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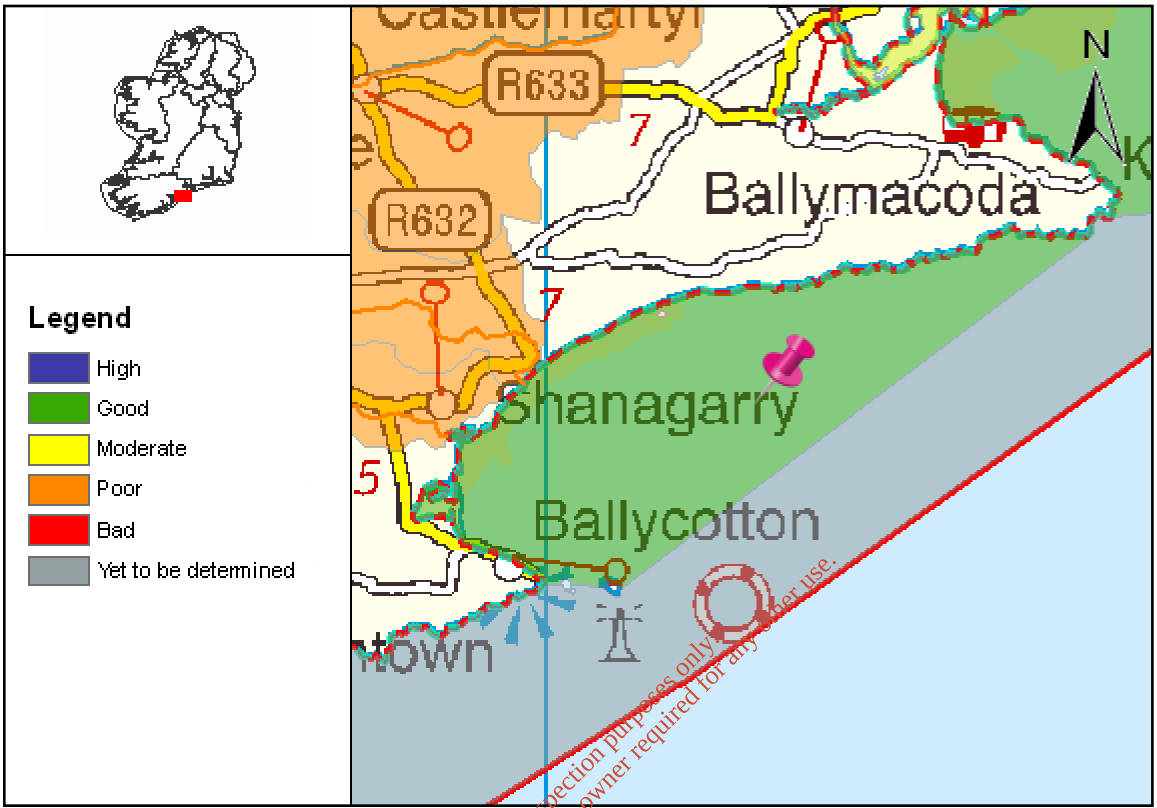
Full Report for Waterbody Ballycotton Bay



Date Reported to Europe: 22/12/2008

Date Report Created 25/08/2009

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;

south western river basin district

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

Date Reported to Europe: 22/12/2008

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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	

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

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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	
MDI O	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

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

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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

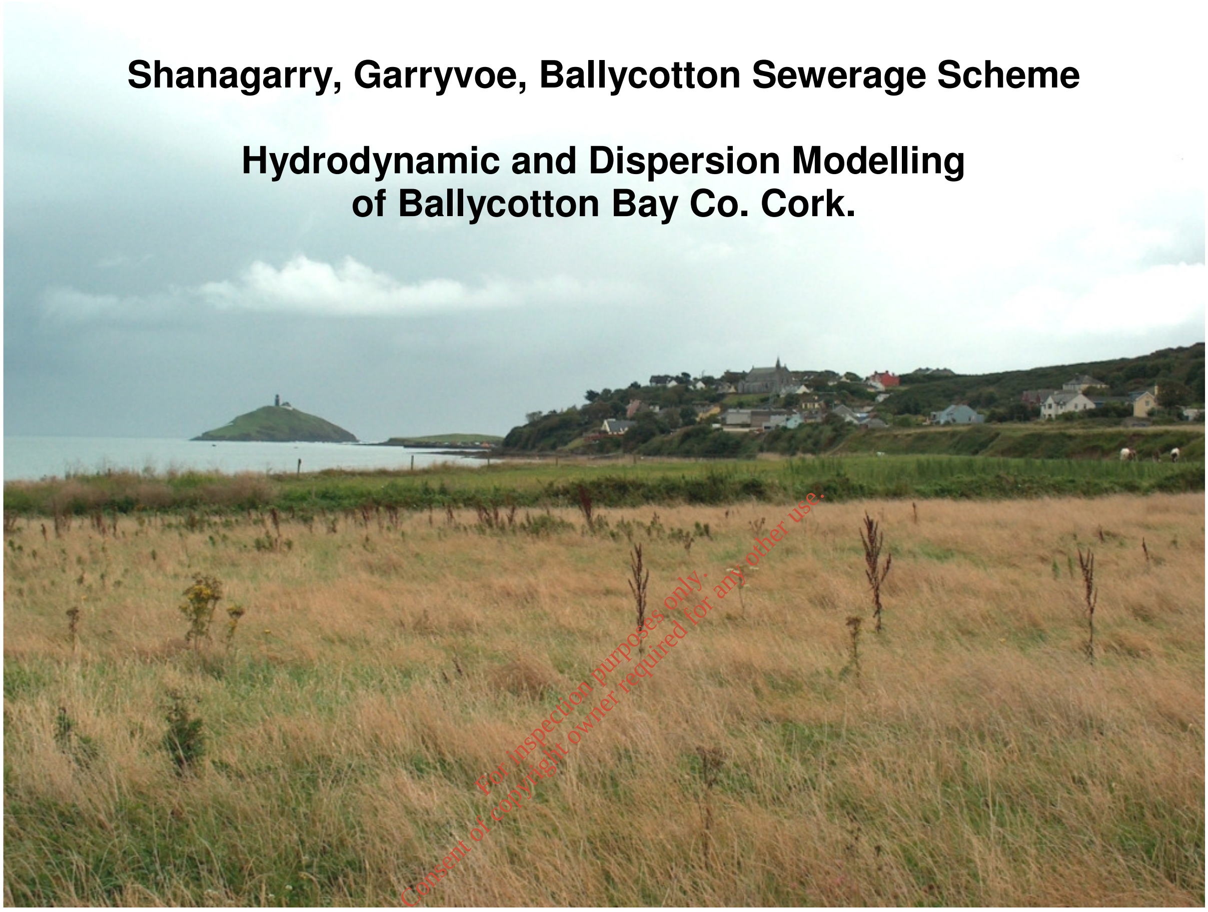
Date Report Created 25/08/2009

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

Hydro Environmental Ltd
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

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

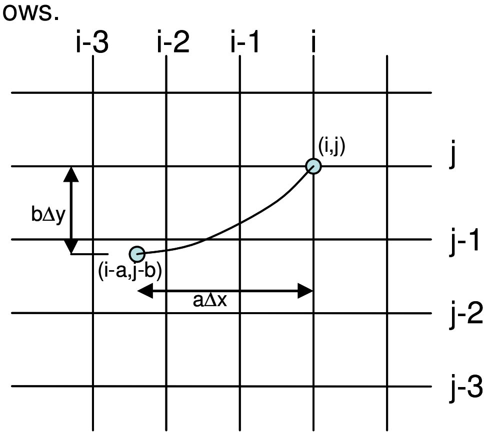
Where (1) is the local/temporal acceleration terms, (2) is the convective terms, (3) the Coriollis term, (4) the hydrostatic pressure term, (5) the bed shear terms, (6) surface wind shear terms and (7) the horizontal eddy viscosity terms. These equations of motion are solved for elevation and horizontal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

$$\frac{DU}{Dt}=\frac{\partial U}{\partial t}+U\frac{\partial U}{\partial x}+V\frac{\partial V}{\partial y}=\frac{U_{(i,j)}^{\;\;n+1}-U_{(i-a,j-b)}^{\;\;n1}}{\Delta t}$$

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:

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

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

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

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

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

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

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.

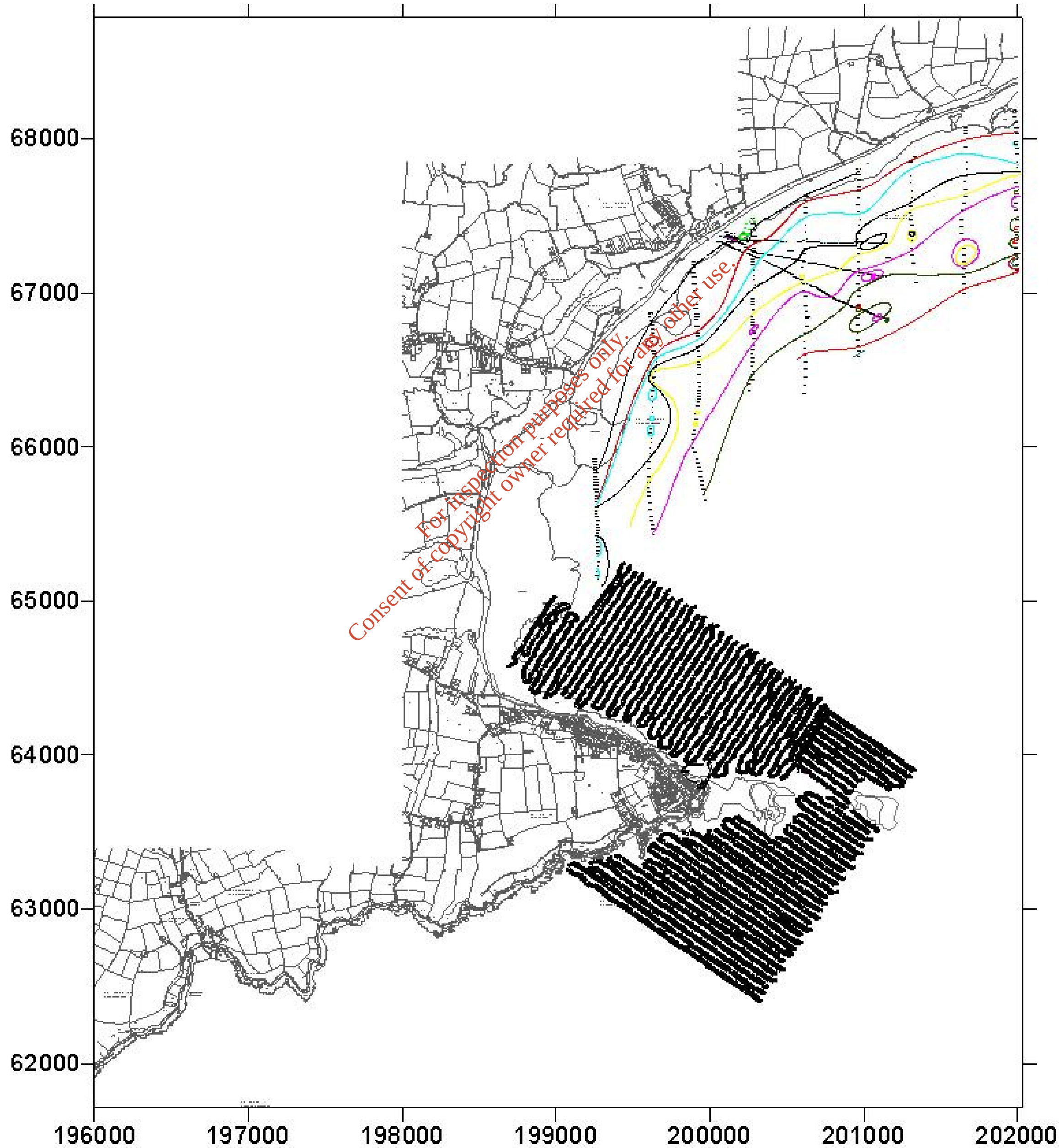


Figure 1 Extent of Bathymetric Surveys used in Model Development

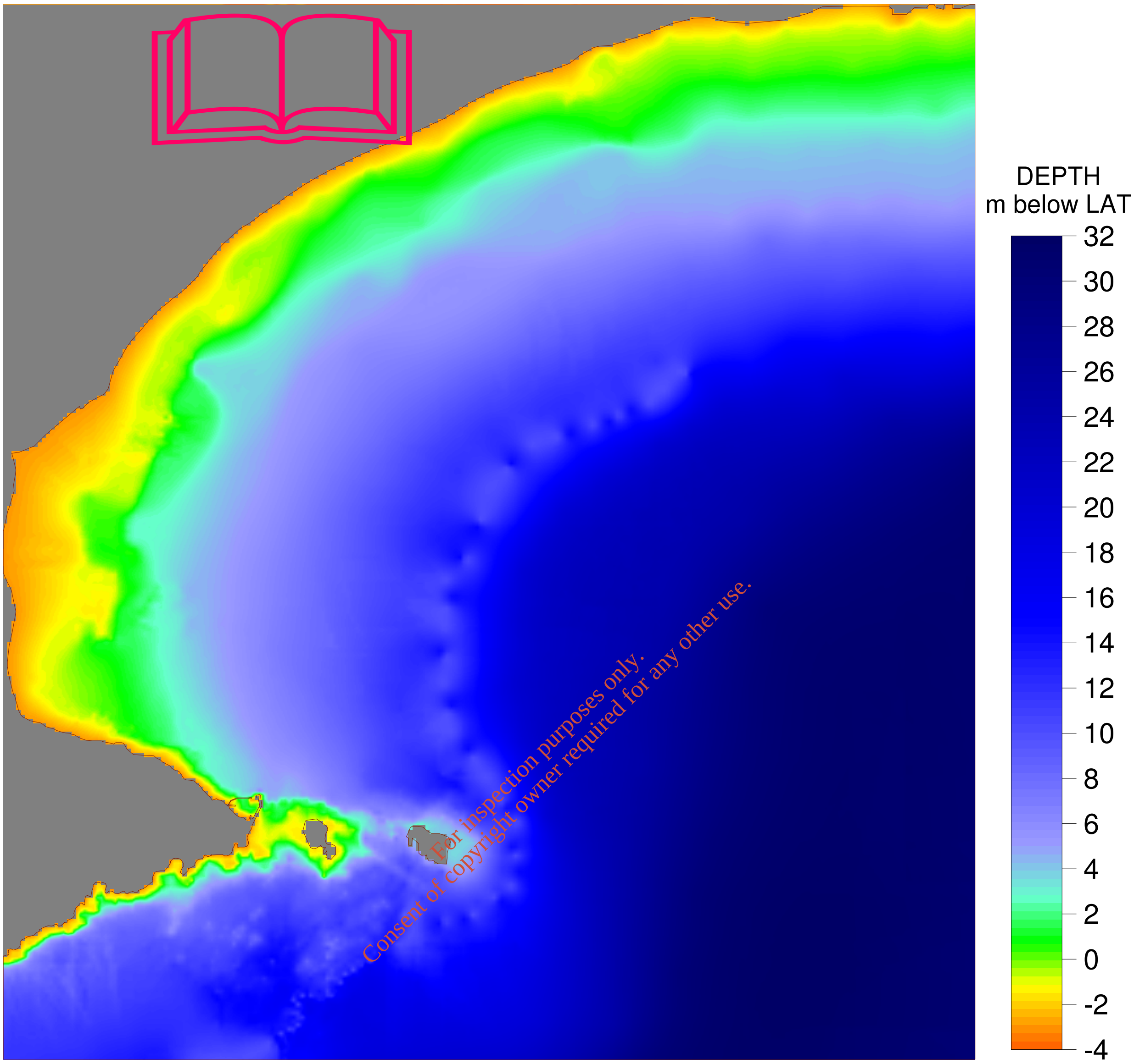


Figure 2   Model Extent and Ballycotton Bay Bathymetry

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:

$$\nu t = C_e U^* H$$

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

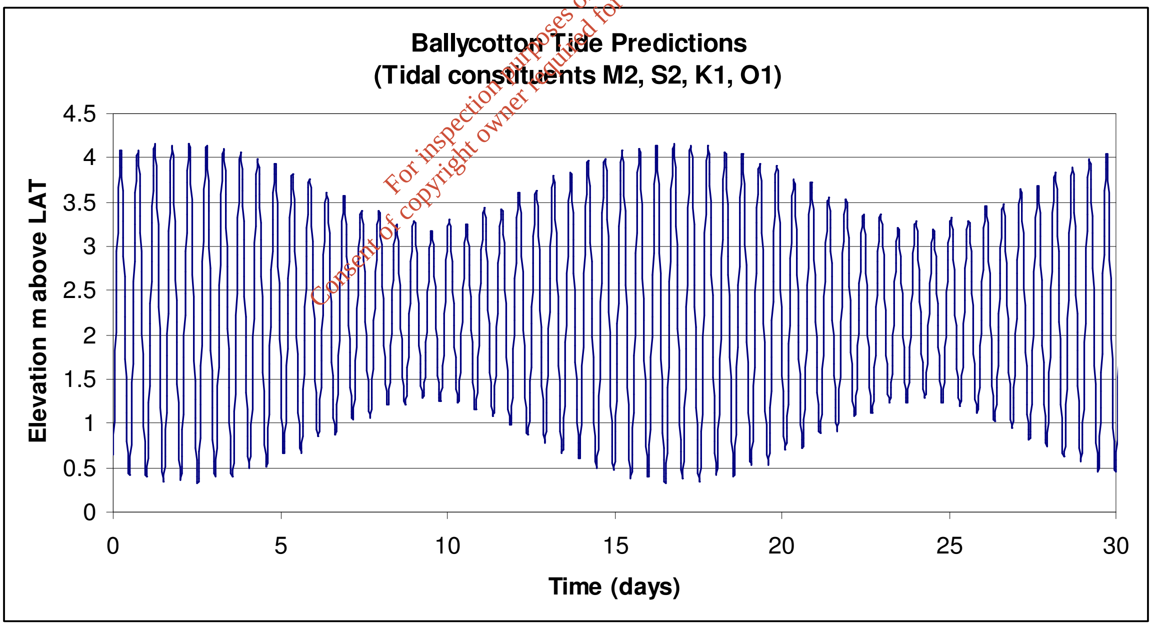


Figure 3 Lunar cycle from derived tide constituents

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.

