EC Regulation 854/2004

CLASSIFICATION OF BIVALVE MOLLUSC PRODUCTION AREAS IN ENGLAND AND WALES

SANITARY SURVEY REPORT

Port Quin Bay (Cornwall)

2009

Cover photo: view of Sandinway Beach from the southern limit of the bivalve mollusc production area.

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STATEMENT OF USE: This report provides information from a study of the information available relevant to perform a sanitary survey of a bivalve mollusc production area in Port Quin Bay. Its primary purpose is to demonstrate compliance with the requirements for classification of bivalve mollusc production areas, determined in EC Regulation 854/2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption. The Centre for Environment, Fisheries & Aquaculture Science undertook this work on behalf of the Food Standards Agency.

DISSEMINATION: Food Standards Agency, Cornwall Council, Cornwall Sea Fisheries Committee, Environment Agency.

CONTENTS

EXECUTIVE SUMMARY

Under EC Regulation 854/2004 there is a requirement for competent authorities intending to classify bivalve mollusc production and relaying areas (BMPAs) to undertake a number of tasks collectively known (in England and Wales) as 'sanitary surveys'. The main purpose of these surveys is to inform the sampling plans for the microbiological monitoring programme and classification of BMPAs. Other wider benefits of these surveys include the potential to improve identification of pollution events and the sources of those events such that in the future remedial action can be taken to the benefit of the fisheries.

This report documents the qualitative assessment made of the levels of microbiological contamination in bivalves from Port Quin Bay and presents the recommended sampling plan as a result of a sanitary survey undertaken by the Centre for Environment, Fisheries and Aquaculture Science (Cefas) on behalf of the Food Standards Agency.

The assessment is supported by published relevant information for Port Quin and Polzeath sub-catchments and new information obtained from a shoreline survey performed in the bay and surrounding coastal area. In addition, statistical analysis of historical data from the Bathing Waters monitoring programme was undertaken. The sampling plan presents information on the recommended location of the monitoring point and sampling frequency for new harvesting areas for mussels, king scallops and Pacific oysters.

The main sources of microbiological contamination in Port Quin Bay are intermittent sewage discharges from sewage pumping stations discharging to Polzeath Stream and one discharge to Polzeath Bay, which are permitted to discharge emergency flows to Hayle Bay. One intermittent discharge from a private dwelling at Port Quin may also be locally important. Bird faeces could constitute a potentially significant source of contamination in the bay.

Agricultural inputs to the estuary are not thought to be a significant source of contamination due to the absence of significant hydrological connections between potentially contaminated agricultural fields and the area of the bay where the aquaculture operation is to be established.

Levels of faecal coliforms in Polzeath designated bathing water have been low in recent years indicating low levels of contamination of seawater in Polzeath, the nearest urbanised area to the BMPA. There is no evidence that levels of contamination increase significantly during summer, when large numbers of tourists visit the area.

The hypertidal regime and overall bathymetric profile will markedly promote the dilution of contamination within the area where the longlines are to be installed. Furthermore, due to its sheltered position, the BMPA is less influenced by wind-driven currents and is less exposed to wave action than other areas towards the eastern part of the bay. These factors will reduce the risk of a pollution event significantly impacting the BMPA from further along the coast.

1. INTRODUCTION

LEGISLATIVE REQUIREMENT

Filter feeding, bivalve molluscan shellfish (e.g. mussels, scallops, oysters) retain and accumulate a variety of microorganisms from their natural environments. Since filter feeding promotes retention and accumulation of these microorganisms, the microbiological safety of bivalves for human consumption depends heavily on the quality of the waters from which they are taken (Bell, 2006).

When consumed raw or lightly cooked, bivalves contaminated with pathogenic microorganisms may cause infectious diseases in humans (e.g. norovirus-associated gastroenteritis, hepatitis A, salmonellosis). Infectious disease outbreaks are more likely to occur in coastal areas, where bivalve mollusc production areas (BMPAs) are impacted by sources of microbiological contamination of human and or animal origin.

In England and Wales, fish and shellfish constitute the fourth most reported food item causing infectious disease outbreaks in humans after poultry, red meat and desserts (Hughes *et al*. 2007).

The risk of contamination of bivalve molluscs with pathogens is assessed through the microbiological monitoring of bivalves. This assessment results in the classification of BMPAs, which determines the level of treatment (e.g. purification, relaying, cooking) required before human consumption of bivalves (Lee and Younger, 2002).

Under EC Regulation 854/2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption, sanitary surveys of BMPAs and their associated hydrological catchments and coastal waters are required in order to establish the appropriate representative monitoring points (RMPs) for the microbiological monitoring programme.

The Centre for Environment Fisheries and Aquaculture Science (Cefas) is performing sanitary surveys for new BMPAs in England and Wales, on behalf of the Food Standards Agency (FSA). The purposes of the sanitary surveys are to demonstrate compliance with the requirements stated in Annex II (Chapter II paragraph 6) of EC Regulation 854/2004, whereby 'if the competent authority decides in principle to classify a production or relay area it must:

(a) make an inventory of the sources of pollution of human or animal origin likely to be a source of contamination for the production area;

(b) examine the quantities of organic pollutants which are released during the different periods of the year, according to the seasonal variations of both human and animal populations in the catchment area, rainfall readings, waste-water treatments, etc.;

(c) determine the characteristics of the circulation of pollutants by virtue of current patterns, bathymetry and the tidal cycle in the production area; and

(d) establish a sampling programme of bivalve molluscs in the production area which is based on the examination of established data, and with a number of samples, a geographical distribution of the sampling points and a sampling frequency which must ensure that the results of the analysis are as representative as possible for the area considered.'

EC Regulation 854/2004 also specifies the use of *Escherichia coli* as indicator of microbiological contamination in bivalves. This bacterium is present in animal and human faeces in large numbers and is therefore indicative of contamination of faecal origin.

Both sewage discharges and agricultural inputs to river systems discharging into estuaries are thought to significantly impact on a number of coastal and estuarine BMPAs in England and Wales (Younger *et al*. 2003).

In addition to better targeting the location of RMPs and frequency of sampling for microbiological monitoring, it is believed that the sanitary survey may serve to help to target future water quality improvements and better analyse their effects on bivalve molluscs. Improved monitoring should lead to improved detection of pollution events and identification of the likely sources of pollution. Remedial action may then be possible either through funding of improvements in point sources of contamination or as a result of changes in land management practices.

This report documents information relevant to undertake a sanitary survey for a new production area of rope-grown mussels (*Mytilus* spp.), Pacific oysters (*Crassostrea gigas*) and king scallops (*Pecten maximus*) in Port Quin Bay (Cornwall).

SITE DESCRIPTION

Port Quin Bay is situated in Cornwall, on the southwest coast of England (Figure 1.1). The bay is approximately 3.6km wide between Sevensouls Rock and Kellan Head and is recessed by 1.3km.

For the purposes of the present assessment, Port Quin Bay is under the influence of pollution sources from two sub-catchments: Port Quin and Porteath (total area=8km^2), which borders the bay and Polzeath (total area=18.8km^2), which is immediately adjacent and borders the western coastal area from Pentire Point to Hayle Bay. Given the distance between the BMPA and Port Isaac and the hydrodynamic regime promoting dispersion and dilution of microbiological contaminants, it is assumed that any inputs of contamination from the catchment to the east of Port Quin are unlikely to affect the BMPA.

Figure 1.1 Aerial view of Port Quin Bay.
Reproduced under licence Google Earth™ mapping service.

Agricultural land dominates land cover within the catchments. Permanent pastures used for livestock production dominate within Port Quin and Porteath sub-catchment, whilst annual crops dominate within Polzeath sub-catchment (Figure 1.2).

Deciduous woodland occupies many areas of steep and undulating river valley sides (Figure 1.3A). The coastal area of the catchment is bordered by maritime cliffs and slopes (Figure 1.3B–D).

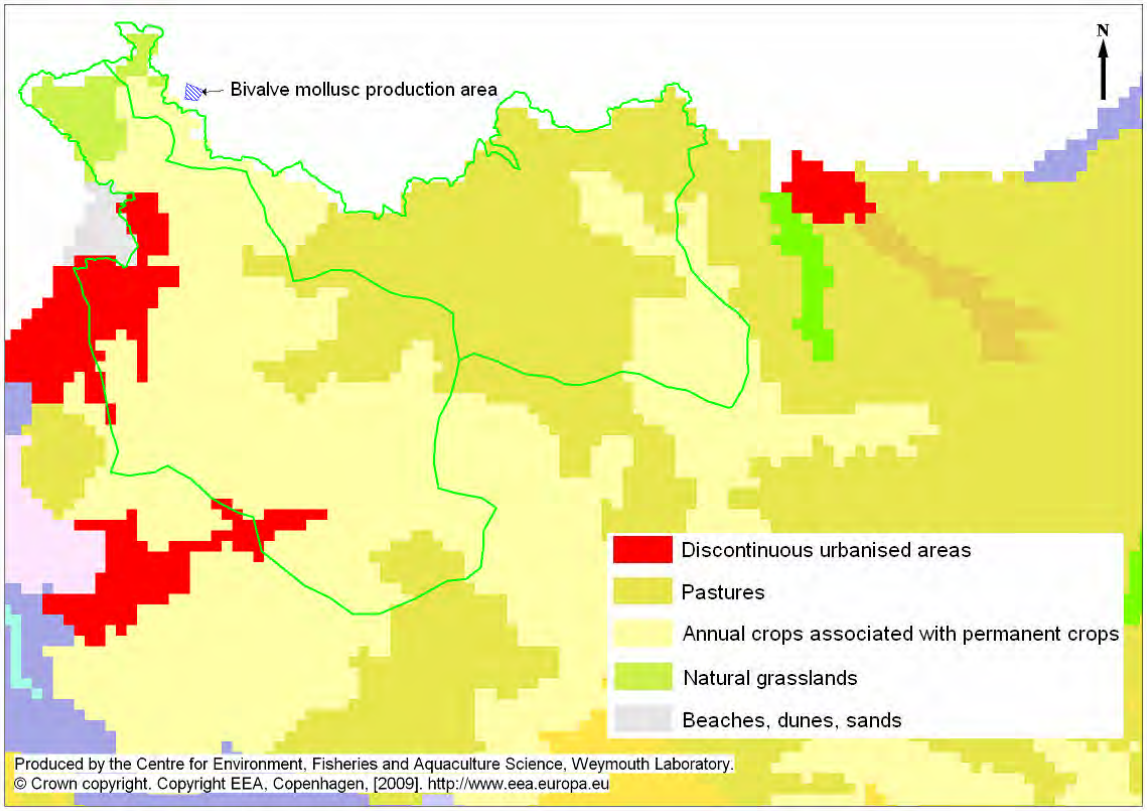

Figure 1.2 Land cover in catchments bordering Port Quin Bay.

The geology of the seabed of Port Quin Bay is mostly composed of gravel, with bedrock formations around Pentire Peninsula (Halcrow Group Ltd, 2003). The geology of these catchments is dominated by sandstones, slates and shales formed during the Devonian and Carboniferous periods. Basalt and spilite occur in the Pentire Peninsula and the Port Quin valley sides (Environment Agency, 2005). Because of the low permeability of these rocks, rainfall can result in rapid runoff and, therefore, water levels in streams generally rise quickly after rainfall (Environment Agency, 1997).

