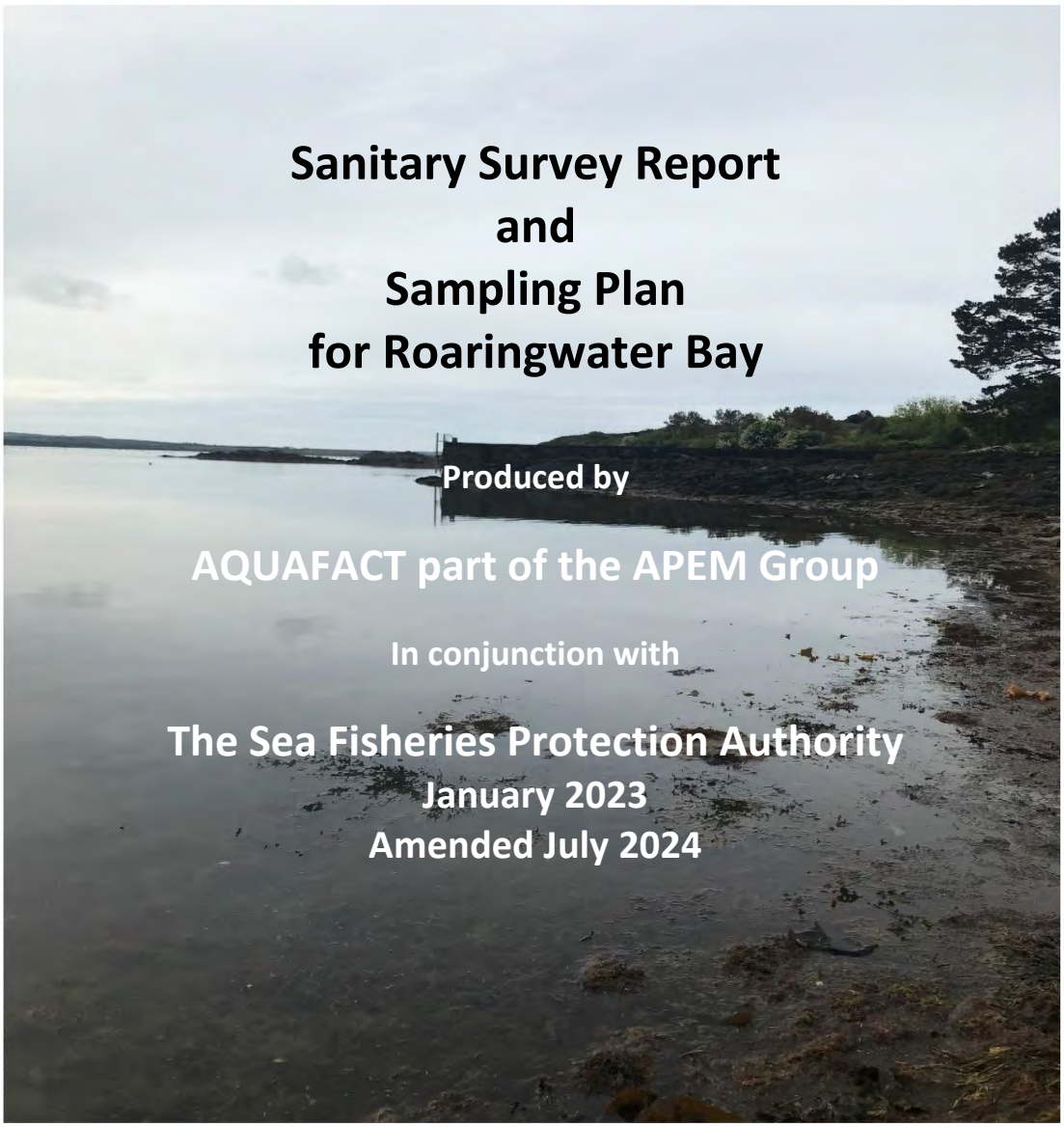

Sanitary Survey Report
and
Sampling Plan
for Roaringwater Bay

Produced by

AQUAFACT part of the APEM Group

In conjunction with

The Sea Fisheries Protection Authority

January 2023

Amended July 2024

AQUAFACT INTERNATIONAL SERVICES Ltd.

12 KILKERRIN PARK,

GALWAY H91FW7V

www.aquafact.ie

info@aquafact.ie

tel +353 (0) 91 756812

Report Approval Sheet

Client	Sea Fisheries Protection Authority
Report Title	Sanitary Survey & Sampling Plan for Roaringwater Bay
Job Number	JN1520
Report Status	Final – Amended
Issue Date	18/07/2024

Rev	Status	Issue Date	Document File Name	Author (s)	Approved by:
1	Draft		JN1520 Roaringwater Interim Report	K. Mc Caffrey	B. O'Connor
2	Draft	09/08/22	JN1520 Roaringwater Draft final Report V2	K. Mc Caffrey	B. O'Connor
3	Draft	29/11/22	JN1520 Roaringwater Draft final Report V3	Aisha O'Connor	E. McCormack
4	Draft	07/12/22	JN1520 Roaringwater Draft final Report V4	Aisha O'Connor	Sarah Buckley Peter McGroary E. McCormack
5	Final	06/01/2023	JN1520 Roaringwater Final Report	Aisha O'Connor	E. McCormack
6	Amended	03/07/2024	JN1520-JN1777_RoaringwaterBay_AmendedSSReport_AMOC030724	Aisha O'Connor	Eddie McCormack
7	Final - Amended	18/07/2024	JN1520-JN1777_RoaringwaterBay_AmendedSSReport_18072024	Aisha O'Connor	Eddie McCormack

AQUAFACT
APEM Group

AN t-ÚDARÁS UM CHOSAINT IASCAIGH MHARA | SEA-FISHERIES PROTECTION AUTHORITY

Contacts

For enquires relating to this report or further information on the implementation of sanitary surveys in Ireland:

Peter McGroary

Food and Fisheries Support Unit

Sea Fisheries Protection Authority

Clonakilty

Cork

Peter.mcgroary@sfpa.ie

Tel.023 885 9300

Statement of use

Under EU Regulation 2019/627 which lays down uniform practical arrangements for the performance of official controls on products of animal origin intended for human consumption, a sanitary survey relevant to bivalve mollusc production in Roaringwater Bay was undertaken in 2022. This will provide an appropriate hygiene classification zoning and monitoring plan based on the best available information with detailed supporting evidence. AQUAFACT undertook the desktop component of the work on behalf of the SFPA.

Report Prepared by

AQUAFACT: Kevin McCaffery, Aisha O'Connor, Dr Eddie McCormack and Dr Brendan O'Connor

SFPA: Sarah Buckley, Peter McGroary, Shane O'Neill, Sean Murran, Kevin Duggan and Thomas Ferron

Table of Contents

1. INTRODUCTION 3

2. OVERVIEW OF THE FISHERY/PRODUCTION AREA 5

2.1. DESCRIPTION OF THE AREA 5

2.2. ROARINGWATER FISHERY 7

2.2.1. Location/Extent of Growing/Harvesting Area 7

2.2.2. Description of Species 9

2.2.2.1. Blue Mussels (Mytilus edulis) 9

3. OVERALL ASSESSMENT OF THE EFFECT OF CONTAMINATION ON SHELLFISH 10

3.1. HUMAN SEWAGE/HUMAN POPULATION 10

3.2. AGRICULTURE 12

3.3. RIVERS AND STREAMS 13

3.4. MOVEMENT OF CONTAMINANTS 14

3.5. WILDLIFE 15

3.6. SEASONALITY 16

3.7. SHORELINE SURVEY 17

4. AMENDMENTS 19

5. RMPS AND SAMPLING PLAN 21

5.1. MUSSELS (MYTILUS EDULIS) 21

5.2. SPECIES SPECIFIC RMP MAP 24

5.3. GENERAL SAMPLING METHOD 25

6. APPENDIX 1: IDENTIFICATION OF POLLUTION SOURCES 26

6.1. DESKTOP SURVEY 26

6.2. HUMAN POPULATION 26

6.2.1. Tourism 33

6.2.2. Sewage Discharges 33

6.2.2.1. Water Treatment Works 34
6.2.2.2. Continuous Discharges 34
6.2.2.3. Rainfall Dependent / Emergency Sewage Discharges 39
6.2.3. Industrial Discharges 42
6.2.4. Landuse Types 44
6.2.5. Other Pollution Sources 51
6.2.5.1. Shipping 51
6.2.5.2. Wildlife 53

6.3. SHORELINE SURVEY 55
6.3.1. Shoreline Survey Report 55
6.3.2. Locations of Sources 81

7. APPENDIX 2: HYDROGRAPHY/HYDRODYNAMICS 88

7.1. SIMPLE/COMPLEX MODELS 88

7.2. DEPTH 88

7.3. TIDES & CURRENTS 90

7.4. WIND AND WAVES 92

7.5. RIVER DISCHARGES 96

7.6. RAINFALL DATA 98
7.6.1. Amount & Time of Year 98
7.6.2. Frequency of Significant Rainfalls 101

7.7. SALINITY 103

7.8. TURBIDITY 103

7.9. RESIDENCE TIME 103

7.10. DISCUSSION 104

8. APPENDIX 3: SHELLFISH AND WATER SAMPLING 105

8.1. HISTORICAL DATA 105
8.1.1. Shellfish Water Quality 105
8.1.2. Shellfish Flesh Quality 105
8.1.3. Norovirus (NoV) 113

8.2. CURRENT DATA 113
8.2.1. Sampling Sites & Methodology 113
8.2.2. Microbial Analysis Results 114
8.2.3. Shellfish Flesh Quality Sampling 116
8.2.4. Shellfish Flesh Quality Results 116
9. APPENDIX 4: STATISTICAL ANALYSIS 119
10. APPENDIX 5: SHORELINE SURVEY IMAGES 120
11. APPENDIX 6: SPECIES SPECIFIC RMPS 127
12. APPENDIX 7: SALINITY SURVEY REPORT 130
13. REFERENCES 131

List of Figures

Figure 2-1: Location of Natura 2000 sites in the vicinity of Roaringwater Bay BMCPA. 6

Figure 2-2: Bivalve Mollusc Classified Production Area and Designated Shellfish Waters within Roaringwater Bay.7

Figure 2-3: Licenced aquaculture sites within Roaringwater Bay (Source: DAFM, 2022).....8

Figure 2-4: Licenced mussel harvesting sites in Roaringwater Bay (Source: DAFM, 2022). 9

Figure 4-1: Roaringwater Bay amended BMPA.....20

Figure 5-1: Amended Bivalve Mollusc Classified Production Area and current Representative Monitoring Point within Roaringwater Bay. 23

Figure 5-2: Location of the new mussel Representative Monitoring Points within Roaringwater Bay. 24

Figure 6-1: Roaringwater Bay catchment area used for assessment of the pollution sources.....26

Figure 6-2: Electoral Divisions within the Roaringwater Bay Catchment Area. 28

Figure 6-3: Human population within the Roaringwater Bay Catchment Area (Source: CSO, 2019a).....30

Figure 6-4: Sewage Treatment Works within the Roaringwater Bay Catchment Area (Source: The EPA, 2019a). ..35

Figure 6-5: Continuous Discharges associated with the Sewage Treatment Works within the Roaringwater Bay Catchment Area (Source: The EPA, 2019a).....36

Figure 6-6: Rainfall Dependent Discharges associated with the Sewage Treatment Works within the Roaringwater Bay Catchment Area (Source: The EPA, 2019a).....41

Figure 6-7: Section 4 discharges within the Roaringwater Bay Catchment Area (Source: (EPA, 2019b; EPA, 2019c).42

Figure 6-8: Land use within the Roaringwater Bay Catchment Area (Source: EPA, 2019d). 44

Figure 6-9: Breakdown of land use within the Roaringwater Bay Catchment Area (only land use ≥1% is labelled).45

Figure 6-10: Area farmed (ha) within the Roaringwater Bay Catchment Area (Source: CSO, 2019b). 48

Figure 6-11: Total crops within the Roaringwater Bay Catchment Area (Source: CSO, 2019b).....48

Figure 6-12: Total grass and rough grazing within the Roaringwater Bay Catchment Area (Source: CSO, 2019b). .49

Figure 6-13: Cattle within the Roaringwater Bay Catchment Area (Source: CSO, 2019b).....49

Figure 6-14: Sheep within the Roaringwater Bay Catchment Area (Source: CSO, 2019b). 50

Figure 6-15: Horses within the Roaringwater Bay Catchment Area (Source: CSO, 2019b). 50

Figure 6-16: Location of all boating facilities and activities in Roaringwater Bay.....52

Figure 6-17: Location of haul-out sites for Grey and Common seals within Roaringwater bay (Source: Biodiversity Ireland).....54

Figure 6-18: Locations of GPS and photograph sites.....55

Figure 6-19: All features (numbering cross-reference to Table 6.12) identified during the shoreline survey. 62

Figure 6-20: Features 1-5 (numbering cross-reference to Table 6.12) identified during the shoreline survey.....63

Figure 6-21: Features 6-8 (numbering cross-reference to Table 6.12) identified during the shoreline survey.....64

Figure 6-22: Features 9-11 (numbering cross-reference to Table 6.12) identified during the shoreline survey.....65

Figure 6-23: Features 12-17 (numbering cross-reference to Table 6.12) identified during the shoreline survey. ...66

Figure 6-24: Features 18-26 (numbering cross-reference to Table 6.12) identified during the shoreline survey. ...67

Figure 6-25: Features 27-30 (numbering cross-reference to Table 6.12) identified during the shoreline survey. ...68

Figure 6-26: Features 31-34 (numbering cross-reference to Table 6.12) identified during the shoreline survey. ...69
Figure 6-27: Features 35-38 (numbering cross-reference to Table 6.12) identified during the shoreline survey. ...70
Figure 6-28: Features 39-56 (numbering cross-reference to Table 6.12) identified during the shoreline survey. ...71
Figure 6-29: Features 57-59 (numbering cross-reference to Table 6.12) identified during the shoreline survey. ...72
Figure 6-30: Features 60 (numbering cross-reference to Table 6.12) identified during the shoreline survey. 73
Figure 6-31: Features 61-69 (numbering cross-reference to Table 6.12) identified during the shoreline survey. ...74
Figure 6-32: Features 70-74 (numbering cross-reference to Table 6.12) identified during the shoreline survey. ...75
Figure 6-33: Feature 75-85 (numbering cross-reference Table 6.12) identified during the shoreline survey. 76
Figure 6-34: Features 86-92 (numbering cross-reference Table 6.12) identified during the shoreline survey. 77
Figure 6-35: Features 93-99 (numbering cross-reference to Table 6.12) identified during the shoreline survey. ...78
Figure 6-36: Features 100-102 (numbering cross-reference to Table 6.12) identified during the shoreline survey.79
Figure 6-37: Features 103-109 (numbering cross-reference to Table 6.12) identified during the shoreline survey.80
Figure 6-38: Location of all watercourses discharging into Roaringwater Bay. 82
Figure 6-39: Locations of all discharges within Roaringwater Bay Catchment Area. 84
Figure 7-1: Depths in Roaringwater Bay (Source: Admiralty Chart 2129). 89
Figure 7-2: Tidal stream data available for Roaringwater Bay from admiralty charts (Current speeds shown were available). 91
Figure 7-3: Wind roses for Sherkin Island from 2016 to 2020 (Source: Met Eireann, 2020a). 95
Figure 7-4: Rivers in the Roaringwater Bay catchment area (Source: EPA, 2019). 97
Figure 7-5: WFD Status of the coastal and river waterbodies in the catchment area (Source EPA, 2019). 97
Figure 7-6 Average monthly rainfall (mm) data from 1981 to 2010 for Ireland (Source: Met Eireann, 2019). 99
Figure 7-7: Location of Met Eireann weather stations in relation to the Roaringwater Bay production area. 100
Figure 7-8: Greatest daily rainfall (mm) at Valentia from 1981-2010 (Source: Met Eireann, 2020c). 102
Figure 7-9: 5 year average of greatest daily rainfall (mm) at Sherkin Island weather station from 2016-2020 (Source: Met Eireann, 2020a). 103
Figure 8-1: Location of SFPA shellfish monitoring point for classification purposes. 106
Figure 8-2: *E. coli* results from mussels at Roaringwater Bay from January 2016 to December 2020 (Source: SFPA). 110
Figure 8-3: Trend in geometric mean of *E. coli* levels from 2016 to 2020 for mussels in Roaringwater Bay. 111
Figure 8-4: Location and magnitude of *E. coli* results from the shoreline survey. 115
Figure 8-5: Current RMP within the current Roaringwater Bay BMPA. 117
Figure 8-6: Suggested RMP 1 within the amended Roaringwater Bay BMPA. 117
Figure 8-7: Suggested RMP 2 within the amended Roaringwater Bay BMPA. 118
Figure 11-1: Mussel Representative Monitoring Points (RMPs) within Roaringwater Bay. 129

List of Tables

Table 5.1: Coordinates of the Production Area. 22
Table 5.2: Coordinates of each RMP and its relevant species. 22
Table 6.1: Human population within the Roaringwater Bay Catchment Area (Source: CSO, 2019a). 31

Table 6.2: Households within the EDs in the Roaringwater Bay Catchment Area (Source: CSO, 2019a). 32
Table 6.3: Sewage Treatment Works within the Roaringwater Bay Catchment Area (Source: EPA, 2019a). 35
Table 6.4: Continuous Discharges within the Roaringwater Bay Catchment area (Source: EPA, 2019a). Map Codes refer to Figure 5.5. 37
Table 6.5: Sewage facilities at permanent households in the catchment area (CSO, 2019a).....38
Table 6.6: Rainfall dependent discharges (storm water overflows) within the Roaringwater Bay Catchment area (Source: EPA, 2019a). Map Codes refer to Figure 6-6. 40
Table 6.7: Details of section 4 discharges within the Roaringwater Bay Catchment Area (Source: EPA, 2019b). Map Codes refer to Figure 6-7. 43
Table 6.8: Farm census data for all EDs within the Roaringwater Bay Catchment Area (Source: CSO, 2019b). 47
Table 6.9: Potential daily loading of *E. coli* (Jones & White, 1984). 51
Table 6.10: Boating facilities in the Roaringwater Bay. Map Code refers to Figure 6-16. 52
Table 6.11: Total number of waterbirds in Roaringwater Bay between 2009/10 and 2017/18 seasons (Source: BWI, 2020). 53
Table 6.12: Features identified during the shoreline survey. Refer to Figure 6-18 for locations and Appendix 6, Figure 6-20 to Figure 6-37 for photographs. 57
Table 6.13: Cross-referenced table for Figure 6-38 watercourses.....83
Table 6.14: Cross-referenced table for Figure 6-39 Discharges. 85
Table 7.1: Roaringwater Bay tidal characteristics (Source: Admiralty Chart No. 2129).....90
Table 7.2: Wind speed and direction data for Sherkin Island from 2016-2020 (Source: Met Eireann, 2020a). 93
Table 7.3: Seasonal averages (knots) for Sherkin Island wind data (Source: Met Eireann, 2020a). 94
Table 7.4: Monthly average rainfall at Valentia from 1981 to 2010 (Source: Met Eireann, 2020b). 98
Table 7.5: Average seasonal rainfall values (mm) from 1981-2010 at Valentia (Source: Met Eireann, 2020b). 98
Table 7.6: Total monthly rainfall (mm) data at Sherkin Island, Co. Cork, from 2016 to 2020 (Source: Met Eireann, 2020a). 101
Table 7.7: Total seasonal rainfall (mm) at Sherkin Island from 2016-2020 (Source: Met Eireann, 2020a).....101
Table 8.1: Coordinates of sampling site within the Roaringwater Bay Production Area. 105
Table 8.2: Classification system for shellfish harvesting areas.....106
Table 8.3: Current and historical classification of shellfish beds in Roaringwater Bay (2016 – 2022).....107
Table 8.4: *E. coli* results from Roaringwater Bay mussels from January 2016 to June 2020 (Source: SFPA). 108
Table 8.5: Summary statistics of historical *E. coli* data monitored from shellfish beds in Roaringwater Bay. 112
Table 8.6: Variation of annual geometric means of *E. coli* (MPN/100g) from shellfish beds monitored in Roaringwater Bay. 112
Table 8.7: Water sample coordinates with date of sampling.....113
Table 8.8: Water *E. coli* results for Roaringwater Bay.....115
Table 8.9: Shellfish *E. coli* results from the current RMP and suggested RMPs for Roaringwater Bay.....116

Glossary

ANOVA	Analysis of Variance
Bathymetry	The measurement of water depth at various places of a water body
Benthic	Of, pertaining to, or occurring at the bottom of a body of water
CD	Chart Datum
Corine land use	Is a Pan-European land use and landcover mapping programme. It supplies spatial data on the state of the European environmental landscape and how it is changing over time. Based on the interpretation of satellite imagery, Corine land use provides national scale maps of landcover and landcover change on a six-year basis for thirty-nine countries in Europe.
CSO	Central Statistics Office
Depuration	The process of purification or removal of impurities
DSW	Designated Shellfish Waters
DWF	Dry Weather Flow
EC	European Commission
E. coli	*Escherichia coli*
Fetch	The distance a wave can travel towards land without being blocked
Geometric Mean	The nth root of the product of n numbers (The average of the logarithmic values of a data set, converted back to a base 10 number).
GIS	Geographical Information Systems
GPS	Global Positioning System
Hydrodynamic	Forces in or motions of liquids
Hydrography	The description and analysis of the physical conditions, boundaries, flows and related characteristics of water bodies
INAB	Irish National Accreditation Board
I-WeBS	Irish Wetland Bird Survey
MPN	Most Probable Number
P	Phosphorus
p.e.	Population Equivalent
Plankton/Planktonic	Pertaining to small, free-floating organisms of aquatic systems
PSP	Paralytic Shellfish Poisoning
PSU	Practical Salinity Units

Regulation (EU) 2017/625

of the European Parliament and of the Council of 15 March 2017 on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products

Regulation (EU) 2019/627

of 15 March 2019 laying down uniform practical arrangements for the performance of official controls on products of animal origin intended for human consumption in accordance with Regulation (EU) 2017/625 of the European Parliament and of the Council and amending Commission Regulation (EC) No 2074/2005 as regards official controls

RMP	Representative Monitoring Point
SAC	Special Area of Conservation
SFPA	Sea Fisheries Protection Authority
SPA	Special Protection Area
SS	Suspended Solids
WWTP	Water Treatment Plant

1. Introduction

Consumption of raw or lightly cooked bivalve molluscs can results in illness due to the presence of micro-organisms, many of which are derived from faecal contamination of the marine environment. Shellfish contaminated with pathogenic microorganisms may cause infectious disease in humans and such outbreaks are more likely to occur close to our coasts where production areas are impacted by sources of human and animal faecal contamination.

The risk of contamination of bivalve molluscs with pathogenic microorganisms is assessed through microbiological monitoring programmes. This assessment results in the classification of bivalve mollusc production areas, which in turn governs the level of treatment required before human consumption of the shellfish.

Under EU regulations sanitary surveys of bivalve mollusc production areas and their associated hydrological catchments and coastal waters are required in order to establish the appropriate representative monitoring points for these monitoring programmes.

Specifically, under regulation (EU) 2017/625 and its subsequent implementing regulation (EU) 2019/627 there is a requirement to carry out a sanitary survey before classifying any shellfish production or relaying area. Article 56 of Implementing Regulation 627 of 219 states:

1. Before classifying a production or relaying area, the competent authorities shall carry out a sanitary survey that includes:

- An inventory of the sources of pollution of human or animal origin likely to be a source of contamination for the production area;

- An examination of the quantities of organic pollutants released during the different periods of the year, according to the seasonal variations of human and animal populations in the catchment area, rainfall readings, wastewater treatment, *etc.*;

- Determination of the characteristics of the circulation of pollutants by virtue of current patterns, bathymetry and the tidal cycle in the production area.

2. The competent authorities shall carry out a sanitary survey fulfilling the requirements set out in paragraph 1 in all classified production and relaying areas, unless carried out previously.

3. The competent authorities may be assisted by other official bodies or food business operators under conditions established by the competent authorities in relation to the performance of this survey.

Currently the Sea Fisheries Protection Authority in conjunction with AQUAFACT International Services Ltd is conducting sanitary surveys for new bivalve mollusc production areas and for those existing classified production areas which were previously not surveyed.

This report contains the documents relevant to the sanitary survey of the bivalve mollusc production area at Roaringwater Bay, Co. Cork. It identifies the representative monitoring points and supporting sampling plan for mussels in Roaringwater Bay. It also sets out the production area boundaries in the bay.

In summary, this report recommends the removal of the existing mussel representative monitoring point and replacing it with two separate monitoring points. The first is located closer to the junction of Ballydehob and Poulgorm Bays whilst the second is located closer to the shore at Reenmurrish. The boundaries of the classified production area have also been amended. The westward boundary now encompasses Castle Island and the southwestern boundary now covers parts of the northern shore of Hare Island. The inner boundary in Ballydehob Bay has been reduced to remove the area around the village and now crosses the channel at Greenmount. Appendix 7: Salinity Survey Report provides justification on maintaining Roaringwater Bay production area as one unit rather than splitting into two distinct production areas; note this text and Appendix 7 were added in July 2024 as an addendum to the original 2023 Sanitary Survey report.

2. Overview of the Fishery/Production Area

2.1. Description of the Area

Roaringwater Bay is located on the southwest coast of Ireland and is a 13km^2 shallow bay. The substrate in the bay is mud except for a small area in the west of the production area at Horse Ridge. The majority of Ballydehob Bay and Poulgorm Bay are intertidal. While Roaringwater Bay proper has only a narrow intertidal band along the shore. Most of the bay is between 4 to 5 m deep. The area is approximately 4km E-W at its widest point and approximately 5km N-S. The catchment area of the BMCPA is 126.8km^2. Three rivers drain 67% of the catchment: the Bawnaknockane River, Leamawadra River and Roaringwater River, along with a series of small streams.

Roaringwater Bay is designated as Roaringwater Bay and Islands SAC (Site Code: IE000101). There are no SPAs within Roaringwater Bay. The closest SPA is Sheep's Head to Toe Head SPA (Site Code: 004156) located 4.5km southeast of the bay (Figure 2-1). These sites are designated for the presence of a number of important habitats and species.

Roaringwater Bay and Islands SAC is a wide, shallow bay located on the south-west coast of Ireland. The SAC includes the immediate coastline on the mainland from Long Island to Baltimore, together with the whole bay and most of the islands. Some of the larger islands included are Sherkin Island, Cape Clear Island, Heir Island, Horse Island, Castle Island and Long Island. The site is designated for a range of species and habitats including: Large Shallow Inlets and Bays, Reefs, Vegetated Sea Cliffs, Dry Heath, Sea Caves, Harbour Porpoise (*Phocoena phocoena*), Otter (*Lutra lutra*) and Grey Seal (*Halichoerus grypus*) (NPWS,2014).

Sheep's Head to Toe Head SPA is located 4.5km southeast of the bay. The site is a Special Protection Area (SPA) under the E.U. Birds Directive, of special conservation interest for the following species: Chough and Peregrine. The site also supports a range of other breeding seabirds including Fulmar (57 pairs), Herring Gull (30 pairs), Shag (17 pairs), Kittiwake (20 pairs), Black Guillemot (137 individuals) and Great Black-backed Gull (1 pair) – all seabird data is from 1999, 2001 and 2002 (NPWS, 2015).

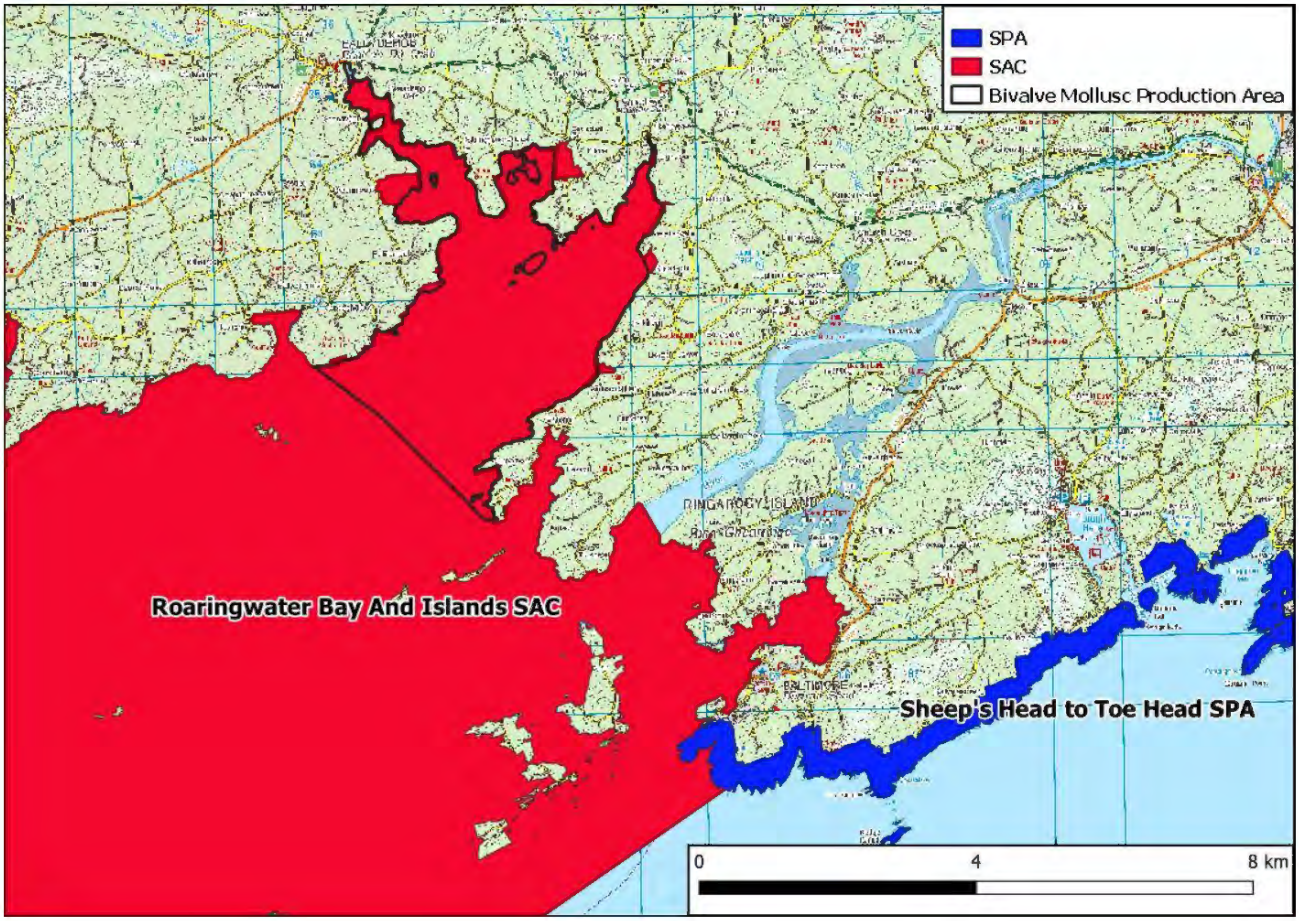

Figure 2-1: Location of Natura 2000 sites in the vicinity of Roaringwater Bay BMCPA.

The Roaringwater Bay waters support a diversity of fish species. Species present in the area include dogfish, flounder, bass and mullet (IFI, 2020).

Land cover within the Roaringwater Bay catchment is a mixture of pastures, land principally occupied by agriculture, with significant areas of natural vegetation, peat bogs, coniferous forest and transitional woodland-shrub.

The population of the catchment is approximately 2,375. The only town/urban centre within the catchment is Ballydehob.

2.2. Roaringwater Fishery

2.2.1. Location/Extent of Growing/Harvesting Area

The shellfish designated waters in Roaringwater Bay cover an area of approximately 22.45km^2 and the Bivalve Mollusc Classified Production Area (BMCPA) covers *c.* 13km^2. Both can be seen in Figure 2-2. Mussel cultivation is predominant in Roaringwater Bay.

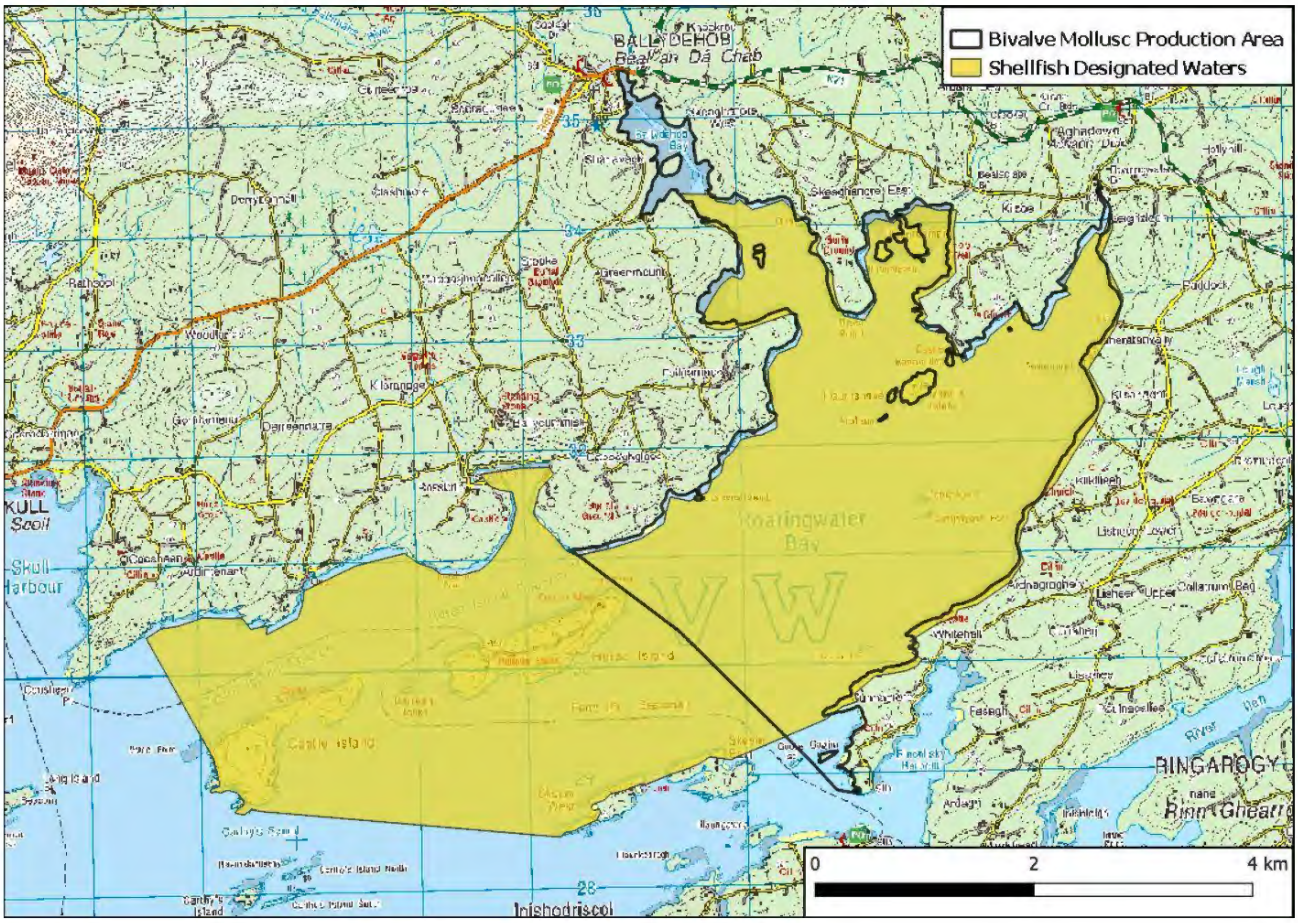

Figure 2-2: Bivalve Mollusc Classified Production Area and Designated Shellfish Waters within Roaringwater Bay.

Figure 2-3 shows the current locations of licenced aquaculture sites within Roaringwater Bay. There are 50 licensed areas within the Roaringwater Bay designated shellfish area, 45 of which are also within the BMPA. 49 of the licences within the designated shellfish area are for mussels, the remaining one is for red seaweeds. (The total licensed area for mussels is *c.* 3.5km^2).

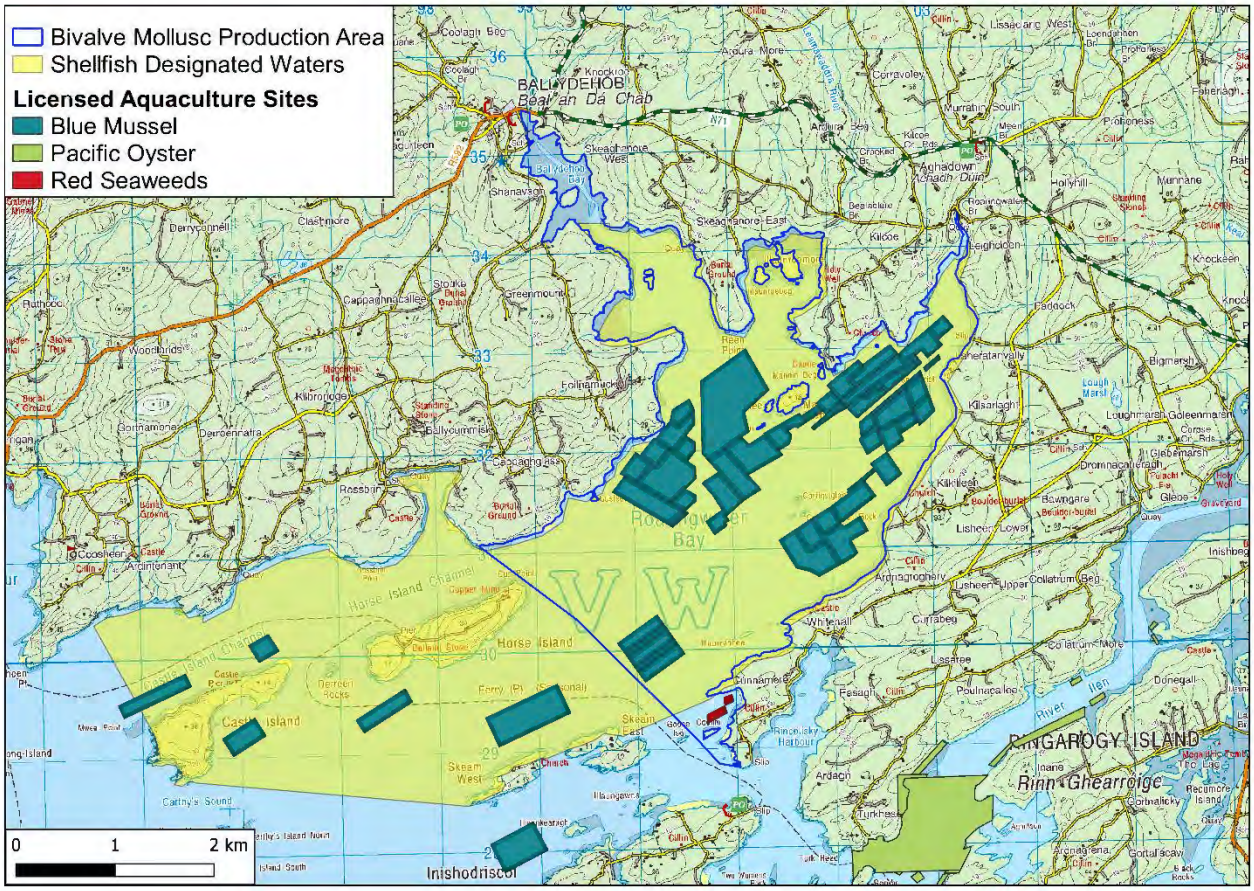

Figure 2-3: Licenced aquaculture sites within Roaringwater Bay (Source: DAFM, 2022).

2.2.2. Description of Species

2.2.2.1. Blue Mussels (Mytilus edulis)

Distribution

Figure 2-4 shows the locations of licensed farmed mussel sites in Roaringwater Bay. These farmed sites cover an area of *c.* 3.5 km^2.

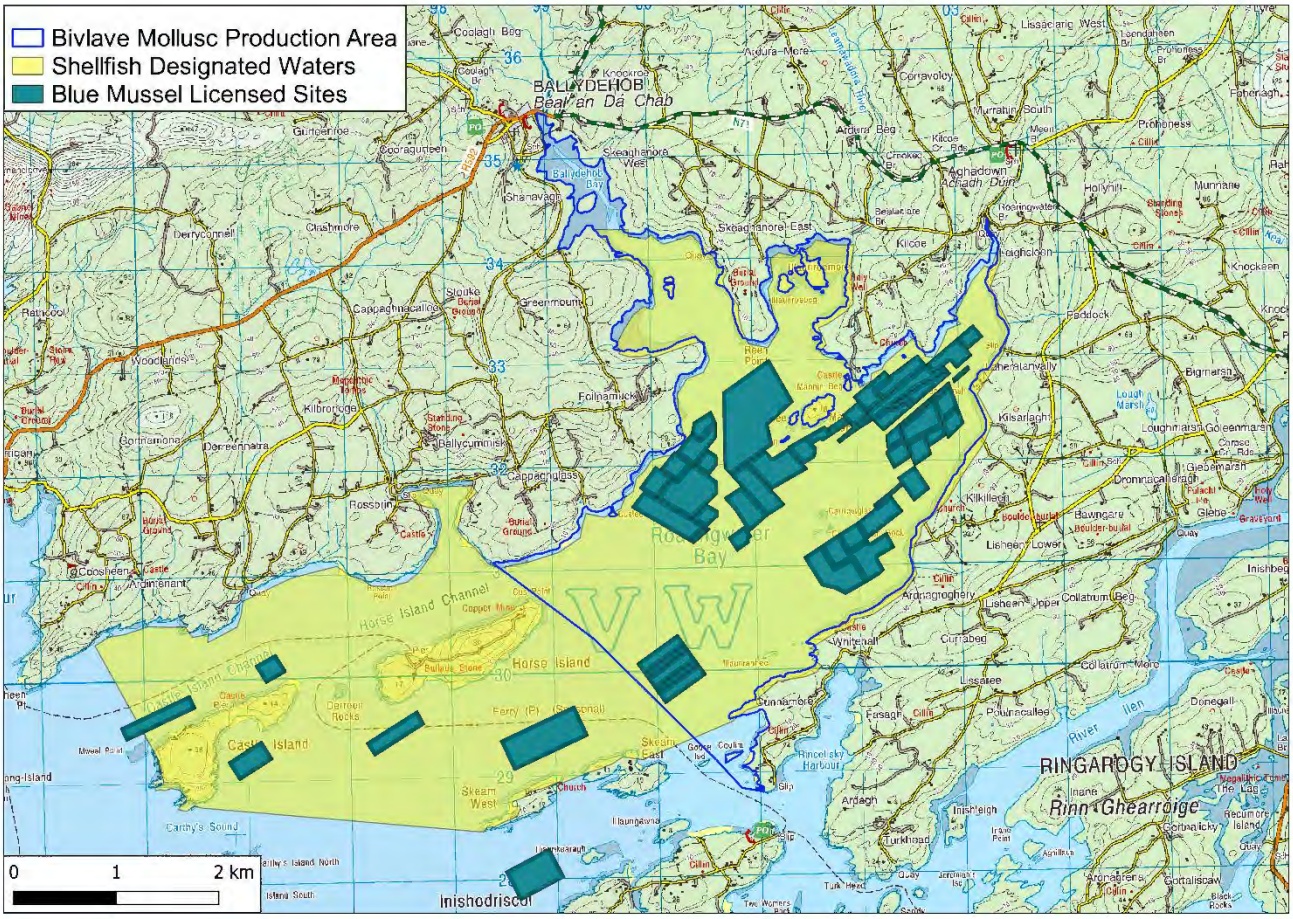

Figure 2-4: Licenced mussel harvesting sites in Roaringwater Bay (Source: DAFM, 2022).

Fishery

There are 49 separate areas licensed for mussel growing in the Roaringwater Bay Designated Shellfish Area. All of these blocks are licensed for the growing of the species using the rope method. Harvesting takes place all year round.

Mussel production in the bay was approximately 2,500 tonnes in 2021. Current employment estimates are approximately 25 FTE jobs. Fishing in the area is limited to a handful of U10 vessels, targeting mainly shrimp in season.

3. Overall Assessment of the Effect of Contamination on Shellfish

3.1. Human sewage/Human population

Roaringwater Bay catchment has a population of 2,375. Three electoral divisions (Ballydehob, Aghadown South and Kilcoe) contain 67% of the catchments population and are located along the shoreline of the bay. There is only one urban centre, Ballydehob which has a population of 274 (Census Mapping, 2016).

The 2016 census recorded 1,483 households in the catchment of which 12% are vacant and 19% are holiday homes. The sewage from only 12.1% of these households are connected to the public sewer/treatment system. The sewage from 84.5% of the households is treated by means of septic tanks or other private treatment methods. Most the households serviced by private treatment are likely to be well dispersed through the catchment as the populated density of the catchment is low. The effectiveness of the private treatment systems is unknown.

The level of treatment will vary significantly from the newer modern systems to older tanks which in some cases will require modernisation. Discharge from private septic tanks is to groundwater and not directly to surface waters. However, where septic tanks have not been maintained or have been incorrectly installed discharge may runoff into surface waters. It can be assumed that a proportion of the septic tanks fall under this category and so will add to the biological load of the catchment. The further the septic tanks are from the bay the less impact they will have due to dispersion and decay of the discharge (Florini *et al*., 2020). The Roaringwater Bay characterisation report (DHLGH, 2012) found that 96.67% of all septic tanks in the catchment were high risk of pathogenic contamination to surface waters. The main reason cited for this was inadequate percolation due to hydrologically unsuitable conditions. The highest population densities in the catchment are located along the shoreline of the bay. Where contamination of surface water from septic tanks occurs, it will flow over ground until it meets a drain, stream or river where it will then flow into the bay. Where houses are located near the shoreline discharges from faulty septic tanks may flow directly into the bay. Due to the disperse nature of the housing in the area this contamination is likely to be dispersed around the bay rather than at any one point. It is likely to be higher relative to the population density in the area. As such the western shore is likely to have the highest contamination followed by the eastern. It should also be stated that the population density in the area is relatively low.

The Ballydehob WWTP is a primary treatment facility with a design capacity of 700 PE (population equivalent) and is operating below its capacity with a loading of 405 PE. However, the 2020 annual environmental report

by Irish Water recorded an annual mean *E. coli* level of 24,197 *E. coli*/100ml (from six samples) for discharge waters. There are two other discharges associated with the facility: a storm water overflow and an emergency discharge, both of which discharge to the Bawnaknockane River at Ballydehob. There is no available data on the spill frequency from either of these discharges. It can be assumed that both points discharge untreated sewage intermittently.

It is worth noting also that two out of range results investigations by Sea Fisheries Protection Authority staff in 2021 and 2022 suggested a role for the wastewater treatment plant in the elevated shellfish *E. coli* results noted at that time. Therefore, it can't be discounted that Ballydehob WWTP may at times contribute a significant bacterial load to the shellfish production area, particularly during summer months when tourism in the area peaks. Additionally, any impact to the shellfish area will likely be high during periods of heavy rain and high turbidity.

There are no IPC or IE industrial discharges within the catchment. There are two section 4 discharges within the catchment. Both discharges undergo secondary treatment and almost all the discharge from the knackery is re-used. Due to their size, nature and treatment level it is not envisaged that the section 4 discharges will impact upon the fishery.

There were relatively few human related potential contamination sources recorded during the shoreline survey. Six discharge pipes were recorded, three within Ballydehob Bay, one near Kilcoe Castle and two in the north-eastern extent of Roaringwater Bay. The discharge near Kilcoe Castle was recorded as containing grey water. The overflow and emergency discharges for Ballydehob were also noted in the shoreline survey. Five piers and three slipways were also recorded during the survey.

There are no commercial ports in Roaringwater Bay and no ferries operate in the bay. Although no ferries pass through the production areas, there are regular ferries in the area between Cape Clear, Baltimore and Skull. There are also active ports in Baltimore and Skull. There are two slipways, two private jetties and a number of quays of varying size. Yachting is prevalent in the area and there are four mooring locations within the production area with approximately 68 moorings between them. There are two mooring locations near the mouth of the Roaringwater River that are in close proximity to the licensed areas. There are two further mooring locations in the west of the bay: one at Audley Cove and the other near Knockrower point. Both are approximately 500 m from licensed shellfish areas. The most active quay is located in the northeast of the bay and is used by Roaringwater Bay Mussels. The majority of these boats are relatively small and not likely to be used for overnight stay. While data on sewage discharge levels from boating activities in the area are

not available, it is highly unlikely that any discharges from the relatively small number of vessels in the area would have a seriously deleterious effect on water quality at the shellfish growing areas.

3.2. Agriculture

Pastures account for 56.8% of the Roaringwater Bay catchment. Grasses and rough grazing account for 99.4% of the land used for farming in the catchment with only 0.6% being used to grow crops.

There are 25,686 cattle in the catchment with the highest number of cattle occurring in Aghadown (4,141). The density of cattle in the catchment is somewhat high at 1.54 cows/ha of farmland, compared to the average national stocking density for cattle of 1.45 cows/ha of farmland. The three areas that border the bay have high densities of cattle. The shoreline survey identified two locations with cattle, one large cattle shed, and three areas used for grazing cattle. These locations were all between Reenmurrish and Poulgorm Bay.

There are 12,092 sheep in the catchment with the highest number of sheep occurring in Dunbeacon (3,320). The stocking density for sheep in the catchment (0.73 sheep/ha of farmland) is much lower than the national average of 1.04 sheep/ha. Also, a significant proportion of the sheep (64.2%) are located in electoral divisions which are mostly outside the catchment.

Considering the low density of sheep within the catchment and the distance of the higher densities from the bay they are unlikely to have a significant impact on the bacterial load on the production area. The high density of cattle though and the high percentage of pastures in the catchment may mean that agriculture is a significant source of contamination within the production area. Contamination can enter surface waters in run-off from the land due to direct faecal load from cattle and the spreading of slurry on pastures. Relatively few field drains (29) were noted during the shoreline survey, however, the majority of these were concentrated in Poulgorm Bay and around the mouth of Ballydehob Bay. The Bawnaknockane, Leamawadra and Roaringwater Rivers drain 66.8% of the catchment. The area of the catchment which they drain also has the highest cattle densities. As such most of the contamination due to agriculture will enter the bay through these rivers. The highest percentage of pasture is located in Ballydehob, Kilcoe, Aghadown South, Cloghdonnell and Caheragh electoral divisions. Discharge from these areas will enter the bay through a mixture of the Bawnaknockane, Leamawadra and Roaringwater Rivers and direct run off from the land.

3.3. Rivers and Streams

Roaringwater Bay drains a catchment of 126.8km^2, the majority of the catchment is drained by three rivers the Bawnaknockane River (33.6%), Leamawadra River (17.5%) and Roaringwater River (15.7). The remainder of the catchment is drained by a series of small unnamed streams. The shoreline survey identified 15 separate streams or rivers of varying sizes within the bay.

As the Bawnaknockane River drains 33.6% of the catchment it is likely to be the single largest source of contamination from land use run off. Along with this the outflows from Ballydehob WWTP discharge at the mouth of the river. The Leamawadra River and Roaringwater River also drain catchments with high cattle densities and so will also be a significant source of contamination. As the highest cattle numbers occur in the electoral divisions bordering the bay there is also likely to be contamination from direct run off into the bay. Therefore, the field drains noted in the shoreline survey may be significant particularly around Poulgorm Bay.

The highest *E. coli* levels recorded from the water sampling were located in Ballydehob Bay, two being located in Ballydehob town and one in a small river halfway down the western side of the bay. Elevated levels were also recorded at the mouth of the Roaringwater River. The elevated levels near Ballydehob town are most likely due to discharges from the WWTP and contamination in the river from agriculture and septic tanks upstream. There are no known discharges located nearby or upstream of the elevated result recorded halfway down the western side of Ballydehob Bay. As such the elevated levels are likely due to contamination either from agricultural land or run off from septic tanks. The elevated levels recorded at the mouth of the Roaringwater River are also likely cause by agricultural land or runoff from septic tanks upstream. There is a discharge from a knackery upstream, however, the discharge is unlikely to be the cause of the elevated result as the discharge is treated and the majority is re-used.

