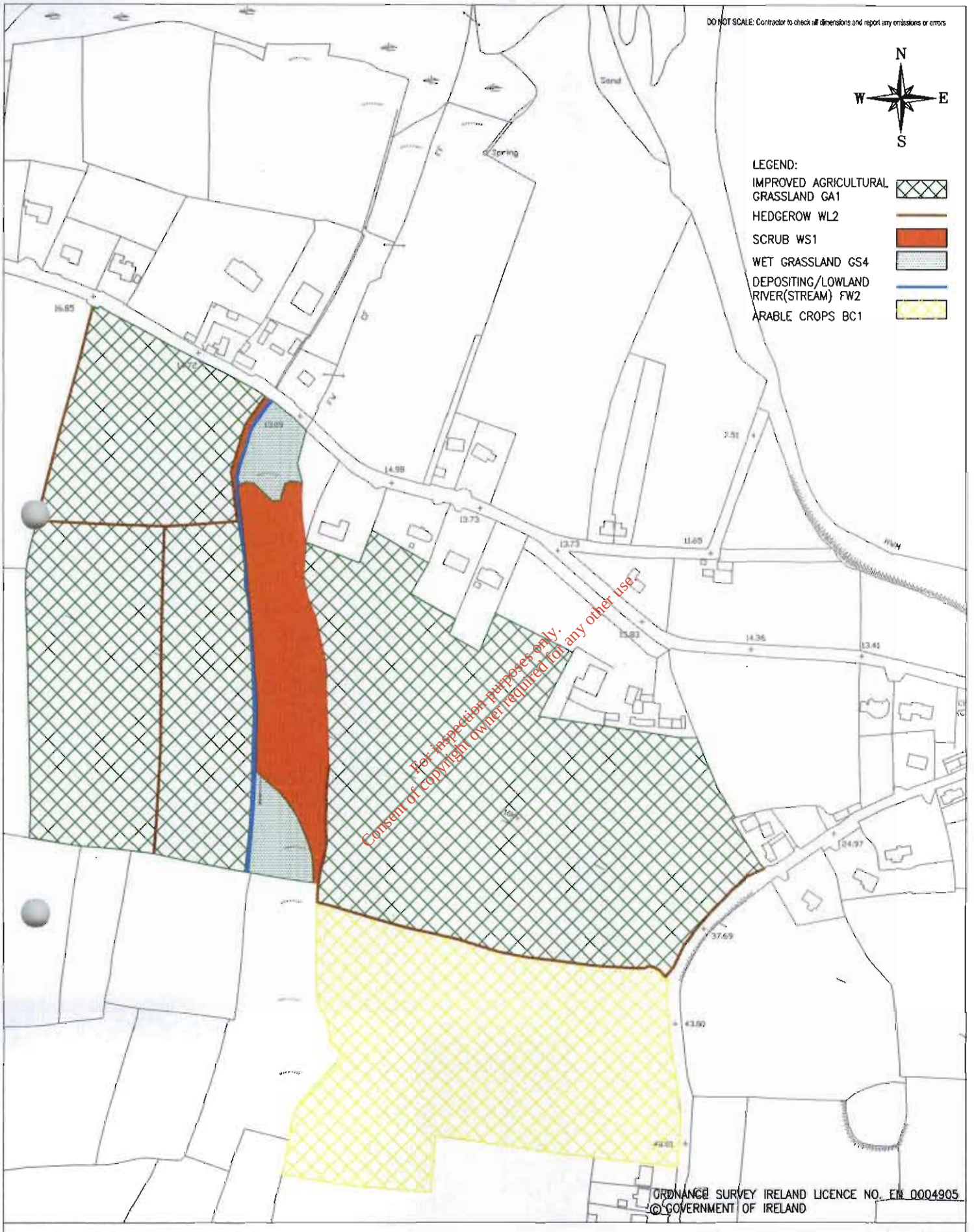
I-WeBS

Herring Gull	13,000	110	183	365	548	145	266	548
Iceland Gull				1			0	1
Glaucous Gull		1	1	1			1	1
Great Black-backed Gull	4,800	634	800	560	335	273	520	800
Sandwich Tern		13	251	12	19	5	80	251
Black Tern				3			1	3
Kingfisher					1	1	0	1

APPENDIX 5

Sensitivity of biotopes in the outfall pipeline impact zone to a range of physical factors. This information is based on the previous biotope codes 97.06 (Connor *et al.*, 1997a) and taken from the Marine Life Information Network (*MarLIN*) (www.marlin.ac.uk).

Current Biotope Code 04.05	Yellow and grey lichens on supralittoral rock (LR.FLR.Lic.YG)		*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock (LR.MLR.BF.PelB).		*Semibalanus balanoides*, *Fucus vesiculosis* and red seaweeds on exposed to moderately exposed eulittoral rock (LR.HLR.MusB.Sem.FvesR).		*Fucus serratus* on moderately exposed lower eulittoral rock (LR.MLR.BF.Fser)		*Laminaria digitata* on moderately exposed sublittoral fringe rock (IR.MIR.KR.Ldig.Ldig)	
Previous Biotope Code 97.06 Higher code where applicable)	Yellow and grey lichens on supralittoral rock (LR.YG)		Barnacles and fucoids (MLR.BF)		Barnacles and fucoids (MLR.BF)		Barnacles and fucoids (MLR.BF)		*Laminaria digitata* on moderately exposed sublittoral fringe rock (MIR.Ldig.Ldig)	
Physical Factor	**Sensitivity**	**Recoverability**	**Sensitivity**	**Recoverability**	**Sensitivity**	**Recoverability**	**Sensitivity**	**Recoverability**	**Sensitivity**	**Recoverability**
Substratum loss	Very high	Very low	Moderate	High	Moderate	High	Moderate	High	Moderate	High
Smothering	Low	Very high	Low	High	Low	High	Low	High	Low	High
Increase in suspended sediment	Not relevant	Not relevant	Low	High	Low	High	Low	High	Low	High
Abrasion & physical disturbance	High	Low	Moderate	High	Moderate	High	Moderate	High	Low	High



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White Young Green

Consulting Engineers

Civil Structural Mechanical Electrical Process Rail Traffic Environmental Project Management

Project:
SHANAGARRY, GARRYVOE, BALLYCOTTON
SEWERAGE SCHEME

CLIENT
CORK COUNTY COUNCIL

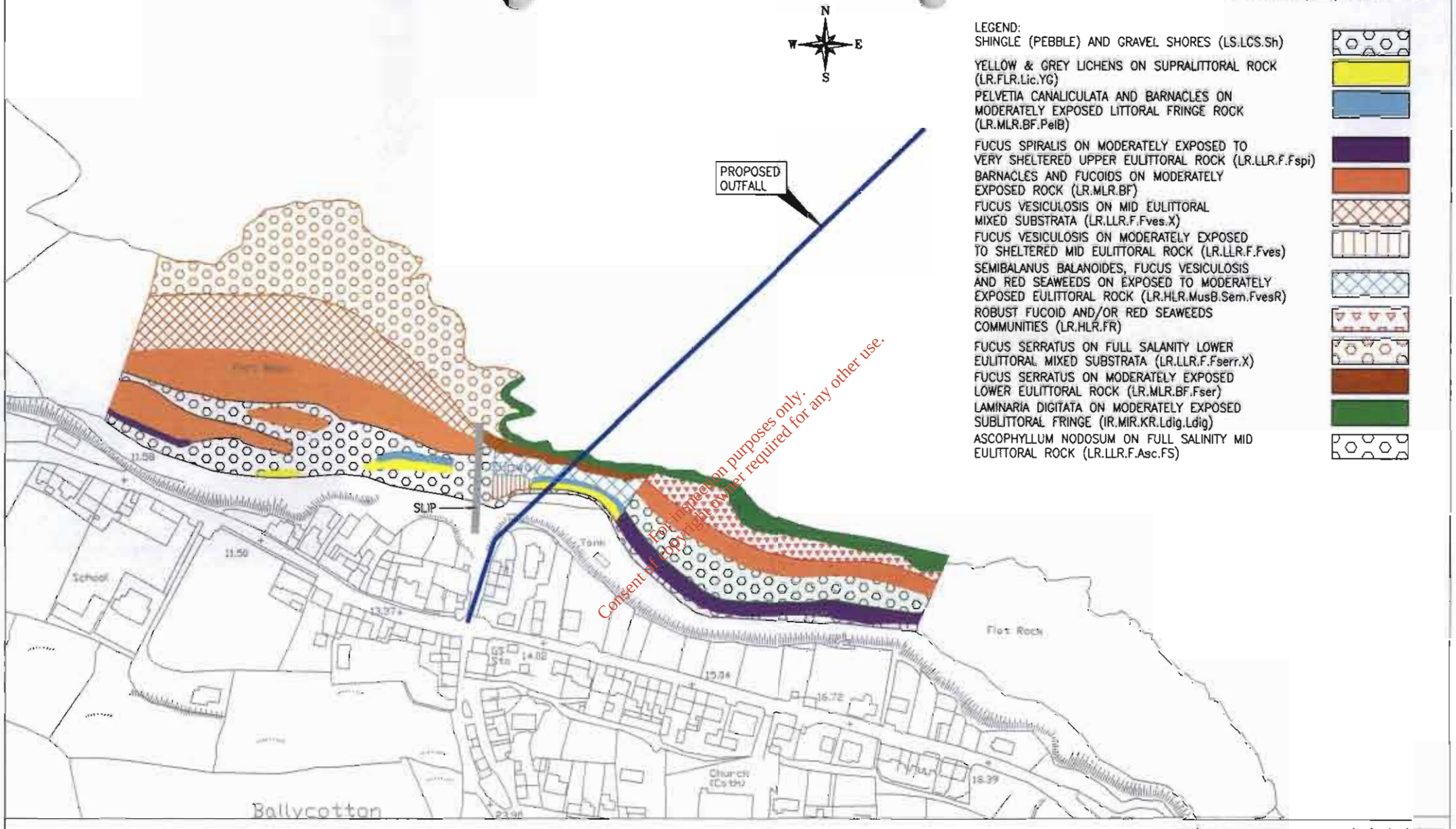
Drawing Title:
ECOLOGY SURVEYS:
TERRESTRIAL HABITAT MAP OF PROPOSED WWTP SITES

Scale at A3	Drawn By	Date	Checked By	Date	Approved By	Date
1:2500	MW	23.02.06	MW	23.02.06	KT	23.02.06

Project No.	Office	Type	Drawing No.	Revision
C003994	12	C	C003994-C-SK051	P1

APPROVAL ☐ INFORMATION ☒ TENDER ☐ CONTRACT ☐ CONSTRUCTION ☐

DO NOT SCALE: Contractor to check all dimensions and report any omissions or errors



LEGEND:

- SHINGLE (PEBBLE) AND GRAVEL SHORES (LS.LCS.Sh)
- YELLOW & GREY LICHENS ON SUPRALITTORAL ROCK (LR.FLR.Lic.YG)
- PELVETIA CANALICULATA AND BARNACLES ON MODERATELY EXPOSED LITTORAL FRINGE ROCK (LR.MLR.BF.PelB)
- FUCUS SPIRALIS ON MODERATELY EXPOSED TO VERY SHELTERED UPPER EULITTORAL ROCK (LR.LLR.F.Fspi)
- BARNACLES AND FUCOIDS ON MODERATELY EXPOSED ROCK (LR.MLR.BF)
- FUCUS VESICULOSIS ON MID EULITTORAL MIXED SUBSTRATA (LR.LLR.F.Fves.X)
- FUCUS VESICULOSIS ON MODERATELY EXPOSED TO SHELTERED MID EULITTORAL ROCK (LR.LLR.F.Fves)
- SEMIBALANUS BALANOIDES, FUCUS VESICULOSIS AND RED SEAWEEDS ON EXPOSED TO MODERATELY EXPOSED EULITTORAL ROCK (LR.HLR.MusB.Sem.FvesR)
- ROBUST FUCOID AND/OR RED SEAWEEDS COMMUNITIES (LR.HLR.FR)
- FUCUS SERRATUS ON FULL SALANITY LOWER EULITTORAL MIXED SUBSTRATA (LR.LLR.F.Fserr.X)
- FUCUS SERRATUS ON MODERATELY EXPOSED LOWER EULITTORAL ROCK (LR.MLR.BF.Fser)
- LAMINARIA DIGITATA ON MODERATELY EXPOSED SUBLITTORAL FRINGE (IR.MIR.KR.Ldig.Ldig)
- ASCOPHYLLUM NODOSUM ON FULL SALINITY MID EULITTORAL ROCK (LR.LLR.F.Asc.FS)

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Project:
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SEWERAGE SCHEME

CLIENT
CORK COUNTY COUNCIL

Rev	Description	By	Chk	App	Date

Drawing Title:
INTERTIDAL BIOTOPE MAP

Scale	Drawn By	Date	Checked By	Date	Approved By	Date
1/2000	NW	13.03.06	KT	13.03.06	KT	13.03.06

Project No.	Office	Type	Drawing No.	Revision
C003994	12	C	C003994-C-SK052	P1

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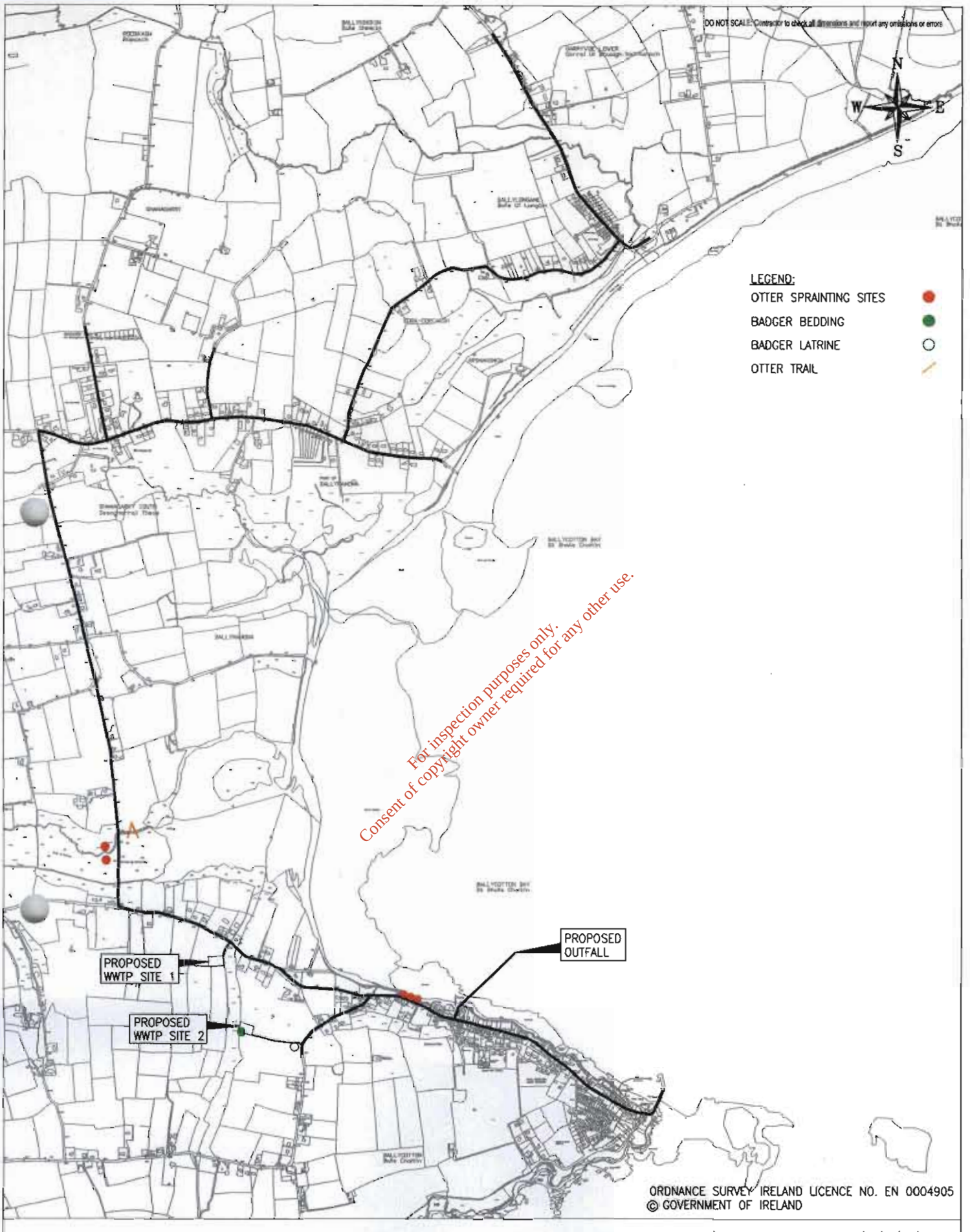

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Consulting Engineers
Civil Structural Mechanical Electrical Process Rail Traffic Environmental Project Management

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SEWERAGE SCHEME

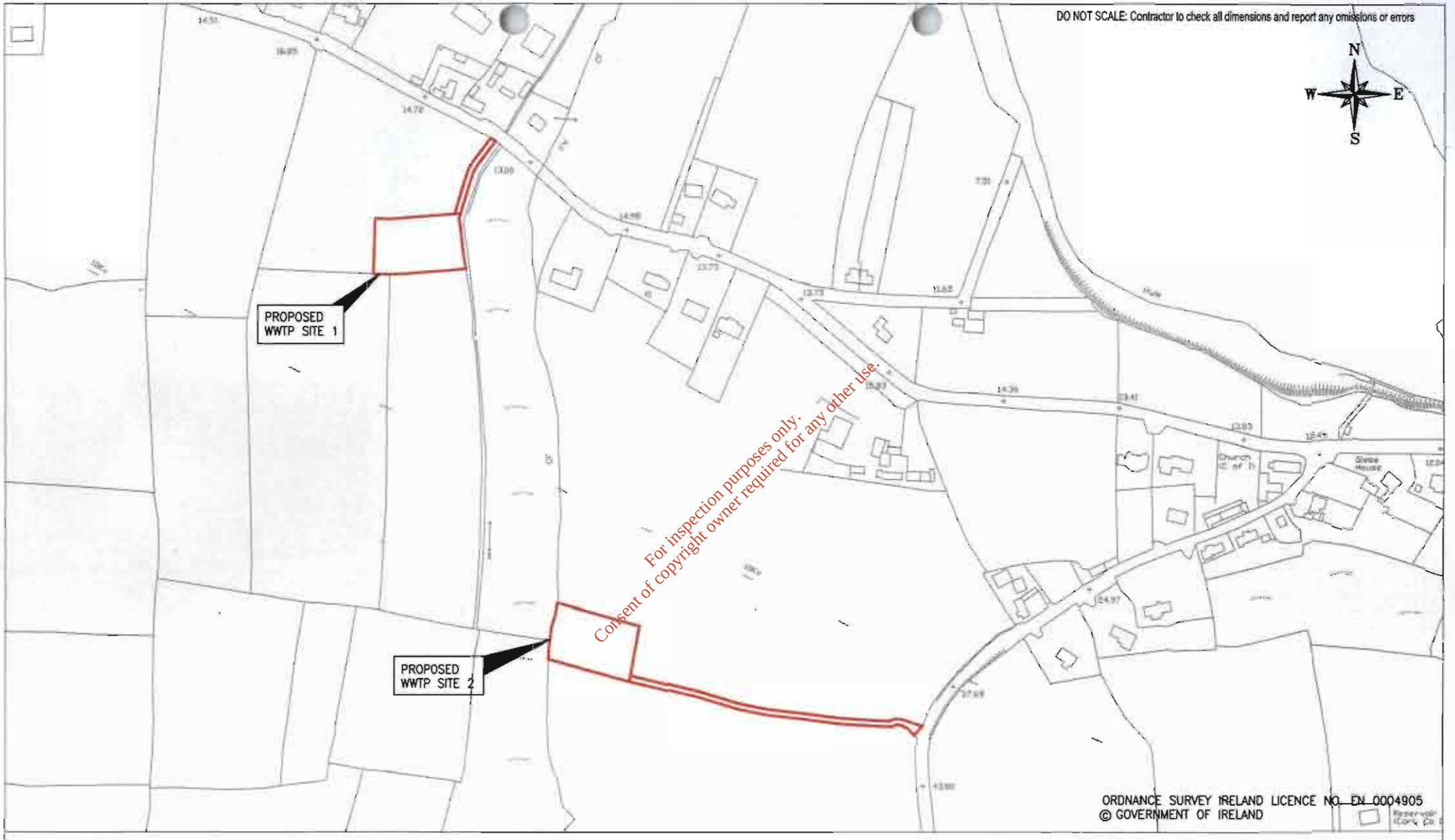
CORK COUNTY COUNCIL

Drawing Title:
LAYOUT SHOWING LOCATION OF MAMMAL SIGNS

Scale at A3	Drawn By	Date	Checked By	Date	Approved By	Date
1/14,000	NM	13.03.06	MW	13.03.06	KT	13.03.06

Project No.	Office	Type	Drawing No.	Revision
C003994	12	C	C003994-C-SK053	P1

APPROVAL ☐ INFORMATION ☒ TENDER ☐ CONTRACT ☐ CONSTRUCTION ☐



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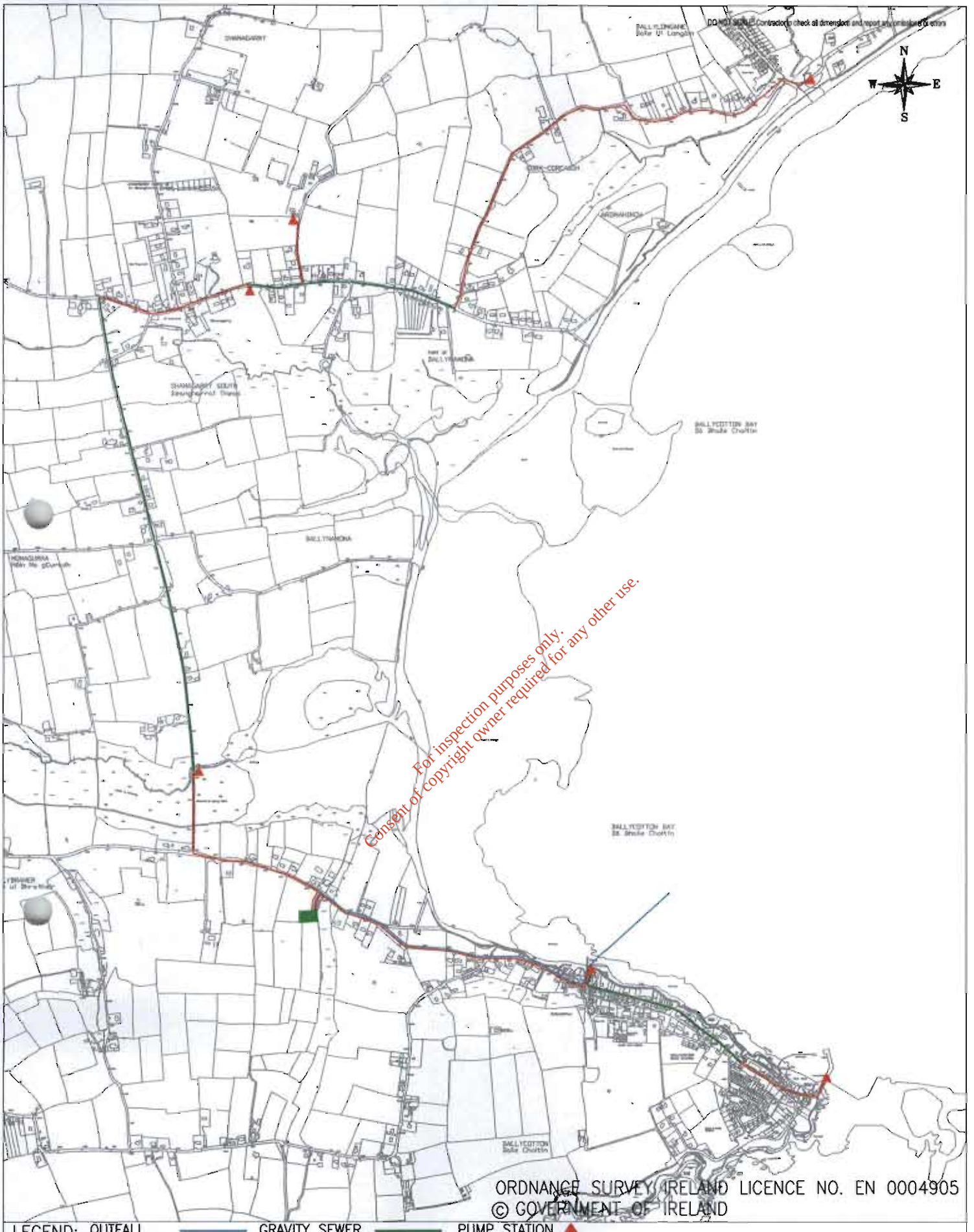
Rev	Description	By	Chk	App	Date

Drawing Title:
LOCATION OF DESIGNATED SITES

Scale	Drawn By	Date	Checked By	Date	Approved By	Date
1:2500	MF	02.05.08	KT	02.05.08	KT	02.05.08

Project No.	Office	Type	Drawing No.	Revision
C003994	12	C	C003994-C-SK055	P1

APPROVAL ☐ INFORMATION ☐ TENDER ☐ CONTRACT ☐ CONSTRUCTION ☐



LEGEND: OUTFALL — GRAVITY SEWER — PUMP STATION ▲
RISING MAIN — WWTP

Rev	Description	By	Chk	App	Date

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White Young Green Consulting