Pentire Peninsula is a Site of Special Scientific Interest. All the coastal area of the bay is part of Cornwall Area of Outstanding Natural Beauty.

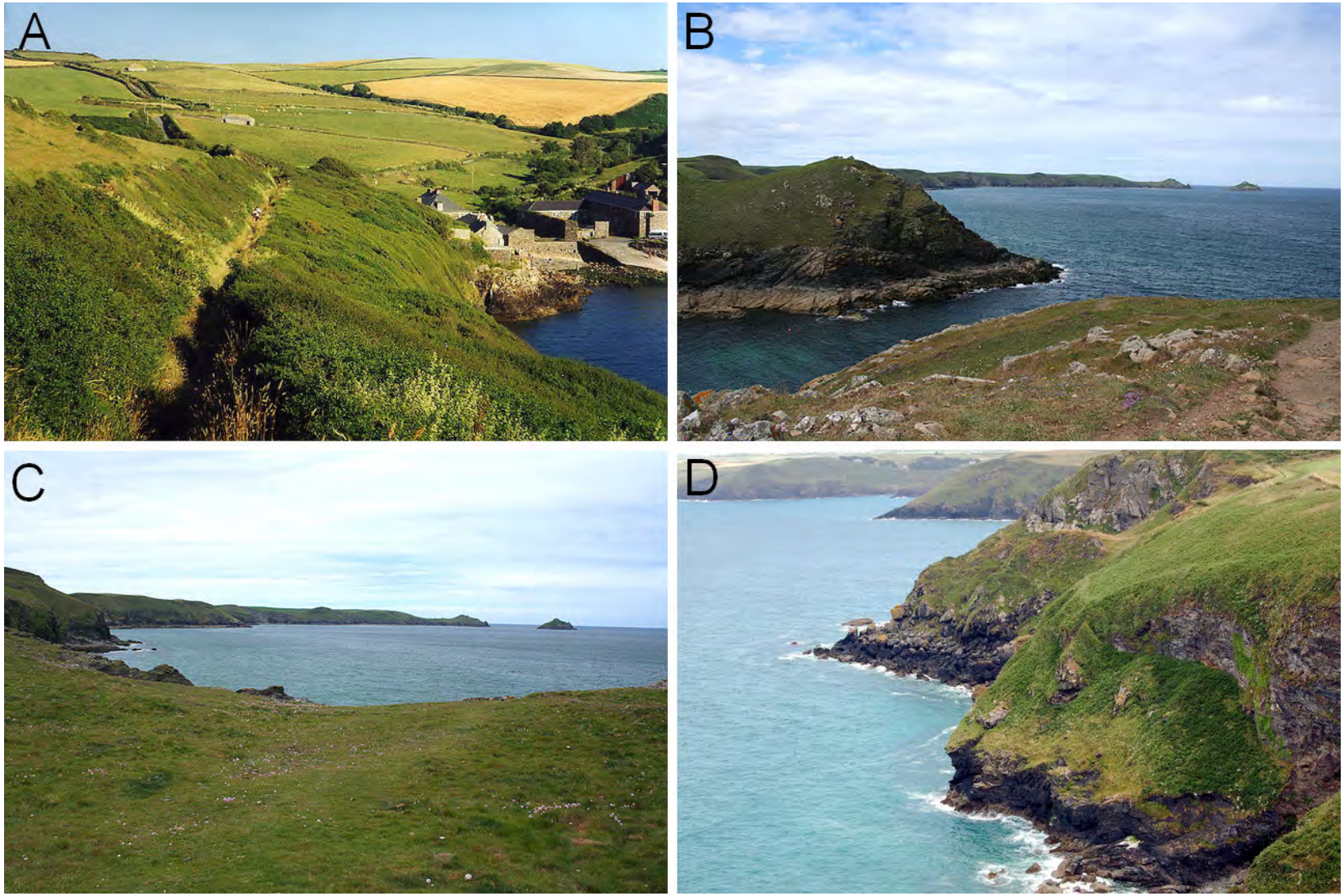

Figure 1.3 South West Coastal Path National Trail at Port Quin (A) and views of Port Quin Bay from Kellan Head (B), Doyden Point (C) and Carnweather Point.
Courtesy Martin Bodman.

2 Shellfisheries

2.1 Species, location and extent

The sanitary survey was prompted by an application for microbiological monitoring and classification of rope-grown cultivation of mussels (*Mytilus* spp.), Pacific oysters (*C. gigas*) and king scallops (*P. maximus*) in Port Quin Bay by Camel Mussels. Figure 2.1 shows the perimeter of the area requiring classification for these species. This is proposed as relaying area for mussels and Pacific oysters.

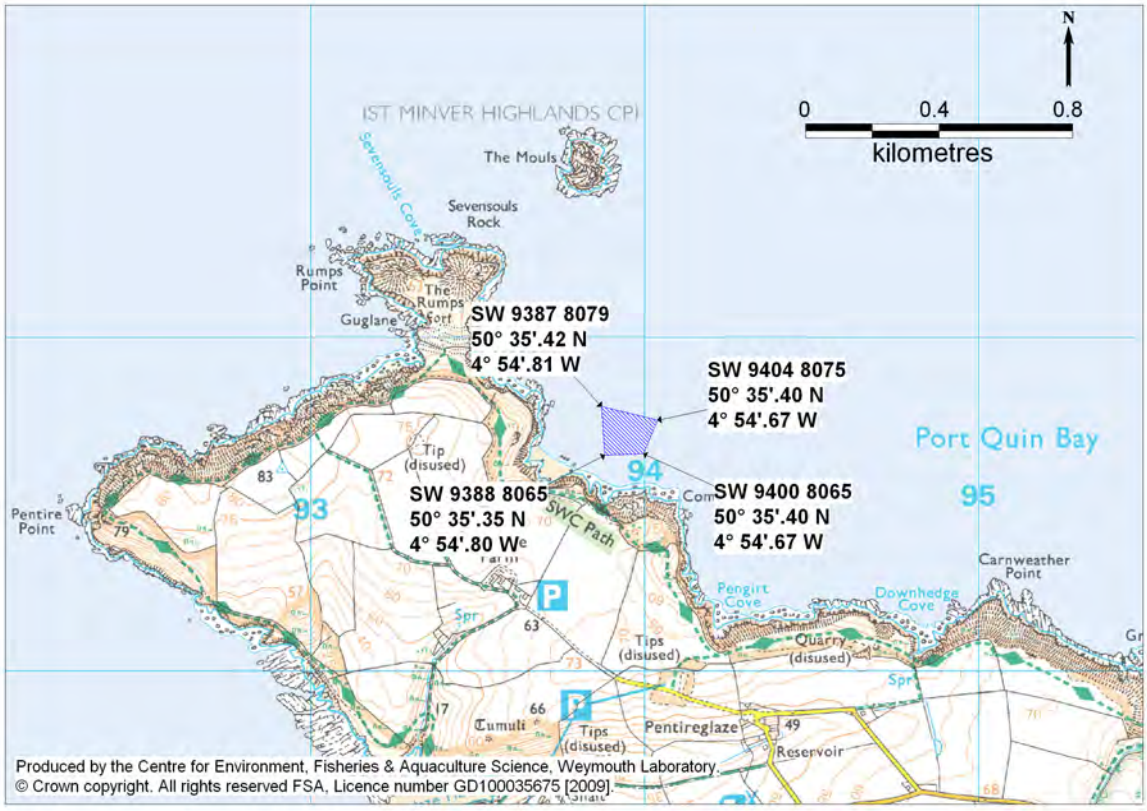

Figure 2.1 Location of the proposed bivalve mollusc production area in Port Quin Bay.

Both *Mytilus galloprovincialis* and *Mytilus edulis* have been recorded in the coasts of North Cornwall (National Biodiversity Network Gateway, 2009). Literature indicates however that both species present large morphological, physiological and behavioural similarities and are therefore difficult to differentiate for commercial purposes due to adaptations to environmental conditions (see Wijsman and Smaal, 2006 and references therein). Data from molecular analyses have highlighted high levels of hybridisation[1] and gene introgression[2] between these species along the West coast of Cornwall. In the context of the present sanitary survey, taxonomy of mussels is therefore referred at genus level.

[1] The formation of a hybrid organism, e.g. by a cross between genetically dissimilar organisms.
[2] The incorporation of the genes of one species into the gene pool of another species.

Mussels are often found in sheltered coasts and estuaries, just below the low water, where a food supply of suspended organic detritus and phytoplankton is available (Tebble, 1976)

The Pacific oyster (*C. gigas*) is a non-native species in the UK (Spencer *et al.* 1994). Cultivation of this species in Port Quin Bay is to be undertaken on a seasonal basis (summer) as a relaying area. The operation relies on the regular supply of juveniles (seed) from commercial hatcheries.

The king scallop (*P. maximus*) is one of two species of scallops cultivated in the UK. Ideal conditions for scallops are sheltered sites with water depth between 15–30m and salinity within 30–35psu. Laboratory experiments indicate that, in the UK, King scallops grow well at temperatures between 10–17°C (Laing, 2002).

Table 2.1 summarises the post-harvest treatment required before bivalve molluscs can be sold for human consumption.

Table 2.1 Criteria for classification of bivalve mollusc production areas.

Class	Microbiological standard[1]	Post-harvest treatment required
A	Live bivalve molluscs from these areas must not exceed 230 Most Probable Number (MPN) *E. coli* $100g^{-1}$ FIL[2]	None
B	Live bivalve molluscs from these areas must not exceed the limits of a five-tube, three dilution Most Probable Number (MPN) test of 4,600 *E. coli* $100g^{-1}$ FIL in more than 10% of samples. No sample may exceed an upper limit of 46,000 *E. coli* $100g^{-1}$ FIL [3]	Purification, relaying or cooking by an approved method
C	Live bivalve molluscs from these areas must not exceed the limits of a five-tube, three dilution MPN test of 46,000 *E. coli* $100g^{-1}$ FIL[4]	Relaying for, at least, two months in an approved relaying area or cooking by an approved method
Prohibited	>46,000 *E. coli* $100g^{-1}$ FIL[5]	Harvesting not permitted

[1] *The reference method is given as ISO 16649-3.*
[2] *By cross-reference from EC Regulation 854/2004, via EC Regulation 853/2004, to EC Regulation 2073/2005.*
[3] *From EC Regulation 1021/2008.*
[4] *From EC Regulation 854/2004.*
[5] *This level is not specifically given in the Regulation but does not comply with classes A, B or C. The competent authority has the power to prohibit any production and harvesting of bivalve molluscs in areas considered unsuitable for health reasons.*

2.2 Growing methods and harvesting techniques

Mussels and Pacific oysters are to be grown in bags suspended from longlines. The operation consists of a series of headlines, each approximately 50m long supported by plastic floats at regular intervals known as “bays”.
The headlines are kept submerged in order to minimise disturbance from wave action and are anchored to the seabed at either end.

Scallop seed produced in hatcheries by the Seafish Industry Authority are to be grown in lantern nets suspended from longlines similar to those used for mussels and oysters (Figure 2.2). Initially, between 30 and 60 scallops (30–40mm) can be put into each compartment of a lantern net; this should be reduced to no more than 10–15 per compartment at 60–80mm (Laing, 2002).