The current (2010-2015) WFD status of the central Bawnaknockane River is unassigned; however, two of its tributaries have been assigned a status. The western tributary is of High status, while the north-eastern tributary is of Good status. The Leamawadra River is of High status and the Roaringwater River is unassigned as are the remainder of the streams in the catchment. Roaringwater Bay coastal waterbody is of Good status.

3.4. Movement of Contaminants

Roaringwater Bay has no major constriction in the bay proper and as such, the water movement will be relatively straight forward. On the flooding tide the water movement will be north-easterly directly into the bay and on the ebbing tide south-easterly out of the bay. Tidal stream data from the Admiralty chart for the bay gives currents of 0.5kn on the flooding tide and 1kn on the ebbing tide at the mouth of the bay. The current speeds are relatively low in the bay which is evident by the presence of mud throughout the bay. Based on the desktop and shoreline surveys the highest level of contamination will enter the production area from Ballydehob and Poulgorm Bays. See section 3.7 below for further details on the sources of contamination observed during the shoreline survey. Contamination entering Roaringwater Bay from Ballydehob Bay and Poulgorm Bay will disperse south-westerly towards the outer bay. The prevailing wind in the area is west southwest. This will likely push contaminated lower salinity water on the surface easterly towards Mannin Island and possibly in behind the island and into the eastern part of Roaringwater Bay. Contamination entering the bay from Roaringwater River will flow south westerly towards the open ocean. In windy conditions, the prevailing wind will likely cause contaminated surface waters to travel along the eastern shore during ebbing tides. Although current speeds are slow the open connection with the sea will allow for good dispersion in the bay. Contamination from the River Ilen was not considered in this report as it was considered outside of the catchment. The main flow from the River Ilen will follow the deeper channel which passes between Hare Island and Sherkin Island. If in certain weather conditions contamination from this source was to reach Roaringwater Bay shellfish area, the levels of contamination would be significantly reduced due to dispersion and degradation from sun light. The distance from the shellfish area and the exposed nature of the area is such that contamination from the River Ilen is not considered to be of concern for Roaringwater Bay shellfish area. The movement of water in the outer bay will have a net westward movement due to the Coriolis effect. During windy periods from the west and south-west the Coriolis effect will be counteracted particularly in the surface layers. The largest movement of water will be due to tidal forces. Tidal currents will run parallel to the mainland to the north. During a flooding tide the direction of flow will be north-easterly and during the ebbing tide it will be south-westerly.

Discharges from the Ballydehob WWTP will travel down Ballydehob Bay and out into the bay towards Mannin Island. In the worst case, faecal coliform levels were predicted to be 20 - 30 fc/100ml by the time they reach the nearest licensed shellfish area (Irish Hydrodata Limited, 2007). The *E. coli* levels are expected to be lower as they will only account for part of the faecal coliform result. Based on these predictions, *E. coli* levels at the licensed shellfish areas due to the WWTP are likely to be minimal in most cases. The likelihood of impact due to the discharge would be high in winter months when rainfall and suspended solid load are highest. The Irish Water annual environmental report recorded a high mean *E. coli* level of 24,197 *E. coli*/100ml. However, as

Ballydehob WWTP is relatively small the discharge rates will be low. Discharge rates will increase during storm events, but the *E. coli* levels will also be diluted by the increased water volume.

The Bivalve Mollusc Production area has been extended to match the existing designated shellfish water area. The result of this is that the BMPA boundary stops just before Skull Harbour. Although not in the catchment there is a WWTP in Skull. Skull WWTP is currently under capacity at 1,619 p.e. and has a design capacity of 3,000 p.e. Although under capacity the area is very popular with tourists and may exceed the capacity at peak times. There is the possibility of discharges from this facility impacting on licensed areas in the outer part of the production area. However, due to the characteristics of this area *E.coli* levels are expected to be lower than at the current RMP located in the inner bay. The outer production area is more exposed, deeper and will generally have higher salinities. It is also only bordered by the mainland on one side and so will be impacted by run off from the land to a lesser degree.

Due to the low population levels and the high cattle densities, agricultural run-off is likely the most significant source of contamination in the catchment. The main point sources of contamination from agriculture in the bay will be from the three main rivers Bawnaknockane, Leamawadra and Roaringwater. Due to the high density of cattle in the land bordering the bay (particularly the inner bay,) diffuse contamination from direct run-off may be of concern. As the sources of contamination from agriculture are distributed throughout the bay, the *E. coli* levels due to this source are likely to be relatively evenly distributed throughout the bay. In general, the levels are likely to decrease towards the mouth of the bay.

3.5. Wildlife

Roaringwater Bay and Ballydehob Estuary are routinely monitored by Bird Watch Ireland with peak numbers from 2009 to 2018 ranging from 226 to 842. The Bird Watch Ireland numbers are for wetland birds and so a large proportion of them will forage on the shore at low water. As such, they will directly add to the faecal load in the production area (Jones *et al.,* 1978; Standridge *et al.* 1979; Levesque *et al.,* 1993, Alderisio & DeLuca 1999, Levesque *et al.,* 2000, Ishii *et al.,* 2007). The highest numbers of wading birds were recorded in Ballydehob Estuary. This is to be expected as virtually all of the tidal flats used by wading birds are located in the estuary and Poulgorm Bay. As such, the majority of bacterial contamination due to birds in Roaringwater Bay is likely to come from this area. Whilst birds were not noted on the mussel lines during the shoreline survey, it is likely that they will land on the above water structures which the rope mussels are suspended from. As such, birds are likely to defecate directly to the area. It is not possible to quantify the level at which

this will affect the *E. coli* levels of the mussels. As there is no data available for this source it cannot be used to select an RMP but will contribute to the background *E. coli* levels in the bay.

Grey seals, harbour seals, otters, harbour porpoises and dolphins are present within Roaringwater Bay, with a number of haul-out sites for common seals. All species are relatively common in the bay, and they will contribute to the background levels of *E. coli*. As these mammals are wide ranging and are active throughout the bay it is difficult to base any RMP location on their presence. The shoreline survey recorded seals hauled out in Poulgorm Bay. There are several other haul-out sites throughout the bay (see section 6.1.3). The highest concentration of haul-out sites is located in the inner bay near Poulgorm. As there are relatively low numbers of seals in the area it is not expected that they will significantly impact the shellfish water quality in the bay. However, the current RMP is located close to the area with the highest concentration of haul-out sites, and so will catch any contamination from this source.

Also due to the high level of connectivity with the open ocean, most waste from wildlife will be diluted and dispersed on each tidal cycle.

3.6. Seasonality

In 2017, more than 1.6m overseas tourists visited Co. Cork, and there were 1,113,000 domestic trips to the city (Failte Ireland, 2018b). The main tourist attractions in the catchment area are Kilcoe Castle, Rincolisky Castle, Horse Island, Heir Island and Mount Gabriel. The number of holiday homes is relatively high at 19% (284 households) of the permanent households in the catchment. For Ireland as a whole, in 2017 most tourists visited between July and September (31%), followed by April to June (27%), October to December (23%) and January to March (18%). There is no reason to expect this trend to be any different for the Roaringwater Bay area. Ballydehob itself has a number of popular festivals across the summer, which attract high numbers of tourists to the area. As the area is popular with tourists it is likely that there could be a seasonal impact on the shellfish area from tourism numbers in terms of increased load to the wastewater systems.

In terms of agriculture, numbers of sheep would be expected to be higher in Spring/Summer when lambs would be present but at this time of the year there will also be more extensive grazing in the hills and thus impacts would be more widely spread. In County Cork, the spreading of slurry or farmyard manure, which would be commonplace in the catchment, is limited by legislation with a closed period from the 1st of November to the 12th January. From mid-January to the end of October there would be a potential risk of

faecal contamination through diffuse run-off from this activity, if it coincides with a period of rainfall after a dry spell then that risk is raised further (Crowther *et al.,* 2002).

There may be an increase in bird numbers during Autumn/Winter due to migrating species. This would particularly be the case with geese and wading birds. Where these birds are feeding or roosting close to the mussel licences there will be a consequential seasonal increase in potential contamination. As the wading bird numbers are higher in Ballydehob Estuary due to the presence of extensive mudflats, contamination due to birds is likely to be higher in this area.

Analysis of rainfall data for the area has shown that October to January are the months with highest rainfall (see Appendix 2 Section 7.6 for details on rainfall). During this period, faecal contamination may enter the bay in run-off from the land. Higher loading from the land might be expected in August and September as faecal load will have been accumulating over the dryer period of April to July. Analysis of high episodic rainfall events though demonstrated that these can occur in most months of the year with an expectant increase in surface water run-off also equally likely. Rainfall data from Sherkin Island recorded the highest daily rainfall in June, even though June is one of the driest months overall.

Analysis of Sea Fisheries Protection Authority *E. coli* results for the representative monitoring point found no significant variation between seasons (summer, autumn, winter or spring).

3.7. Shoreline survey

In total 109 features were identified, of which 15 rivers/streams were identified, 29 field drains, 6 pipes, 8 piers, 3 slipways, 2 manholes, 2 locations with cattle, 1 cattle shed, 1 storm outflow and 2 locations where wildlife was recorded.

No signs of pollution or enrichment were noted at any of the rivers/streams during the survey. Water sampling was carried out as part of the shoreline survey. Eight stations were sampled at the mouth of rivers and streams. The highest *E. coli* levels were recorded (743 cfu/100ml) at a small unnamed river that flows into the western side of Ballydehob Bay. The next two highest levels were record in Ballydehob town, one at the pier (433 cfu/100ml) and the other further upstream just passed the first bridge (399 cfu/100ml). Somewhat elevated levels were recorded at the mouth of the Roaringwater River (214 cfu/100ml). The remaining samples were below 200 cfu/100ml.

The locations of WWTP infrastructure which was identified during the desktop survey were confirmed by the shoreline survey. The discharge from Ballydehob WWTP is subtidal and could not be observed during the shoreline survey. However, water passing through the lagoon outlet was recorded as having a dirty appearance. This lagoon is located downstream of the storm water overflow and emergency discharge from Ballydehob WWTP.

There were 29 field drains and 6 piped discharges recorded during the survey. At the time of surveying only two of these showed signs of contamination. A pipe discharging at a slipway near Kilcoe Castle was observed as discharging grey water and a field drain to the west of Kilcoe Castle had significant green seaweed growth.

The shoreline survey identified two locations with cattle present, one large cattle shed, and three areas used for grazing cattle. These locations were all between Reenmurrish and Poulgorm Bay. A small herd of goats was recorded near Coosheen Point. Seals were recorded hauled out in Poulgorm Bay and 60 gulls were recorded near Ballydehob Town.

4. Amendments

This section should be read in conjunction with **Appendix 7: Salinity Survey Report** which provides further justification for the boundary of the production area. **Appendix 7**: Salinity Survey Report was added as an addendum in July 2024, however no other details in the 2023 Roaringwater Bay Salinity Survey report have been changed. In summary, **Appendix 7** did not find sufficient evidence to justify splitting the BMPA into two distinct production areas.

The boundary of the Roaringwater Bay BMPA has been amended. The amendments have been made to the western extent of the production area so as to include the licensed aquaculture sites that are currently located outside of it. The original BMPA boundary tracked right along the shoreline at Ballydehob, however this has been adjusted in the amended BMPA in order to remove the area which the Ballydehob WWTP directly discharged into. Additionally, the BMPA has been amended to include the aquaculture site located northwest of Hare Island. The designated shellfish waters (DSW) for Roaringwater Bay extend outside of the current BMPA boundary; the amended BMPA encompasses these DSW and overlap with the DSW for Baltimore Harbour/Sherkin. The amendments can be seen in Figure 4-1 below (see Figure 2-2 for current BMPA).

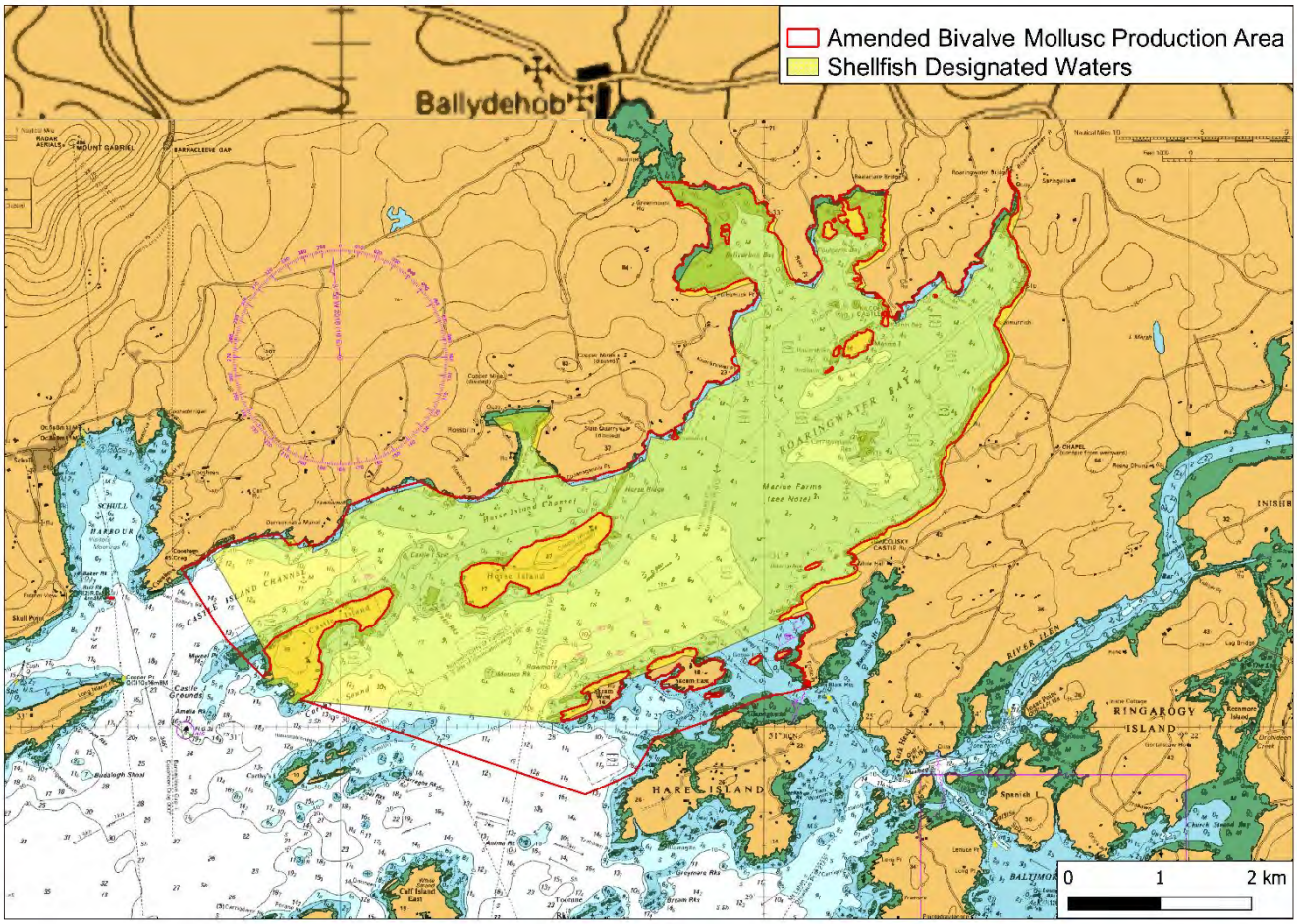

Figure 4-1: Roaringwater Bay amended BMPA.

5. RMPs and Sampling Plan

5.1. Mussels (*Mytilus edulis*)

The location of the current RMP for mussels is 51.52889, -9.42861 (470267.88E, 5708729.20N) which is shown in Figure 5-1. A shellfish bacteriological sampling programme was carried out during the shoreline survey to assist in the identification of the most suitable location for the monitoring point. Three points were sampled within the current BMPA of inner Roaringwater Bay (see Appendix 3 Section 8.2 for more detail).

Based on this survey, the current RMP has been removed and two new RMPs are proposed due to the bacteriological sampling results showing relatively low levels of *E. coli* at the current RMP and comparatively higher levels of *E. coli* at the two new proposed RMPs: RMP 1 and RMP 2 (Table 8.9). Additionally, there is a high concentration of discharges into inner Roaringwater Bay compared to the southwestern shoreline parallel to Horse Island and Castle Island Channels (Figure 6-39). RMP 1 will account for the discharge from Ballydehob WWTP, a lagoon discharge, and numerous pipe discharges, field drains and rivers/streams. RMP 2 will account for numerous field drains, and a few pipe discharges and rivers/streams. The location of RMP 1 for mussels is 51.537970, -9.427539 (470348.08E, 5709738.58N) and for RMP 2 is 51.536718, -9.400658 (472211.63E, 5709588.79N); both are shown in Figure 5-2.

RMP 1 has been chosen because bacteriological sampling from June-October 2022 returned higher average levels of *E. coli* in shellfish over the sampling period, during which 6 samples were taken. Additionally, this RMP will account for numerous discharges flowing into Roaringwater Bay as mentioned above. The main outflow from Ballydehob Bay bifurcates on entering outer Roaringwater Bay. Due to the Coriolis effect, the smaller flow tracks along the northern shore through Horse Island Channel and Castle Island Channel *i.e.,* between the mainland and Horse Island/Castle Island. The larger flow tracks south to the Carrigviglash Rocks, then, due to the Coriolis effect, it tracks north/northwest and intersects with the smaller flow. Based on this information, the location of RMP 1 has been chosen as it is likely to account for any contaminants from Ballydehob Bay.

RMP 2 has been chosen because bacteriological sampling returned the highest average levels of *E. coli* in shellfish over the same sampling period as stated above. Additionally, this RMP will account for numerous discharges flowing into Roaringwater Bay as mentioned above. Due to the prevailing south-westerly wind (Figure 7-3), surface waters are blown up into the bay in a north-easterly direction, ultimately intersecting

with RMP 2. Surface waters are predominantly composed of freshwater due to freshwater being less saline and therefore less dense than seawater, and freshwater tends to have higher levels of *E. coli*.

In terms of the number of mussels collected, this should be a minimum 15 individuals (minimum 4 cm shellfish size) for bacteriological analysis. As harvesting can take place throughout the year, sampling needs to be carried out on a monthly basis.

Table 5.1: Coordinates of the Production Area.

Corner	Longitude	Latitude	Easting	Northing
SW	-9.46585	51.52435	98314.21	31142.79
SW	-9.52505	51.51534	94184.41	30223.92
SSW	-9.50625	51.50259	95460.49	28778.17
S	-9.45059	51.49887	99317.04	28287.12
N	-9.44605	51.55298	99751.14	34300.21
SE	-9.40543	51.52586	102510.6	31228.64
ESE	-9.39492	51.53589	103260.8	32330.36
E	-9.39197	51.54455	103483.8	33289.39
N	-9.41419	51.55215	101959.3	34164.78
SW	-9.45122	51.52877	99339.23	31614.22
SW	-9.49835	51.52158	96052.17	30879.76
SW	-9.50812	51.51761	95364.61	30452.16

Table 5.2: Coordinates of each RMP and its relevant species.

RMP	Site Code	Species	Longitude	Latitude	Easting (IG)	Northing
1	CK-RB-RB-1	Mussel (*M. edulis*)	-9.427539	51.537970	101002.4	32605.266
2	CK-RB-RB-2	Mussel (*M. edulis*)	-9.400658	51.536718	102864.747	32429.921

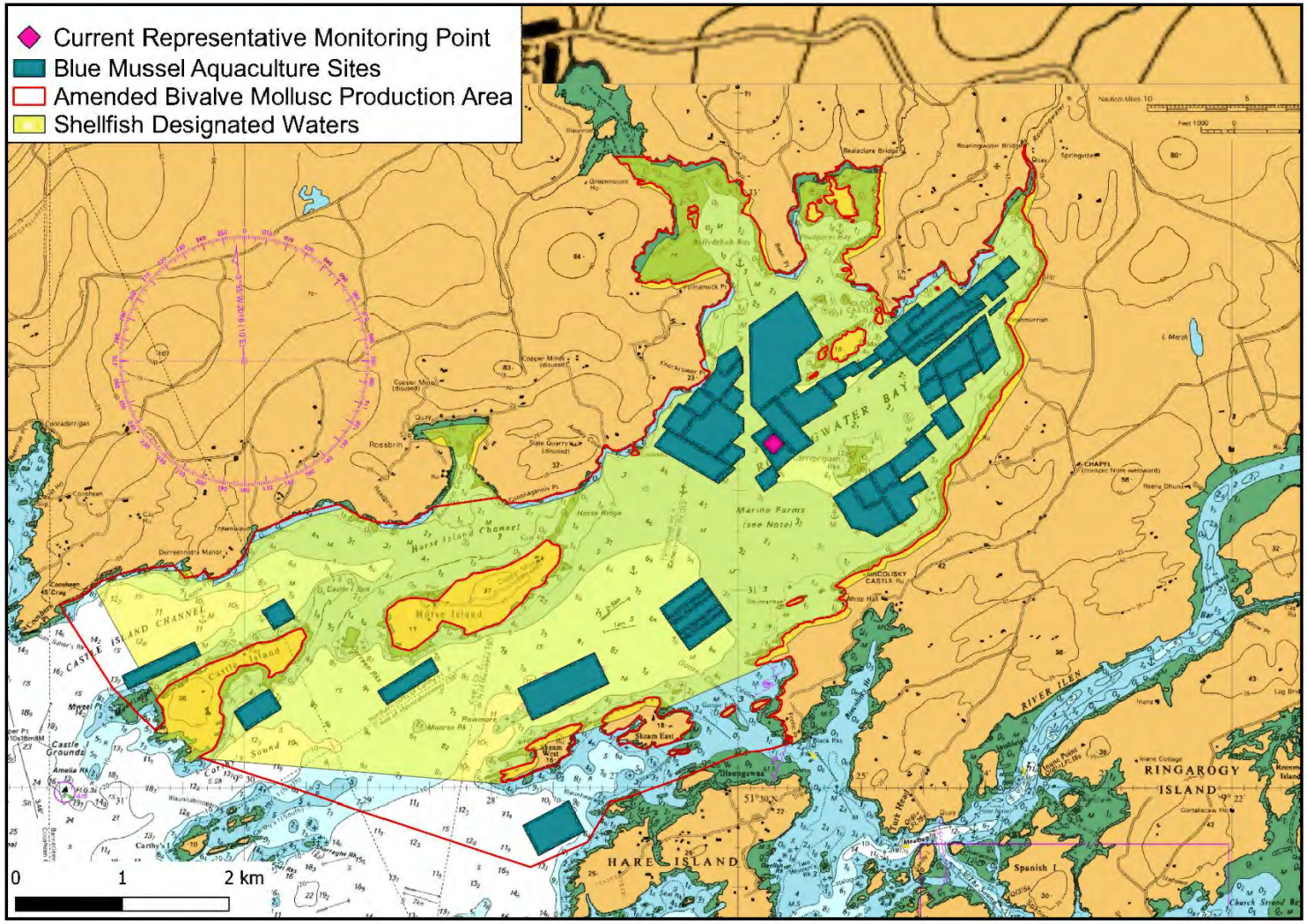

Figure 5-1: Amended Bivalve Mollusc Classified Production Area and current Representative Monitoring Point within Roaringwater Bay.

5.2. Species Specific RMP map

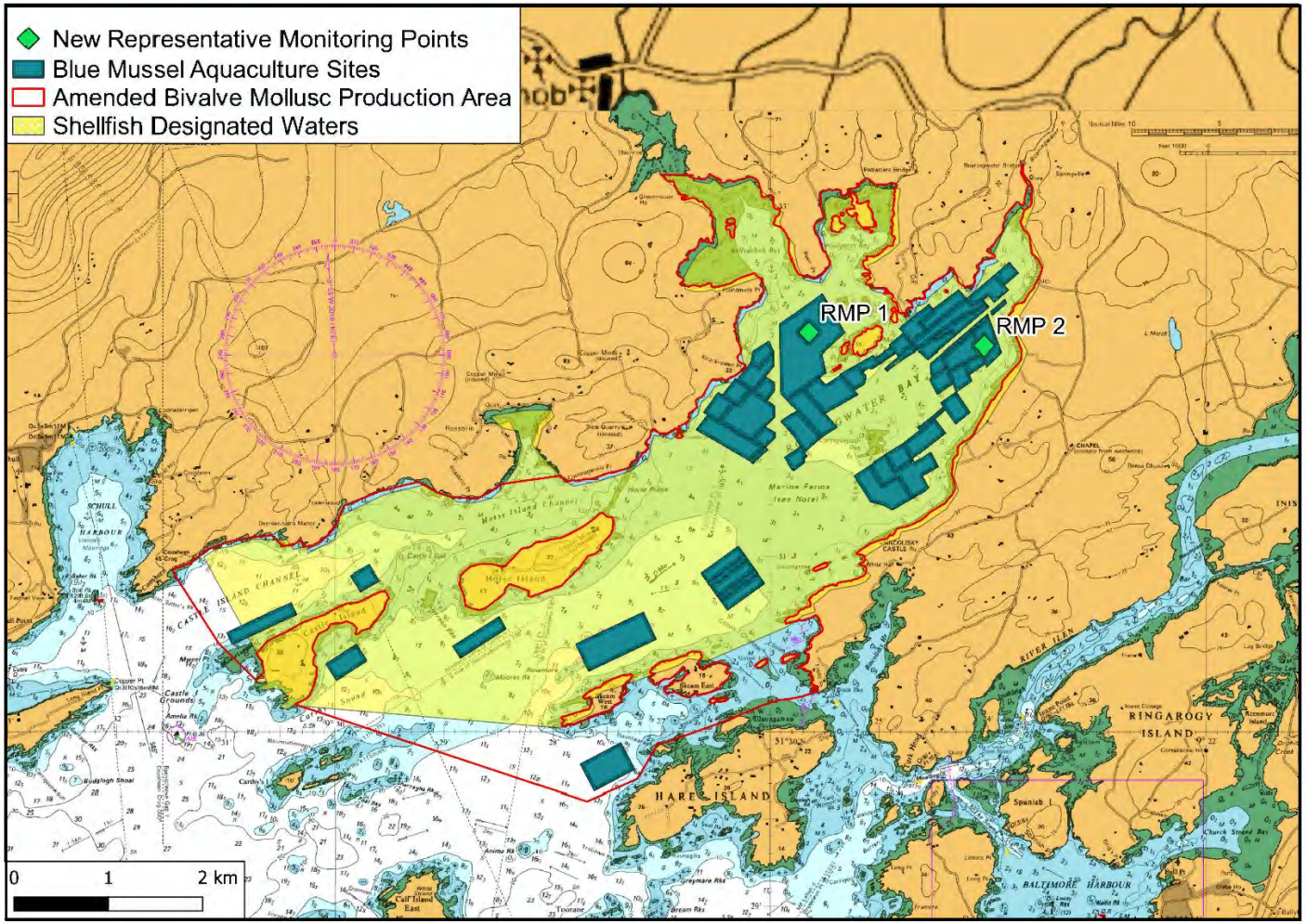

Figure 5-2: Location of the new mussel Representative Monitoring Points within Roaringwater Bay.

5.3. General Sampling Method

All collection and transport of shellfish samples for *E. coli* testing under the Sampling Plan identified as part of the Roaringwater Bay Sanitary Survey should follow the Sea Fisheries Protection Authority's own Code of Practice for the Microbiological Monitoring of Bivalve Mollusc Production Areas (SFPA, 2020). The guidance notes are found at Appendix 9.2 (page 36) of that document.

6. Appendix 1: Identification of Pollution Sources

This section attempts to document all pollution sources within the Roaringwater Bay catchment area.

6.1. Desktop Survey

Pollution sources were considered within the catchment area of Roaringwater Bay (see Figure 6-1). The catchment area covers an area of 126.7 km^2, approximately 15.8 km east-west at its widest point and 13.3 km north-south at its longest point.

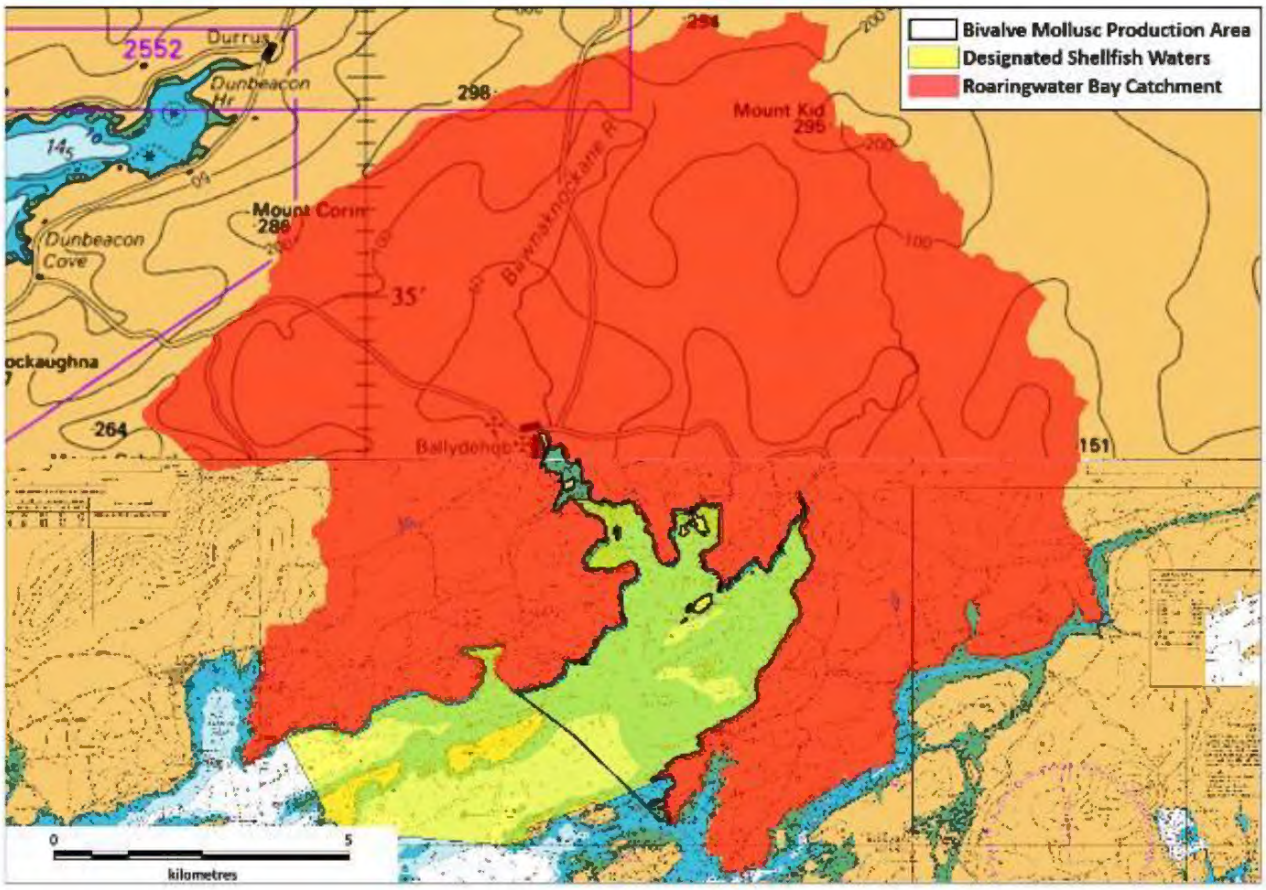

Figure 6-1: Roaringwater Bay catchment area used for assessment of the pollution sources.

6.2. Human Population

Population census data used by the Central Statistics Office (CSO) is given in units of Electoral Divisions (ED). Figure 6-2 shows the EDs within the catchment area. The population data were obtained through the Central

Statistics Office (CSO) online Small Area Population Statistics (SAPS) (CSO, 2019a) for the year 2016. Town populations were also taken for the 2016 Census. Figure 6-3 shows the human population within Roaringwater Bay catchment area and

Table 6.1 shows these data in tabular form.

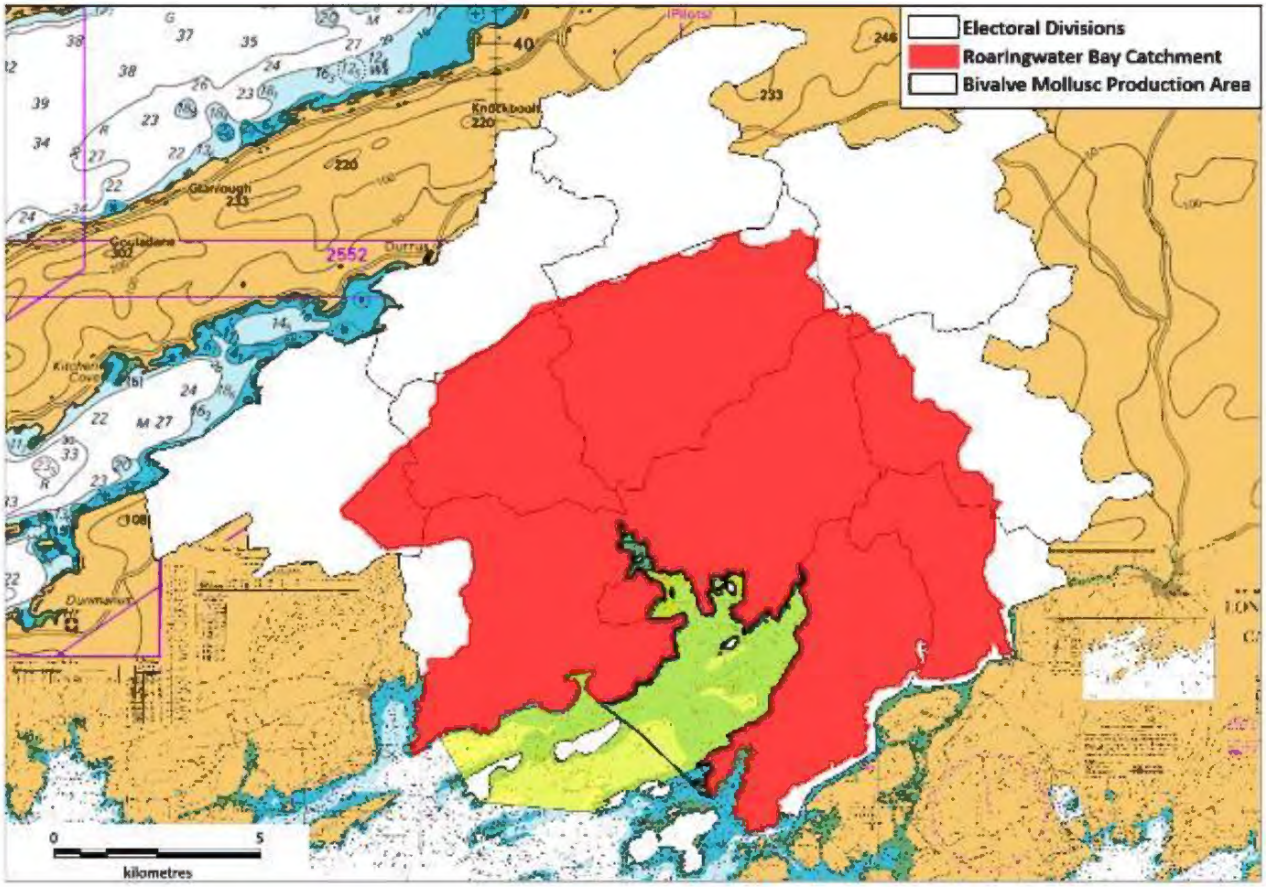

Figure 6-2: Electoral Divisions within the Roaringwater Bay Catchment Area.

The Roaringwater Bay Catchment Area partially overlaps 11 EDs. These EDs are Kilcoe, Coolagh, Ballydehob, Scart, Dunbeacon, Caheragh, Aghadown South, Cloghdonnell, Ballybane, Aghadown North and Durrus East. Ballydehob contains the largest population (846) followed by Aghadown South (574) and Kilcoe (441).

These 11 EDs accommodate a total population of 4,059. As all of these EDs only partially overlap the catchment area, an attempt was made to estimate the actual population within the catchment. The percentage of the ED lying within the catchment was calculated using the mapping software GIS and from this value the population size was calculated *e.g.*, if 50% of an ED lies within the catchment area then 50% of the total population was taken to be the population size of the area within the catchment. Using this method, the population of the catchment area is estimated at 2,375 people.

Table 6.1 shows this estimation.

There is only one main town/urban centre within the catchment area: Ballydehob, which has a population of 274.

There are 2,383 households within the 11 EDs within the catchment area. Of this, 12% are vacant (289) and a further 18% are holiday homes (422). Of the 1,483 houses actually within the catchment (based on the % of the ED within the catchment), 12% are vacant and 19% are holiday homes. Table 6.2 shows the number of households in each ED and the proportion actually within the catchment area.

Human population in given areas is obtainable from census data; however, relating this information to the level of microbial contamination in coastal waters is difficult and is constrained by the geographic boundaries used. Nonetheless, it is clear that areas with a higher population will have higher levels of sewage and wastewater entering the Roaringwater Bay system. The population in the Roaringwater Bay catchment is relatively low, with population density slightly higher in the south of the catchment. As holiday homes account for 19% of the dwellings in the catchment, they may cause a significant increase in the sewage and wastewater levels relative to the permanent population.

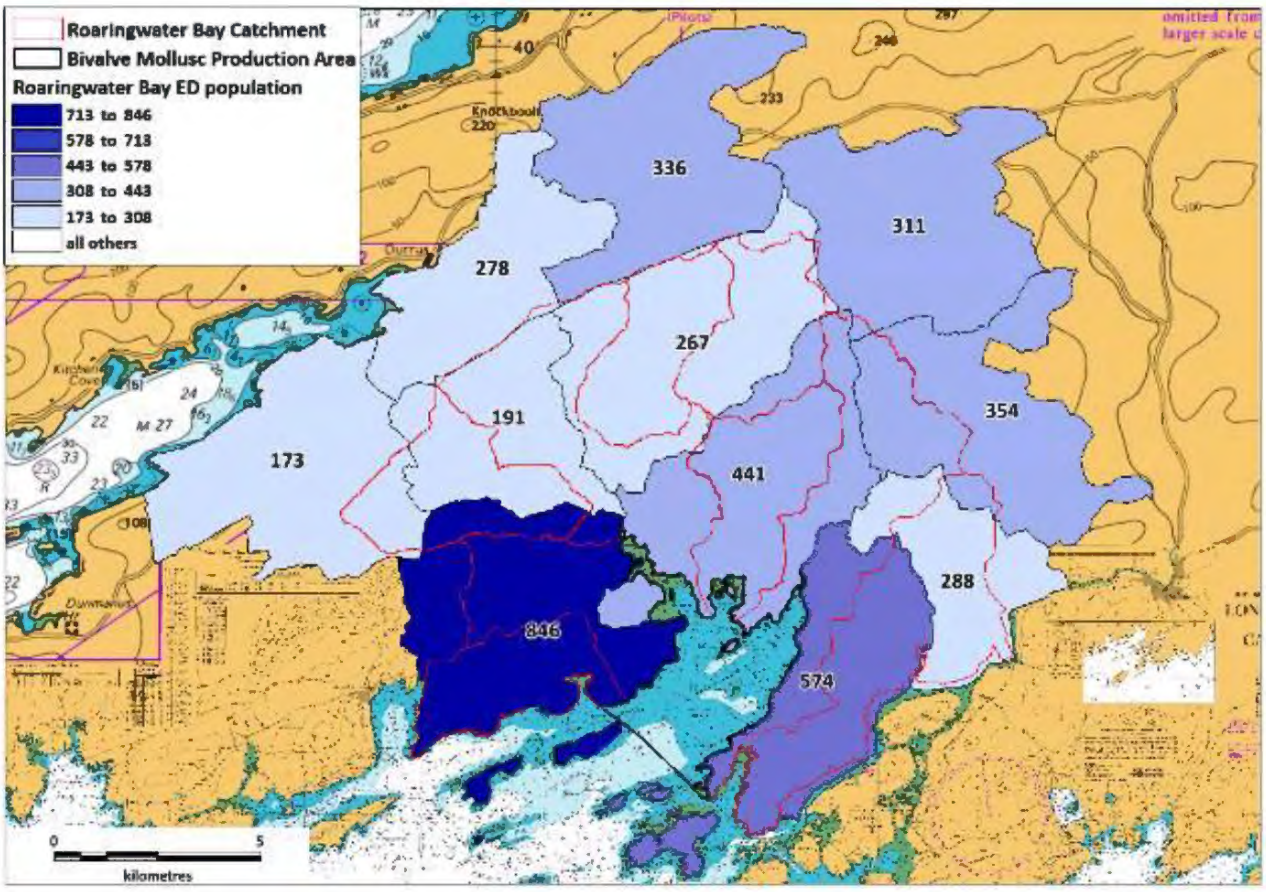

Figure 6-3: Human population within the Roaringwater Bay Catchment Area (Source: CSO, 2019a).

Table 6.1: Human population within the Roaringwater Bay Catchment Area (Source: CSO, 2019a).

Electoral Division	Population (2016)	% ED in Catchment	Estimated Population
Kilcoe	441	99.0	436
Coolagh	191	92.7	177
Ballydehob	846	80.9	684
Scart	336	0.3	1
Dunbeacon	173	11.8	20
Caheragh	311	1.1	3
Aghadown South	574	83.3	478
Cloghdonnell	354	29.0	103
Ballybane	267	93.8	250
Aghadown North	288	75.8	218
Durrus East	278	1.1	3

Table 6.2: Households within the EDs in the Roaringwater Bay Catchment Area (Source: CSO, 2019a).

Electoral Division	Total Households	No. Occupied*	Unoccupied holiday homes	Vacant houses	Total Households in Catchment	No. Occupied in Catchment	Unoccupied holiday homes in Catchment	Vacant houses in Catchment
Kilcoe	249	179	41	29	246	177	41	29
Coolagh	119	91	11	17	110	84	10	16
Ballydehob	612	388	151	73	495	314	122	59
Scart	145	120	8	17	0	0	0	0
Dunbeacon	137	77	42	18	16	9	5	2
Caheragh	133	108	7	18	1	1	0	0
Aghadown South	375	243	86	46	312	202	72	38
Cloghdonnell	171	143	6	22	50	41	2	6
Ballybane	157	117	21	19	147	110	20	18
Aghadown North	135	108	17	10	102	82	13	8
Durrus East	150	98	32	20	2	1	0	0

* This figure includes those houses temporarily unoccupied on census night.

6.2.1. Tourism

In 2017, 4.6 million tourists visited the Southwest Region of Ireland (Failte Ireland, 2018a). This figure was made up of 2,400,000 overseas tourists, 2,100,000 domestic tourists and 69,000 Northern Irish tourists. Of the overseas tourists, 1,605,000 visited Co. Cork, and of the domestic tourists 1,113,000 visited Co. Cork (Failte Ireland, 2018b). The main tourist attractions in the area are Kilcoe Castle, Rincolisky Castle, Horse Island, Heir Island, Inish Beg Estate, Cadogan's Strand, Schull Planetarium, Silver Strand, Sherkin Island, The Beacon, Dun na Sea Castle, Mount Gabriel, Long Island and Cape Clear.

The attractions located inside the catchment area are Kilcoe Castle, Rincolisky Castle, Horse Island, Heir Island and Mount Gabriel. For Ireland as a whole, in 2017 most tourists visited between July and September (31%), followed by April to June (27%), October to December (23%) and January to March (18%). There is no reason to expect this trend to be any different in the Southwest region.

A chartered boat operates out of Heir Island carrying out ferry services between Heir Island, Cunnamore Pier and Sherkin Island. There are no Blue Flag Beaches in the area, although Cadogan's Strand is located to the west near Schull and Silver Strand to the south on Sherkin Island both of which are Green Coast beaches. There are three quays one to the northwest in Ballydehob and two in the northeast of the bay one near Roaringwater Bridge and the other 1km to the south which is used by Roaringwater Bay Mussels.

Increases in population in the local area due to tourism may result in an increase in the quantity of sewage discharged within the Roaringwater Bay catchment area. In addition, Papadakis *et al.* (1997) found significant correlations between the number of swimmers present on beaches and the presence of pathogenic bacteria. In 2007, Elmir *et al.* (2007) showed the role of human skin as an intermediate mechanism of pathogen transmission to the water column. There are no monitored bathing water areas in the bay. In addition, waste can enter the area from recreational vessels.

6.2.2. Sewage Discharges

Sewage effluent can vary in nature depending on the degree to which the sewage has been treated. Discharges of sewage effluent can arise from a number of different sources and be continuous or intermittent in nature:

- treated effluent from urban sewage treatment plants (continuous)
- storm discharges from urban sewage treatment plants (intermittent)

- effluent from 'package' sewage treatment plants serving small populations (continuous)
- combined sewer and emergency overflows from sewerage systems (intermittent)
- septic tanks (intermittent)
- crude sewage discharges at some estuarine and coastal locations (continuous)

Treatment of sewage ranges from:

- none at all (crude sewage)
- preliminary (screening and/or maceration to remove/disguise solid matter)
- primary (settling to remove suspended solids as sewage sludge). Typically removes 40% of BOD (Biochemical Oxygen Demand), 60% of suspended solids; 17% of nitrogen and 20% of phosphorus from the untreated sewage
- secondary (settling and biological treatment to reduce the organic matter content). Typically removes 95% of BOD, 95% of suspended solids, 29% of nitrogen and 35% of phosphorus from the untreated sewage. Nutrient removal steps can be incorporated into secondary treatment which can reduce ammonia - N down to 5 mg/l and phosphorus to 2mg/l
- tertiary (settling, biological treatment and an effluent polishing step which may involve a reed bed (unlikely for coastal works) or a treatment to reduce the load of micro-organisms in the effluent). Typically removes 100% of BOD, 100% of suspended solids, 33% of nitrogen and 38% of phosphorus from the untreated sewage

6.2.2.1. Water Treatment Works

There is one wastewater or sewage treatment works within the Roaringwater Bay catchment, it is located in Ballydehob Town. Figure 6-4 shows the location of this treatment works within the Roaringwater Bay catchment area and
Table 6.3 shows the coordinates and facility capacities (EPA, 2019a).

6.2.2.2. Continuous Discharges

Ballydehob WWTP is a primary treatment facility with a design capacity of 700 p.e. and is currently under capacity at 405 p.e. However, the 2020 annual environmental report by Irish Water recorded an annual mean *E. coli* level of 24,197 *E. coli*/100ml (from six samples). The maximum discharge for this facility is 432 m^3/day. The locations of the discharges can be seen in Figure 6-5 and Table 6.4 provides details of the discharge. Strict emissions limits are set out in the discharge licence for the facility in terms of BOD (Biological Oxygen Demand), Ortho-Phosphate, Suspended Solids, Nitrogen and Ammonia.

There is no geo-referenced database for septic tanks and on-site domestic wastewater treatment systems. In order to estimate the numbers of these domestic sewage facilities within the catchment, information on the number of permanent private households and their sewage facilities was sourced from the 2016 census (CSO, 2019a). Of the 1,609 permanent private households in the 11 EDs, 9.2% (148) were connected to a public sewer/treatment system and 86.9% (1,399) had septic tanks or other individual treatment systems. The estimate for the total number of private permanent households actually within the catchment (based on % within the catchment) is 980 and of this 12.1% (118) are on the public system while 84.5% (828) households have their own septic tanks or other individual treatment systems. Table 6.5 shows this information at the ED level and an estimation (based on % within the catchment) of the numbers actually within the catchment.

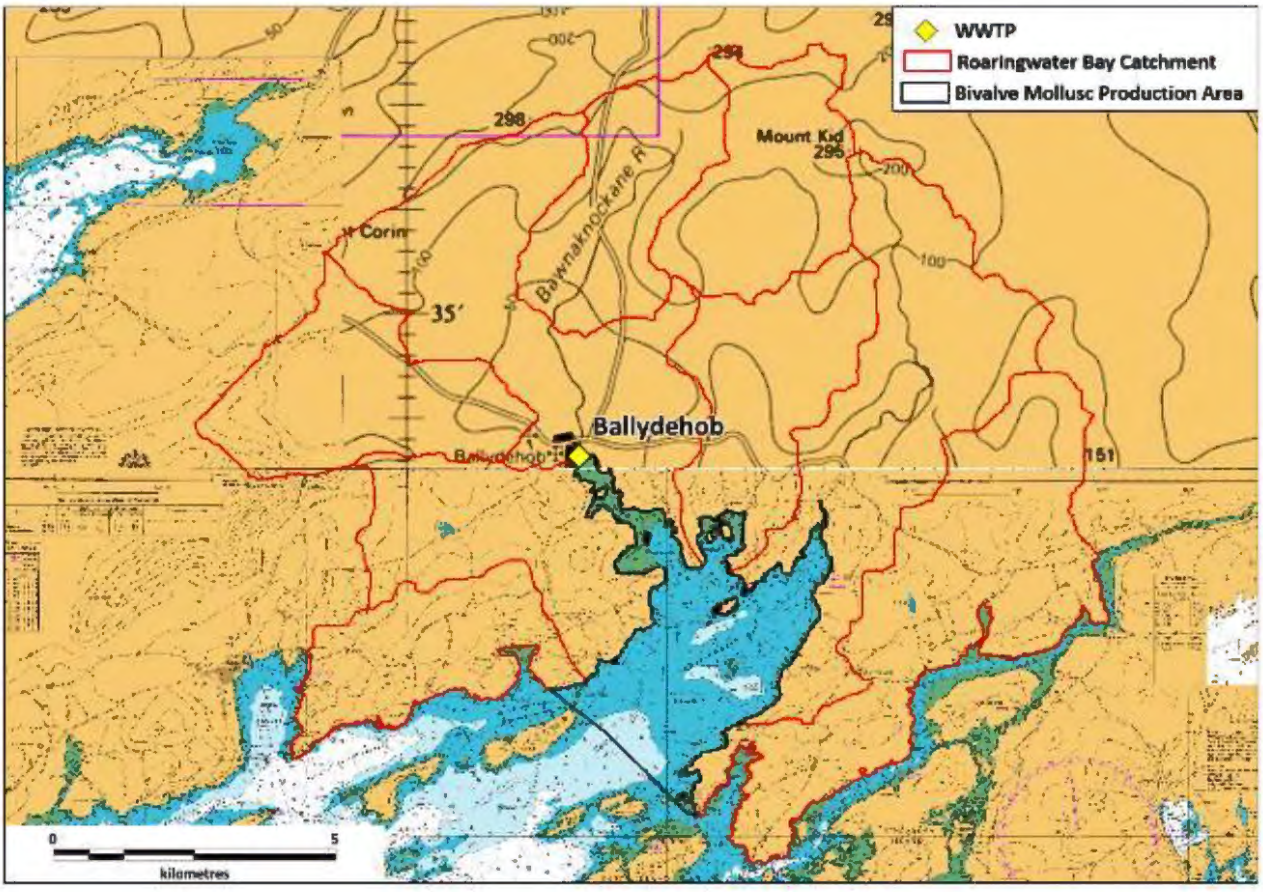

Figure 6-4: Sewage Treatment Works within the Roaringwater Bay Catchment Area (Source: The EPA, 2019a).

Table 6.3: Sewage Treatment Works within the Roaringwater Bay Catchment Area (Source: EPA, 2019a).