Project:
SHANAGARRY, GARRYVOE, BALLYCOTTON
SEWERAGE SCHEME

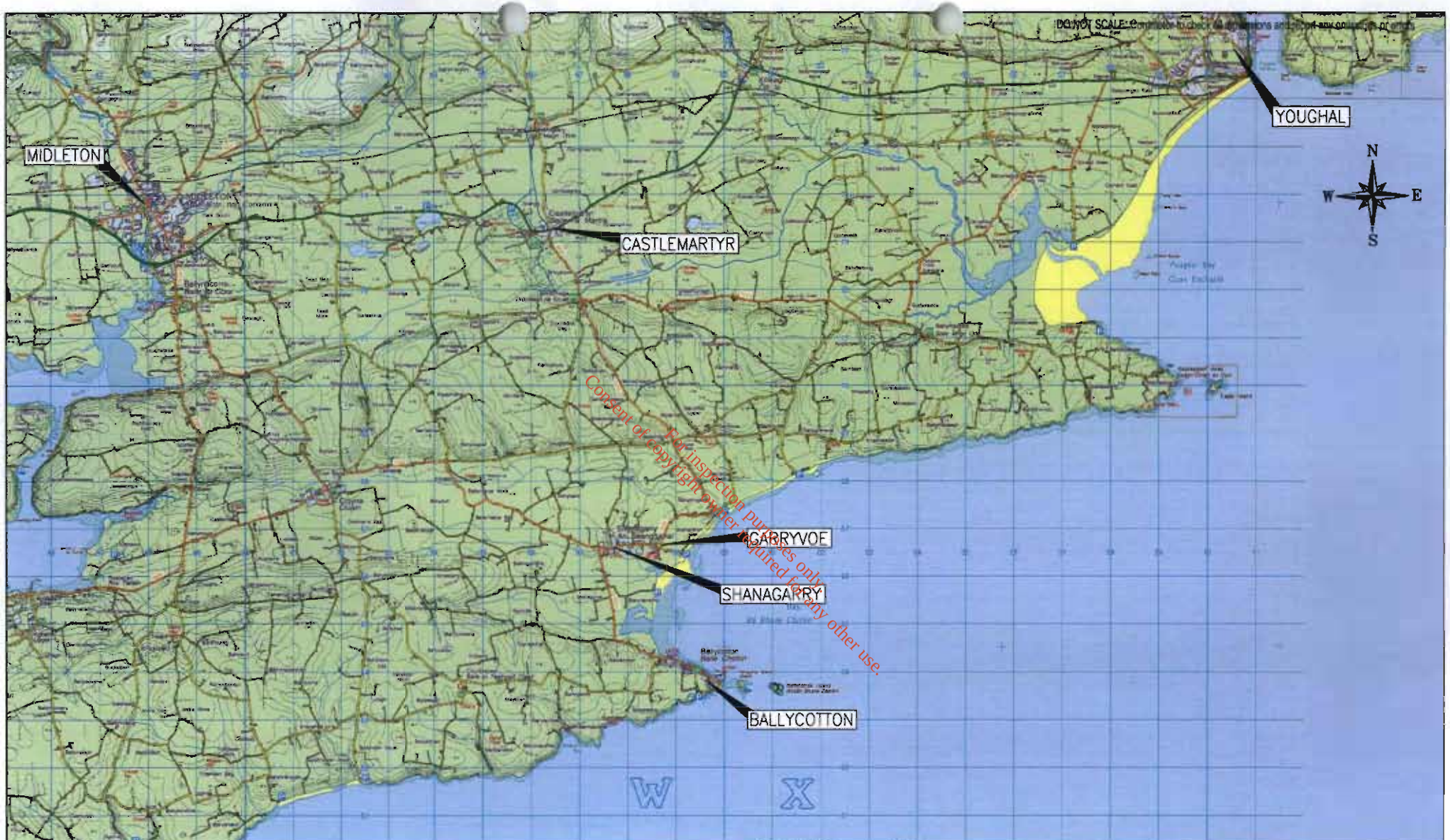
CLIENT:
CORK COUNTY COUNCIL

Drawing Title:
PROPOSED LAYOUT OF SEWERAGE SCHEME

Scale at A4	Drawn By	Date	Checked By	Date	Approved By	Date
N.T.S.	NM	02.05.08	KT	02.05.08	KT	02.05.08

Project No.	Office	Type	Drawing No.	Revision
C003994	12	C	C003994-C-SK056	P1

APPROVAL ☐ INFORMATION ☒ TENDER ☐ CONTRACT ☐ CONSTRUCTION ☐



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Rev	Description	By	Chk	App	Date

DRAWING TITLE
LOCATION PLAN

Scale	Drawn By	Date	Checked By	Date	Approved By	Date
N.T.S.	AW	05.06.08	AT	05.06.08	AT	05.06.08

Project No.	Office	Type	Drawing No.	Revision
C003994	12	C	C003994-C-SK057	P1

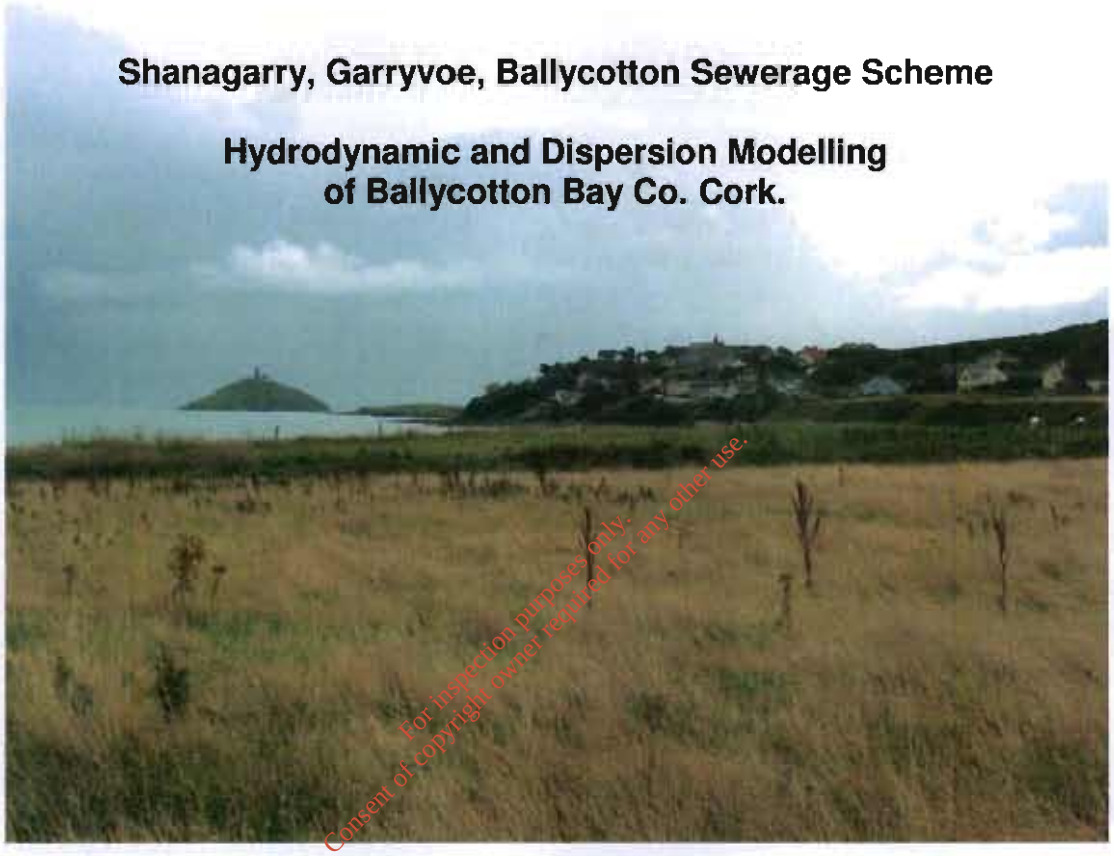
APPROVAL ☐ INFORMATION ☐ TENDER ☐ CONTRACT ☐ CONSTRUCTION ☐

Report No. 66601 v1.2

Cork County Council

Shanagarry, Garryvoe, Ballycotton Sewerage Scheme

Hydrodynamic and Dispersion Modelling of Ballycotton Bay Co. Cork.



On behalf of

White Young Green Ireland Ltd.
Consulting Engineers

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Unit 3, Campus Innovation Centre
Newcastle, Galway, Ireland.
Tel: 091-584473 Fax: 091-587460
hydroenvironmental@eircom.net

TABLE OF CONTENTS

1. Introduction

1.1.1 Hydro Environmental Ltd., Galway was appointed by White Young Green. Consulting Engineers on behalf of Cork Co. Council to undertake a detailed hydrodynamic and water quality model study of Ballycotton Bay so as to assess the water quality impact of the proposed Sewerage Schemes for Garryvoe, Shanagarry and Ballycotton. Hydrographic Surveys Ltd was appointed to carry out the hydrographic marine survey element of the study. This survey information was used in constructing and calibrating the mathematical predictive model of the receiving water.

1.1.2 The proposed scheme will collect and treat to the required standard the sewage from the villages of Garryvoe, Shanagarry and Ballycotton and discharge it to the receiving marine waters of Ballycotton Bay at suitable outfall location or locations. The suitability of the outfall locations will consider both water quality impact and engineering feasibility. The level of treatment will be secondary treatment with an option to provide UV disinfection to significantly reduce bacterial and viral concentrations should the water quality modelling indicate so.

1.1.3 Ballycotton Bay has a designated Blue Flag beach at Garryvoe. The beach and bathing area extends a considerable distance both southwest and northeast from Garryvoe. The quay area at Ballycotton village represents amenity water use and south of the Ballycotton headland a local swimming spot within the rock outcrop pools know as at Bishops leap exists. Ballycotton Bay is not currently designated as a shellfish bay nor is there licensed shellfish activities currently in operation within the Bay.

1.1.4 The objectives of the marine hydrographic survey and water quality model study are as follows:-

To simulate the water circulation patterns in Ballycotton Bay under different tide and wind conditions.

To assess various outfall location options in terms of near and far field water quality impacts.

To predict the spread and fate of faecal coliforms and BOD for specified loadings and wastewater treatment levels (i.e. secondary treated and disinfected).

1.1.5 A two-dimensional depth averaged hydrodynamic and advection-dispersion model of Ballycotton Bay was used to predict the hydrodynamic mixing, spread and fate of pollutant concentrations under different tide and wind conditions, different outfall locations, and different treatment standards. A two-dimensional depth averaged model was deemed appropriate to model the hydrodynamics (water elevation and circulation) of Ballycotton Bay. This is due to its generally shallow depths with extensive areas drying out at low water.

2. Hydrodynamic and Dispersion Model Description

2.1 General

2.1.1 For the purposes of assessing the water quality impact of the proposed treated sewage discharge on the coastal waters of Ballycotton Bay a two-dimensional depth-averaged hydrodynamic and advection-dispersion model was used. This model is based on Casuilli's (1990) Euler-Lagrangian semi-implicit finite difference scheme, which is internationally recognised as an accurate and numerically stable method for modelling marine and freshwater hydrodynamic systems. The scheme also includes for wetting and drying of inter-tidal mudflat regions and is particularly stable when applied to such regions in comparison to other numeric schemes (i.e. ADI finite difference schemes).

2.1.2 This model has been used successfully by Hydro Environmental Ltd. on numerous coastal sewerage schemes recently. These are hydrodynamic modelling of the Shannon and Fergus Estuaries as part of the Ennis Main Drainage and Flooding Study (2000), Mutton Island Sewage Outfall (2000), Kinvarra Bay Water Quality Study Co. Galway (1999, 2002), Newport Sewage Outfall Study Co. Mayo (2001), Ennis Main Drainage Outfall Co. Clare (2002), Cork Harbour Aghada Cooling water study (2004), Liscannor and Spanish Point Outfalls Co. Clare (2004), Courtown S.S. Co. Wexford (2005), Timoleague & Courtmacsharry S.S. Co. Cork (2005) and Carna Outfall (2005).

2.1.3 The hydrodynamic model simulates the time varying water level and depth averaged horizontal currents in response to a variety of forcing functions (i.e. tide, wind, and river inflows). The advection-dispersion model simulates the spread and fate of pollutants either as particulates or as solutes under the influence of flow velocities, diffusion and dispersion, sources and sinks and natural die-off.

2.2 Hydrodynamic Model

2.2.1 The model solves the depth averaged Navier-Stokes equations for fluid flow using a finite difference semi-implicit, Euler-Lagrangian solution scheme developed by Prof Vincenzo Casulli of the University of Trento, Italy. The finite difference scheme is carried out on a traditional space staggered grid. The depth integrated Flow equations solved by H2DIM are presented as follows:

x-direction momentum equation

$$\underbrace{\frac{\partial U}{\partial t}}_{1} + \underbrace{U\frac{\partial U}{\partial x} + V\frac{\partial V}{\partial y}}_{2} = \underbrace{fV}_{3} + \underbrace{g\frac{\partial \eta}{\partial x}}_{4} - \underbrace{\frac{gn^2|U|}{H^{4/3}}U}_{5} + \underbrace{\frac{c_w \rho_a W_x \sqrt{W_x^2 + W_y^2}}{\rho H}}_{6} + \underbrace{\bar{\varepsilon}\left[\frac{\partial^2 U}{\partial x^2} + \frac{\partial^2 U}{\partial y^2}\right]}_{7}$$

y-direction momentum equation#

$$\underbrace{\frac{\partial V}{\partial t}}_{1} + \underbrace{U\frac{\partial V}{\partial x} + V\frac{\partial V}{\partial y}}_{2} = \underbrace{-fU}_{3} + \underbrace{g\frac{\partial \eta}{\partial y}}_{4} - \underbrace{\frac{gn^2|V|}{H^{4/3}}V}_{5} + \underbrace{\frac{c_w \rho_a W_y \sqrt{W_x^2 + W_y^2}}{\rho H}}_{6} + \underbrace{\bar{\varepsilon}\left[\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2}\right]}_{7}$$

continuity equation

$$\frac{\partial \eta}{\partial t} + \frac{\partial UH}{\partial x} + \frac{\partial VH}{\partial y} = 0$$

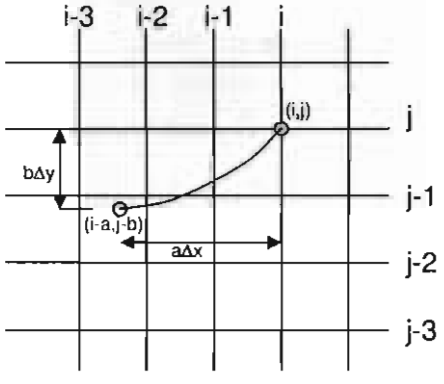
Where (1) is the local/temporal acceleration terms, (2) is the convective terms, (3) the Coriollis term, (4) the hydrostatic pressure term, (5) the bed shear terms, (6) surface wind shear terms and (7) the horizontal eddy viscosity terms. These equations of motion are solved for elevation and horizontal velocities using a finite difference scheme.

2.2.2 The difference equations are fully centred in both time and space with the advection accelerations determined by a Lagrangian procedure which involves determining the flow path for the previous time step and representing the partial derivatives of the local and convective acceleration as the total derivative, as follows.

Δ

$$\frac{DU}{Dt} = \frac{\partial U}{\partial t} + U\frac{\partial U}{\partial x} + V\frac{\partial V}{\partial y} = \frac{U_{(i,j)}^{n+1} - U_{(i-a,j-b)}^{n}}{\Delta t}$$

Where a $a = U\dfrac{\Delta t}{\Delta x}$ and $b = V\dfrac{\Delta t}{\Delta y}$



2.2.3 The finite difference scheme has no stability constraints. The numerical scheme handles wetting and drying of mudflat areas through definition of a minimum depth (typically set at 0.1 to 0.2m) where once water levels fall below this level the grid square is assumed dry and temporarily removed from the computational scheme until its subsequent wetting on the rising tide. In applications involving extensive wetting and drying areas the switching on and off of such grid squares can produce local shock waves causing numerical noise that sometimes cannot be dissipated resulting in spurious results (oscillations/ noise). Such effects can be overcome by using artificial damping through the implicitness factor (θ) (i.e. when set above 0.5, typically set at 0.55 introduces slight numerical dispersion that dampens spurious noise).

2.2.4 The finite difference method involves generating a mesh of rectangular grids of fixed spatial step to cover the area of interest. At each cell the bathymetry (i.e. the bed elevation) and cell definition (i.e. land, water or boundary) are specified. The tide forcing is introduced by specifying the time varying tidal elevations at the open sea boundary. Land boundaries are modelled as zero normal flux boundaries and also "no slip at the boundary" condition is set in regard to tangential velocities. River inflow is modelled as an internal flow boundary, which can be specified either as constant or variable with respect to time. The wind condition is specified as a surface wind stress over the domain. This wind stress term is computed based on wind speed magnitude and direction multiplied by the air water resistance constant. The bed friction resistance is introduced as a Manning roughness coefficient n and the bed stress is calculated at each grid cell. The eddy viscosity coefficient is also specified at each grid cell and accounts for large-scale horizontal mixing/eddying. The bed friction and eddy viscosity terms vary depending on the shear velocity and the water depth.

2.3 The Advection – Dispersion Model

2.3.1 The advection–dispersion (Water Quality) model simulates the advection, dispersion and fate (die-off, take-up, settlement, etc.) of a pollutant either as a particulate in suspension or as a solute in solution. The water quality model works interactively with the hydrodynamic model to simulate the simultaneous processes of advection, dispersion and biochemical interaction for given environmental and climatic conditions. The water quality model requires hydrodynamic input in terms of depth-averaged velocities and water depths at

each grid cell and for each computational time step. In the water quality model two different solution schemes are available, namely an Eulerian finite difference technique, which is grid based similar to the hydrodynamic model (same domain definition) and solves for pollutant concentration at each grid cell centre and a Lagrangian (particle tracking) technique which tracks individual particles in the flow field. The Eulerian scheme is depth averaged and uses a third order upwinding scheme to solve the convective transport terms.

2.3.2 The concentration of a particular solute in a grid square can change due to one of the following processes (Casulli (1990)):

- Change in surface elevation of the mesh. If the concentration is to remain constant the mass must change.
- Water flowing from one mesh to another. The solute moves with the water and so mass changes. This is known as advection.
- Velocity differences between adjacent meshes. This causes mixing of water and thus solute across grid faces. This is known as dispersion/diffusion.
- Chemical reactions between solutes, or biological effects on solutes. If a solute is non-conservative the decay or production of the solute in each grid square is modelled by zero or first order kinetics.
- The model takes account of inputs of solutes from point sources. The total mass input in each time step is mixed throughout the mesh where the input occurs.

2.3.3 The two-dimensional depth-averaged advective-diffusion equation is first integrated over the depth giving:

$$\underbrace{\frac{\partial S}{\partial t}+U\frac{\partial S}{\partial x}+V\frac{\partial S}{\partial y}}_{\text{Convective Acc}}=\frac{1}{H}\frac{\partial}{\partial x}\left[HD_{xx}\frac{\partial S}{\partial x}+HD_{xy}\frac{\partial S}{\partial y}\right]+\frac{1}{H}\frac{\partial}{\partial y}\left[HD_{yx}\frac{\partial S}{\partial x}+HD_{yy}\frac{\partial S}{\partial y}\right]+KS+\underbrace{\frac{Q_{out}S_{out}}{H\Delta x\Delta y}}_{S_o}$$

Where S is depth averaged solute concentration, D_{xx}, D_{xy}, D_{yx}, and D_{yy} are the depth averaged longitudinal dispersion coefficients in x and y directions, S_o is a source (outfall discharge Q_{out} and effluent concentration S_{out}) and KS is first order decay rate or growth rate of the solute.

2.3.4 For the dispersion terms, the coefficients can be shown to be of the following form

$$D_{xx} = K_L \cos^2\theta + K_T \sin^2\theta$$
$$D_{yy} = K_L \sin^2\theta + K_T \cos^2\theta$$
$$D_{xy} = D_{yx} = (K_L - K_T)\sin\theta\cos\theta$$

where

$$\theta = \tan^{-1}(u/v)$$

$$K_L = 5.93 * Hu_* \quad \text{and} \quad K_T = 0.15 Hu_* \,, \quad u_* = \frac{\sqrt{g}}{C} u_c \text{ and } u_c = \sqrt{u^2 + v^2}$$

Elliott(1997) found for a number of Irish coastal bays that the horizontal diffusion coefficient could be approximated by the following regression equation

$$K_H = 0.03 + 1.03 u_c + .04W$$

2.3.5 The advection-diffusion equation is solved using a non-splitting finite difference scheme with the convective terms formulated using Leonard's (1991) ULTIMATE QUICKEST Scheme (Lin & Falconer, 1997) and the dispersion terms being represented using explicit second-order central difference scheme and the source and decay terms were represented by the Euler method.

2.4 Hydrodynamic Model Description

2.4.1 A finite difference mesh of 25m x 25m was used to model the study area. The finite difference domain size is 244 x 254 grid squares, this represents a total of 61,976 grid cells. The total number of wet cells in the domain is 50,674 and the remainding11302 are land cells. The 25m grid spacing is sufficient to define the variable shoreline and inter-tidal geometry. Each grid cell was defined as either land or sea and the depth to seabed relative to chart datum was specified at each grid cell corner node. Hydrographic Surveys Ltd was commissioned to carry out a bathymetric survey of the receiving waters in the vicinity of Ballycotton headland. They had previously surveyed the seabed bathymetry in the inner bay area of Garryvoe / Shanagarry (HSL, 1999), which was made available for this study.

2.4.2 The bathymetric survey off Ballycotton Head was carried out May/June 2005 using standard echo-sounding techniques with horizontal position fixing by differential global

positioning system (accurate to within 0.5 to 1m) and vertical resolution accurate to 0.01m. The bathymetric survey was interpolated over a grid of 25m and input to the model.

2.4.3 Supplementary bathymetric data for the offshore waters was obtained from Admiralty Chart 1410 (large scale 1:200,000) for model regions not covered by the HSL survey (refer to Figure 1 for extent of bathymetric survey). The depth contours defined in the hydrodynamic model are presented in Figure 2.

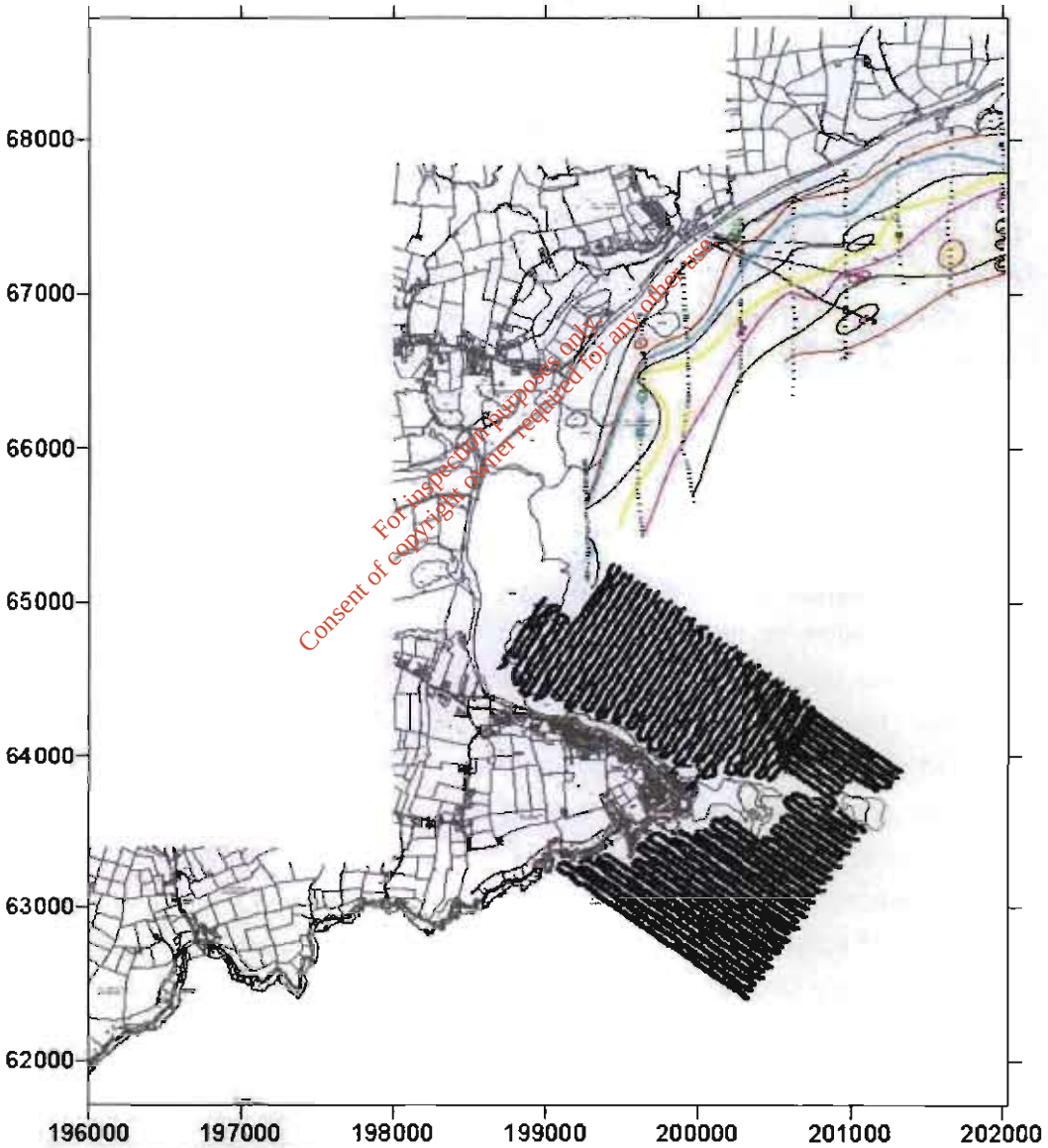


Figure 1 Extent of Bathymetric Surveys used in Model Development

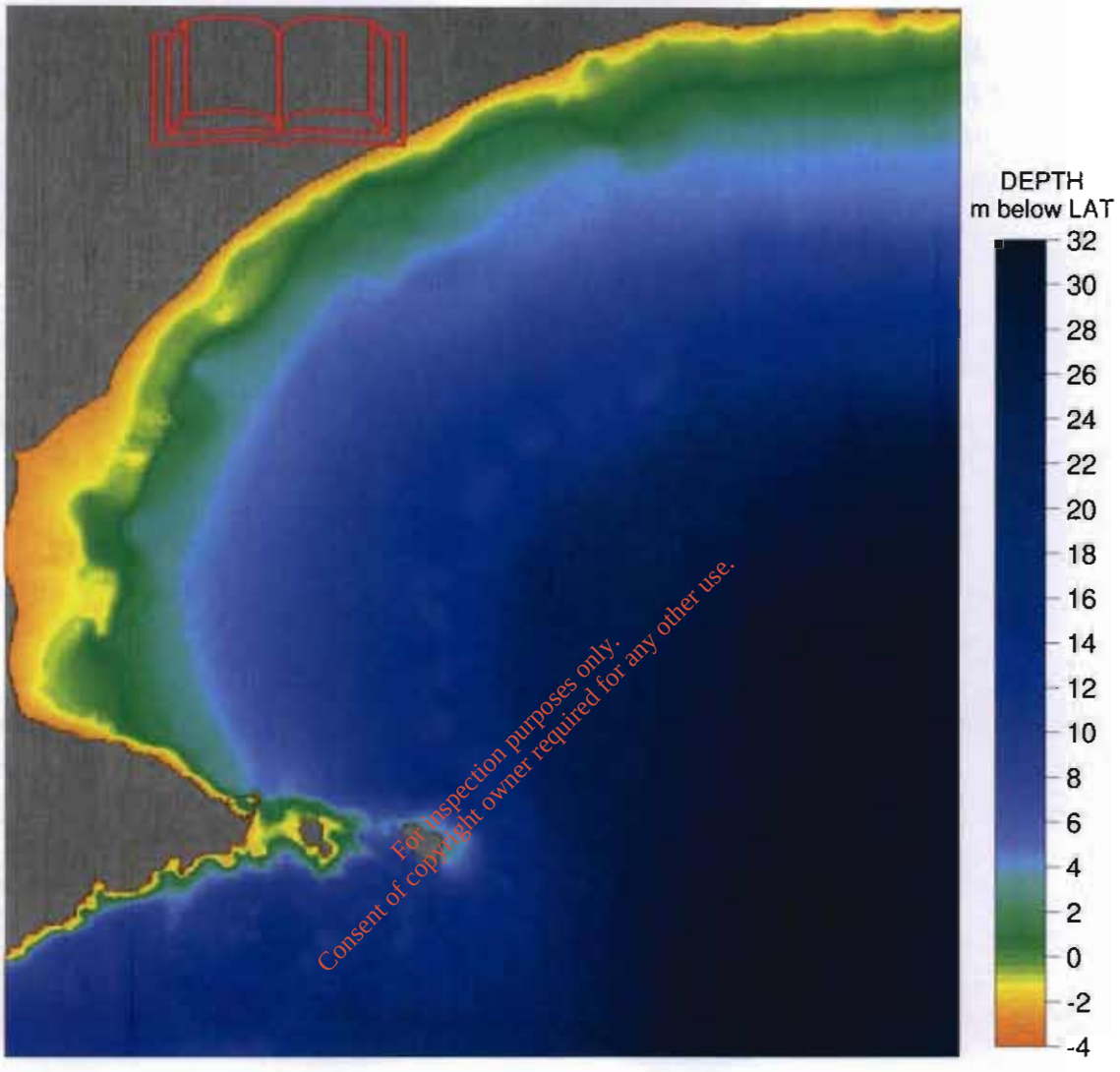


Figure 2 Model Extent and Ballycotton Bay Bathymetry

Boundary Conditions

2.4.4 A tidal elevation boundary is specified along the south open sea boundary and a zero flux boundary is specified along the remaining east water boundary. This approach should allow reasonable representation of the tidal currents within Ballycotton Bay and particularly along the shoreline area away from the influence of the modelled open sea boundaries.