Figure 2.2 Lantern net for scallops (A) and bag for mussels and Pacific oysters (B).
Photo A for illustrative purpose only.

Commercially sized mussels and Pacific oysters are to be brought from classified areas in Taw/Torridge (Yelland and Appledore) and relayed in Port Quin Bay. For the purposes of monitoring towards provisional classification, bivalves brought from Taw/Torridge must have been *in situ* for, at least, two weeks before the first classification sample is taken (Cefas, 2009).

Bivalve molluscs are to be harvested by hand using a boat to recover bags and lantern-nets.

2.3 Seasonality of harvest, conservation controls and development potential

The operation will be initiated in March 2010. All species are to be harvested at Port Quin Bay during summer.

EC Regulation 854/2004 requires that relaying areas must be classified and monitored in a similar manner to production areas. They must be designated by the FSA (European Communities, 2004a). Furthermore, EC Regulation 853/2004 also specifies that relay areas must have clearly identifiable boundaries (by buoys, poles or other fixed means) and operate on a batch basis i.e. ”all in all out” system (European Communities, 2004b). There must be sufficient separation of sites within a relaying area to prevent mixing of batches.

The commercial production of bivalve molluscs in Port Quin Bay is not covered by Several, Regulating or Hybrid Order.

The estimated production for each species is approximately 5 tonnes per year.

3. OVERALL ASSESSMENT

AIM

This section presents an overall assessment of pollution sources on the microbiological contamination of cultivation of mussels (*Mytilus* spp.), Pacific oysters (*C. gigas*) and king scallops (*Pecten maximus*) in Port Quin Bay, as a result of a sanitary survey undertaken by Cefas on behalf of the FSA. Its main purpose is to inform the sampling plan for the microbiological monitoring and classification of the bivalve mollusc production area (BMPA) at this location. The area proposed as a normal production area for scallops and a designated relaying area for mussels and Pacific oysters.

For the purposes of food hygiene, microbiological monitoring of the BMPA falls under the jurisdiction of Cornwall Council Local Enforcement Authority.

POLLUTION SOURCES

Given the rural character of the catchment bordering the bay and the low human population density[3], there are very few sewage discharges in the main populated centres of Port Quin and Polzeath. However, human population in Polzeath increases significantly during summer due to tourism and this is likely to increase the background levels of contamination at Hayle Bay and Pentireglaze Hevan, two beaches located approximately 4km from the northern edge of the BMPA)[4]. Freshwater inputs to Port Quin Bay are limited to several discrete coastal streams[5]. Two streams discharging to Pentireglaze Hevan were sampled during the shoreline survey on 28 May 2009 and returned results of 0CFU *E. coli* per 100ml.

The majority of the land within the Port Quin river catchment is crops and improved grassland used as pasture for livestock production[6]. The dominant farmed animals are cattle and sheep[7]. The majority of farmers in Cornwall spread manure during the spring prior to the growing season and biosolids during the autumn for winter cereals. Sewage sludge is also applied to land during spring and in September. Faecal matter from livestock and manure and slurry applied shortly before/during rainfall events can pose a risk of pollution which can be delivered to the bay via watercourses. On average, rainfall levels decrease significantly from July to September; the wettest month tends to be between October and December[8]. The number of hydrological connections possible between farms and the bay is low. There is only one significant stream discharging at Port Quin village (approximately 2.8km east of the BMPA). This stream also receives discharges from one unsewered private dwelling. A freshwater sample collected from this stream on 28 May 2009 also returned a result of 0CFU *E. coli* per 100ml.

[3] Appendix I
[4] Appendix VII
[5] Appendix III
[6] See Introduction - Site Description: catchment
[7] Appendix VIII
[8] Appendix II

A second potential connection is Lundy Hole (see Figure 1.1), a small sandy bay and the only site where access to the bay by foot is allowed. The water of this stream was sampled and again the result was 0CFU *E. coli* per 100ml.

The risk of agricultural runoff is considered to be very low[9] due to the absence of hydrological connections between potentially contaminated agricultural fields and the western part of the bay[10]. Moreover, freshwater streams discharged to the eastern part of the bay were found not to be contaminated with *E. coli* at the time of the shoreline survey. As harvesting of bivalve molluscs is to be undertaken during summer, when application of manure and slurry to land is low and therefore the risk of runoff from agricultural land is lower than during the autumn-winter period.

The main point sources of microbiological contamination are intermittent discharges from sewage pumping stations discharging to Polzeath Stream and one discharge to Polzeath Bay, which are permitted to discharge emergency flows to Hayle Bay; one non-water company intermittent discharges to Port Quin Stream. Investigations carried out by the Environment Agency in 2004–2005 demonstrated that, despite the high concentrations of faecal coliforms occasionally detected in Polzeath Stream, they did not affect the quality of the designated Polzeath bathing water. The stream was sampled at the discharge point by the beach on 28 May 2009 and returned a result of 3,100CFU *E. coli* per 100ml. A smaller stream which flows from Trenant and also discharges to Hayle Bay was also sampled and returned a result of 0CFU *E. coli* per 100ml. Mussels sampled on the same day returned an *E. coli* concentration below the detection limit (see below). This suggests that the production area is unlikely to be vulnerable to inputs of contamination from Polzeath catchment.

The lack of a harbour, established anchorage or appreciable boat facilities at Port Quin indicate that sewage discharges from boats are unlikely to represent a potential source of contamination to bivalve molluscs.

The Port Quin catchment supports important populations of farmland bird species[11]. Maritime cliffs and slopes also on the western area of the bay sustain important colonies of seabirds. Woodland species also occur in wooded valleys, being Pentire Point being a preferential roosting and feeding area. The Mouls Island, a rocky island just north of the proposed BMPA, is the main site for Puffin in Cornwall. Literature indicates that very significant concentrations of microbiological contaminants can be deposited in roosting areas. Birds will contribute to background levels of contamination in the bay. Locally, the period of higher risk will be March–August, when colonies of puffins, guillemots and razorbills are present.

A schematic representation of the most significant pollution sources likely to cause microbiological contamination to the BMPA is shown in Figure 3.1.

[9] Appendix VIII
[10] Appendix III
[11] Appendix X

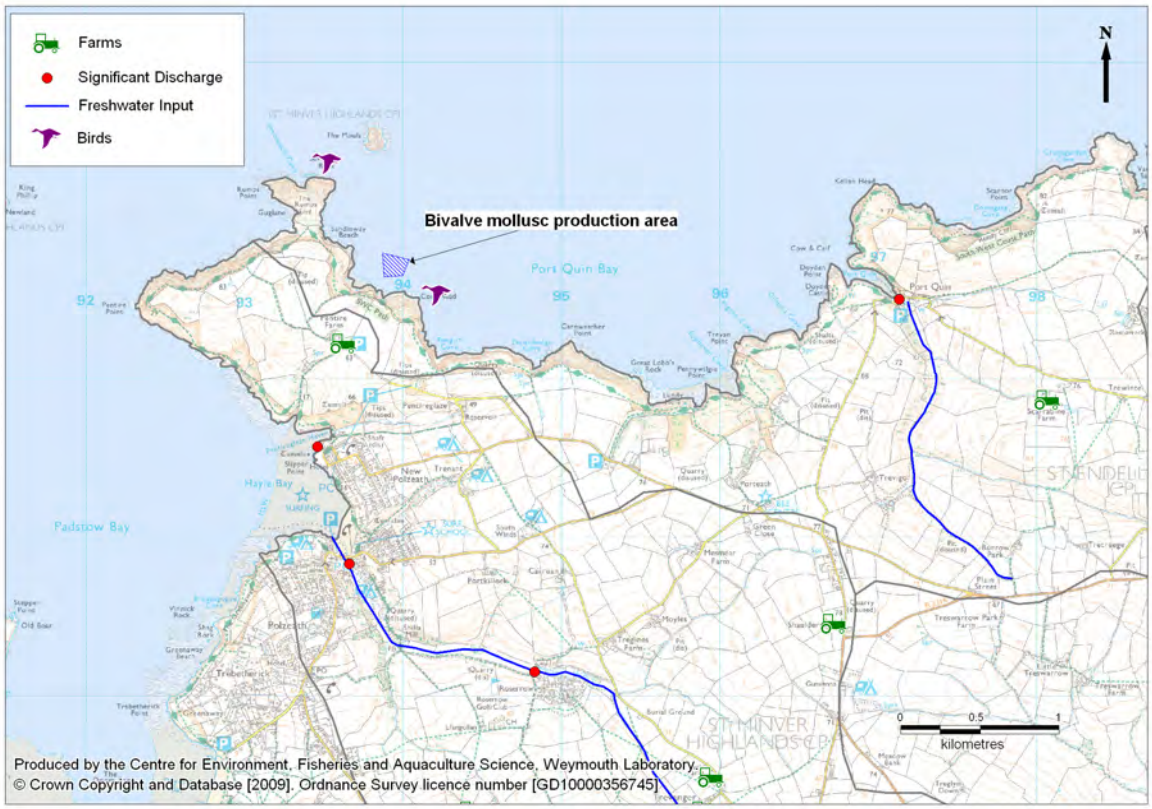

Figure 3.1 Overview of sources of pollution likely to affect the levels of microbiological contamination in bivalve molluscs in Port Quin Bay.

HYDRODYNAMICS

The area of Port Quin Bay where the longlines are to be installed is shallow[12] (depths increase to approximately 4m at Chart Datum) and hypertidal (mean spring tide range=6.6m and mean neap tidal range=3.3m at Port Isaac)[13]. This variation in tidal range relative to the overall bathymetric profile will markedly promote the dilution of contamination within the bay.

Tidal currents off Port Quin Bay are generally less than 0.08m s^{-1}. Water movements follow an East–West direction as a result of a clockwise circulation pattern which develops offshore[14]. Tidal currents are thought to be weaker towards the inner bay. Due to its sheltered position, the BMPA is less influenced by wind-driven currents and less exposed to wave action than the sea to the north of The Mouls island or areas towards the eastern part of the bay. These afford ideal conditions for bivalves to grow and decrease the likeliness of pollution events from the western coastal area impacting on the BMPA. These conditions were observed during the shoreline survey on 28 May 2009. Furthermore, during summer, when the operator is proposing to harvest bivalves, wind speeds tend to be lower than those recorded during autumn–winter[15]. In the absence of further information on water movements under

[12] Appendix V
[13] Appendix IV
[14] Appendix IV
[15] Appendix VI

differing environmental conditions, one monitoring point situated in the centroid of the production area would be representative of the range of pollution sources impacting the western part of Port Quin Bay.

The unlikely worst-case scenario of contamination would be a significant pollution event at Polzeath coincident with high river flow discharges from the Camel Estuary transported round the coast into the bay under the influence of west–southwest winds.

MICROBIOLOGICAL DATA

Geometric means of faecal coliforms in Polzeath designated bathing water have been low (3 in 2004, 15 in 2007 and 12 in 2008)[16] indicating low levels of contamination of seawater in developed areas of pollution in Polzeath catchment nearest to the BMPA.

There are no other existing classified BMPAs at Port Quin Bay and therefore no historical data associated with bivalve molluscs for the area. The legislation[17] requires that the sampling plan[18] must be as representative as possible for the BMPA considered. Bagged mussels were established 3 weeks prior to the shoreline survey in the southern edge of the area requiring classification. A sample collected in the morning of 28 May 2009 (one hour before the beginning of the shoreline survey) returned an MPN of *E. coli* <20 per 100g FIL (class A).