Name	Easting	Northing	Longitude	Latitude	p.e.	Designed p.e.
Ballydehob	99,023	35,290	-9.45700	51.56149	405	700

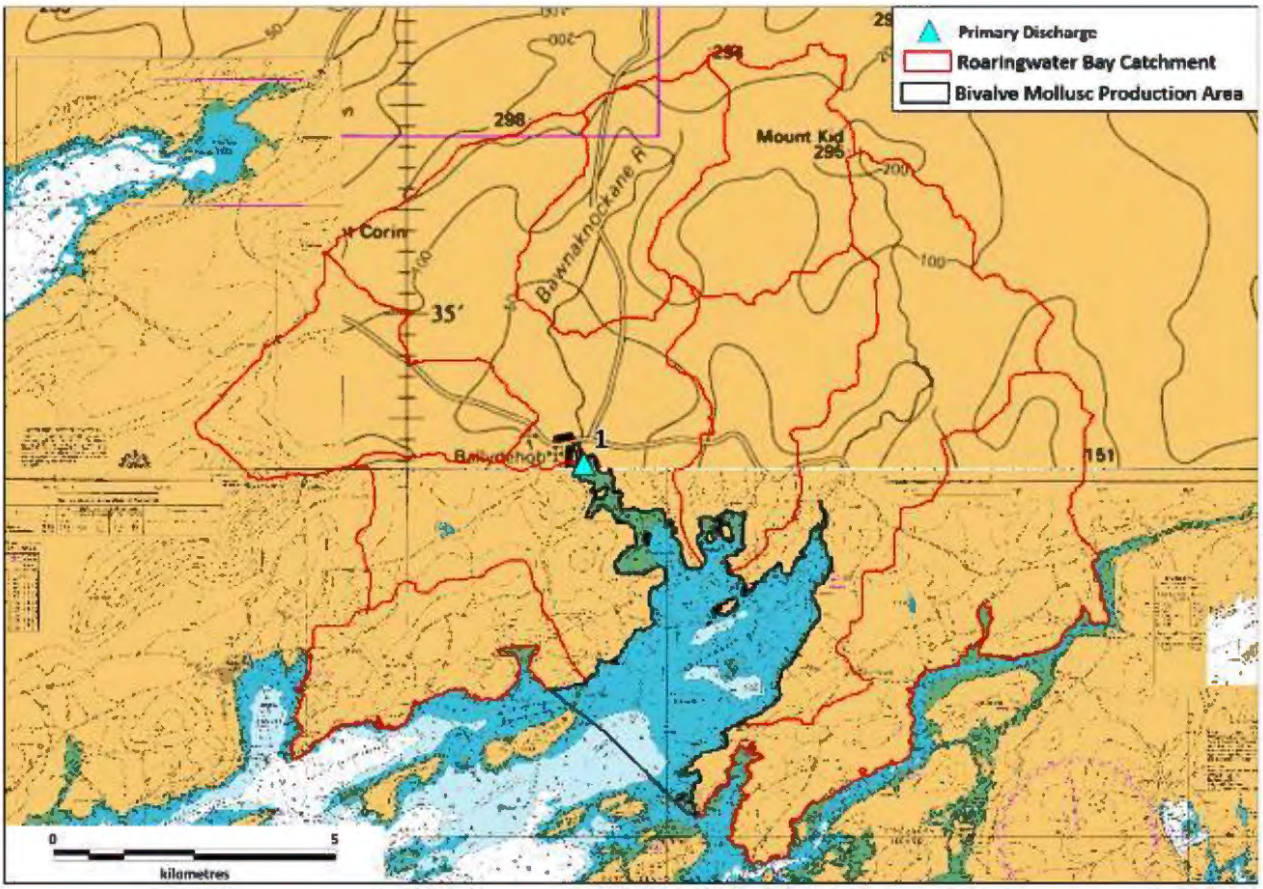

Figure 6-5: Continuous Discharges associated with the Sewage Treatment Works within the Roaringwater Bay Catchment Area (Source: The EPA, 2019a).

Table 6.4: Continuous Discharges within the Roaringwater Bay Catchment area (Source: EPA, 2019a). Map Codes refer to Figure 5.5.

Map Code	Name	Treatment	Easting	Northing	Longitude	Latitude	Receiving Body	Max Discharge/ day (m^3)	DWF/ day (m^3)
1	Ballydehob	Primary Treatment	99,090	35,099	-9.45580	51.56004	Bawnaknockane River	432	144

Table 6.5: Sewage facilities at permanent households in the catchment area (CSO, 2019a).

Electoral Division	Entire ED						Catchment %					
	Permanent Private Household	Public Sewage Scheme	Individual Septic Tank	Other individual treatment	Other /Not Stated	No sewage facility	Permanent Private Households	Public Sewage Scheme	Individual Septic Tank	Other individual treatment	Other /Not Stated	No sewage facility
Kilcoe	170	9	147	8	0	6	168	9	146	8	0	6
Coolagh	85	2	79	1	3	0	122	3	113	1	4	0
Ballydehob	372	129	221	12	3	7	195	68	116	6	2	4
Scart	116	1	103	8	0	4	0	0	0	0	0	0
Dunbeacon	74	0	68	3	1	2	73	0	67	3	1	2
Caheragh	107	2	99	2	1	3	1	0	1	0	0	0
Aghadown South	234	2	217	10	1	4	32	0	29	1	0	1
Cloghdonnell	140	0	122	6	8	4	2	0	1	0	0	0
Ballybane	114	1	94	11	5	3	79	1	65	8	3	2
Aghadown North	103	1	97	4	1	0	52	1	49	2	1	0
Durrus East	94	1	82	5	4	2	57	1	49	3	2	1

6.2.2.3. Rainfall Dependent / Emergency Sewage Discharges

In addition to WWTPs having a continuous discharge pipe, they also have intermittent or rainfall dependent discharge pipes in the form of storm water overflows and emergency overflows. During storm flows in excess of a predetermined flow rate, the excess will bypass the works and flow directly to the outfall via the storm overflow discharge pipes. The details for the intermittent discharges can be seen in Table 6.6 and Figure 6-6.

Table 6.6: Rainfall dependent discharges (storm water overflows) within the Roaringwater Bay Catchment area (Source: EPA, 2019a). Map Codes refer to Figure 6-6.

Map Code	Name	Discharge	Discharge Point Code	Easting	Northing	Longitude	Latitude	Receiving Body
2	Ballydehob	Storm Water Overflow	SW2	98,964	35,317	-9.45768	51.56198	Bawnaknockane River
3	Ballydehob	Emergency Overflow	SW3	98,976	35,430	-9.45754	51.56299	Bawnaknockane River

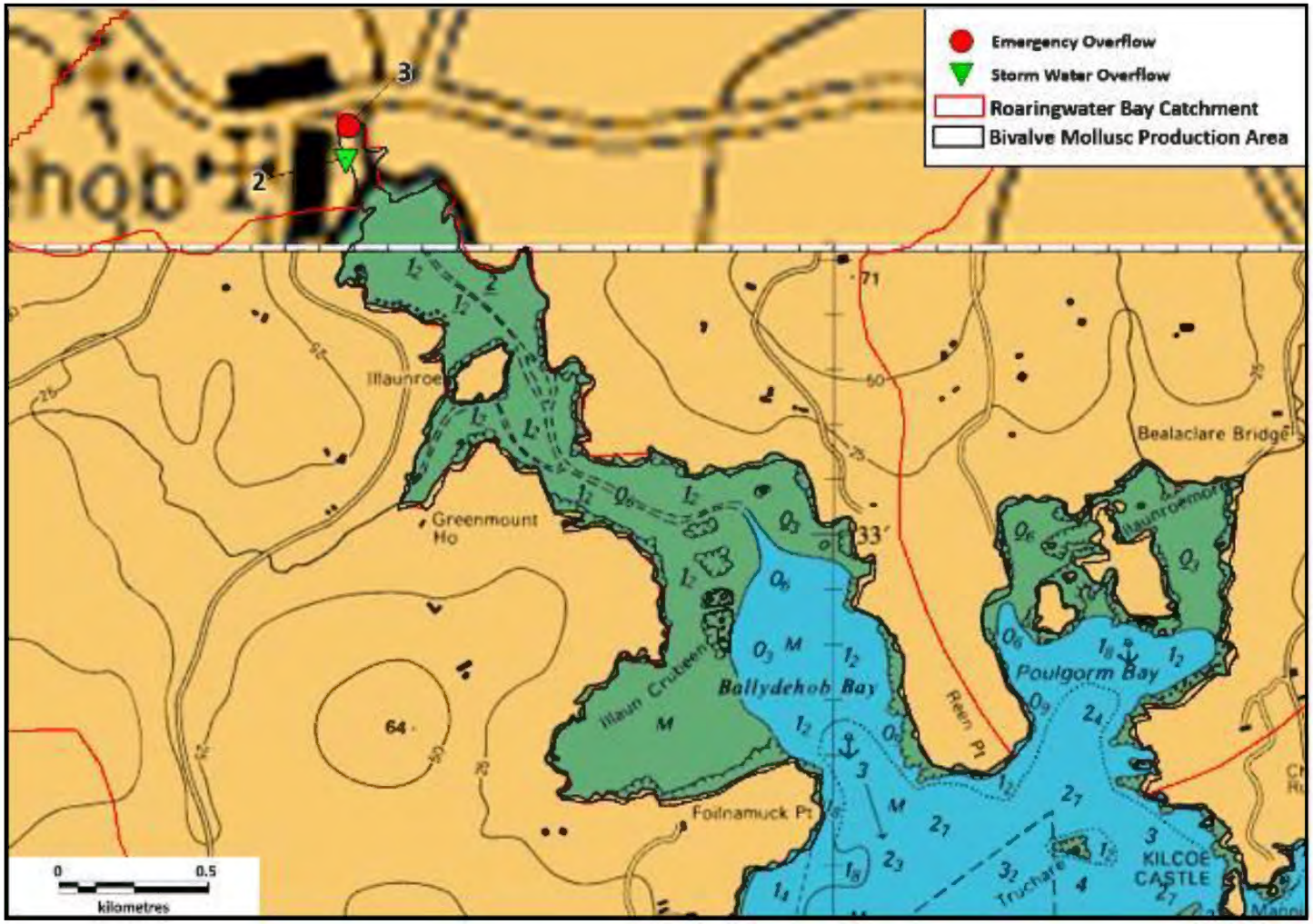

Figure 6-6: Rainfall Dependent Discharges associated with the Sewage Treatment Works within the Roaringwater Bay Catchment Area (Source: The EPA, 2019a).

6.2.3. Industrial Discharges

Figure 6-7 shows the section 4 discharges within the Roaringwater Bay catchment area accounted for during the desk-based assessment (EPA, 2019b; EPA, 2019c). There are no IPC or IE facilities within the catchment. Two section 4 discharges have been identified within the catchment. Both discharges undergo secondary treatment and almost all of the discharge from the knackery (Map ID 1) is re-used. Details on these discharges can be seen in Table 6.7.

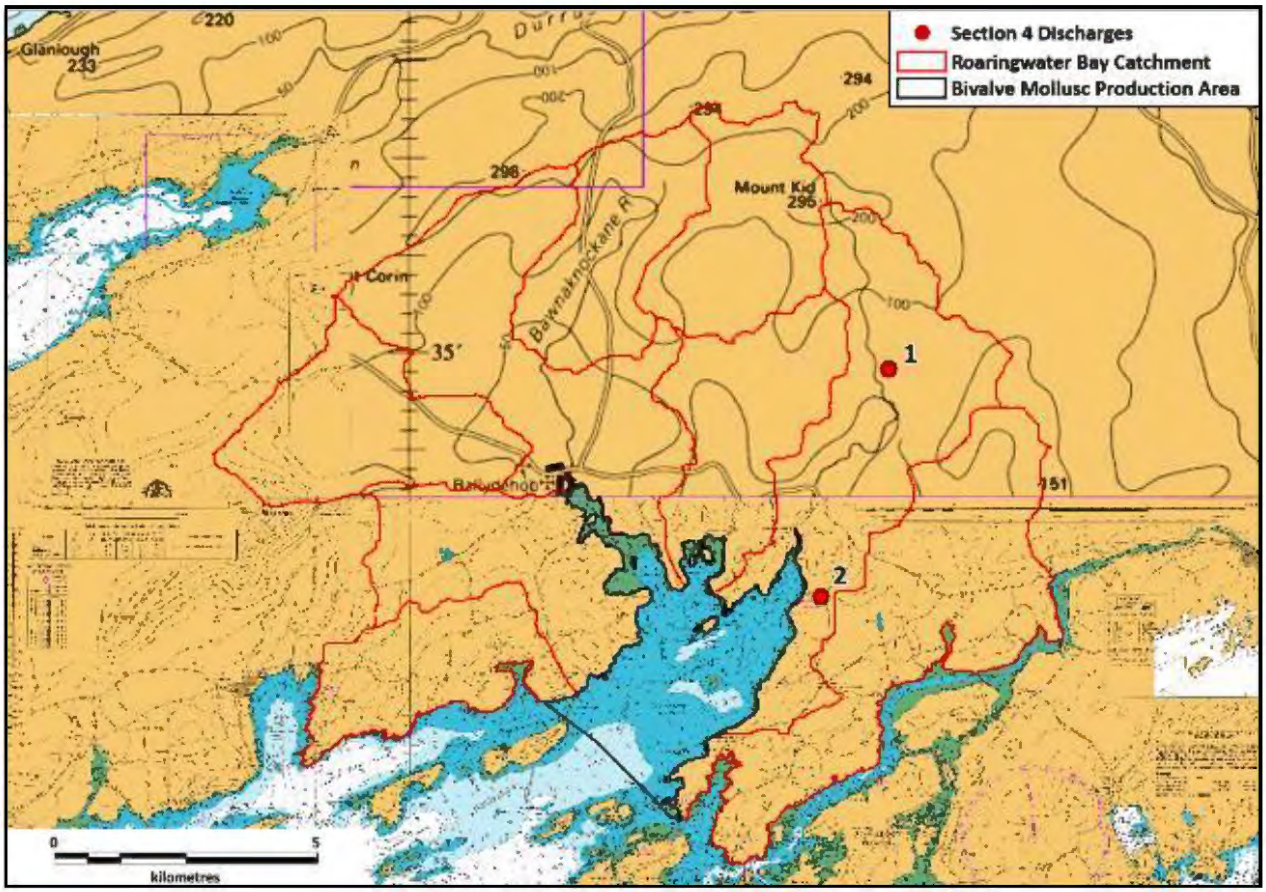

Figure 6-7: Section 4 discharges within the Roaringwater Bay Catchment Area (Source: (EPA, 2019b; EPA, 2019c).

Table 6.7: Details of section 4 discharges within the Roaringwater Bay Catchment Area (Source: EPA, 2019b). Map Codes refer to Figure 6-7.

Map ID	Discharge Code	Discharge Type	Treatment	Longitude	Latitude	Easting	Northing
1	WP(W) 15/06	Wash water from knackery	Secondary	-9.369263	51.581472	105,135.6	37,367.7
2	WP(W) 25/05	Shellfish depuration	Secondary	-9.388197	51.542357	103,740.6	33,040.6

6.2.4. Landuse Types

Figure 6-8 shows the Corine land use (EPA, 2019d) within the Roaringwater Bay catchment area. Figure 7-4 shows all rivers/streams within the catchment area. Within the catchment area, land use is dominated by pastures (71.9km^2, 56.8%), land principally occupied by agriculture, with significant areas of natural vegetation (22km^2; 17.4%) peat bogs (10.1km^2; 8%), coniferous forest (6.9km^2, 5.5%) and Transitional woodland-shrub (6.2km^2, 4.9%). See Figure 6-9.

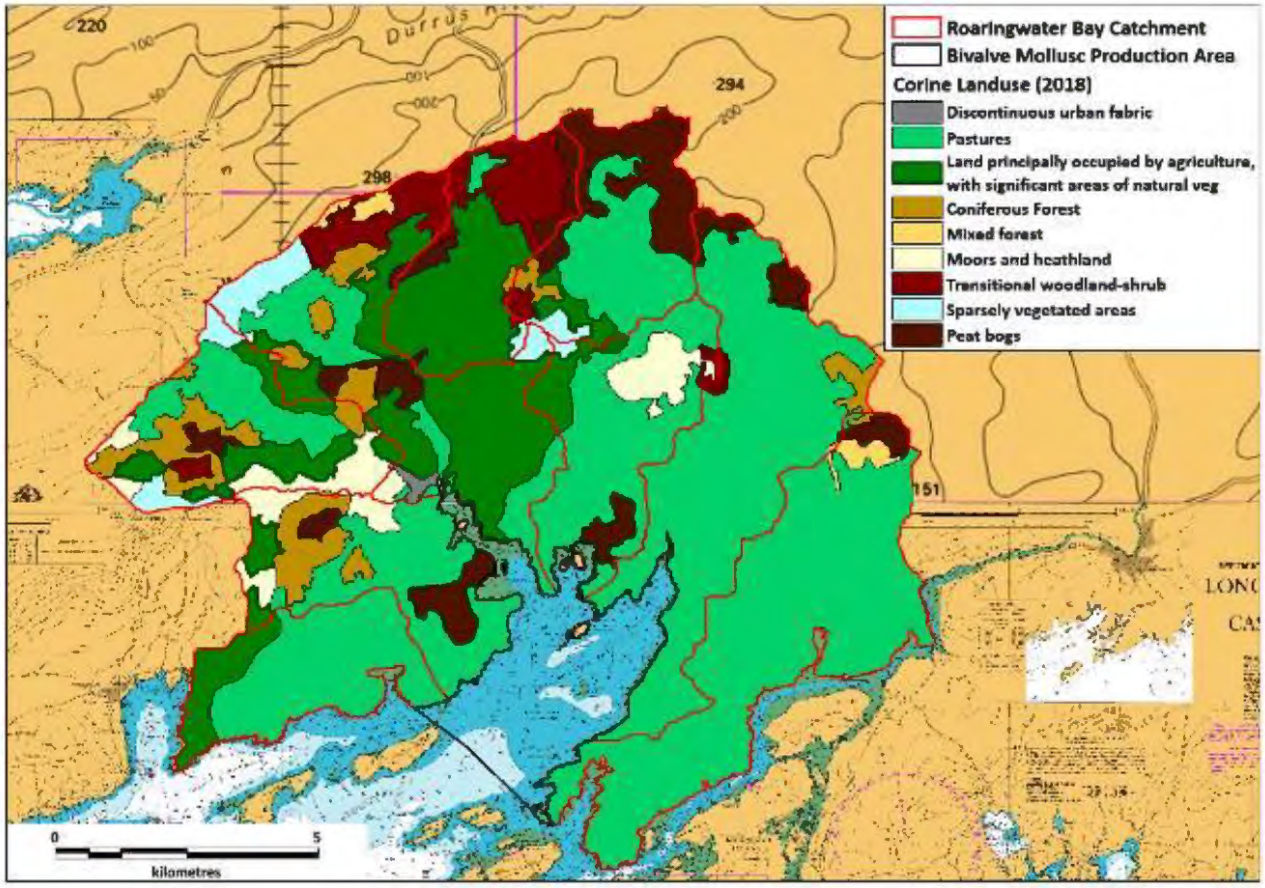

Figure 6-8: Land use within the Roaringwater Bay Catchment Area (Source: EPA, 2019d).

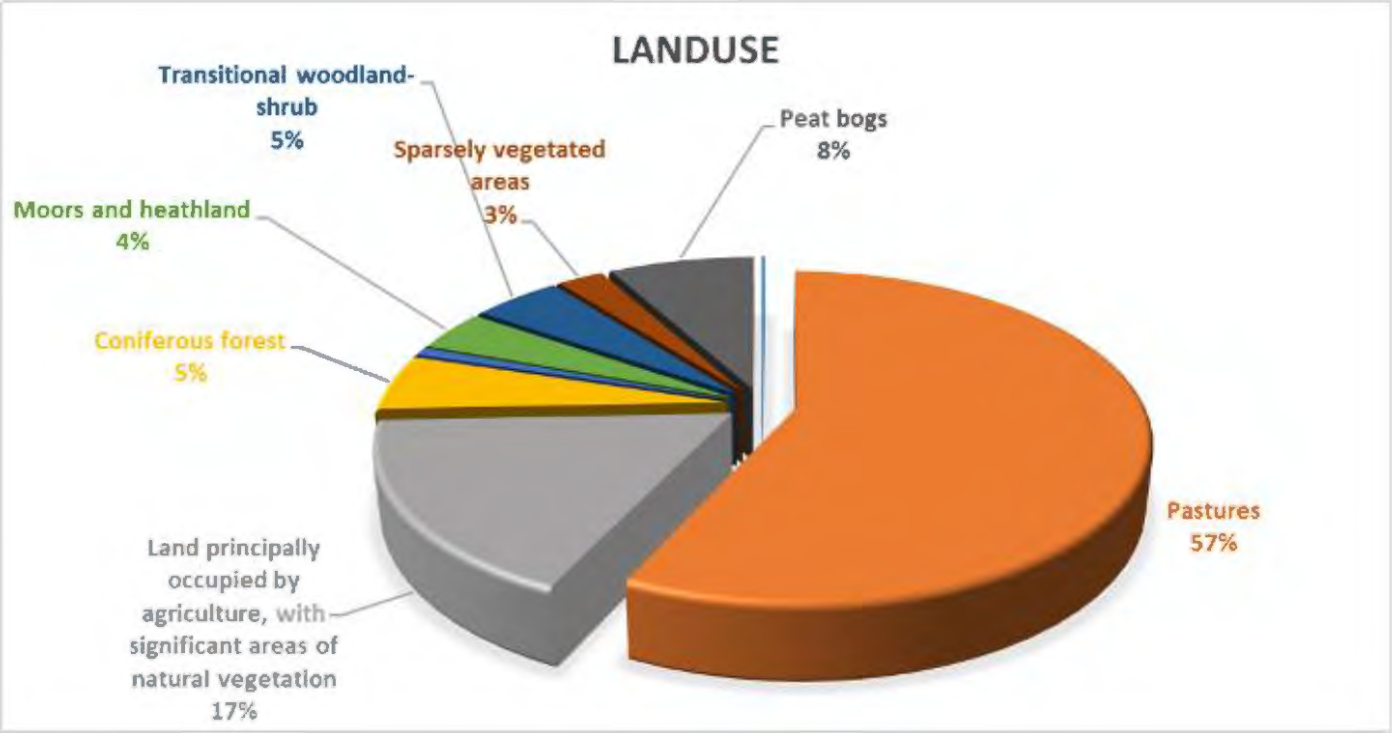

Figure 6-9: Breakdown of land use within the Roaringwater Bay Catchment Area (only land use ≥1% is labelled).

Data from the Census of Agriculture 2010 (CSO, 2019b) can be seen in Table 6.8 below. Figure 6-10 to Figure 6-15 show thematic maps for each category in Table 6.8.

The total area farmed within the catchment varies from 756 ha in Aghadown North to 2,023 ha in Ballydehob.

Total grass and rough grazing (combination of total pasture, total silage, total hay and rough grazing) accounted for almost all of the area farmed, ranging from 747 ha in Aghadown North to 2,015 ha in Ballydehob. Total crops range from 0 ha in Coolagh, Scart, Dunbeacon and Durrus to 26 ha in Aghadown South.

The total number of cattle within the catchment range from 956 in Coolagh to 4,141 in Aghadown South. The total number of sheep within the catchment range from 79 in Kilcoe to 3,320 in Dunbeacon. The total number of horses within the catchment range from 9 in Cloghdonnell to 43 in Ballydehob.

The total area farmed in the entire ED's shown in Figure 6-10 to Figure 6-15 amounts to 16,612 ha. However, as most of these ED's only partially overlap the catchment area, an attempt was made to estimate the actual area farmed within the catchment. The percentage of the ED lying within the catchment was calculated in the mapping software GIS and from this value the area farmed was calculated *e.g.,* if 50% of an ED lies within

the catchment area then 50% of the area farmed was taken to be the area farmed within the catchment. Using this method, the area farmed within the catchment is estimated at 8,549 ha. This represents 50% of the area.

Table 6.8: Farm census data for all EDs within the Roaringwater Bay Catchment Area (Source: CSO, 2019b).

ED Name	County	Area Farmed (ha)	Total Crops (ha)	Total Grass & Rough Grazing (ha)*	Cattle	Sheep	Horses
Kilcoe	Cork	1946	26	1921	3841	79	11
Coolagh	Cork	882	0	881	956	872	11
Ballydehob	Cork	2023	8	2015	2588	754	43
Scart	Cork	1420	0	1419	1642	2318	12
Dunbeacon	Cork	1750	0	1750	1721	3320	17
Caheragh	Cork	1719	5	1714	2726	941	31
Aghadown South	Cork	1787	26	1761	4141	159	16
Cloghdonnell	Cork	1776	18	1758	3585	422	9
Ballybane	Cork	1443	13	1431	1681	811	36
Aghadown North	Cork	756	9	747	1649	285	10
Durrus East	Cork	1110	0	1110	1156	2131	24

* Total Grass and Rough Grazing was taken to be the sum of Total Pasture, Total Silage, Total Hay and Rough Grazing.

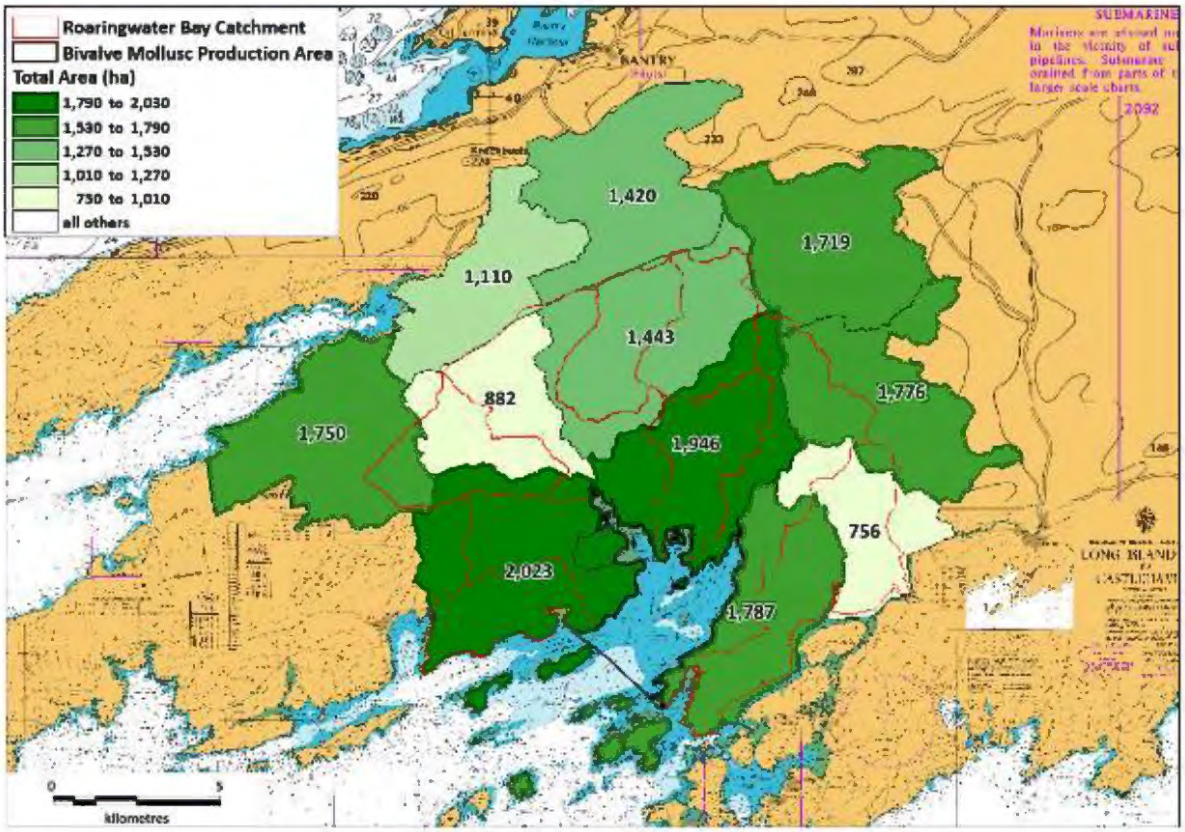

Figure 6-10: Area farmed (ha) within the Roaringwater Bay Catchment Area (Source: CSO, 2019b).

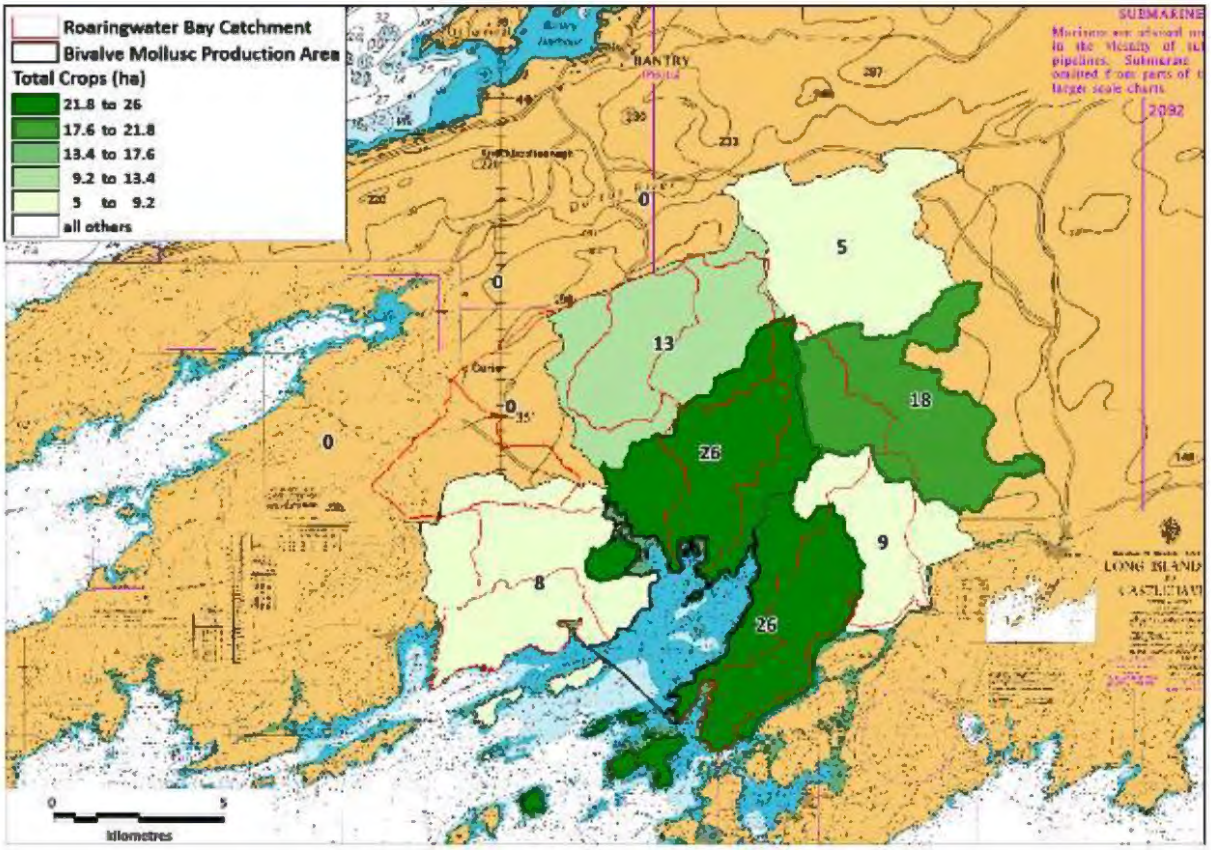

Figure 6-11: Total crops within the Roaringwater Bay Catchment Area (Source: CSO, 2019b).

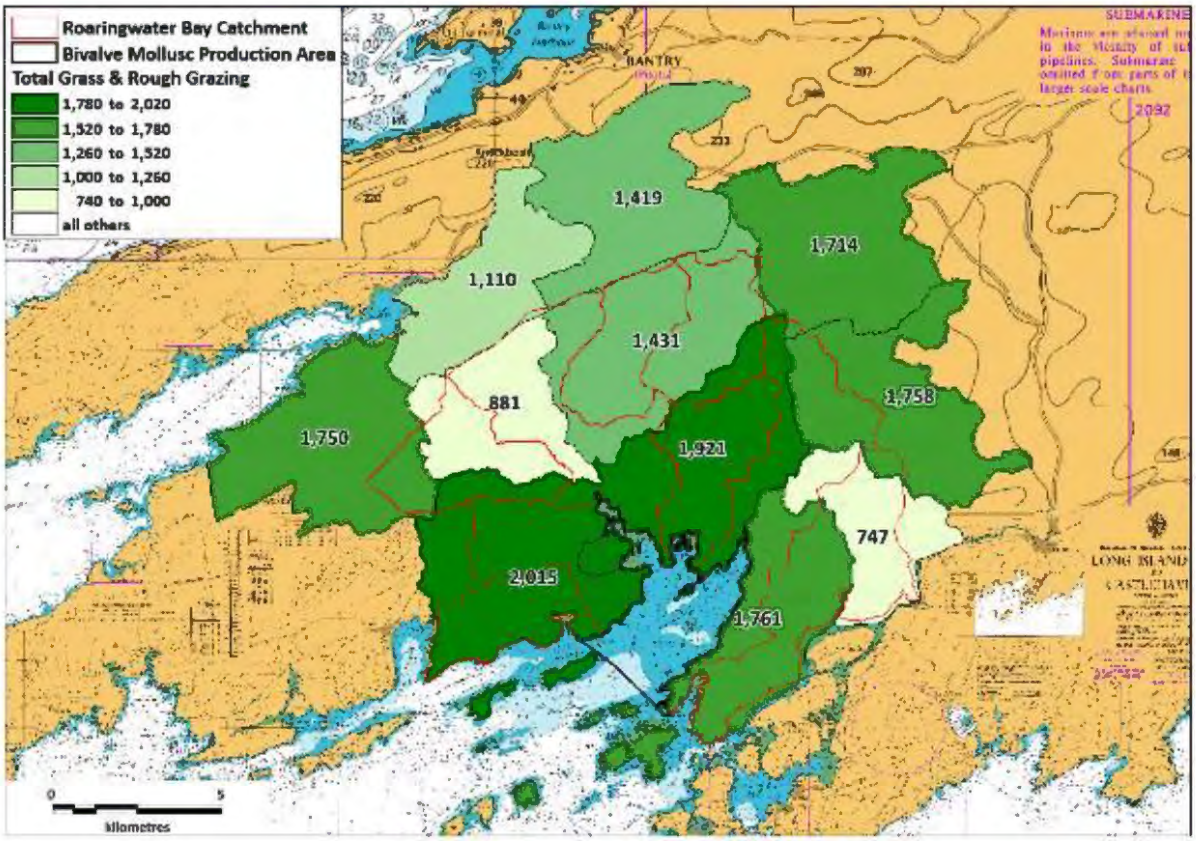

Figure 6-12: Total grass and rough grazing within the Roaringwater Bay Catchment Area (Source: CSO, 2019b).

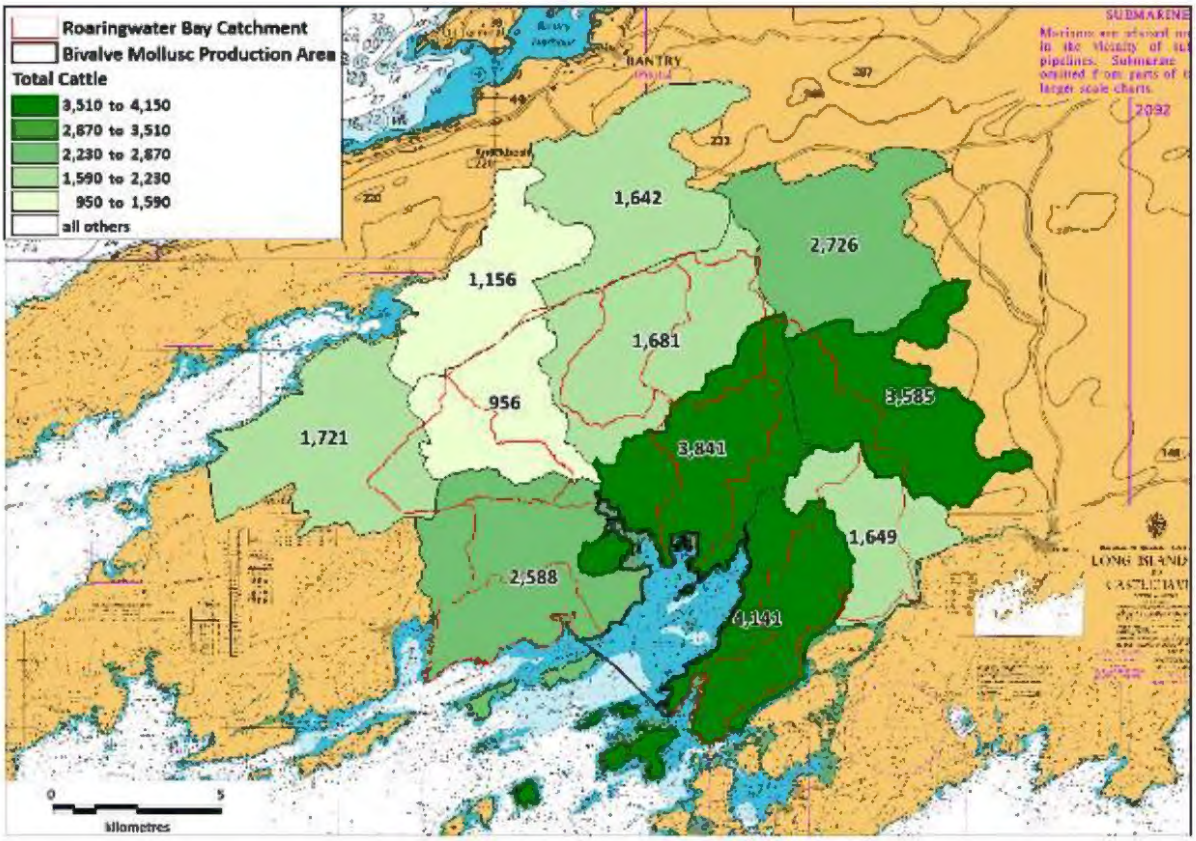

Figure 6-13: Cattle within the Roaringwater Bay Catchment Area (Source: CSO, 2019b).

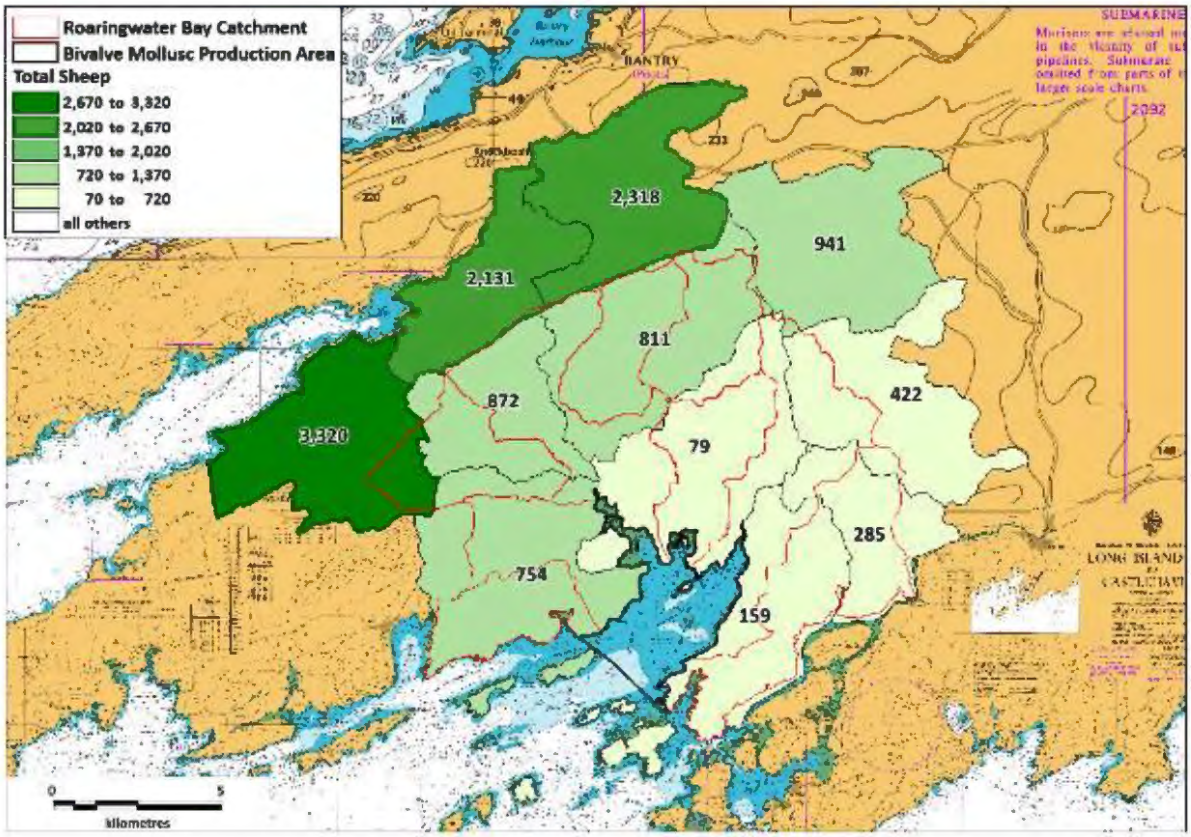

Figure 6-14: Sheep within the Roaringwater Bay Catchment Area (Source: CSO, 2019b).

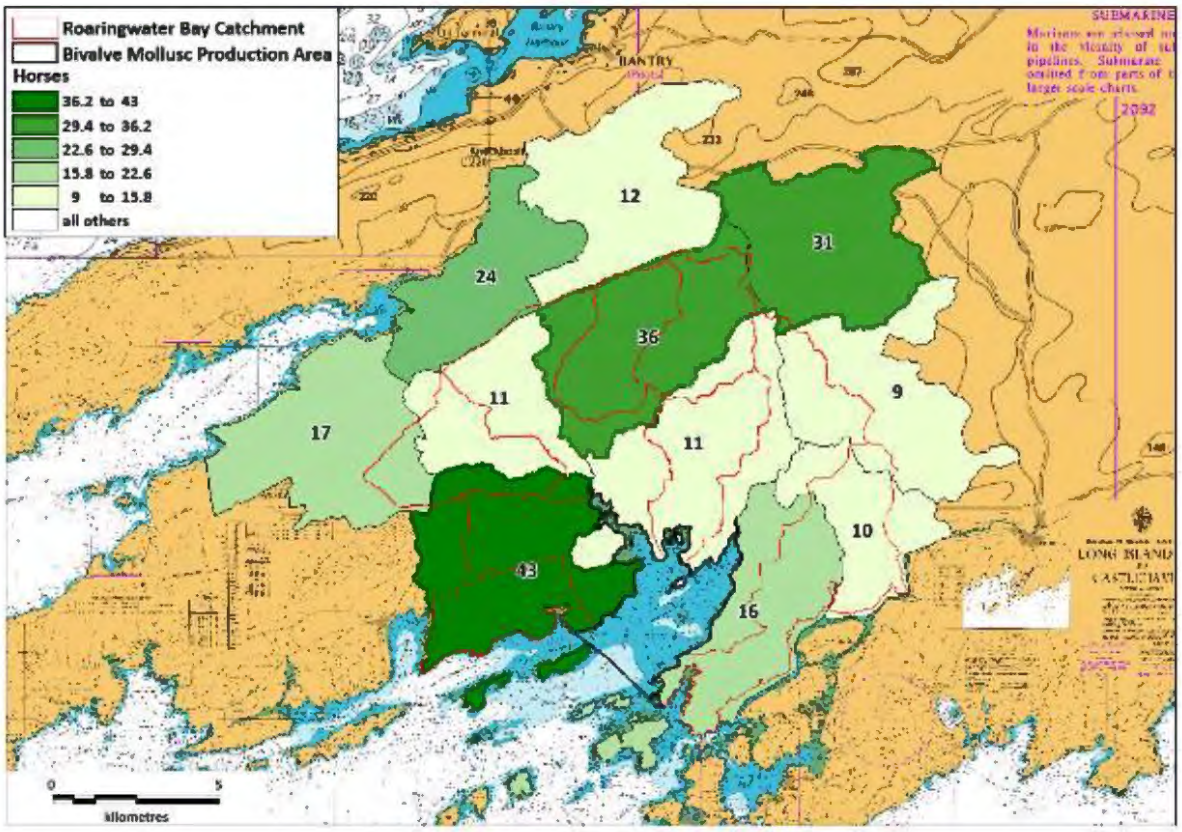

Figure 6-15: Horses within the Roaringwater Bay Catchment Area (Source: CSO, 2019b).

A number of studies have reported a strong association between intensive livestock farming areas and faecal indicator concentrations of microorganisms in streams and coastal waters due to run-off from manure, especially during high flow conditions, both from point and non-point sources of contamination (*e.g.,* Crowther *et al.,* 2002). Table 6.9 shows the potential daily loading of *E. coli* from livestock (compared to humans and birds). It can be seen that sheep rank the worst, followed by pigs, cows, birds, humans and poultry.

Table 6.9: Potential daily loading of *E. coli* (Jones & White, 1984).

Source	Faecal Production (g/day)	Average Number (*E. coli*/g)	Daily Load (*E. coli*)	Rank
Man	150	13×10^6	1.9×10^9	5
Cow	23600	0.23×10^6	5.4×10^9	3
Sheep	1130	16×10^6	18.1×10^9	1
Chicken	182	1.3×10^6	0.24×10^9	6
Pig	2700	3.3×10^6	8.9×10^9	2
Gull	15.3	131.2×10^6	2×10^9	4

The largest majority of livestock in the area are cattle. Sheep are also present but at approximately half the density. The majority of agricultural land use in the area is total grass and rough grazing. The highest density of cattle are present in the south of the catchment and for sheep in the north of the catchment. Livestock droppings along with slurry and farmyard manure may impact the fishery when washed into the sea during and/or after periods of rainfall unless deposited directly on the shoreline.

6.2.5. Other Pollution Sources

6.2.5.1. Shipping

Figure 6-16 shows all boat facilities and activities in Roaringwater Bay.

Table 6.10 details these facilities. There are no commercial ports in Roaringwater Bay. There are no ferries operating in Roaringwater Bay. Although no ferries pass through the production areas there are regular ferries in the area between Cape Clear, Baltimore and Skull. There are also active ports in Baltimore and Skull. There are two slipways, two private jetties and a number of quays of varying size. Yachting is prevalent in the area and there are four mooring locations within the production area with approximately 68 moorings between them. The most active quay is located in the northeast of the bay (Map ID 14 below) and is used by Roaringwater Bay Mussels.

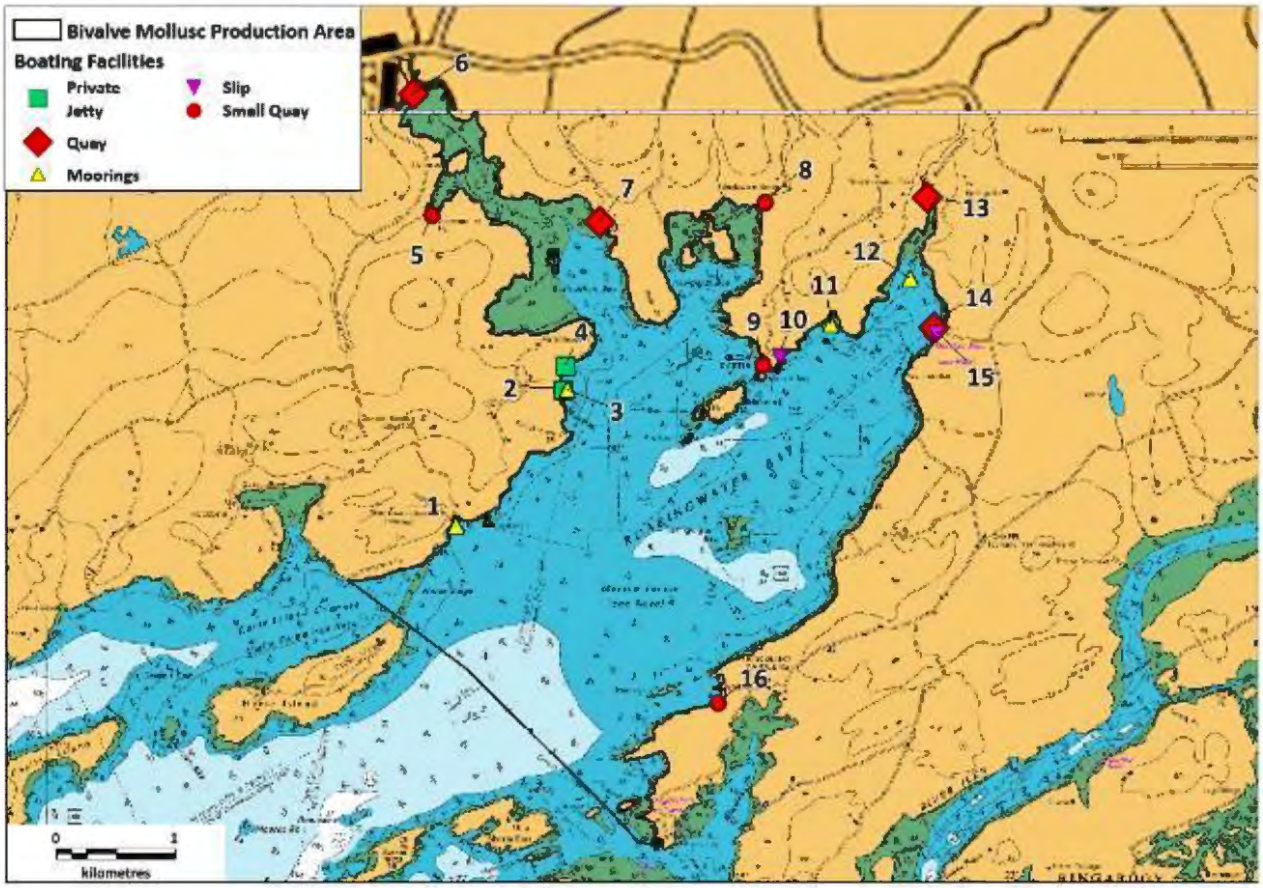

Figure 6-16: Location of all boating facilities and activities in Roaringwater Bay.

Table 6.10: Boating facilities in the Roaringwater Bay. Map Code refers to Figure 6-16.

Map Code	Feature	Use (if known)
1	Moorings	Approx. 23 moorings at Audley Cove (8 boats present in satellite image)
2	Private Jetty	
4	Private Jetty	
3	Moorings	4 moorings (one boat present in satellite image)
5	Small Quay	
6	Quay	Ballydehob quay
7	Quay	
8	Small Quay	
9	Small Quay	Quay at Kilcoe Castle
10	Slip	
11	Moorings	6 Moorings (Two boats present in satellite image)
12	Moorings	Approx. 35 moorings (10 boats present in satellite image)
13	Quay	10 boats present in satellite image
14	Quay	Active quay used in relation to Rope mussel culture with a number of working boats present.
15	Slip	
16	Small Quay	

6.2.5.2. Wildlife

Birds

It is important to document the bird populations in the Roaringwater Bay area as bird faeces are rich in faecal bacteria (Oshira & Fujioka, 1995) and have been shown to be a source of faecal contamination in the marine environment (Jones *et al.* 1978; Standridge *et al.* 1979; Levesque *et al.* 1993, Alderisio & DeLuca 1999, Levesque *et al.* 2000, Ishii *et al.* 2007).

There are no SPAs within Roaringwater Bay. The closest SPA is Sheep's Head to Toe Head SPA (Site Code: 004156) located 4.5km southeast of the bay. The site is a Special Protection Area (SPA) under the E.U. Birds Directive, of special conservation interest for the following species: Chough and Peregrine. The site also supports a range of other breeding seabirds including Fulmar (57 pairs), Herring Gull (30 pairs), Shag (17 pairs), Kittiwake (20 pairs), Black Guillemot (137 individuals) and Great Black-backed Gull (1 pair) – all seabird data is from 1999, 2001 and 2002 (NPWS, 2015). It is likely that some of these species will visit the production area from time to time.

Roaringwater Bay is routinely surveyed by Birdwatch Ireland (through the I-WeBS [Irish Wetland Bird Survey] Project). The total peak counts for each season from 2009 to 2018 can be seen in Table 6.11.

Table 6.11: Total number of waterbirds in Roaringwater Bay between 2009/10 and 2017/18 seasons (Source: BWI, 2020).

Site Name	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	Mean
Roaringwater Bays	67	171	186	165	N/A	244	160	249	174	177
Ballydehob bay	159	264	322	677	517	323	352	412	394	380

Population levels of birds in Roaringwater Bay proper over the 9 years are fairly stable with a slight increase over the years, with a low in the 2009/2010 season and a high in the following year 2016/2016. The bird numbers in Ballydehob Estuary are higher. With bird numbers generally around three to four hundred. The highest numbers occurred in 2012/2013 and the lowest was in 2009/2010. Bird numbers in the area increase during the winter months when the wintering waterfowl arrive. Overall, the population levels are relatively low and when compared with land-based discharges will have little impact.