2.4.5 The mean spring and neap tide levels in the vicinity of the Ballycotton Bay from HSL tidal observations are presented below in Table 1:

Table 1 Mean Tide Levels for Ballycotton Bay

MHWS	MHWN	MLWN	MLWS
4.1	3.2	1.4	0.4

These levels are set to Chart datum, which is approximately the level of lowest astronomical tide (LAT).

Table 2 HSL Derived tide elevation constituents for Ballycotton Harbour from HSL June 2005 tide monitoring

Name	Amplitude	Phase
M2	1.4417	144.54
S2	0.4619	194.78
K1	0.0171	162.83
O1	0.0399	36.52
F4	0.0278	281.60
F6	0.0091	97.26

Model empirical hydrodynamic coefficients

2.4.6 Initial values of eddy viscosity and Manning's roughness coefficients were specified using standard values from literature (Manning n = 0.015 and eddy viscosity coefficient = 1.0). These coefficients were later tuned during model calibration to improve model fit.

Cheng et al. (1992) recommended the following variation in Manning coefficient with water depth for coastal and estuarine applications.

Table 3 Variation of Manning's Roughness Coefficient with Depth

Water Depth	Manning's n value
0.0 < H < 0.5	0.024
0.5 < H < 1.0	0.022
1.0 < H < 3.0	0.020
3.0 < H < 10.0	0.018
H > 10.0	0.015

The turbulent depth averaged eddy viscosity can be approximated from a logarithmic velocity profile giving:

$$vt = C_e U^* H$$

where C_e is the coefficient of eddy viscosity (=0.15 to 1.2), U^* is the shear velocity and H the water depth.

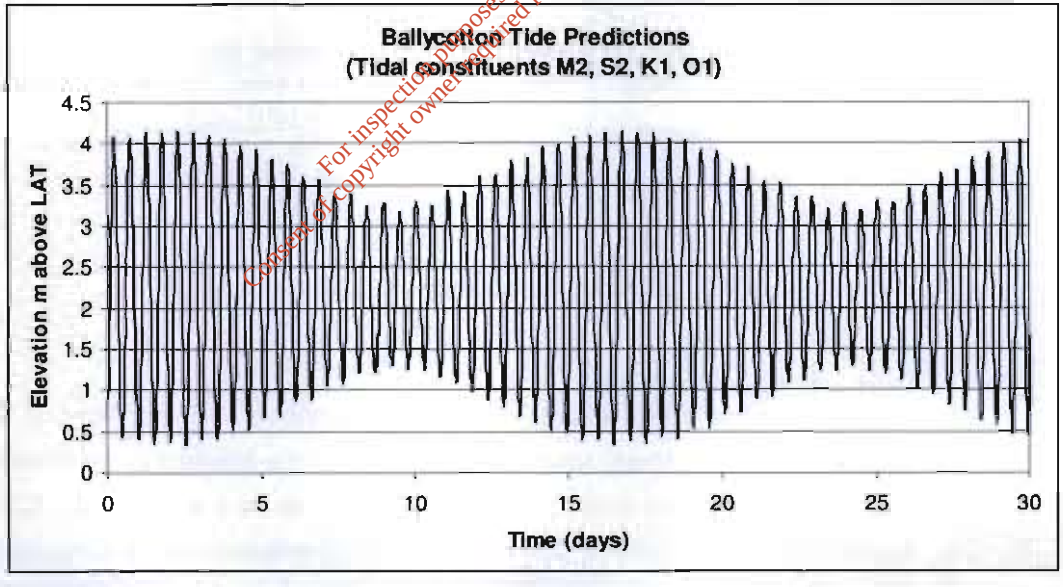


Figure 3 Lunar cycle from derived tide constituents

2.5 Water Quality Model Input Description

2.5.1 The following information is required to perform the water quality model simulations:

(i) Outfall location;
(ii) Outfall discharge characteristics
(iii) Pollutant loadings
(iv) Decay / take-up rates
(v) Background concentrations
(vi) Dispersion coefficients

Outfall Sites

2.5.2 Three potential outfall locations were modelled using a 25m grid finite difference model of the same structure as the hydrodynamic model. The locations of these outfall sites are shown in Figure 4 and are labelled Location1, Location 3 and Location 4.

Table 4 Location and water depth of Potential Outfall Sites

Site	Easting	Northing	Distance from Shore (m)	Ambient Depth m below LAT
A	200,000	63,480	190	4.7
B	199,390	64,470	320	1.8
C	199,260	65,660	700	0.2

Please note that LAT is 2.58m below Malin Head Datum

Discharge Characteristics

2.5.3 In the model the outfall diffuser line is represented by a single 25m-grid square. It is unlikely given the relatively small discharge rate that the eventual outfall diffuser length will exceed 25m and most likely the outfall will terminate as a single point discharge. The specific outfall discharge characteristics, in terms of pollutant type, loading and flow regime are as follows:

2.5.4 Effluent Standards :	Faecal coliforms	1×10^6 No./100ml
(Secondary Treatment)	BOD	25 mg/l
	Suspended Solids	35mg/l
	Total nitrogen	50mg/l

2.5.5 Hydraulic Load: Continuous at 1DWF and peak flows at 3DWF

Design PE Loadings (2030)

Shanagarry

Summer PE	1,457
Winter PE	790

Garryvoe

Summer PE	521
Winter PE	197

Ballycotton

Summer PE	1,204
Winter PE	887

TOTAL

Summer PE	**3,182**
Winter PE	**1,921**

Design Effluent Load (Summer loading @ 180 l/day per person)

1DWF	6.63 l/s
3DWF	19.89 l/s

Faecal Coliform Mortality Rate

2.5.6 The die-off rate of pathogens (bacteria and viruses) is, among other factors, a function of solar radiation, temperature, predation and sedimentation. The decay rate is usually specified in terms of a T_{90} value, which is the time taken for 90% of the pathogens entering the bay at a given instance to die-off. Hence the larger the T_{90} value, the greater the possibility of pathogens existing in the bay a long distance from the outfall.

2.5.7 In predicting the spread and fate of faecal coliforms in the marine environment, the mortality rate (specified as a T_{90}) can be the most critical parameter, particularly at sites remote from the source (travel time greater than 4 hours). Numerous studies (Neville-jones and Dorling (1986), Gameson, (1985), Fujioka et al. (1981)) have reported T_{90}'s of the order of 4 hours or less for daylight hours and in bright sunshine of the order of 1 to 2 hours (Fujioka et al., 1981). A recommended design figure for marine outfall studies is a T_{90} of between 5 and 10 hours (Gameson, 1985). T_{90}'s have been shown to increase with turbidity and water depth (i.e. reduction in short wavelengths). Research has shown that

night time mortality rates are very low (mortality due to starvation only), of the order of 60 to 80 hours (Gameson, 1985). Because of the sensitivity of the waters in regard to shellfish a relatively conservative T_{90} of 24hours will be used in modelling faecal coliform concentrations.

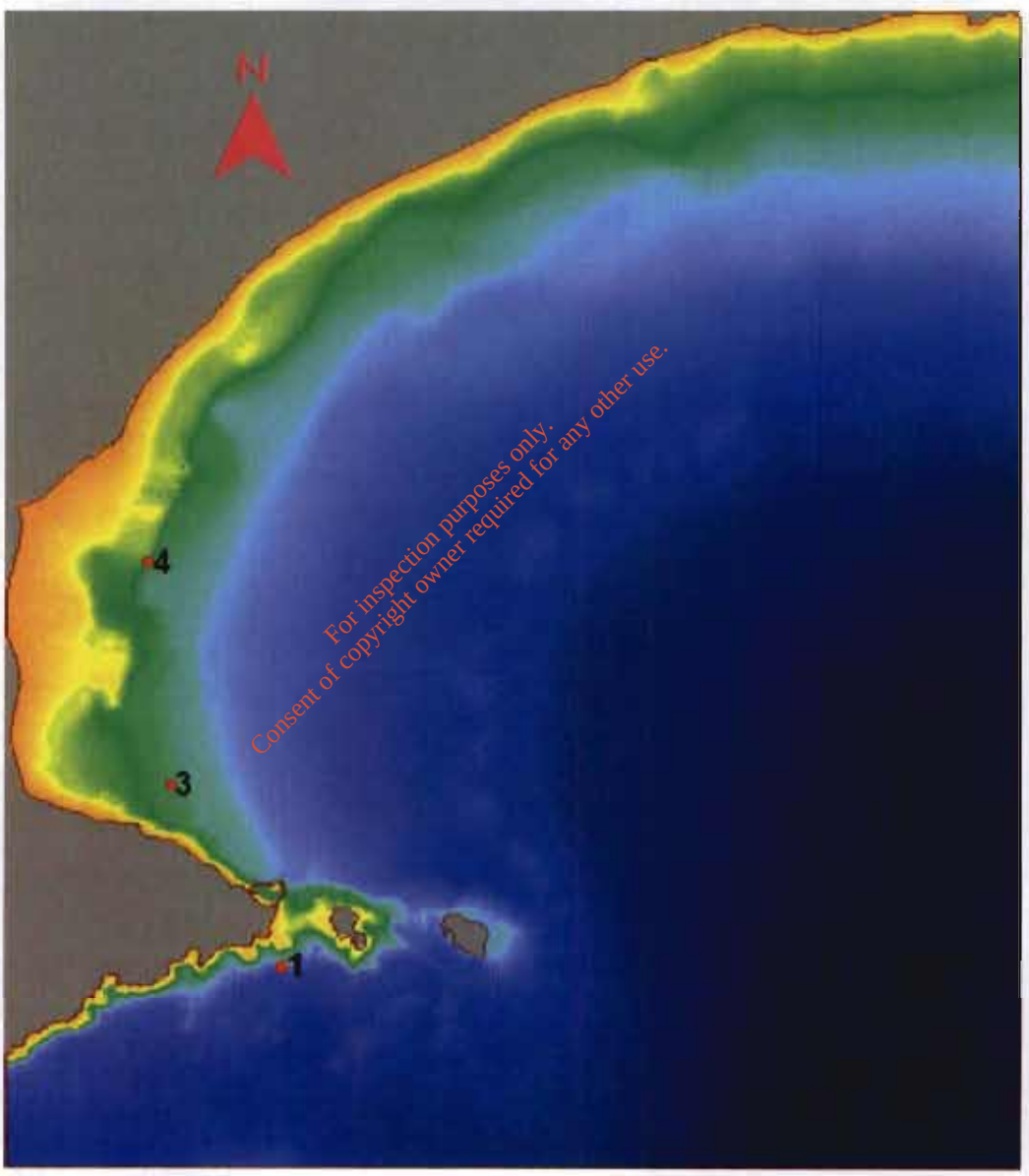


Figure 4 Modelled Sewage Outfall Locations

Background Concentrations

2.5.8 In the model simulations the background concentration of the pollutant being investigated (faecal coliform) was set to zero so that the simulations present the net effect of the outfall discharge on the receiving waters. In modelling certain biological parameters such as nutrients (nitrogen and phosphorous cycles) background concentrations are often important as they influence the chemical/biological reactions of the pollutant. Die-off rates for faecal coliforms are considered to be independent of faecal coliform background concentrations.

Dispersion Coefficients

2.5.9 The Transport-dispersion model uses Elder's dispersion equation:

$$D_L = k_L V_L^* H \qquad D_T = k_T V_T^* H$$

where, D_L and D_T are the longitudinal and transverse depth-averaged dispersion coefficients (m^2/s), V^* the shear velocity, H the water depth and k_L and k_T the longitudinal and transverse empirical dispersion constants. The theoretical longitudinal and transverse dispersion constants assuming a logarithmic velocity distribution are k_L = 5.93 (Elder, 1959) and k_T = 0.15 (Fisher,1976). It is generally found that in the sea the dispersion coefficients are often significantly greater than the theoretical coefficients presented above. However in the interest of conservatism and also taking into account numerical dispersion introduced by the finite difference scheme the above theoretical coefficients are used in the simulations.

3. Depth Averaged Hydrodynamic Simulation

3.1 Introduction

3.1.1 The hydrodynamic model resolves depth averaged flow velocities and water depth in each wet (sea) grid square within the model domain. The forcing function is an oscillating open sea tidal elevation boundary condition with specified tidal amplitude, low-water level and tidal period (approx 12.4hrs) based on the nautical almanac and monitored tide levels within the Bay. Initially the entire water body is assumed at rest but as the solution progresses these initial starting conditions no longer influence the computation with the tidal forcing dictating the circulation pattern and water levels within the domain.

3.2 Model Calibration

3.2.1 Calibration of a hydrodynamic model involves fine tuning boundary conditions, the roughness coefficients (Manning's n and eddy viscosity coefficients) and often poorly defined geometry so as to produce the best possible fit between computed and measured current speeds and directions. Depending on the complexity of the domain being modelled and particularly where tidal forcing is not the dominant influence on circulation (wind and wave generated 3-D currents) it can often be difficult to achieve reasonable calibration. Ballycotton Bay is an open bay to the south and east resulting in generally slack tidal flows within the Bay. Model testing found that the best results in respect to agreement with observed flows (HSL Drogue tracks and current metering, 1999 and 2005) was to extend the model eastward away from the area of interest and apply a streamline boundary along that boundary and to tidal force the southern open sea boundary.

3.2.2 A Marine Survey was carried out by Hydrographic Surveys Ltd. in May/June 2005, which measured spring and neap tidal currents at two DCRM Sites (C_C, C_D) and two recording current meter sites (C_A and C_B) off Ballycotton. A previous current metering survey was carried out off Garryvoe where velocity measurements over a tidal cycle were carried out at 3 sites (C_1, C_2 and C_3). The surveys showed very slack tidal velocities at all sites inside Ballycotton Headland except site C_B located in the straights west of Ballycotton Island.

3.2.4 The current metering survey results were used to calibrate and assess the predictive capability of the hydrodynamic model. Tuning of roughness coefficients, boundary definition and fine-tuning of bathymetry in the inter-tidal drying areas was carried out so as to achieve reasonable agreement with observations. Reasonable agreement was achieved between observed and computed and particularly so given the data limitations in respect to the bathymetry/geometry and Open sea boundary definition Refer to HSL reports (1999 and 2005) and figures 5 to 8 for comparison.

3.3 Hydrodynamic Simulation Results

3.2.1 The hydrodynamic model was run for a mean spring and mean neap tide conditions to examine the tidal circulation patterns and variation of tidal velocities throughout the Bay and provide necessary hydrodynamic input to the pollutant transport dispersion model. The simulations were run with a mean prevailing southerly wind of 5m/s specified. The spring tide simulations at the four principal stages of the tidal cycle are presented in Figures 5 to 8.