4 RECOMENDATIONS

Given the above assessment, it is recommended that:

- One Representative Monitoring Point (RMP) should be established in the centroid of the relaying area. Given the lack of significant point sources of pollution and the fact that birds would locally constitute the most significant sources of faecally derived pollution, this RMP should adequately represent the microbiological quality of bivalves across the proposed harvesting area[19] in Port Quin Bay.

- For preliminary classification, 10 samples of scallops should be taken from the top compartment of the lantern net (<2m depth). Ten samples of mussels and Pacific oysters should be taken from bags suspended from the longline. Given the hypertidal regime, shallow bathymetry, absence of freshwater inputs and sheltered position of the area requiring classification in the western part of the bay, it is unlikely that stratification will occur in the water column. Therefore, sampling from the top of lantern net/longline should be representative of the levels of contamination in the water column, whilst preventing unnecessary disturbance generated by the sampling method.

[16] Appendix X
[17] EC Regulation 854/2004
[18] Section 5
[19] See Section 5

- Adult mussels and Pacific oysters brought from classified areas in Taw/Torridge and relayed in Port Quin Bay should be left *in situ* for, at least, two weeks prior to commencement of sampling. This is a requirement stipulated in the Cefas protocol for provisional classifications of BMPAs (Cefas, 2009).

- The recommended maximum tolerance for this RMP is 10m. It is considered that this tolerance minimises the effect of spatial variability in the extent of microbiological contamination whilst preserving the fixed location concept.

- The classification zone boundary should be defined by an enforceable perimeter line of, at least, 10m outside the edge of the area required by Camel Mussels to be classified. At the time of the shoreline survey, the applicant informed Cefas that there is no intention to expand the operation in the foreseeable future.

5. SAMPLING PLAN

GENERAL INFORMATION

Location Reference

Production Area	Camel
Cefas Main Site Reference	M035
Cefas Area Reference	FDR 3582
Ordnance survey 1:25,000 map	Explorer 106: Newquay & Padstow (Wadebridge, Port Isaac & St Columb Major
Admiralty Chart	Admiralty 1168: England - West Coast (Harbours on North Coast of Cornwall)

Shellfishery

Species/culture	Mussels (*Mytilus* spp.)	Relayed
	Pacific oysters (*Crassostrea gigas*)	Relayed
	King scallops (*Pecten maximus*)	Farmed
Seasonality of harvest	Mussels: summer	
	Pacific oysters: summer	
	Great scallops: summer	

Local Enforcement Authority

Name of Local Enforcement Authority	Cornwall Council Trevanion Road, Wadebridge, Cornwall PL27 7NU
Telephone number ☎	01208 893333
Environmental Health Officer	Sally Glover
Telephone number ☎	01208 893514
Fax number	01208 893455
E-mail 📧	sally.glover@cornwall.gov.uk
Sampling Officer	Chris Brenton
Telephone number ☎	01208 893463
Fax number	01208 893455
E-mail 📧	chris.brenton@cornwall.gov.uk

Table A1. Number and location of representative monitoring point (RMP) and frequency of sampling in Port Quin Bay bivalve mollusc production area.

Classification zone			Port Quin Bay	Port Quin Bay	Port Quin Bay
RMP			B035Z	B35AA	B35AB
RMP name			Sandinway Beach	Sandinway Beach	Sandinway Beach
Geographic grid references (datum) of sampling points	**Eastings** **Northings**		193,960 80,720	193,960 80,720	193,960 80,720
	NGR		SW 9396 8072	SW 9396 8072	SW 9396 8072
	WGS84	**Latitude** **Longitude**	50°35.39'N 4°54.73'W	50°35.39'N 4°54.73'W	50°35.39'N 4°54.73'W
Species			*Mytilus* spp.	*C. gigas*	*P. maximus*
Growing method			Bags	Bags	Lantern nets
Harvesting technique			Bags recovered by hand from boat	Bags recovered by hand from boat	Lantern nets recovered by hand from boat
Sampling method			Bags recovered by hand from boat	Bags recovered by hand from boat	Lantern nets recovered by hand from boat
Depth (m)			2 (top bag)	2 (top bag)	2 (top net)
Tolerance for sampling points (m)			10	10	10
Frequency of sampling (PRELIMINARY Classification)			10 samples taken over at least 3 months (interval between sampling not less than 1 week).	10 samples taken over at least 3 months (interval between sampling not less than 1 week).	10 samples taken over at least 3 months (interval between sampling not less than 1 week).
Frequency of sampling (FULL Classification)			At least monthly over one year. If seasonal classification only is required, 12 samples taken during the active season and the preceding 2 months (interval between sampling not less than 1 week)	At least monthly over one year. If seasonal classification only is required, 12 samples taken during the active season and the preceding 2 months (interval between sampling not less than 1 week)	At least monthly over one year. If seasonal classification only is required, 12 samples taken during the active season and the preceding 2 months (interval between sampling not less than 1 week)

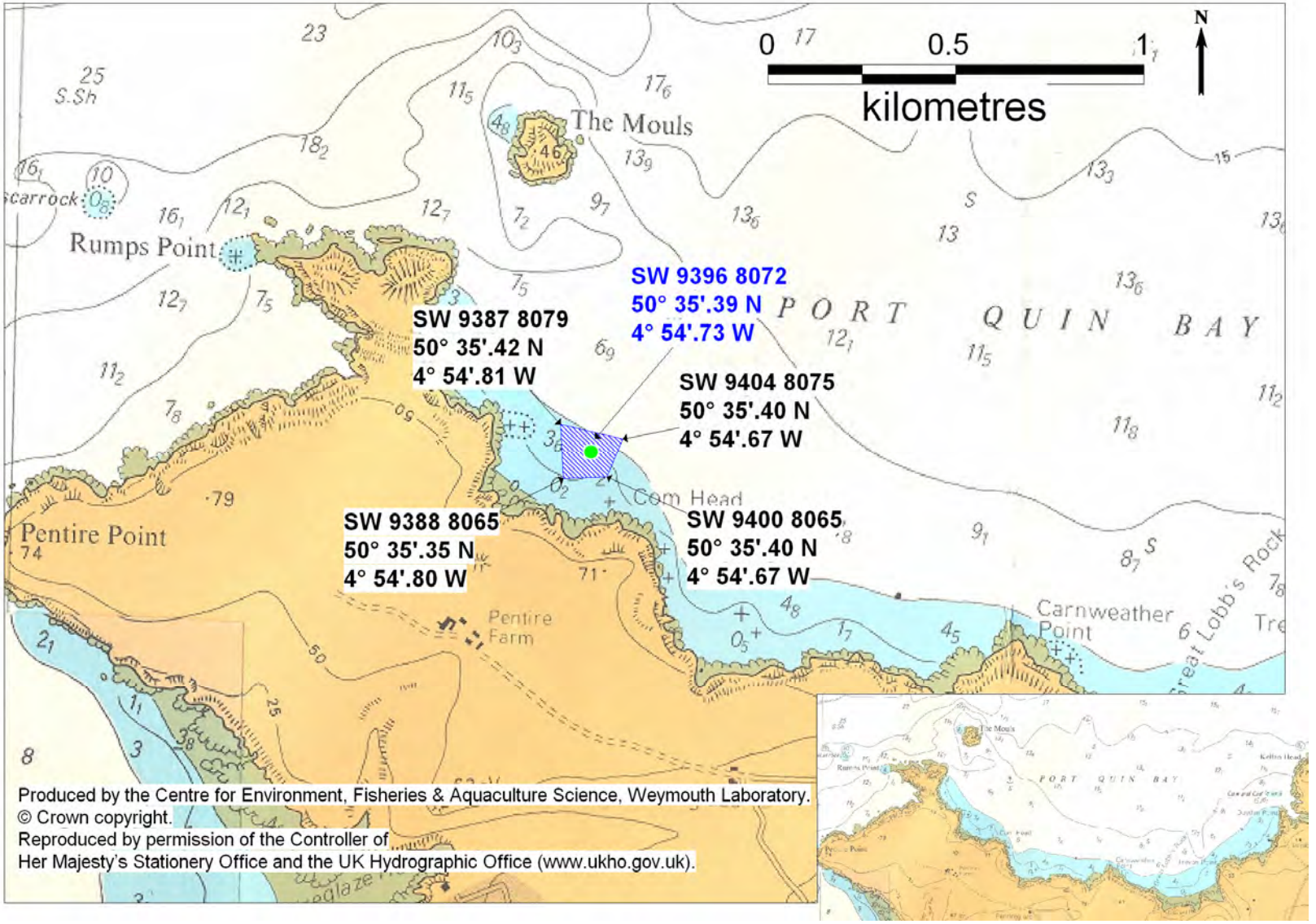

Figure S1 Location of representative monitoring point (RMP) and recommended boundaries for classification zones in Port Quin Bay.

REQUIREMENT FOR REVIEW

The need for this sampling plan to be reviewed will be assessed by the competent authority within six years or in light of any obvious known changes in sources of pollution of human (e.g. improvements in sewage treatment works) or animal origin likely to be a source of contamination for the bivalve mollusc production area.

APPENDICES

Appendix I

HUMAN POPULATION: DENSITY AND ACTIVITIES

The distribution of resident human population totally or partially included within Polzeath and Port Quin is shown in Figure I.1. Population density by Super Output Area Boundary[20] in Port Quin is very low (<1 person per hectare). Polzeath and Port Quin are the only settlements of note on this stretch of coast.

There is a very significant influx of visitors during summer peak season, particularly motivated by the good quality of bathing waters at the mouth of the Camel Estuary. The number of visitors to Padstow area exceeds 1M per year. In 2008, the National Lobster Hatchery at Padstow itself attracted approximately 40,000 visitors (National Lobster Hatchery, 2009).

Population in Polzeath area increases significantly during summer months (June–August) due to tourism. Local residents and tourists make recreational use of the beaches for swimming and surfing. Fishing is also popular in the coastal cliffs. Estimates indicate that as much as 500,000 people may visit Polzeath during summer, many using the three caravan parks and numerous holiday homes in the area (North Cornwal District Council, 2009).

Walking and birdwatching activities are very popular along the South West Coast Path National Trail running along the coast.

Although the microbiological quality of water could deteriorate during summer as a result of higher human presence in the catchment, the relative distance of the BMPA to developed areas and the absence of significant human activities in Port Quin Bay itself determine low risk of pollution from pollution sources of human origin.

[20] Super Output Area (SOA) boundaries are in part derived from Ordnance Survey information and some SOA boundaries which follow ward or parish boundaries reproduce limited parts of the OS Boundary-Line product.