Aquatic mammals

Roaringwater is designated as an SAC (Roaringwater Bay and Islands SAC) for Grey seals (*Haliochoerus grypus*), Otters (*Lutra lutra)* and Harbour Porpoise (*Phocoena phocoena*). Grey seals are present in the bay

throughout the year. A minimum population for all ages was estimated at 116-149 in 2005 (NPWS, 2014). The entire shoreline within the bay is designated as otter habitat. Population estimates for otters range from 175 – 219 (Ploeg *et al*. 2014). The Harbour porpoise population is estimated at between 117 – 201 individuals (NPWS, 2014). Harbour seals also occur in the area, with a maximum count of 95 individuals recorded in 2010 (NPWS, 2011). There are several haul-out sites within the bay for both Grey and Common seals. The majority of Common seal haul-out sites are located in the inner bay, while the Grey seal sites are mostly in the outer bay (see Figure 6-17). Multiple dolphin species have also been recorded in the area including Bottle-nosed dolphin, Atlantic white-sided dolphin, Risso's dolphin and Common dolphin.

All aquatic mammals that occur in the BMPA are likely to contribute to background levels of faecal contamination within the area.

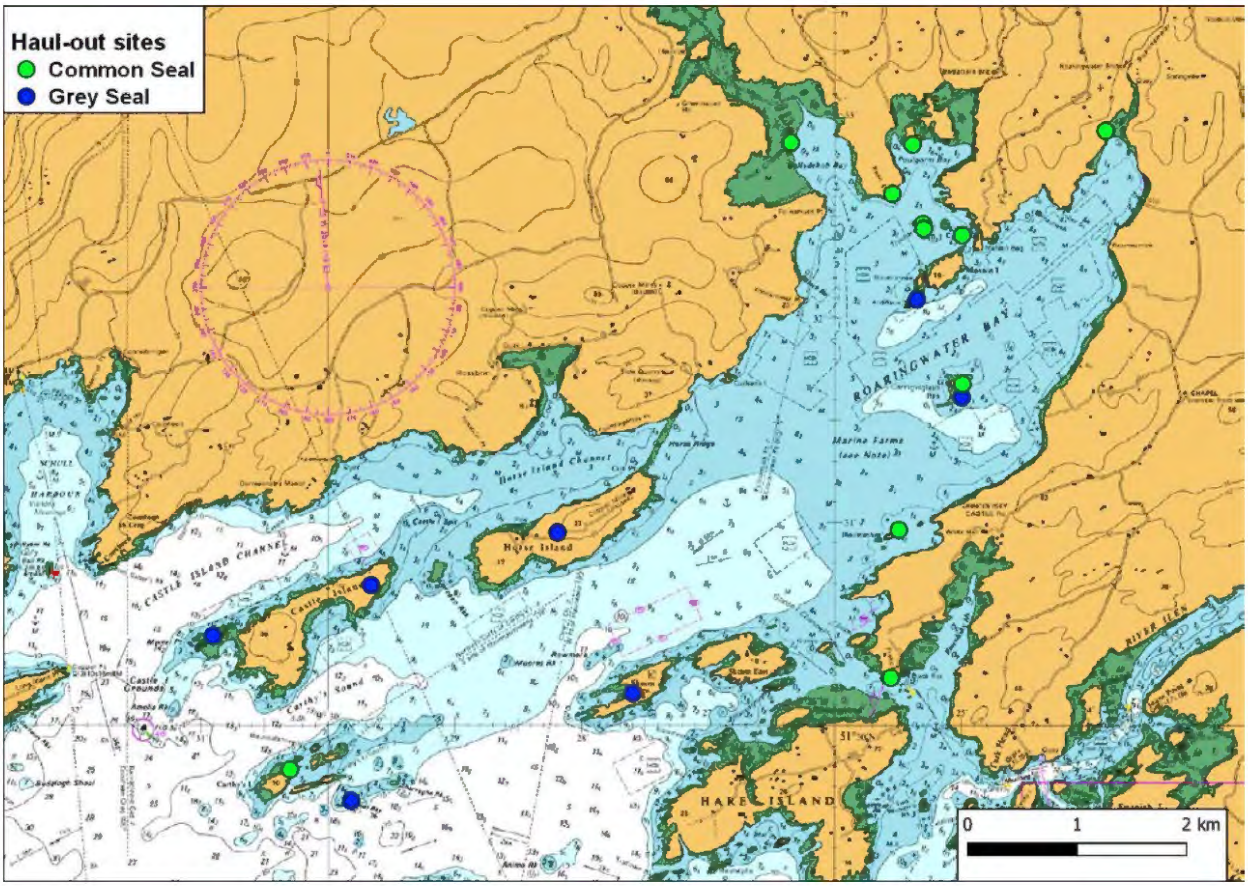

Figure 6-17: Location of haul-out sites for Grey and Common seals within Roaringwater bay (Source: Biodiversity Ireland).

6.3. Shoreline Survey

6.3.1. Shoreline Survey Report

A shoreline survey was carried out by the Sea Fisheries Protection Authority over 6 days between May and June 2021. A further day survey was completed in April 2022 by boat. Figure 6-18 shows the GPS (Global Positioning System) and photography sites accounted for during the 7 survey days.

The aim of this survey was to identify potential sources of contamination in the vicinity of the bivalve mollusc production area such as piped discharges, wastewater infrastructure, waterways, farm animals, large numbers of wild animals and piers/marinas *etc*. The survey was carried out on foot with Sea Fisheries Officers walking the actual shoreline during the low water period and a further day of surveying by boat.

GPS coordinates were recorded for all features encountered. In addition, all features were photographed digitally (where possible). Notes were made on the observations including the type, flow, numbers *etc*.

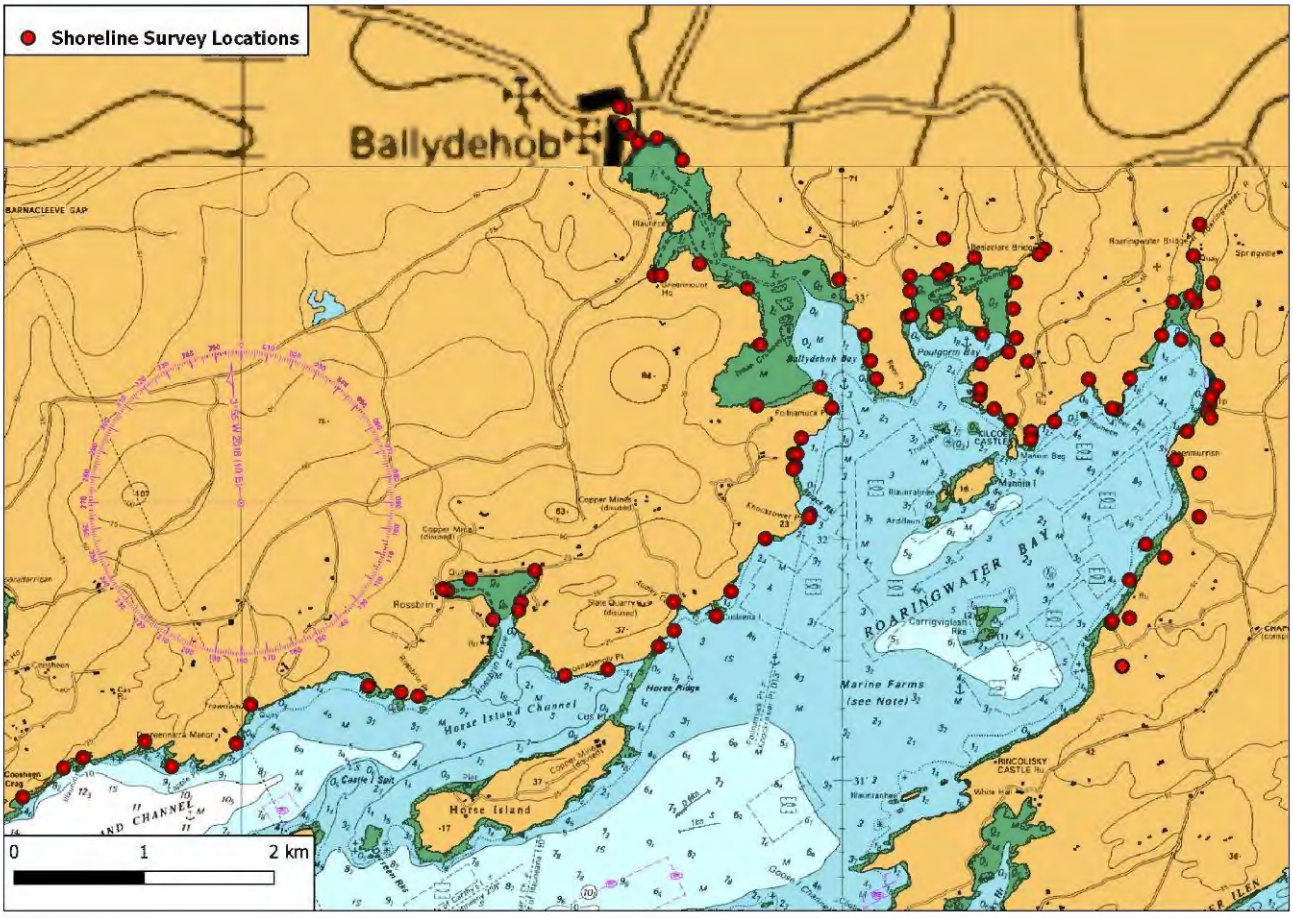

Figure 6-18: Locations of GPS and photograph sites.

Figure 6-19 shows the locations of all features observed during the shoreline survey. In total 109 features were identified, of which 15 rivers/streams were identified, 29 field drains, 6 pipes, 8 piers, 3 slipways, 2 manholes, 2 locations with cattle, 1 cattle shed, 1 storm outflow and 2 locations where wildlife was recorded. Figure 6-20 to Figure 6-37 show aerial imagery of the location of the features and Appendix 5 shows images of most of these features. Table 6.12 details all features identified, and the numbering used is cross-referenced to Figure 6-20 to Figure 6-37 and Appendix 5.

Table 6.12: Features identified during the shoreline survey. Refer to Figure 6-18 for locations and Appendix 6, Figure 6-20 to Figure 6-37 for photographs.

Map Code	Observation	Comments	Latitude	Longitude	Easting	Northing
1	Large pasture area	Large pasture area sloping towards shoreline	51.52452	-9.40238	102719.2	31075.2
2	Shingle Beach	Shingle beach with 1 punt on mooring.	51.52753	-9.40359	102641.7	31411.7
3	Field Drain		51.52768	-9.40350	102648.2	31428.2
4	Field Drain		51.52787	-9.40158	102781.9	31446.8
5	Field Drain	No pipe	51.53050	-9.40158	102787.5	31739.4
6	Field Drain	No pipe	51.53298	-9.39976	102919.0	32012.9
7	Field Drain	No pipe	51.53206	-9.39765	103063.5	31907.8
8	Pipes		51.53487	-9.39388	103331.1	32215.4
9	Stream	Large Stream & reed bed	51.53789	-9.39388	103337.6	32551.4
10	Cattle	Cattle grazing adjacent to shoreline	51.53881	-9.39642	103163.2	32657.1
11	Access track	Access track to shoreline	51.54079	-9.39520	103252.0	32875.8
12	Cattle	Approx. 20 cattle grazing in field beside drain	51.54172	-9.39257	103436.5	32975.8
13	Drain	Field Drain outflow. Large Pipe attached to drain (maybe broken)	51.54208	-9.39290	103414.3	33016.2
14	Laheratnavally Pier	Approx. 10 vessels A/S. All inshore fishing or mussel farm access boats	51.54264	-9.39272	103428.0	33078.3
15	Hardening area	Concrete slab used to harden mussels	51.54320	-9.39255	103441.0	33140.4
16	Field Drain	Good flow, water clear	51.54340	-9.39239	103452.5	33162.4
17	Pipes	1 blue, 1 black pipe. Water intake and power for pump	51.54391	-9.39180	103494.5	33218.4
18	Stream	Moderate stream. Flowing through scrub and pasture. Water clear	51.54714	-9.39181	103500.6	33577.8
19	Moorings	Approx. location. 5 moorings for mussel harvesting barges	51.54713	-9.39588	103218.3	33582.0
20	observed point	Difficult to access area, no evidence of pollution sources	51.54972	-9.39423	103338.2	33868.0
21	Steep Pasture Field	Steep incline, Field for Cattle grazing	51.55102	-9.39231	103474.2	34010.1
22	Roaringwater Pier	Pier with 5 Pleasure Boats, no overnight use	51.55293	-9.39450	103326.4	34225.9
23	Small River	Good water flow, slight brown tinge, possible upland from upland bogs	51.55511	-9.39382	103377.9	34466.9
24	observed point	Difficult to access area, no evidence of pollution sources	51.55014	-9.39480	103299.6	33915.5

Map Code	Observation	Comments	Latitude	Longitude	Easting	Northing
25	Wooded area	No evidence of runoff	51.54975	-9.39677	103162.1	33874.7
26	Edge of tree line	No evidence of runoff	51.54743	-9.39801	103071.2	33618.2
27	Small Beach	No evidence of runoff	51.54446	-9.40151	102822.1	33292.4
28	observed point	No Visible source of pollution	51.54229	-9.40304	102711.3	33053.0
29	Steep Shore	No evidence of runoff	51.54238	-9.40352	102678.2	33063.7
30	Stream	Low water flow, clean appearance	51.54439	-9.40612	102502.1	33290.8
31	observed point	No Visible source of pollution	51.54145	-9.40992	102232.2	32968.8
32	Pipes at Slipway	Pipes observed discharging small volume of grey water	51.54077	-9.41254	102049.0	32896.6
33	Drain	Very small drain, low flow	51.54023	-9.41254	102047.8	32836.5
34	Field Drain	Land Drain	51.54155	-9.41475	101897.4	32986.4
35	Pasture	Grazing Land	51.54234	-9.41660	101770.7	33076.7
36	Field Drain	Field drain	51.54326	-9.41820	101661.7	33181.2
37	Field Drain	Significant green seaweed growth adjacent to drain	51.54371	-9.41811	101668.9	33231.2
38	Field Drain	Very little flow observed	51.54545	-9.41801	101679.6	33424.6
39	Field Drain	Slow water flow	51.54629	-9.41499	101890.9	33514.0
40	Cattle Shed and Pasture	Large Cattle Shed	51.54564	-9.41289	102035.2	33438.9
41	Pasture	No Pollution source observed	51.54724	-9.41416	101950.5	33618.6
42	Field Drain	Low flow	51.54926	-9.41447	101933.4	33843.8
43	Drain	very low flow	51.55108	-9.41425	101952.5	34045.9
44	River Bridge	Bridge over fast flowing river	51.55302	-9.41159	102140.9	34258.4
45	Bealaclare Bridge Pier	River mouth, high water flow, clear water	51.55339	-9.41100	102183.2	34298.2
46	Stream	Strong flow with clear water	51.55280	-9.41876	101643.4	34243.4
47	Pasture	Cattle pasture	51.55412	-9.42218	101409.1	34394.8
48	Field Drain	Low flow	51.55196	-9.42188	101425.2	34154.1
49	Border of lagoon	Intersection of shoreline with large lagoon	51.55162	-9.42271	101366.9	34117.4
50	Pasture	Pasture running from above old pier to this point; farm track reaches shore	51.55162	-9.42271	101366.9	34117.4
51	Wildlife, Seals	Seals resting on Rocks	51.54749	-9.41790	101691.6	33651.4

Map Code	Observation	Comments	Latitude	Longitude	Easting	Northing
52	Field drain	Small field drain	51.54885	-9.42290	101347.7	33809.5
53	Field drain	Small field drain	51.55153	-9.42592	101144.1	34111.7
54	Disused pier	Old pier and (apparent) lobster tanks in poor repair	51.55049	-9.42591	101142.5	33996.0
55	Slipway	Small disused slipway in poor repair.	51.54884	-9.42573	101151.4	33812.2
56	Stream	Small stream/field drain. Water clear	51.54874	-9.42620	101118.6	33801.7
57	Field drain	Small field drain. Water clear	51.54441	-9.42965	100869.9	33324.6
58	Water pipe	Small water pipe approx. 5cm diameter opening onto shoreline	51.54566	-9.43032	100826.1	33464.6
59	Possible field drain	Possible field drain. Small volume of water at time of survey.	51.54744	-9.43090	100789.8	33663.4
60	Tidal pier	End of access at small tidal pier, apparently unused. Skeganore West. Headland between Skeganore East and Skeganore West appears all scrub/ rough pasture. No cattle observed during survey, but some tracks of cattle.	51.55130	-9.43380	100597.0	34096.8
61	Scrubland	No habitation	51.55955	-9.45118	99409.7	35038.4
62	Pipe	4-inch water pipe	51.56107	-9.45397	99219.6	35211.4
63	Manhole	Located close to Ballydehob road bridge	51.56317	-9.45750	98979.5	35449.9
64	Stream and outfall pipe	Steady flow of stream	51.56326	-9.45813	98936.0	35460.8
65	Wildlife, Seagulls	Over 40 Seagulls observed in location	51.56196	-9.45763	98967.8	35315.5
66	Storm outflow	Located at Ballydehob Lagoon	51.56196	-9.45763	98967.8	35315.5
67	Wastewater Treatment plant	Ballydehob Wastewater Treatment plant	51.56173	-9.45760	98969.4	35289.8
68	Inspection manhole	located in lagoon, low flow at time of observation	51.56138	-9.45707	99005.3	35250.2
69	Outlet from lagoon	fast flow, dirty appearance	51.56076	-9.45605	99074.7	35179.8
70	Stream	Located at old unused quay, south of Shanavagh	51.55157	-9.45428	99177.1	34154.9
71	Land Drain	18'' pipe, high flow clear water adjacent o pier at Shanavagh	51.55159	-9.45350	99231.3	34156.0
72	Grazing land	evidence of recent grazing by cattle	51.55237	-9.44928	99525.7	34237.0
73	Headland	seal spotted in area, large quantity of mussel and cockle shells broken on rocks	51.55068	-9.44393	99893.0	34041.7
74	Headland	scrubland	51.54677	-9.44253	99981.6	33604.7
75	Stream	Low trickle, clean water	51.54257	-9.44292	99945.3	33138.0
76	Headland	Scrubland and pasture	51.54384	-9.43589	100435.8	33269.7

Map Code	Observation	Comments	Latitude	Longitude	Easting	Northing
77	Land Drain	Low flow of clean water	51.54241	-9.43460	100522.1	33108.8
78	Land drain	Marsh land and rough pasture	51.54033	-9.43797	100283.8	32882.0
79	Pier	Old pier in good condition at Foilnamuck	51.53921	-9.43845	100248.0	32758.1
80	Field Drain	4 houses close to shore in this area	51.53920	-9.43884	100221.0	32757.5
81	Narrow pier	Pier in use for swimmers and small boats	51.53836	-9.43863	100233.7	32663.8
82	Land Drain	Drain from a water feature pond located in a private garden	51.53817	-9.43887	100216.6	32642.9
83	Headland	Headland adjacent to mussel lines, in production	51.53506	-9.43700	100339.6	32294.4
84	Steep Face	No evidence of runoff	51.53482	-9.43708	100333.5	32267.8
85	Small Cove	No evidence of runoff	51.53336	-9.44196	99991.7	32112.0
86	Steep Shore	No evidence of runoff	51.52971	-9.44578	99718.6	31711.2
87	Spit Island	Mussel lines close to shore, rough pasture	51.52800	-9.44739	99603.1	31523.1
88	Stream from Lagoon	Stream drain saltwater lagoon to sea cove	51.52900	-9.45214	99275.7	31640.9
89	Cliff Face	No evidence of runoff	51.52700	-9.45208	99275.5	31418.3
90	Beach Area	No evidence of runoff	51.52590	-9.45380	99153.7	31298.3
91	Cliff Face	No evidence of runoff	51.52432	-9.45945	98758.1	31130.4
92	Coosnatanniv pt	No evidence of runoff	51.52389	-9.46419	98428.1	31089.1
93	Stream	clear water	51.52841	-9.46931	98082.9	31599.1
94	Field drain	Low flow	51.52897	-9.46904	98102.9	31661.0
95	Stream	Low flow of clean water	51.53115	-9.46752	98213.2	31901.4
96	Pier	Pier for leisure and small fishing boats at Rossbrin	51.53057	-9.47467	97715.8	31846.9
97	Boatyard Slip and river	good flow of clean water	51.52989	-9.47772	97502.5	31775.7
98	Pier & Stream	Rossbrin Slip and Stream, adjacent to pleasure boatyard	51.52979	-9.47720	97538.5	31763.6
99	Field Drain	Low flow	51.52777	-9.47214	97885.1	31531.8
100	Field Drain	The fields behind the shoreline grazed by a small herd of goats	51.52247	-9.48046	97295.8	30953.8
101	Field Drain	Low flow of clear water	51.52273	-9.48237	97163.8	30985.4
102	Cliff Face	extent of foot survey for Rossbrin point area	51.52316	-9.48601	96912.2	31038.4
103	Ardintenant Stream	Strong clear flow, pier for access to Horse and Castle Islands	51.52188	-9.49903	96005.6	30914.4

Map Code	Observation	Comments	Latitude	Longitude	Easting	Northing
104	Shingle Beach	No evidence of runoff	51.51919	-9.50063	95888.4	30617.4
105	Steep Shore	Capple pt, no evidence of runoff	51.51759	-9.50779	95387.8	30449.6
106	Stream	Cobble beach with marsh land behind	51.51934	-9.51076	95185.7	30648.6
107	Fast Flowing Stream	Rocky ground	51.51820	-9.51763	94706.2	30531.6
108	Cliff & Rocky Island	No evidence of runoff	51.51749	-9.51976	94556.7	30455.7
109	Cliff Face	No evidence of runoff	51.51547	-9.52431	94236.2	30237.5

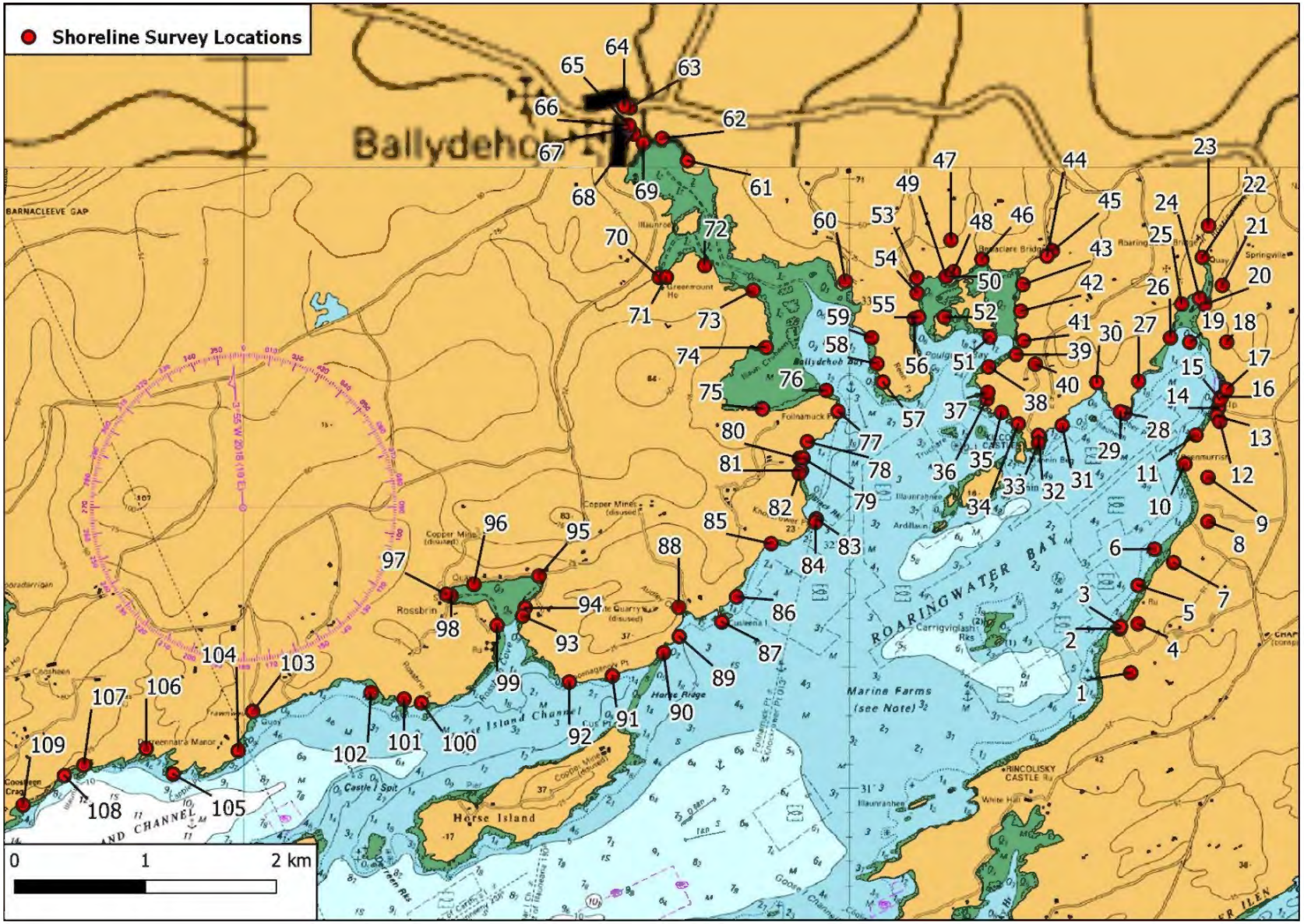

Figure 6-19: All features (numbering cross-reference to Table 6.12) identified during the shoreline survey.

Figure 6-20: Features 1-5 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

Figure 6-21: Features 6-8 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

Figure 6-22: Features 9-11 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

Figure 6-23: Features 12-17 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

Figure 6-24: Features 18-26 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

Figure 6-25: Features 27-30 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

Figure 6-26: Features 31-34 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

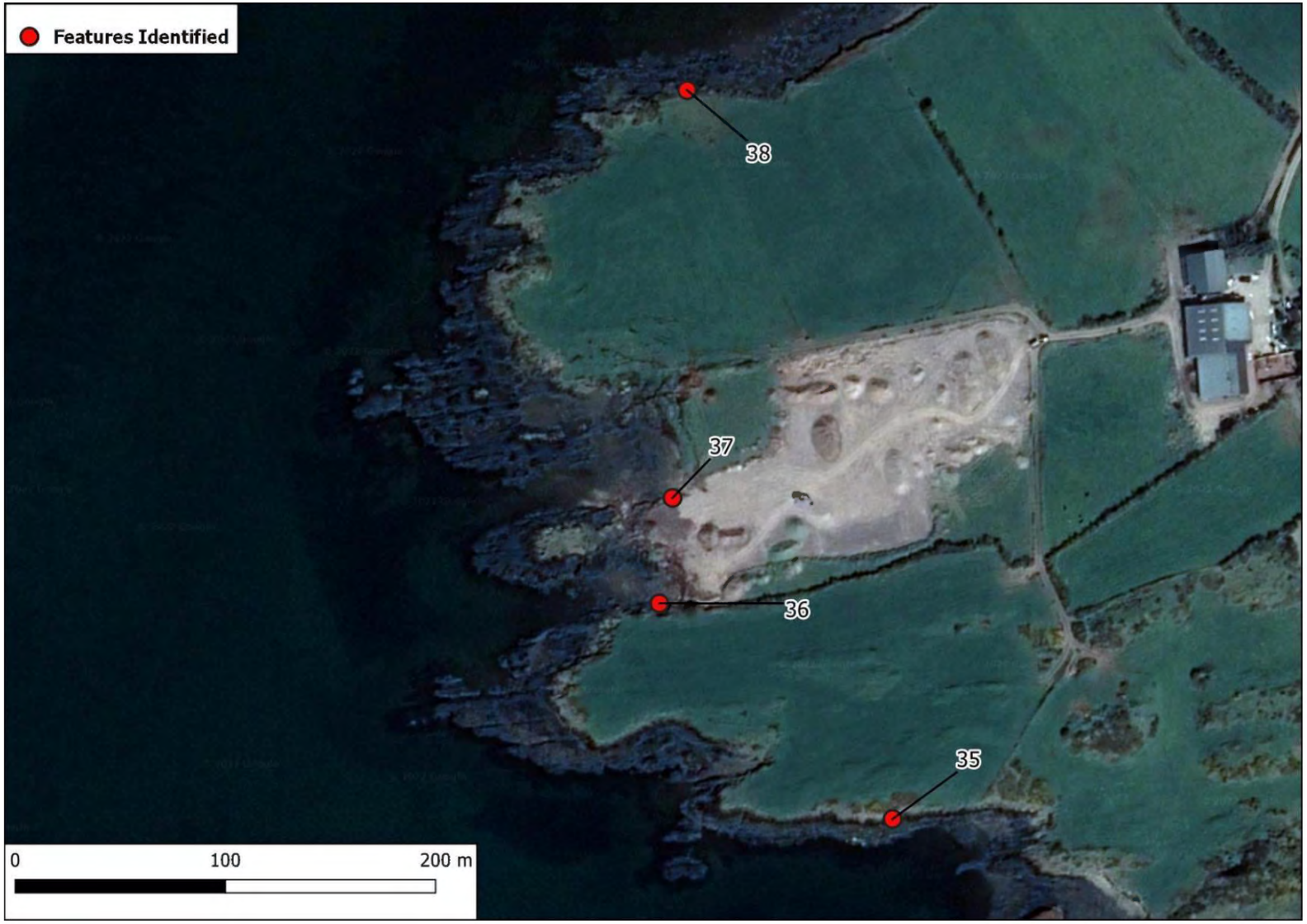

Figure 6-27: Features 35-38 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

Figure 6-28: Features 39-56 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

Figure 6-29: Features 57-59 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

Figure 6-30: Features 60 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

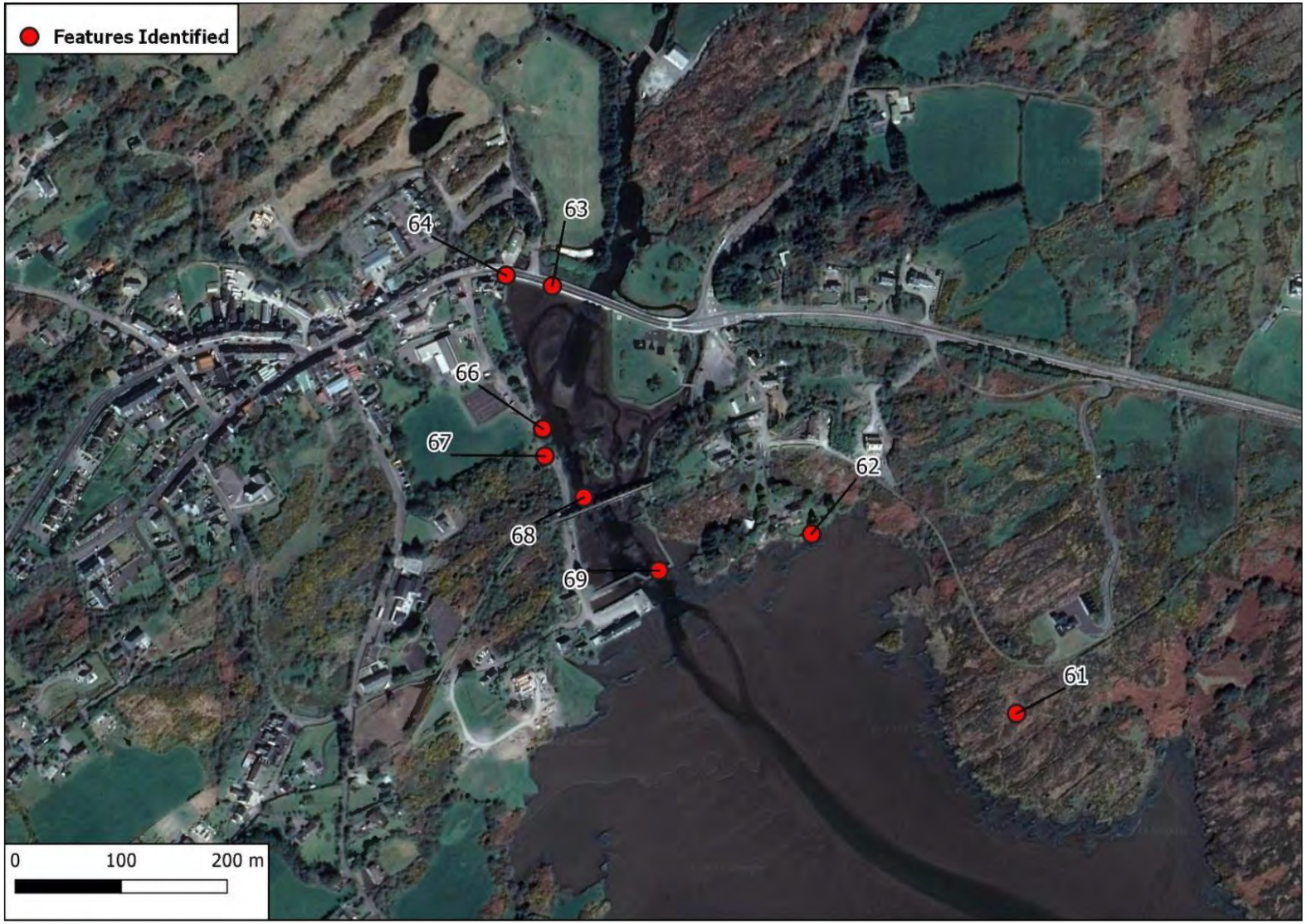

Figure 6-31: Features 61-69 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

Figure 6-32: Features 70-74 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

Figure 6-33: Feature 75-85 (numbering cross-reference Table 6.12) identified during the shoreline survey.

Figure 6-34: Features 86-92 (numbering cross-reference Table 6.12) identified during the shoreline survey.

Figure 6-35: Features 93-99 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

Figure 6-36: Features 100-102 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

Figure 6-37: Features 103-109 (numbering cross-reference to Table 6.12) identified during the shoreline survey.

6.3.2. Locations of Sources

Figure 6-38 shows all watercourses discharging into Roaringwater Bay and Table 6.13 provides cross-referenced details for this map. Figure 6-39 shows all discharges in the Roaringwater Bay catchment area and Table 6.14 provides cross-referenced details for all these discharges.

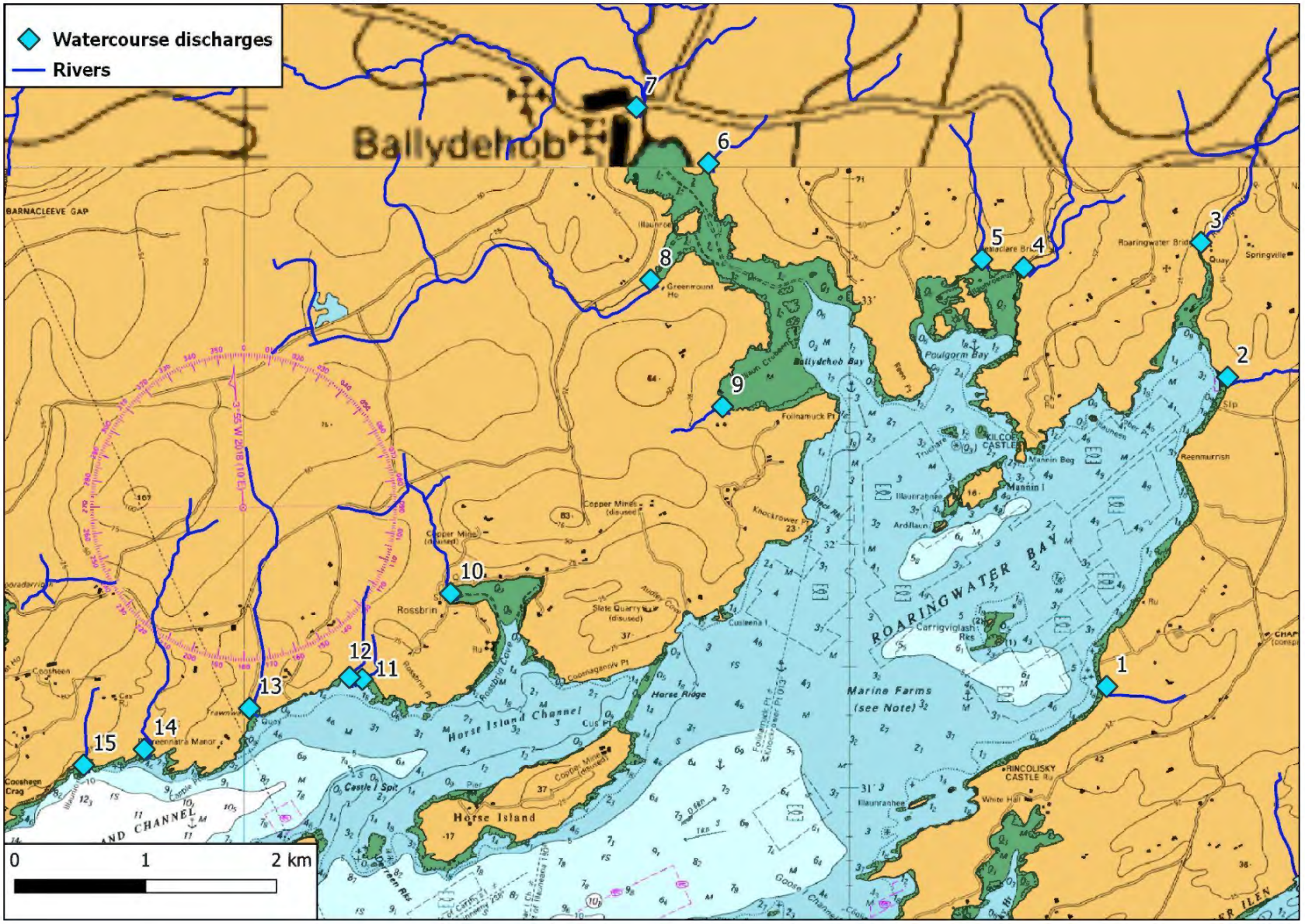

Figure 6-38: Location of all watercourses discharging into Roaringwater Bay.

Table 6.13: Cross-referenced table for Figure 6-38 watercourses.

Map ID	Watercourse
1	Unnamed
2	Unnamed
3	Roaringwater River
4	Leamawadra
5	Unnamed
6	Bawnaknockane
7	Unnamed
8	Unnamed
9	Unnamed
10	Unnamed
11	Unnamed
12	Unnamed
13	Derreennatra
14	Ardintenant
15	Unnamed

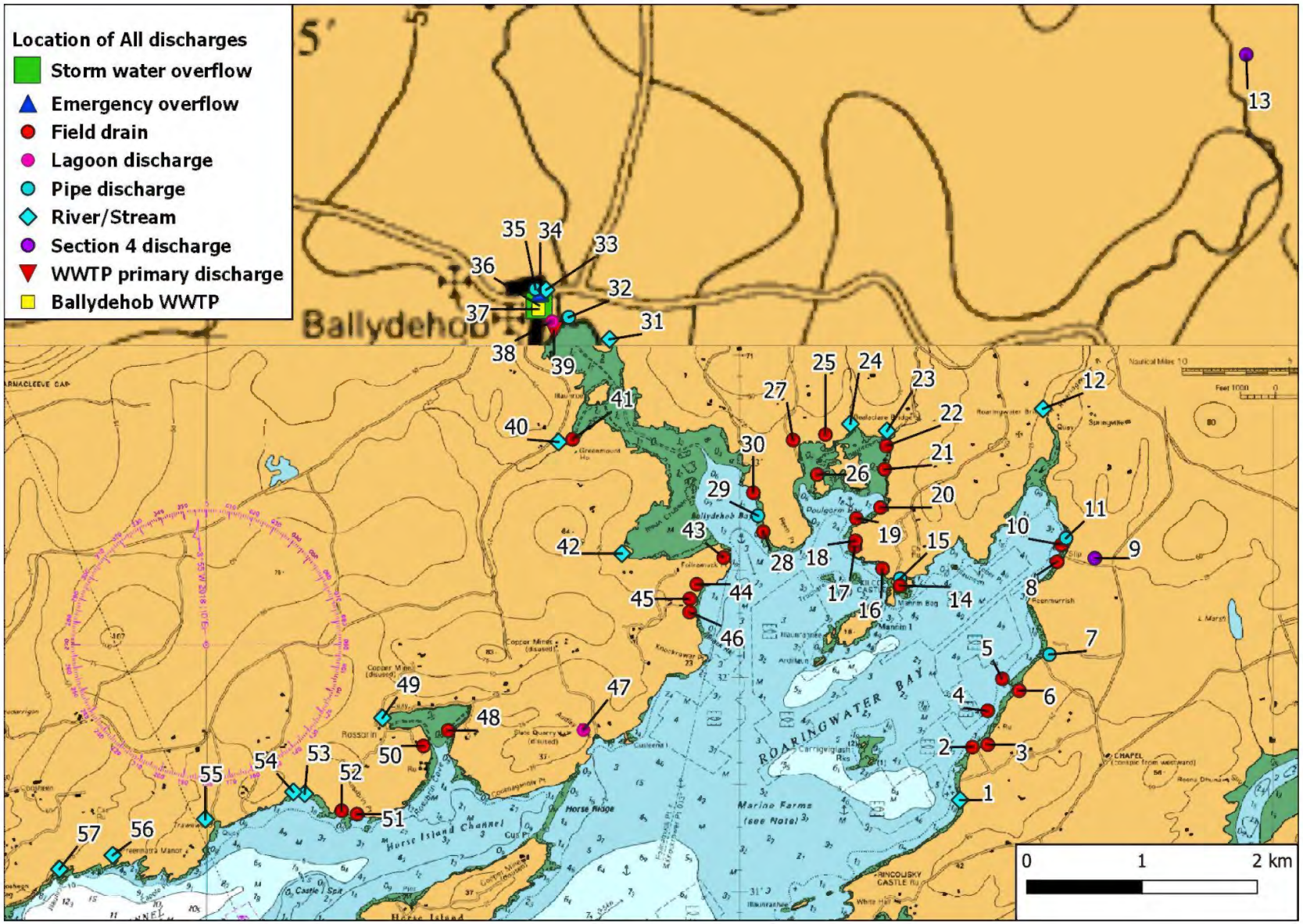

Figure 6-39: Locations of all discharges within Roaringwater Bay Catchment Area.

Table 6.14: Cross-referenced table for Figure 6-39 Discharges.

Map_ID	Observation	Comments	Longitude	Latitude	Easting	Northing
1	River/Stream	Unnamed	-9.40504	51.52356	102482.5	30996.4
2	Field drain		-9.40350	51.52768	102598.1	31452.4
3	Field drain		-9.40158	51.52787	102731.7	31471.0
4	Field drain	No pipe	-9.40158	51.53050	102737.3	31763.6
5	Field drain	No pipe	-9.39976	51.53298	102868.9	32037.1
6	Field drain	No pipe	-9.39765	51.53206	103013.3	31931.9
7	Pipe discharge		-9.39388	51.53487	103280.9	32239.6
8	Field drain	Field Drain outflow. Large Pipe attached to drain (maybe broken)	-9.39290	51.54208	103364.2	33040.4
9	Section 4 discharge	Shellfish depuration	-9.38820	51.54236	103691.0	33065.0
10	Field drain	Good flow, water clear	-9.39239	51.54340	103402.3	33186.6
11	Pipe discharge	1 blue, 1 black pipe. Water intake and power for pump	-9.39180	51.54391	103444.4	33242.6
12	River/Stream	Roaringwater River	-9.39467	51.55396	103266.9	34364.1
13	Section 4 discharge	Wash water from knackery	-9.36926	51.58147	105086.0	37392.0
14	Field drain	Very small drain, low flow	-9.41254	51.54023	101997.7	32860.7
15	Pipe discharge	Pipes observed discharging small volume of grey water	-9.41254	51.54077	101998.8	32920.8
16	Field drain	Land Drain	-9.41475	51.54155	101847.2	33010.5
17	Field drain	Field drain	-9.41820	51.54326	101611.5	33205.4
18	Field drain	Significant green seaweed growth adjacent to drain	-9.41811	51.54371	101618.8	33255.4
19	Field drain	Very little flow observed	-9.41801	51.54545	101629.4	33448.8
20	Field drain	Slow water flow	-9.41499	51.54629	101840.8	33538.2
21	Field drain	Low flow	-9.41447	51.54926	101883.2	33867.9
22	Field drain	very low flow	-9.41425	51.55108	101902.4	34070.1
23	River/Stream	Leamawadra	-9.41418	51.55224	101909.5	34199.3
24	River/Stream	Unnamed	-9.41877	51.55279	101592.7	34266.5

Map_ID	Observation	Comments	Longitude	Latitude	Easting	Northing
25	Field drain	Low flow	-9.42188	51.55196	101375.1	34178.3
26	Field drain	Small field drain	-9.42290	51.54885	101297.6	33833.7
27	Field drain	Small field drain	-9.42592	51.55153	101093.9	34135.9
28	Field drain	Small field drain. Water clear	-9.42965	51.54441	100819.7	33348.8
29	Pipe discharge	Small water pipe approx. 5cm diameter opening onto shoreline	-9.43032	51.54566	100776.0	33488.8
30	Field drain	Possible field drain. Small volume of water at time of survey.	-9.43090	51.54744	100739.6	33687.6
31	River/Stream	Bawnaknockane	-9.44888	51.55936	99518.9	35038.4
32	Pipe discharge	4-inch water pipe	-9.45397	51.56107	99169.5	35235.6
33	River/Stream	Unnamed	-9.45681	51.56320	98977.3	35476.0
34	Emergency overflow		-9.45754	51.56299	98925.9	35454.2
35	Pipe discharge	Steady flow of stream	-9.45813	51.56326	98885.9	35485.0
36	Storm water overflow		-9.45769	51.56198	98913.9	35342.2
37	Ballydehob WWTP	Primary treatment	-9.45775	51.56170	98908.6	35310.8
38	Lagoon discharge	fast flow, dirty appearance	-9.45605	51.56076	99024.6	35204.0
39	WWTP primary discharge		-9.45581	51.56004	99039.9	35123.2
40	River/Stream	Unnamed	-9.45526	51.55138	99058.9	34159.8
41	Field drain	18'' pipe, high flow clear water adjacent to pier at Shanavagh	-9.45350	51.55159	99181.1	34180.2
42	River/Stream	Unnamed	-9.44732	51.54272	99590.0	33184.4
43	Field drain	Low flow of clean water	-9.43460	51.54241	100472.0	33133.0
44	Field drain	Marsh land and rough pasture	-9.43797	51.54033	100233.6	32906.2
45	Field drain	4 houses close to shore in this area	-9.43884	51.53920	100170.8	32781.7
46	Field drain	Drain from a water feature pond located in a private garden	-9.43887	51.53817	100166.5	32667.1
47	Lagoon discharge	Stream drain saltwater lagoon to sea cove	-9.45214	51.52900	99225.6	31665.1
48	Field drain	Low flow	-9.46904	51.52897	98052.7	31685.2
49	River/Stream	Unnamed	-9.47727	51.52994	97483.9	31804.8
50	Field drain	Low flow	-9.47214	51.52777	97834.9	31556.0

Map_ID	Observation	Comments	Longitude	Latitude	Easting	Northing
51	Field drain	The fields behind the shoreline grazed by a small flock of goats	-9.48046	51.52247	97245.6	30978.0
52	Field drain	Low flow of clear water	-9.48237	51.52273	97113.7	31009.6
53	River/Stream	Unnamed	-9.48698	51.52406	96796.6	31164.0
54	River/Stream	Unnamed	-9.48840	51.52419	96698.3	31181.0
55	River/Stream	Derreennatra	-9.49942	51.52207	95929.0	30960.8
56	River/Stream	Ardintenant	-9.51100	51.51927	95118.7	30665.2
57	River/Stream	Unnamed	-9.51767	51.51819	94653.4	30554.3

7. Appendix 2: Hydrography/Hydrodynamics

7.1. Simple/Complex Models

At the time of writing there was no model available for all of Roaringwater Bay. Irish Hydrodata Limited (2007) modelled the dispersion of the discharge from Ballydehob WWTP. Some basic tidal stream data is available for the mouth of Roaringwater Bay from the admiralty chart for the area. This along with the below data on weather, rivers and chemistry data from the Marine Institute will be used to describe the hydrodynamics of the bay.

7.2. Depth

Roaringwater is a relatively small bay in the southwest of Ireland. The substrate in the bay is mud except for a small area in the west of the production area at Horse Ridge. The vast majority of the bay is between 4 to 5 m deep. There are a number of slightly deeper locations where the depth is approximately 5 to 6 m at the mouth of the bay and south of Mannin Island and Carrigviglash Rocks. The majority of Ballydehob Bay and Poulgorm Bay are intertidal (Admiralty Chart 2129). Figure 7-1 shows water depth in the area.

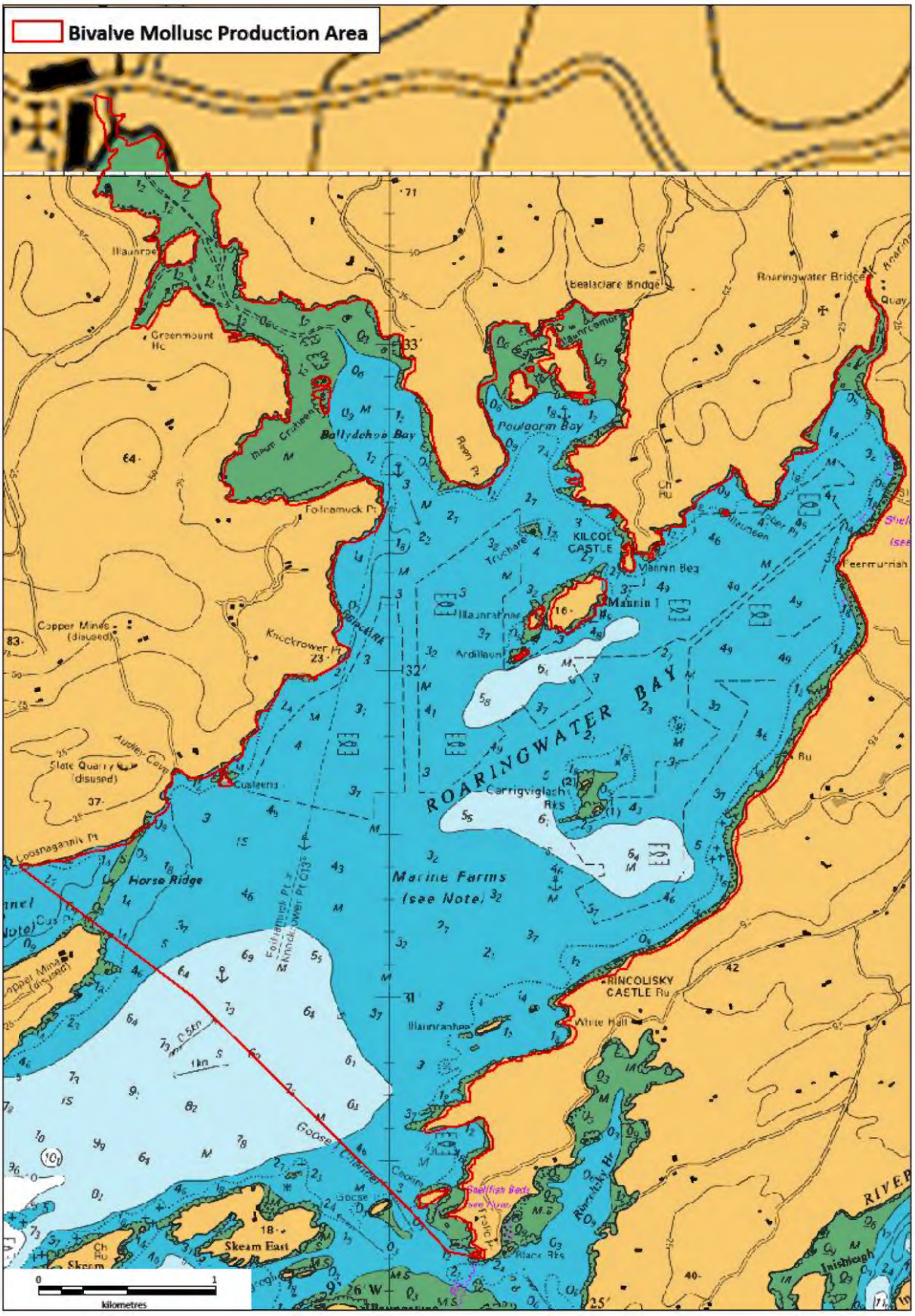

Figure 7-1: Depths in Roaringwater Bay (Source: Admiralty Chart 2129).