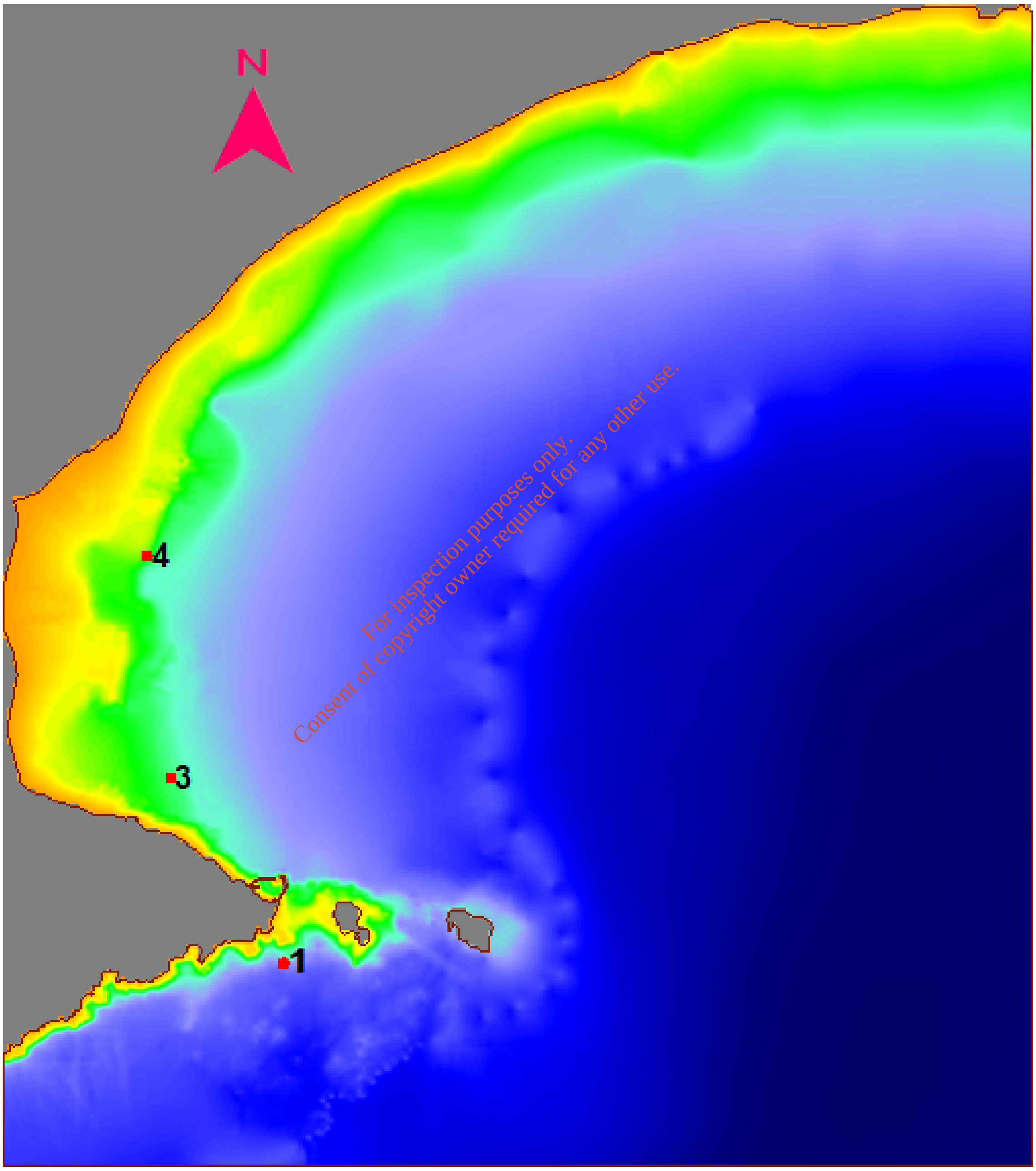


Figure 4 Modelled Sewage Outfall Locations

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 the 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.