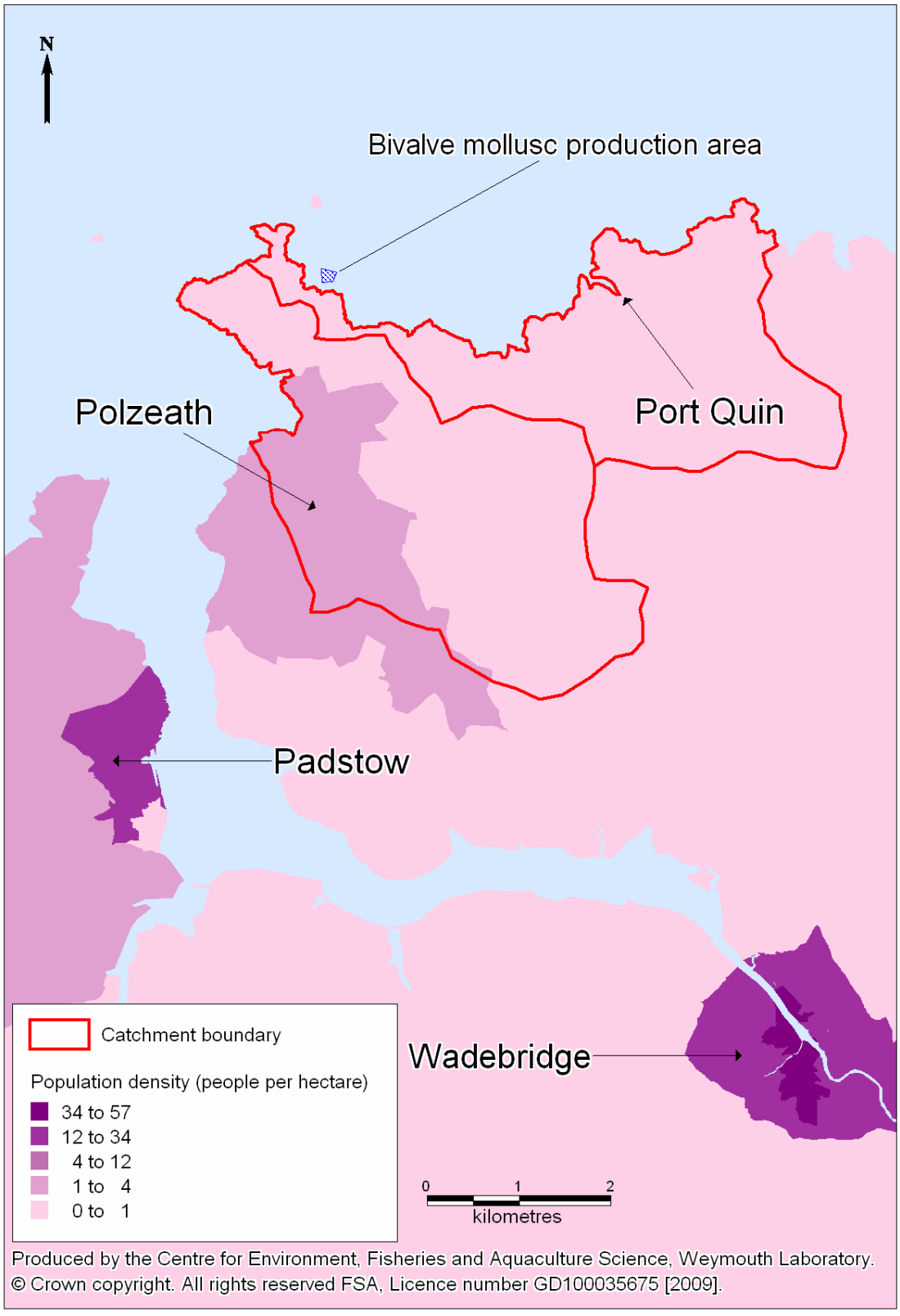

Figure I.1 Human population density in river catchments bordering Port Quin Bay.
Source: ONS, Super Output Area Boundaries. Crown copyright 2004. Crown copyright material is reproduced with the permission of the Controller of HMSO.

Appendix II
HYDROMETRIC DATA: RAINFALL

Most coastal areas of Cornwall experience 900–1,000mm of rainfall per annum (Met Office, 2007). This range compares with an average annual rainfall for England and Wales of approximately 1,250 mm (Perry, 2006).

The rainfall pattern varies greatly throughout the Camel catchment. The variation in rainfall is heavily influenced by the topography, which forces the moisture-laden air to precipitate high levels of rainfall throughout the upper reaches of the catchment. In the wettest years, uplands such as Bodmin Moor may experience double the rainfall of that falling over coastal areas (Met Office, 2007).

Figure II.1 shows monthly averaged total rainfall monitored daily at a tipping bucket gauge installed at Wadebridge STW (Eastings/Northings: 198,834/72,707) representative of the lower catchment for the period January 2004–December 2007. A significant decrease in rainfall levels occurred from July to September. The wettest period was October–December.

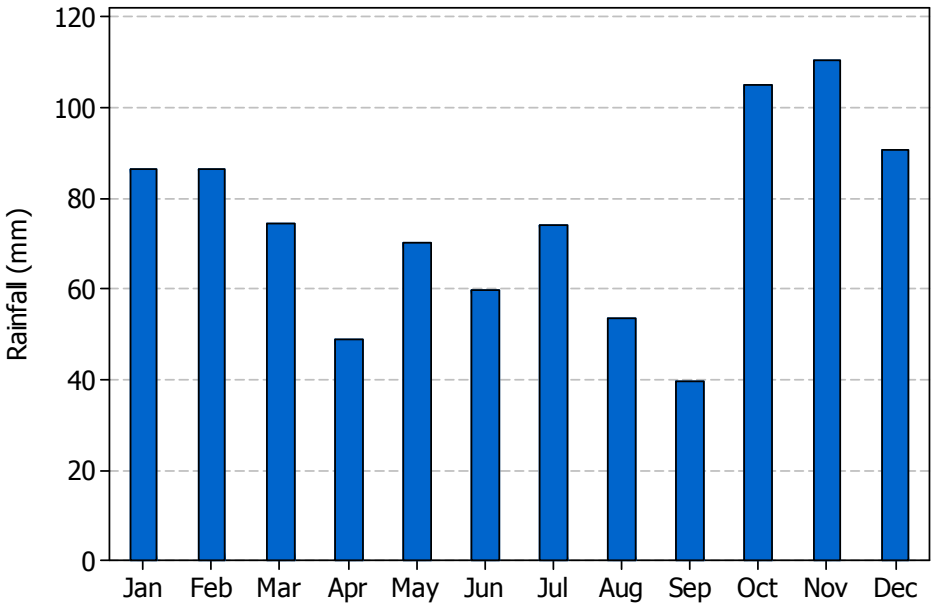

Figure II.1 Monthly average of rainfall in Wadebridge WTW gauging station for the period January 2002–December 2007.
Data from the Environment Agency (2007).

Rainfall may lead to the discharge of raw or partially treated sewage from combined sewer overflows as well as runoff from faecally contaminated land (Younger *et al.* 2003). An inventory of sewage discharges to the bay and its vicinity is presented in Appendix VII.

Levels of microbiological contamination are therefore expected to show a degree of association with increased rainfall during autumn–winter months. There are no existing Shellfish Hygiene monitoring points in the bay from which levels of *E. coli* in bivalves could be checked for correlation with rainfall.

Appendix III
HYDROMETRIC DATA: FRESHWATER INPUTS

Freshwater inputs to Port Quin Bay are limited to several discrete coastal streams (Figure III.1). No continuous flow monitoring is undertaken in these watercourses (Environment Agency, 2005).

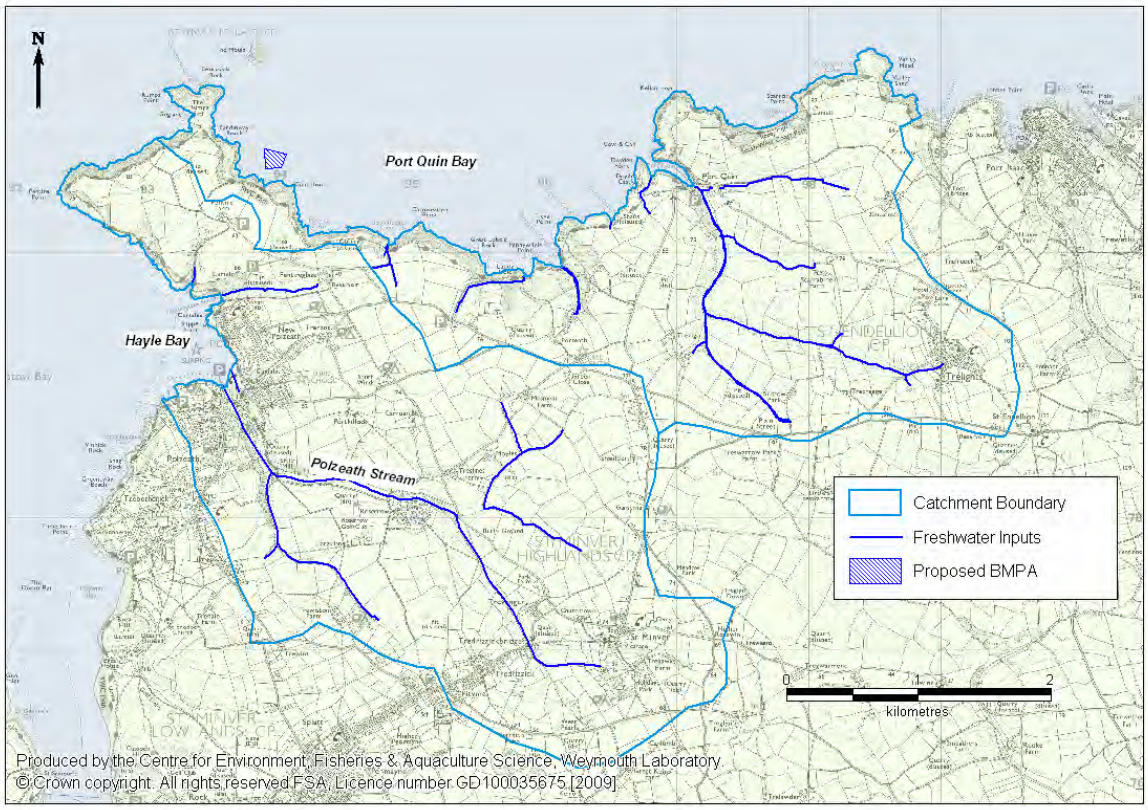

Figure III.1 Watercourses in catchments bordering Port Quin Bay.

One stream flows along the southwest side of Hayle Bay (Polzeath Beach). Although this does not represent a direct freshwater input to Port Quin Bay, the stream receives direct inputs of microbiological contamination from intermittent sewage discharges (see section 4.2). The Environment Agency evaluated the potential impact of bacteriological contamination in this stream on the quality of Polzeath Bathing Water.

During the 2004–2007 bathing seasons, water samples from the stream were collected on a weekly basis approximately 5 minutes after each sampling of surface water took place on the beach. Samples were quantified for faecal coliforms and faecal streptococci. Results for faecal coliforms are summarised in Table III.1. These were compared with levels of the microbiological indicator quantified in surface waters as part of the Bathing Water monitoring programme (Figure III.2).

Maximum levels indicate that Polzeath Stream had the potential to deliver high levels of contamination to coastal waters. However, it should be pointed out that the impact would depend on the load, not on concentrations themselves.

Table III.1 Summary statistics for levels of faecal coliforms (CFU 100ml^{-1}) in water from Polzeath Stream for the period 2004–2007.

Bathing season	Number of samples	Minimum	Maximum	Median	Geometric mean
2004	20	500	>100,000	2,380	3,292
2005	20	615	>100,000	7,500	6,069
2006	22	1,520	90,000	5,000	7,046
2007	20	538	68,000	2,920	3,133

N.B. Samples taken 30cm below the surface and semi-randomly through the day to reflect a representative selection of tidal states.