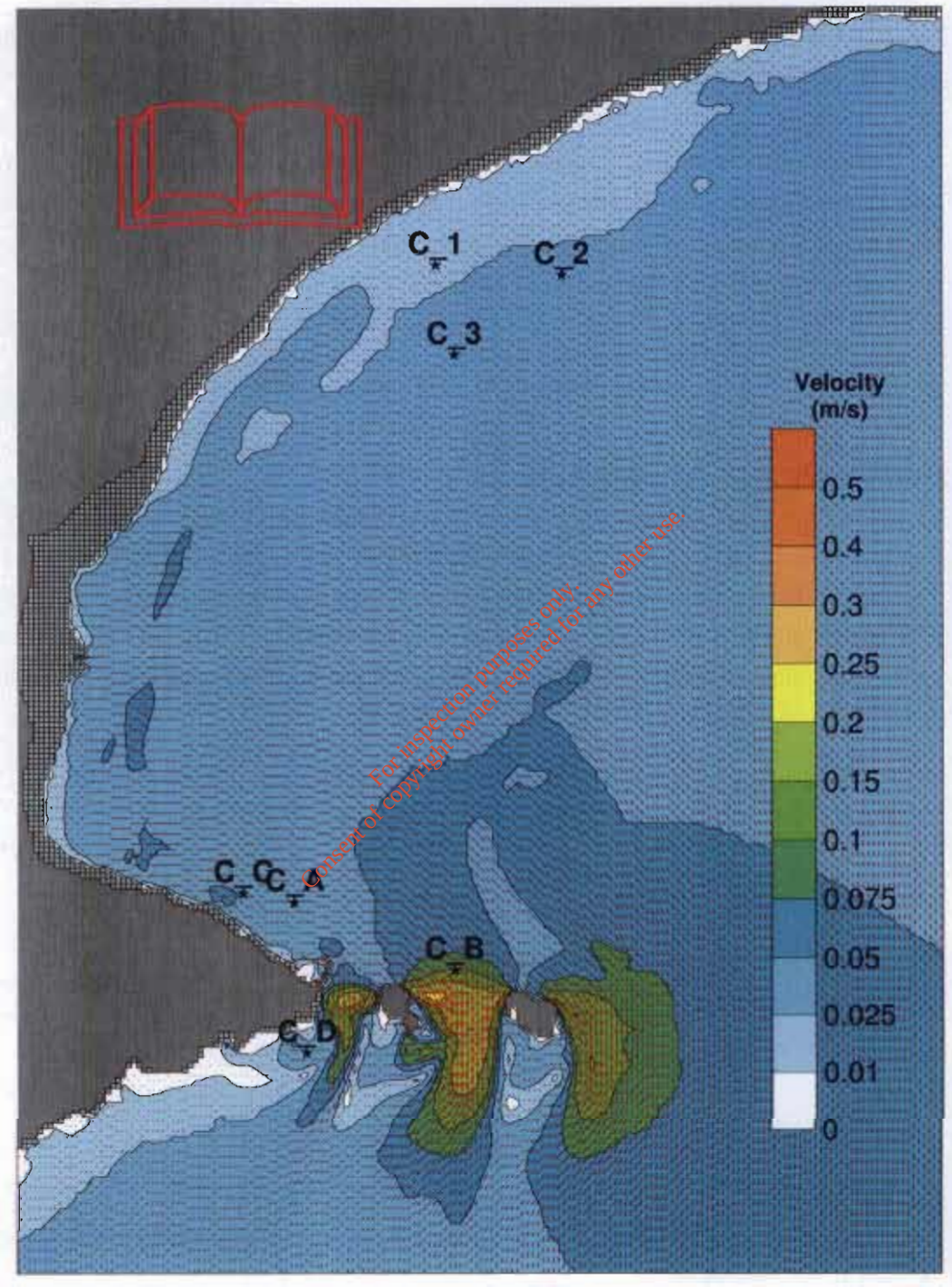


Figure 5 Mid-Ebb Hydrodynamics – Spring Tide

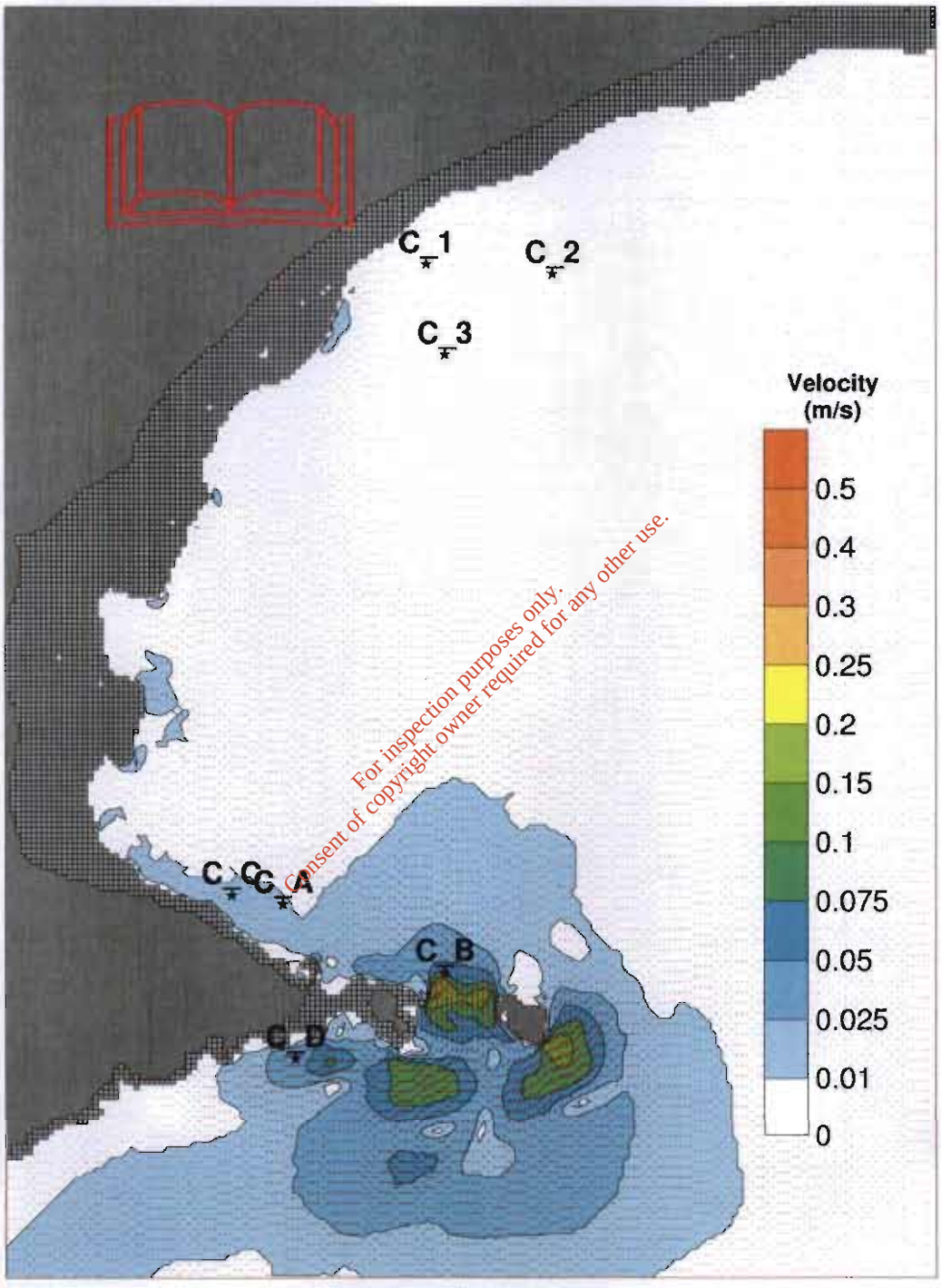


Figure 6 Low water Hydrodynamics – Spring Tide

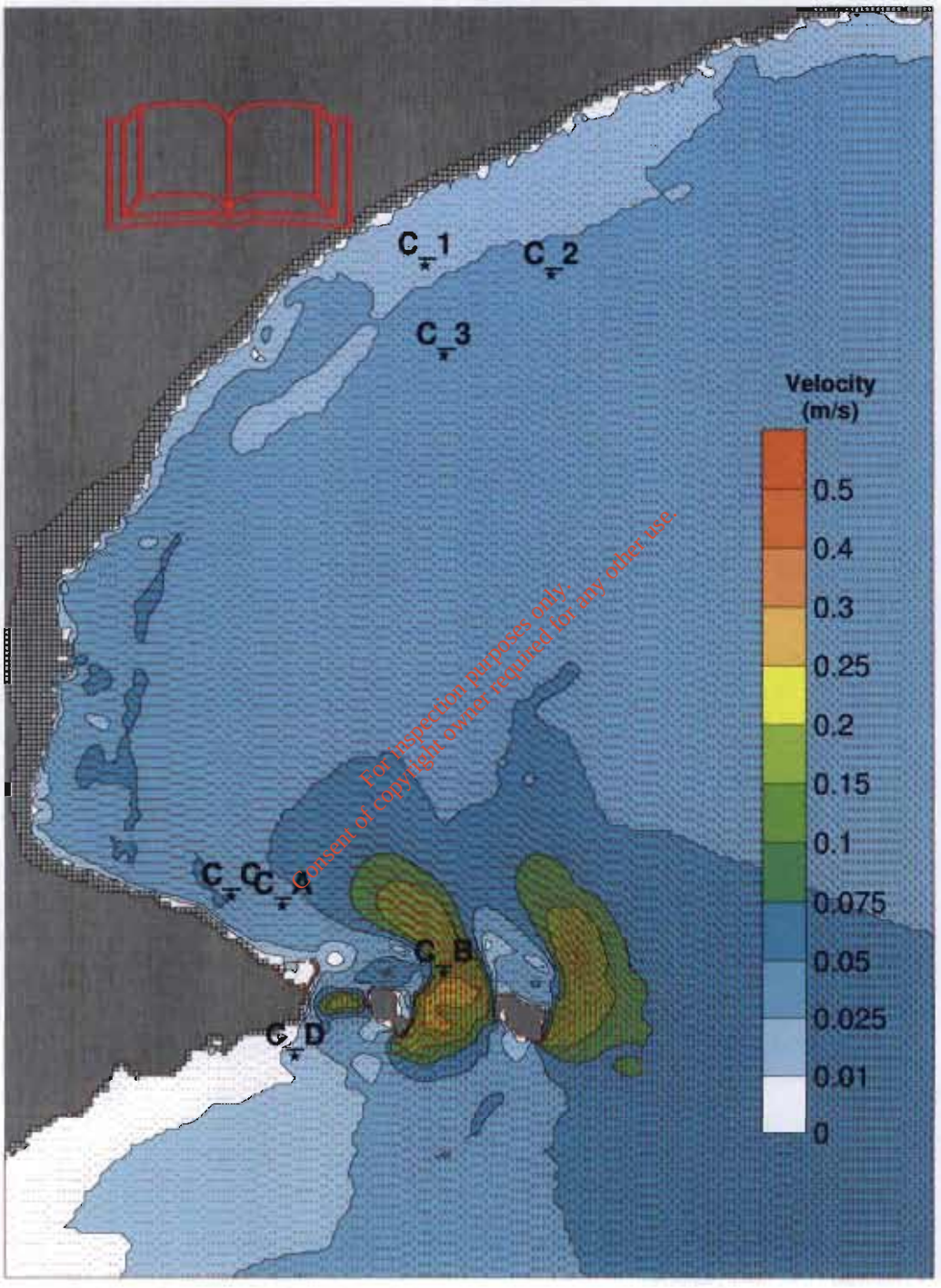


Figure 7 Mid-Flood Hydrodynamics – Spring Tide

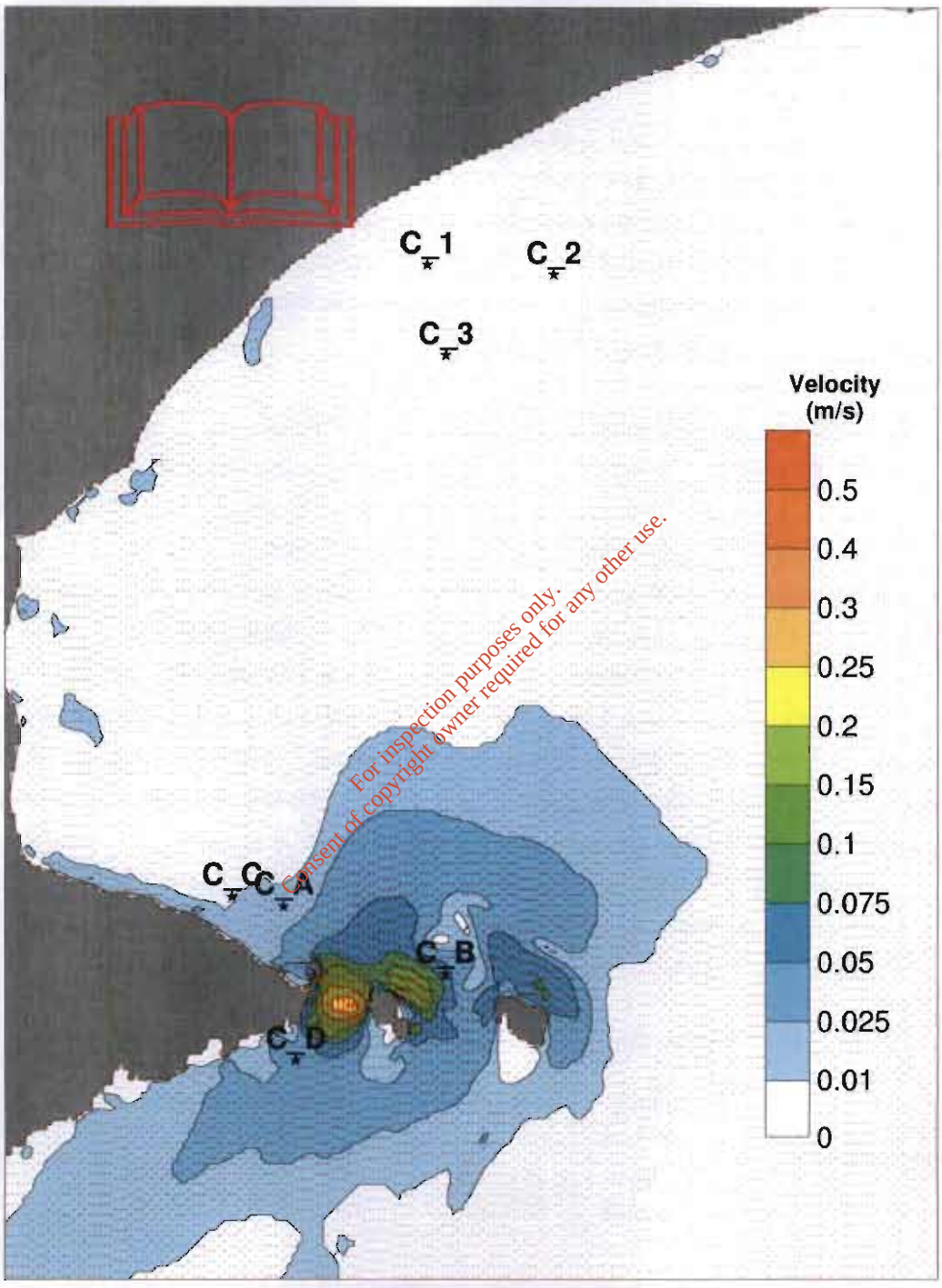


Figure 8 Highwater Hydrodynamics – Spring Tide

4. Depth Averaged Faecal Coliform Simulation Results

4.1 Introduction

4.1.1 Three outfall sites A, B and C were chosen to assess the bacterial impact of the proposed discharge on receiving water quality of Ballycotton Bay and associated bathing and water recreational areas. These three outfalls were selected as part of the outfall site selection process previously reduced from 7 potential locations. As a prerequisite the three remaining outfall options are all located below the Low Water Mark defined by LAT (mean spring tides have low water 0.5m above LAT).

4.1.2 Outfall 1 was selected south of Ballycotton Headland outside of the bay area in exposed South Atlantic coastal waters. This location has possibly the best mixing due to its exposed nature with wind and wave generated current producing good dilution. Outfall 1 also provides the greatest water depth but represents a difficult engineering feat due to its exposure to west, south and east Atlantic offshore winds and extensive rock outcropping. Outfall 3 is located inside the headland adjacent to the existing Ballycotton Village outfall and septic tank east of Ballycotton Village. The outfall is located 320m east of Ballycotton shoreline in a water depth 1.8m below LAT. This site is characterised by very slack tides and is reasonably sheltered against prevailing winds. Outfall 4 is the innermost site located off Ballynamona Strand and is 700m from the shoreline to provide a water depth of 0.2m at LAT. The majority the 700m pipeline length is located in the intertidal zone (approx 525 m). Site C is characterised by very slack tides and the resultant pollutant plume would be significantly influenced by the direction of prevailing winds, generally from the south and southwest which would target the strand area at Ballynamona.

Table 5 Site Selection Outfall Site Summary

Site	Easting	Northing	Distance from Shore (m)	Ambient Depth m below LAT
1	200000E	63480N	190	4.7
3	199390E	64470N	300	1.8
4	199260E	65660N	700	0.2

4.1.3 Currently the Blue flag bathing status only applies to the beach area at Garryvoe but it would be the objective of the Local Authority that this standard is achieved/maintained at all adjoining beach areas such as Ballynamona and Ardnahinch strands.

4.1.4 Faecal Coliform Simulations were modelled for a combined (Shanagarry, Garryvoe and Ballycotton Villages) DWF flow of 6.56l/s and a peak flow of 3DWF = 19.68l/s and secondary treated effluent concentration of 1.0 $x10^6$ No./100ml. A conservative daily decay rate of 2.306 day^{-1} which is equivalent to a T_{90} of 24hours was specified in the model runs.

4.1.5 The faecal coliform discharge was modelled as a continuous discharge from each of the outfall sites for the following hydrodynamic conditions:

(i) Repeating mean neap tide having highwater level of 3.2m and low water level of 1.4m Chart datum.

(ii) Repeating mean spring tide having highwater level of 4.1m and low water level of 0.5m Chart datum.

4.1.6 Modelling a 3DWF discharge as opposed to the mean discharge of 1DWF represents a worst case scenario in respect to quantifying the bacterial impact on nearby existing and potential Bathing waters and Blueflag beaches.

Bathing Waters

4.1.7 The EU directive and the Irish National Limit values which relate to the quality of bathing waters set different standards in regard to mandatory and guideline values for faecal coliform and faecal streptococci concentrations. The Blue Flag beach standard in regard to bacterial impact requires that the EU Directive Guideline limit of 100 No./100ml faecal coliforms at 80% compliance and 100 No./100ml faecal streptococci at 90% compliance is meet. Based on recent findings by the World Health Organisation these Guideline values may in the future become more stringent. The bathing water standards are summarised in Table 6 below.

4.1.8 The general practice in establishing the effluent treatment standard is to comply with the Blue Flag Beach water quality standards at recognised bathing areas. In the case of Ballycotton Bay the entire strand area from Ballynamona to northeast of Garryvoe could be described as bathing waters and therefore the more stringent Blue flag standard would apply.

Table 6 Irish National and EU Directive Bathing Water Quality Standards:

	Total Coliforms (No./100ml)	Faecal Coliforms (No./100ml)	Faecal Streps (No./100ml)	% Compliance
EC Guideline Values	500	100	100	80%
EC Mandatory Values	10,000	2,000	-	95%
National Mandatory Values	5,000	1,000	300	90% 95%

4.1.9 Bathing does not take place to any significant extent in the immediate vicinity of Ballycotton Village. Nevertheless, it is considered that the disposal of treated effluent should result in compliance with the Irish National limit values for bathing waters within the Harbour area and at a local swimming spot referred to as Priests Leap.

4.2 Faecal Coliform Simulation Results – Outfall Option 1

4.2.1 Outfall 1 was selected in the exposed deeper waters south of Ballycotton headland and outside of the Bay (200000E, 063480N). The discharge point was extended from the shore 190m to avoid impact on a local bathing site (Priest's Leap). The water depth at this location is approximately 5m at Low water mean spring tide. This site will have good lateral and vertical mixing due to its variable rocky bed and open sea exposure and is expected to produce minimal water quality impact on Ballycotton Bay.

4.2.2 The tidal cycle was repeated until equilibrium concentrations at the outfall site and within Ballycotton Bay were achieved. The predicted faecal coliform concentrations at 4 principal stages (mid-ebb, low water, mid-flood and highwater) of the mean spring and neap tidal cycles are presented in Figures 9 to 16 for the peak 3DWF (19.68l/s) discharge scenario.

4.2.3 The simulation results show for both spring and neap tide simulations that the effluent plume is well dispersed and generally remains south of Ballycotton Headland. The plume on a spring flood tide has the opportunity to migrate northwards into Ballycotton

Bay between the headland and the islands. This plume generally remains offshore and is well diluted. Under neap tides the plume is shown to be locally dispersed about the outfall with little opportunity to migrate northwards around the headland on the flooding tide.

4.2.4 Predicted maximum faecal coliform concentrations inside Ballycotton Harbour are less than 10No/100ml occurring on a spring tide and substantially lower on neap tides. Maximum predicted concentrations at the local bathing spot (Priest's Leap) are 75 to 100No./100ml which are well below the national mandatory limit of 1000No./100ml. The simulation shows no migration of plume towards the bathing beaches of Ballynamona, Ardnahinch and Garryvoe with predicted concentrations imperceptible at these locations due to the travel distance involved combined with the low tidal currents within Ballycotton Bay, the faecal coliform mortality rate of 90% in 24hours and the large volume of receiving water available for dilution.

4.2.5 Predicted faecal coliform concentrations and dilutions in the immediate vicinity of the Outfall (25m by 25m outfall grid) are presented in Table 7 below for mean spring and neap tide simulations.

Table 7 Predicted Dilutions and Concentrations at Outfall 1 for 3DWF Design Load

	Spring Tide		Neap Tide	
	Outfall Dilution	**Faecal coliform No./100ml**	**Outfall Dilution**	**Faecal coliform No./100ml**
Median Dilution	478	2090	282	3546
Minimum Dilution	186	5368	191	5236
Maximum Dilution	1300	769	385	2599

4.2.6 In conclusion the simulation results show that a proposed outfall at Site A is suitable for the combined secondary treated discharge from Shanagarry, Garryvoe and Ballycotton Villages in respect to bacterial impact and the bathing water and blue flag standards within Ballycotton Bay. From an outfall construction perspective Outfall 1 represents a difficult engineering challenge due to the rocky shoreline and bed and exposed nature of the site.

4.3 Faecal Coliform Simulation Results – Outfall Site 3

4.3.1 Outfall 3 was selected inside Ballycotton headland adjacent to the existing outfall pipe but extended eastward a distance of 320m from the shore to prevent significant shoreline plume attachment, avail of reasonable water depth for initial mixing at the outfall site (i.e. 2.3m water depth available at low water spring tides). The modelled discharge point is located at E199390, N64470. This general location is characterised by slack tidal flows and is also sheltered against north-westerly to south-easterly winds.

4.3.2 The tidal cycle was repeated until equilibrium concentrations in the receiving waters off Ballycotton Village was achieved. The predicted faecal coliform concentrations at 4 principal stages (mid-ebb, low water, mid-flood and highwater) of the mean spring and neap tidal cycles are presented in Figures 17 to 24 for peak 3DWF discharge scenario.

4.3.3 The predicted plume moves parallel to the shoreline in a southeast direction on the ebbing tide and west-northwest direction towards the shoreline on the flooding tide. The plume generally remains offshore and unattached particularly on the ebbing tide and thus is shown to have minimal impact on the Harbour area at Ballycotton and consequently will not impact on the recreational status of the Harbour in respect to mandatory bathing water standards. The neap tide shows similar plume characteristics to the spring tide except that plume migration is reduced due to lower tidal velocities.

4.3.4 The simulations show that a combined peak discharge at Outfall 3 will not impact on the bathing waters at the Priest's leap or the blue flag standards at the beaches and bathing waters of Ballynamona, Ardnahinch or Garryvoe.

4.3.5 Predicted faecal coliform concentrations and dilutions in the immediate vicinity of the outfall (25m by 25m outfall grid) are presented in Table 8 below for mean spring and neap tide simulations. Minimum outfall dilution occurs at low water slack tides whereas maximum dilution occurs at mid-ebb.

Table 8 Predicted dilutions and Concentrations at Outfall 3 for 3DWF Design Load

	Spring Tide		Neap Tide	
	Outfall Dilution	Faecal coliform No./100ml	Outfall Dilution	Faecal coliform No./100ml
Median Dilution	133	7514	204	4889
Minimum Dilution	57	17440	51	19772
Maximum Dilution	205	4866	329	3039

4.3.6 In conclusion the simulation results show that a proposed outfall at Site B is suitable for the combined secondary treated discharge from Shanagarry, Garryvoe and Ballycotton Villages in respect to bacterial impact and bathing water and blue flag standards. From an outfall construction perspective Outfall 3 is in a considerably more sheltered location than Outfall 1 and should be more feasible to construct.

4.4 Faecal Coliform Simulation Results – Outfall Site 4

4.4.1 Outfall 4 was selected as inshore outfall site allowing a WWTP option at an intermediate site between Ballycotton and Shanagarry Villages. To achieve sufficient water depth at low water the outfall has to be extended 700m from the shore with the majority of this distance in the intertidal zone. The water depth at this outfall is 0.7m at low water mean spring tide. The modelled discharge point is located at E199260, N65660 having a water depth at low water mean spring tide of 0.7m.

4.4.2 In the dispersion simulations spring and neap tidal cycles were repeated until equilibrium concentrations within the receiving waters at Ballynamona was achieved. The predicted faecal coliform concentrations at 4 principal stages (mid-ebb, low water, mid-flood and highwater) of the mean spring and neap tidal cycles are presented in Figures 48 to 45 for the 1DWF (1.7l/s) discharge scenario and Figures 25 to 32 for the peak 3DWF discharge scenario.

4.4.3 the receiving waters in the vicinity of Outfall 4 are characterised by extremely slack tides and shallow waters resulting in poor dilution at the Outfall site. The simulated effluent plume shows little difference between spring and neap tides dispersing radially with slight

southerly movement on the ebbing tide and northerly movement on the flooding tide. The plume is shown to significant contaminate the adjacent shoreline / intertidal region at Ballynamona with faecal coliform concentrations exceeding the mandatory bathing water limit of 1000 No./100ml. At low water a very concentrated plume forms which on the flooding tide is pushed onto the Ballynamona shoreline particularly during spring tides.

4.4.4 Prevailing southerly and south-westerly winds will force the plume on to the shore and beach area with little opportunity for southerly excursion on the ebbing tide. Under prevailing winds conditions the beach area at Ardnahinch will also be impacted.

4.4.5 To protect the important bathing status of Ballycotton Bay in the vicinity of Ballynamona and Ardnahinch disinfection will be required if Outfall 4 is to be selected.

4.4.6 Predicted faecal coliform concentrations and dilutions in the immediate vicinity of the outfall (25m by 25m outfall grid) are presented in Table 9 below for mean spring and neap tide simulations. Minimum outfall dilution occurs at low water slack tides whereas maximum dilution occurs at mid-ebb and mid-flood.

Table 9 Predicted dilutions and Concentrations at Outfall 3 for 3DWF Design Load

	Spring Tide		Neap Tide	
	Outfall Dilution	**Faecal coliform No./100ml**	**Outfall Dilution**	**Faecal coliform No./100ml**
Median Dilution	115	8661	75	13271
Minimum Dilution	21	46762	28	35284
Maximum Dilution	231	4327	115	8657

4.4.7 In conclusion the simulation results show that a proposed outfall at Site C produces a significant impact locally particularly at low water spring tide is not suitable for a combined discharge from Shanagarry, Garryvoe and Ballycotton Villages unless disinfection is provided to as to satisfy the National mandatory bathing water limit of 1000 No./100ml at Ballynamona Beach.