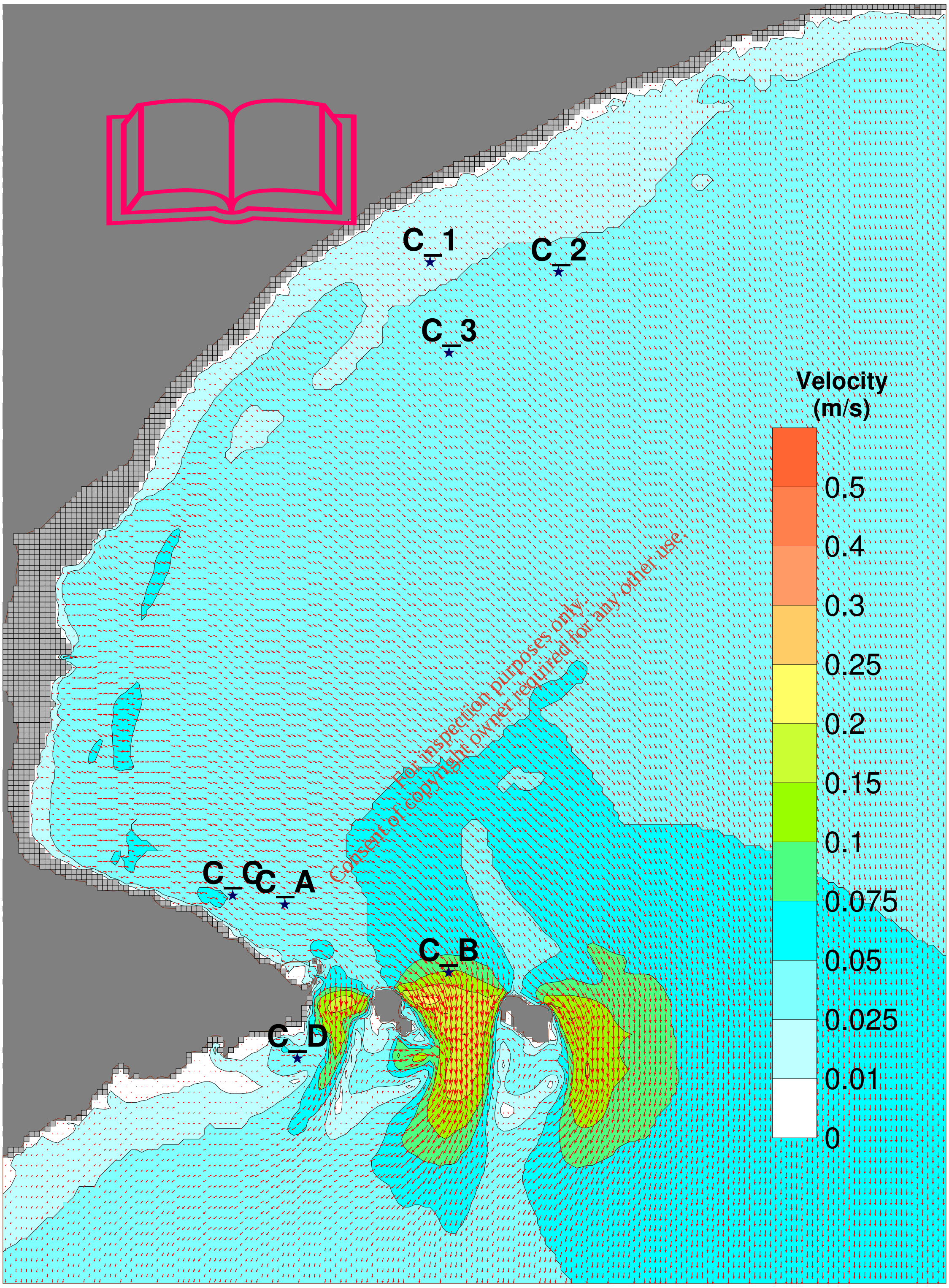


Figure 5 Mid-Ebb Hydrodynamics – Spring Tide

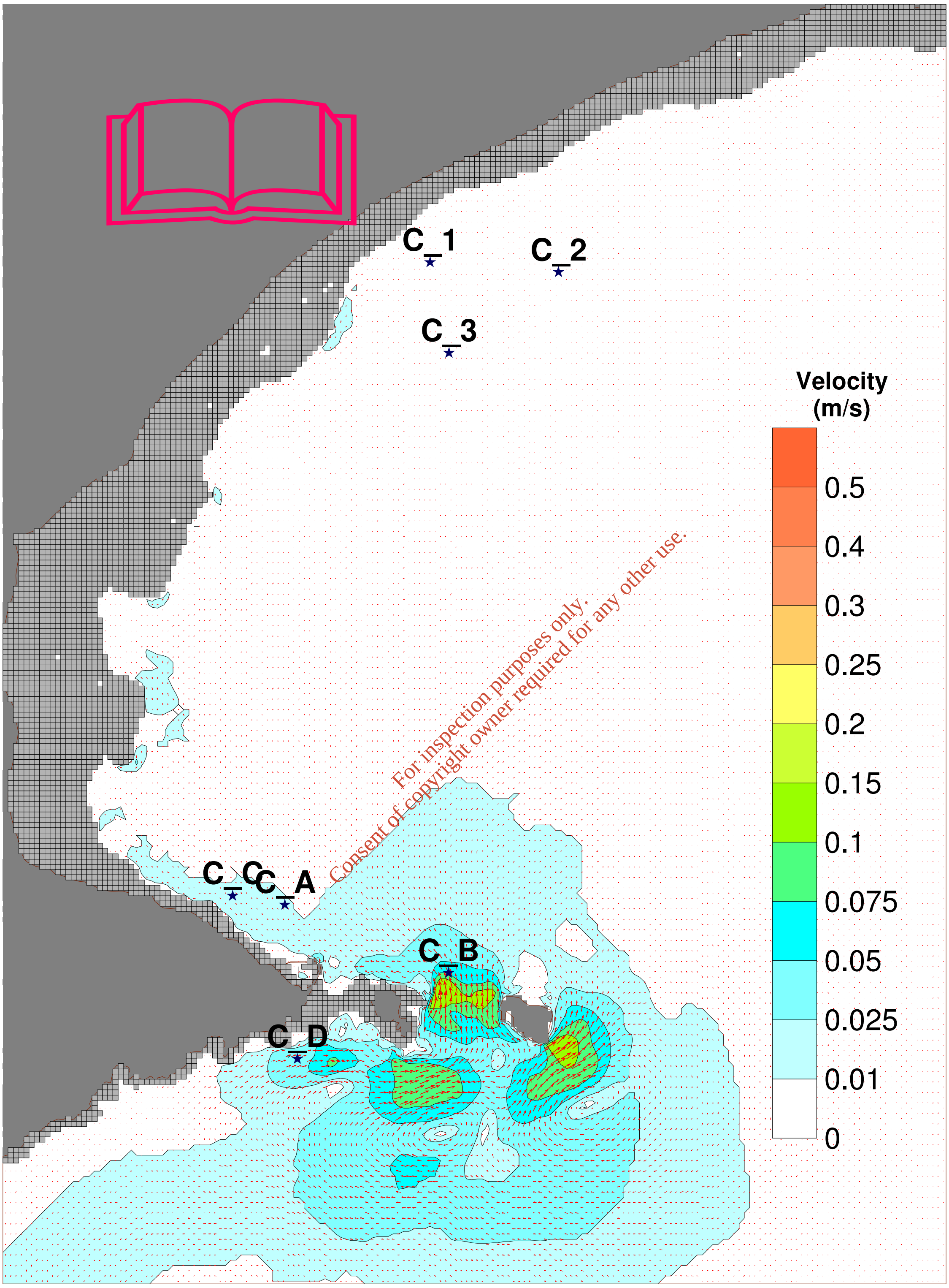


Figure 6 Low water Hydrodynamics – Spring Tide

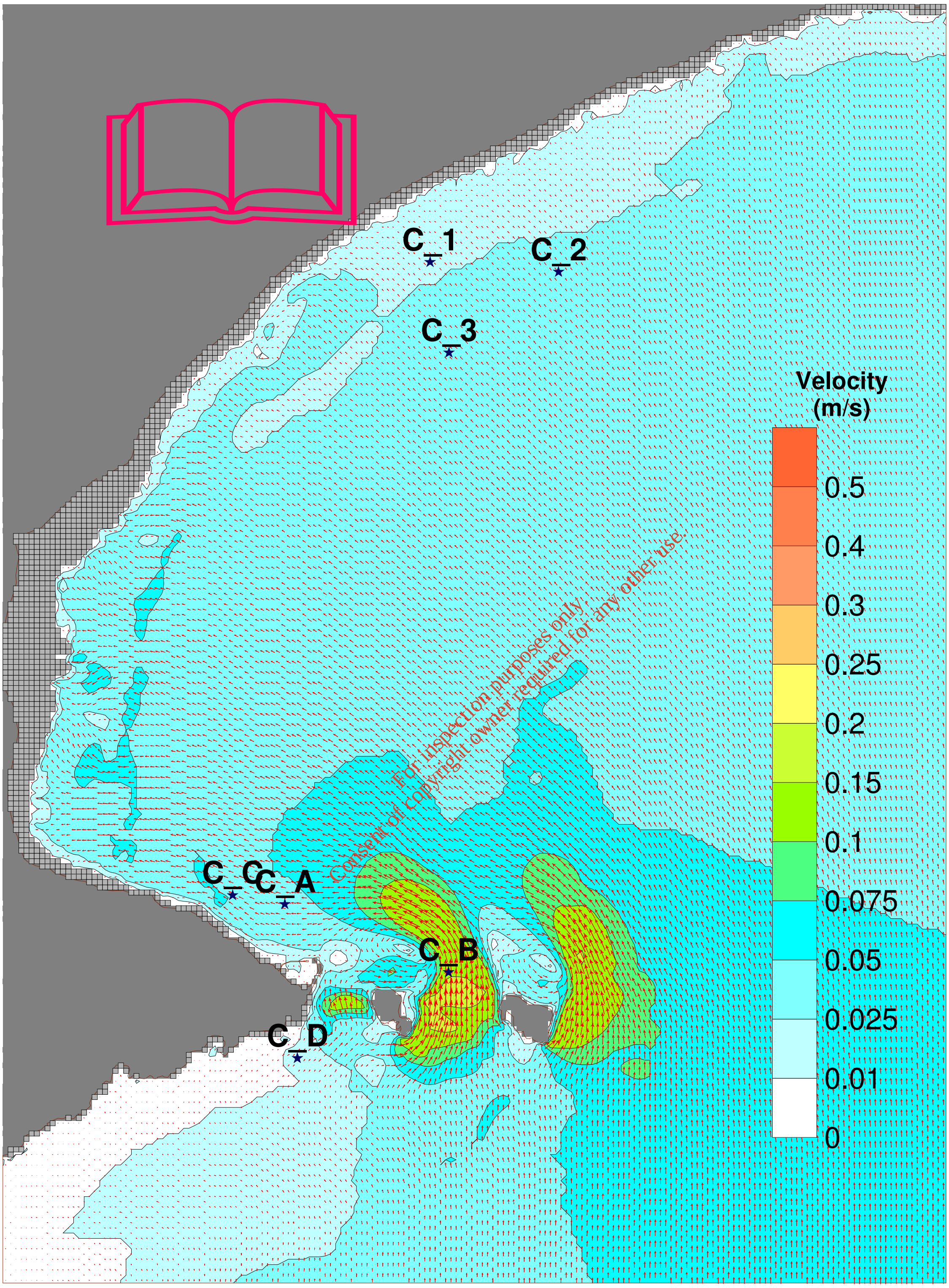


Figure 7 Mid-Flood Hydrodynamics – Spring Tide

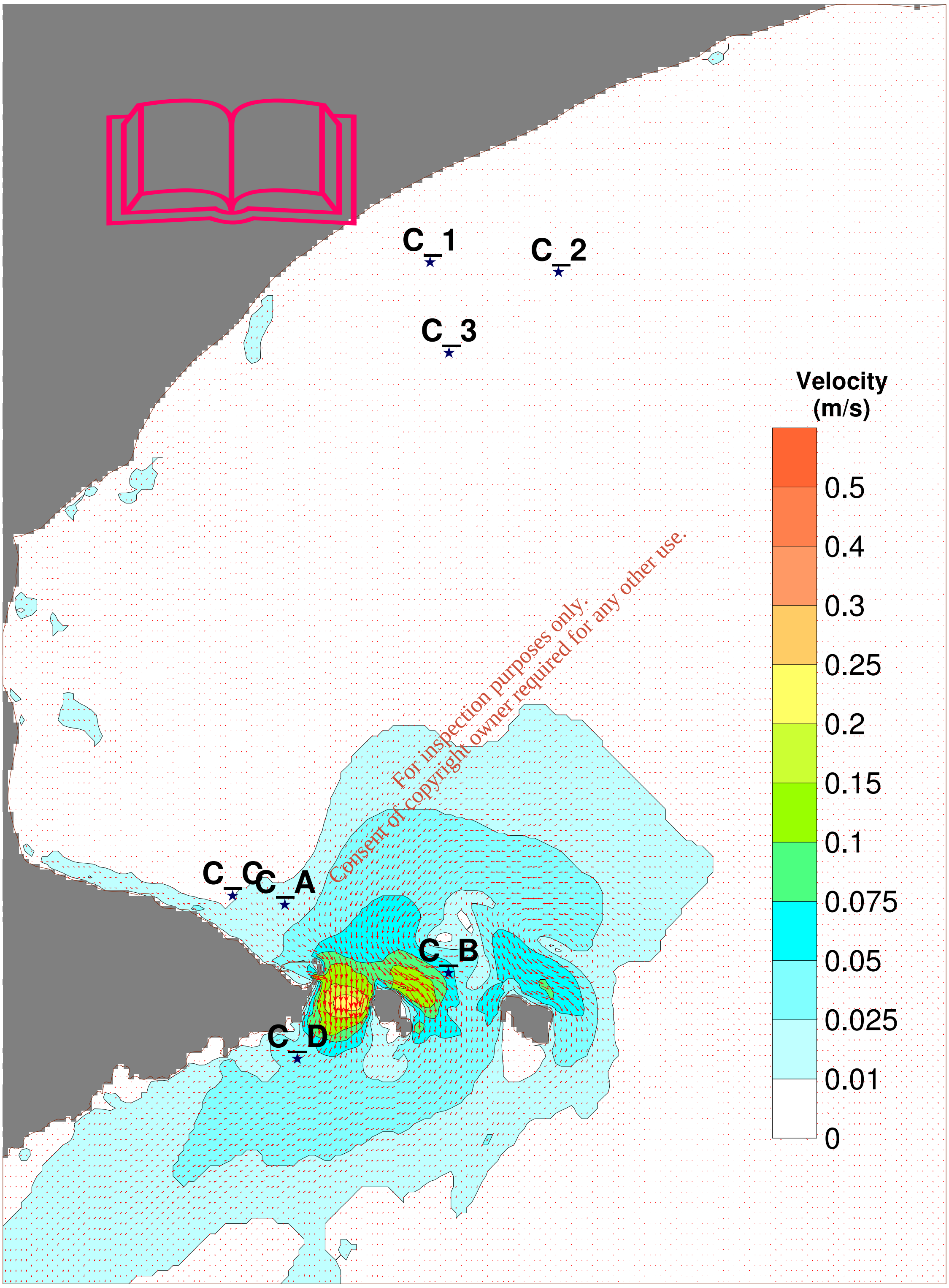


Figure 8 Highwater Hydrodynamics – Spring Tide

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.