7.3. Tides & Currents

Predicted spring and neap tidal ranges in Roaringwater Bay are in the region of 2.9 and 1.5 m respectively (Admiralty Chart 2129). Irish Hydrodata Limited (2007) found that discharge from Ballydehob WWTP will largely be confined to Ballydehob Bay. The model predicted that the plume from the WWTP would travel the furthest during windy conditions on a spring tide. In these conditions at low water the max faecal coliform concentration was 20 to 30 fc/100ml as far out as Knockrower Point to Mannin Island. The model predicted that the designated shellfish site would experience elevated bacterial levels due to the outfall from the WWTP. The *E. coli* levels are expected to be lower as they will only account for part of the faecal coliform result. Roaringwater Bay has no major constriction in the bay proper and as such the water movement will be relatively straight forward. On the flooding tide the water movement will be north easterly directly into the bay and on the ebbing tide south-westerly out of the bay. Tidal stream data from the Admiralty chart for the bay gives currents of 0.5kn on the flooding tide and 1kn on the ebbing tide at the mouth of the bay (see Figure 7-2). The current speeds are relatively low in the bay which is evident by the presence of mud throughout the bay.

Table 7.1: Roaringwater Bay tidal characteristics (Source: Admiralty Chart No. 2129).

Admiralty Chart 1547 Levels (m CD)	MHWS	MHWN	MLWN	MLWS
Baltimore	3.5	2.9	1.4	0.6

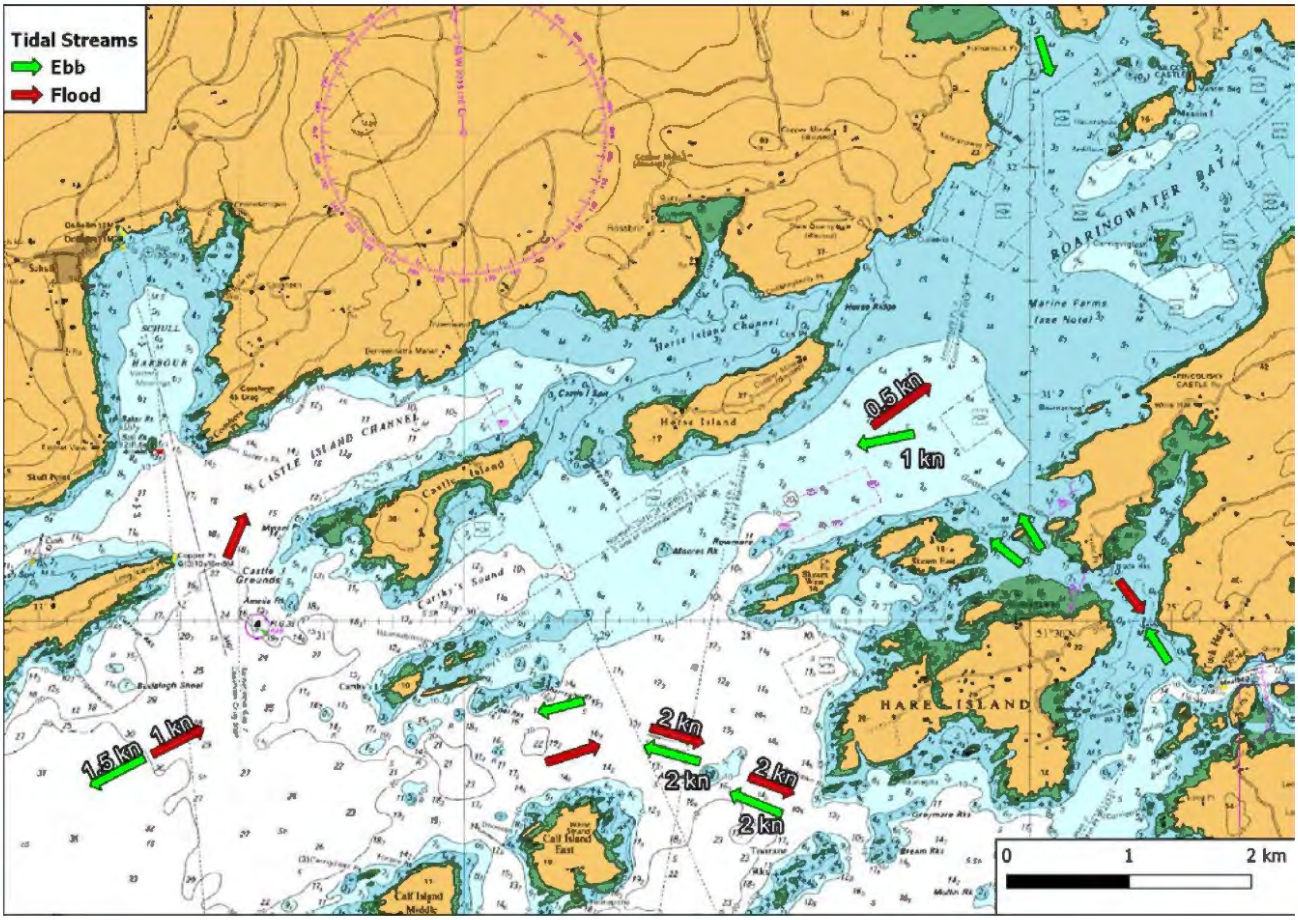

Figure 7-2: Tidal stream data available for Roaringwater Bay from admiralty charts (Current speeds shown were available).

7.4. Wind and Waves

Wind data from 2016 to 2020 from the Sherkin Island station (Met Eireann, 2020a) are displayed in Table 7.2 below and wind roses for each year can be seen in Figure 7-3.

In 2016, 25.5% of the wind came from the west, while 19.3% came from the southwest and 13.6% from the south. The strongest winds came from the west (49kn). In 2017, 29.1% of the wind came from the west, 23% from the southwest and 15% from the south. The strongest winds (52kn) came from the south. In 2018, 23.4% of the wind came from the west, 21.4% came from the southwest and 15.2% came from the south. The strongest winds (44kn) came from the west southwest. In 2019, 27.8% of the winds came from the west, with 19.5% coming from the southwest and 14% coming from the south. The strongest winds (46kn) came from the west. In 2020, 26.7% of the wind came from the west, 22.9% came from the southwest and 11.4% came from the south. The strongest winds (44kn) came from the south. It can be seen from the 2016-2020 wind rose diagram that the prevailing wind direction is southwest. The effect of wind on surface water movements in the area will be in the same direction as the wind is blowing. Winds from the west and south will have the effect of blowing surface water up into the bay. While winds from the east and north will blow surface waters out of the bay.

Table 7.3 shows the seasonal averages from 2016 to 2020. Seasons were selected by grouping the results from the following periods: spring (March-May), summer (June-August), autumn (September-November) and winter (December-February). Seasonal averages over the past 5 years indicate that winds are typically strongest in the winter months (15.4kn), followed by autumn (12.9kn), spring (11.8) and summer is the calmest (10.5kn).

Table 7.2: Wind speed and direction data for Sherkin Island from 2016-2020 (Source: Met Eireann, 2020a).

	2016		2017		2018		2019		2020	
Month	Mean Speed (knots)	Mean Direction (°)	Mean Speed (knots)	Mean Direction (°)	Mean Speed (knots)	Mean Direction (°)	Mean Speed (knots)	Mean Direction (°)	Mean Speed (knots)	Mean Direction (°)
January	16.7	222.4	12.3	189.5	17.6	216.9	11.6	231.9	14.7	200.9
February	16.7	210.5	16.5	193.3	14.3	204.6	16.5	195.3	21.5	235.0
March	12.4	205.6	14.6	200.5	12.3	161.0	14.4	218.8	14.8	170.9
April	11.7	187.9	9.1	199.9	12.2	163.6	12.9	150.6	9.9	130.1
May	9.9	173.5	11.2	156.4	9.4	170.8	10.0	191.9	12.1	141.9
June	10.1	210.5	12.1	214.7	8.7	159.5	10.7	202.0	11.6	214.6
July	9.9	230.4	10.4	223.4	8.5	200.5	9.0	204.5	11.7	227.1
August	11.3	214.3	10.2	227.8	10.4	231.4	12.2	218.3	10.3	201.3
September	12.4	215.5	12.5	222.5	11.3	208.3	12.1	206.0	10.8	196.2
October	11.9	136.0	13.2	203.1	10.9	192.9	13.5	191.6	15.3	219.3
November	12.4	186.8	11.6	230.1	16.5	161.3	14.0	221.6	14.4	189.5
December	13.0	187.0	13.5	230.9	15.5	206.1	15.7	194.8	15.2	238.4

Degrees Direction Key: 0°/360° = N; 23° = NNE; 45° = NE; 68° = ENE; 90° = N; 113° = ESE; 135° = SE; 158° = SSE; 180° = S; 203° = SSW; 225° = SW; 248° = WSW; 270° = W; 293° = WNW; 315° = NW; 338° = NNW

Table 7.3: Seasonal averages (knots) for Sherkin Island wind data (Source: Met Eireann, 2020a).

Season	2016	2017	2018	2019	2020	5 Year Average
Winter	15.5	14.1	15.8	14.6	17.1	15.4
Spring	11.3	11.6	11.3	12.4	12.3	11.8
Summer	10.4	10.9	9.2	10.6	11.2	10.5
Autumn	12.2	12.4	12.9	13.2	13.5	12.9

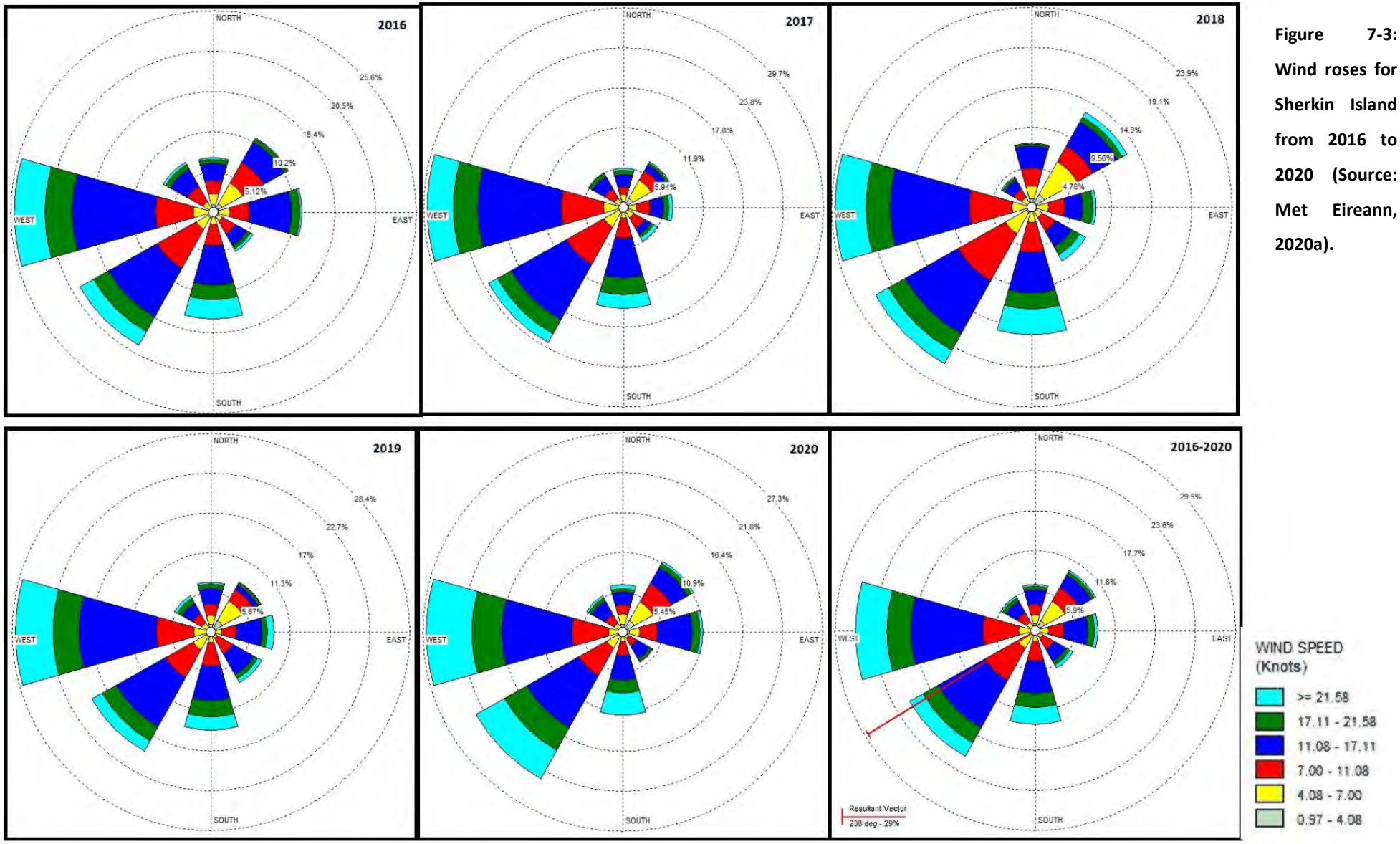

Figure 7-3: Wind roses for Sherkin Island from 2016 to 2020 (Source: Met Eireann, 2020a).

Wind conditions affect the hydrodynamic conditions in Roaringwater Bay by generating wind-induced currents and waves. Of these phenomena, wind-induced waves are an important factor in the process of sediment resuspension and transport. Wind waves are produced by the local prevailing wind. They travel in the direction of the prevailing wind, *i.e.,* a southwesterly wind will produce northeasterly moving waves. The height of wind wave depends on:

- the strength of the wind;
- the time the wind has been blowing and
- the fetch.

7.5. River Discharges

Roaringwater Bay drains a catchment of 126.8km^2, the majority of the catchment is drained by three rivers the Bawnaknockane River (33.6%, 42.6km^2), Leamawadra River (17.5%, 22.23km^2) and Roaringwater River (15.7%, 19.93) (Figure 7-4). The remainder of the catchment is drained by a series of small unnamed streams.

The current (2010-2015) WFD status of Roaringwater Bay and its associated freshwater sources can be seen in Figure 7-5. The central Bawnaknockane River is unassigned, however, two of its tributaries have been assigned a status. The western tributary is of High status, while the north-eastern tributary is of Good status. The Leamawadra River is of High status and the Roaringwater River is unassigned as are the remainder of the streams in the catchment. Roaringwater Bay coastal waterbody is of Good status.

Figure 7-4: Rivers in the Roaringwater Bay catchment area (Source: EPA, 2019).

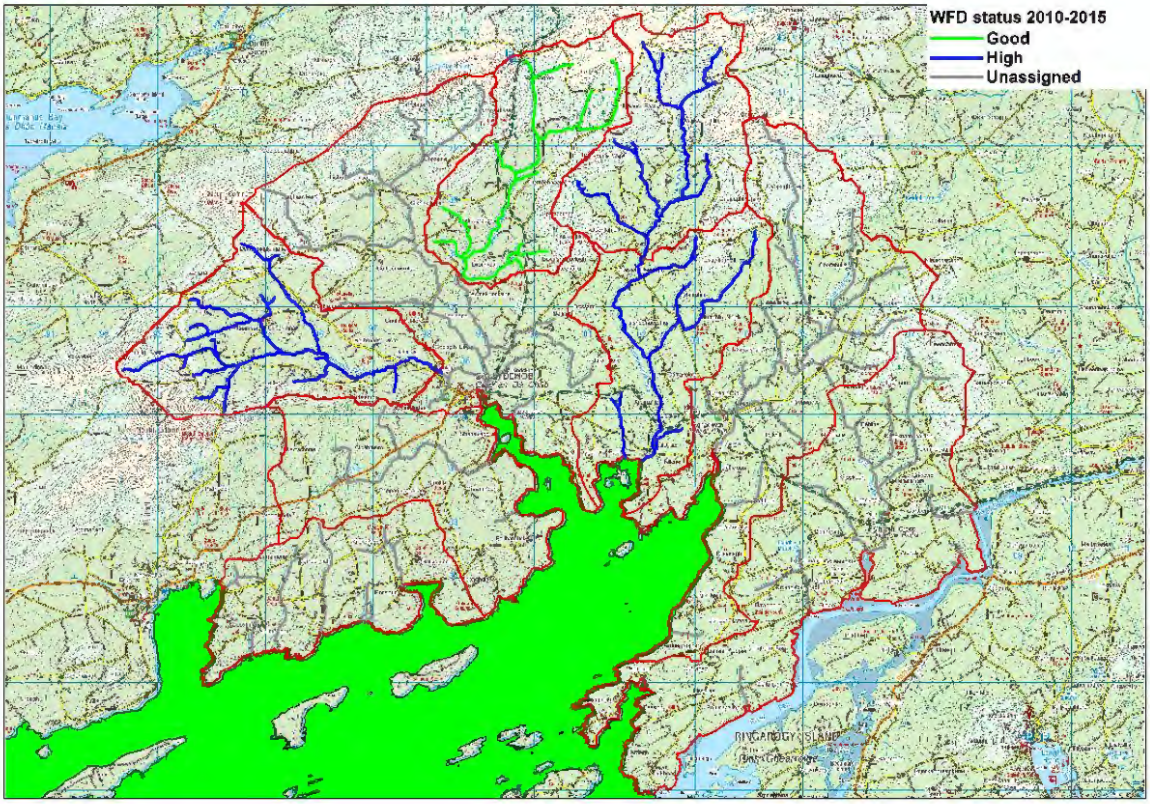

Figure 7-5: WFD Status of the coastal and river waterbodies in the catchment area (Source EPA, 2019).

7.6. Rainfall Data

7.6.1. Amount & Time of Year

Figure 7-6 shows the average monthly rainfall data for Ireland (Met Eireann, 2019) from 1981 to 2010. The wettest months in the Roaringwater Bay region over this 30-year period were October to January with the driest months from April to July. Table 7.4 shows the 30-year average monthly rainfall at the Valentia station which is located *c*. 71 km northeast of Roaringwater Bay (Figure 7-7 shows the location of the Valentia station). During the period 1981 to 2010, average rainfall at Valentia was lowest in May (93.5mm) and highest in October (177.1mm). The greatest daily total ranged from a low of 38.2mm in May to a high of 94.3mm in September. Table 7.5 shows the seasonal averages at Valentia from 1981 to 2010. Lowest average rainfall over the 30-year period was in summer (103.1mm) with the highest average rainfall experienced in autumn (157.3mm).

Table 7.4: Monthly average rainfall at Valentia from 1981 to 2010 (Source: Met Eireann, 2020b).

Month	Average Rainfall (mm)	Greatest Daily Total (mm)
January	173.8	48.5
February	123.7	51.6
March	123.8	48.6
April	96.7	55.1
May	93.5	38.2
June	95.3	51.8
July	99	45.5
August	114.9	88.8
September	125.4	94.3
October	177.1	51.7
November	169.3	80.9
December	164.9	69.9
Year	1557.4	94.3

Table 7.5: Average seasonal rainfall values (mm) from 1981-2010 at Valentia (Source: Met Eireann, 2020b).

Season	Average
Spring	104.7
Summer	103.1
Autumn	157.3
Winter	154.1

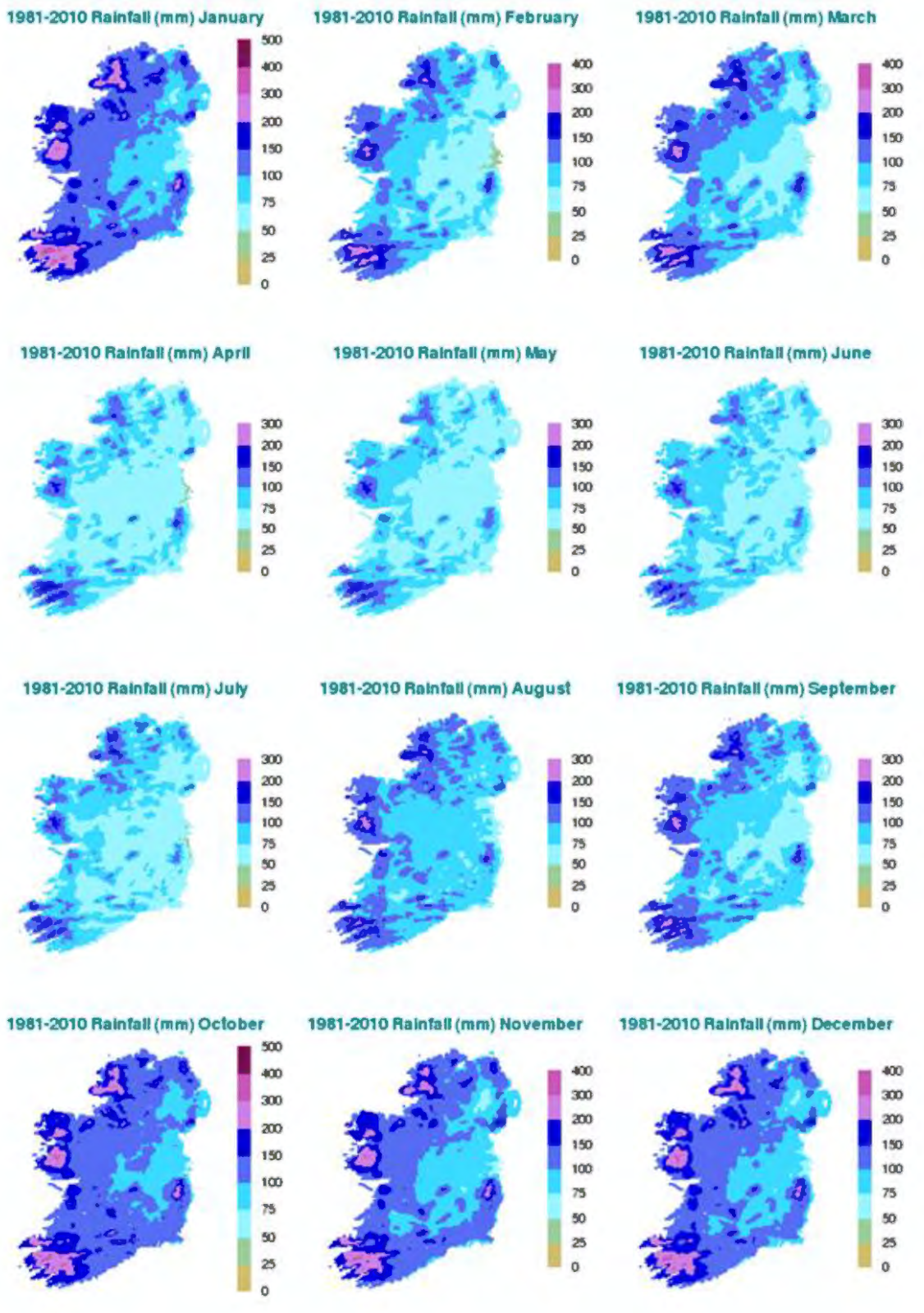

Figure 7-6 Average monthly rainfall (mm) data from 1981 to 2010 for Ireland (Source: Met Eireann, 2019).

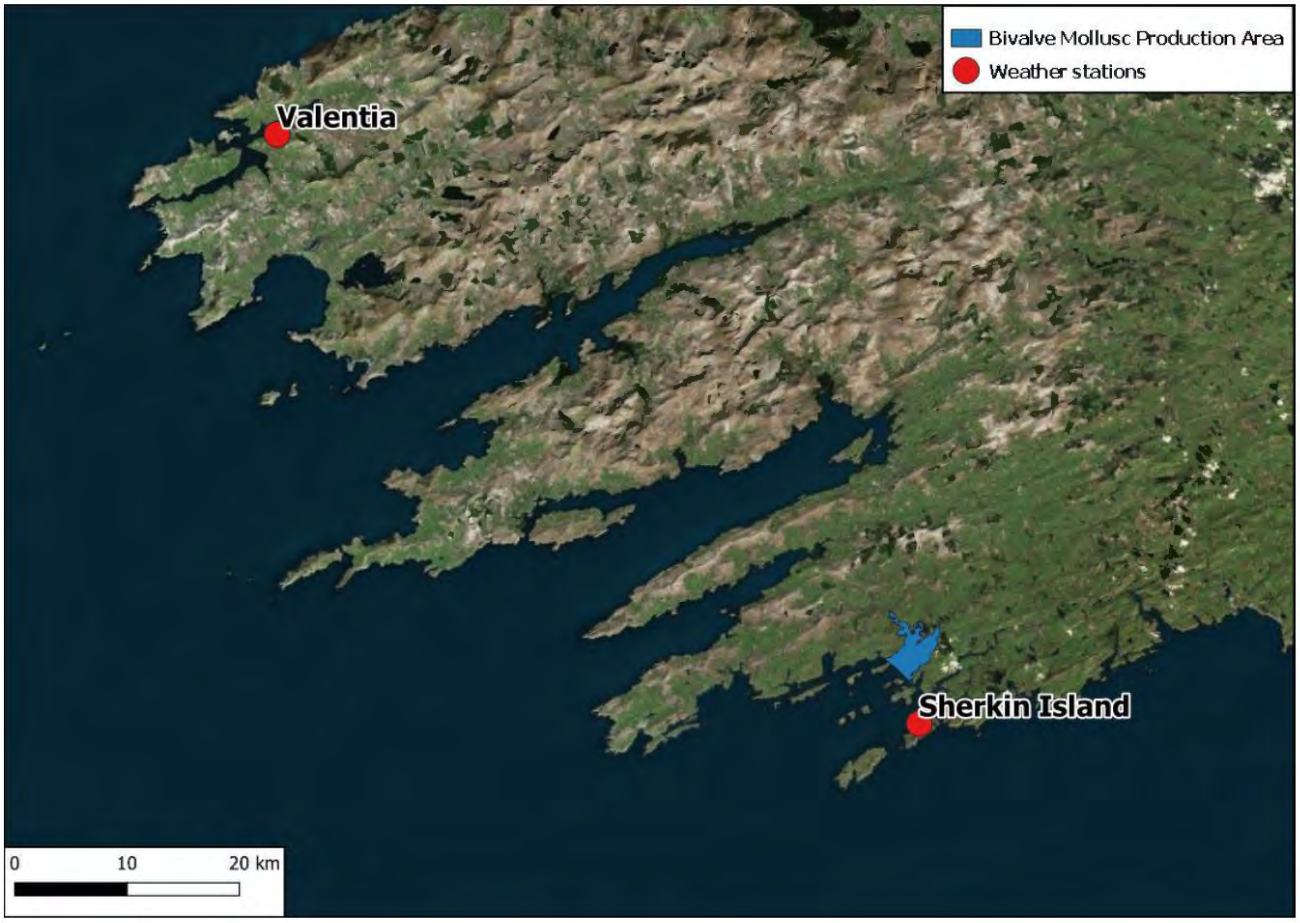

Figure 7-7: Location of Met Eireann weather stations in relation to the Roaringwater Bay production area.

Table 7.6 shows total monthly rainfall at the Sherkin Island Met Eireann station (see Figure 7-7), located *c.* 5 km south of the Roaringwater Bay production area from 2016 to 2020 (Met Eireann, 2020a).

The maximum monthly rainfall at Sherkin Island weather station was in January 2018 (199.1mm) and the lowest monthly rainfall was April 2017 (14.6mm). The 5-year average monthly rainfall ranged from a low of 54.3mm in May to a high of 143.8mm in December. Annual averages ranged from 85.7mm in 2016 to 105.9mm in 2020.

Table 7.7 shows the total seasonal rainfall at Sherkin Island from 2016-2020 (Met Eireann, 2020a). The following seasonal fluctuations were observed from 2016-2020: in 2016 spring was the driest and winter was the wettest. In 2017, spring was the driest and autumn was the wettest. In 2018, summer was the driest and winter was the wettest. In 2019, summer was the driest and autumn was the wettest. In 2020, spring was the driest and winter was the wettest. Over the five years, summer 2018 was the driest season and winter 2020 was the wettest season.

Table 7.6: Total monthly rainfall (mm) data at Sherkin Island, Co. Cork, from 2016 to 2020 (Source: Met Eireann, 2020a).

Year	2016	2017	2018	2019	2020	Monthly 5 yr. Average
Jan	185.8	66.7	199.1	65.4	105.2	124.4
Feb	113.0	78.5	67.2	70.7	156.8	97.2
Mar	61.5	132.7	116.6	123.2	67.0	100.2
Apr	68.8	14.6	129.3	121.4	53.8	77.6
May	59.4	39.2	93.0	33.5	46.6	54.3
Jun	61.5	112.3	17.2	61.4	64.2	63.3
Jul	69.7	89.9	48.8	33.9	104.3	69.3
Aug	111.1	78.6	62.5	120.2	189.7	112.4
Sep	111.1	150.8	82.7	96.5	79.1	104.0
Oct	64.4	115.5	59.5	150.9	101.6	98.4
Nov	43.3	51.9	171.0	118.0	121.1	101.1
Dec	78.3	147.5	174.1	137.5	181.6	143.8
Annual Average	85.7	89.9	101.8	94.4	105.9	

Table 7.7: Total seasonal rainfall (mm) at Sherkin Island from 2016-2020 (Source: Met Eireann, 2020a).

Station	Season/Year	2016	2017	2018	2019	2020
Money Point	**Spring**	189.7	186.5	338.9	278.1	167.4
	Summer	242.3	280.8	128.5	215.5	358.2
	Autumn	218.8	318.2	313.2	365.4	301.8
	Winter	377.1	292.7	440.4	273.6	443.6

7.6.2. Frequency of Significant Rainfalls

Figure 7-8 shows the greatest daily rainfall at Valentia observatory from 1981-2010 and Figure 7-9 shows the 5-year monthly average rainfall at Sherkin Island weather station from 2016-2020. Over the 30-year period from 1981 to 2010, September had the greatest daily rainfall followed closely by August, and May had the lowest daily rainfall. Over the past 5 years at Sherkin Island, June had the highest daily rainfall even though it was one of the driest months over the 5-year period. February had the lowest daily rainfall followed closely by May and November.

Met Eireann has developed a depth duration frequency model for the estimation of point rainfall frequencies (Fitzgerald, 2007; Met Eireann, 2020c). For a 1 in 100-year return period, 33.4mm of rain would be expected

over 1 hour and 109.1mm over 24 hours. While these would be extreme uncommon events, the model predicts that once a year 12.5mm would fall in 1 hour and 51.7mm over a 24-hour period.

Increased faecal contamination of coastal waters is typically associated with high rainfall and storm events through surface water run-off from livestock or other animals present and through sewer and wastewater treatment plant overflows (Mallin *et al.,* 2001; Lee & Morgan, 2003). It is therefore expected that run-off due to rainfall will be higher during the October to January period as the highest total rainfall occurs in these months. However, as can be seen in Figure 7-8 and Figure 7-9 below, extreme rainfall events leading to episodes of high run-off can occur in most months of the year and it is therefore not just the winter months that are at risk of increased contamination. When these occur during generally drier periods in spring and summer months, they are likely to carry higher loadings of faecal material which have accumulated on pastures where greater numbers of livestock are present.

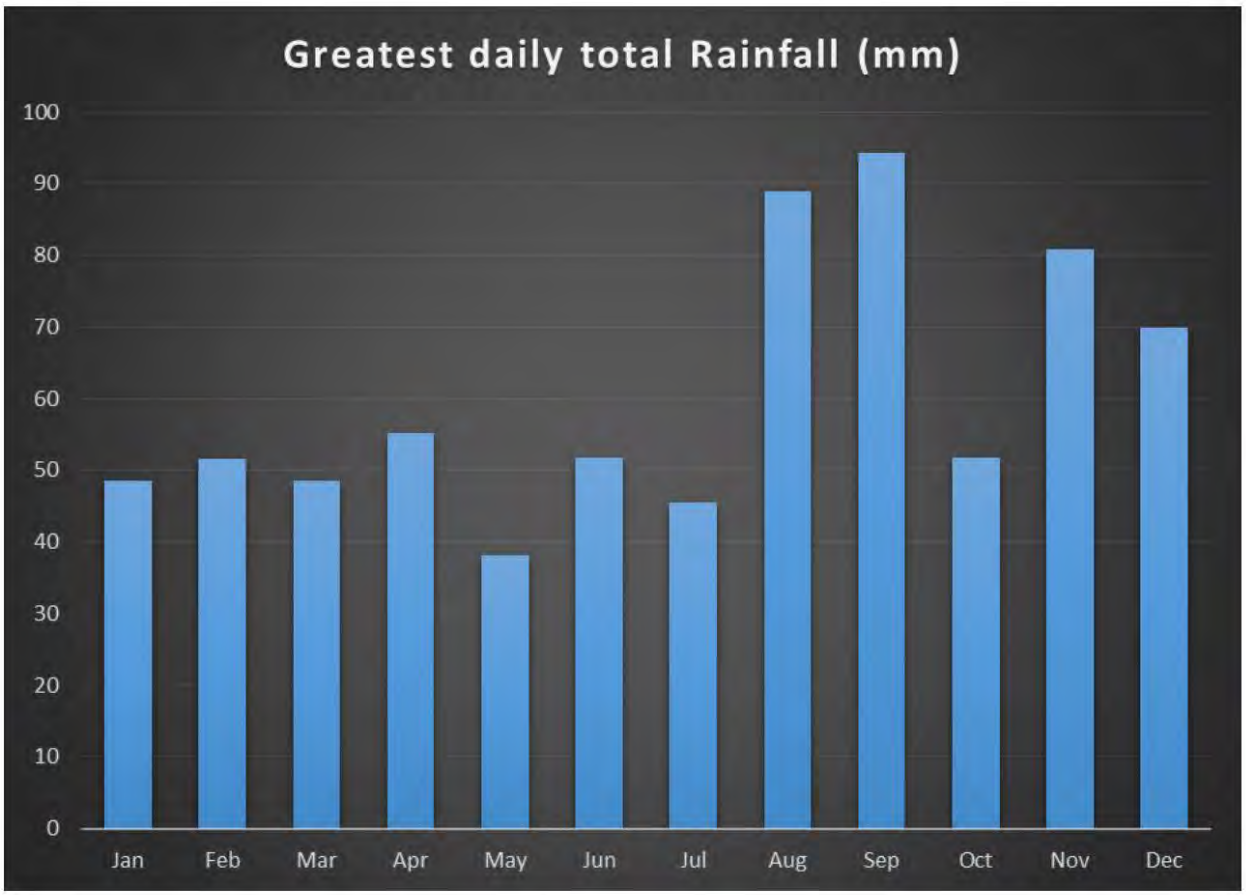

Figure 7-8: Greatest daily rainfall (mm) at Valentia from 1981-2010 (Source: Met Eireann, 2020c).

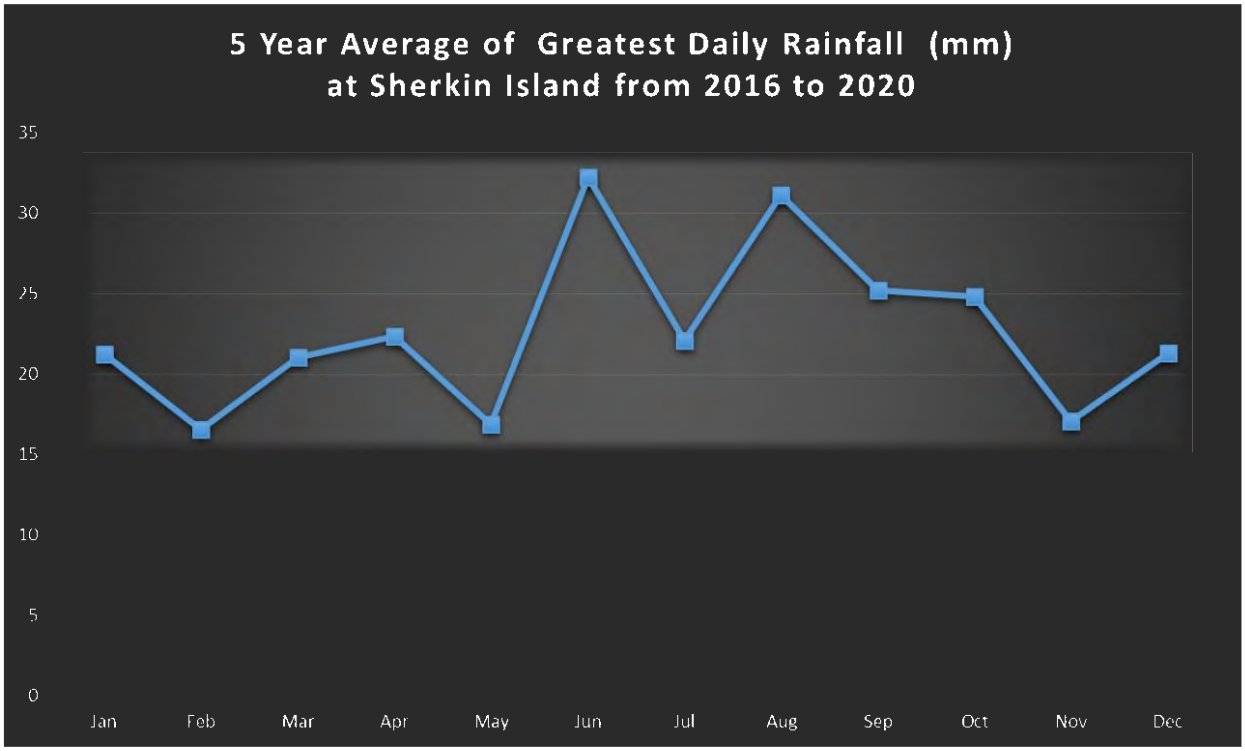

Figure 7-9: 5 year average of greatest daily rainfall (mm) at Sherkin Island weather station from 2016-2020 (Source: Met Eireann, 2020a).

7.7. Salinity

The closest salinity results for Roaringwater Bay are located near Long Island. The salinity at this location is constantly between 34 and 35 PSU (source: Marine Institute). The salinity in Roaringwater Bay is likely to be more variable due to freshwater influence from the surrounding rivers. However, the salinity will still be high in most of the bay due to the high connectivity with the open sea. The salinity is effected by the stage of the tide and the level of freshwater influence from the Roaringwater Bay catchment.

7.8. Turbidity

At the time of writing there were no turbidity data available for Roaringwater Bay production area.

7.9. Residence Time

Residence time can be defined as the average amount of time that a molecule of water or a particle spends in a particular system. Residence times are important because of the way they govern productivity rates as well as the vulnerability to water quality degradation. The residence time as calculated by Kochmann *et al*. (2013) is approximately 6 days.

7.10. Discussion

Roaringwater Bay is a relatively small bay in the southwest of Ireland. The substrate in the bay is mud except for a small area in the west of the production area at Horse Ridge. The vast majority of the bay is between 4 to 5 m deep. The Irish Hydrodata Limited model predicted that the designated shellfish site would experience elevated bacterial levels due to the outfall from the WWTP. On the flooding tide the water movement will be north-easterly directly into the bay and on the ebbing tide south-easterly out of the bay. Tidal stream data from the Admiralty chart for the bay gives currents of 0.5kn on the flooding tide and 1kn on the ebbing tide at the mouth of the bay. The strongest winds over the five years of data ranged from 44 to 52kn and tended to come from between the west and south. The prevailing wind for the bay is from the southwest. Winds from this direction will push contaminates, particularly in the surface layer, into the northeast of the bay. Strong winds will also increase the level of mixing in the bay diluting contaminants entering from rivers and streams. Three rivers drain 67% of the catchment: the Bawnaknockane River, Leamawadra River and Roaringwater River. The driest period in the Roaringwater area is between April and July, while the wettest period is between October and January.

8. Appendix 3: Shellfish and Water Sampling

8.1. Historical Data

8.1.1. Shellfish Water Quality

The Marine Institute carries out quarterly water quality monitoring as part of the Shellfish Waters Directive in Roaringwater Bay. Sampling is confined to the mussel aquaculture area. The EPA carries out monitoring under the Water Framework Directive. However, *E. coli* is not routinely measured under these programmes.

8.1.2. Shellfish Flesh Quality

In accordance with Regulation (EU) 2017/625 and the subsequent implementing regulation (EU) 2017/627 the Sea Fisheries Protection Authority is required to classify bivalve mollusc production areas and to fix the boundaries thereof. The process involves regular sampling of shellfish from each area to be classified in order to establish levels of microbiological contamination which subsequently determines which classification should be awarded for that particular area. The SFPA currently sample shellfish flesh at one location in the Roaringwater Bay production area for classification purposes. Figure 8-1 shows this location of this sampling site and Table 8.1 shows the coordinates.

Table 8.1: Coordinates of sampling site within the Roaringwater Bay Production Area.

Sample Code	Species	Latitude	Longitude
CK-RB-RB	Mussels (*M. edulis*)	51.52889	-9.42861

The regulations stipulate that the competent authority must monitor the levels of *E. coli* within the harvesting area and that according to the sample results, must classify the area as being one of three categories: A, B or C.

Table 8.2 summarizes this system. Table 8.3 shows the current and historical (back to 2016) classifications within Roaringwater Bay. For 2022 Roaringwater Bay is classified as A for mussels.

Table 8.2: Classification system for shellfish harvesting areas.

Classification			Permitted Levels	Outcome
	A	<230	Not exceeding 230 *E. coli* per 100 g flesh and intravalvular liquid in 80% of the samples in the review period	May go direct for human consumption if end product standard met.
	B	<4600	Not exceeding 4600 *E. coli* per 100 g flesh and intravalvular liquid in 90% of the samples	Must be subject to purification, relaying in Class A area (to meet Category A requirements) or cooked by an approved method.
	C	<46000	Not exceeding 46,000 *E. coli* per 100 g of flesh and intravalvular liquid	Must be subject to relaying for a period of at least 2 months or cooked by an approved method.
	Above 46,000 *E.coli*/100g flesh			Prohibited. Harvesting not permitted

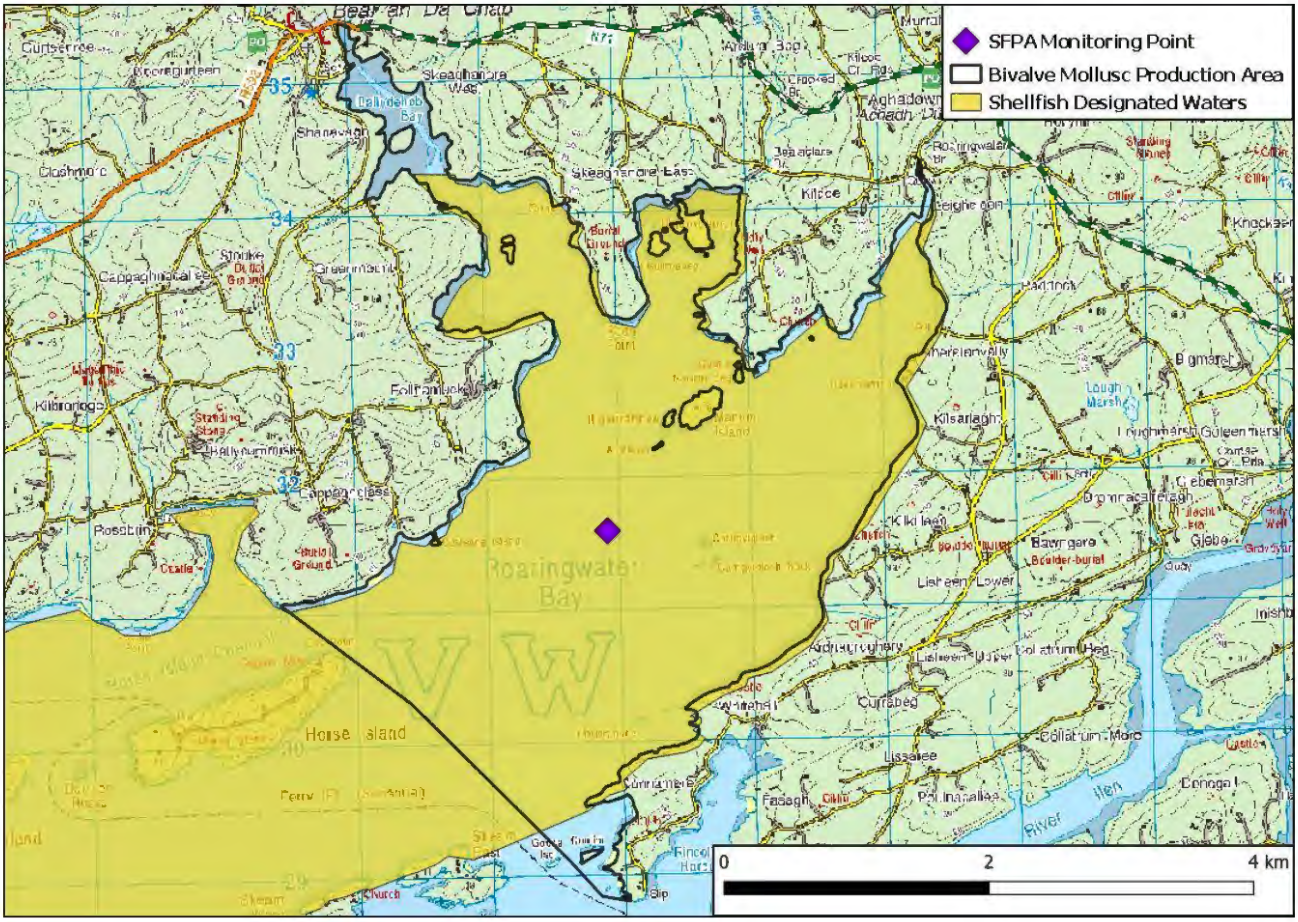

Figure 8-1: Location of SFPA shellfish monitoring point for classification purposes.

Table 8.3: Current and historical classification of shellfish beds in Roaringwater Bay (2016 – 2022).

Boundaries	Bed Name	Species	Classification						
			2016	2017	2018	2019	2020	2021	2022
Coosnaganniv Point to Frolic Point	All Beds	Mussels	A	A	A	A	A	A	A

Table 8.4 lists the *E. coli* results for mussels in Roaringwater Bay from January 2016 to December 2020. Figure 8-2 shows these data in graphical form.

As shown in Table 8.3 above, Roaringwater Bay has had an **A** classification for mussels from 2016 to 2020. The monthly classification trends for mussels can be seen in Table 8.4 and Figure 8-2.

Table 8.5 shows the summary statistics for the *E. coli* historical data from the mussel monitoring site from 2016 to 2020. Table 8.6 shows the variations of the annual geometric means of *E. coli* for the monitoring site from the year 2016 to 2020. Figure 8-3 shows the trend in geometric means from 2016 to 2020 for mussels in Roaringwater Bay. The geometric mean ranged from 23.8 MPN/100ml in 2018 to 42.7 MPN/100ml in 2019.

There was no statistical difference between the mussel *E. coli* results between seasons or between years (one-way ANOVA, p = 0.76655 [seasons], one-way ANOVA, p = 0.72356 [years], Appendix 4).

Table 8.4: *E. coli* results from Roaringwater Bay mussels from January 2016 to June 2020 (Source: SFPA).

Date	MPN *E. coli* /100g	Category	Date	MPN *E. coli* /100g	Category
14-Jan-16	68	A	6-Jun-18	18	A
15-Feb-16	45	A	24-Jul-18	18	A
7-Mar-16	210	A	20-Nov-18	20	A
19-Apr-16	18	A	4-Dec-18	18	A
17-May-16	18	A	12-Dec-18	20	A
21-Jun-16	110	A	11/02/2019	18	A
4-Jul-16	18	A	26/02/2019	61	A
17-Aug-16	18	A	19/03/2019	18	A
22-Sep-16	20	A	23/04/2019	18	A
13-Oct-16	20	A	28/05/2019	18	A
15-Nov-16	130	A	08/07/2019	18	A
29-Nov-16	18	A	28/08/2019	490	B
17-Jan-17	18	A	23/09/2019	78	A
16-Feb-17	45	A	21/10/2019	230	A
30-Mar-17	18	A	18/11/2019	20	A
25-Apr-17	18	A	07/01/2020	18	A
26-Jun-17	18	A	04/02/2020	130	A
3-Jul-17	20	A	03/03/2020	18	A
8-Aug-17	20	A	12/05/2020	18	A
19-Sep-17	18	A	09/06/2020	78	A
4-Oct-17	130	A	13/07/2020	18	A
22-Nov-17	18	A	08/09/2020	18	A
12-Dec-17	230	A	12/10/2020	18	A

Date	MPN *E. coli* /100g	Category	Date	MPN *E. coli* /100g	Category
19-Feb-18	20	A	24/11/2020	78	A
14-May-18	93	A	07/12/2020	18	A

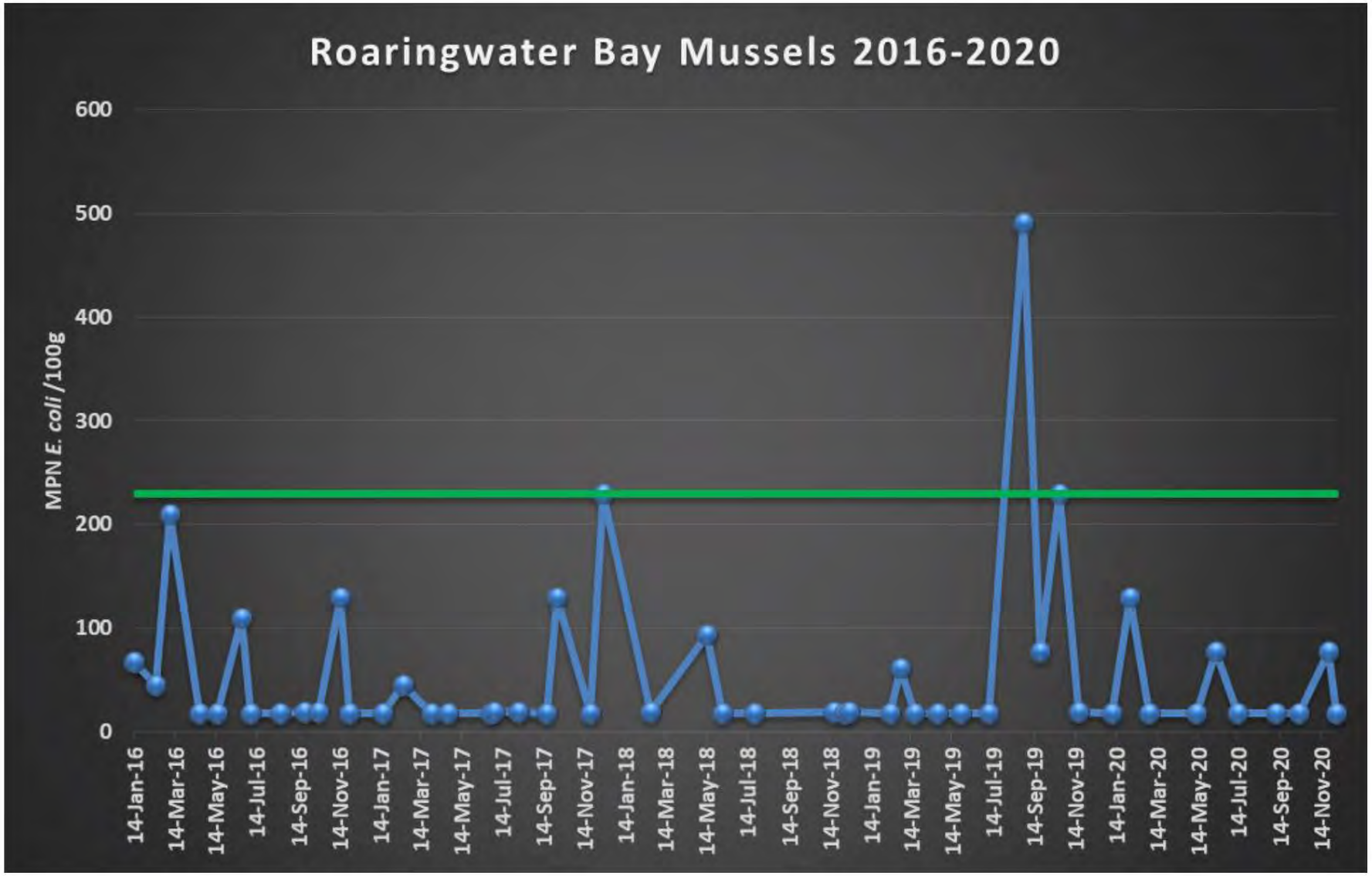

Figure 8-2: *E. coli* results from mussels at Roaringwater Bay from January 2016 to December 2020 (Source: SFPA).