Figure III.2 shows that where high levels of faecal coliforms were discharged from Polzeath Stream they did not affect the quality of Hayle Bay bathing water during the period 2004–2005. In 2006–2007, there were occasions when elevated concentrations of faecal coliforms in the stream corresponded with elevated concentrations of the microbiological indicator in the designated bathing water (e.g. on 17 August 2006: 90,000 faecal coliforms in the stream and 10,400 faecal coliforms in the bathing water; 25 June 2006: 24,000 faecal coliforms in the stream and 1,640 faecal coliforms in the bathing water).

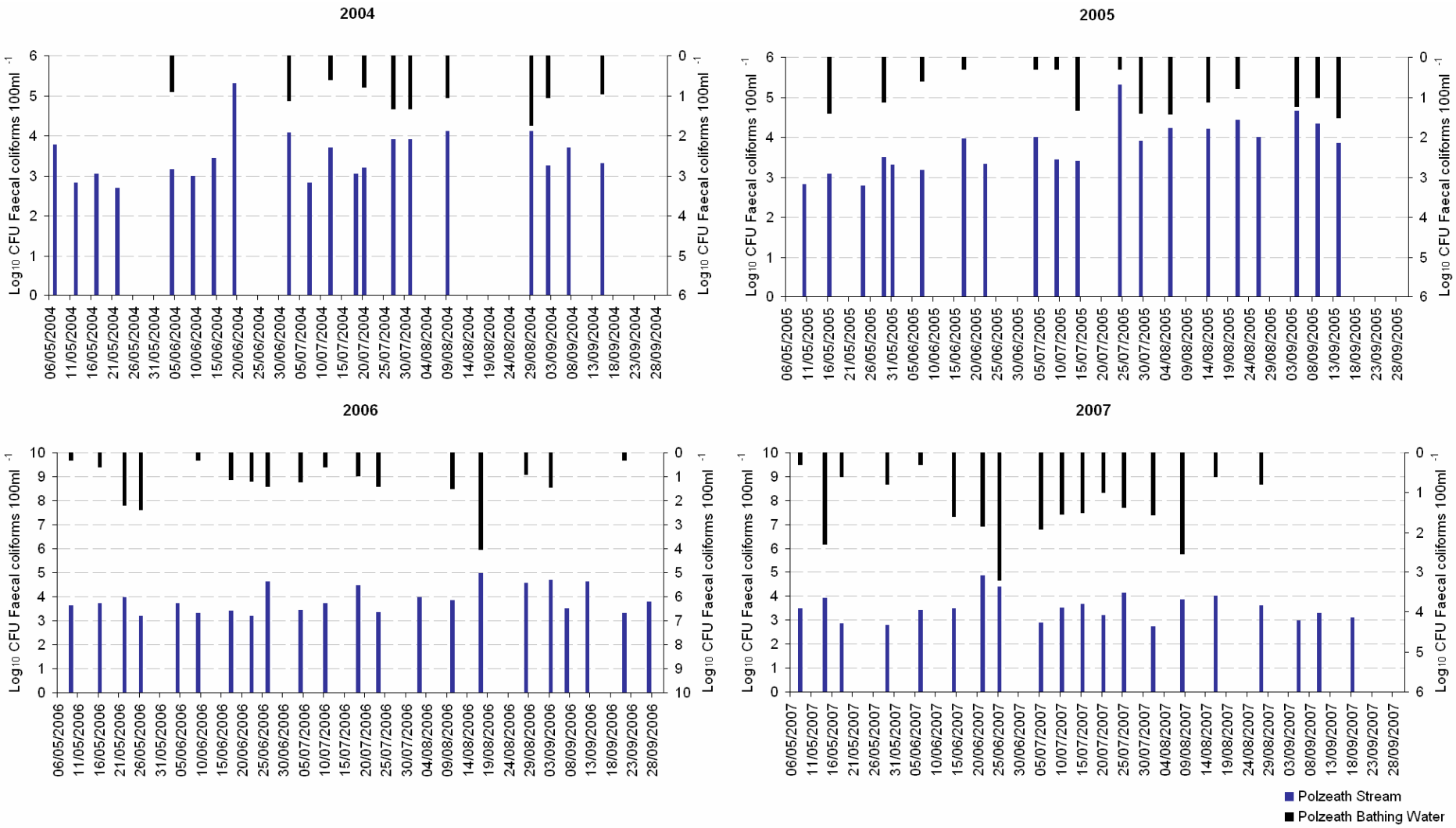

Figure III.2 Time series of levels of faecal coliforms in surface waters of Polzeath designated Bathing Water and Polzeath Stream for the bathing seasons 2004–2007.

Data from the Environment Agency (2008).

NB. The bathing season runs from 15 May to 30 September. First samples collected approximately one week before the beginning of bathing season.

Appendix IV
HYDRODYNAMIC DATA: TIDES AND TIDAL CURRENTS

Lee and Morgan (2003) analysed the effect of a number of environmental parameters on the levels of microbiological contamination in three BMPAs in England and Wales. The authors found that tide is one of the main factors influencing the levels of *E. coli* in native oysters. The study also highlighted that the effect varied between production areas and individual sampling points within production areas.

Port Quin Bay has an asymmetrical hypertidal regime with semi-diurnal tides (two tidal cycles per day). At Port Isaac (see Figure 1.1), the mean spring tide range is 6.6m and the mean neap range is 3.3m (Table V.1).

Table V.1 Tide levels and ranges relevant to Port Quin Bay.

	Height (m) above Chart Datum				Range (m)	
Port	MHWS	MHWN	MLWN	MLWS	Spring	Neap
Port Isaac	7.5	5.8	2.5	0.9	6.6	3.3

N.B. Tidal levels referred to Datum of soundings.
Data from UK Hydrographic Office (2002).

Differences in *E. coli* levels frequently reflect the locations of RMPs to specific sources of pollution and spatial differences in flushing conditions over the tidal cycle. The effect of tides on the levels of *E. coli* in bivalves from Port Quin Bay should be assessed at the time of the review of the sanitary survey, assuming that sufficient monitoring data is available.

Offshore near-surface tidal currents along the coast of North Cornwall flow north-eastward. A number of small eddies are formed in inshore waters as schematised in Figure V.1. Inside the bay, residual tidal currents are thought to be weak, with some residual tidal drift flowing in a westerly direction.

The area of the bay where the aquaculture operation is to be established is less exposed to wave action derived from the influence of south-westerly winds than, for example, Daymer Bay (see Figure 1.1). The Mouls island offers additional protection from winds blowing from the North.

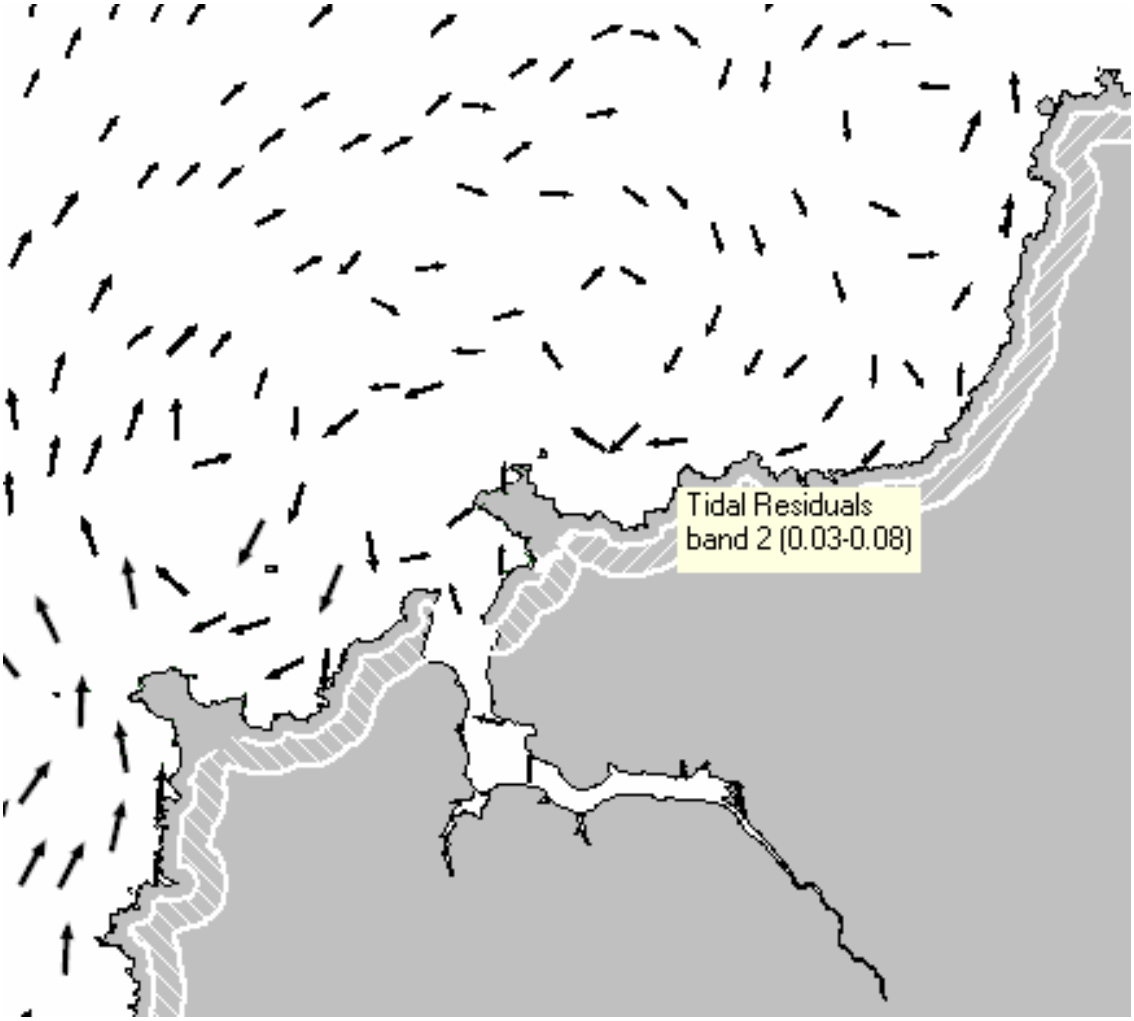

Figure V.1 Directions of residual surface tidal currents along the coasts of North Cornwall between Trevose Head and Hartland Point.

Data from Halcrow Group Ltd (2003) © Crown Copyright. All rights reserved 2002.

Appendix V
HYDRODYNAMIC DATA: BATHYMETRY

Soundings increase to 14.5m at Chart Datum (CD) just off Kellan Head (see Figure 1.1), in the eastern part of Port Quin Bay (Figure IV.1). Depths from the shore at Com Head (see Figure 1.1), increase to approximately 4m at CD just south of The Mouls island (UK Hydrographic Office, 1983). The subtidal around Pentire Peninsula is considerable deeper, reaching 18m at CD just North of Rumps Point. The proposed BMPA lies largely between 2m and 5m depth contours at CD.

Differences in bathymetry between the coastal and the central areas of the bay may determine significant differences on the way that tides and currents take the contamination to the BMPA, particularly in decay rates of microorganisms. In general, less dilution of contaminants would occur in nearshore shallow waters such as those off Com Head.