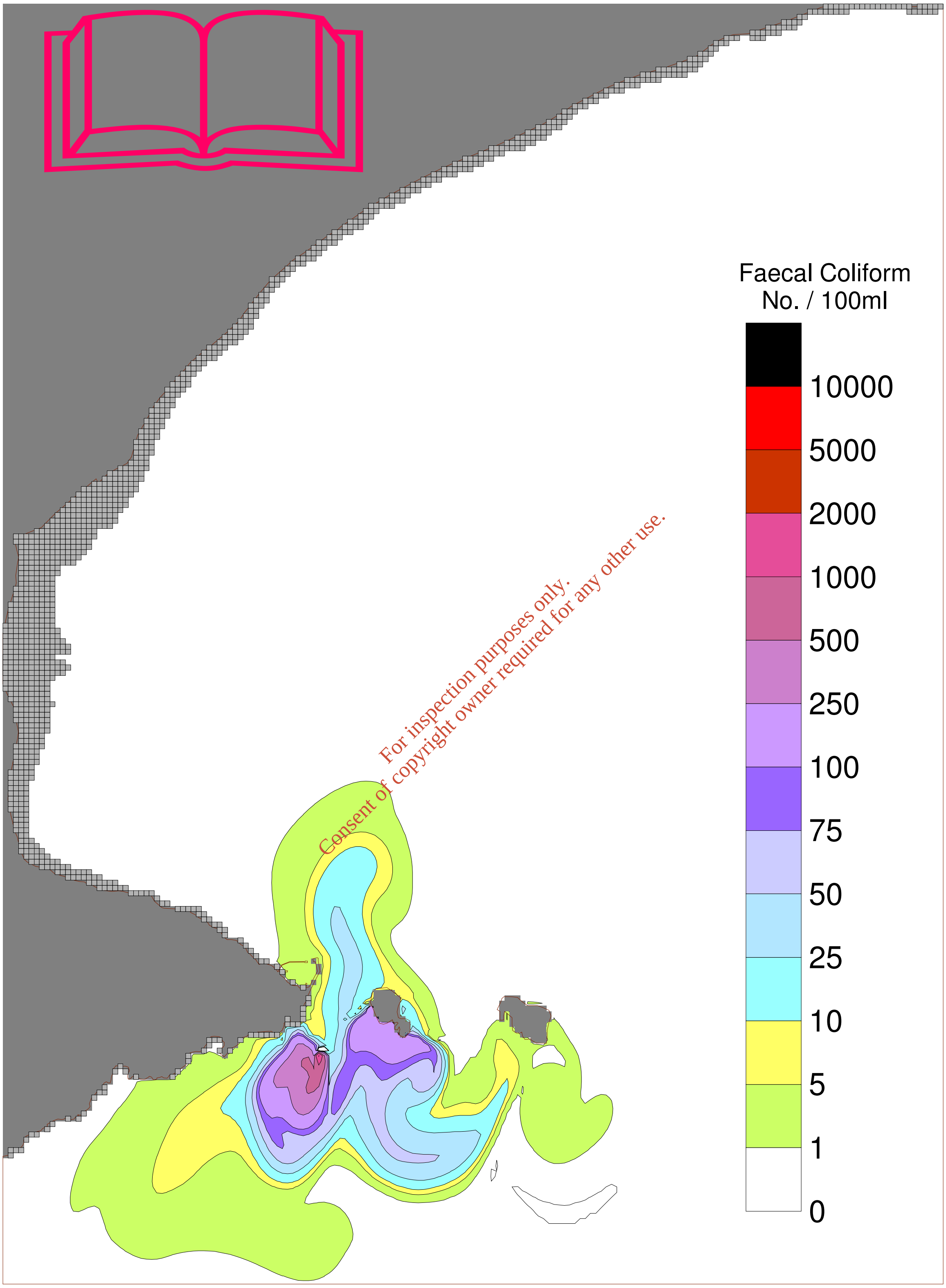


Figure 9 Outfall 1 3DWF Faecal Coliform Concentration Spring Tide at Mid-Ebb

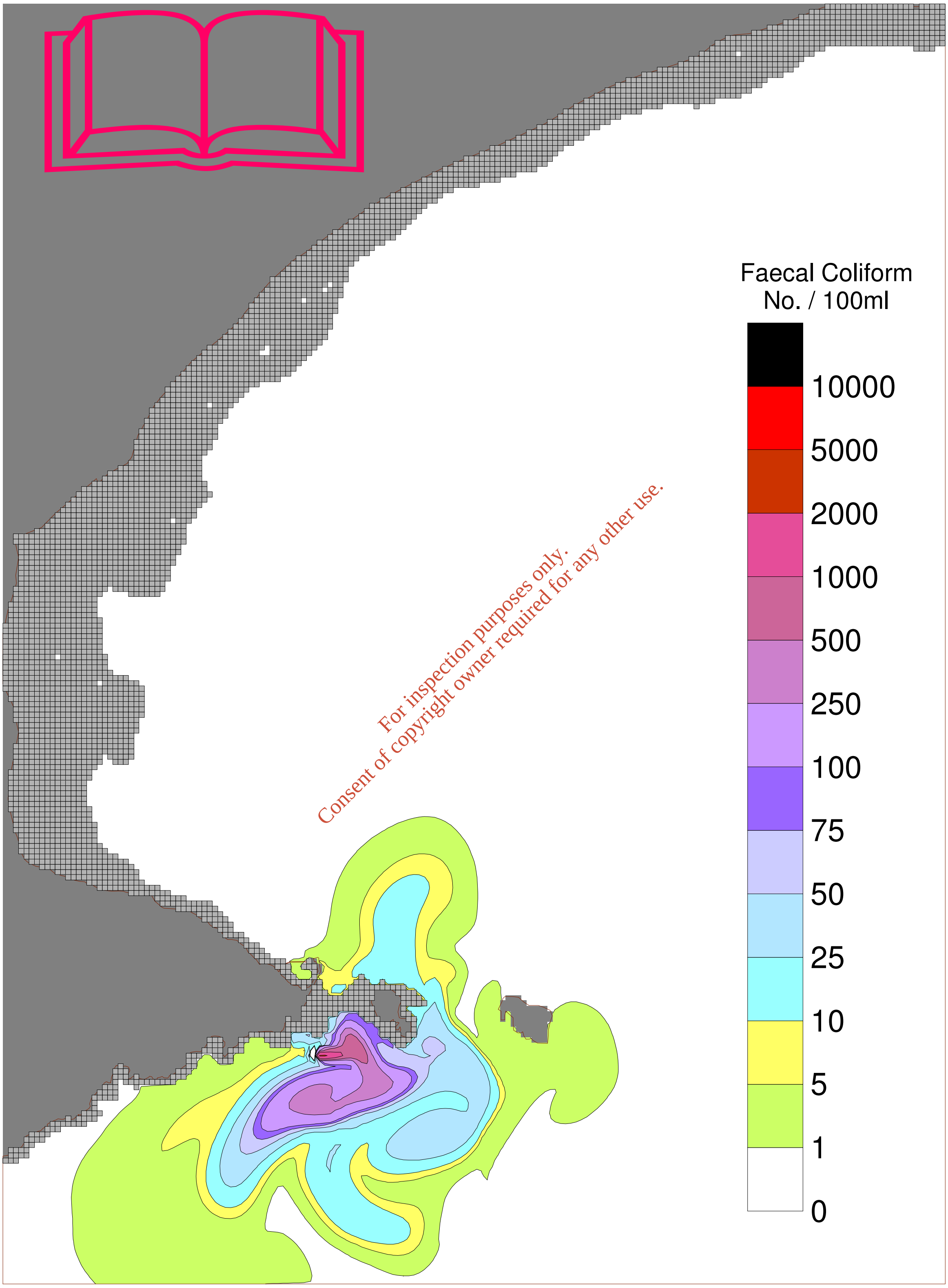


Figure 10 Outfall 1 3DWF Faecal Coliform Concentration Spring Tide at Low Water

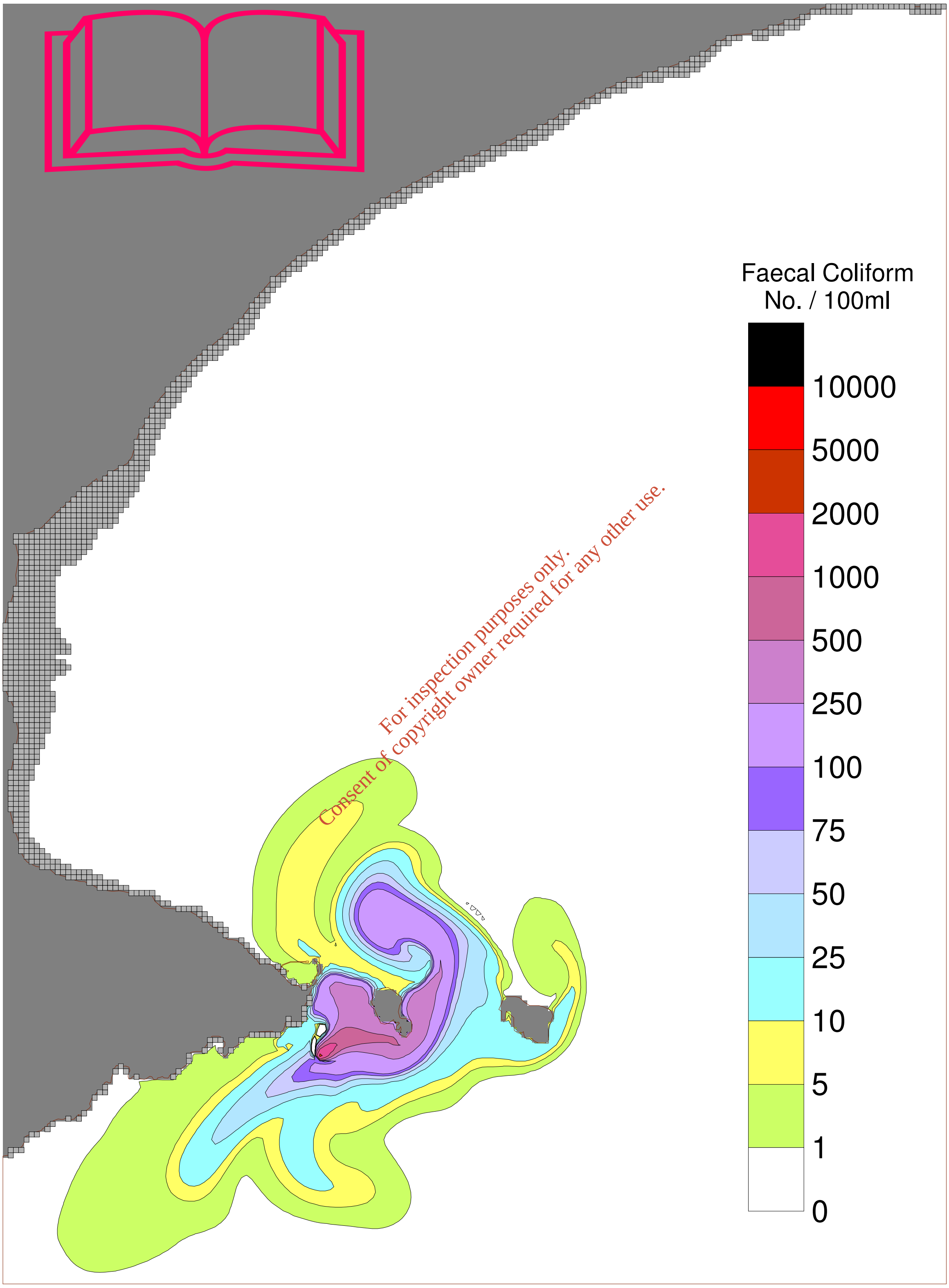


Figure 11 Outfall 1 3DWF Faecal Coliform Concentration Spring Tide at Mid-Flood

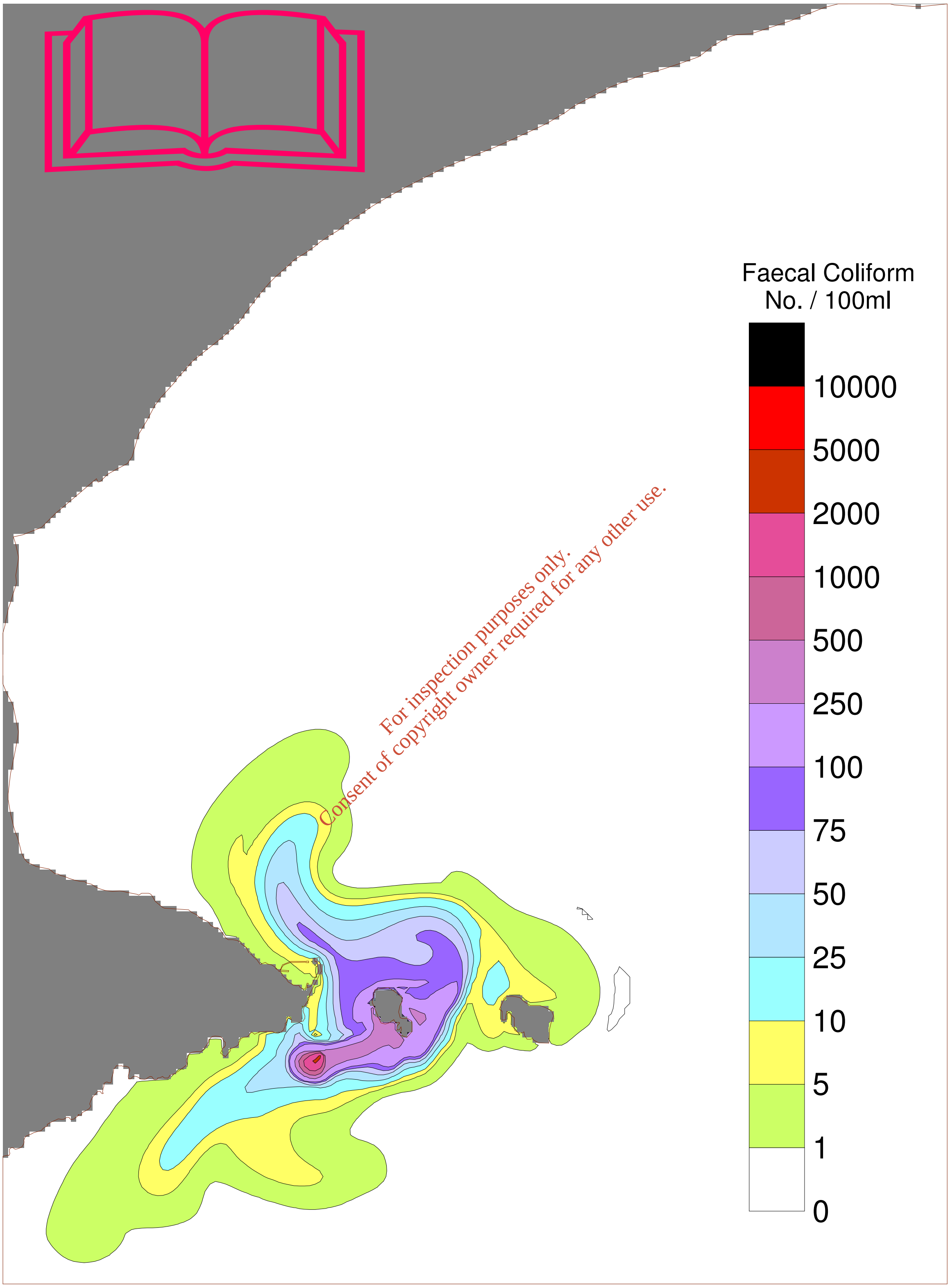


Figure 12 Outfall 1 3DWF Faecal Coliform Concentration Spring Tide at Highwater

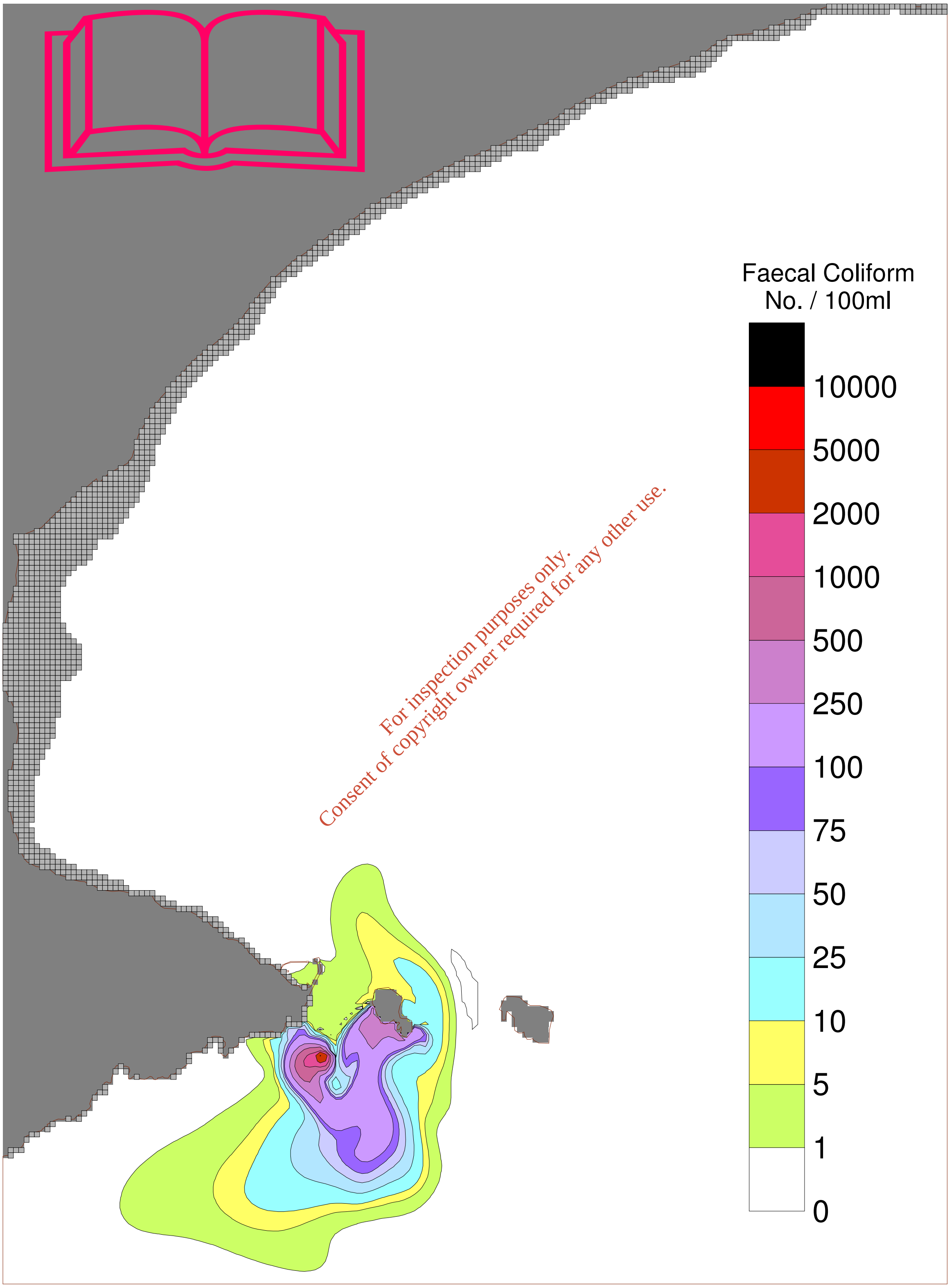


Figure 13 Outfall 1 3DWF Faecal Coliform Concentration Neap Tide at Mid-Ebb

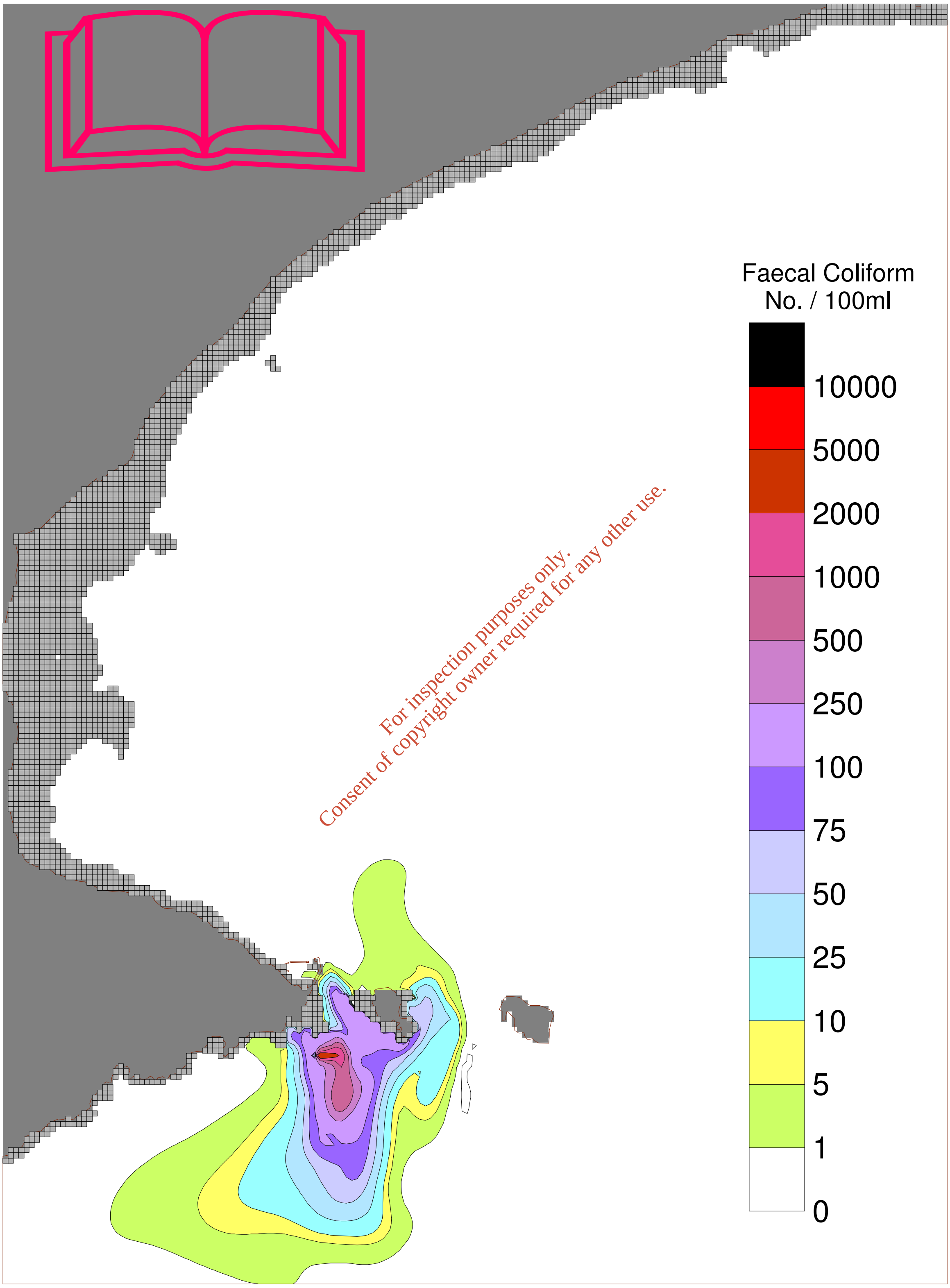