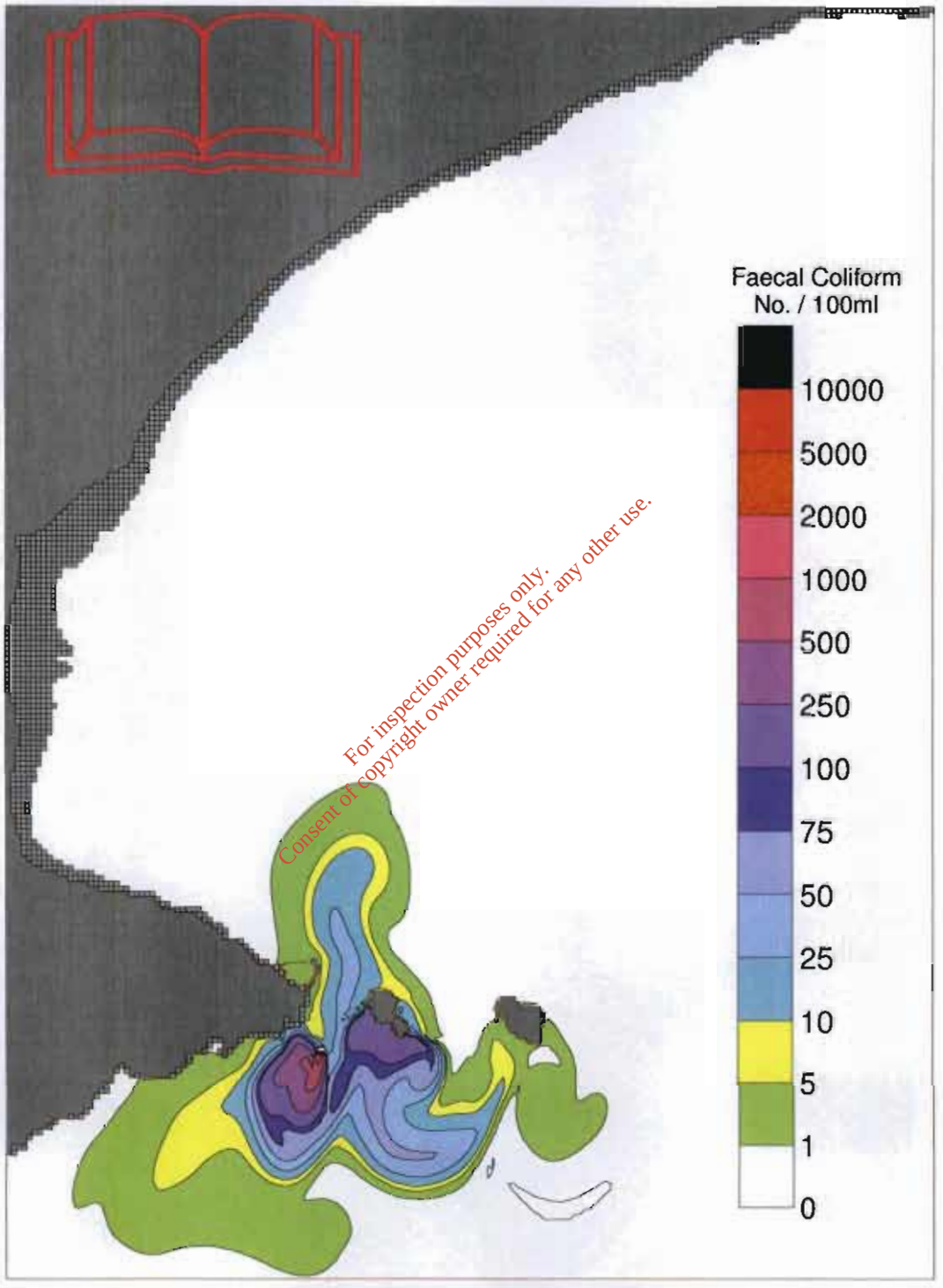


Figure 9 Outfall 1 3DWF Faecal Coliform Concentration Spring Tide at Mid-Ebb

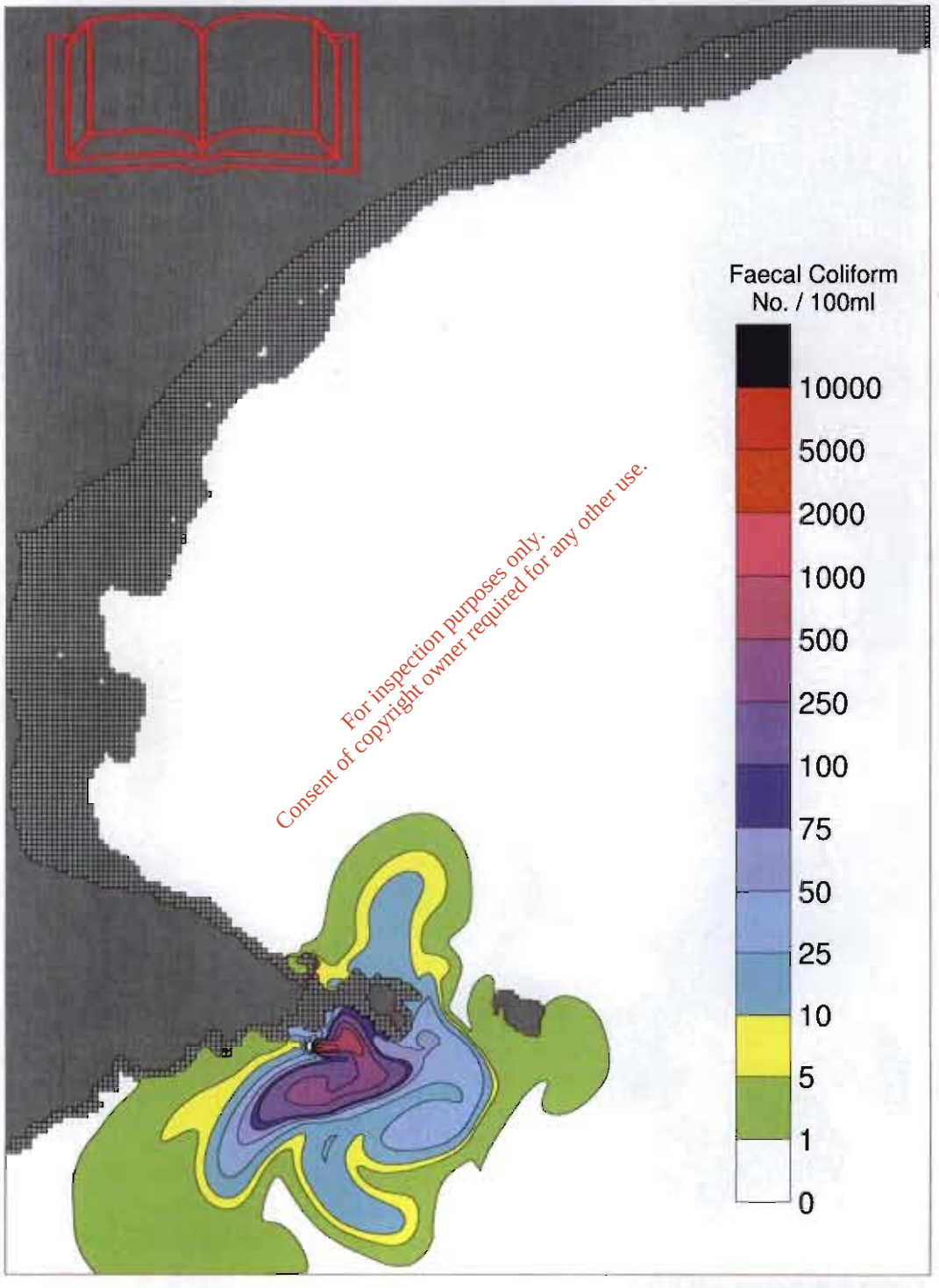


Figure 10 Outfall 1 3DWF Faecal Coliform Concentration Spring Tide at Low Water

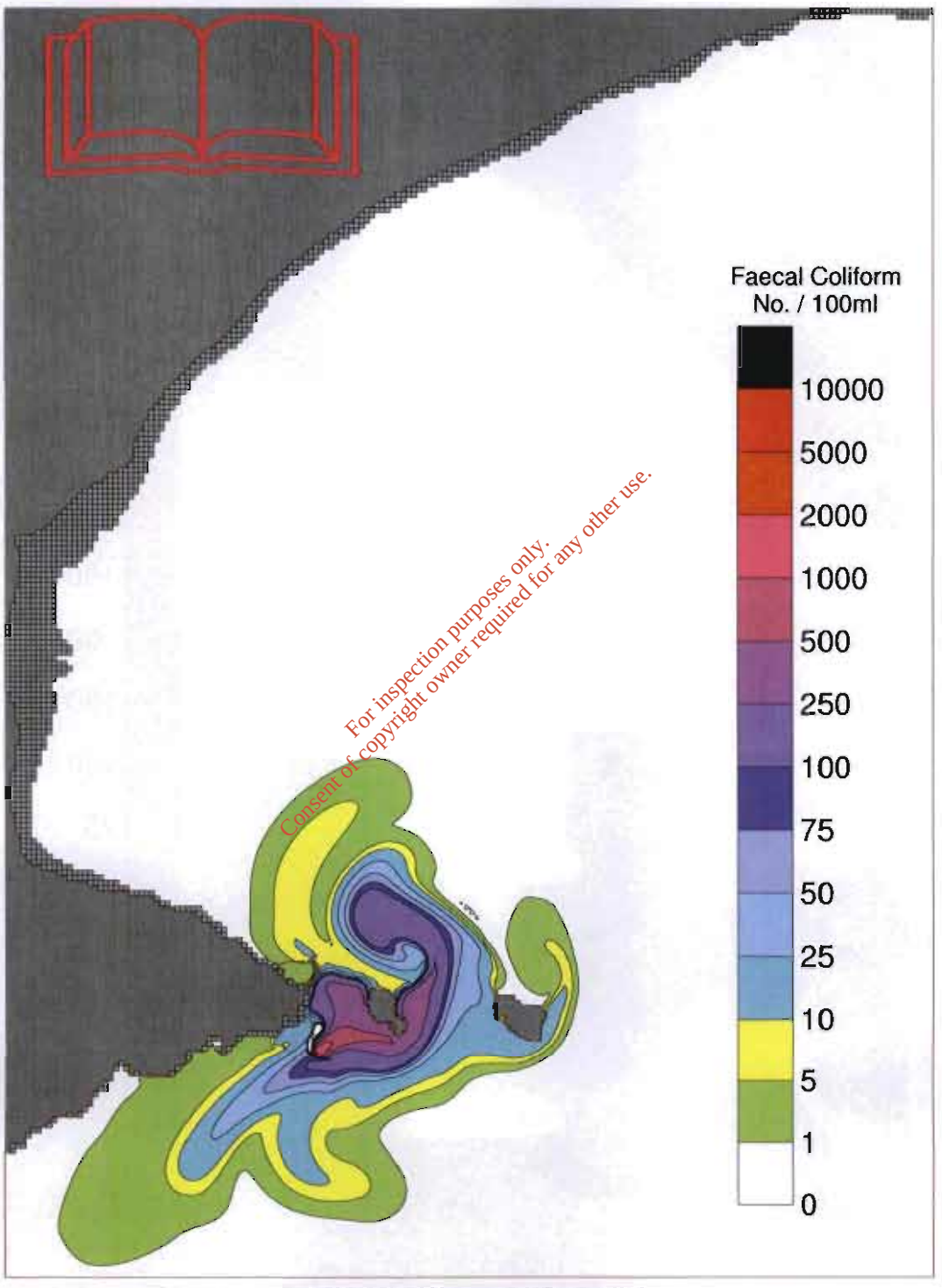


Figure 11 Outfall 1 3DWF Faecal Coliform Concentration Spring Tide at Mid-Flood

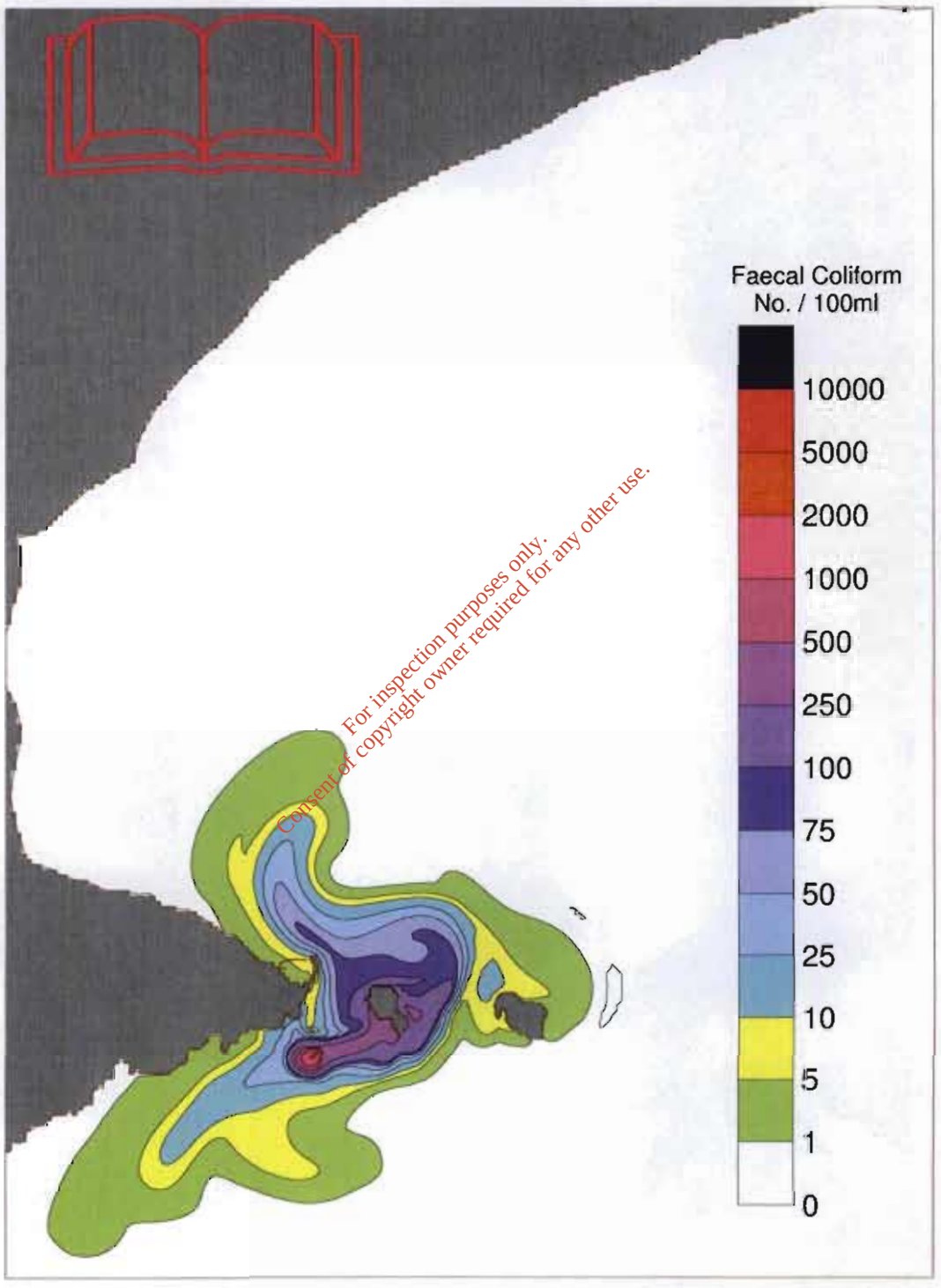


Figure 12 Outfall 1 3DWF Faecal Coliform Concentration Spring Tide at Highwater

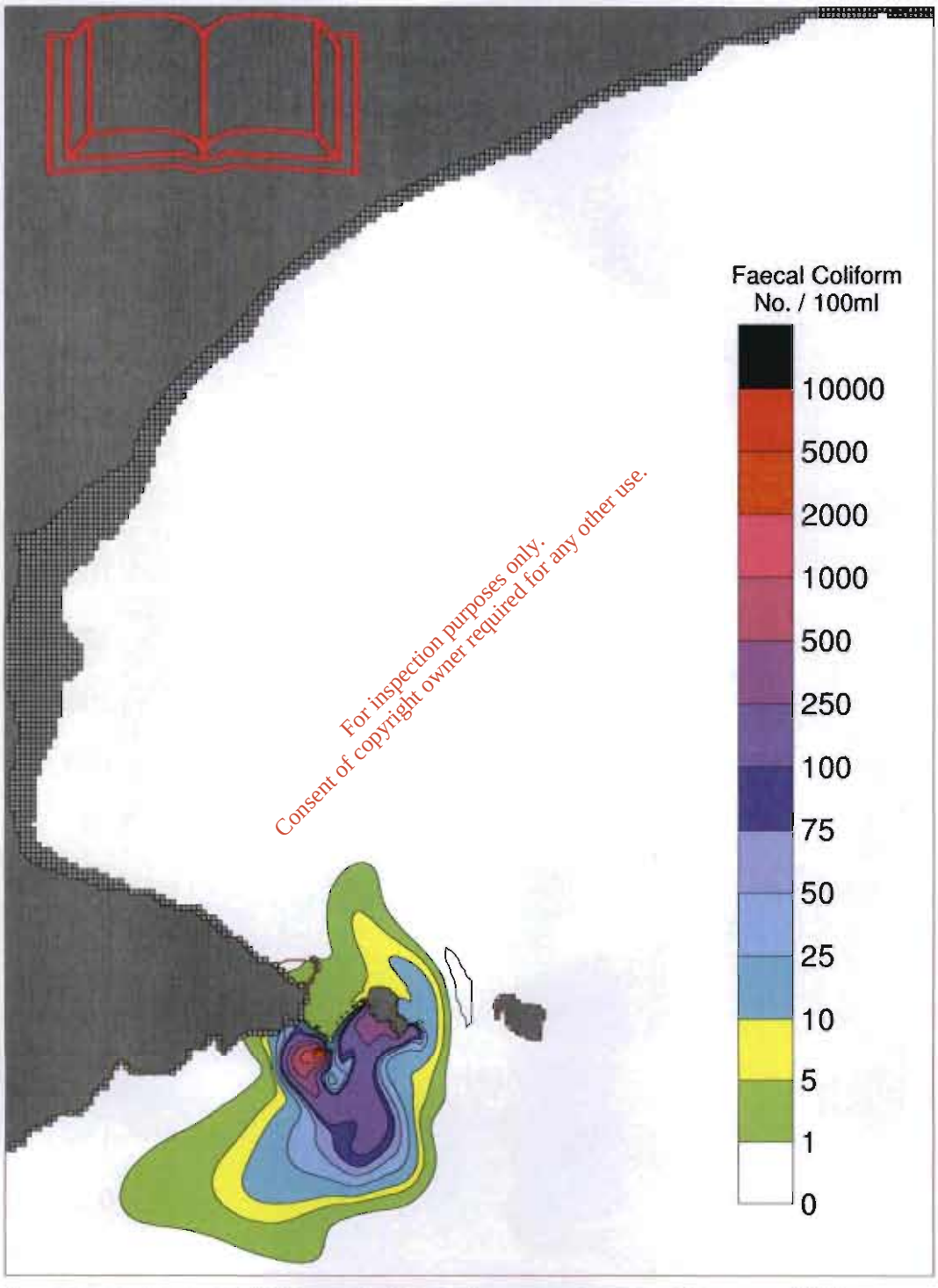


Figure 13 Outfall 1 3DWF Faecal Coliform Concentration Neap Tide at Mid-Ebb

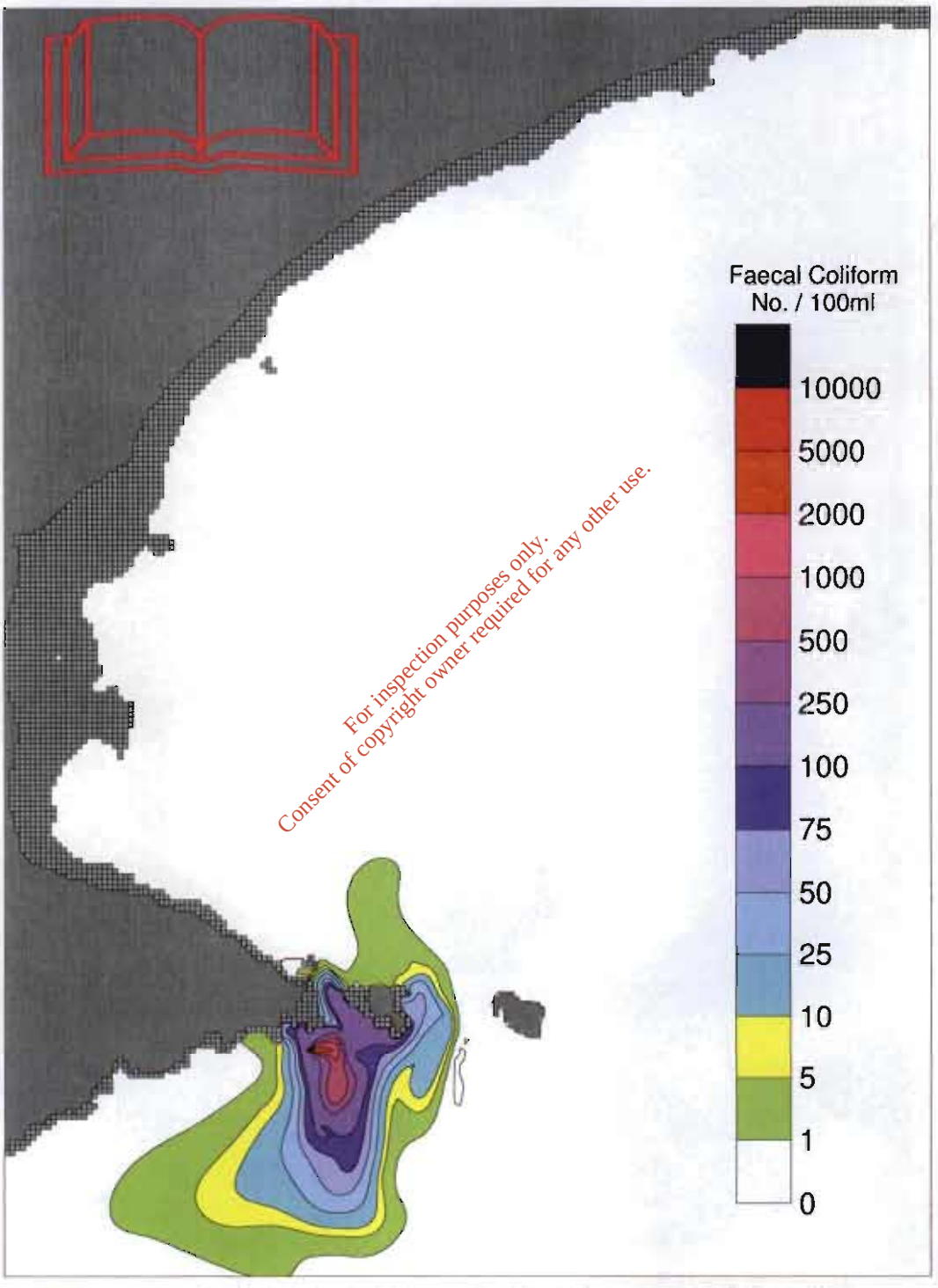


Figure 14 Outfall 1 3DWF Faecal Coliform Concentration Neap Tide at Low Water

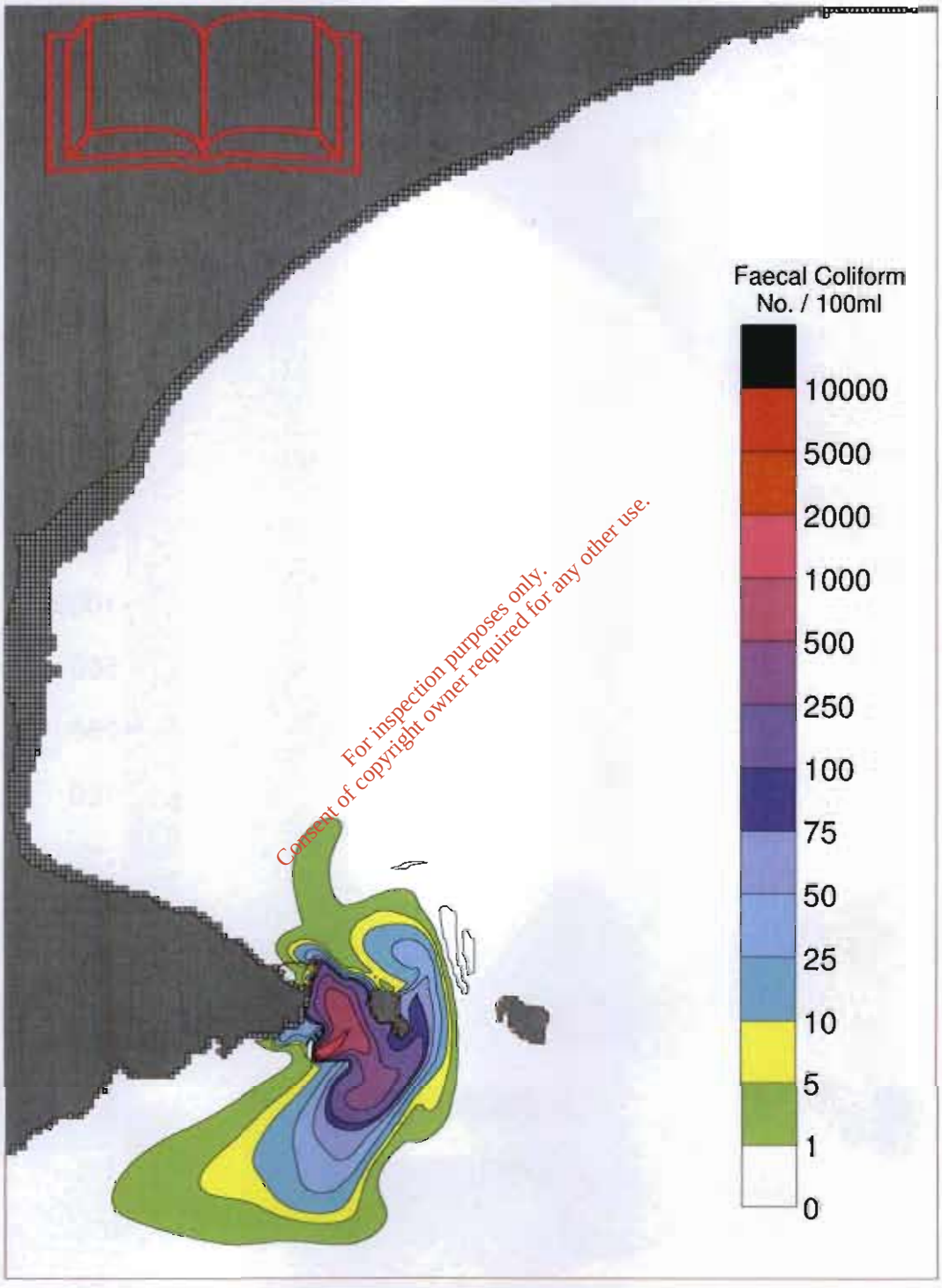


Figure 15 Outfall 1 3DWF Faecal Coliform Concentration Neap Tide at Mid-Flood

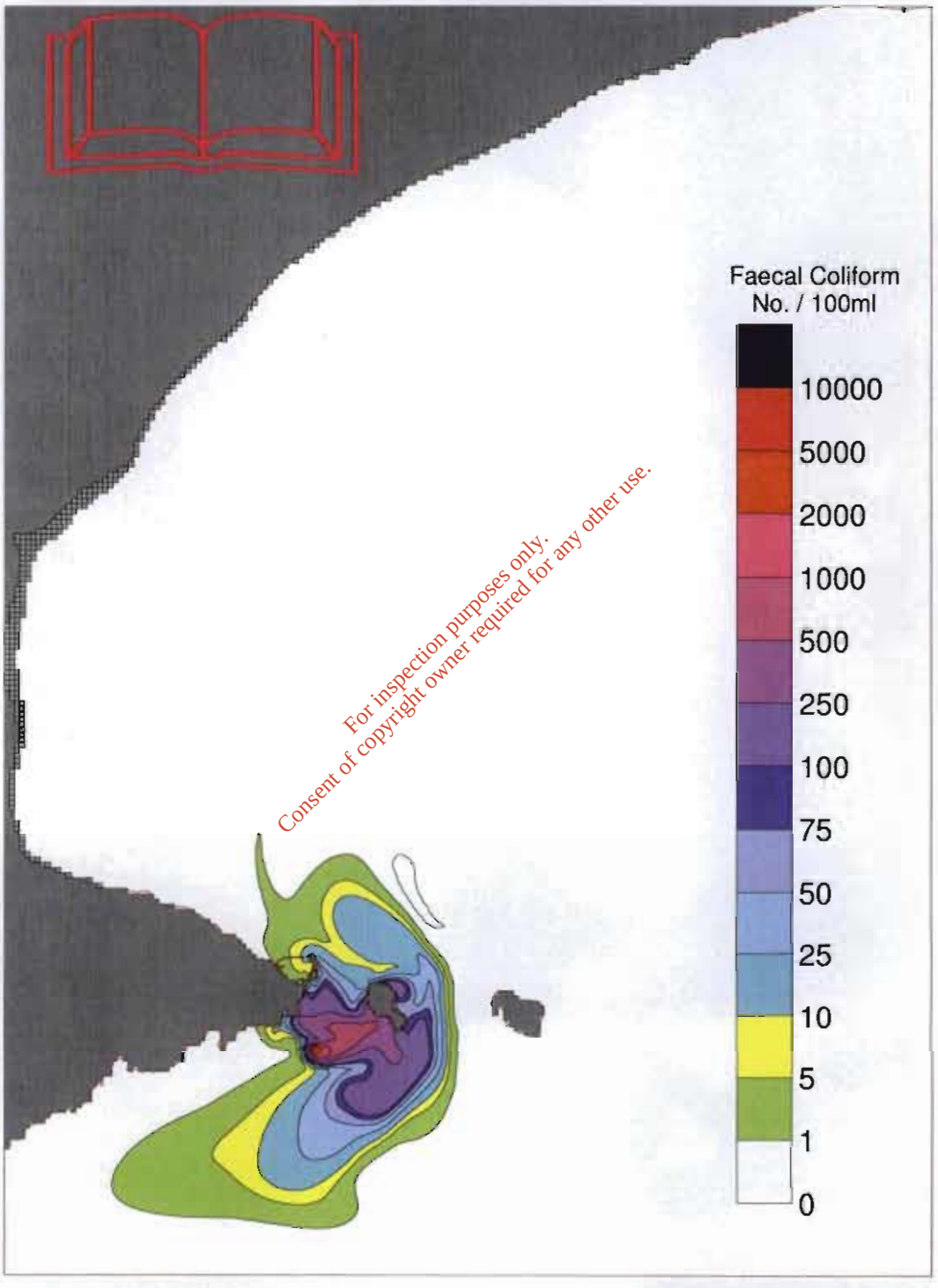


Figure 16 Outfall 1 3DWF Faecal Coliform Concentration Neap Tide at Highwater

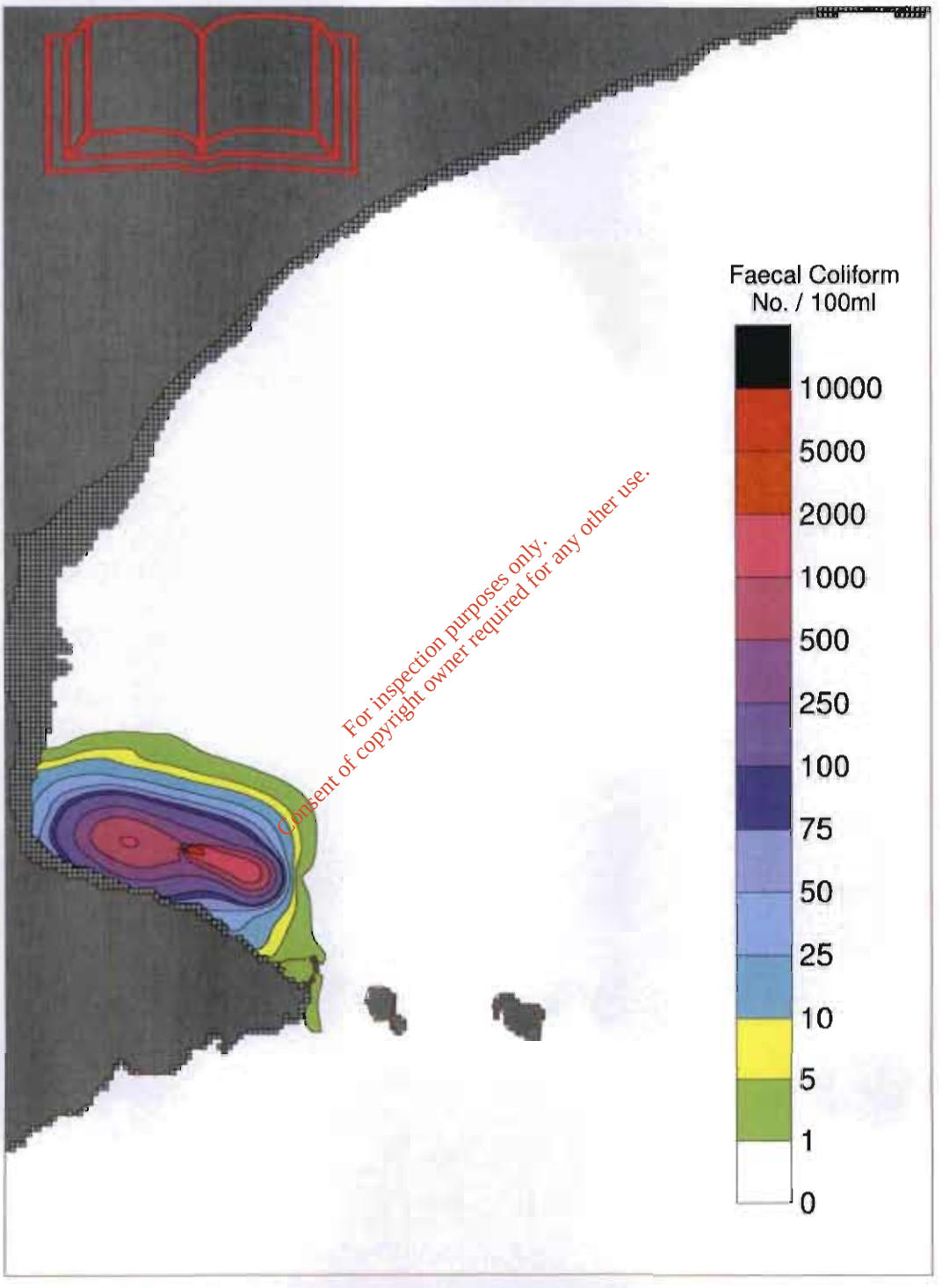


Figure 17 Outfall 3 3DWF Faecal Coliform Concentration Spring Tide Mid-Ebb

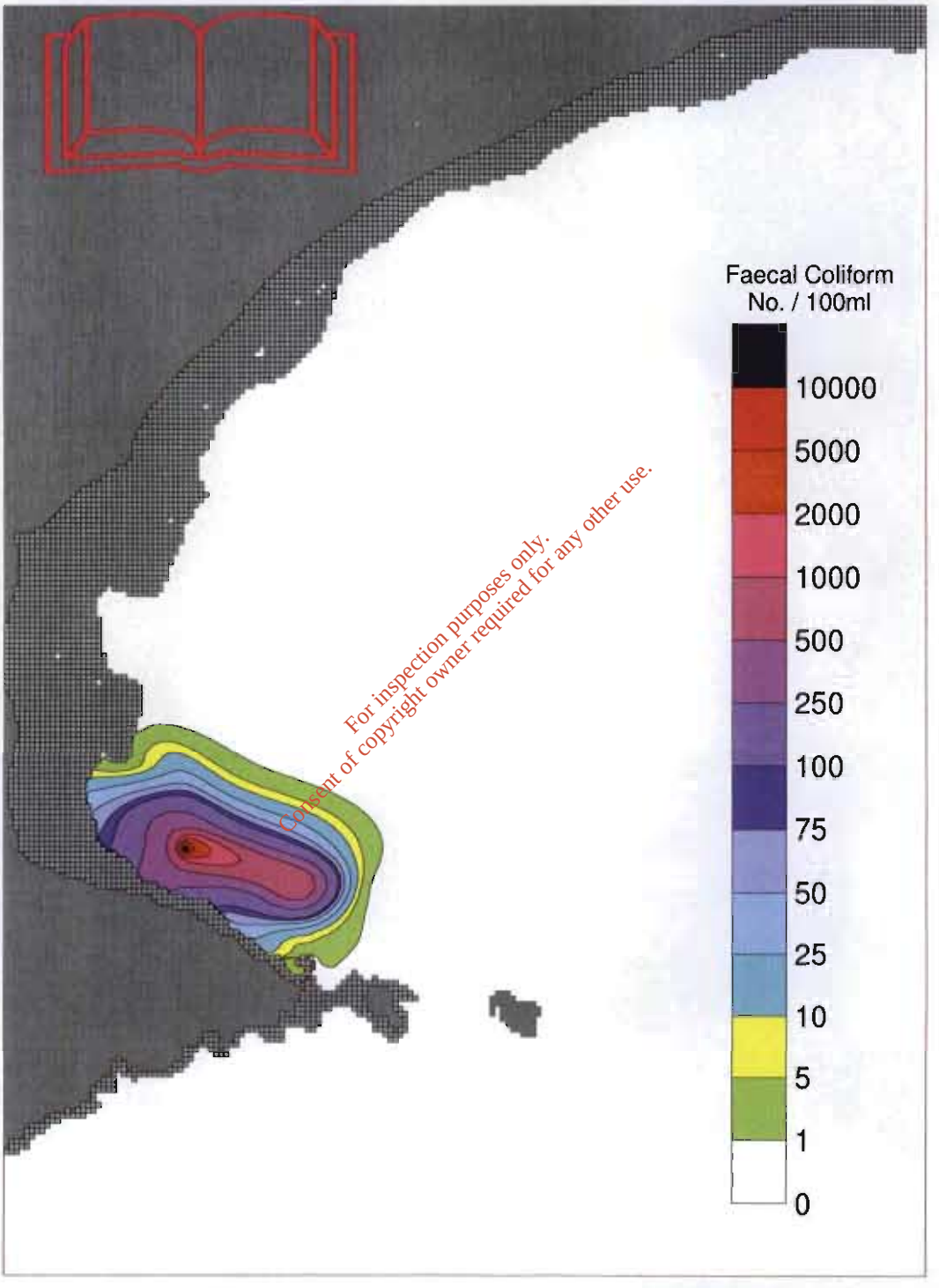