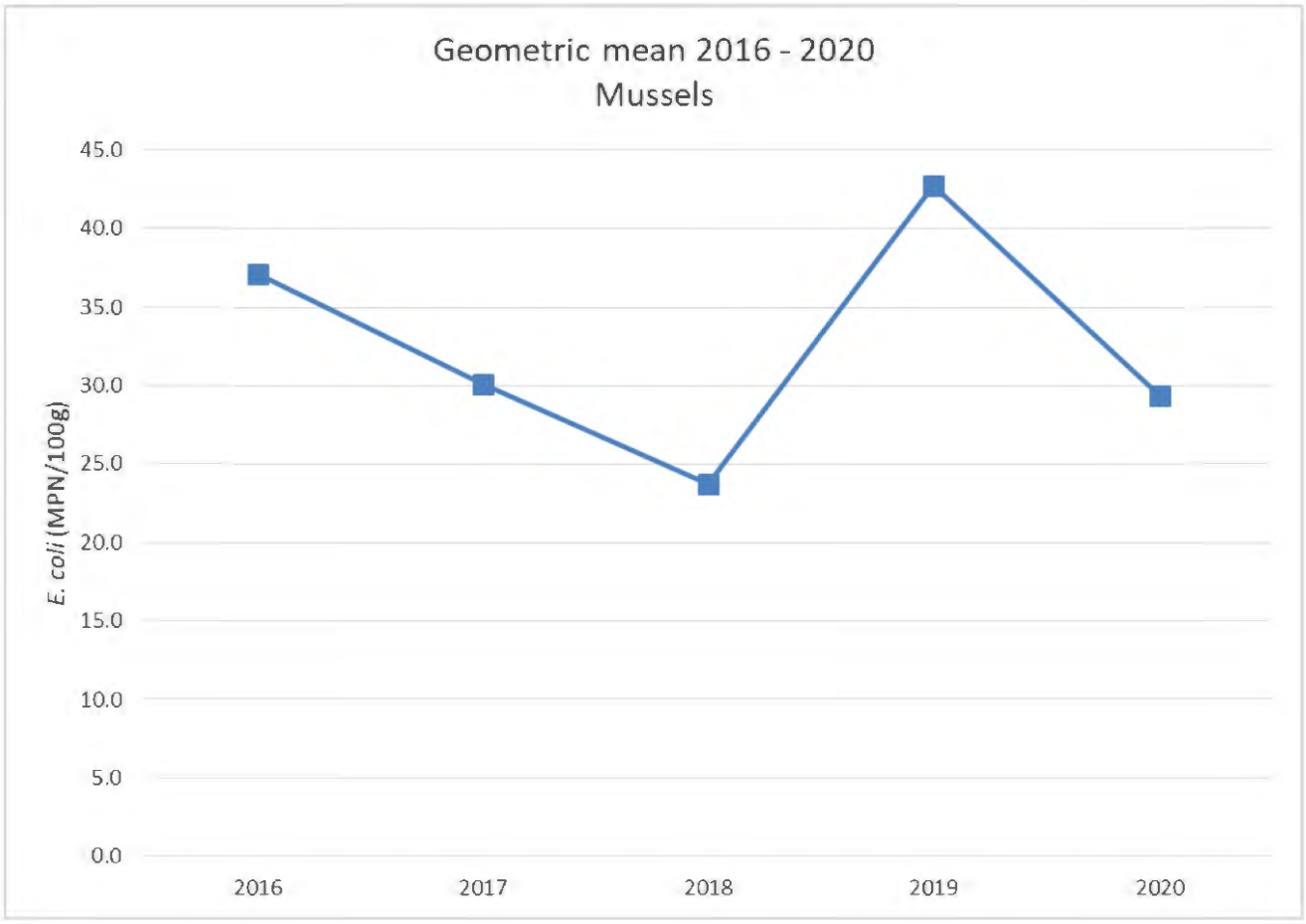

Figure 8-3: Trend in geometric mean of *E. coli* levels from 2016 to 2020 for mussels in Roaringwater Bay.

Table 8.5: Summary statistics of historical *E. coli* data monitored from shellfish beds in Roaringwater Bay.

Code	Species	Date of 1st Sample	Date last Sample	Minimum *E. coli* (MPN/100g)	Maximum *E. coli* (MPN/100g)	Median *E. coli* (MPN/100g)	Geometric Mean *E. coli* (MPN/100g)
CK-RB-RB	Mussels	14/01/2016	07/12/2020	18	490	18	32.7

Table 8.6: Variation of annual geometric means of *E. coli* (MPN/100g) from shellfish beds monitored in Roaringwater Bay.

Code	Species	2016	2017	2018	2019	2020
CK-RB-RB	Mussels	37.2	30.1	23.8	42.7	29.4

In addition to *E. coli* monitoring carried out by the SFPA, the Marine Institute (MI) conducts monthly monitoring for the presence of toxin producing phytoplankton in shellfish waters, including *Alexandrium spp.* and *Dinophysis spp.* and for marine biotoxins (including DSP, PSP and ASP) in shellfish flesh. The MI also monitors shellfish flesh for chemical contaminants *e.g.* heavy metals, organochlorides, polychlorinated biphenyls (PCB), polycyclic aromatic hydrocarbons (PAH), pentachlorophenol (PCP) and Tributyl Tin Oxide (TBTO).

Over the period 2016 to 2020, there have been 8 biotoxin related closures.

8.1.3. Norovirus (NoV)

The Roaringwater Bay production area has to date not been subject to any norovirus sampling programme or baseline studies of norovirus levels.

8.2. Current Data

8.2.1. Sampling Sites & Methodology

Eleven water sampling sites were sampled within the Roaringwater Bay BMCPA in November 2021 by Sea Fisheries Protection Authority staff. The locations of these sites can be seen in Figure 8-4 and Table 8.7 shows the station coordinates. There was 15.1 mm of rain over the previous 48 Hours. One further station was sampled in April 2022. There had been not rain in the previous 48 hours.

Table 8.7: Water sample coordinates with date of sampling.

Station	Feature	Latitude	Longitude	Easting	Northing	Sampling Date
RWB-W-1	Kilcullen Beach	51.52362	-9.40516	102524.4	30978.7	1/11/2021
RWB-W-2	Roaringwater Pier	51.55290	-9.39433	103338.1	34221.9	1/11/2021
RWB-W-3	Leighcloon	51.54477	-9.39225	103465.1	33314.7	1/11/2021
RWB-W-4	Kilcoe Graveyard	51.54452	-9.40608	102505.2	33305.2	1/11/2021
RWB-W-5	Bealaclare Bridge	51.55259	-9.41386	101982.8	34213.4	1/11/2021
RWB-W-6	Ballydehob outer	51.56046	-9.45613	99068.5	35146.5	1/11/2021
RWB-W-7	Ballydehob inner	51.56217	-9.45792	98948.2	35339.2	1/11/2021
RWB-W-8	Shanavagh	51.55151	-9.45392	99202.0	34147.7	22/03/2022
RWB-W-9	Gleenkeen	51.53838	-9.43892	100213.6	32666.4	1/11/2021
RWB-W-10	Foilnamuch	51.52893	-9.45186	99295.0	31632.8	1/11/2021

RWB-W-11	Rossbrin Boatyard	51.52979	-9.47712	97544.0	31763.5	1/11/2021
RWB-W-12	Ardnitenant, Dereenatra	51.52174	-9.49890	96014.3	30898.6	1/11/2021

All water samples were collected in sterile plastic water bottles. These samples were stored in a cool box until delivery to the lab for analysis (within 24hrs of collection).

8.2.2. Microbial Analysis Results

The water sampling results taken in November 2021 ranged from 20 cfu/100ml at stations 4 and 10 to 743 cfu/100ml at station 8 (see Table 8.8). The elevated levels recorded at stations 2 and 8 are most likely due to runoff from agricultural land, with the possibility of impact from septic tanks in the area. The elevated levels recorded at stations 6 and 7 are likely due to discharges from Ballydehob WWTP. There will also be some impact from agricultural land and septic tanks upstream.

Table 8.8: Water *E. coli* results for Roaringwater Bay.

Station No.	*E. coli* (cfu/100ml)
RWB-W-1	86
RWB-W-2	214
RWB-W-3	161
RWB-W-4	20
RWB-W-5	131
RWB-W-6	433
RWB-W-7	399
RWB-W-8	743
RWB-W-9	86
RWB-W-10	20
RWB-W-11	75
RWB-W-12	189

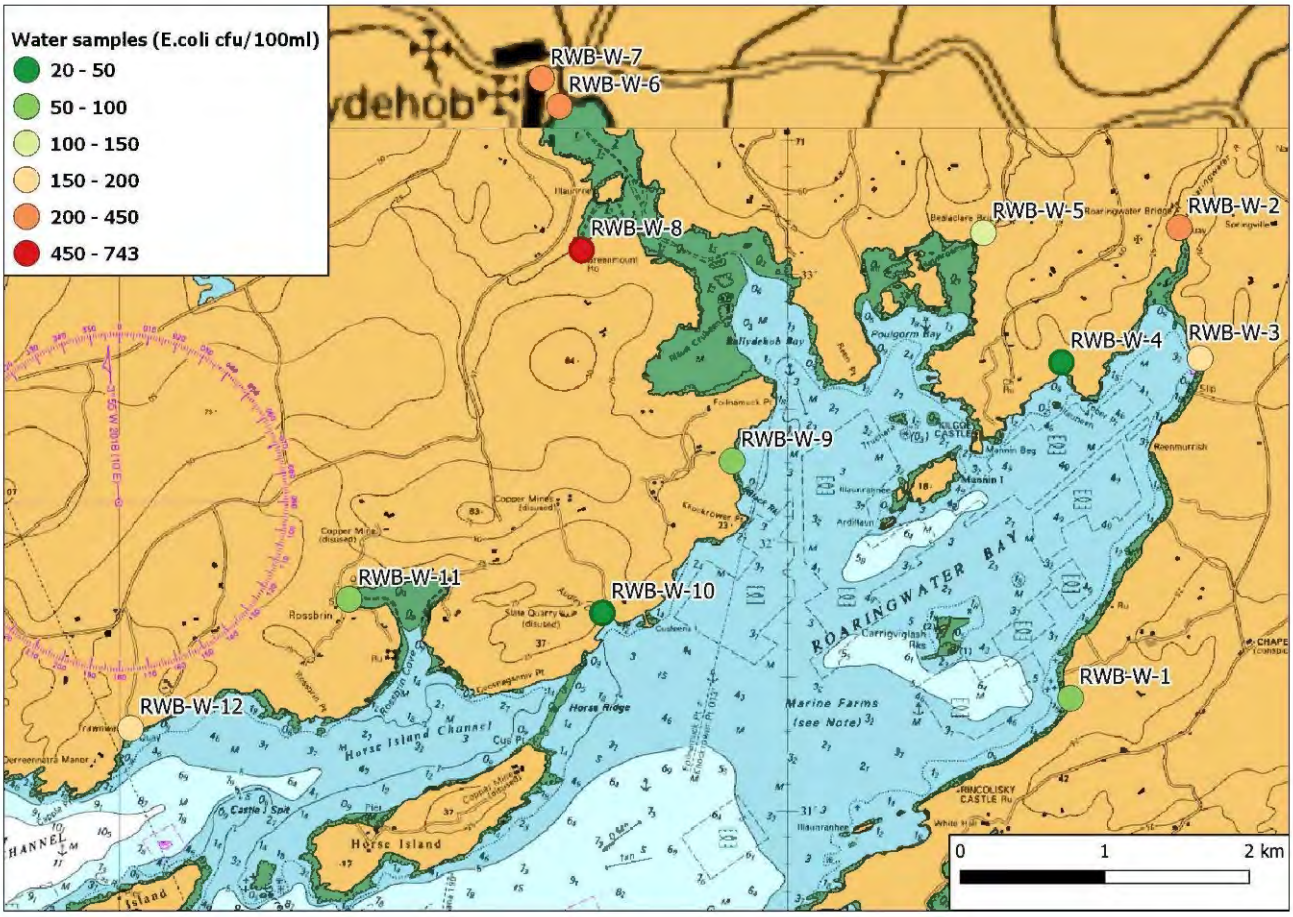

Figure 8-4: Location and magnitude of *E. coli* results from the shoreline survey.

8.2.3. Shellfish Flesh Quality Sampling

In order to determine if the current RMP was indeed representative of *E. coli* levels in the water or if new RMPs needed to be added, further shellfish flesh samples were taken. Six additional shellfish flesh samples were taken at the current RMP and at two suggested RMPs between June and October 2022 by SFPA staff. The location of the current RMP can be seen in Figure 8-5 and Table 8.1 shows the coordinates. The location of the suggested RMP sites *i.e.,* RMP 1 and RMP 2, can be seen in Figure 8-6 and Figure 8-7, respectively, and Table 5.2 shows the coordinates.

8.2.4. Shellfish Flesh Quality Results

The shellfish flesh sampling results taken from the current and suggested RMPs from June-October 2022 ranged from <18 cfu/100ml at all three stations to 490 cfu/100ml at RMP 2 (see Table 8.9). Lowest *E. coli* levels were recorded at the current RMP which indicates this station is no longer representative. The high *E. coli* levels at RMP 1 and RMP 2 indicate that these stations should be used for future monitoring of the *E. coli* levels within Roaringwater Bay BMPA.

Table 8.9: Shellfish *E. coli* results from the current RMP and suggested RMPs for Roaringwater Bay.

Sampling date	13/06/2022	11/07/2022	08/08/2022	22/08/2022	19/09/2022	24/10/2022
Current RMP	<18	<18	<18	<18	<18	130
RMP 1	45	45	130	<18	20	390
RMP 2	<18	<18	490	20	<18	490

* *E. coli* results are recorded in cfu/100ml

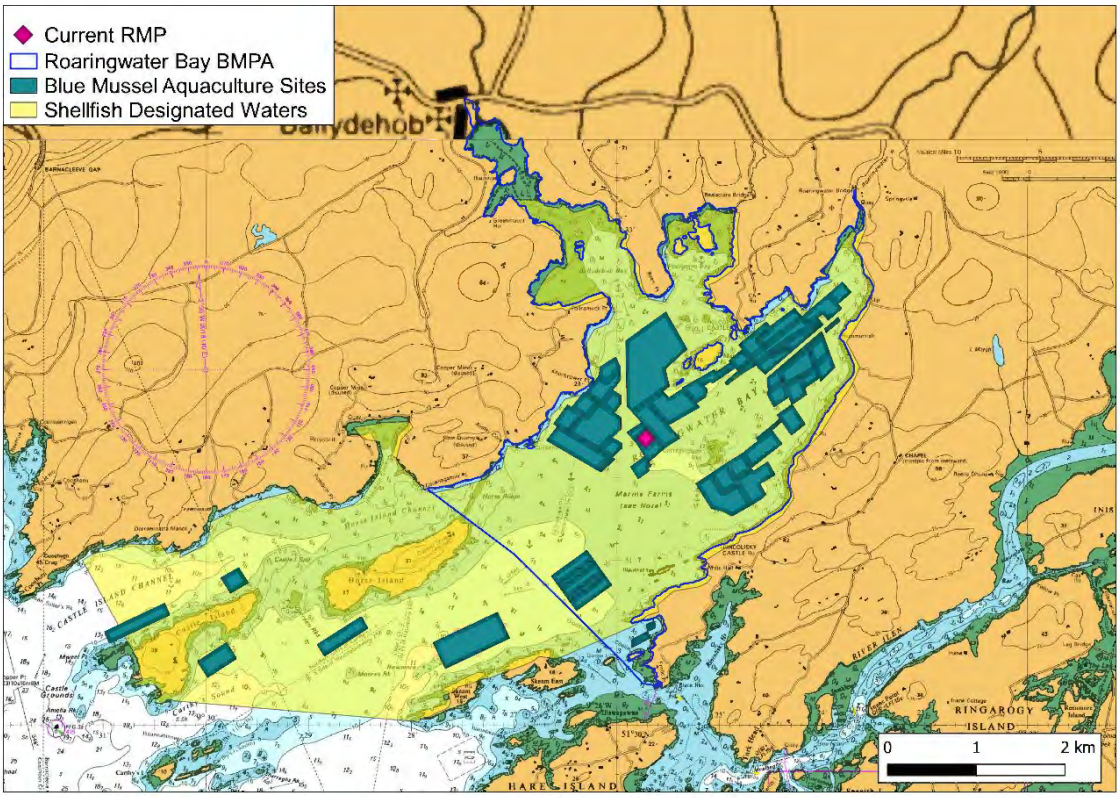

Figure 8-5: Current RMP within the current Roaringwater Bay BMPA.

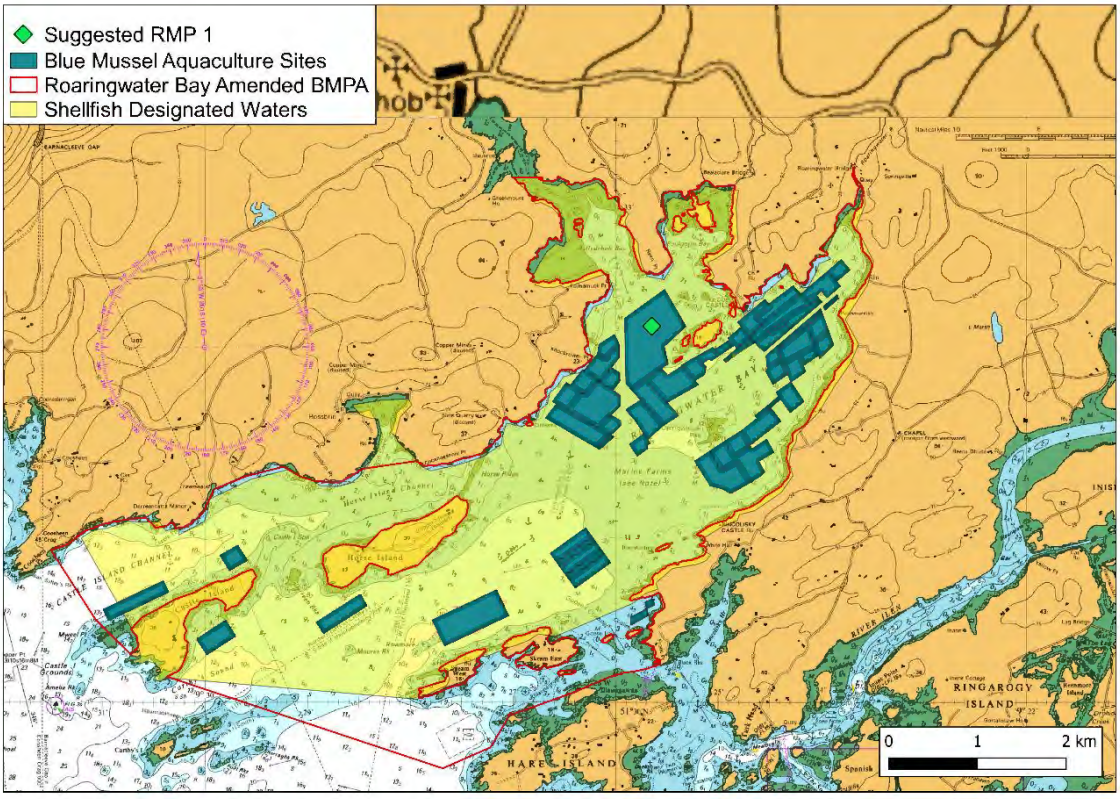

Figure 8-6: Suggested RMP 1 within the amended Roaringwater Bay BMPA.

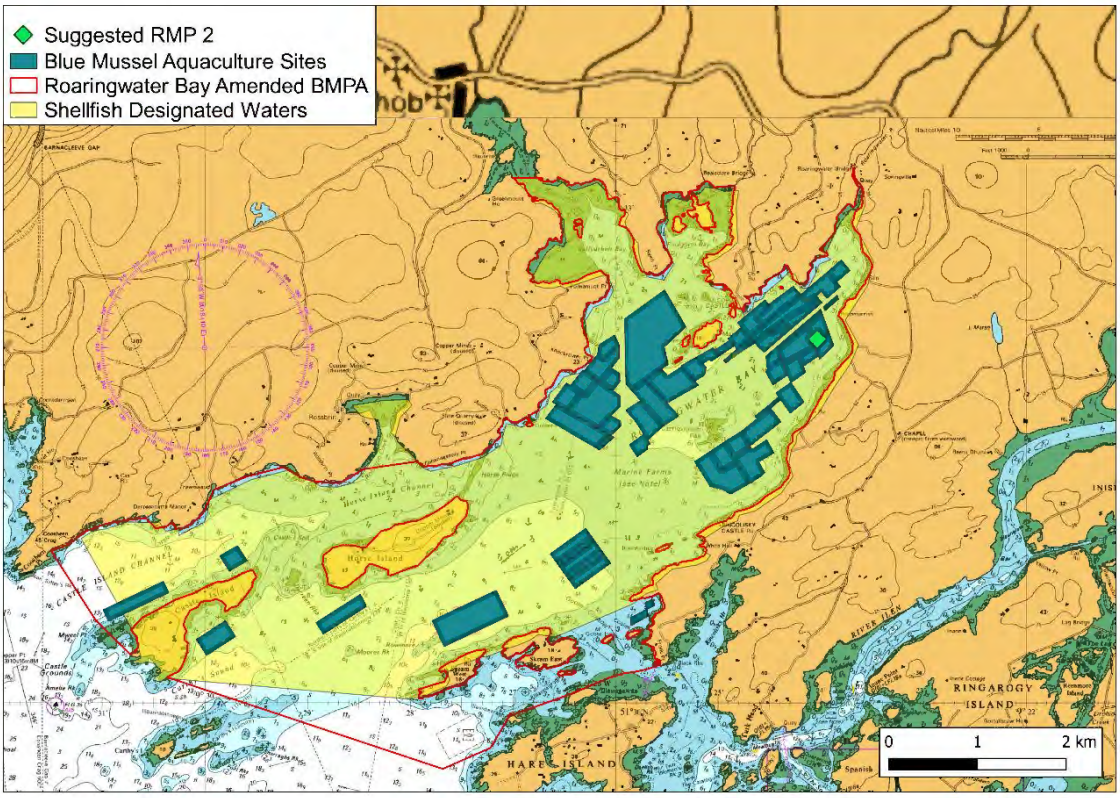

Figure 8-7: Suggested RMP 2 within the amended Roaringwater Bay BMPA.

9. Appendix 4: Statistical Analysis

Mussels v Season

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Winter	12	19.19709	1.599758	0.138158
Spring	11	15.80619	1.436927	0.130008
Summer	12	18.22975	1.519145	0.206875
Autumn	14	22.07605	1.576861	0.162504

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.183494	3	0.061165	0.381854	0.766548	2.811544
Within Groups	7.207992	45	0.160178			
Total	7.391486	48				

Mussels v Year

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
2016	12	19.02669	1.585558	0.156297
2017	11	16.4606	1.496418	0.151011
2018	7	9.776047	1.396578	0.065108
2019	10	16.4607	1.64607	0.274566
2020	10	14.8638	1.48638	0.115337

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.32765	4	0.081912	0.51704	0.723562	2.578739
Within Groups	7.129153	45	0.158426			
Total	7.456803	49				

10.Appendix 5: Shoreline Survey Images


22
23
32
33
35
36


37
38
39
43
44
45


46
48
49
50
53
57


58
59
60
62
63
64


66
ONLY
WASTE WATER
PERSONNEL
BEYOND THIS
POINT
67
68
70
75
81


82
101
103

11.Appendix 6: Species Specific RMPs

Roaringwater Bay

Bivalve Mollusc Classified Production Area

Mussel Monitoring Information

Site Name: Roaringwater Bay

Site Identifier: CK-RB-RB-1 and CK-RB-RB-2

Monitoring Point Coordinates

RMP 1

Latitude: 51.537970 **Longitude:** -9.427539

RMP 2

Latitude: 51.536718 **Longitude:** -9.400658

Species: *Mytilus edulis*

Sample Depth: Samples should be taken within first 1.5 m of surface

Sample Frequency: Monthly

Responsible Authority: Sea Fisheries Protection Authority

Authorised Samplers: SFPA Port Office Dingle

Maximum Allowed Distance from Sampling Point: The sample must be taken from within 100 m of the sampling point.

Sampling Size: Minimum 15 market sized animals

Sampling Method: Taken from rope at point

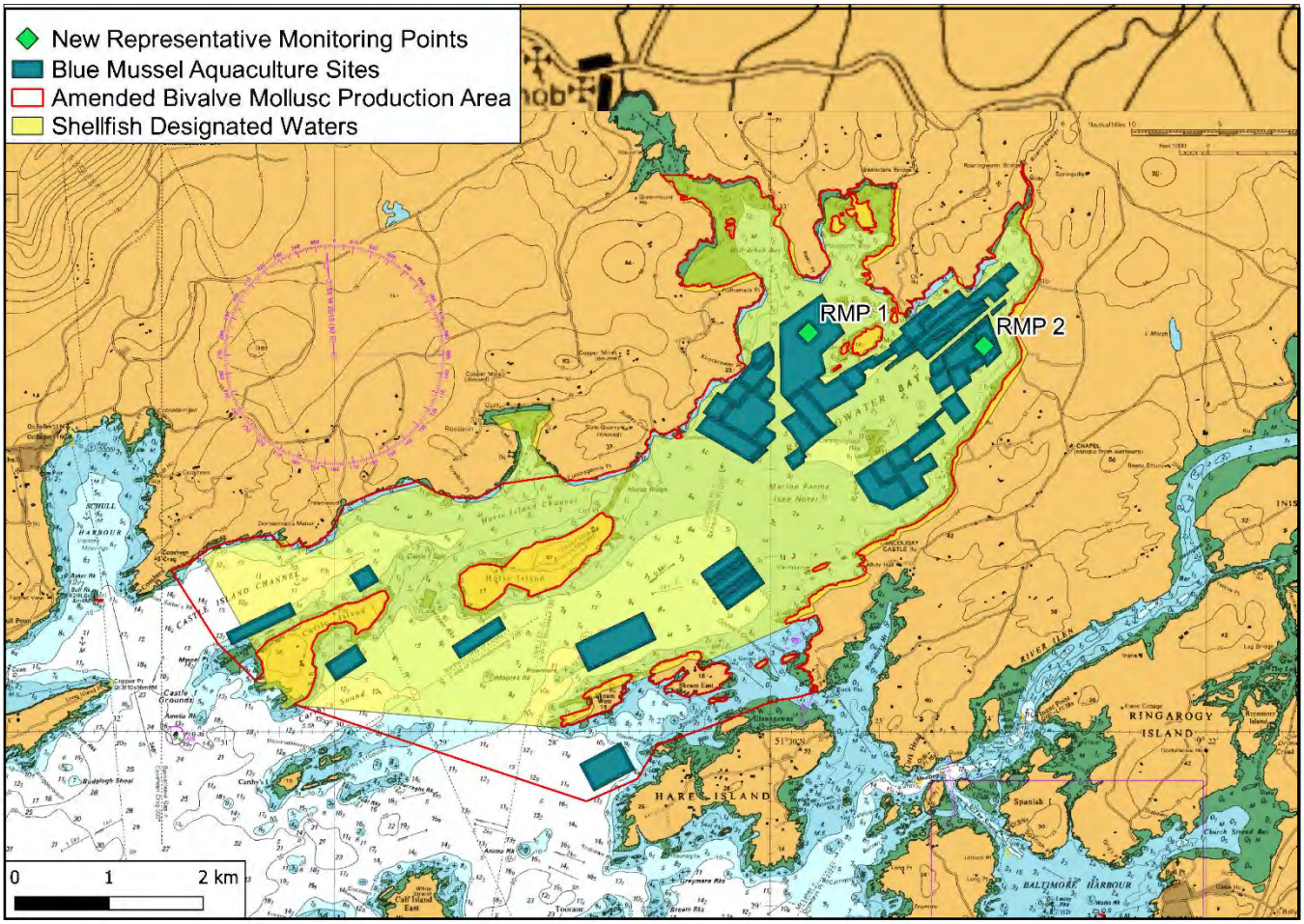

Figure 11-1: Mussel Representative Monitoring Points (RMPs) within Roaringwater Bay.

12.Appendix 7: Salinity Survey Report

Roaringwater Bay Salinity Survey

Produced by

AQUAFACT - APEM Group

On behalf of

Sea Fisheries Protection Authority

July 2024

AQUAFACT – APEM Group
Unit 9A Liosban Business Park,
Tuam Road, Galway
H91 K120
www.aquafact.ie
info@aquafact.ie
Tel. +353 (0) 91 756812

Report Approval Sheet

Client	Sea Fisheries Protection Authority
Report Title	Roaringwater Bay Salinity Survey
Job Number	JN1777/P00013131
Report Status	Final
Issue Date	18/07/2024

Rev	Status	Issue Date	Document File Name	Author (s)	Approved by:
1	Draft	24/06/2024	JN1777_Roaringwater Bay_Salinity_Survey_JS080524	Jake Shiel	Aisha O'Connor
2	Draft	08/07/2024	JN1777_Roaringwater Bay_Salinity_Survey_AOC080724	Jake Shiel Aisha O'Connor	Shane O'Boyle Eddie McCormack
3	Final	18/07/2024	JN1777_Roaringwater Bay_Salinity_Survey_Final_18072024	Aisha O'Connor	Eddie McCormack

Table of Contents

1. Introduction 1

1.1 Overview 1

1.2 Site Description 2

2. Methodology 3

2.1 Salinity Survey 3

2.1 Shellfish Microbiological Survey 4

3. Results 7

3.1 Salinity Results 7

3.1.1 Overview 7

3.1.2 Temperature Salinity Profiles 8

3.1.3 Average Site Salinities 20

3.2 Shellfish Microbiology Survey Results 20

4. Discussion 22

5. Conclusion 24

6. Appendix 1: Shellfish Analysis Reports 25

7. References 26

8. List of Endnotes 26

Table of Figures

Figure 1-1: Representative monitoring points (RMPs) 1 and 2 as recommended in the 2023 Roaringwater Bay sanitary survey. 2

Figure 2-1: Location of salinity survey monitoring points in relation to the representative monitoring points within the Roaringwater Bay production area. 4

Figure 2-2: Map of sites from which mussel (*Mytilus edulis*) samples were taken on the 11th and 19th March, and 30th April 2024 for *E. coli* analysis. 6

Figure 3-1: Temperature salinity plot for the spring tide on the 11/03/2024. 8

Figure 3-2:Temperature salinity plot for the neap tide on the 01/05/2024. 8

Figure 3-3:RW01 spring tide salinity and temperature profile. 9

Figure 3-4:RW01 neap tide salinity and temperature profile. 9

Figure 3-5:RW02 spring tide salinity and temperature profile. 10

Figure 3-6: RW02 neap tide salinity and temperature profile. 10

Figure 3-7: RW03 spring tide salinity and temperature profile. 12

Figure 3-8: RW03 neap tide salinity and temperature profiles. 12

Figure 3-9: RW04 spring tide salinity and temperature profile. 13

Figure 3-10: RW04 neap tide salinity and temperature profile. 13

Figure 3-11: RW05 spring tide salinity and temperature profile. 14

Figure 3-12: RW05 neap tide salinity and temperature profile. 14

Figure 3-13:RW06 spring tide salinity and temperature profile. 15

Figure 3-14: RW06 neap tide salinity and temperature profile. 15

Figure 3-15: RW07 spring tide salinity and temperature profile. 16

Figure 3-16: RW07 neap tide salinity and temperature profile. 17

Figure 3-17: RW08 spring tide salinity and temperature profile. 18

Figure 3-18: RW08 neap tide salinity and temperature profiles. 18

Figure 3-19: RW09 spring tide salinity and temperature profile. 19

Figure 3-20: RW09 neap tide salinity and temperature profile. 19

Figure 3-21: Average salinity for each site over the entire survey. 20

List of Tables

Table 2.1: *Escherichia coli* (*E. coli*) results from monthly monitoring of mussels (*Mytilus edulis*) in Roaringwater Bay production area 2021-2024. MPN = most probable number. 4

Table 3.1: Tidal conditions 11/03/2024. 7

Table 3.2: Tidal conditions 01/05/2024. 7

Table 3.3: Results of shellfish analysis for Roaringwater Bay March and April 2024. 21

Table 4.1: Characterisation of water bodies based on salinity; table adapted from Directive 2000/60/EC. .. 22

List of Appendices

Appendix 1: Shellfish Analysis Reports

List of Acronyms/Glossary

Abbreviation	Explanation
BMPA	Bivalve Mollusc Production Area
CLS	Complete Laboratory Solutions
MPN	Most probable number (relates to bacterial colony counts)
NPWS	National Parks & Wildlife Service
PPT	Parts per thousand[2]
PSU	Practical Salinity Units[2]
RIB	Rigid Inflatable Boat
RMP	Representative monitoring point
RW	Roaringwater
SAC	Special Area of Conservation
SFPO	Sea Fisheries Protection Officer
SPA	Special Protection Area

1. Introduction

1.1 Overview

AQUAFACT - APEM Group (herein referred to as AQUAFACT) have been commissioned by the Sea Fisheries Protection Authority (SFPA) to carry out a salinity survey in the bivalve mollusc production area (BMPA) of Roaringwater Bay, Co. Cork. The purpose of this survey is to provide integral data to justify dividing the BMPA into two distinct production areas or leaving the BMPA as one unit.

Under regulation (EU) 2017/625 and its subsequent implementing regulation (EU) 2019/627 there is a requirement to carry out a sanitary survey before classifying any shellfish production or relaying area. A sanitary survey for Roaringwater Bay BMPA was completed by AQUAFACT in January 2023, which advised the original representative monitoring point (RMP) be moved and an additional RMP be added (**Figure 1-1**). While these RMPs were chosen based on the full sanitary survey assessment, concerns have been raised by producers in the outer bay area regarding the suitability of these RMPs in relation to the outer sites due to the geographic separation that exists. Splitting the BMPA in two was suggested as a remedy to this so that producers in the outer bay would not be unfairly 'penalised' by a closure of the bay or downgrading the classification status based on the *E. coli* data from the RMPs in the inner bay.

This report should be viewed in conjunction with the 2023 Roaringwater Bay sanitary survey report to provide further justification for the designation of the BMPA boundaries in Roaringwater Bay.

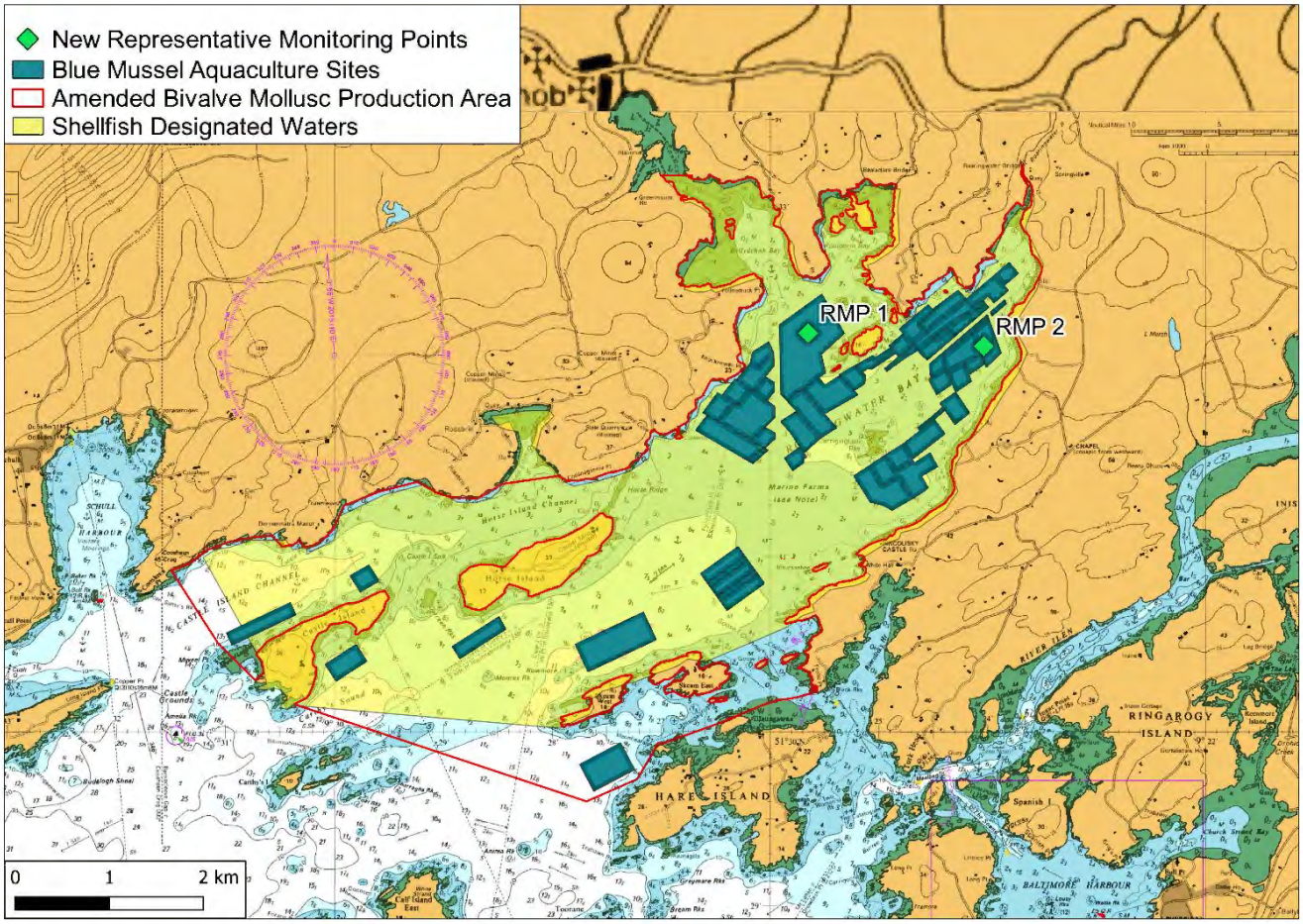

Figure 1-1: Representative monitoring points (RMPs) 1 and 2 as recommended in the 2023 Roaringwater Bay sanitary survey.

1.2 Site Description

Roaringwater Bay located on the southwest coast of Ireland in County Cork is the southernmost bay in Ireland. It is a wide and shallow bay covering an area of 13 km^2, with most of the bay exhibiting depths of 4 to 5 m. Depths increase to greater than 14 m at the production area outer boundary and reach 44 m at the deepest point in the bay. The bay is approximately 4 km east-west at its widest point and approximately 5 km north-south. Most of the coastline surrounding the bay is low lying with the exception of some of the southern coasts. Cape Clear Island and Sherkin Island have stretches of rocky cliffs rising 30-60 m in height. The substrate of the bay is predominately mud. The BMPA has a contributing catchment of 126.8 km^2; the Bawnaknockane, Leamawadra and Roaringwater Rivers are responsible for draining 67% of the contributing catchment along with a series of minor streams and tributaries.

The bay falls within a designated Special Area of Conservation (SAC), so named Roaringwater Bay and Islands SAC (site code: IE000101). The SAC ranges from the coastline at Castlepoint to the headland past Baltimore and encompasses all of the islands in the bay including some larger ones like Cape Clear, Sherkin, and Long Island. The Roaringwater Bay SAC was designated for the following list of species/habitats derived from Annex

I/II of the EU habitats directive: large shallow inlets and bays, reefs, vegetated sea cliffs, dry heath, sea caves, harbour porpoise (*Phocoena phocoena*), otter (*Lutra lutra*), and grey seal (*Halichoerus grypus*)[1]. There are no SPAs within Roaringwater Bay. The closest SPA is Sheep's Head to Toe Head SPA (site code: 004156) located 4.5 km southeast of the bay.

2. Methodology

As previously stated, the purpose of this survey was to review the boundaries of the Roaringwater Bay BMPA and determine the feasibility of separating the area into two separate production areas. It was agreed that one option to identify conditions for separating the inner and outer regions of the bay would be through a collection of salinity data across the BMPA. The salinity data should help to determine if there are differing water masses or patterns of circulation within the production area or whether the area has an overall salinity uniformity. As an additional method to determine differences across the production area shellfish samples were taken by SFPOs at three production sites in the bay and tested for *E. coli* (**Figure 2-2**).

2.1 Salinity Survey

Salinity profiles were taken at nine predetermined locations: RW01-09 (RW = Roaringwater). The measurement locations (see **Figure 2-1**) were chosen to get a broad coverage of the production area so that the inner, middle, and outer zones were well represented and any discrepancies in salinity measurements were picked up. The first survey was completed on the 11th of March 2024 during a spring tide for the falling and rising tides. The second survey was conducted during a neap tide on the 1st of May 2024 also surveying each location during the falling and rising tides. The sampling was conducted from a subcontracted RIB by a member of the AQUAFACT Field Team.

At each location a YSI EXO 2 multiparameter probe was used to get salinity and temperature profiles. Measurements were recorded at 0.1 m, 0.5 m, 1.0 m, and each metre thereafter until the seabed was reached. This process was then repeated coming back up from the seabed to the surface. The probe was calibrated for conductivity/salinity preceding each survey. Water samples were taken at three locations on each survey date. These water samples were sent to Complete Laboratory Solutions (CLS) for salinity analysis and were used as a method of quality control for the probe measurements.

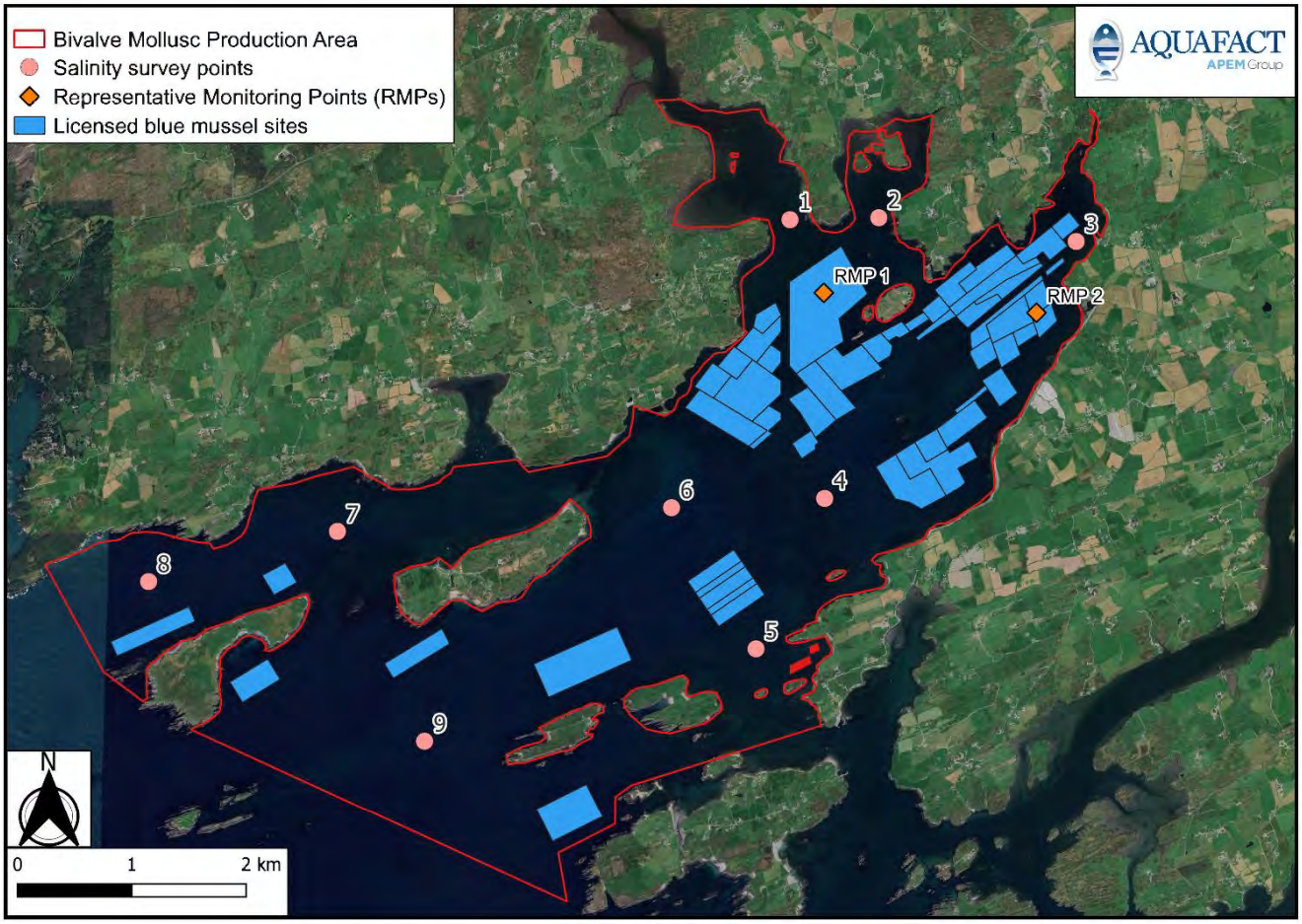

Figure 2-1: Location of salinity survey monitoring points in relation to the representative monitoring points within the Roaringwater Bay production area.

2.1 Shellfish Microbiological Survey

Shellfish samples are routinely taken from RMPs in Roaringwater Bay to test for levels of *E. coli* as part of the National Microbiological Monitoring and Classification Programme in Ireland. Samples are coordinated by the SFPA, and the National Reference Laboratory in the Marine Institute oversees the programme. Two RMPs were determined for Roaringwater Bay BMPA resulting from the 2023 sanitary survey: RMP 1 and RMP 2 (**Figure 1-1**). Before the placement of these RMPs, shellfish samples were taken from other monitoring points not specifically identified by a sanitary survey but deemed to be representative of the shellfish production in the BMPA. **Table 2.1** shows these monitoring results as MPN/100 g from January 2021 until June 2024.

Table 2.1: *Escherichia coli* (*E. coli*) results from monthly monitoring of mussels (*Mytilus edulis*) in Roaringwater Bay production area 2021-2024. MPN = most probable number.

Date	Sample Position	MPN/100 g	Date	Sample Position	MPN/100 g
11-Jan-21	N/A	220	14-Apr-23	RMP 1 - WEST	78
2-Mar-21	N/A	<18	25-Apr-23	RMP 1 - WEST	20
16-Mar-21	N/A	<18	15-May-23	RMP 1 - WEST	<18
20-Apr-21	N/A	<18	13-Jun-23	RMP 1 - WEST	<18
24-May-21	N/A	68	17-Jul-23	RMP 1 - WEST	<18

15-Jun-21	N/A	<18	22-Aug-23	RMP 1 - WEST	490*
5-Jul-21	N/A	20	28-Aug-23	RMP 1 - WEST	<18
11-Aug-21	N/A	68	11-Sep-23	RMP 1 - WEST	<18
6-Sep-21	N/A	45	7-Nov-23	RMP 1 - WEST	45
3-Nov-21	N/A	110	5-Dec-23	RMP 1 - WEST	<18
17-Nov-21	N/A	490	19-Dec-23	RMP 1 - WEST	78
15-Dec-21	N/A	<18	23-Jan-23	RMP 2 - EAST	<18
17-Jan-22	N/A	20	22-Feb-23	RMP 2 - EAST	130
14-Feb-22	N/A	490	5-Apr-23	RMP 2 - EAST	<18
28-Mar-22	N/A	<18	14-Apr-23	RMP 2 - EAST	40
27-Apr-22	N/A	<18	25-Apr-23	RMP 2 - EAST	<18
23-May-22	N/A	<18	15-May-23	RMP 2 - EAST	<18
13-Jun-22	N/A	<18	13-Jun-23	RMP 2 - EAST	<18
11-Jul-22	N/A	<18	17-Jul-23	RMP 2 - EAST	<18
8-Aug-22	N/A	<18	22-Aug-23	RMP 2 - EAST	330*
5-Dec-22	N/A	<18	28-Aug-23	RMP 2 - EAST	40
13-Dec-22	N/A	<18	11-Sep-23	RMP 2 - EAST	<18
22-Aug-22	RMP	<18	7-Nov-23	RMP 2 - EAST	20
19-Sep-22	RMP	<18	5-Dec-23	RMP 2 - EAST	<18
24-Oct-22	RMP	130	19-Dec-23	RMP 2 - EAST	130
8-Aug-22	SS - OPTION 1	130	29-Jan-24	RMP 1 - WEST	230
22-Aug-22	SS - OPTION 1	<18	28-Feb-24	RMP 1 - WEST	<18
19-Sep-22	SS - OPTION 1	20	26-Mar-24	RMP 1 - WEST	78
24-Oct-22	SS - OPTION 1	330	7-May-24	RMP 1 - WEST	<18
8-Aug-22	SS - OPTION 2	490	20-May-24	RMP 1 - WEST	<18
22-Aug-22	SS - OPTION 2	20	17-Jun-24	RMP 1 - WEST	<18
19-Sep-22	SS - OPTION 2	<18	29-Jan-24	RMP 2 - EAST	78
24-Oct-22	SS - OPTION 2	490	28-Feb-24	RMP 2 - EAST	40
13-Jun-22	SS OPTION 1	45	26-Mar-24	RMP 2 - EAST	<18
11-Jul-22	SS OPTION 1	45	7-May-24	RMP 2 - EAST	<18
13-Jun-22	SS OPTION 2	<18	20-May-24	RMP 2 - EAST	<18
11-Jul-22	SS OPTION 2	<18	17-Jun-24	RMP 2 - EAST	<18
23-Jan-23	N/A	<18			
23-Jan-23	RMP 1 - WEST	<18			
22-Feb-23	RMP 1 - WEST	<18			
5-Apr-23	RMP 1 - WEST	790**			

*sample discounted due to mislabelling
**sample discounted due to engineering works locally

As previously mentioned, microbiological testing of shellfish samples for *E. coli* levels was carried out as part of the overall survey project. While data exists for the RMPs in Roaringwater Bay, these being located in the inner bay does not provide an indication into the *E. coli* levels detected at shellfish sites in the mid- to outer bay area. Therefore, shellfish were sampled from three locations in the mid- to outer production area on three occasions (11/03/2024, 19/03/2024 and 30/04/2024) by SFPOs and subsequently tested for *E. coli* by Southern Scientific Services Ltd., an accredited laboratory. All shellfish samples comprised the mussel species *Mytilus edulis*. The results of the testing are presented in **section 3.2** and the official analysis reports are available in **Appendix 1: Shellfish Analysis** . Note that for samples taken on the 11th and 19th of March from site T05-598A, they are mislabelled on the associated analysis reports as T05-498A.

The locations chosen for sampling of shellfish in Roaringwater Bay were T05/497N1 on the northern side of Castle Island, T05/499N1 just south of Skeam West, and site T05/598A to the northeast of Skeam East (**Figure 2-2**).