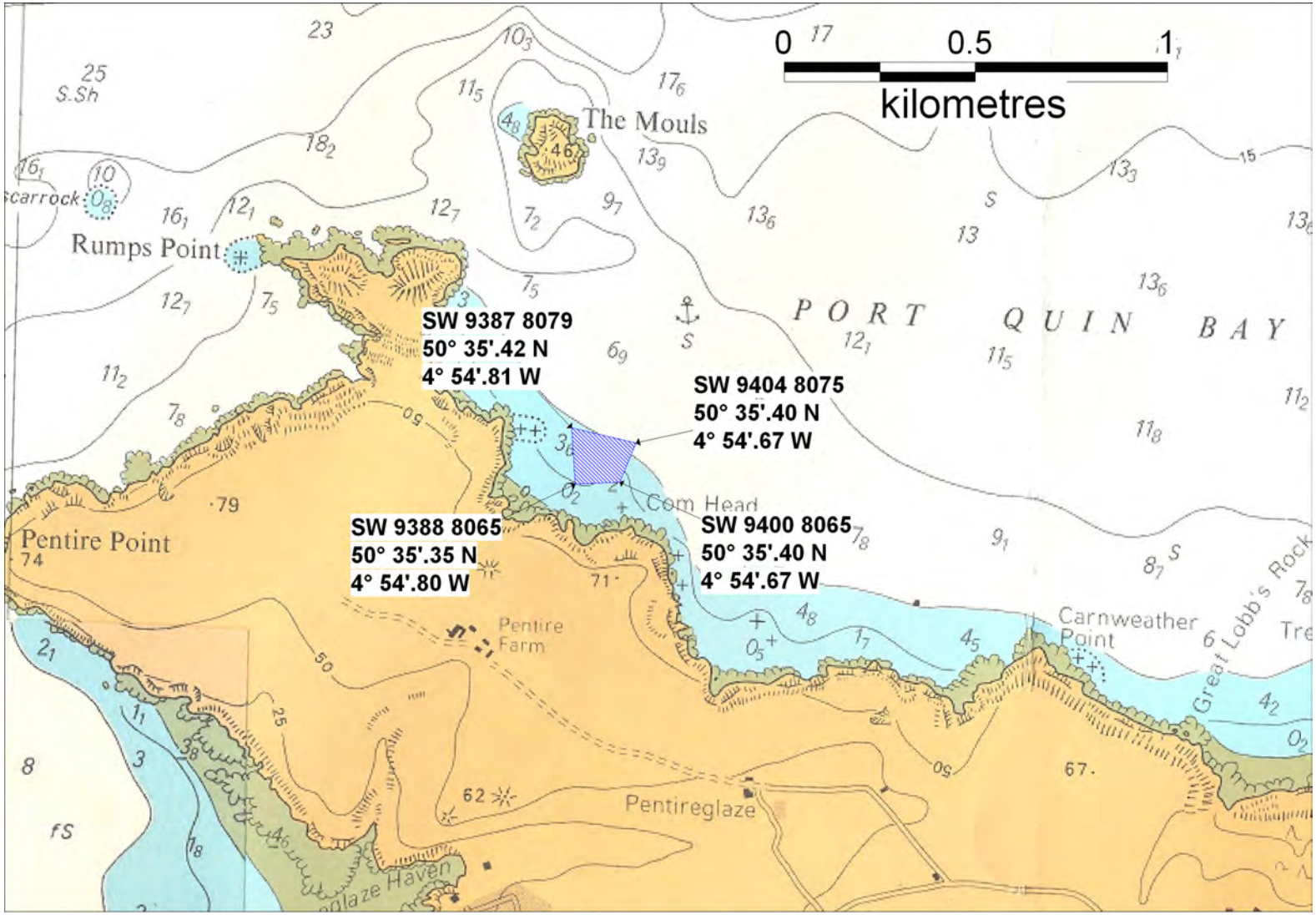

Figure IV.1 Bathymetry in Port Quin Bay.
Reproduced by permission of the Controller of Her Majesty's Stationery Office and the UK Hydrographic Office (www.ukho.gov.uk).

Appendix VI
METEOROLOGICAL DATA: WIND PATTERN

The southwest is one of the most exposed areas of the UK. The strongest winds are associated with the passage of deep depressions and the frequency and strength of depressions is greatest in the winter (Met Office, 2007). In coastal areas of Cornwall, mean wind speeds are less than 12knots between April and September (Met Office, 2009)[21].

Figure VI.1 shows monthly variation of averaged wind speed and maximum "instantaneous" speed averaged over 3 seconds for St. Mawgan (approximately 16km southwest from BMPA). The period November–March has the highest mean speeds, whilst the period June–August has the lightest winds.

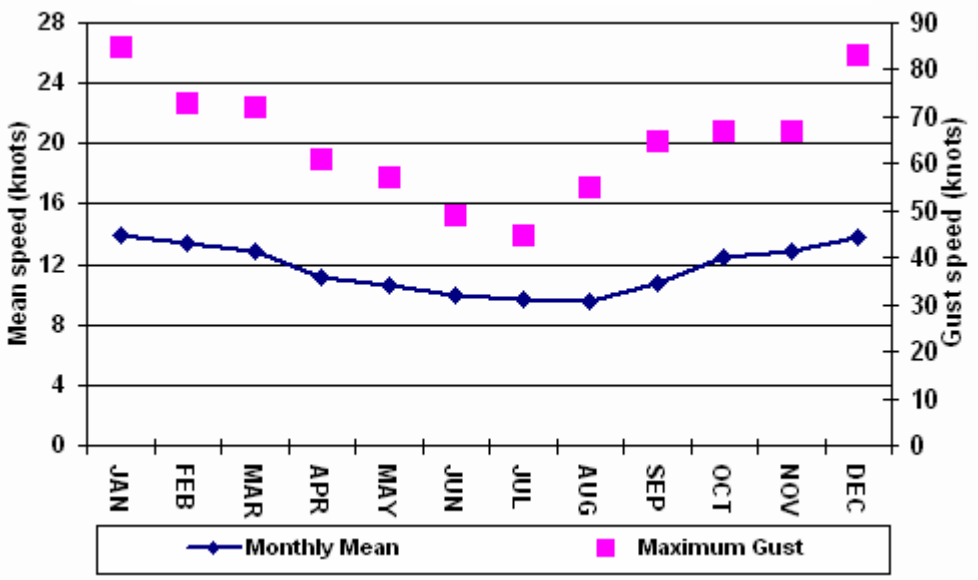

Figure VI.1 Monthly variation of wind speed and maximum gust at St. Mawgan.
Republished under permission of Met Office (2009).

As Atlantic depressions pass the UK, the wind typically starts to blow from the south or southwest, but later comes from the west or northwest as the depressions move away.

Wind driven currents may have a pronounced effect in modifying the pattern of circulation of contaminants as determined by the prevalent pattern of tidal currents. Wind driven currents will promote the transport of fully saline waters to the bay which, in the absence of significant freshwater inputs and sewage discharges to Port Quin Bay, will maintain low background levels of microbiological contamination impacting the BMPA.

[21] Information based on historical data 1971–2000 for St. Mawgan station.

Appendix VII

SOURCES AND VARIATION OF MICROBIOLOGICAL POLLUTION

SEWAGE DISCHARGES

There are no continuous sewage discharges to Port Quin Bay (Table VII.1; Figure VII.1). Two intermittent discharges from sewage pumping stations to Polzeath Stream and one to Polzeath Bay are permitted to discharge emergency flows to Hayle Bay, within the Polzeath catchment. Hayle Bay (Mean Low Water Mark) is approximately 3.8km from the northern edge of the BMPA. No information on the frequency or volume of these discharges is available. However, the Environment Agency carried out a bacteriological survey to determine whether inputs to Polzeath Stream are impacting the quality of the designated bathing water. Results of this analysis are presented in the Appendix III.

There are some unsewered private dwellings (one in Port Quin village, which discharges to a freshwater stream approximately 3.2km from the BMPA) and nine others throughout the Polzeath catchment. These discharge to soakaways. Collectively, their impact to levels of contamination in the coastal area is considered to be insignificant.

The discharge at Port Quin village was inspected at the time of the shoreline survey. Five small pipes were evident from wall (see Appendix XIII).

Table VII.1. Sewage discharges to Port Quin Bay and its vicinity.

No	Discharge Name	Discharge type	Sewerage catchment	NGR of outfall (Eastings/Northings)	Receiving water	Approximate distance (km) from BMPA
1	Quin Cottage and Carolina Cellar	Treated effluent, not water company	Port Quin	197130/80,500	Port Quin Stream	3.2
2	Roserrow PS	Emergency	Polzeath	194830/78150	Polzeath Stream	6.3
3	Polzeath PS	Emergency	Polzeath	193660/78830	Tidal Polzeath Stream	4.9
4	New Polzeath PS	Emergency (screened)	Polzeath	193460/79570	Pentiregla ze Hevan	4.3

Figure VII.1 Location of sewage discharges in the vicinity of Port Quin Bay.

Appendix VIII

SOURCES AND VARIATION OF MICROBIOLOGICAL POLLUTION

AGRICULTURE

Agricultural land covers a substantial proportion of the catchment. Livestock farming constitutes the principal farming activity, with mixed farming and rough grazing taking place on poorer land (Environment Agency, 1997).

Dozens of sheep were observed at Pentire Farm and in fields adjacent to Pentireglaze Hevan and Portheath (see Appendix XI).

Farmyards can significantly contribute to loads of faecal indicator microorganisms to watercourses or coastal waters when they have a ready and renewable source of faecal material, a direct hydrological connection with open water channels exists and a sufficient proportion of livestock farms are present in the catchment (Edwards *et al.* 2008). The concentration of faecal coliforms excreted in the faeces of animal species and humans and corresponding loads are summarised in Table VIII.1.

Table VIII.1 Levels of faecal coliforms and corresponding loads excreted in the faeces of warm-blooded animals.

Farm Animal	Faecal coliforms (No. g^{-1} wet weight)	Excretion rate (g day^{-1} wet weight)	Faecal coliform load (No. day^{-1})
Chicken	1,300,000	182	2.3×10^{8}
Cow	230,000	23,600	5.4×10^{9}
Pig	3,300,000	84,000,000	8.9×10^{8}
Sheep	16,000,000	38,000,000	1.8×10^{10}
Human	13,000,000	3,000,000	1.9×10^{9}

Data from (Geldreich, 1978) and (Ashbold et al. 2001)

Although a significant proportion of the land bordering the bay supports livestock production, there are no relevant watercourses which could act as routes of contaminated runoff to the bay. It is therefore considered that the risk of contamination from farmyards is low.

Appendix IX

SOURCES AND VARIATION OF MICROBIOLOGICAL POLLUTION

WILDLIFE AND DOMESTIC ANIMALS

The coastal area of Port Quin Bay supports significant communities of farmland species of birds. Maritime cliffs and slopes also sustain important colonies of seabirds. Woodland species may occur in wooded valleys. At the time of the shoreline survey, flocks of woodland birds were observed at Lundy Hole; seabird colonies were seen at Pentireglaze Hevan and from Pentire Point to Rumps Point (see Figure 1.1). Pentire Point is a preferential habitat for skuas, auks, terns, waders, gannets, divers, sea duck, petrels, shearwaters, gulls and phalaropes (Lawson, 1999). Table IX.1 presents counts of seabirds in the coastal area of Port Quin Bay.