Figure 18 Outfall 3 3DWF Faecal Coliform Concentration Spring Tide Low Water

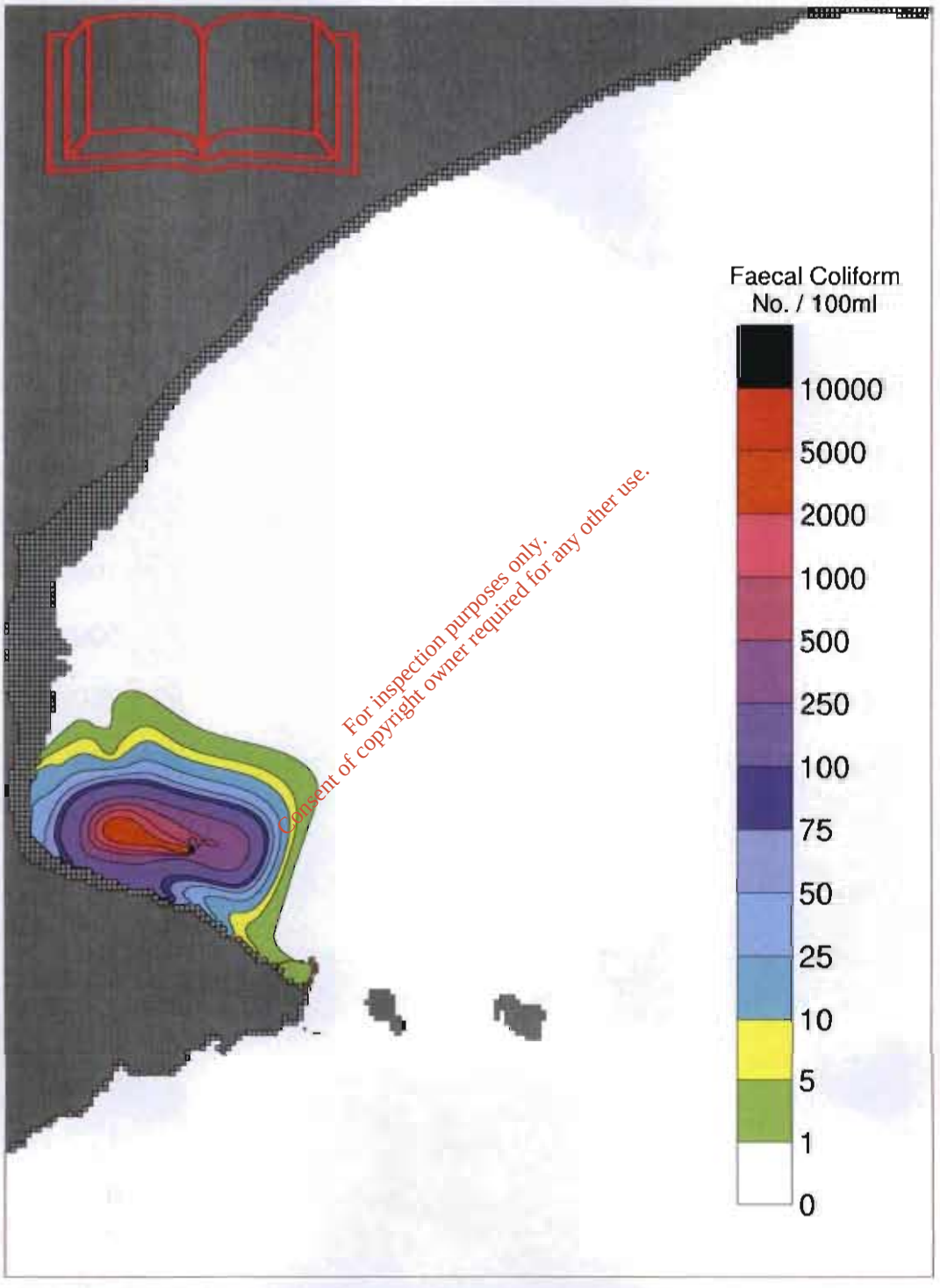


Figure 19 Outfall 3 3DWF Faecal Coliform Concentration Spring Tide Mid-Flood

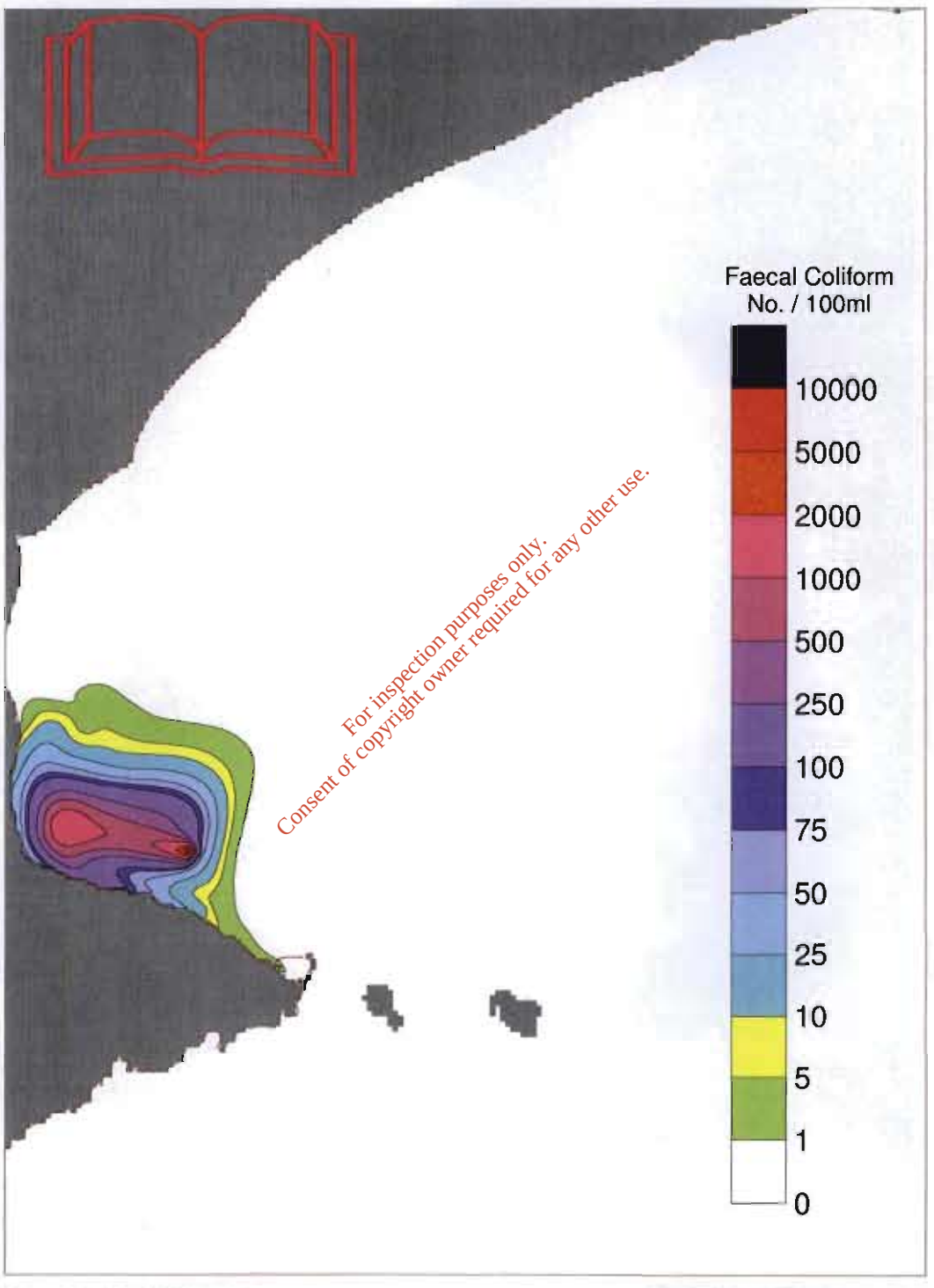


Figure 20 Outfall 3 3DWF Faecal Coliform Concentration Spring Tide Highwater

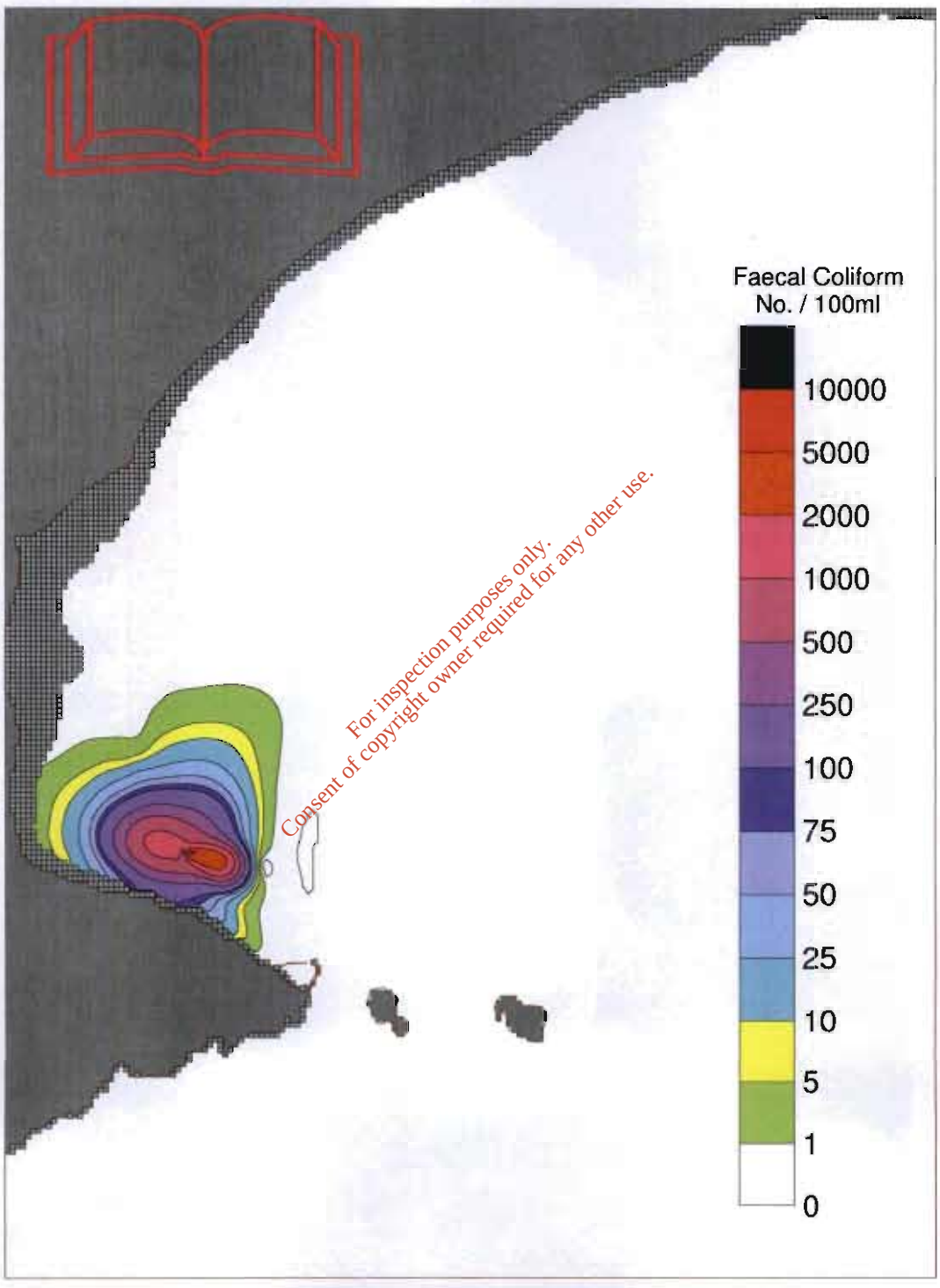


Figure 21 Outfall 3 3DWF Faecal Coliform Concentration Neap Tide Mid-Ebb

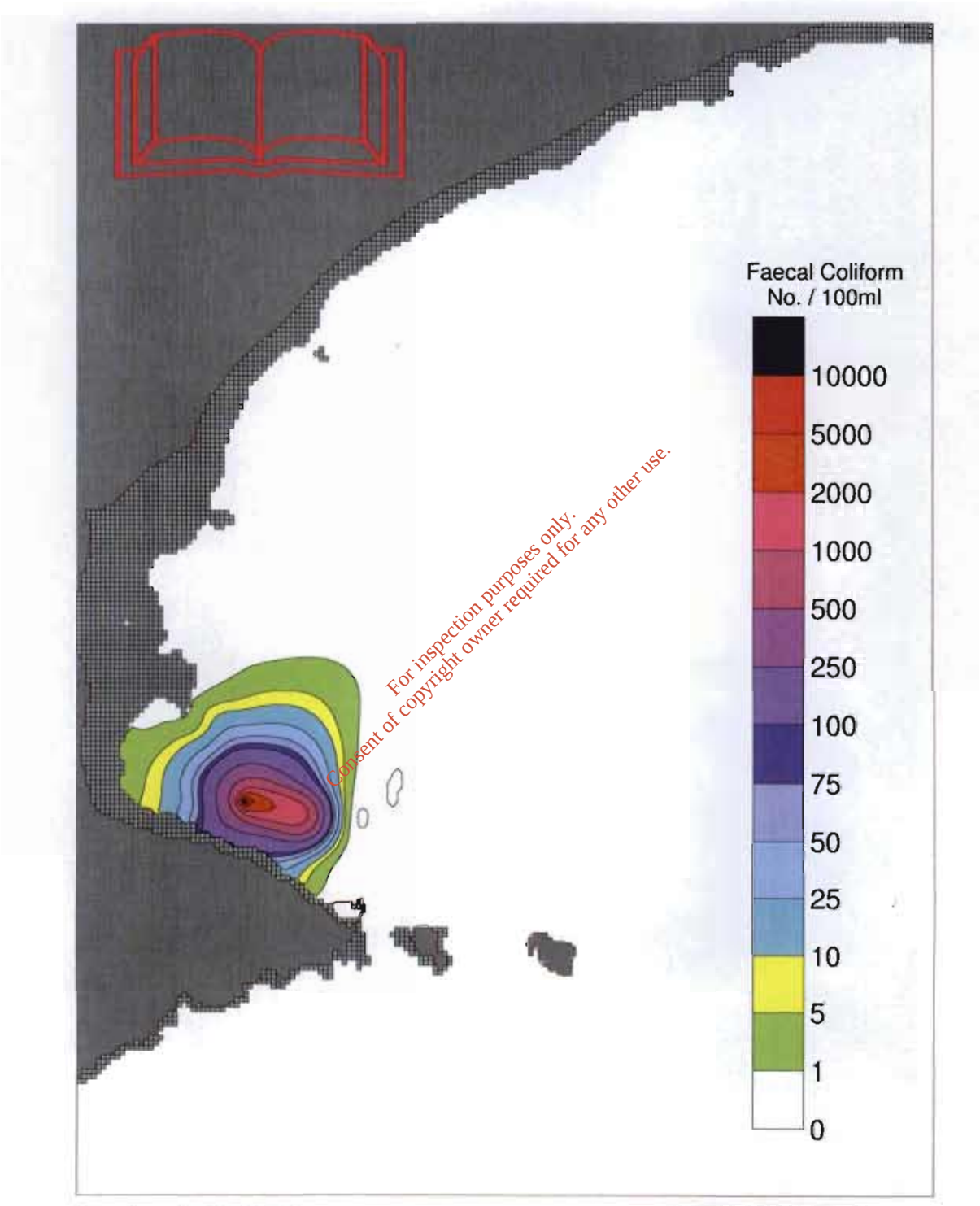


Figure 22 Outfall 3 3DWF Faecal Coliform Concentration Neap Tide Low Water

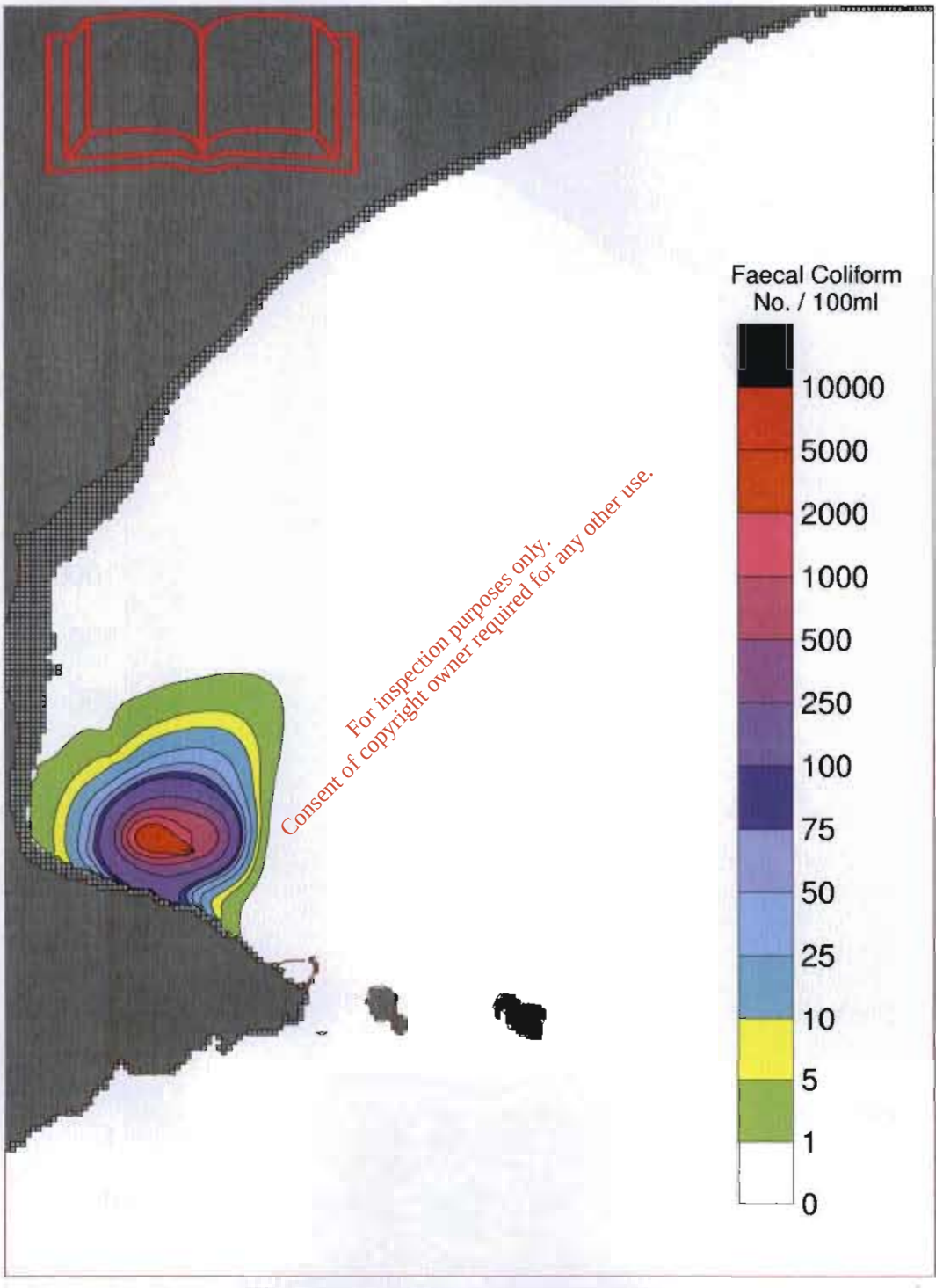


Figure 23 Outfall 3 3DWF Faecal Coliform Concentration Neap Tide Mid-Flood

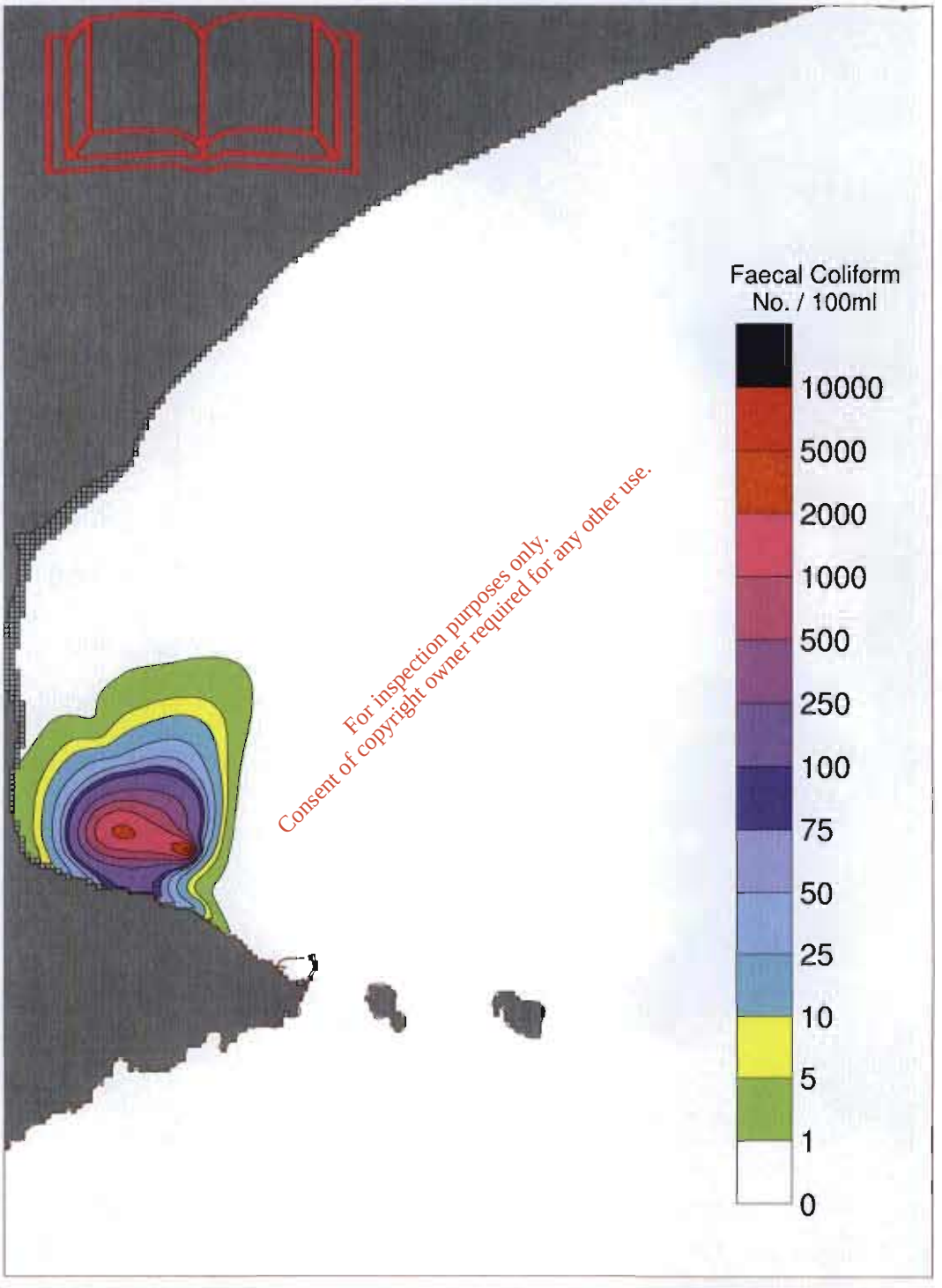


Figure 24 Outfall 3 3DWF Faecal Coliform Concentration Neap Tide Highwater

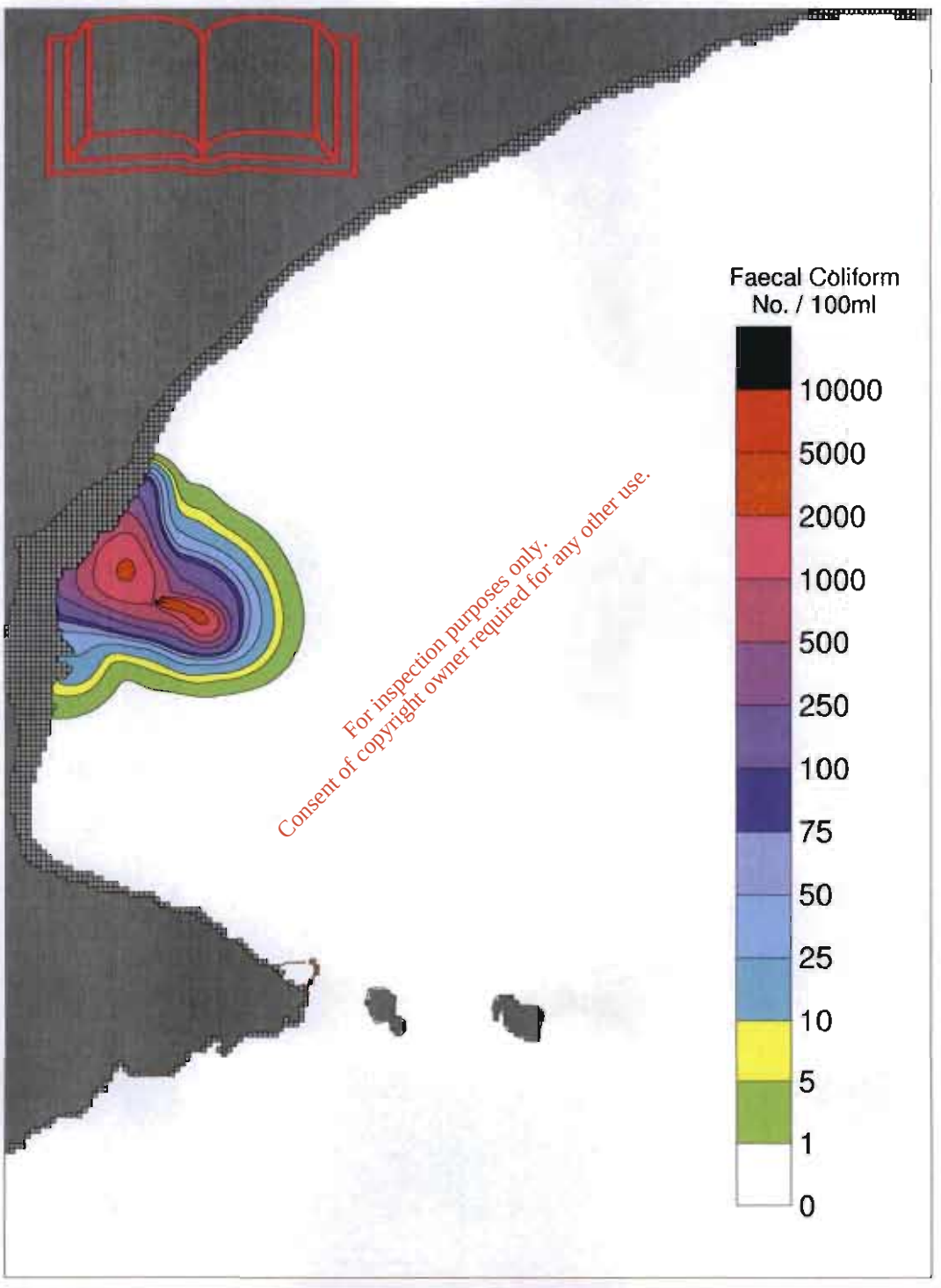


Figure 25 Outfall 4 3DWF Faecal Coliform Concentration Spring Tide Mid-Ebb

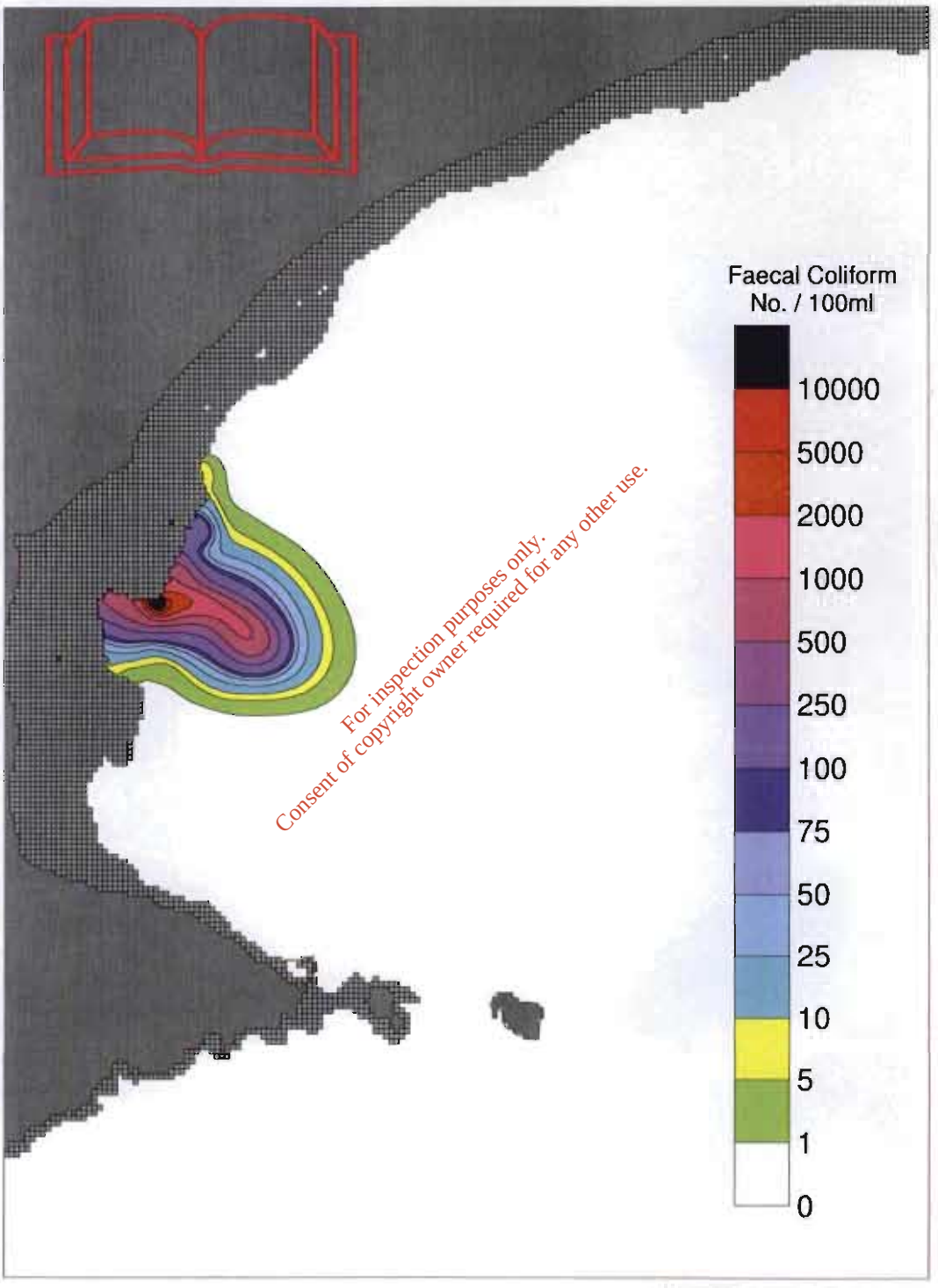


Figure 26 Outfall 4 3DWF Faecal Coliform Concentration Spring Tide Low Water

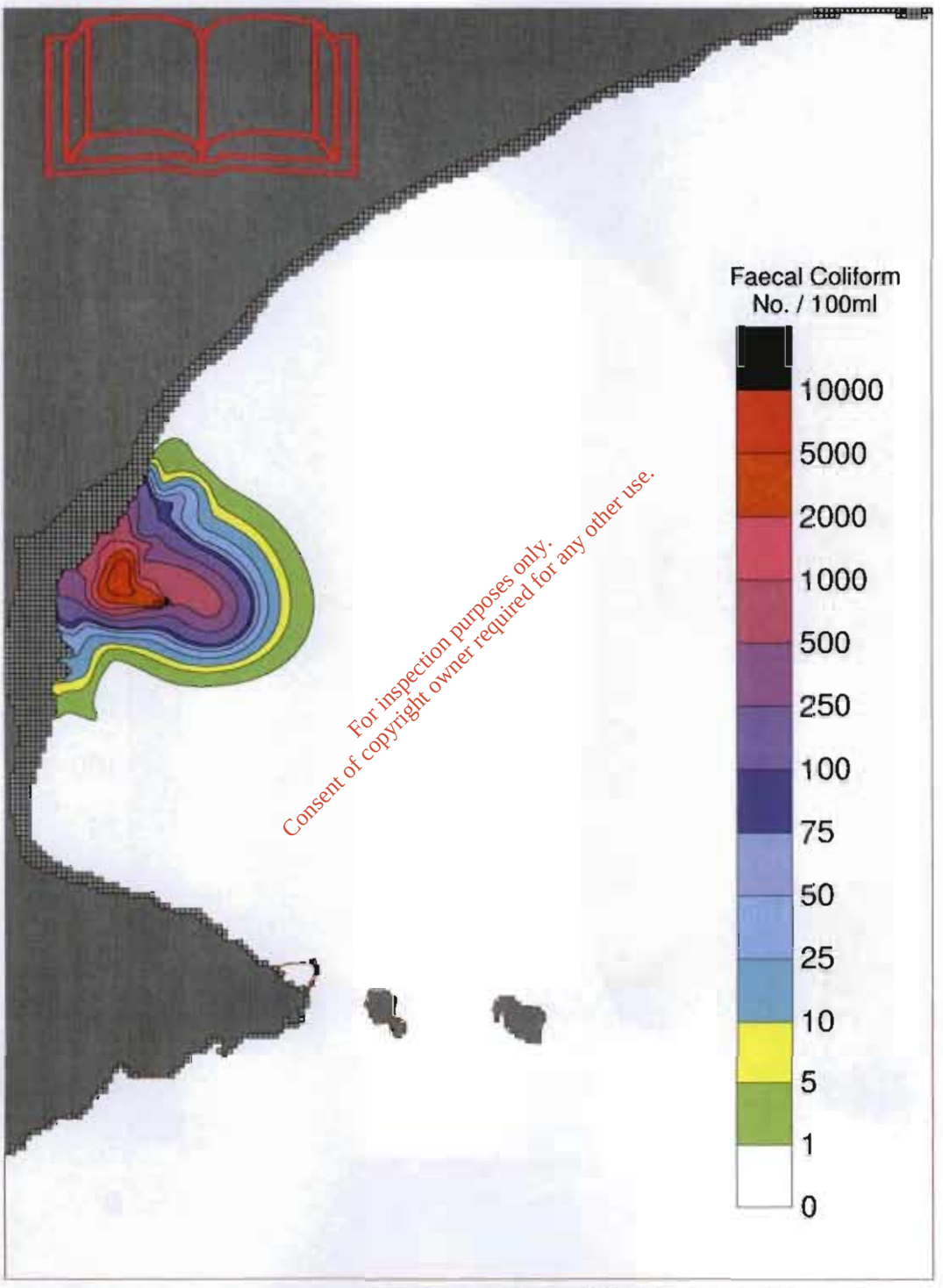


Figure 27 Outfall 4 3DWF Faecal Coliform Concentration Spring Tide Mid-Flood