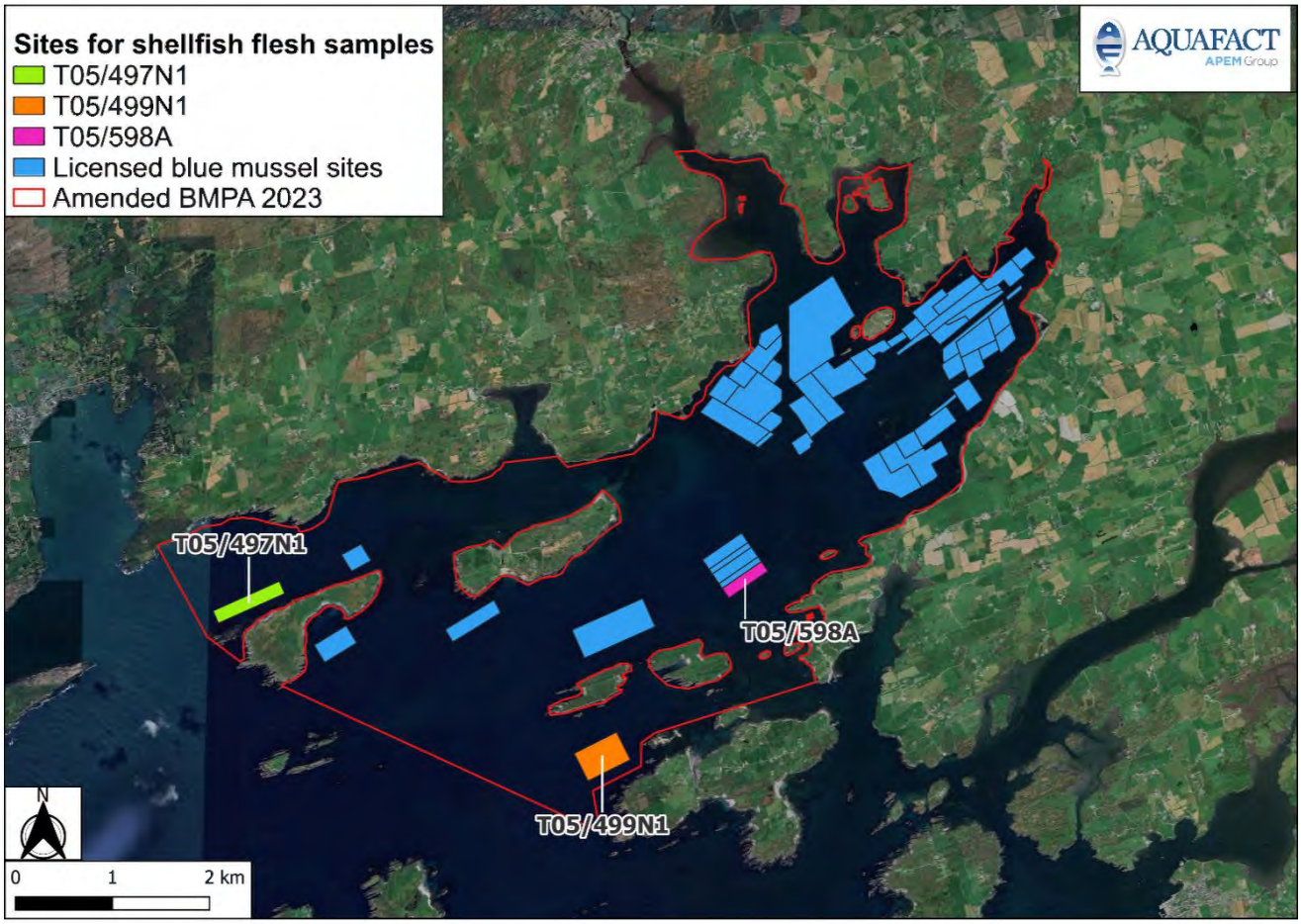

Figure 2-2: Map of sites from which mussel (*Mytilus edulis*) samples were taken on the 11th and 19th March, and 30th April 2024 for *E. coli* analysis.

3. Results

In this section the results of both the salinity survey and the *E. coli* testing are clearly laid out and discussed.

3.1 Salinity Results

3.1.1 Overview

The first survey was completed on the 11th of March 2024. The measurements taken were used to establish salinity and temperature values at nine locations in Roaringwater Bay during a spring tide. The tidal conditions on the 11th of March were as follows:

Table 3.1: Tidal conditions 11/03/2024.

	Time	Height
High	05:41	3.7
Low	11:53	0.1
High	18:01	3.6

As a result of the large difference in tidal heights there would have been a much greater movement of water on this day relative to the survey on the 1st of May. The survey on the 1st of May 2024 was conducted during a neap tide when the tidal range is very low. The tidal conditions on the 1st of May were as follows:

Table 3.2: Tidal conditions 01/05/2024.

	Time	Height
Low	04:50	1.3
High	11:01	2.7
Low	17:21	1.3

The measurements for each survey day have been graphed onto **Figure 3-1** and **Figure 3-2** to observe the relationship between salinity and temperature at each site over the course of the survey. During the spring tide, salinities ranged from 31.61 PSU at RW01 to 34.29 PSU at RW09, and during the neap tide, from 32.16 PSU at RW01 to 34.58 PSU at RW08. Temperature variations were higher during the neap tide with all measurements recorded within a 2.5°C range. This contrasts with the spring tide readings where all measurements were between a 1°C range. For the neap tide there is a clear trend of lower temperatures with higher salinities. This trend is not as evident during the spring tide. In both **Figure 3-1** and **Figure 3-2** there is a clear trend of increasing salinities moving from stations in the inner to the outer bay, with the lowest salinities recorded at stations RW01-03 where there are more prominent freshwater influences, and the highest measurements recorded at the outer stations (RW07-RW09). The inner sites (RW01-03) have an average salinity of 33.35 PSU and the outer sites (RW07-09) averaged at 34.29 PSU.

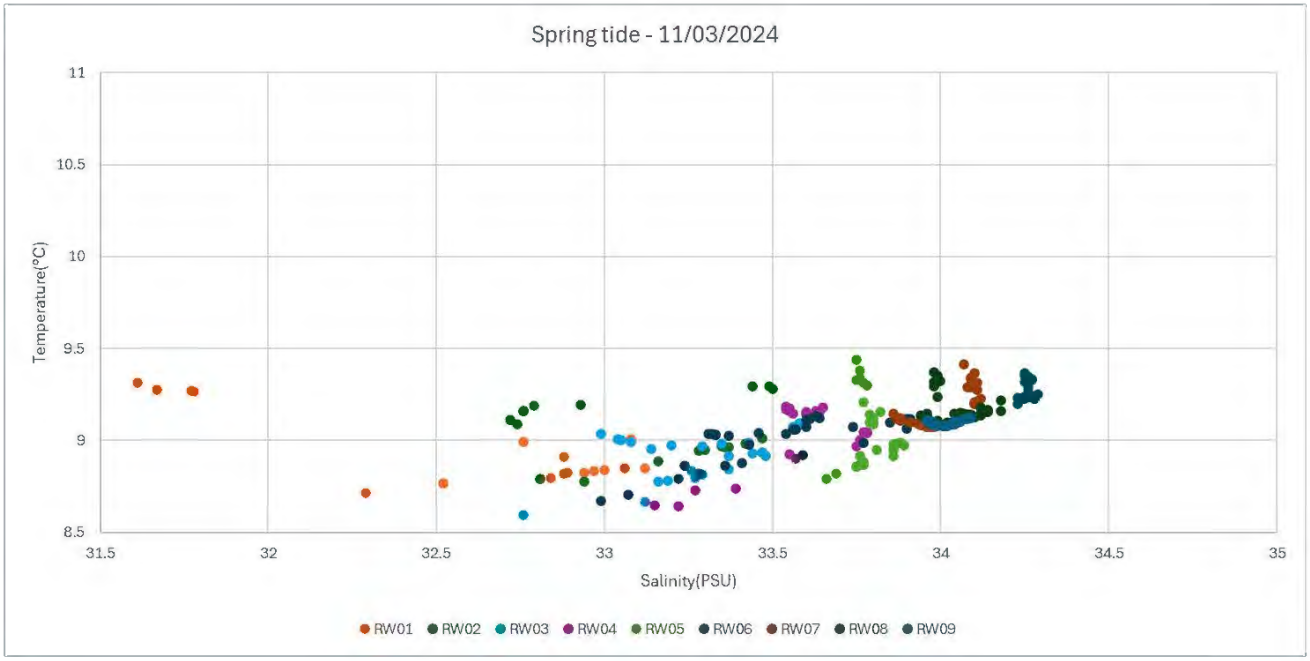

Figure 3-1: Temperature salinity plot for the spring tide on the 11/03/2024.

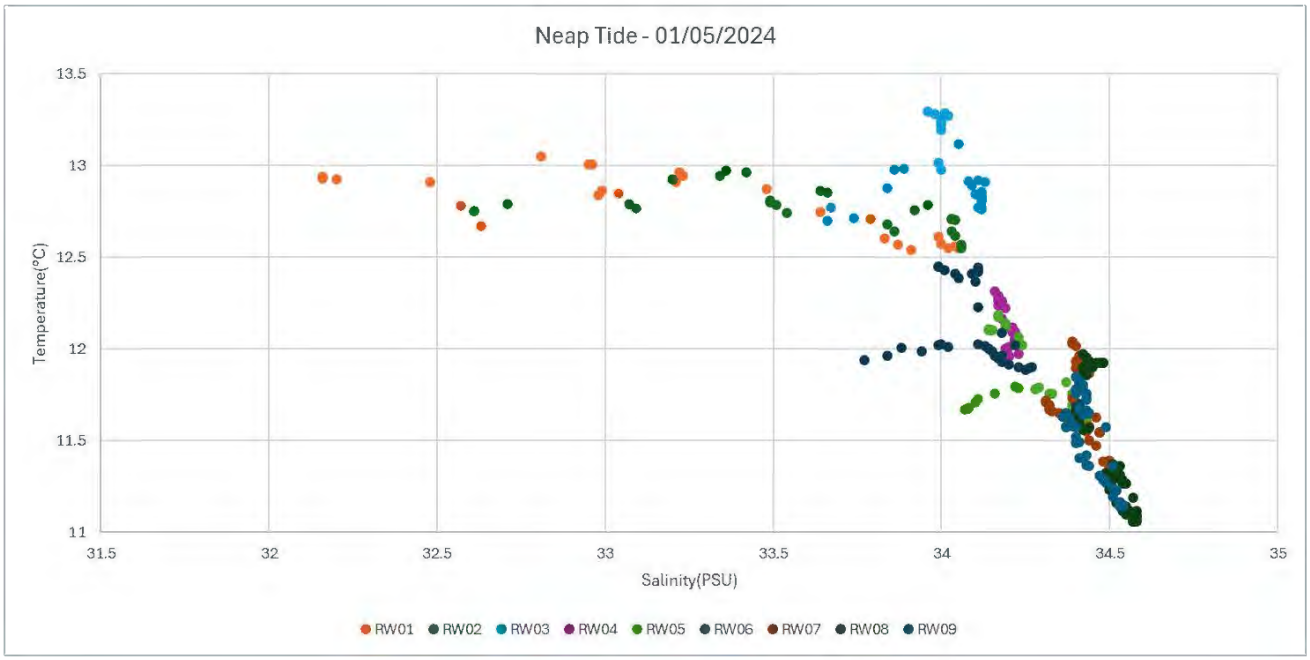

Figure 3-2:Temperature salinity plot for the neap tide on the 01/05/2024.

3.1.2 Temperature Salinity Profiles

The salinity and temperature profiles measured for each station on the 11th of March and 1st of May 2024 are presented in sections **3.1.2.1** to **3.1.2.9**. These graphs show each profile measured from surface to bottom and back to surface. The salinity profiles are presented as solid lines and the temperature as dashed lines. Water depth is represented on the y-axis with salinity on the bottom x-axis and temperature on the top x-axis.

3.1.2.1 RW01

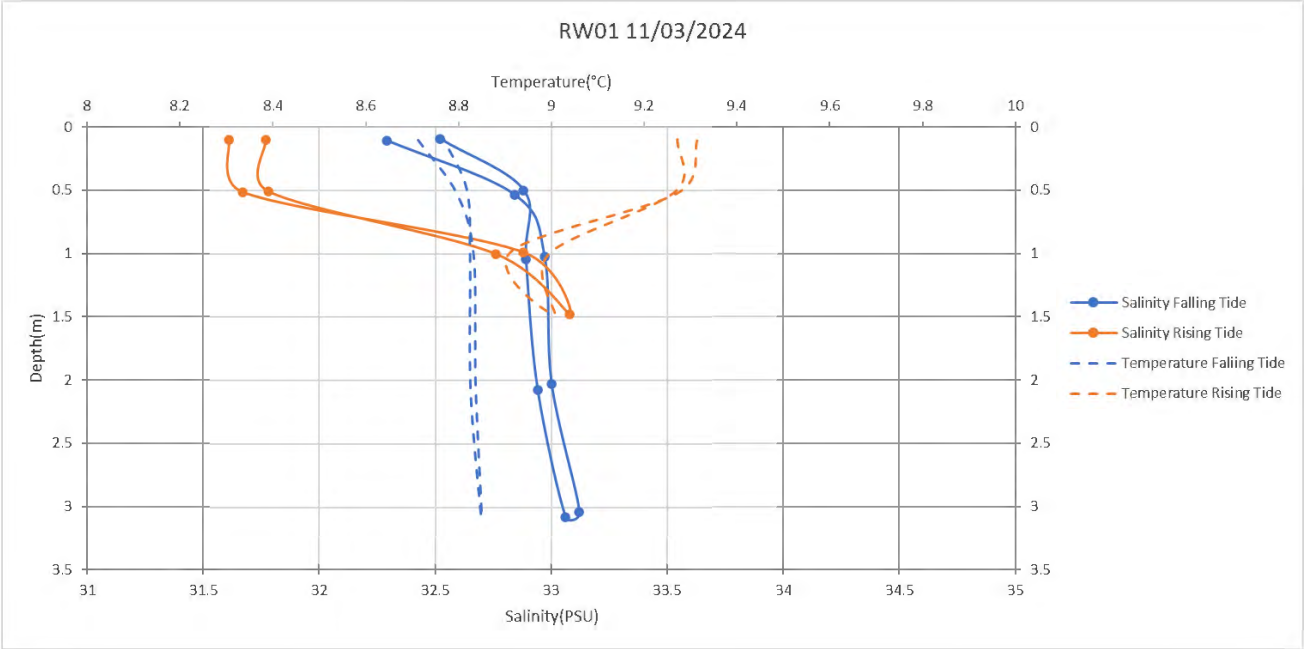

Figure 3-3:RW01 spring tide salinity and temperature profile.

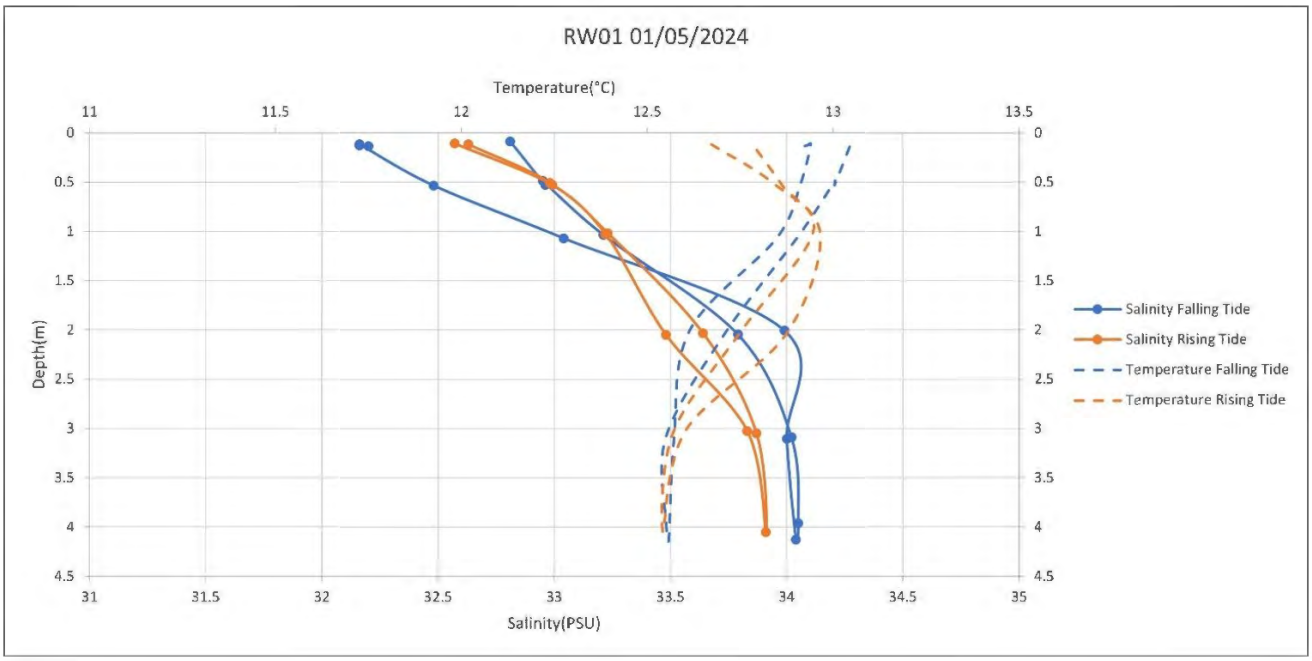

Figure 3-4:RW01 neap tide salinity and temperature profile.

RW01 (51.54366874, -9.431977032) is located in the northwestern corner of the bay and is the closest point to where the Bawnaknockane River discharges into the sea. On the 11th of March salinity ranged from 32.29 PSU at the surface to 33.12 PSU at the bottom during the ebbing tide, and 31.61 PSU to 33.08 PSU on the flooding tide. Temperature varied from 8.712°C to 8.85°C on the ebbing tide, and 8.911°C to 9.314°C on the flooding tide. On the 1st of May salinity ranged from 32.57 PSU at the surface to 33.91 PSU at the bottom

during the flooding tide, and 32.16 PSU to 34.05 PSU on the ebbing tide. Temperature varied from 12.54°C to 12.97°C on the flooding tide, and 12.55°C to 13.05°C on the ebbing tide.

3.1.2.2 RW02

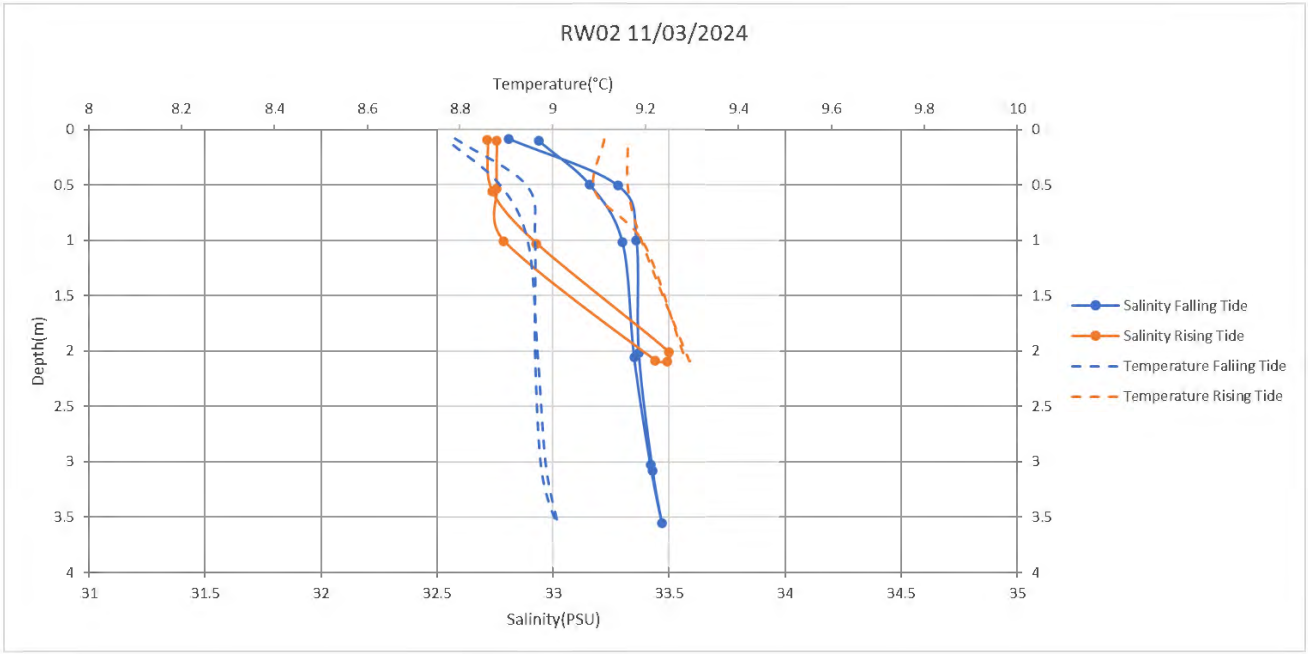

Figure 3-5:RW02 spring tide salinity and temperature profile.

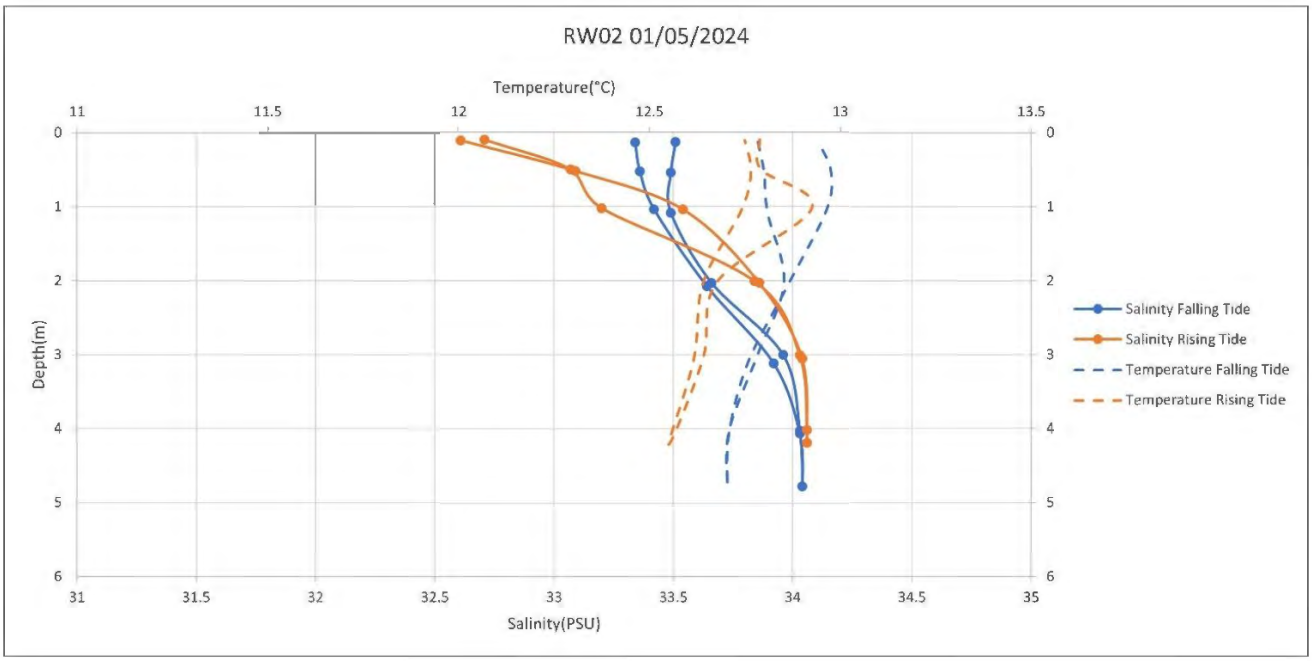

Figure 3-6: RW02 neap tide salinity and temperature profile.

RW02 (51.54396075, -9.420777992) is located in the north of the bay and is the closest point to where the Leamawaddra River discharges into the sea. On the 11th of March salinity ranged from 32.81 PSU at the surface

to 33.47 PSU at the bottom during the ebbing tide, and 32.76 PSU to 33.5 PSU on the flooding tide. Temperature varied from 8.78°C to 9.01°C on the ebbing tide, and 9.11°C to 9.29°C on the flooding tide.

On the 1st of May salinity ranged from 32.61 PSU at the surface to 34.06 PSU at the bottom during the flooding tide, and 33.34 PSU to 34.04 PSU on the ebbing tide. Temperature varied from 12.55°C to 12.79°C on the flooding tide, and 12.71°C to 12.98°C on the ebbing tide.

3.1.2.3 RW03

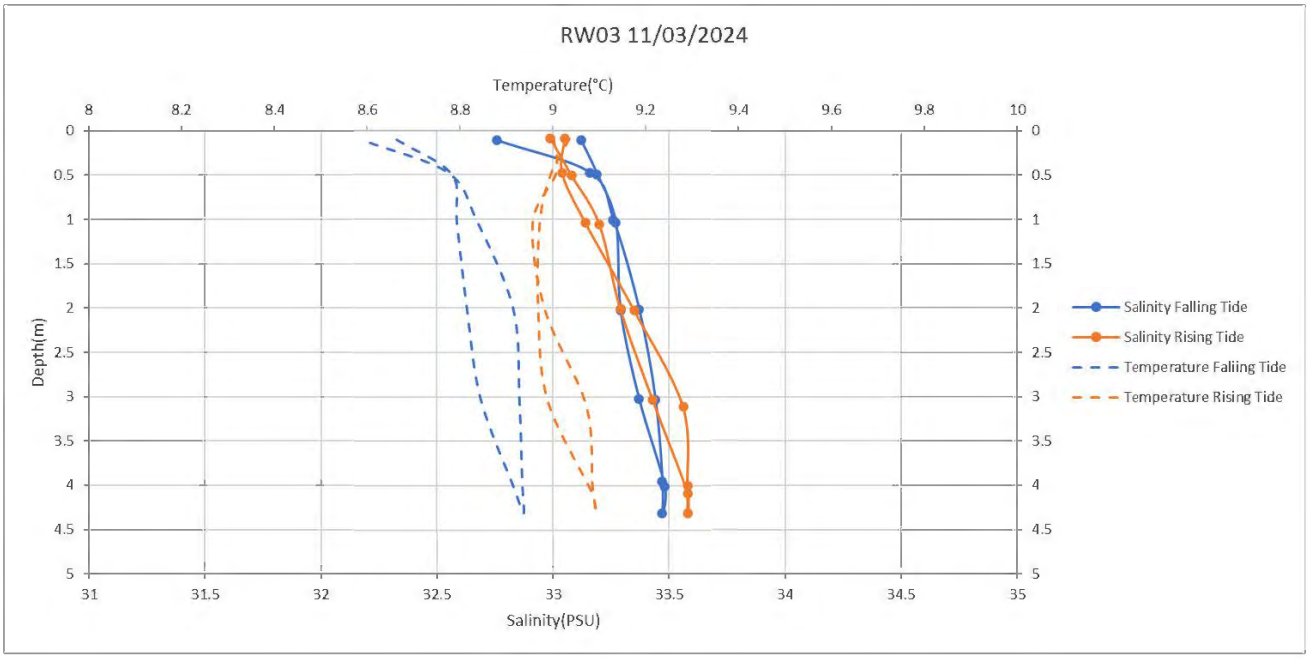

Figure 3-7: RW03 spring tide salinity and temperature profile.

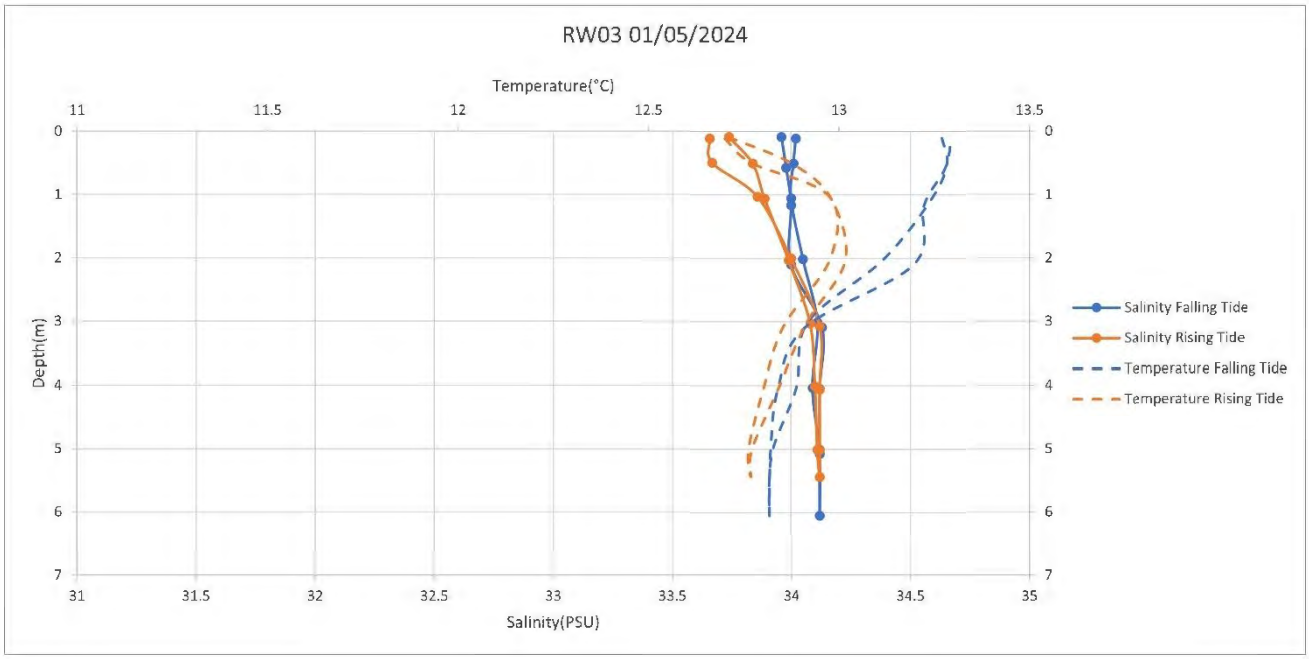

Figure 3-8: RW03 neap tide salinity and temperature profiles.

RW03 (51.54238976, -9.395813595) is located in the northeastern corner of the bay and is the closest point to where the Roaringwater River discharges into the sea. On the 11th of March salinity ranged from 32.76 PSU at the surface to 33.48 PSU at the bottom during the ebbing tide, and 32.99 PSU to 33.58 PSU on the flooding tide. Temperature varied from 8.59°C to 8.94°C on the ebbing tide, and 8.96°C to 9.09°C on the flooding tide.

On the 1st of May salinity ranged from 33.66 PSU at the surface to 34.12 PSU at the bottom during the flooding tide, and 32.96 PSU to 34.12 PSU on the ebbing tide. Temperature varied from 12.70°C to 13.02°C on the flooding tide, and 12.82°C to 13.30°C on the ebbing tide.

3.1.2.4 RW04

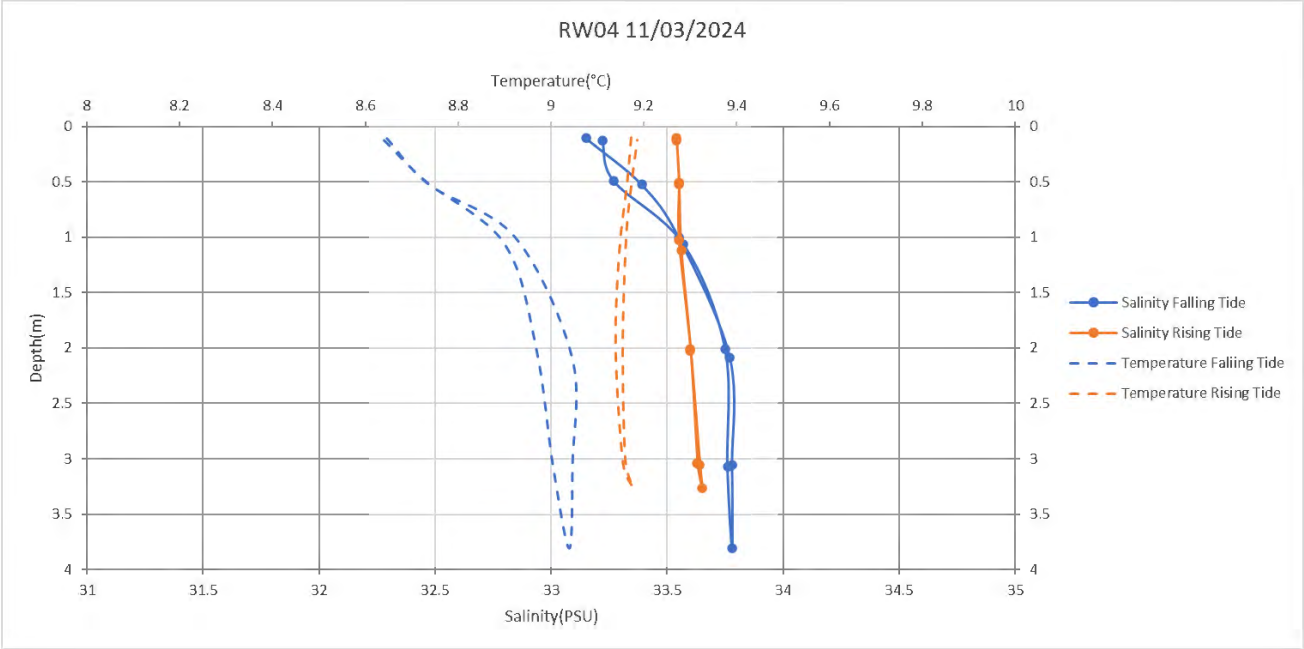

Figure 3-9: RW04 spring tide salinity and temperature profile.

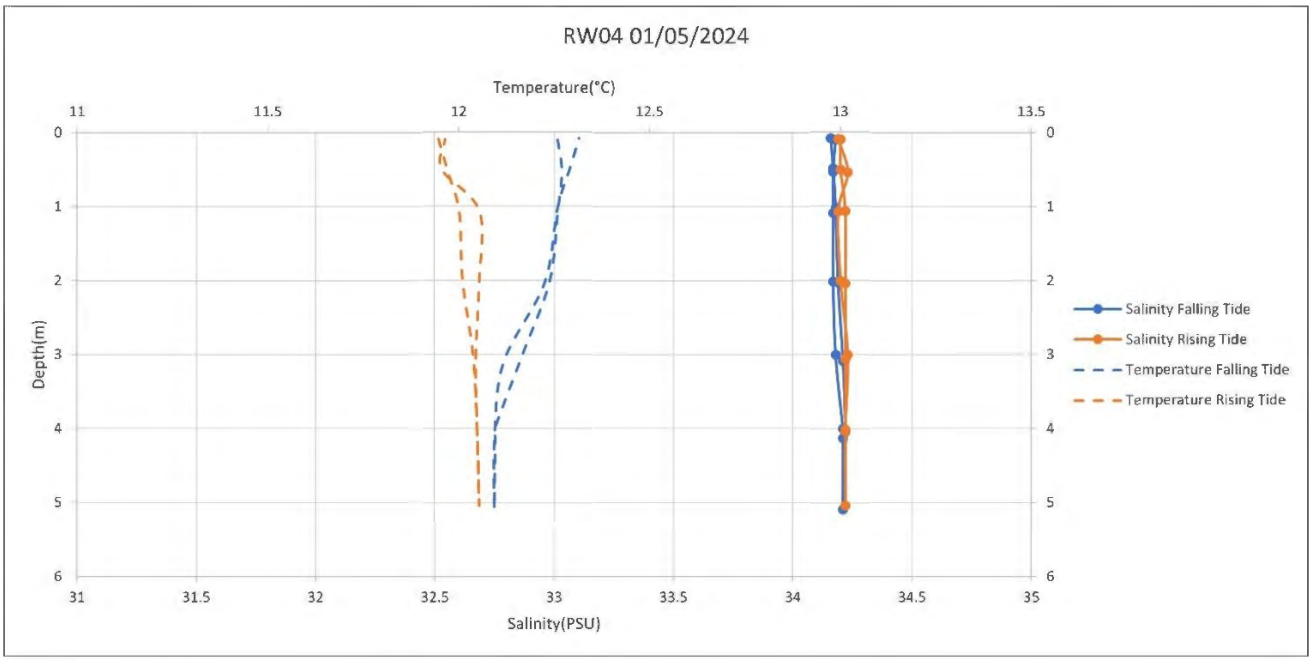

Figure 3-10: RW04 neap tide salinity and temperature profile.

RW04 (51.52177695, -9.426917564) is the inner most of the three central sites (RW04,05&06) On the 11th of March salinity ranged from 33.15 PSU at the surface to 33.78 PSU at the bottom during the ebbing tide, and 33.54 PSU to 33.65 PSU on the flooding tide. Temperature varied from 8.64°C to 9.05°C on the ebbing tide, and 9.14°C to 9.19°C on the flooding tide.

On the 1st of May salinity ranged from 34.19 PSU at the surface to 34.23 PSU at the bottom during the flooding tide, and 34.16 PSU to 34.22 PSU on the ebbing tide. Temperature varied from 11.95°C to 12.06°C on the flooding tide, and 12.09°C to 12.32°C on the ebbing tide.

3.1.2.5 RW05

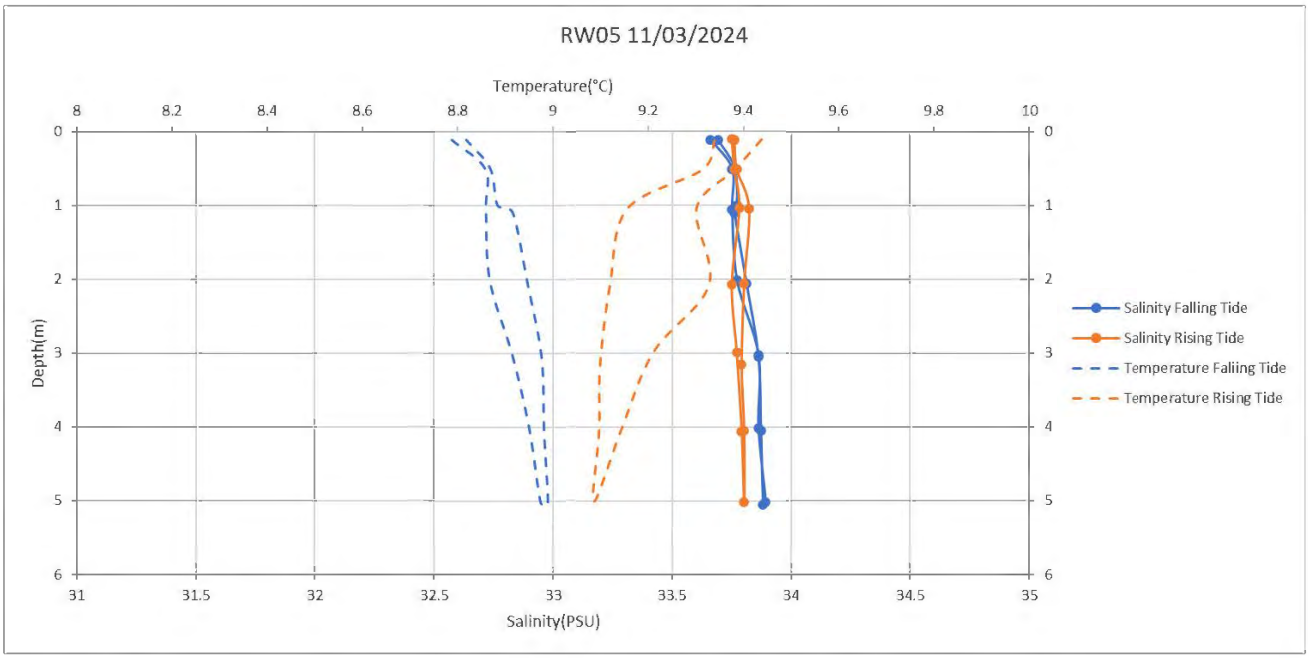

Figure 3-11: RW05 spring tide salinity and temperature profile.

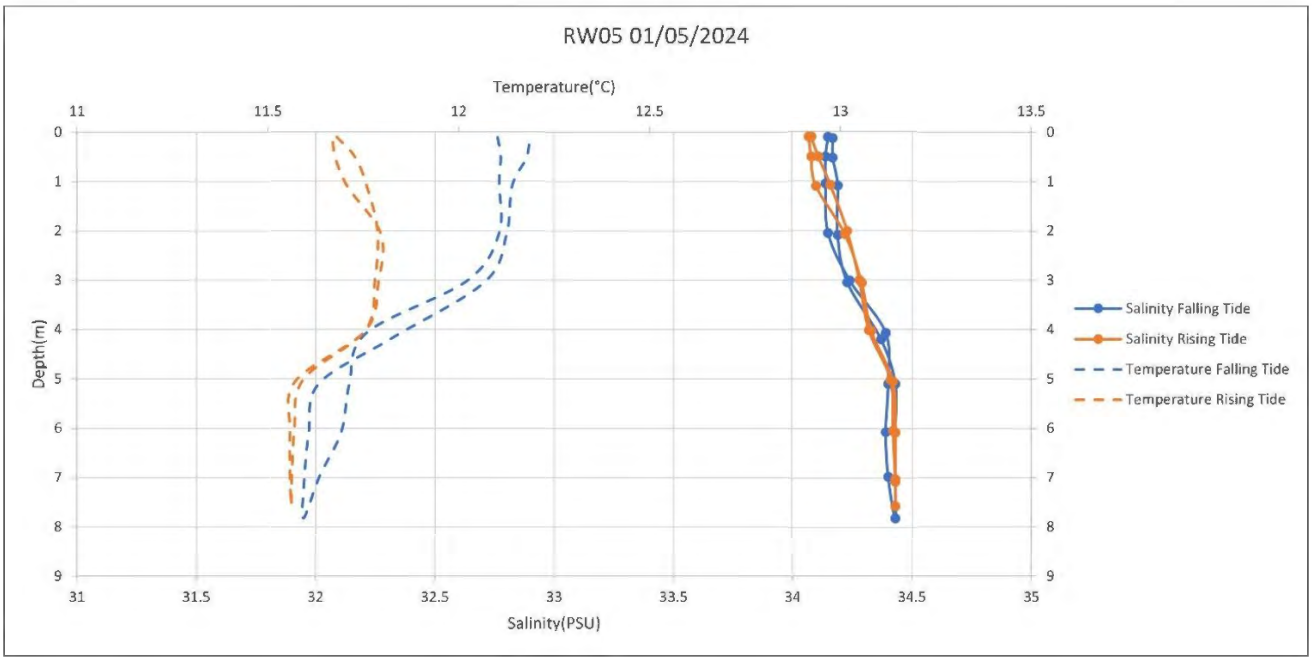

Figure 3-12: RW05 neap tide salinity and temperature profile.

RW05 (51.50982878, -9.435204407) is located less than 700 m northeast of Skeam East. On the 11th of March salinity ranged from 33.66 PSU at the surface to 33.89 PSU at the bottom during the ebbing tide, and 33.75

PSU to 33.82 PSU on the flooding tide. Temperature varied from 8.79°C to 8.99°C on the ebbing tide, and 9.09°C to 9.44°C on the flooding tide.

On the 1st of May salinity ranged from 34.07 PSU at the surface to 34.43 PSU at the bottom during the flooding tide, and 34.14 PSU to 34.43 PSU on the ebbing tide. Temperature varied from 11.56°C to 11.80°C on the flooding tide, and 11.59°C to 12.19°C on the ebbing tide.

3.1.2.6 RW06

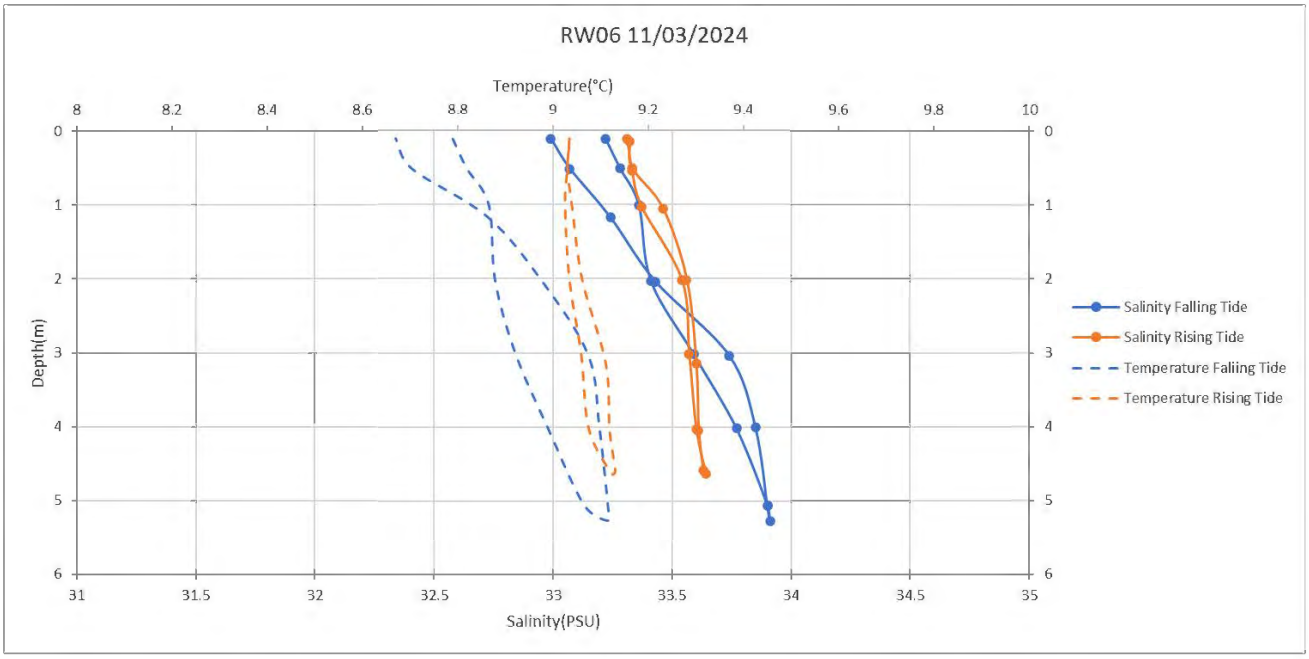

Figure 3-13:RW06 spring tide salinity and temperature profile.

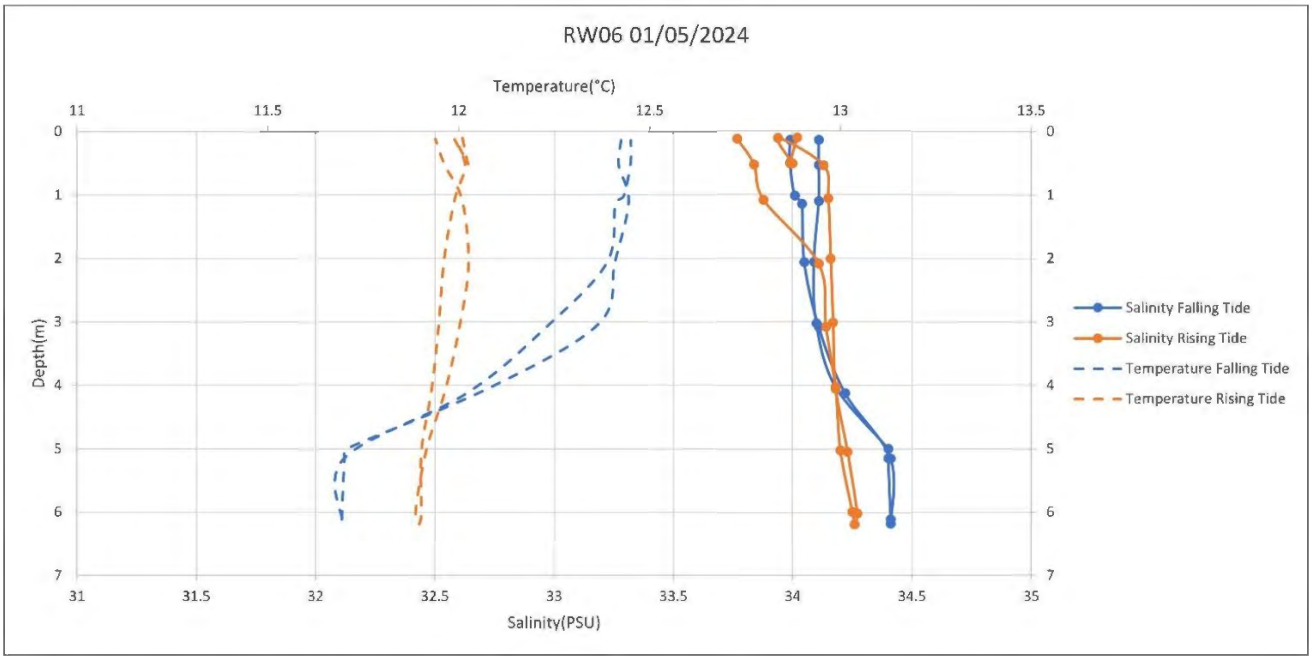

Figure 3-14: RW06 neap tide salinity and temperature profile.

RW06 (51.52081327, -9.446210774) is located less than 750 m northeast of Horse Island. On the 11th of March salinity ranged from 32.99 PSU at the surface to 33.91 PSU at the bottom during the ebbing tide, and 33.31 PSU to 33.64 PSU on the flooding tide. Temperature varied from 8.67°C to 9.12°C on the ebbing tide, and 9.03°C to 9.13°C on the flooding tide.

On the 1st of May salinity ranged from 33.77 PSU at the surface to 34.27 PSU at the bottom during the flooding tide, and 33.99 PSU to 34.41 PSU on the ebbing tide. Temperature varied from 11.89°C to 12.03°C on the flooding tide, and 11.69°C to 12.45°C on the ebbing tide.

3.1.2.7 RW07

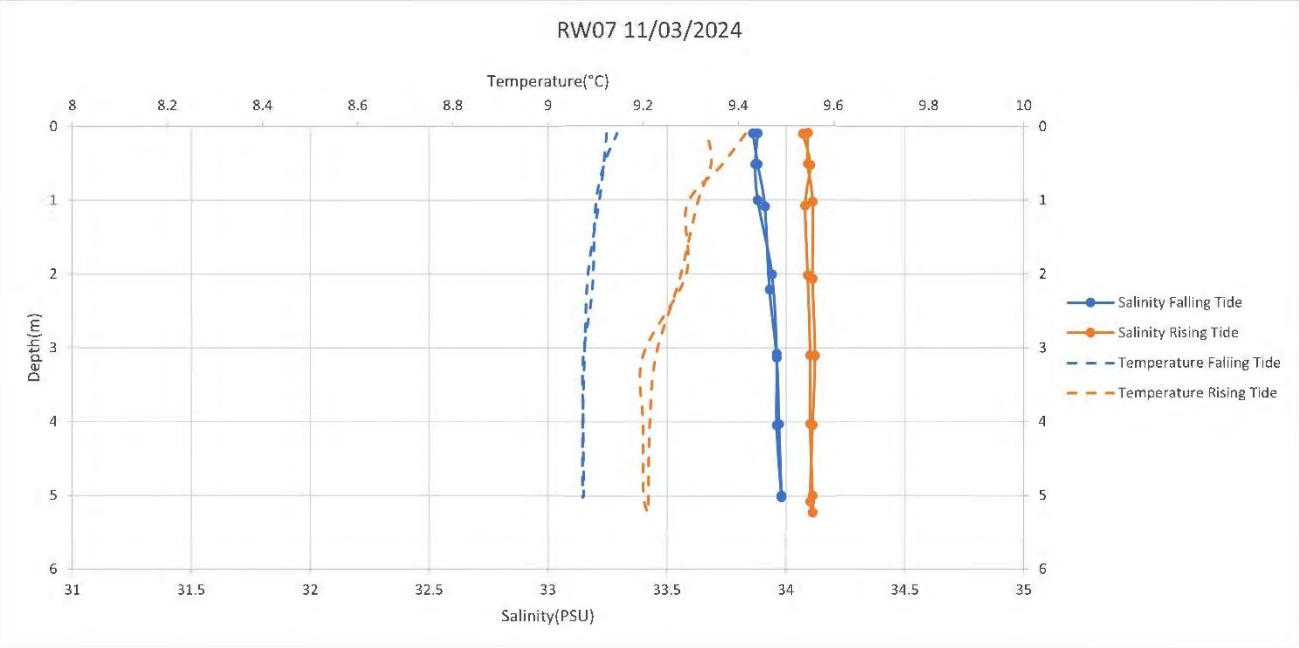

Figure 3-15: RW07 spring tide salinity and temperature profile.