Figure 14 Outfall 1 3DWF Faecal Coliform Concentration Neap Tide at Low Water

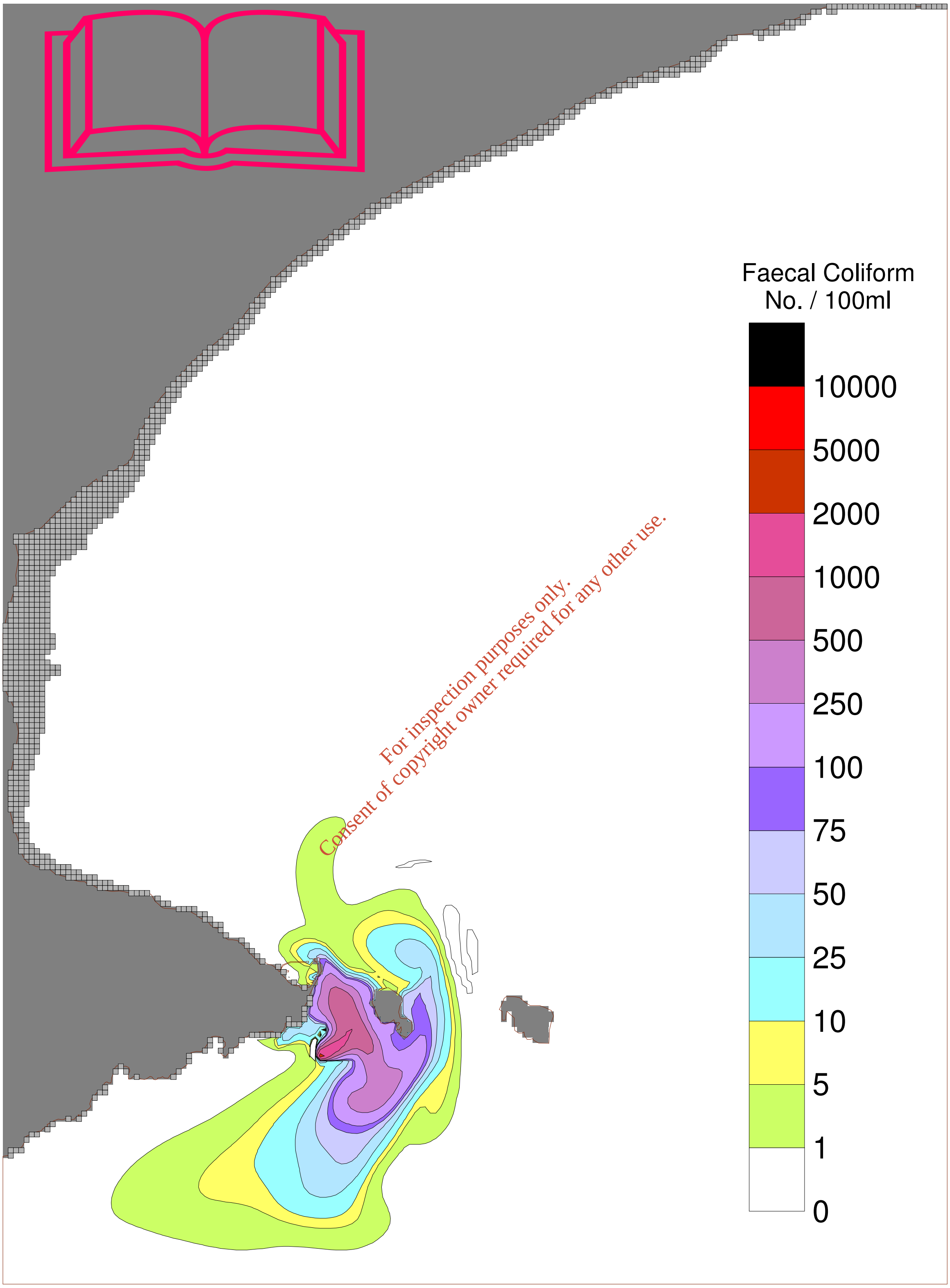


Figure 15 Outfall 1 3DWF Faecal Coliform Concentration Neap Tide at Mid-Flood

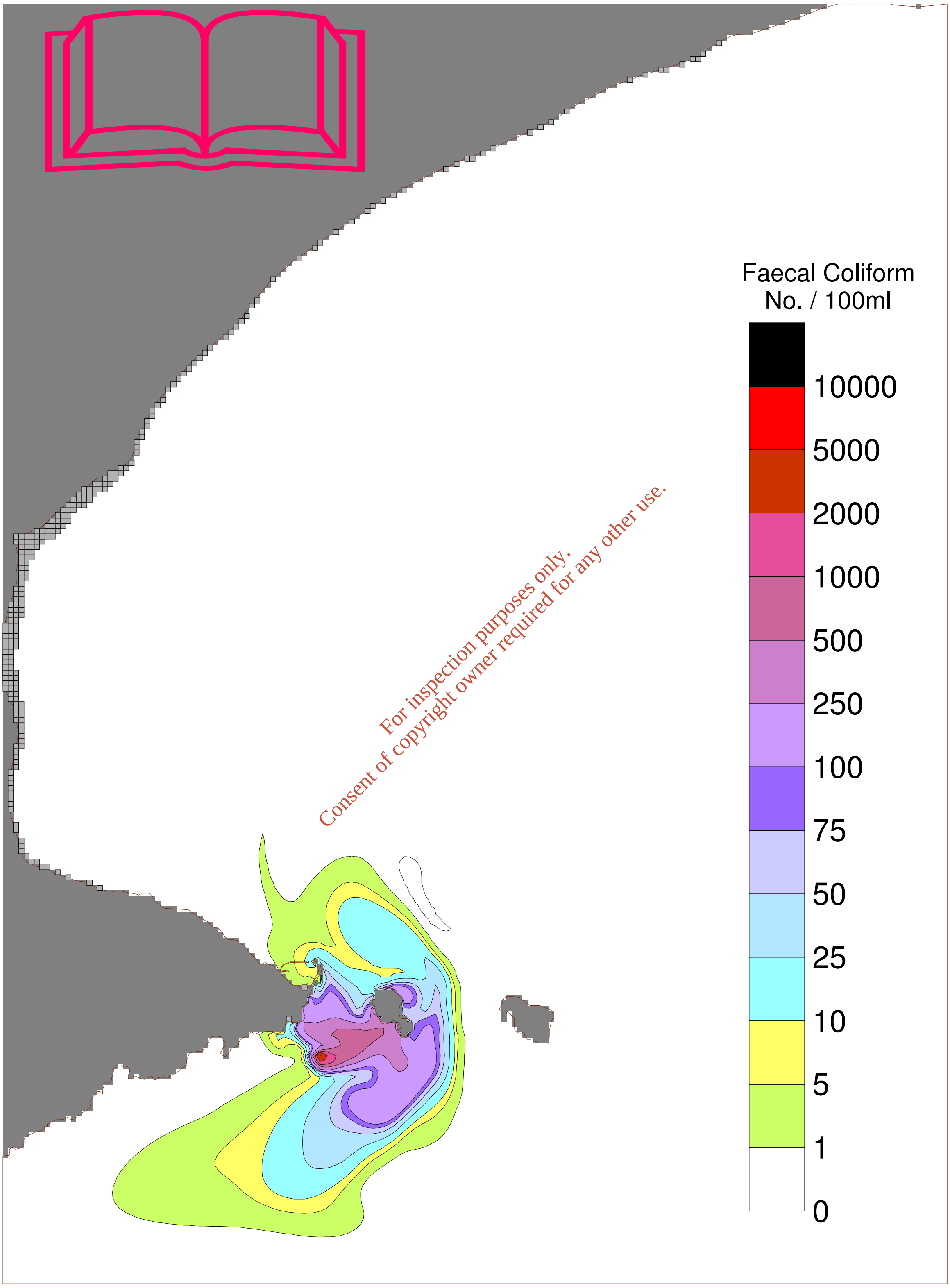


Figure 16 Outfall 1 3DWF Faecal Coliform Concentration Neap Tide at Highwater

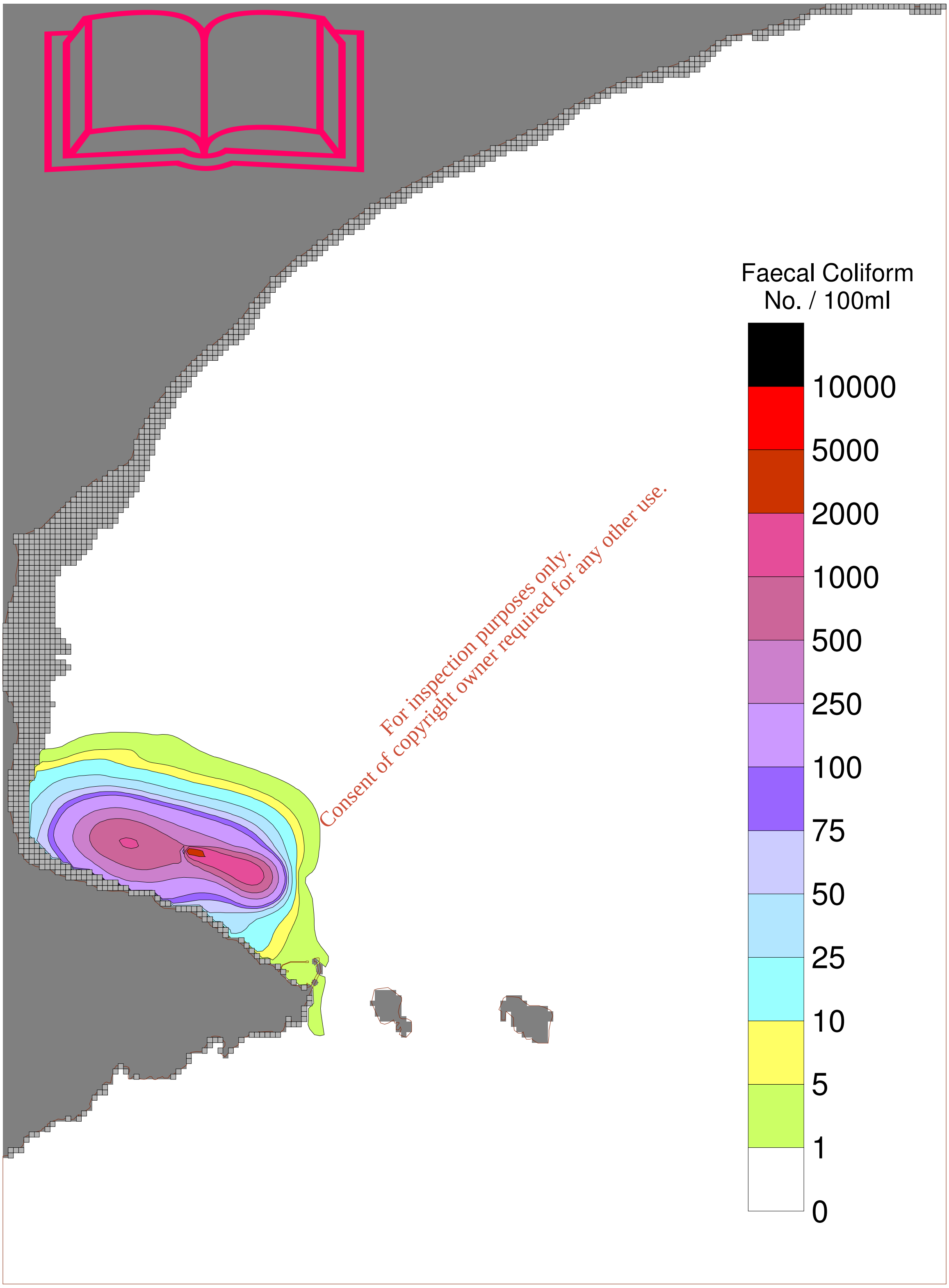


Figure 17 Outfall 3 3DWF Faecal Coliform Concentration Spring Tide Mid-Ebb

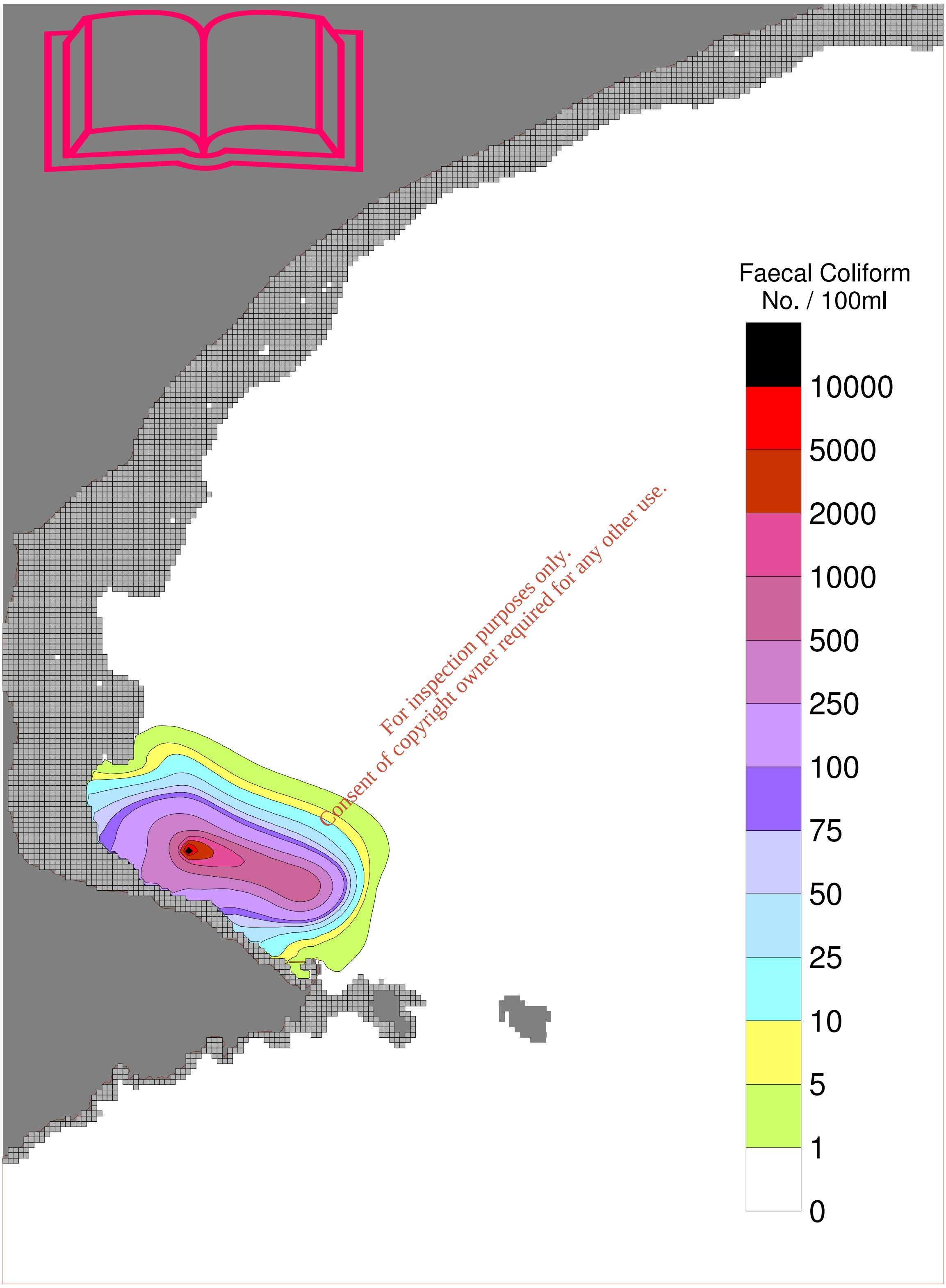


Figure 18   Outfall 3 3DWF Faecal Coliform Concentration Spring Tide Low Water

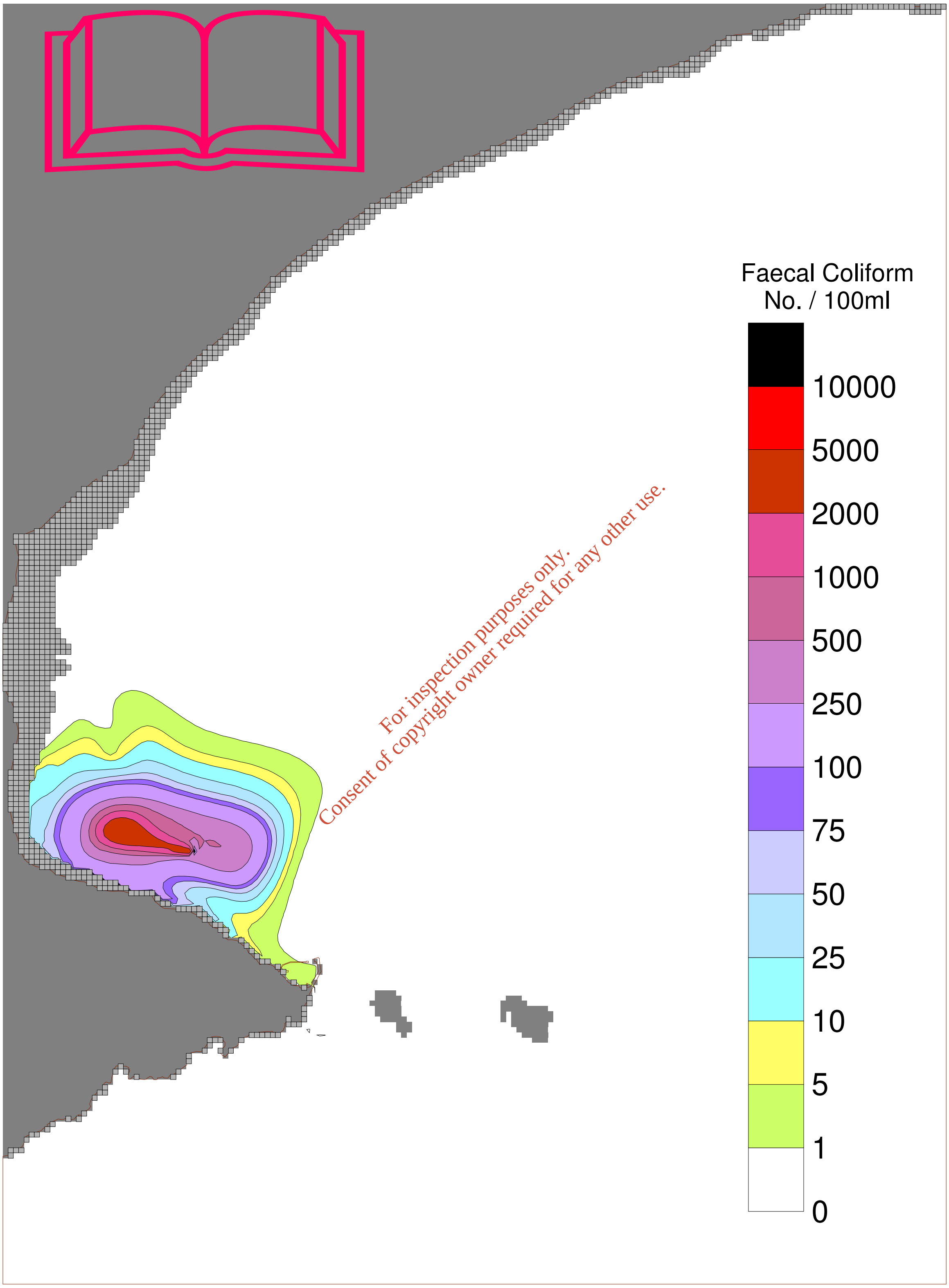


Figure 19 Outfall 3 3DWF Faecal Coliform Concentration Spring Tide Mid-Flood

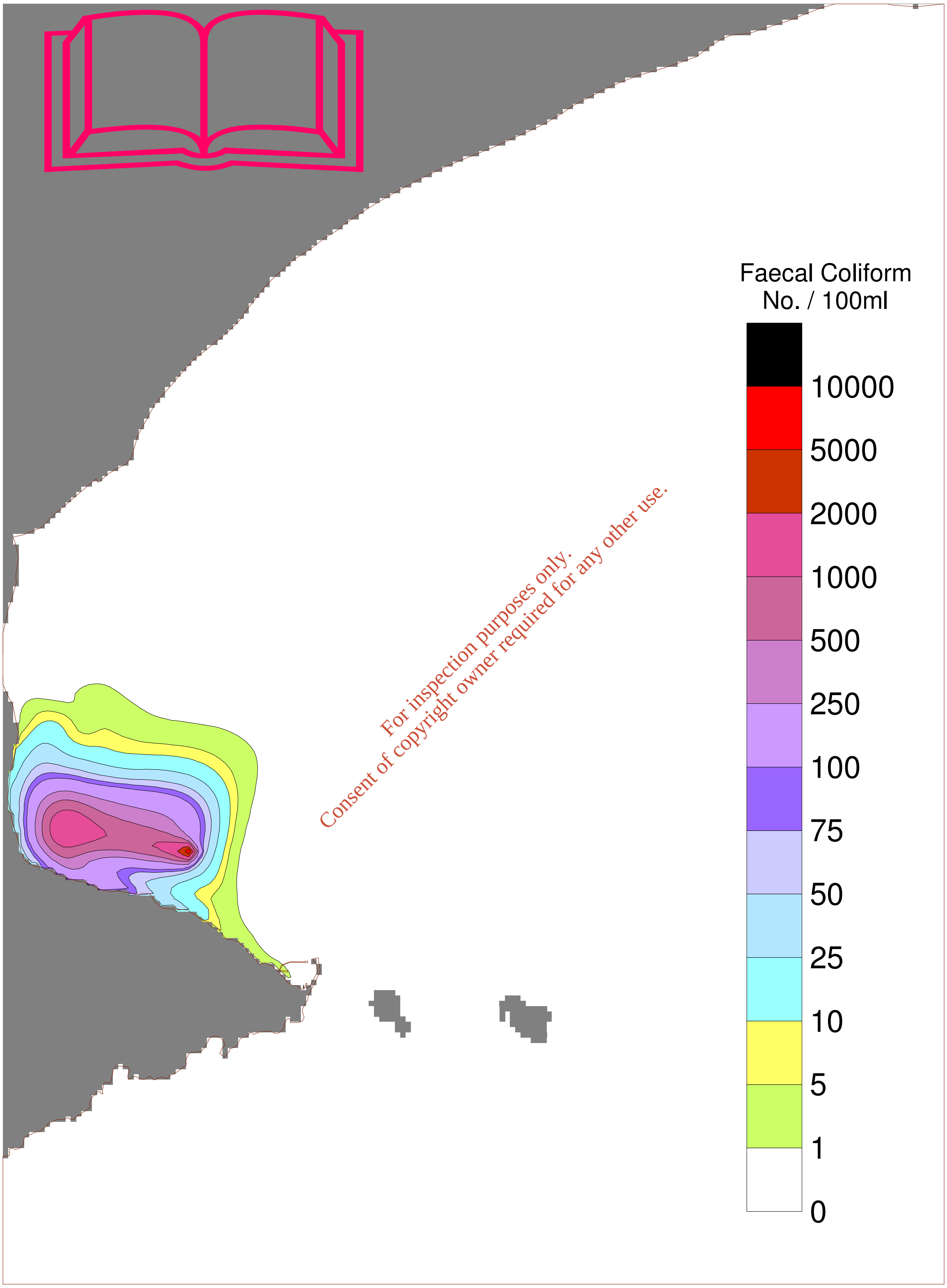