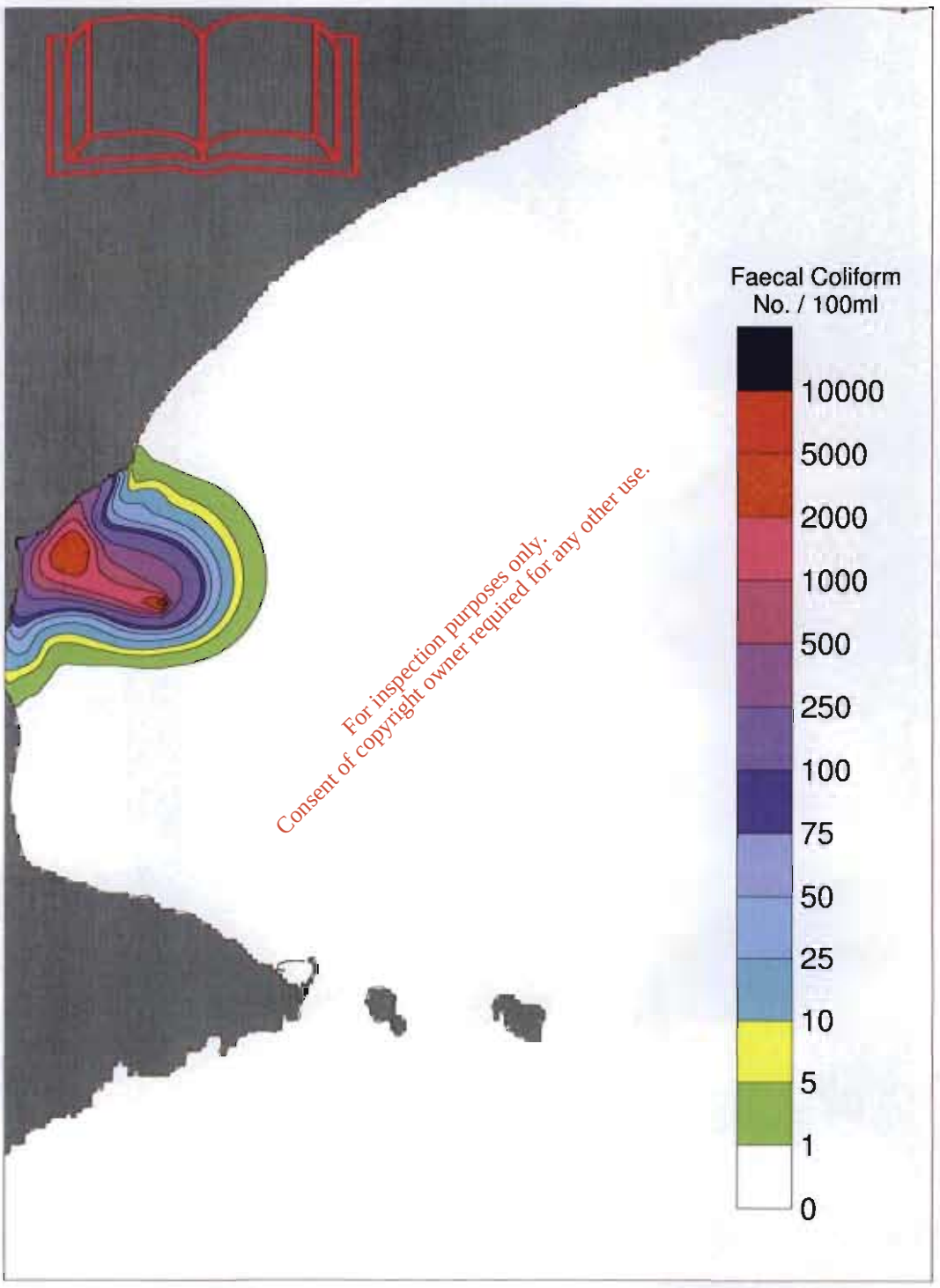


Figure 28 Outfall 4 3DWF Faecal Coliform Concentration Spring Tide Highwater

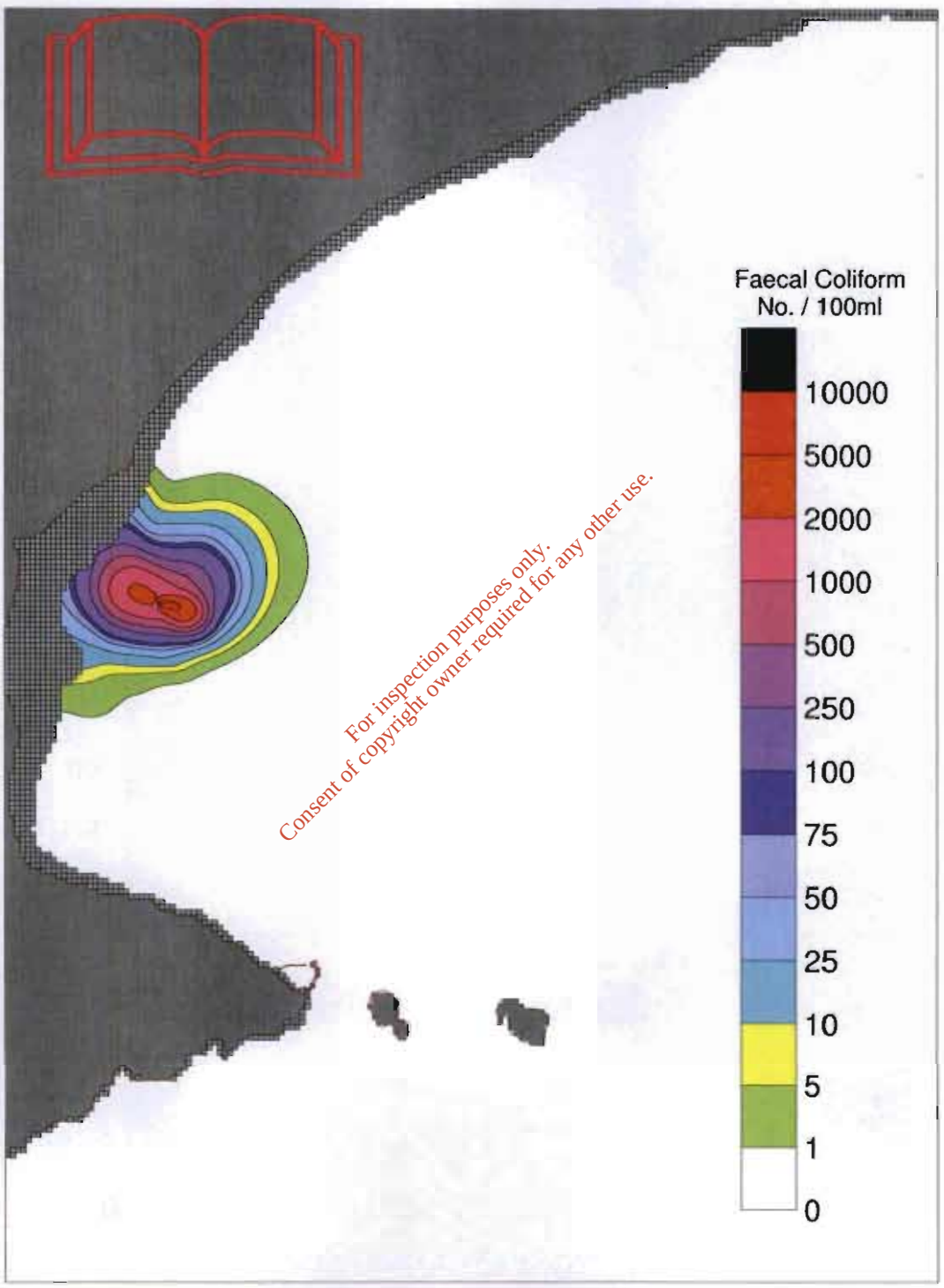


Figure 29 Outfall 4 3DWF Faecal Coliform Concentration Neap Tide Mid-Ebb

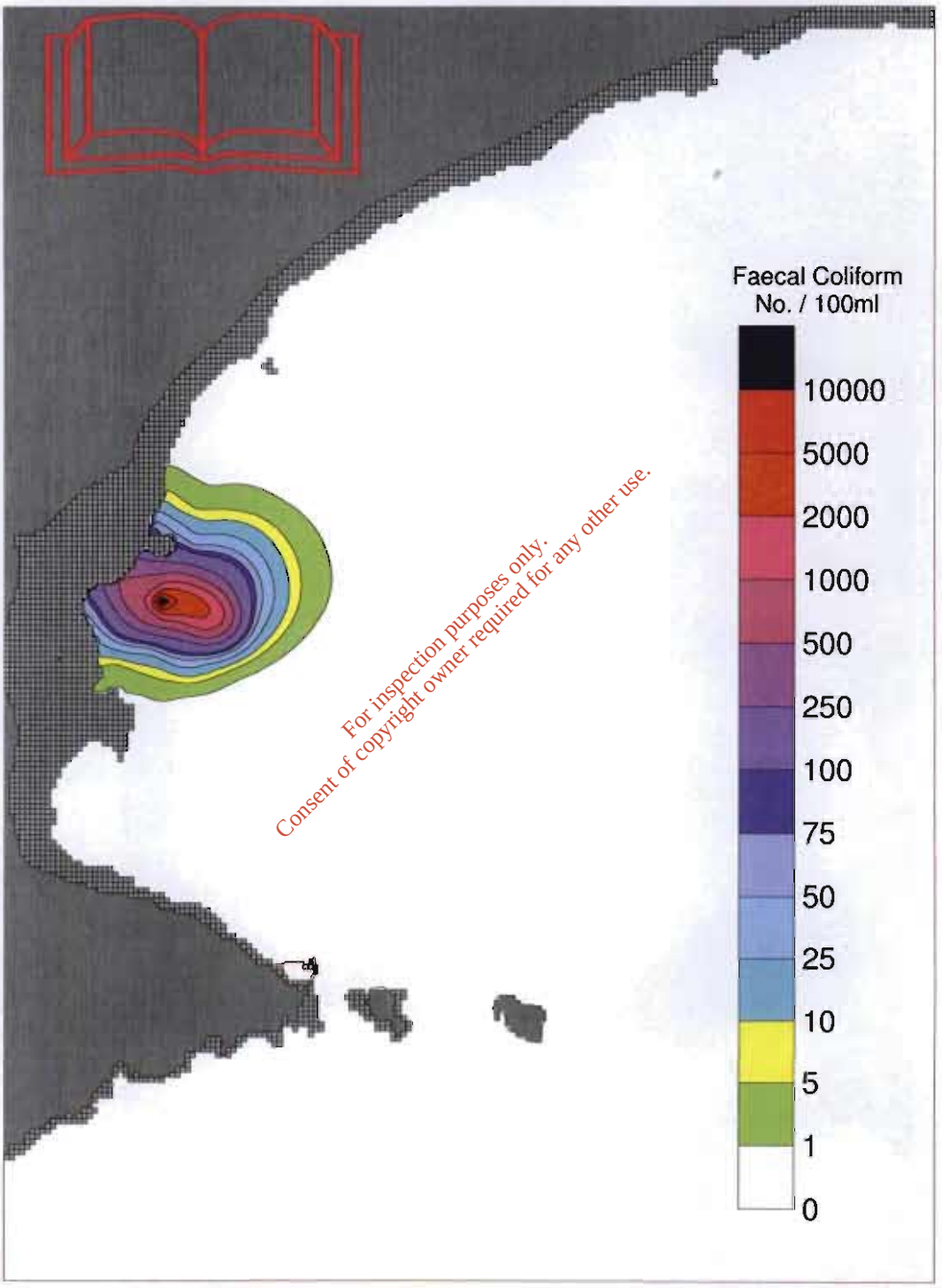


Figure 30 Outfall 4 3DWF Faecal Coliform Concentration Neap Tide Low Water

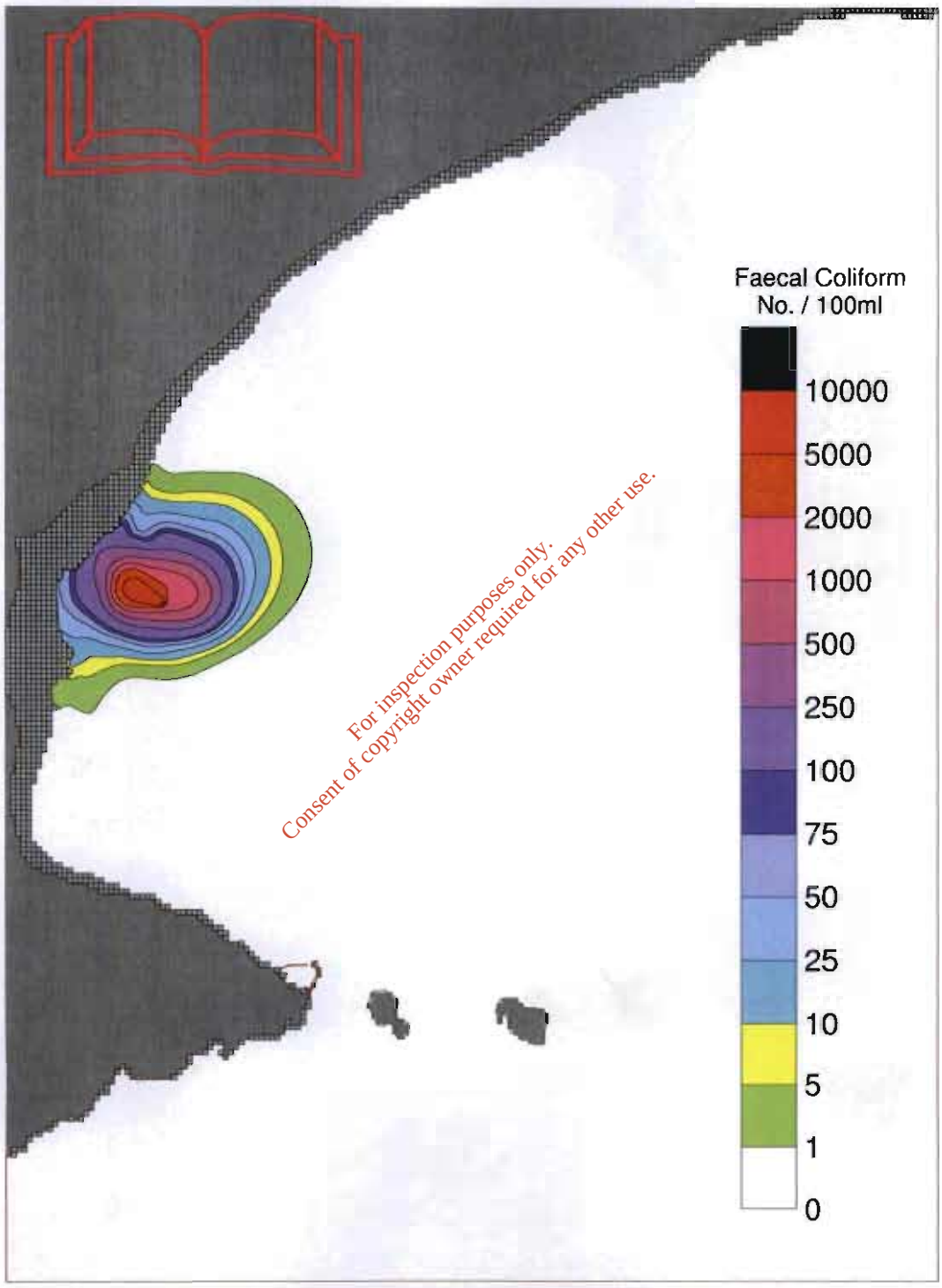


Figure 31 Outfall 4 3DWF Faecal Coliform Concentration Neap Tide Mid-Flood

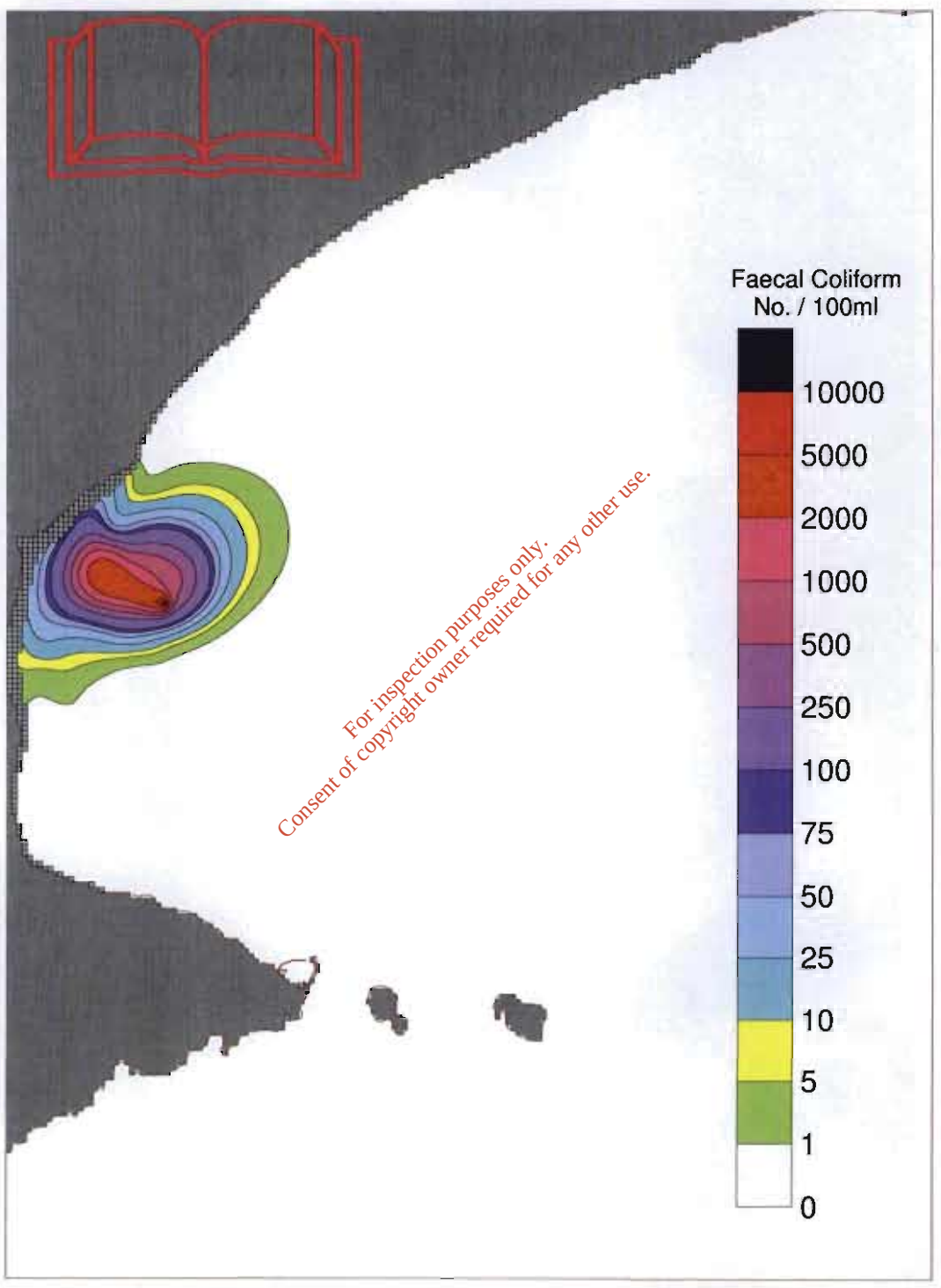


Figure 32 Outfall 4 3DWF Faecal Coliform Concentration Neap Tide Highwater

5. Summary & Conclusions

5.1 Introduction

5.1.1 Three outfall options 1, 3 and 4 were investigated using hydrodynamic and dispersion mathematical modelling to assess the bacterial impact of the proposed sewage discharge on the receiving water quality of Ballycotton Bay and to determine the potential impact on bathing and water recreational areas within the Bay. These three outfall locations were selected as part of the outfall site selection process previously reduced from 7 potential locations.