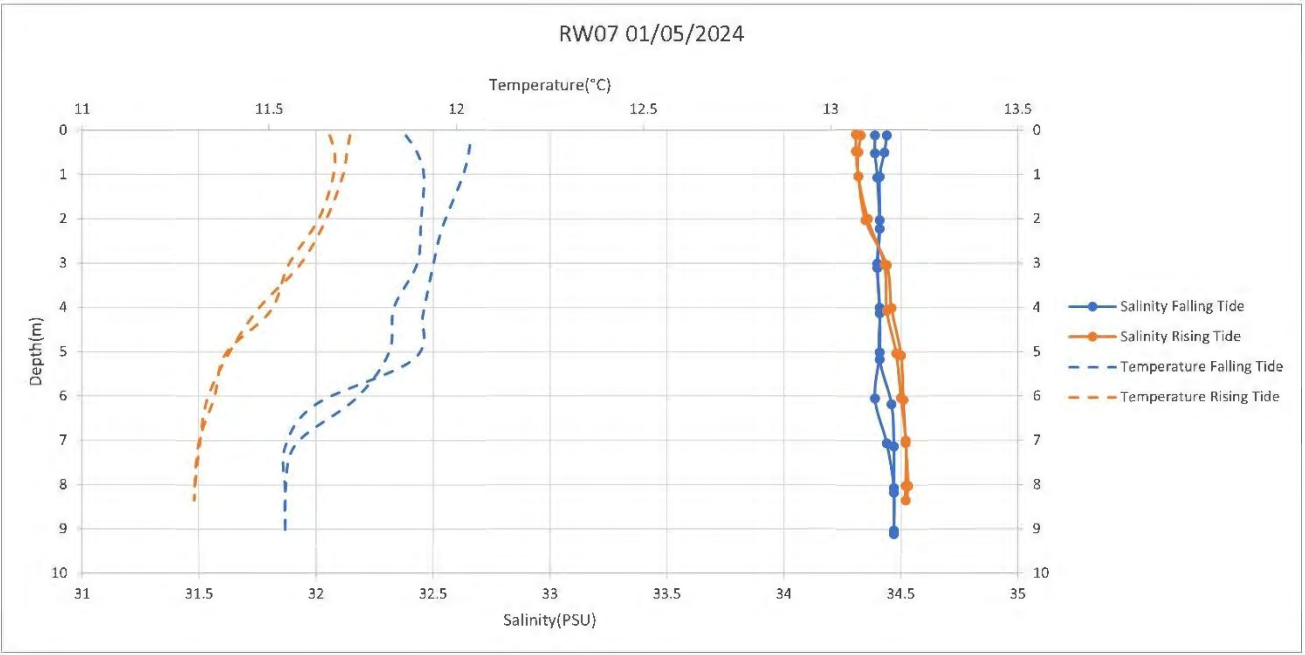

Figure 3-16: RW07 neap tide salinity and temperature profile.

RW07 (51.51841659, -9.488277623) is located west of the passage between Castle and Horse Island. On the 11th of March salinity ranged from 33.86 PSU at the surface to 33.98 PSU at the bottom during the ebbing tide, and 34.07 PSU to 34.12 PSU on the flooding tide. Temperature varied from 9.07°C to 9.15°C on the ebbing tide, and 9.2°C to 9.41°C on the flooding tide.

On the 1st of May salinity ranged from 34.31 PSU at the surface to 34.53 PSU at the bottom during the flooding tide, and 34.39 PSU to 34.47 PSU on the ebbing tide. Temperature varied from 11.3°C to 11.72°C on the flooding tide, and 11.54°C to 12.04°C on the ebbing tide.

3.1.2.8 RW08

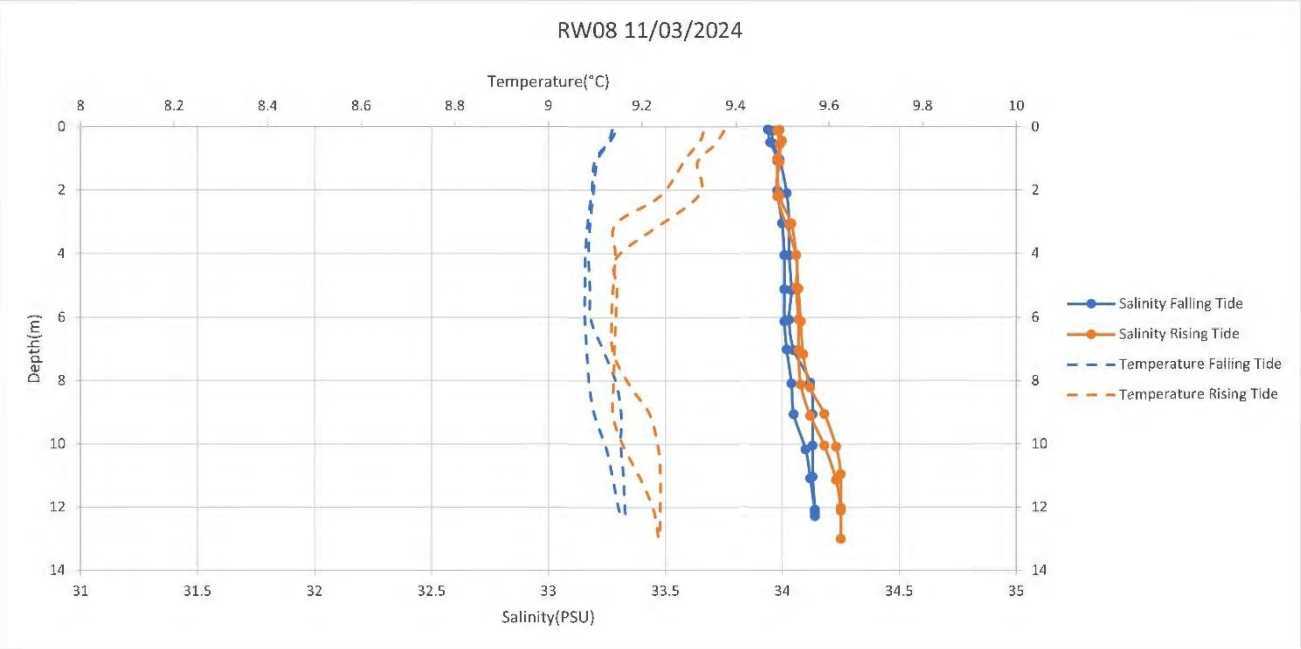

Figure 3-17: RW08 spring tide salinity and temperature profile.

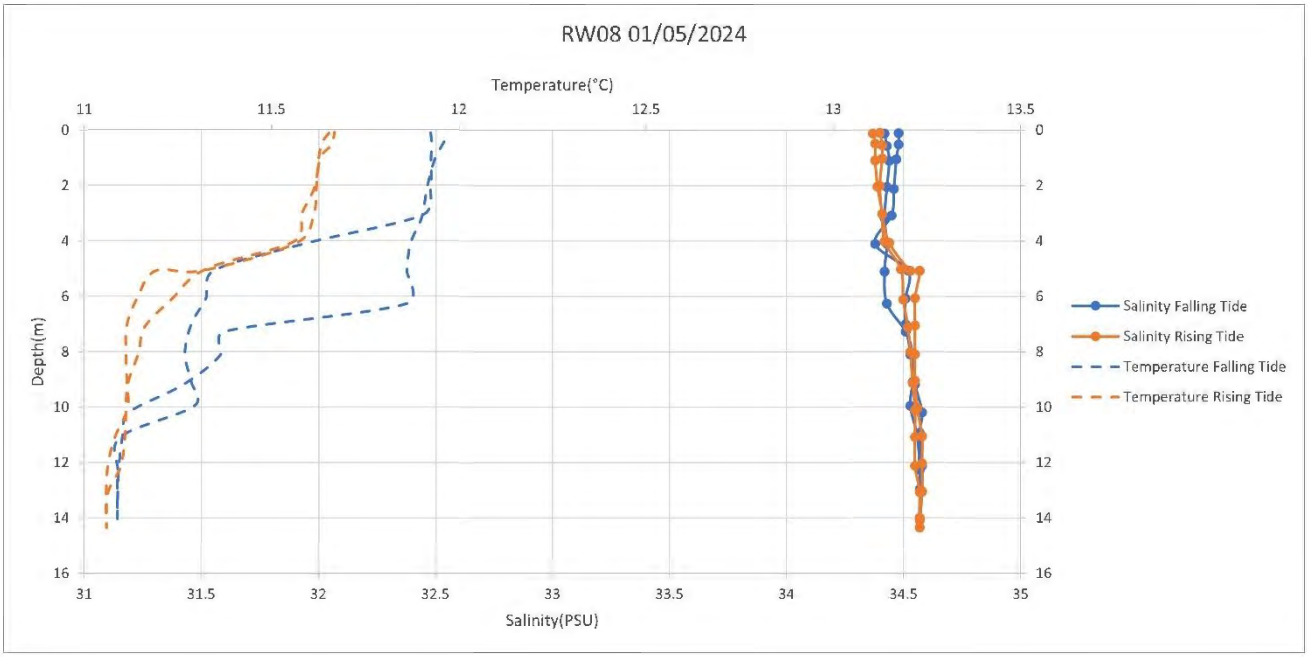

Figure 3-18: RW08 neap tide salinity and temperature profiles.

RW08 (51.51416476, -9.511956747) is located less than 600 m northwest of Castle Island. On the 11th of March salinity ranged from 33.94 PSU at the surface to 34.14 PSU at the bottom during the ebbing tide, and 33.98 PSU to 34.25 PSU on the flooding tide. Temperature varied from 9.08°C to 9.17°C on the ebbing tide, and 9.14°C to 9.37°C on the flooding tide.

On the 1st of May salinity ranged from 34.37 PSU at the surface to 34.58 PSU at the bottom during the flooding tide, and 34.38 PSU to 34.58 PSU on the ebbing tide. Temperature varied from 11.06°C to 11.67°C on the flooding tide, and 11.09°C to 11.97°C on the ebbing tide.

3.1.2.9 RW09

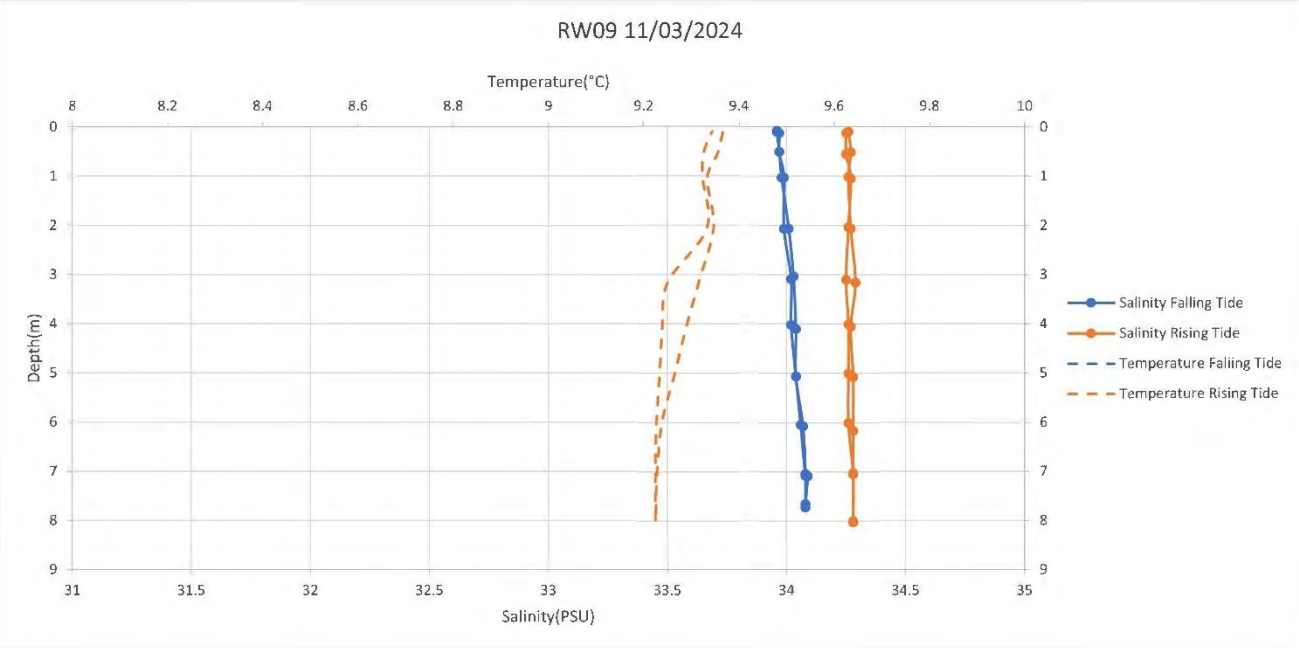

Figure 3-19: RW09 spring tide salinity and temperature profile.

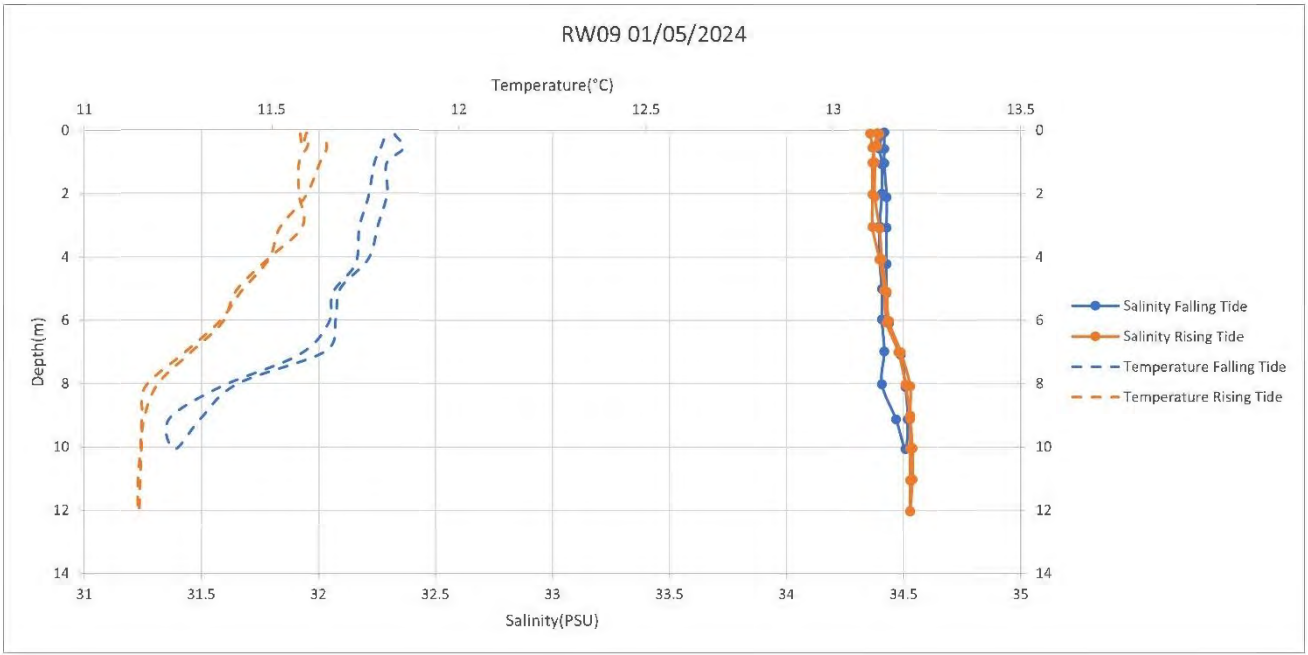

Figure 3-20: RW09 neap tide salinity and temperature profile.

RW09 (51.50203854, -9.476754273) is the final station in the survey and is located just west of Skeam West. On the 11th of March salinity ranged from 33.96 PSU at the surface to 34.09 PSU at the bottom during the

ebbing tide, and 34.25 PSU to 34.29 PSU on the flooding tide. Temperature varied from 9.08°C to 9.12°C on the ebbing tide, and 9.23°C to 9.37°C on the flooding tide.

On the 1st of May salinity ranged from 34.36 PSU at the surface to 34.54 PSU at the bottom during the flooding tide, and 34.4 PSU to 34.52 PSU on the ebbing tide. Temperature varied from 11.14°C to 11.65°C on the flooding tide, and 11.23°C to 11.85°C on the ebbing tide.

3.1.3 Average Site Salinities

In **Figure 3-21** the average salinity of each site (RW01 – 09) is presented. These averages were calculated from each profile recorded for falling and rising tides for the neap and spring cycle. The dashed line represents the trend line for the sites.

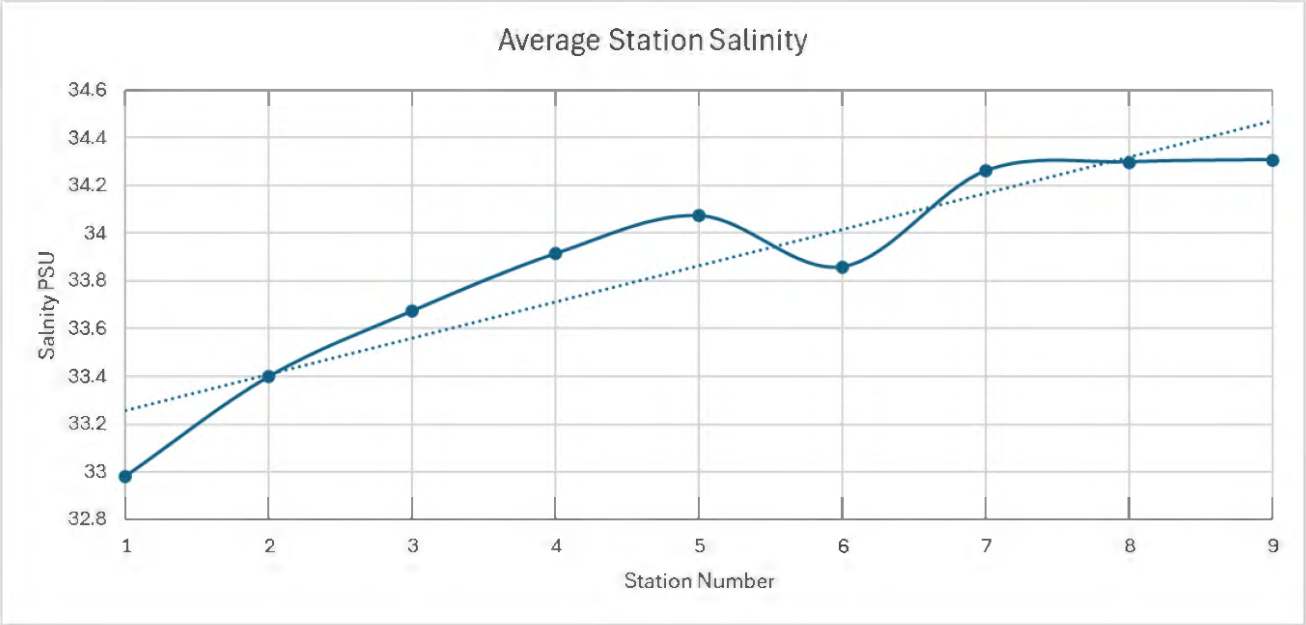

Figure 3-21: Average salinity for each site over the entire survey.

The graph shows the range of approximately 1.3 PSU between site RW01 and site RW09. There is a clear trend of increasing salinity from the inner to outer sites, with the exception of RW06 which demonstrates a minor drop in salinity compared to site RW05. The graph begins to level off at the end around the three outer sites RW07, 08, and 09. Splitting the nine sites into inner (RW01-03), middle (RW04-06), and outer (RW07-09) the average salinities are 33.35, 33.95, and 34.29 PSU, respectively.

3.2 Shellfish Microbiology Survey Results

Of the nine shellfish samples taken, six were below the limits of detection of 18 MPN *E. coli*/100 g. For sampling point T05-499 N1 levels of 230 and 78 MPN/100 g were detected on the 11th and 19th of March, respectively.

Site T05-598A had levels of 230 MPN/100 g on the 19th of March but was below detection limits for the 11th of March and 30th of April. Site T05-497N1 levels remained <18 MPN/100 g over the three sampling occasions.

All levels are relatively low and would fall into the Class A category which requires levels not exceeding 230 *E. coli* per 100 g flesh and intravalvular liquid in 80% of the samples (**Appendix 1: Shellfish Analysis Reports**; note that for samples taken on the 11th and 19th of March from site T05-598A, they are mislabelled on the associated analysis reports as T05-498A).

Table 3.3: Results of shellfish analysis for Roaringwater Bay March and April 2024.

Date Sampled	Sampling Point	Result (MPN/100 g)
11/03/2024	T05-497 N1	<18
	T05-598 A	<18
	T05-499 N1	230
19/03/2024	T05-497 N1	<18
	T05-598 A	230
	T05-499 N1	78
30/04/2024	T05-497 N1	<18
	T05-598 A	<18
	T05-499 N1	<18

Despite *E. coli* results for some months in the period 2021-2024 exceeding the limit of 230 MPN/100 g to achieve an A classification, the status is based on the previous three years of data, therefore Roaringwater Bay has maintained an A classification since 2016 (see Roaringwater Bay 2023 sanitary survey for 2016-2020 *E. coli* results). Furthermore, the results from the 2024 shellfish microbiological survey in March and April align with the current classification status of Roaringwater Bay BMPA.

4. Discussion

The overall purpose of this project was to determine the feasibility of dividing the Roaringwater Bay BMPA into two separate production areas. The collection of the salinity data aimed to help determine if there were differing water masses or patterns of circulation within the production area or whether the area has an overall salinity uniformity. As expected, the lowest salinity measurements were recorded at sites RW01, 02, and 03. This is a result of their proximity to freshwater sources such as the Bawnaknockane, Leamawaddra and Roaringwater Rivers. This lower salinity water is less dense and so sits on top of the higher saline (*i.e.*, denser) seawater as is evident in the salinity profiles. Sites RW01 and 02 are further inland than any of the shellfish production sites and site RW03 is in the same position as aquaculture site T05-311N1. The lowest reading encountered at these sites was 31.61 PSU on the surface of RW01 which would still be classed as marine water rather than brackish. Salinities above 30 are considered euhaline (**Table 4.1**), whereas full seawater, not influenced by freshwater, has a salinity of 35. This reading was taken less than an hour after low water on a spring tide and as such would have been subject to a larger influence of freshwater from the Bawnaknockane River. The salinity of surface seawater is 3.5 parts per hundred which equates to 35 PSU (Harvey, 1955). As such even at the lowest measurement recorded in Roaringwater Bay over the course of the survey the water was still 90% full marine water (**Table 4.1**).

Table 4.1: Characterisation of water bodies based on salinity; table adapted from Directive 2000/60/EC.

Salinity (parts per thousand; ‰)	Type
< 0.5	Freshwater
0.5 - < 5	Oligohaline
5 - < 18	Mesohaline
18 - < 30	Polyhaline
30 - < 40	Euhaline

Moving further into the outer bay average salinities increased and variation between surface and bottom salinity reduced. This can be clearly seen in the salinity profile plots in **section 3.1.2**. At the outer sites salinities rose as high as 34.58 PSU at the bottom of RW08 which, compared with the basic value of 35 PSU, is approximately 98.8% full seawater. The surface readings for RW08 were 34.42 – 34.48 PSU for the high and low water sampling events on the same day. Temperature variations were higher during the neap tidal sampling event. This was likely a result of the time of year with sea surface temperatures increasing and from less mixing because of the lower volume of water movement due to the tidal range.

In summary, the range of salinities encountered over the two sampling dates indicate that the salinity characteristics of Roaringwater Bay are mostly uniform and euhaline in nature with little evidence of significant freshwater influence even towards the more inner sites.

E. coli survival rates decrease as salinity levels change from brackish to marine water (DeVilbiss *et al.*, 2021). In Carlucci and Pramer (1960) it was recorded that the percentage survival of *E. coli* after a 48-hour period

decreased from 74.5% in brackish to 8.2% in full strength seawater. In support of these results Anderson *et al.* (1979), reported a decrease in percentage survival of *E. coli* from 53.5% to 2% as salinity increased from 10 to 30 ppt[2]. As a result, it is not likely that there would be a large difference in the survival rates of *E. coli* between these sites.

The general trend in *E. coli* levels for the period 2021-2023 in Roaringwater Bay are results <230 MPN *E. coli*/100 g, *i.e.*, A classification, though there are spikes in *E. coli* levels in shellfish samples on occasion. The results from shellfish sampling undertaken in March and April 2024 are low (majority <18 MPN *E. coli*/100 g) but only provide a snapshot of the *E. coli* levels at these sites.

As identified in the 2023 Roaringwater Bay sanitary survey, the main sources of *E. coli* contamination are situated in the inner bay hence the positioning of the RMPs. As the hydrodynamic conditions of Roaringwater Bay move *E. coli* contamination from its sources in the inner bay, over the RMPs and into the outer bay, the *E. coli* decays and disperses. Therefore, it is expected that *E. coli* levels in the mid- to outer shellfish sites would be lower than those detected at the RMPs. The findings of the March and April 2024 sampling events corroborate this assumption. For *E. coli* data to be used as justification for splitting Roaringwater Bay into two distinct BMPAs or retaining as one BMPA, more detailed *E. coli* data would need to be collected at the inner and outer parts of the bay to cover various tidal conditions, and *E. coli* input levels over a relatively long period of time (Guanghai Gao, AQUAFACT Numerical Modeller, *pers. comm*).

5. Conclusion

A review of salinity values at three inner bay sites (RW01-03) compared to three outer bay sites (RW07-09) reveals no significant difference, with the inner sites averaging 33.35 PSU and the outer sites averaging 34.29 PSU. Despite some freshwater influences in the inner bay, all sites maintained marine salinity levels. Given the data, there is insufficient justification to divide the bay based on salinity classifications, as the salinity values across all sites fall within the marine range, indicating an overall uniformity in salinity conditions suitable for similar aquaculture practices throughout the bay.

6. Appendix 1: Shellfish Analysis Reports

southern scientific services ltd.

OUR REF: RP 2024 | MI-SFPA 13828 M (Rev 00)

ANALYSIS REPORT

CUSTOMER:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**SAMPLE TYPE:**	Mussels Mytilus edulis	
ADDRESS:	The Pier, Castletownbere, Co.Cork	**CONDITION OF SAMPLE ON RECEIPT:**	Satisfactory	7.5°C
REPORT TO:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**DATE & TIME SAMPLED:**	11/03/2024	09:45
SAMPLED BY:	Shane O'Neill	**DATE / TIME RECEIVED:**	12/03/2024	12:30
SAMPLING PT:	Roaringwater bay 105-497 N1	**DATE ANALYSED:**	12/3/24-14/3/24	
ORDER NO:	MI-24-0072	**ISSUE DATE**	14/03/2024	
PROPOSAL NO:	13P-148	**WORK NO.:**	13828 M	

TABLE OF RESULTS

Sample ID	Method:	Parameter (D)	Result	Units
M24-00146	SMP 018 based on ISO 16649-3:2015	*E. coli*	<18	MPN/100g

QUALITY CONTROL

TEST STRAINS	RESULT
E. coli NCTC 12923	Satisfactory
E. coli NCTC 13216	Satisfactory
E. faecalis NCTC 775	Satisfactory
Ps. aeruginosa NCTC 12903	Satisfactory
Blank	Satisfactory

Index of symbols used

(F)	Analysis carried out at our Farranfore Laboratory
(D)	Analysis carried out at our Dunrine Laboratory

Louise Moynan

Louise Moynan
Microbiology Analyst

The results relate only to the items tested.
Opinions and interpretations expressed herein are outside the scope of INAB accreditation.
The analysis report shall not be reproduced except in full without written approval of the laboratory.
Sampling is outside the scope of the laboratory activities.

(registered office)
4 park business centre | farranfore | county kerry | ireland | telephone +353 66 976 3588 | fax +353 66 976 3589
dunrine | killarney | county kerry | ireland | telephone +353 64 66 33922 | fax +353 64 66 39022
web site www.southernscientificireland.com | e-mail info@southernscientificireland.com
directors: K. Murphy, M. Murphy & C. Murphy
registered in ireland no 323196 | vat reg no IE 6343196 M

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.194T

southern scientific services ltd.

OUR REF: RP 2024 | MI-SFPA 13830 M (Rev 00)

ANALYSIS REPORT

CUSTOMER:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**SAMPLE TYPE:**	Mussels Mytilus edulis	
ADDRESS:	The Pier, Castletownbere, Co.Cork	**CONDITION OF SAMPLE ON RECEIPT:**	Satisfactory	9°C
REPORT TO:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**DATE & TIME SAMPLED:**	11/03/2024	11:30
SAMPLED BY:	Shane O'Neill	**DATE / TIME RECEIVED:**	12/03/2024	12:30
SAMPLING PT:	Roaringwater bay 105-498 A	**DATE ANALYSED:**	12/3/24-14/3/24	
ORDER NO:	MI-24-0072	**ISSUE DATE**	14/03/2024	
PROPOSAL NO:	13P-148	**WORK NO.:**	13830 M	

TABLE OF RESULTS

Sample ID	Method:	Parameter (D)	Result	Units
M24-00148	SMP 018 based on ISO 16649-3:2015	*E. coli*	<18	MPN/100g

QUALITY CONTROL

TEST STRAINS	RESULT
E. coli NCTC 12923	Satisfactory
E. coli NCTC 13216	Satisfactory
E. faecalis NCTC 775	Satisfactory
Ps. aeruginosa NCTC 12903	Satisfactory
Blank	Satisfactory

Index of symbols used

(F)	Analysis carried out at our Farranfore Laboratory
(D)	Analysis carried out at our Dunrine Laboratory

Louise Moynan

Louise Moynan
Microbiology Analyst

The results relate only to the items tested.
Opinions and interpretations expressed herein are outside the scope of INAB accreditation.
The analysis report shall not be reproduced except in full without written approval of the laboratory.
Sampling is outside the scope of the laboratory activities.

(registered office)
4 park business centre | farranfore | county kerry | ireland | telephone +353 66 976 3588 | fax +353 66 976 3589
dunrine | killarney | county kerry | ireland | telephone +353 64 66 33922 | fax +353 64 66 39022
web site www.southernscientificireland.com | e-mail info@southernscientificireland.com
directors: K. Murphy, M. Murphy & C. Murphy
registered in ireland no 323196 | vat reg no IE 6343196 M

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.194T

southern scientific services ltd.

OUR REF: RP 2024 | MI-SFPA 13829 M (Rev 00)

ANALYSIS REPORT

CUSTOMER:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**SAMPLE TYPE:**	Mussels Mytilus edulis	
ADDRESS:	The Pier, Castletownbere, Co.Cork	**CONDITION OF SAMPLE ON RECEIPT:**	Satisfactory	8.7°C
REPORT TO:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**DATE & TIME SAMPLED:**	11/03/2024	10:45
SAMPLED BY:	Shane O'Neill	**DATE / TIME RECEIVED:**	12/03/2024	12:30
SAMPLING PT:	Roaringwater bay 105-499 N1	**DATE ANALYSED:**	12/3/24-14/3/24	
ORDER NO:	MI-24-0072	**ISSUE DATE**	14/03/2024	
PROPOSAL NO:	13P-148	**WORK NO.:**	13829 M	

TABLE OF RESULTS

Sample ID	Method:	Parameter (D)	Result	Units
M24-00147	SMP 018 based on ISO 16649-3:2015	*E. coli*	230	MPN/100g

QUALITY CONTROL

TEST STRAINS	RESULT
E. coli NCTC 12923	Satisfactory
E. coli NCTC 13216	Satisfactory
E. faecalis NCTC 775	Satisfactory
Ps. aeruginosa NCTC 12903	Satisfactory
Blank	Satisfactory

Index of symbols used

(F)	Analysis carried out at our Farranfore Laboratory
(D)	Analysis carried out at our Dunrine Laboratory

Louise Moynan

Louise Moynan
Microbiology Analyst

The results relate only to the items tested.
Opinions and interpretations expressed herein are outside the scope of INAB accreditation.
The analysis report shall not be reproduced except in full without written approval of the laboratory.
Sampling is outside the scope of the laboratory activities.

(registered office)
4 park business centre | farranfore | county kerry | ireland | telephone +353 66 976 3588 | fax +353 66 976 3589
dunrine | killarney | county kerry | ireland | telephone +353 64 66 33922 | fax +353 64 66 39022
web site www.southernscientificireland.com | e-mail info@southernscientificireland.com
directors: K. Murphy, M. Murphy & C. Murphy
registered in ireland no 323196 | vat reg no IE 6343196 M

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.194T

southern scientific services ltd.

OUR REF: RP 2024 | MI-SFPA 13839 M (Rev 00)

ANALYSIS REPORT

CUSTOMER:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**SAMPLE TYPE:**	Mussels Mytilus edulis	
ADDRESS:	Castletownbere	**CONDITION OF SAMPLE ON RECEIPT:**	Satisfactory	10.5°C
REPORT TO:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**DATE & TIME SAMPLED:**	19/03/2024	09:30
SAMPLED BY:	Shane O'Neill	**DATE / TIME RECEIVED:**	20/03/2024	12:45
SAMPLING PT:	Roaringwater Bay T05-497N1	**DATE ANALYSED:**	20/3/24-22/3/24	
ORDER NO:	MI-24-0072	**ISSUE DATE**	22/03/2024	
PROPOSAL NO:	13P-148	**WORK NO.:**	13839 M	

TABLE OF RESULTS

Sample ID	Method:	Parameter (D)	Result	Units
M24-00162	SMP 018 based on ISO 16649-3:2015	*E. coli*	<18	MPN/100g

QUALITY CONTROL

TEST STRAINS	RESULT
E. coli NCTC 12923	Satisfactory
E. coli NCTC 13216	Satisfactory
E. faecalis NCTC 775	Satisfactory
Ps. aeruginosa NCTC 12903	Satisfactory
Blank	Satisfactory

Index of symbols used

(F)	Analysis carried out at our Farranfore Laboratory
(D)	Analysis carried out at our Dunrine Laboratory

Louise Moynan

Louise Moynan
Microbiology Analyst

The results relate only to the items tested.
Opinions and interpretations expressed herein are outside the scope of INAB accreditation.
The analysis report shall not be reproduced except in full without written approval of the laboratory.
Sampling is outside the scope of the laboratory activities.

(registered office)
4 park business centre | farranfore | county kerry | ireland | telephone +353 66 976 3588 | fax +353 66 976 3589
dunrine | killarney | county kerry | ireland | telephone +353 64 66 33922 | fax +353 64 66 39022
web site www.southernscientificireland.com | e-mail info@southernscientificireland.com
directors: K. Murphy, M. Murphy & C. Murphy
registered in ireland no 323196 | vat reg no IE 6343196 M

southern scientific services ltd.

OUR REF: RP 2024 | MI-SFPA 13842 M (Rev 00)

ANALYSIS REPORT

CUSTOMER:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**SAMPLE TYPE:**	Mussels Mytilus edulis	
ADDRESS:	Castletownbere	**CONDITION OF SAMPLE ON RECEIPT:**	Satisfactory	11.6°C
REPORT TO:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**DATE & TIME SAMPLED:**	19/03/2024	10:00
SAMPLED BY:	Shane O'Neill	**DATE / TIME RECEIVED:**	20/03/2024	12:45
SAMPLING PT:	Roaring water bay T05-498A	**DATE ANALYSED:**	20/3/24-22/3/24	
ORDER NO:	MI-24-0072	**ISSUE DATE**	22/03/2024	
PROPOSAL NO:	13P-148	**WORK NO.:**	13842 M	

TABLE OF RESULTS

Sample ID	Method:	Parameter (D)	Result	Units
M24-00165	SMP 018 based on ISO 16649-3:2015	*E. coli*	230	MPN/100g

QUALITY CONTROL

TEST STRAINS	RESULT
E. coli NCTC 12923	Satisfactory
E. coli NCTC 13216	Satisfactory
E. faecalis NCTC 775	Satisfactory
Ps. aeruginosa NCTC 12903	Satisfactory
Blank	Satisfactory

Index of symbols used

(F)	Analysis carried out at our Farranfore Laboratory
(D)	Analysis carried out at our Dunrine Laboratory

Louise Moynan

Louise Moynan
Microbiology Analyst

The results relate only to the items tested.
Opinions and interpretations expressed herein are outside the scope of INAB accreditation.
The analysis report shall not be reproduced except in full without written approval of the laboratory.
Sampling is outside the scope of the laboratory activities.

(registered office)
4 park business centre | farranfore | county kerry | ireland | telephone +353 66 976 3588 | fax +353 66 976 3589
dunrine | killarney | county kerry | ireland | telephone +353 64 66 33922 | fax +353 64 66 39022
web site www.southernscientificireland.com | e-mail info@southernscientificireland.com
directors: K. Murphy, M. Murphy & C. Murphy
registered in ireland no 323196 | vat reg no IE 6343196 M

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.194T

southern scientific services ltd.

OUR REF: RP 2024 | MI-SFPA 13843 M (Rev 00)

ANALYSIS REPORT

CUSTOMER:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**SAMPLE TYPE:**	Mussels Mytilus edulis	
ADDRESS:	Castletownbere	**CONDITION OF SAMPLE ON RECEIPT:**	Satisfactory	11.2°C
REPORT TO:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**DATE & TIME SAMPLED:**	19/03/2024	11:00
SAMPLED BY:	Shane O'Neill	**DATE / TIME RECEIVED:**	20/03/2024	12:45
SAMPLING PT:	Roaringwater bay T05-499N1	**DATE ANALYSED:**	20/3/24-22/3/24	
ORDER NO:	MI-24-0072	**ISSUE DATE**	22/03/2024	
PROPOSAL NO:	13P-148	**WORK NO.:**	13843 M	

TABLE OF RESULTS

Sample ID	Method:	Parameter (D)	Result	Units
M24-00166	SMP 018 based on ISO 16649-3:2015	*E. coli*	78	MPN/100g

QUALITY CONTROL

TEST STRAINS	RESULT
E. coli NCTC 12923	Satisfactory
E. coli NCTC 13216	Satisfactory
E. faecalis NCTC 775	Satisfactory
Ps. aeruginosa NCTC 12903	Satisfactory
Blank	Satisfactory

Index of symbols used

(F)	Analysis carried out at our Farranfore Laboratory
(D)	Analysis carried out at our Dunrine Laboratory

Louise Moynan

Louise Moynan
Microbiology Analyst

The results relate only to the items tested.
Opinions and interpretations expressed herein are outside the scope of INAB accreditation.
The analysis report shall not be reproduced except in full without written approval of the laboratory.
Sampling is outside the scope of the laboratory activities.

(registered office)
4 park business centre | farranfore | county kerry | ireland | telephone +353 66 976 3588 | fax +353 66 976 3589
dunrine | killarney | county kerry | ireland | telephone +353 64 66 33922 | fax +353 64 66 39022
web site www.southernscientificireland.com | e-mail info@southernscientificireland.com
directors: K. Murphy, M. Murphy & C. Murphy
registered in ireland no 323196 | vat reg no IE 6343196 M

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.194T

southern scientific services ltd.

OUR REF: RP 2024 | MI-SFPA 13914 M (Rev 01:03/05/2024)

ANALYSIS REPORT

CUSTOMER:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**SAMPLE TYPE:**	Mussels Mytilus edulis	
ADDRESS:	Castletownbere	**CONDITION OF SAMPLE ON RECEIPT:**	satisfactory	6.1°C
REPORT TO:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**DATE & TIME SAMPLED:**	30/04/2024	16:00
SAMPLED BY:	Una Ni Charra	**DATE / TIME RECEIVED:**	01/05/2024	14:05
SAMPLING PT:	Roaringwater Bay T05-497N1	**DATE ANALYSED:**	01/05/24-03/05/24	
ORDER NO:	MI-24-0072	**ISSUE DATE**	03/05/2024	
PROPOSAL NO:	13P-148	**WORK NO.:**	13914 M	

TABLE OF RESULTS

Sample ID	Method:	Parameter (D)	Result	Units
M24-00269	SMP 018 based on ISO 16649-3:2015	*E. coli*	<18	MPN/100g

QUALITY CONTROL

TEST STRAINS	RESULT
E. coli NCTC 12923	Satisfactory
E. coli NCTC 13216	Satisfactory
E. faecalis NCTC 775	Satisfactory
Ps. aeruginosa NCTC 12903	Satisfactory
Blank	Satisfactory

Index of symbols used

(F)	Analysis carried out at our Farranfore Laboratory
(D)	Analysis carried out at our Dunrine Laboratory

Louise Moynan

Louise Moynan
Microbiology Analyst

The results relate only to the items tested.
Opinions and interpretations expressed herein are outside the scope of INAB accreditation.
The analysis report shall not be reproduced except in full without written approval of the laboratory.
Sampling is outside the scope of the laboratory activities.

(registered office)
4 park business centre | farranfore | county kerry | ireland | telephone +353 66 976 3588 | fax +353 66 976 3589
dunrine | killarney | county kerry | ireland | telephone +353 64 66 33922 | fax +353 64 66 39022
web site www.southernscientificireland.com | e-mail info@southernscientificireland.com
directors: K. Murphy, M. Murphy & C. Murphy
registered in ireland no 323196 | vat reg no IE 6343196 M

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.194T

southern scientific services ltd.

OUR REF: RP 2024 | MI-SFPA 13916 M (Rev 01: 03/05/2024)

ANALYSIS REPORT

CUSTOMER:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**SAMPLE TYPE:**	Mussels Mytilus edulis	
ADDRESS:	Castletownbere	**CONDITION OF SAMPLE ON RECEIPT:**	satisfactory	6.6°C
REPORT TO:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**DATE & TIME SAMPLED:**	30/04/2024	16:00
SAMPLED BY:	Una Ni Charra	**DATE / TIME RECEIVED:**	01/05/2024	14:05
SAMPLING PT:	Roaringwater Bay T05-598A	**DATE ANALYSED:**	01/05/24-03/05/24	
ORDER NO:	MI-24-0072	**ISSUE DATE**	03/05/2024	
PROPOSAL NO:	13P-148	**WORK NO.:**	13916 M	

TABLE OF RESULTS

Sample ID	Method:	Parameter (D)	Result	Units
M24-00271	SMP 018 based on ISO 16649-3:2015	*E. coli*	<18	MPN/100g

QUALITY CONTROL

TEST STRAINS	RESULT
E. coli NCTC 12923	Satisfactory
E. coli NCTC 13216	Satisfactory
E. faecalis NCTC 775	Satisfactory
Ps. aeruginosa NCTC 12903	Satisfactory
Blank	Satisfactory

Index of symbols used

(F)	Analysis carried out at our Farranfore Laboratory
(D)	Analysis carried out at our Dunrine Laboratory

Louise Moynan

Louise Moynan
Microbiology Analyst

The results relate only to the items tested.
Opinions and interpretations expressed herein are outside the scope of INAB accreditation.
The analysis report shall not be reproduced except in full without written approval of the laboratory.
Sampling is outside the scope of the laboratory activities.

(registered office)
4 park business centre | farranfore | county kerry | ireland | telephone +353 66 976 3588 | fax +353 66 976 3589
dunrine | killarney | county kerry | ireland | telephone +353 64 66 33922 | fax +353 64 66 39022
web site www.southernscientificireland.com | e-mail info@southernscientificireland.com
directors: K. Murphy, M. Murphy & C. Murphy
registered in ireland no 323196 | vat reg no IE 6343196 M

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.194T

southern scientific services ltd.

OUR REF: RP 2024 | MI-SFPA 13915 M (Rev 01: 03/05/2024)

ANALYSIS REPORT

CUSTOMER:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**SAMPLE TYPE:**	Mussels Mytilus edulis	
ADDRESS:	Castletownbere	**CONDITION OF SAMPLE ON RECEIPT:**	satisfactory	6.2°C
REPORT TO:	MARINE INSTITUTE SEA FISHERIES PROTECTION AUTHORITY	**DATE & TIME SAMPLED:**	30/04/2024	16:00
SAMPLED BY:	Una Ni Charra	**DATE / TIME RECEIVED:**	01/05/2024	14:05
SAMPLING PT:	Roaringwater Bay T05-499N1	**DATE ANALYSED:**	01/05/24-03/05/24	
ORDER NO:	MI-24-0072	**ISSUE DATE**	03/05/2024	
PROPOSAL NO:	13P-148	**WORK NO.:**	13915 M	

TABLE OF RESULTS

Sample ID	Method:	Parameter (D)	Result	Units
M24-00270	SMP 018 based on ISO 16649-3:2015	*E. coli*	<18	MPN/100g

QUALITY CONTROL

TEST STRAINS	RESULT
E. coli NCTC 12923	Satisfactory
E. coli NCTC 13216	Satisfactory
E. faecalis NCTC 775	Satisfactory
Ps. aeruginosa NCTC 12903	Satisfactory
Blank	Satisfactory

Index of symbols used

(F)	Analysis carried out at our Farranfore Laboratory
(D)	Analysis carried out at our Dunrine Laboratory

Louise Moynan

Louise Moynan
Microbiology Analyst

The results relate only to the items tested.
Opinions and interpretations expressed herein are outside the scope of INAB accreditation.
The analysis report shall not be reproduced except in full without written approval of the laboratory.
Sampling is outside the scope of the laboratory activities.

(registered office)
4 park business centre | farranfore | county kerry | ireland | telephone +353 66 976 3588 | fax +353 66 976 3589
dunrine | killarney | county kerry | ireland | telephone +353 64 66 33922 | fax +353 64 66 39022
web site www.southernscientificireland.com | e-mail info@southernscientificireland.com
directors: K. Murphy, M. Murphy & C. Murphy
registered in ireland no 323196 | vat reg no IE 6343196 M

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO.194T

7. References

Anderson, I.C., Rhodes, M., & Kator, H. (1979). "Sublethal stress in *Escherichia coli*: a function of salinity". *Applied Environmental Microbiology*, 38 (6), 1147-1152. 10.1128/aem.38.6.1147-1152.1979

Carlucci, A.F., & Pramer, D. (1960). "An Evaluation of Factors Affecting the Survival of *Escherichia coli* in Sea Water". *Applied Microbiology*., 8 (4), 247-250. 10.1128/am.8.4.247-250.1960

DeVilbiss, S.E., Steele, M.K., Krometis, L.H., & Badgley, B.D. (2021). "Freshwater salinization increases survival of *Escherichia coli* and risk of bacterial impairment". *Water Research*, 191.

Harvey, H. W. (1955). "The chemistry and fertility of seawaters". *Cambridge university Press*, **5** (**5**).

8. List of Endnotes

[1] NPWS. 2014. Roaringwater Bay and Islands SAC (Site Code: IE000101) Site Synopsis. https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY000101.pdf.

[2] Practical salinity units (PSU) is an equivalent unit of salinity measurement to parts per thousand (ppt).

13.References

Alderisio, K.A., & N. DeLuca. 1999. Seasonal Enumeration of Fecal Coliform Bacteria from the Feces of Ring-Billed Gulls (*Larus delawarensis*) and Canada Geese (*Branta canadensis*). *Appl. Environ. Microbiol*. **65:**655628–5630.

Crowther, J., Kay, D. & M.D. Wyer. 2002. Faecal indicator concentrations in waters draining lowland pastoral catchments in the UK: relationships with land use and farming practices. *Water Research* **36:** 1725-1734.

CSO. 2016. Census Mapping 2016 Settlements. https://visual.cso.ie/?body=entity/ima/cop/2016&boundary=C03899V04650&guid=75397936-23B2-458B-94C4-EA7695CC5B11 Accessed November 2022.

CSO. 2019a. Census 2016 Small Area Population Statistics. http://census.cso.ie/sapmap/ Accessed March 2019.

CSO. 2019b. Census of Agriculture 2010. http://census.cso.ie/censusagriculture Accessed March 2019.

DAFM. 2022. Licenced Aquaculture Sites. November 2022.

Elmir, S.M., Wright, M.E., Abdelzaher, A., Solo-Gabriele, H.M., Fleming, L.E., Miller, G., Rybolowik, M, Shih, M.-T.P., Pillai, S.P., Cooper, J.A & E.A. Quaye. 2007. Quantitative evaluation of bacteria released by bathers in a marine water. *Water Research*, **41(1):** 3-10.

EPA. 2019. WFD Status 2010 – 2015. https://gis.epa.ie/EPAMaps/ Accessed March 2020.

EPA. 2019a. WWTP locations https://gis.epa.ie/EPAMaps/SewageTreatment Accessed March 2019.

EPA. 2019b. EPA licenced facilities (IPC, IEL and Waste) http://gis.epa.ie/GetData/Download Accessed March 2019.

EPA. 2019c. WFD Section 4 Discharges http://gis.epa.ie/GetData/Download Accessed March 2019.

EPA. 2019d. Corine Land use http://gis.epa.ie/GetData/Download Accessed March 2019

Failte Ireland. 2018a. Tourism Facts 2017. Issued by Research Unit, Failte Ireland July 2018. http://www.failteireland.ie/FailteIreland/media/WebsiteStructure/Documents/3_Research_Insights/5_International_Tourism_Trends/Tourism-Facts-2017_1.pdf?ext=.pdf

Failte Ireland. 2018b. 2017 Topline Performance by County. http://www.failteireland.ie/FailteIreland/media/WebsiteStructure/Documents/3_Research_Insights/2_Regional_SurveysReports/2017-topline-regional-performance-(003).pdf?ext=.pdf

Fitzgerald D. L. 2007. Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin

Irish Hydrodata Limited. 2007. Report on Marine Outfall Studies at Ballydehob, Co. Cork. Document Ref 1030-1/07. http://www.hydrodata.ie/index.php

Ishii, S., Hansen, D.L., Hicks, R.E., & M.J. Sadowsky. 2007. Beach sand and sediments are temporal sinks and sources of *Escherichia coli* in Lake Superior. *Environ. Sci. Technol*. **41:**2203–2209.

Jones, F. & R.W. White. 1984. Health and amenity aspects of surface waters. *Water Pollution Control* **Vol. 83:** 215-225.

Jones, F., Smith, P., & D.C. Watson. 1978. Pollution of a water supply catchment by breeding gulls and the potential of environmental health implications. *J. Institution of Water Engineers and Scientists* **32:**469–482.

Kochmann, Judith & Yearsley, Jon & O'Beirn, F.X. & Crowe, Tasman. (2013). Environmental factors associated with invasion: Modelling occurrence data from a coordinated sampling programme for Pacific oysters. Biological Invasions. 15. 10.1007/s10530---013---.

Levesque, B., Brousseau, P., Simard, P., Dewailly, Meisels, M., Ramsay, D. & J. Joly. 1993. Impact of the Ring-Billed Gull (*Larus delawarensis*) on the Microbiological Quality of Recreational Water. *Applied and Environmental* Microbiology 1228-1230.

Levesque, B., Brousseau, P., Bernier, F., Dewailly, E & J. Joly. 2000. Study of the content of ring-billed gull droppings in relation to recreational water quality. *Water Res*. **34:**1089–1096.

Met Eireann. 2019. The current rainfall Irish climatology and the long term average period 1981 to 2010. https://www.met.ie/climate/what-we-measure/rainfall Accessed February 2019.

Met Eireann. 2020a. Historical Data Sherkin Island 2016-2020. https://www.met.ie/climate/available-data/historical-data Accessed February 2021.

Met Eireann. 2020b. Valentia 1981-2010 averages. https://www.met.ie/climate-ireland/1981-2010/valentia.html Accessed March 2021.

Met Eireann. 2020c. return period rainfall depths for sliding durations (101009E; 034538N). https://www.met.ie/climate/services.

NPWS. 2011. Harbour Seal Pilot Monitoring Project, 2010. Unpublished

NPWS. 2014. Roaringwater Bay and Islands SAC (Site Code: IE000101) Site Synopsis. https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY000101.pdf.

NPWS. 2015. Sheep's Head to Toe Head SPA (Site Code: IE004156) Site Synopsis. https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY004156.pdf.

Oshira, R. & R. Fujioka. 1995. Sand, soil, and pigeon droppings: Sources of indicator bacteria in the waters of Hanauma Bay, Oahu, Hawaii. *Water Sci. Technol*. **31:** 251–254.

Papadakis, J.A., Mavridou, A., Richardson, S.C., Lampiri, M. & U. Marcelou. 1997. Bather-related microbial and yeast populations in sand and seawater. *Water Research*, **314:** 799-804.

Ploeg, J.A., Smink, T., & Smit, D. 2014. Distribution, activity patterns and genetic relations of Eurasian otter (*Lutra lutra*) in Roaring Water Bay, Ireland.

Standridge, J.H., Delfino, J.J., Kleppe, L.B., & R. Butler. 1979. Effect of waterfowl (*Anas platyrhynchos*) on indicator bacteria populations in a recreational lake in Madison, Wisconsin. *Appl. Environ. Microbiol*. **38:**547–550.