Figure 20 Outfall 3 3DWF Faecal Coliform Concentration Spring Tide Highwater

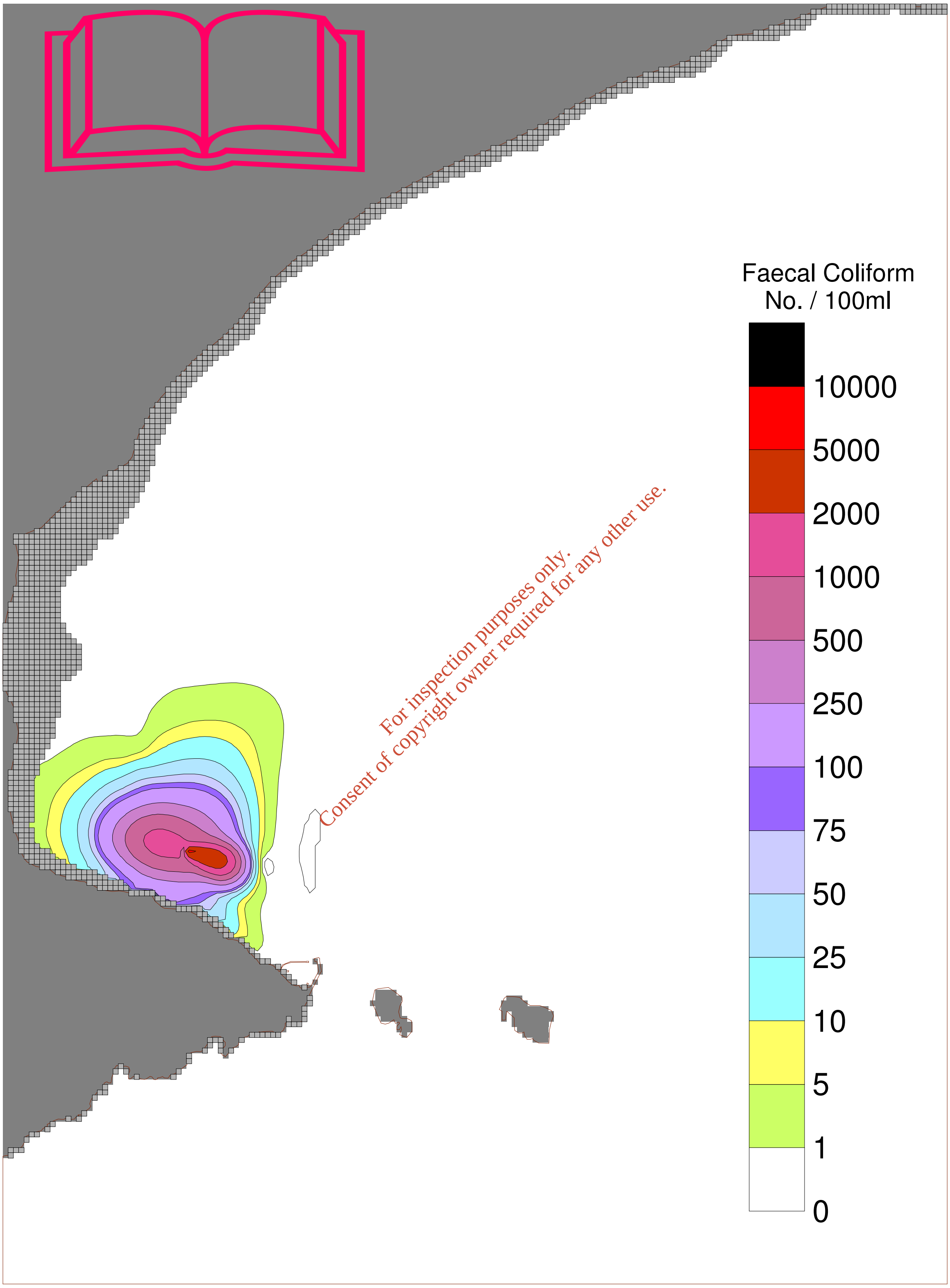


Figure 21 Outfall 3 3DWF Faecal Coliform Concentration Neap Tide Mid-Ebb

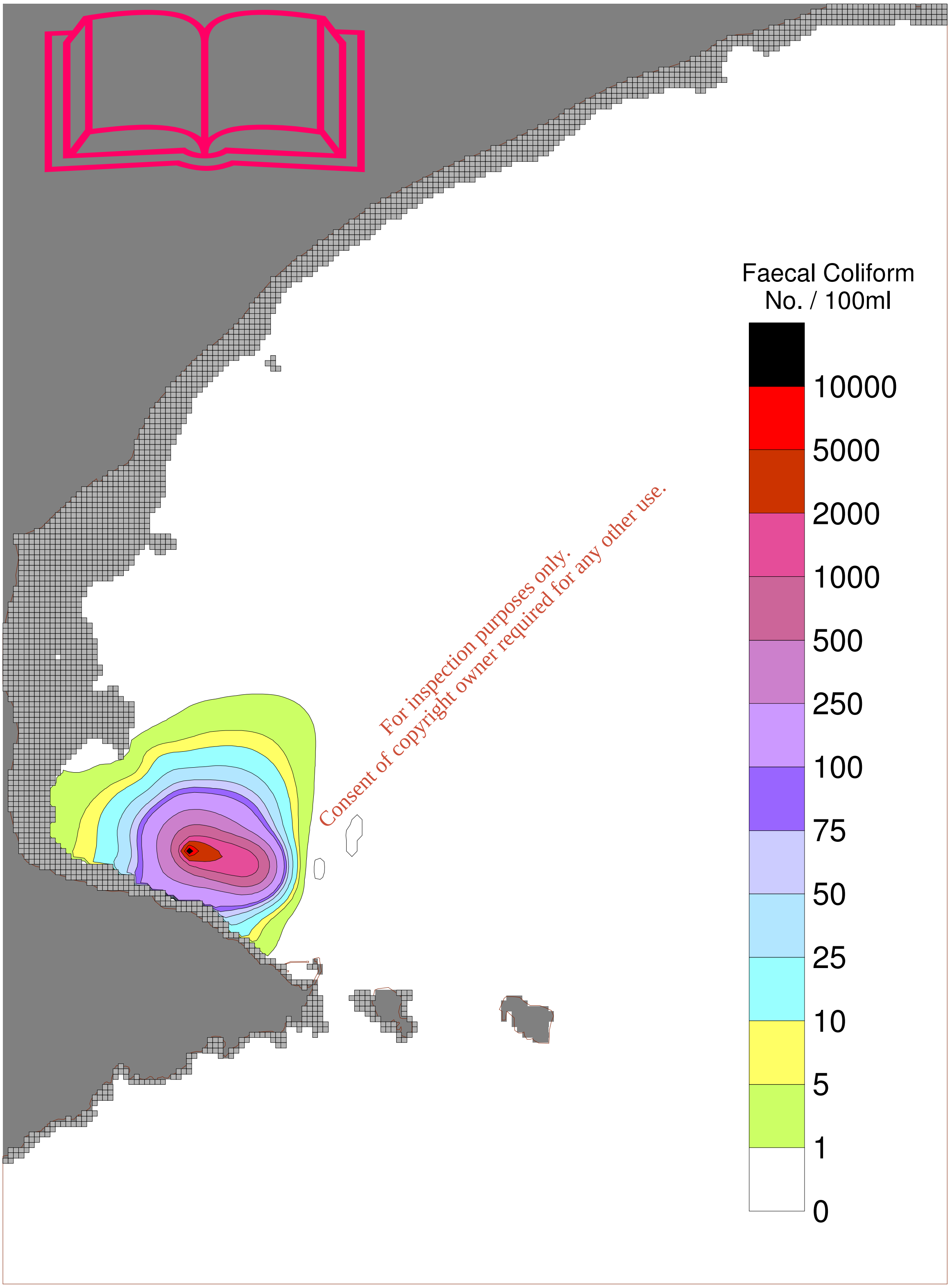


Figure 22   Outfall 3 3DWF Faecal Coliform Concentration Neap Tide Low Water

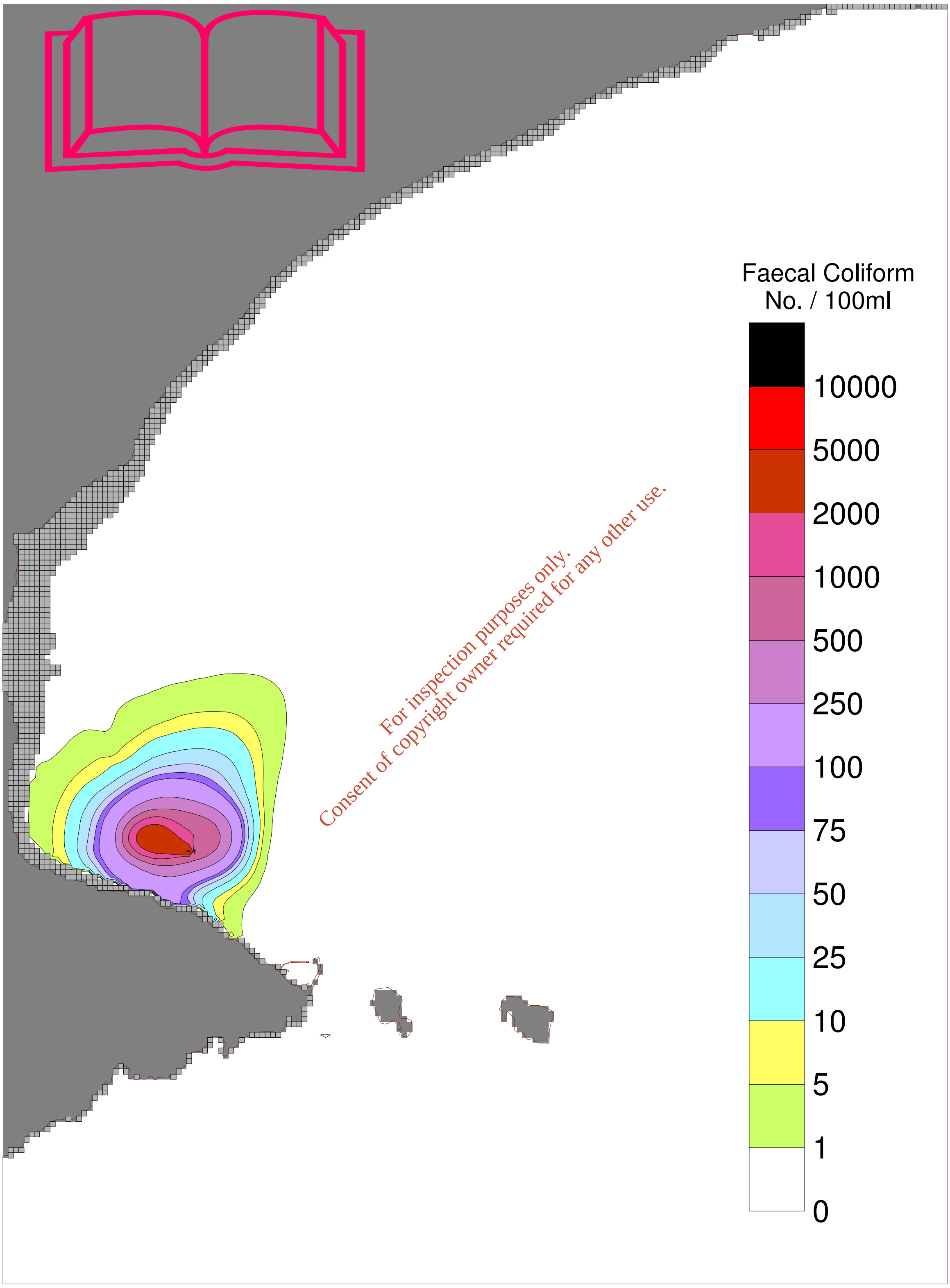


Figure 23 Outfall 3 3DWF Faecal Coliform Concentration Neap Tide Mid-Flood

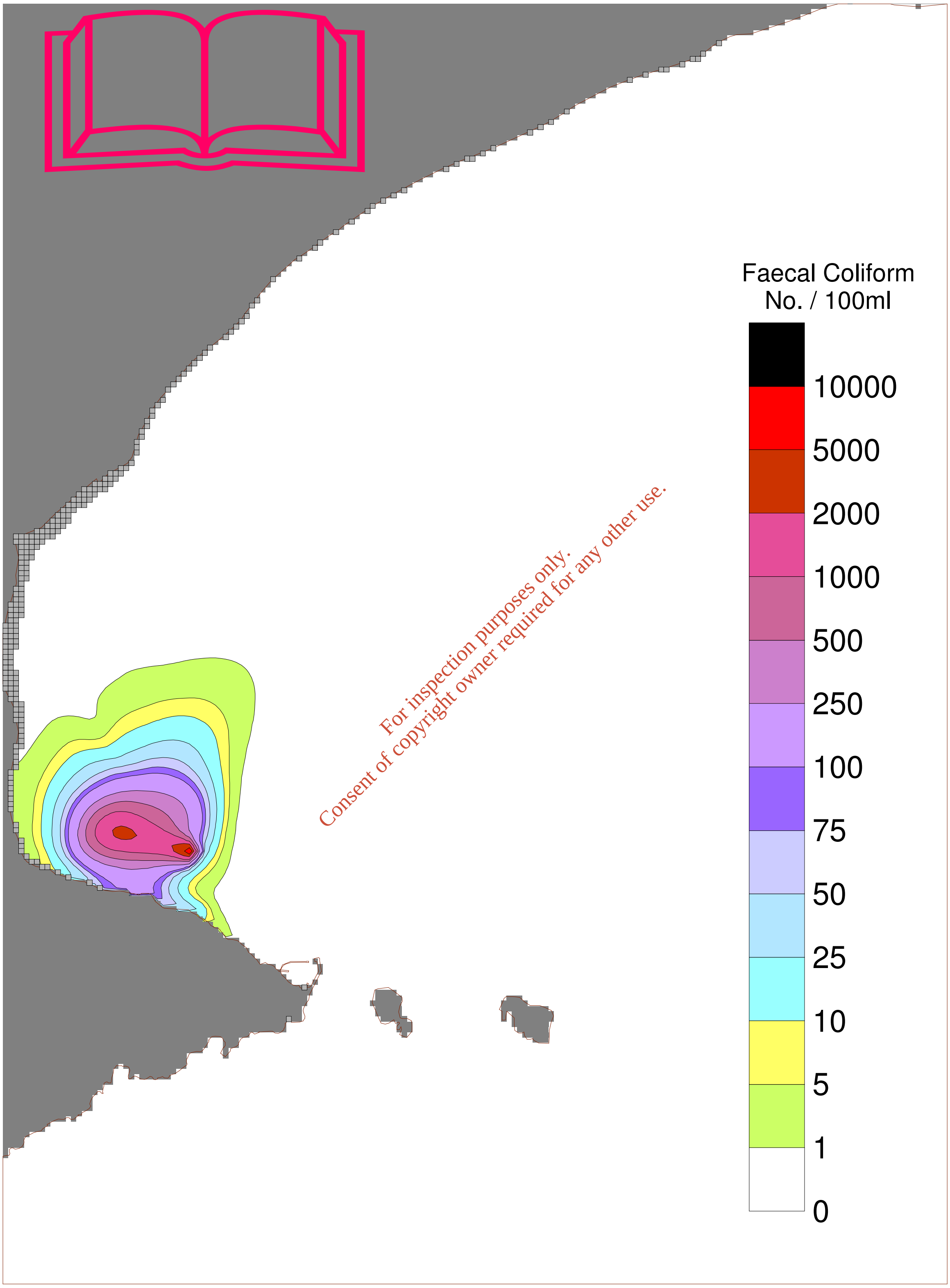


Figure 24 Outfall 3 3DWF Faecal Coliform Concentration Neap Tide Highwater

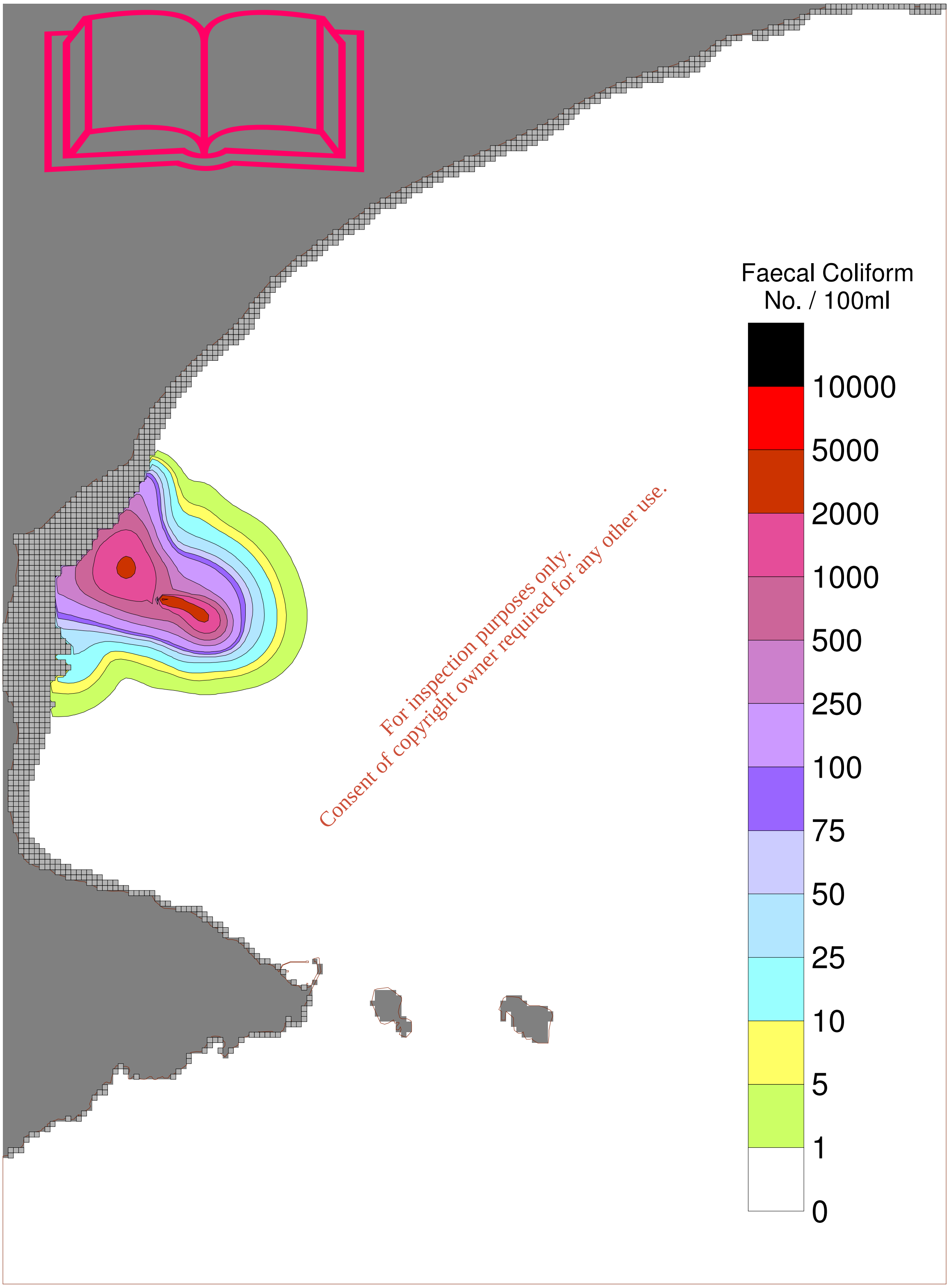


Figure 25 Outfall 4 3DWF Faecal Coliform Concentration Spring Tide Mid-Ebb