5.2 Outfall Option 1

5.2.1 This outfall option is located south of Ballycotton Headland outside of the bay area in exposed South Atlantic coastal waters. The site provides the best mixing of the three outfall sites considered due to its exposed nature with wind and wave generated currents and deep water producing good initial dilutions. The outfall, however, represents a difficult engineering feat due to its exposure to west, south and east Atlantic offshore winds and the presence of extensive rock outcropping along its pipeline route.

5.2.2 The simulation results show for both spring and neap tidal cycles that the effluent plume is well dispersed and generally remains south of Ballycotton Headland. In conclusion, the simulation results show that a proposed outfall at Site 1 is suitable for the combined secondary treated discharge from Shanagarry, Garryvoe and Ballycotton Villages in respect to bacterial impact and the bathing water and blue flag standards within Ballycotton Bay.

5.3 Outfall Option 3

5.3.1 Outfall 3 was selected inside Ballycotton headland adjacent to the existing outfall pipe but extended eastward a distance of 320m from the shore to prevent significant shoreline plume attachment and to avail of a reasonable depth of water for initial mixing at the outfall site (i.e. 2.3m water depth available at low water spring tides). This general location is characterised by slack tidal flows and is also sheltered against north-westerly to south-easterly winds.

5.3.2 The hydrodynamic simulations show the effluent plume to generally remain offshore and unattached particularly on the ebbing tide having minimal impact on the Harbour area at Ballycotton Village and consequently will not impact on the recreational status of the Harbour or the local swimming spot at Priest's leap in respect to mandatory bathing water standards. The outfall discharge is shown to have negligible/imperceptible impact on the bathing waters at Ballynamona, Ardnahinch or Garryvoe and thus will not alter the Blue Flag status of the beach at Garryvoe.

5.3.3 In conclusion the simulation results show that a proposed outfall at Site 3 is suitable for the a secondary treated effluent discharge from the combined villages of Shanagarry, Garryvoe and Ballycotton in respect to bacterial impact and bathing water and blue flag standards. From an outfall construction perspective outfall option 3 is located in a considerably more sheltered location than outfall 1 and thus poses less difficulties for construction.

5.4 Outfall Option 4

5.4.1 Outfall option 4 was selected as an inshore outfall site allowing a WWTP option at an intermediate site between Ballycotton and Shanagarry Villages. To achieve sufficient water depth at low water the outfall has to be extended 700m from the shore with the majority of this distance in the intertidal zone (depending on the route taken). The water depth at this outfall is shallow at 0.7m at low water mean spring tide or 0.2m at LAT.

5.4.2 The receiving waters in the vicinity of Outfall 4 are characterised by extremely slack tides and shallow waters resulting in poor dilution at the outfall site. The simulated effluent plume shows little difference between spring and neap tides dispersing slowly radially with slight southerly movement on the ebbing tide and northerly movement on the flooding tide. The plume is shown to significantly contaminate the adjacent shoreline / intertidal region at Ballynamona with faecal coliform concentrations exceeding the mandatory bathing water limit of 1000 No./100ml along the shoreline there. At low water a very concentrated plume forms which on the flooding tide is pushed onto the Ballynamona shoreline particularly during spring tides.

5.4.3 Prevailing southerly and south-westerly winds will force the plume on to the shore and beach areas with little opportunity for southerly excursion on the ebbing / retreating tide.

Under prevailing winds the beach area at Ardnahinch has the potential to be impacted on by wind blown surface effluent plume.

5.4.4 To protect the important blue flag bathing status of Ballycotton Bay in the vicinity of Ballynamona and Ardnahinch beaches disinfection will be required if Outfall option 4 is to be selected. Alternatively, relocating the outfall 400m further offshore in a 2.0m water depth at low tide will facilitate a secondary treated effluent discharge.

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THIS APPLICATION HAS NOT BEEN SUBMITTED

Agglomeration details

Leading Local Authority	Cork County Council
Co-Applicants	
Agglomeration	Ballycotton
Population Equivalent	971
Level of Treatment	Primary
Treatment plant address	Ballycotton, Cork.
Grid Ref (12 digits, 6E, 6N)	199209 / 064224 (Verifed using GPS)
EPA Reference No:	

Contact details

Contact Name:	Patricia Power
Contact Address:	Water Services Section Cork County Council Southern Division Carrigrohane Road Cork
Contact Number:	021-4276891
Contact Fax:	021-4276321
Contact Email:	patricia.power@corkcoco.ie

Table D.1(i)(a): EMISSIONS TO SURFACE/GROUND WATERS (Primary Discharge Point)

Discharge Point Code: SW-1

Local Authority Ref No:	SW1BCTN	
Source of Emission:	Primary Discharge	
Location:	Ballycotton	
Grid Ref (12 digits, 6E, 6N)	199250 / 064250 (Verifed using GPS)	
Name of Receiving waters:	Ballycotton Bay	
Water Body:	Coastal Water Body	
River Basin District	South Western RBD	
Designation of Receiving Waters:	None	
Flow Rate in Receiving Waters:	0	$m^3.sec^{-1}$ Dry Weather Flow
	0	$m^3.sec^{-1}$ 95% Weather Flow
Additional Comments (e.g. commentary on zero flow or other information deemed of value)	Coastal Waters - No Dry Weather Flow or 95% Flow available.	

Emission Details:

(i) Volume emitted			
Normal/day	125.3 m^3	Maximum/day	376 m^3
Maximum rate/hour	15.7 m^3	Period of emission (avg)	60 min/hr 24 hr/day 365 day/yr
Dry Weather Flow	0.0015 m^3/sec		

THIS APPLICATION HAS NOT BEEN SUBMITTED

Table D.1(i)(b): EMISSIONS TO SURFACE/GROUND WATERS - Characteristics of The Emission (Primary Discharge Point)

Discharge Point Code: SW-1

Substance	As discharged			
	Unit of Measurement	Sampling Method	Max Daily Avg.	kg/day
pH	pH	Grab	= 9	
Temperature	°C	Grab	= 25	
Electrical Conductivity (@ 25°C)	µS/cm	Grab	= 1000	
Suspended Solids	mg/l	Grab	= 350	131.6
Ammonia (as N)	mg/l	Grab	= 25	9.4
Biochemical Oxygen Demand	mg/l	Grab	= 300	112.8
Chemical Oxygen Demand	mg/l	Grab	= 800	300.8
Total Nitrogen (as N)	mg/l	Grab	= 85	31.96
Nitrite (as N)	mg/l	Grab	= 0	0
Nitrate (as N)	mg/l	Grab	= 10	3.76
Total Phosphorous (as P)	mg/l	Grab	= 12	4.51
OrthoPhosphate (as P)	mg/l	Grab	= 3	1.13
Sulphate (SO_4)	mg/l	Grab	= 80	30.1
Phenols (Sum)	µg/l	Grab	< 0.1	0.038

For Orthophosphate: this monitoring should be undertaken on a sample filtered on 0.45µm filter paper
For Phenols: USEPA Method 604, AWWA Standard Method 6240, or equivalent

Table D.1(i)(c): DANGEROUS SUBSTANCE EMISSIONS TO SURFACE/GROUND WATERS - Characteristics of The Emission (Primary Discharge Point)

Discharge Point Code: SW-1

Substance	As discharged			
	Unit of Measurement	Sampling Method	Max Daily Avg.	kg/day
Atrazine	µg/l	Grab	< 0.01	0.0038
Dichloromethane	µg/l	Grab	< 1	0.38
Simazine	µg/l	Grab	< 0.01	0.0038
Toluene	µg/l	Grab	< 0.28	0.11
Tributyltin	µg/l	Grab	= 0	0
Xylenes	µg/l	Grab	< 0.73	0.27
Arsenic	µg/l	Grab	< 0.96	0.361
Chromium	µg/l	Grab	< 20	7.52
Copper	µg/l	Grab	< 20	7.52
Cyanide	µg/l	Grab	< 5	1.88
Flouride	µg/l	Grab	= 0.6	0.23
Lead	µg/l	Grab	< 20	7.52
Nickel	µg/l	Grab	< 20	7.52
Zinc	µg/l	Grab	< 20	7.52
Boron	µg/l	Grab	= 100	37.6
Cadmium	µg/l	Grab	< 20	7.52
Mercury	µg/l	Grab	< 0.03	0.011
Selenium	µg/l	Grab	= 4	1.5
Barium	µg/l	Grab	< 20	7.52

For Orthophosphate: this monitoring should be undertaken on a sample filtered on 0.45µm filter paper
For Phenols: USEPA Method 604, AWWA Standard Method 6240, or equivalent.

Table D.1(ii)(a): EMISSIONS TO SURFACE/GROUND WATERS (Secondary Discharge Point)

Discharge Point Code: SW-2

Local Authority Ref No:	SW2BCTN	
Source of Emission:	Secondary Discharge	
Location:	Ballycotton Pier	
Grid Ref (12 digits, 6E, 6N)	200017 / 063889 (Verifed using GPS)	
Name of Receiving waters:	Ballycotton Bay	
Water Body:	Coastal Water Body	
River Basin District	South Eastern RBD	
Designation of Receiving Waters:	None	
Flow Rate in Receiving Waters:	0	$m^3.sec^{-1}$ Dry Weather Flow
	0	$m^3.sec^{-1}$ 95% Weather Flow
Additional Comments (e.g. commentary on zero flow or other information deemed of value)	Coastal Waters - No Dry Weather Flow or 95% Flow available.	

Emission Details:

(i) Volume emitted			
Normal/day	93.15 m^3	Maximum/day	279.45 m^3
Maximum rate/hour	11.64 m^3	Period of emission (avg)	60 min/hr 24 hr/day 365 day/yr
Dry Weather Flow	0.00112 m^3/sec		

THIS APPLICATION HAS NOT BEEN SUBMITTED

Table D.1(ii)(b): EMISSIONS TO SURFACE/GROUND WATERS - Characteristics of The Emission (Secondary Discharge Point)

Discharge Point Code: SW-2

Substance	As discharged			
	Unit of Measurement	Sampling Method	Max Daily Avg.	kg/day
pH	pH	Grab	= 9	
Temperature	°C	Grab	= 25	
Electrical Conductivity (@ 25°C)	µS/cm	Grab	= 1000	
Suspended Solids	mg/l	Grab	= 350	97.81
Ammonia (as N)	mg/l	Grab	= 30	8.39
Biochemical Oxygen Demand	mg/l	Grab	= 300	83.84
Chemical Oxygen Demand	mg/l	Grab	= 800	223.56
Total Nitrogen (as N)	mg/l	Grab	= 85	23.75
Nitrite (as N)	mg/l	Grab	= 0	0
Nitrate (as N)	mg/l	Grab	= 5	1.4
Total Phosphorous (as P)	mg/l	Grab	= 12	3.35
OrthoPhosphate (as P)	mg/l	Grab	= 3	0.84
Sulphate (SO_4)	mg/l	Grab	= 60	16.77
Phenols (Sum)	µg/l	Grab	< 0.1	0.028

For Orthophosphate: this monitoring should be undertaken on a sample filtered on 0.45µm filter paper
For Phenols: USEPA Method 604, AWWA Standard Method 6240, or equivalent

Table D.1(ii)(c): DANGEROUS SUBSTANCE EMISSIONS TO SURFACE/GROUND WATERS - Characteristics of The Emission (Secondary Discharge Point)

Discharge Point Code: SW-2

Substance	As discharged			
	Unit of Measurement	Sampling Method	Max Daily Avg.	kg/day
Atrazine	µg/l	Grab	< 0.01	0.0028
Dichloromethane	µg/l	Grab	< 1	0.28
Simazine	µg/l	Grab	< 0.01	0.0028
Toluene	µg/l	Grab	= 5	1.4
Tributyltin	µg/l	Grab	= 0	0
Xylenes	µg/l	Grab	< 0.73	0.2
Arsenic	µg/l	Grab	< 0.96	0.27
Chromium	µg/l	Grab	< 20	5.59
Copper	µg/l	Grab	< 20	5.59
Cyanide	µg/l	Grab	< 5	1.4
Flouride	µg/l	Grab	= 0.5	0.14
Lead	µg/l	Grab	< 20	5.59
Nickel	µg/l	Grab	< 20	5.59
Zinc	µg/l	Grab	< 20	5.59
Boron	µg/l	Grab	= 60	16.77
Cadmium	µg/l	Grab	< 20	5.59
Mercury	µg/l	Grab	< 0.03	0.0084
Selenium	µg/l	Grab	= 4	1.12
Barium	µg/l	Grab	< 20	5.59

For Orthophosphate: this monitoring should be undertaken on a sample filtered on 0.45µm filter paper
For Phenols: USEPA Method 604, AWWA Standard Method 6240, or equivalent.

Table D.1(iii)(a): EMISSIONS TO SURFACE/GROUND WATERS (Storm Overflow)

Discharge Point Code: SW-3

Local Authority Ref No:	SW3BCTN	
Source of Emission:	Storm Water Overflow	
Location:	Ballycotton	
Grid Ref (12 digits, 6E, 6N)	199250 / 064250 (Verifed using GPS)	
Name of Receiving waters:	Ballycotton Bay	
Water Body:	Coastal Water Body	
River Basin District		
Designation of Receiving Waters:	None	
Flow Rate in Receiving Waters:		$m^3.sec^{-1}$ Dry Weather Flow
		$m^3.sec^{-1}$ 95% Weather Flow
Additional Comments (e.g. commentary on zero flow or other information deemed of value)		

Emission Details:

(i) Volume emitted			
Normal/day	m^3	Maximum/day	m^3
Maximum rate/hour	m^3	Period of emission (avg)	min/hr hr/day day/yr
Dry Weather Flow	m^3/sec		

TABLE E.1(i): WASTE WATER FREQUENCY AND QUANTITY OF DISCHARGE – Primary and Secondary Discharge Points

Identification Code for Discharge point	Frequency of discharge (days/annum)	Quantity of Waste Water Discharged (m^3/annum)
SW-2	365	33999.75
SW-1	365	45734.5

TABLE E.1(ii): WASTE WATER FREQUENCY AND QUANTITY OF DISCHARGE – Storm Water Overflows

Identification Code for Discharge point	Frequency of discharge (days/annum)	Quantity of Waste Water Discharged (m^3/annum)	Complies with Definition of Storm Water Overflow
SW-3			No

TABLE F.1(i)(a): SURFACE/GROUND WATER MONITORING

Primary Discharge Point

Discharge Point Code:	SW-1
MONITORING POINT CODE:	aSW-1a
Grid Ref (12 digits, 6E, 6N)	200015 / 063940 (Verifed using GPS)

Parameter	Results (mg/l)				Sampling method	Limit of Quantitation	Analysis method / technique
	01/01/09	16/09/09					
pH		= 8.1			Grab	2	Electrochemical
Temperature	= 0				Grab	0.5	Electrochemical
Electrical Conductivity (@ 25°C)		= 44400			Grab	0.5	Electrochemical
Suspended Solids		= 10			Grab	0.5	Gravimetric
Ammonia (as N)		= 0.6			Grab	0.02	Colorimetric
Biochemical Oxygen Demand		= 1			Grab	0.06	Electrochemical
Chemical Oxygen Demand		= 51			Grab	8	Digestion & Colorimetric
Dissolved Oxygen	= 0				Grab	0.2	ISE
Hardness (as $CaCO_3$)	= 0				Grab	1	Titrimetric
Total Nitrogen (as N)		= 0.484			Grab	0.5	Digestion & Colorimetric
Nitrite (as N)		= 0.1			Grab	0.1	Colorimetric
Nitrate (as N)		= 0.5			Grab	0.5	Colorimetric
Total Phosphorous (as P)		= 0.048			Grab	0.2	Digestion & Colorimetric
OrthoPhosphate (as P)		= 0.05			Grab	0.02	Colorimetric
Sulphate (SO_4)	= 0				Grab	30	Turbidimetric
Phenols (Sum)		= 0.1			Grab	0.1	GC-MS2

For Orthophosphate: this monitoring should be undertaken on a sample filtered on 0.45µm filter paper
For Phenols: USEPA Method 604, AWWA Standard Method 6240, or equivalent.

Additional Comments:	Default of 01/01/09 and 0 where no results are available

TABLE F.1(i)(b): SURFACE/GROUND WATER MONITORING (Dangerous Substances)

Primary Discharge Point

Discharge Point Code:	SW-1
MONITORING POINT CODE:	aSW-1a
Grid Ref (12 digits, 6E, 6N)	200015 / 063940 (Verifed using GPS)

Parameter	Results (µg/l)				Sampling method	Limit of Quantitation	Analysis method / technique
	01/01/09	16/09/09					
Atrazine		= 0.01			Grab	0.96	HPLC
Dichloromethane		= 1			Grab	1	GC-MS1
Simazine		= 0.01			Grab	0.01	HPLC
Toluene		= 0.28			Grab	0.02	GC-MS1
Tributyltin	= 0				Grab	0.02	GC-MS1
Xylenes		= 0.73			Grab	1	GC-MS1
Arsenic		= 1.4			Grab	0.96	ICP-MS
Chromium		= 126.6			Grab	20	ICP-OES
Copper		= 20			Grab	20	ICP-OES
Cyanide		= 5			Grab	5	Colorimetric
Flouride		= 754			Grab	100	ISE
Lead		= 20			Grab	20	ICP-OES
Nickel		= 20			Grab	20	ICP-OES
Zinc		= 20			Grab	20	ICP-OES
Boron		= 3143			Grab	20	ICP-OES
Cadmium		= 20			Grab	20	ICP-OES
Mercury		= 0.044			Grab	0.2	ICP-MS
Selenium		= 0.74			Grab	0.74	ICP-MS
Barium		= 20			Grab	20	ICP-OES

Additional Comments:	TBT value is 0.02ug/l as Sn Default of 01/01/09 and 0 where no results are available

Annex 2: Check List For Regulation 16 Compliance

Regulation 16 of the waste water discharge (Authorisation) Regulations 2007 (S.I. No. 684 of 2007) sets out the information which must, in all cases, accompany a discharge licence application. In order to ensure that the application fully complies with the legal requirements of regulation 16 of the 2007 Regulations, all applicants should complete the following.

In each case, refer to the attachment number(s), of your application which contains(s) the information requested in the appropiate sub-article.

Regulation 16(1) **In the case of an application for a waste water discharge licence, the application shall -**		**Attachment Number**	**Checked by Applicant**
(a)	give the name, address, telefax number (if any) and telephone number of the applicant (and, if different, of the operator of any treatment plant concerned) and the address to which correspondence relating to the application should be sent and, if the operator is a body corporate, the address of its registered office or principal office,	Application Form	Yes
(b)	give the name of the water services authority in whose functional area the relevant waste water discharge takes place or is to take place, if different from that of the applicant,	Application Form	Yes
(c)	give the location or postal address (including where appropriate, the name of the townland or townlands) and the National Grid reference of the location of the waste water treatment plant and/or the waste water discharge point or points to which the application relates,	Application Form	Yes
(d)	state the population equivalent of the agglomeration to which the application relates,	Application Form	Yes
(e)	specify the content and extent of the waste water discharge, the level of treatment provided, if any, and the flow and type of discharge,	Application Form	Yes
(f)	give details of the receiving water body, including its protected area status, if any, and details of any sensitive areas or protected areas or both in the vicinity of the discharge point or points likely to be affected by the discharge concerned, and for discharges to ground provide details of groundwater protection schemes in place for the receiving water body and all associated hydrogeological and geological assessments related to the receiving water environment in the vicinity of the discharge.	Application Form	Yes
(g)	identify monitoring and sampling points and indicate proposed arrangements for the monitoring of discharges and, if Regulation 17 does not apply, provide details of the likely environmental consequences of any such discharges,	Application Form	Yes
(h)	in the case of an existing waste water treatment plant, specify the sampling data pertaining to the discharge based on the samples taken in the 12 months preceding the making of the application,	Not Applicable	Yes
(i)	describe the existing or proposed measures, including emergency procedures, to prevent unintended waste water discharges and to minimise the impact on the environment of any such discharges,	Application Form	Yes
(j)	give particulars of the nearest downstream drinking water abstraction point or points to the discharge point or points,	Application Form	Yes
(k)	give details, and an assessment of the effects, of any existing or proposed emissions on the environment, including any environmental medium other than those into which the emissions are, or are to be made, and of proposed measures to prevent or eliminate or, where that is not practicable, to limit any pollution caused in such discharges,	Application Form	Yes
(l)	give detail of compliance with relevant monitoring requirements and treatment standards contained in any applicable Council Directives of Regulations,	Application Form	Yes
(m)	give details of any work necessary to meet relevant effluent discharge standards and a timeframe and schedule for such work.	Application Form	Yes
(n)	Any other information as may be stipulated by the Agency.	Application Form	Yes
Regulation 16(3) **Without prejudice to Regulation 16 (1) and (2), an application for a licence shall be accompanied by -**		**Attachment Number**	**Checked by Applicant**
(a)	a copy of the notice of intention to make an application given pursuant to Regulation 9,	Attachment B	Yes
(b)	where appropriate, a copy of the notice given to a relevant water services authority under Regulation 13,	Attachment B	Yes
(c)	Such other particulars, drawings, maps, reports and supporting documentation as are necessary to identify and describe, as appropriate -	Attachments A & B	Yes
(c) (i)	the point or points, including storm water overflows, from which a discharge or discharges take place or are to take place, and	Attachments A & B	Yes
(c) (ii)	the point or points at which monitoring and sampling are undertaken or are to be undertaken,	Attachments A & B	Yes
(d)	such fee as is appropriate having regard to the provisions of Regulations 38 and 39.	See Cover Letter	Yes

THIS APPLICATION HAS NOT BEEN SUBMITTED

Regulation 16(4) **An original application shall be accompanied by 2 copies of it and of all accompanying documents and particulars as required under Regulation 16(3) in hardcopy or in an electronic or other format as specified by the Agency.**		**Attachment Number**	**Checked by Applicant**
1	An Original Application shall be accompanied by 2 copies of it and of all accompanying documents and particulars as required under regulation 16(3) in hardcopy or in electronic or other format as specified by the agancy.	Included	Yes
Regulation 16(5) **For the purpose of paragraph (4), all or part of the 2 copies of the said application and associated documents and particulars may, with the agreement of the Agency, be submitted in an electronic or other format specified by the Agency.**		**Attachment Number**	**Checked by Applicant**
1	Signed original.	Included	Yes
2	2 hardcopies of application provided or 2 CD versions of application (PDF files) provided.	Included	Yes
3	1 CD of geo-referenced digital files provided.	Included	Yes
Regulation 17 **Where a treatment plant associated with the relevant waste water works is or has been subject to the European Communities (Environmental Impact Assessment) Regulations 1989 to 2001, in addition to compliance with the requirements of Regulation 16, an application in respect of the relevant discharge shall be accompanied by a copy of an environmental impact statement and approval in accordance with the Act of 2000 in respect of the said development and may be submitted in an electronic or other format specified by the Agency**		**Attachment Number**	**Checked by Applicant**
3	2 CD versions of EIS, as PDF files, provided.	Copies of Report Included	Yes
1	EIA provided if applicable	Copies of Report Included	Yes
2	2 hardcopies of EIS provided if applicable.	Ecological Report Only	Yes
Regulation 24 **In the case of an application for a waste water discharge certificate of authorisation, the application shall –**		**Attachment Number**	**Checked by Applicant**
(a)	give the name, address, telefax number (if any) and telephone number of the applicant and the address to which correspondence relating to the application should be sent and, if the operator of the waste water works is a body corporate, the address of its registered office or principal office	Application Form	Yes
(b)	give the name of the water services authority in whose functional area the relevant waste water discharge takes place or is to take place, if different from that of the applicant,	Application Form	Yes
(c)	give the location or postal address (including where appropriate, the name of the townland or townlands) and the National Grid reference of the location of the discharge point or points to which the application relates,	Application Form	Yes
(d)	state the population equivalent of the agglomeration to which the application relates,	Application Form	Yes
(e)	in the case of an application for the review of a certificate, specify the reference number given to the relevant certificate in the register,	Application Form	Yes
(f)	specify the content and extent of the waste water discharge, the level of treatment provided and the flow and type of discharge,	Application Form	Yes
(g)	give details of the receiving water body, its protected area status, if any, and details of any sensitive areas or protected areas, or both, in the vicinity of the discharge point or points or likely to be affected by the discharge concerned,	Application Form	Yes
(h)	identify monitoring and sampling points and indicate proposed arrangements for the monitoring of discharges and of the likely environmental consequences of any such discharges,	Application Form	Yes
(i)	in the case of an existing discharge, specify the sampling data pertaining to the discharge based on the samples taken in the 12 months preceding the making of the application,	Not Applicable	Yes
(j)	describe the existing or proposed measures, including emergency procedures, to prevent unauthorised or unexpected waste water discharges and to minimise the impact on the environment of any such discharges,	Application Form	Yes
(k)	give particulars of the location of the nearest downstream drinking water abstraction point or points to the discharge point or points associated with the waste water works,	Application Form	Yes
(l)	give details of any designation under any Council Directive or Regulations that apply in relation to the receiving waters,	Application Form	Yes
(m)	give details of compliance with any applicable monitoring requirements and treatment standards,	Application Form	Yes
(n)	give details of any work necessary to meet relevant effluent discharge standards and a timeframe and schedule for such work,	Application Form	Yes
(o)	give any other information as may be stipulated by the Agency, and	Application Form	Yes
(p)	be accompanied by such fee as is appropriate having regard to the provisions of Regulations 38 and 39.	See Cover Letter	Yes