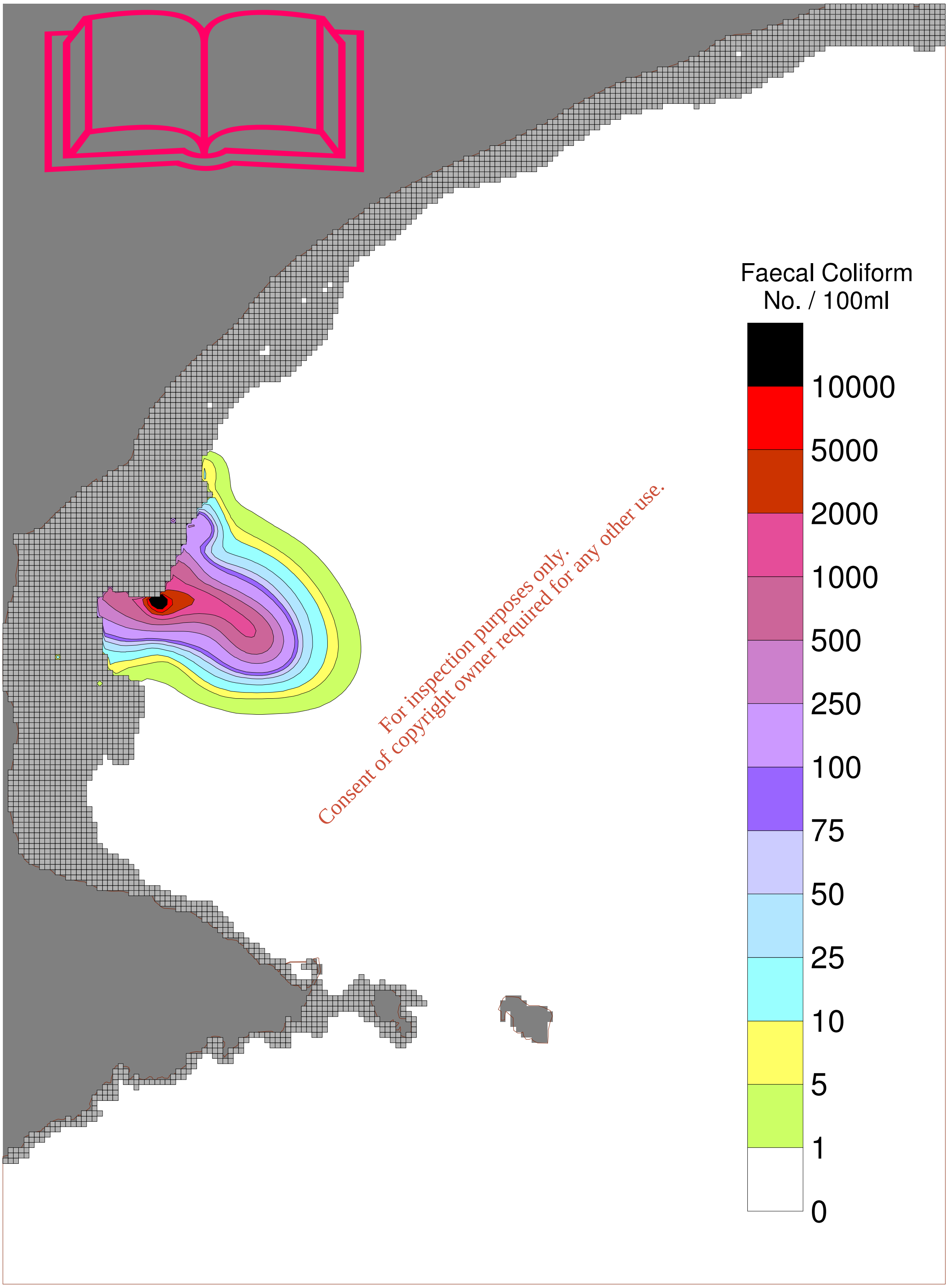


Figure 26 Outfall 4 3DWF Faecal Coliform Concentration Spring Tide Low Water

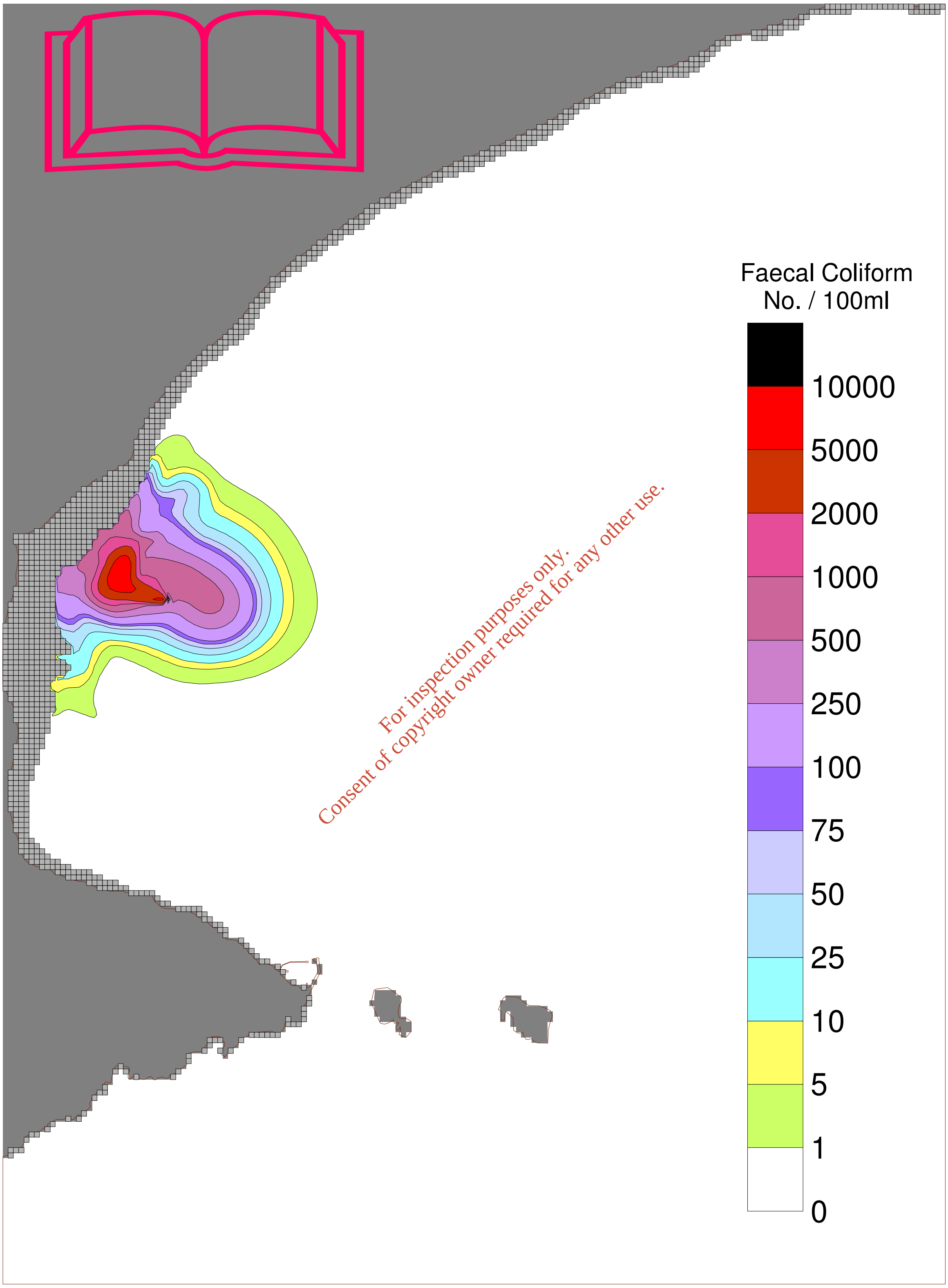


Figure 27 Outfall 4 3DWF Faecal Coliform Concentration Spring Tide Mid-Flood

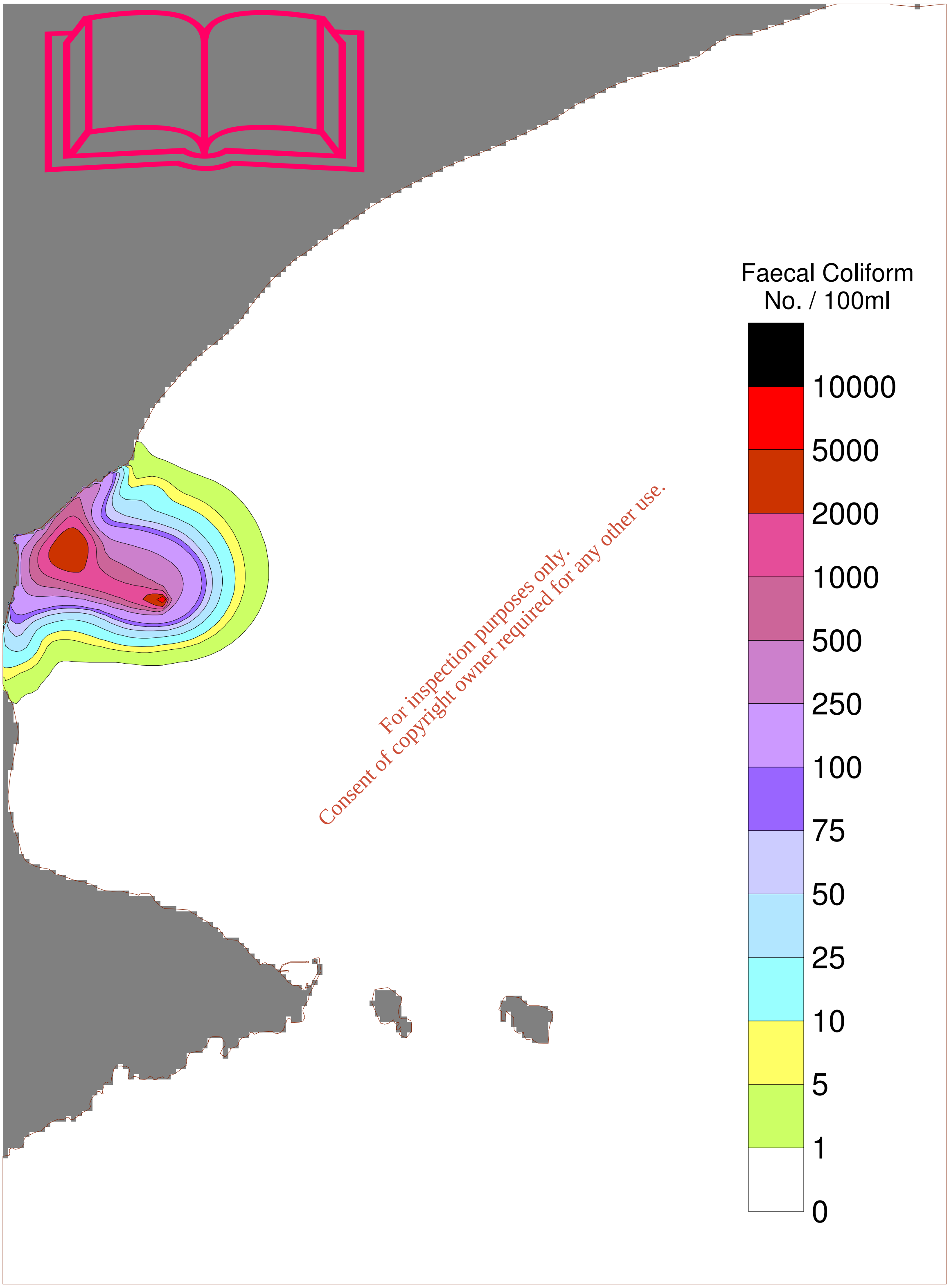


Figure 28 Outfall 4 3DWF Faecal Coliform Concentration Spring Tide Highwater

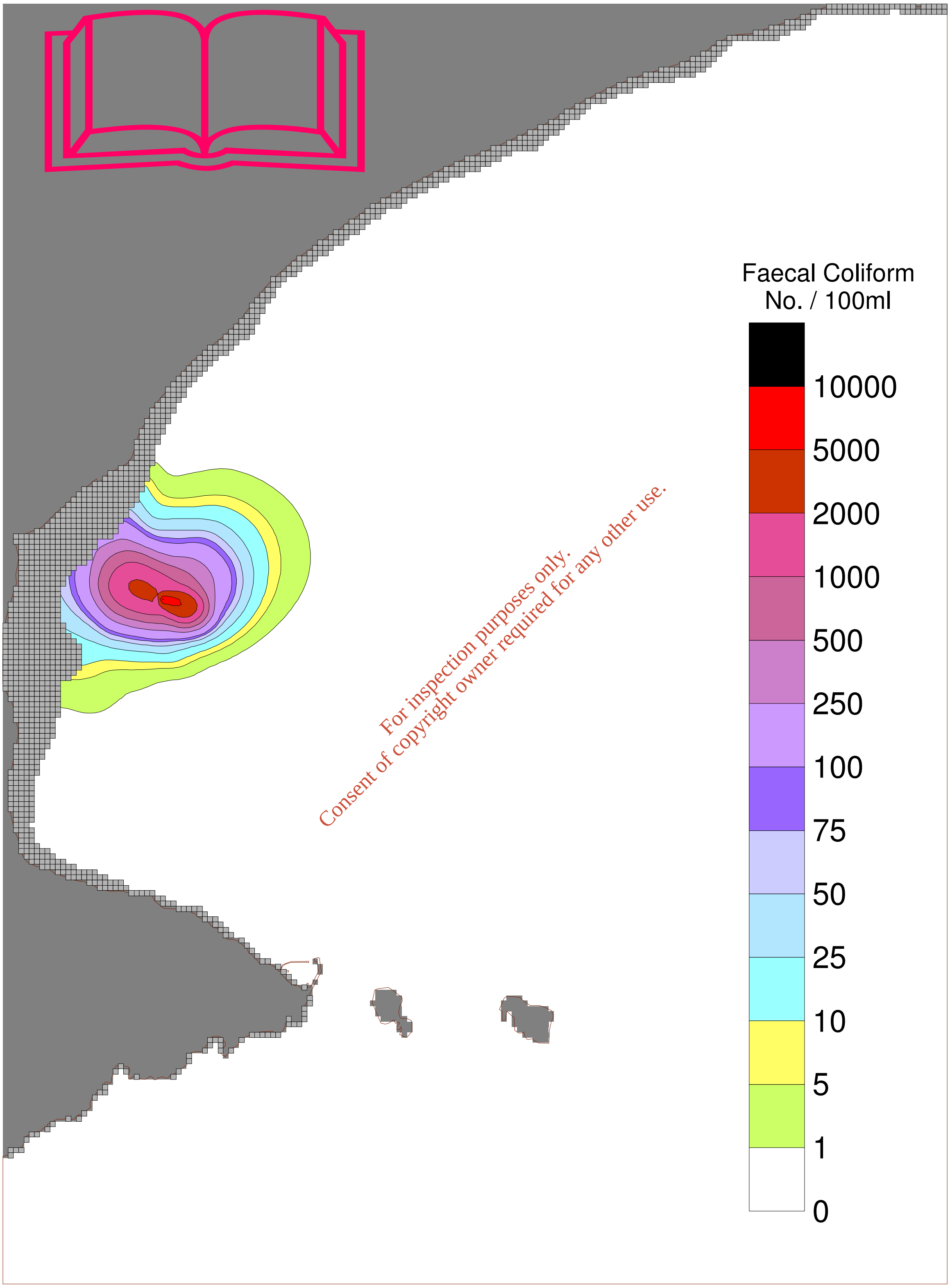


Figure 29 Outfall 4 3DWF Faecal Coliform Concentration Neap Tide Mid-Ebb

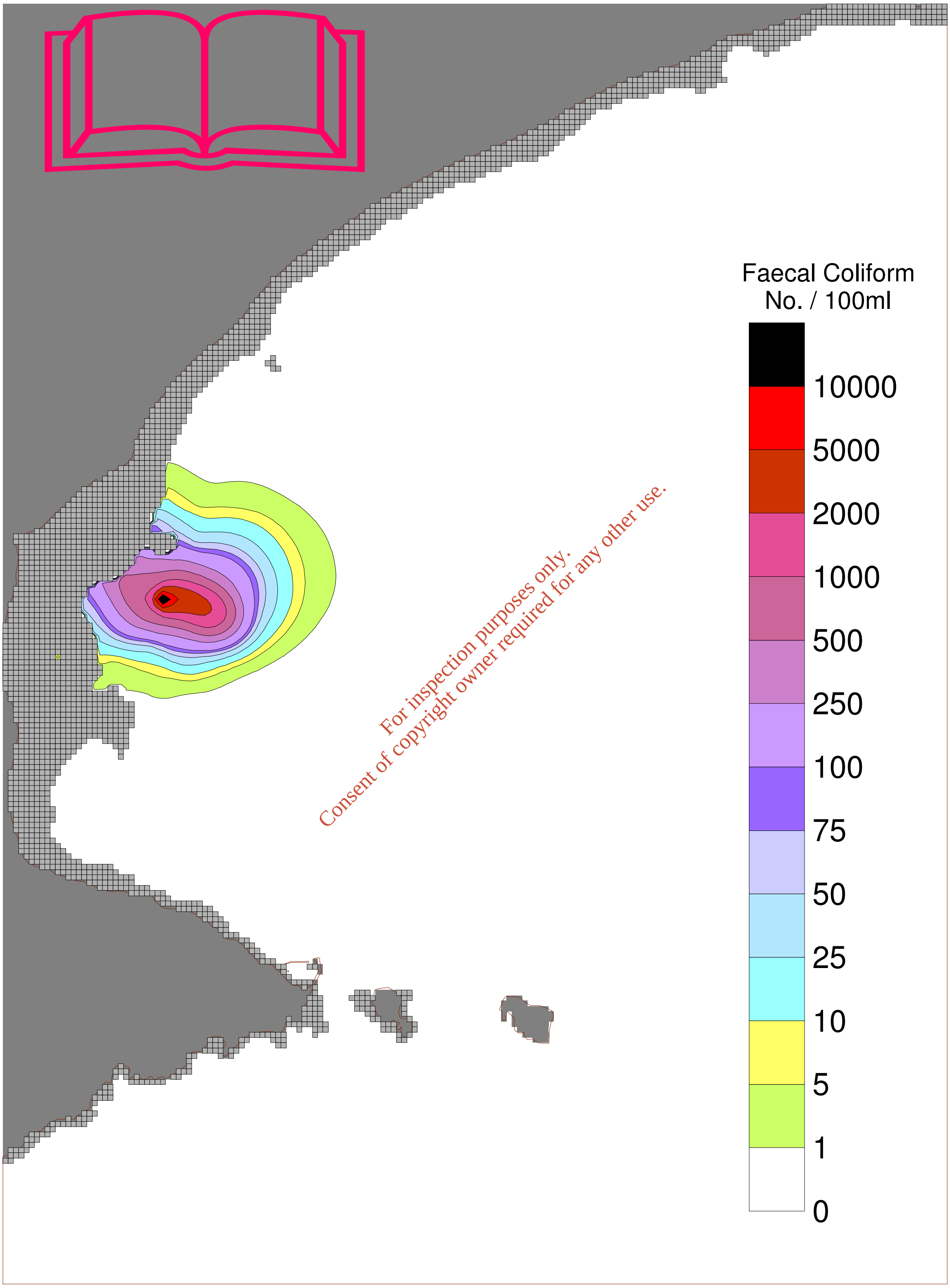


Figure 30 Outfall 4 3DWF Faecal Coliform Concentration Neap Tide Low Water

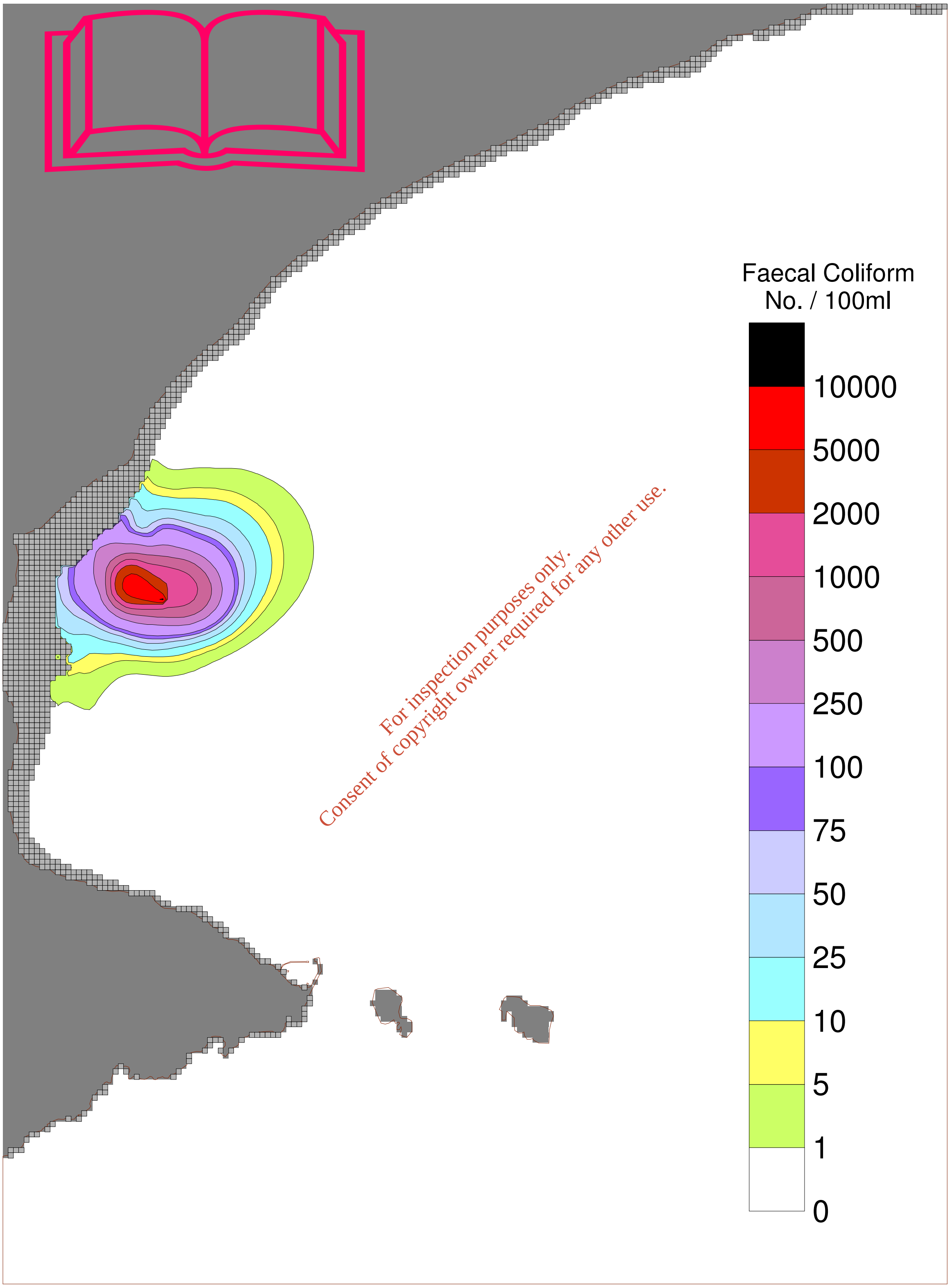


Figure 31 Outfall 4 3DWF Faecal Coliform Concentration Neap Tide Mid-Flood

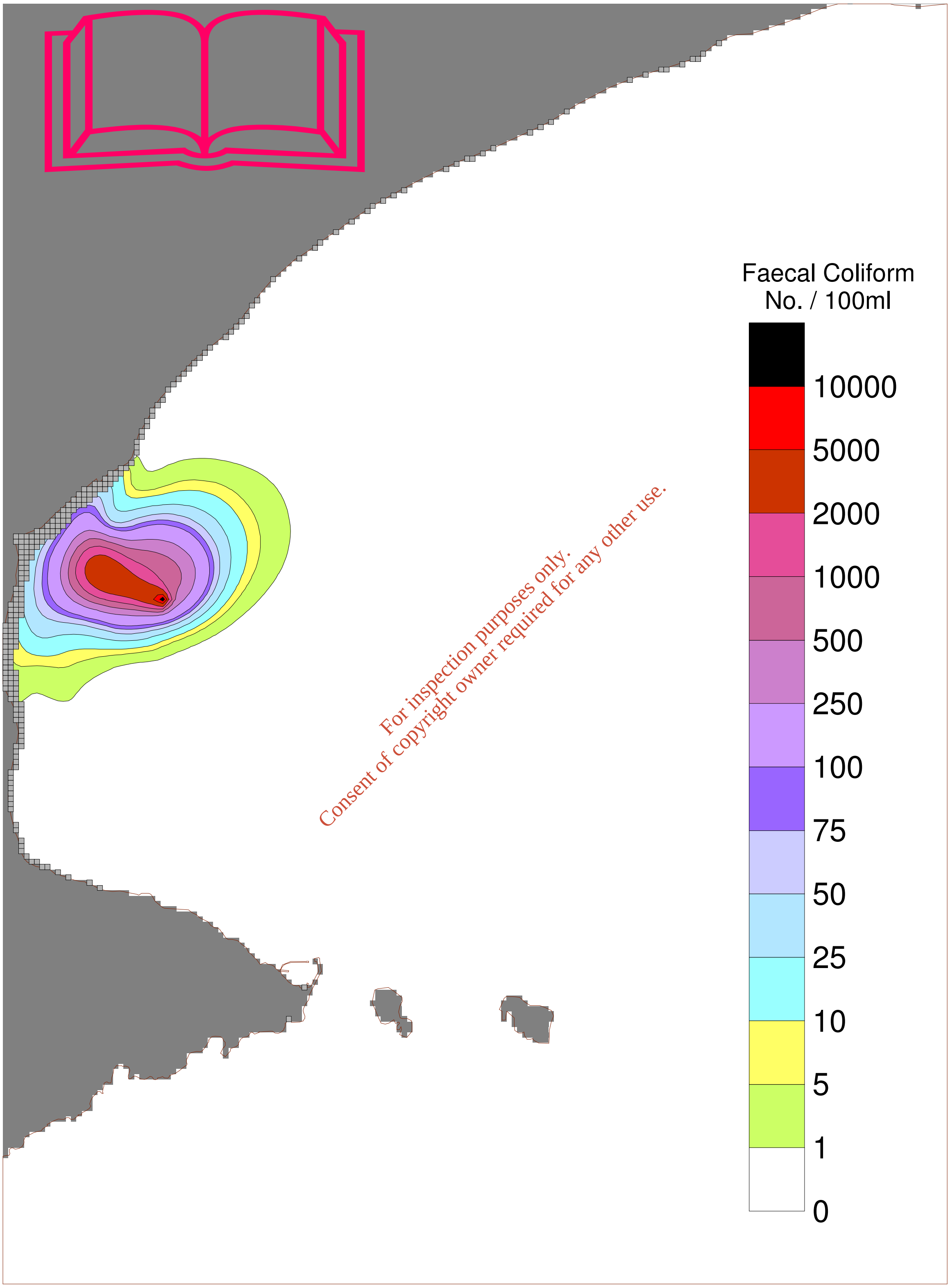


Figure 32 Outfall 4 3DWF Faecal Coliform Concentration Neap Tide Highwater

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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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.

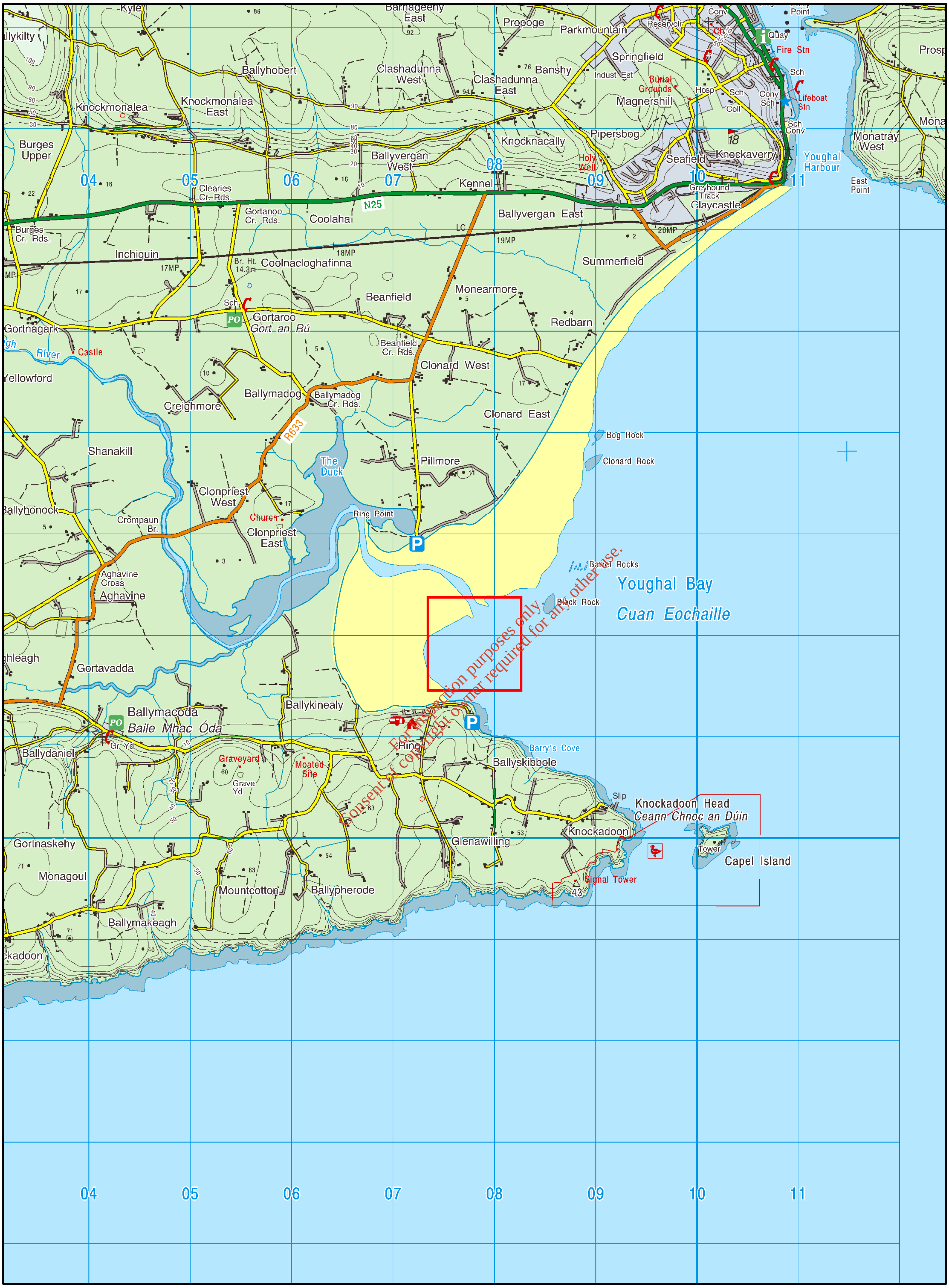
The principal habitat within the site is inter-tidal sand and mudflats. These are mostly well-exposed and the sediments are predominantly firm sands. In the more sheltered conditions of the inlets, sediments contain a higher silt fraction. The inter-tidal flats provide the main feeding habitat for the 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