The Mouls Island is the main site for Puffin (*Fratercula arctica*) in Cornwall. It is estimated that the population of this species in the island is reduced to 25 individuals (Mike Lawson, pers. com.). Adults arrive in Cornwall back at the breeding colony in March and April and leave again in mid-August (Royal Society for the Protection of Birds, 2009). Guillemot (*Uria aalge*) also nests in colonies, from March to the end of July (Royal Society for the Protection of Birds, 2009).

Previous studies in the UK have indicated significant concentrations of microbiological contaminants (thermophilic campylobacters, salmonellae, faecal coliforms and faecal streptococci) from intertidal sediment samples supporting large communities of birds (Obiri-Danso and Jones, 2000). For example, geometric means of *E. coli* detected in faecal samples of Starling (*Sturnus vulgaris*) can reach as much as 4.6 x 10^7CFU $100g^{-1}$ (Environment Agency, 2003; Whither *et al.* 2003). Geometric means of *Salmonella* spp. and faecal coliforms in samples of Gull droppings from colonies along St. Lawrence River (Canada) in 1996 were $2.6x10^6$ and $2.1x10^8$CFUg^{-1}, respectively (Levesque *et al*. 2000).

Faecal matter deposited on intertidal rocky shores of Port Quin Bay over the low water period when birds are feeding may constitute a potentially significant source of contamination. Feare (2001) suggests that approximately 10% of the faecal matter could be deposited under a roost, suggesting the potential significant contribution of contamination in roosting areas. This contamination may be washed down the cliffs during periods of heavy rainfall.

The main areas for seabird activity in Port Quin Bay are Pentire Point, Ramparts, The Mouls, Com Head and Carnweather Point. It is therefore expected that the impact of faecal contamination from birds would be higher in the western part of the bay. Given the diffuse nature of this source of contamination, consideration is given at siting the RMP in the centroid of the BMPA as this would be representative of contamination from these areas.

Table IX.1 Numbers of seabids monitored in ten sites in Port Quin Bay.

Site	Common name	Scientific name	Count (Individual/pair)	Habitat and seasonality
Pentire Point	Herring Gull	*Larus argentatus*	12 pairs	Nests in loose colonies, mainly on sea cliffs. Resident. All year round
Round Hill	Fulmar	*Fulmarus glacialis*	4 pairs	Rests and nests on cliff ledges. Present at breeding sites nearly all year, although young birds leave in late summer. Most easily seen offshore from August to November
Ramparts	Fulmar	-	13 pairs	-
The Mouls Island	Razorbill	*Alca torda*	12 individuals on land	Nests among boulders and in rock crevices on cliffed coasts. From March to the end of July.
Com Head	Fulmar	-	22 pairs	-
Carnweather Point	Fulmar	-	12 pairs	-
Trevan Point	Fulmar	-	2 pairs	-
Doyden Point	Fulmar	-	5 pairs	-
Reedy Cliff	Fulmar	-	6 pairs	-
Varley Head	Fulmar	-	2 pairs	-

Data from Seabird 2000 supplied by joint Nature Conservation Committee.
Information on habitats from (Sterry, 1997).
Information on seasonality from (Royal Society for the Protection of Birds, 2009).

Appendix X
MICROBIOLOGICAL DATA: WATER

Polzeath is designated bathing water under the Directive 76/160/EEC (European Communities, 2006) concerning the quality of bathing water[22].

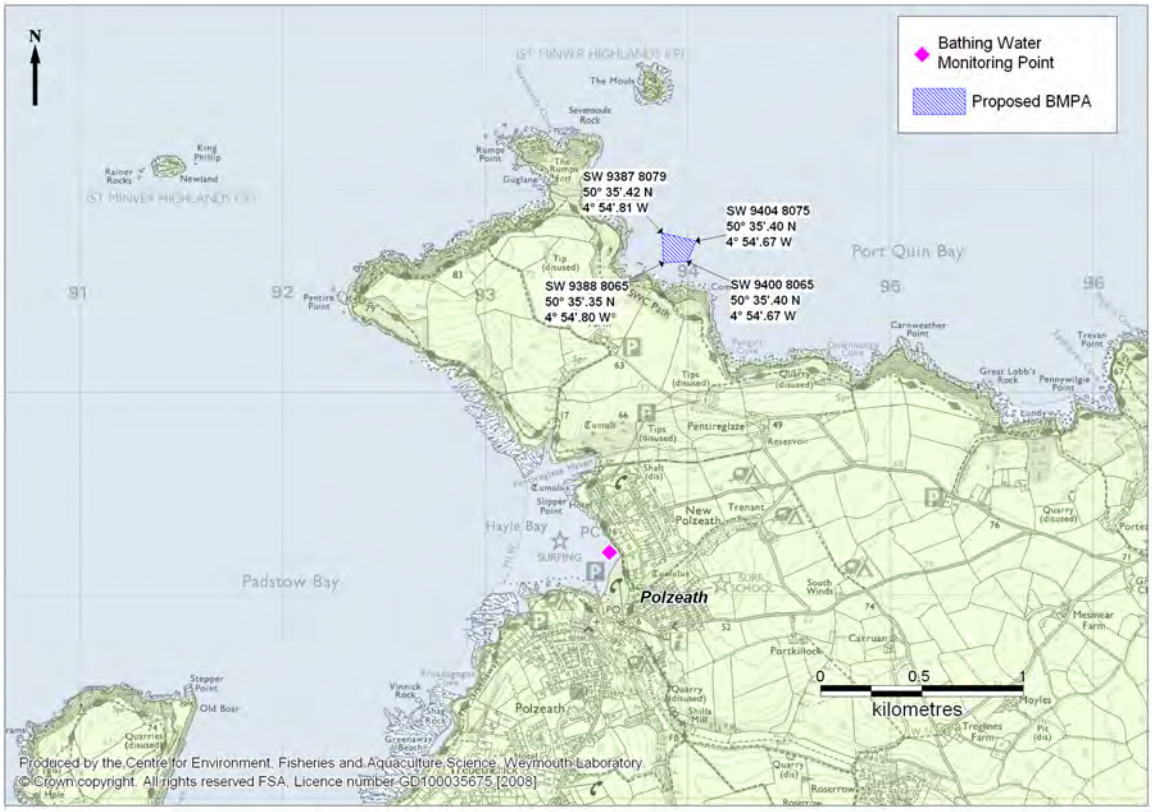

Figure X.1 Location of Polzeath designated Bathing Water.

The overall quality of the Bathing Water is summarised in Table X.1.

Table X.1 Quality of Polzeath Bathing Water for the period 2004–2008.

Compliance	Bathing season				
	2004	2005	2006	2007	2008
Excellent (Guideline Pass)	√	√	√	√	√
Good (Mandatory Pass)					
Poor (Mandatory Fail)					

The descriptions in this table are based on compliance monitoring and assessment against the current Bathing Water Directive. This will be replaced by assessment against the Directive in 2014.

[22] The bathing season runs from 15 May to 30 September. Water is sampled throughout the season. Levels of bacteria must not exceed the Imperative (I) value (2000CFU of faecal coliforms 100ml^{-1}) and the Guideline (G) value (100CFU of faecal coliforms 100ml^{-1}) represents the ideal maximum value. Bathing waters in England and Wales are classified as:
Poor - fails at least one coliform I standard;
Good - passes coliform I standards but fails at least one coliform G standard;
Excellent - passes coliform G standard and national faecal streptococci standard (100CFU of faecal streptococci 100ml^{-1}).

Under the revised Bathing Waters Directive, Polzeath BW meets excellent status (Table X.2).

Table X.2 Quality of Polzeath bathing water for the period 2004–2008.

2003–2006	2004–2007	2005–2008
Excellent Quality	Excellent Quality	Excellent Quality

Information from Environment Agency (2008)
(http://www.environment-agency.gov.uk/research/library/data/34381.aspx)

Table X.2 summarises sampling effort, range, geometric mean, median and 95% confidence intervals for the mean of levels of faecal coliforms in surface waters from Polzeath for the period 2004–2008.

The geometric mean is the mean value of logarithms and is often reported for positively skewed data sets, i.e. data sets with number of high extreme values. The median (or 50th percentile) is the central value of the distribution when the data are ranked in order of magnitude, i.e. for an odd number of observations, is the data point which has an equal number of observations both above and below it. The analysis of medians is preferable to the analysis of geometric means when the data set is not strongly influenced by a few extreme results (Helsel and Hirsch, 2002).

Table X.2 Summary statistics of levels of faecal coliforms in Polzeath designated Bathing Water for the period 2004–2008.

	CFU Faecal coliforms 100ml^{-1}		
Year	Range (Min.-Max.) (number of samples)	Geometric mean	Median
2004	<2–54 (20)	3	3
2005	<2–32 (20)	5	5
2006	<2–10,400 (20)	12	11
2007	<2–1,640 (20)	15	17
2008	<2–589 (20)	12	11
2004–2008	<2–10,400 (100)	8	8

Data from Environment Agency (2008).

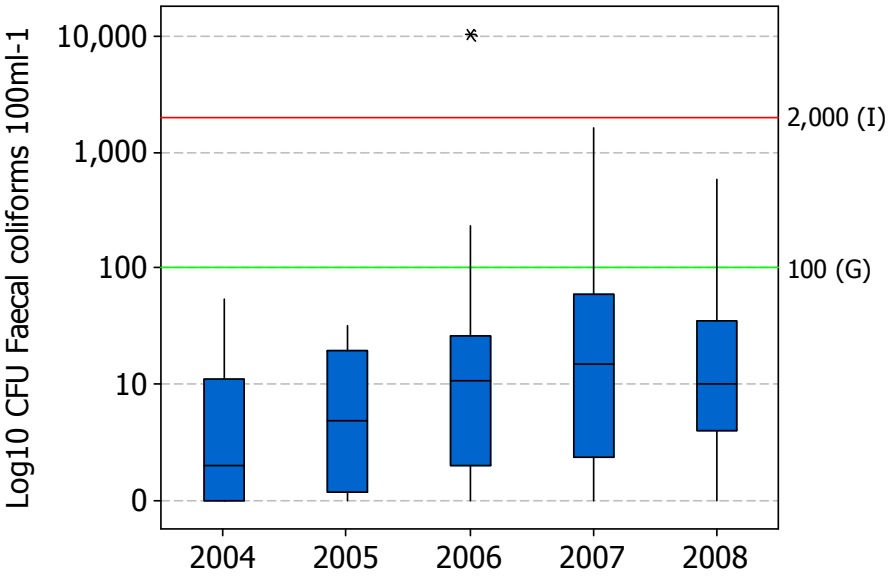

Figure X.2 Box-and-whisker plots of levels of faecal coliforms in Polzeath designated Bathing Water for the period 2004–2008.
Data from Environment Agency (2008).

The annual geometric means of faecal coliforms would be equivalent to class B in bivalve mollusc fluid and intravalvular liquid. These figures suggest that, during most of the time, there are not appreciable levels of pollution from the Camel Estuary susceptible to impact the BMPA at Port Quin Bay.

Appendix XI
SHORELINE SURVEY

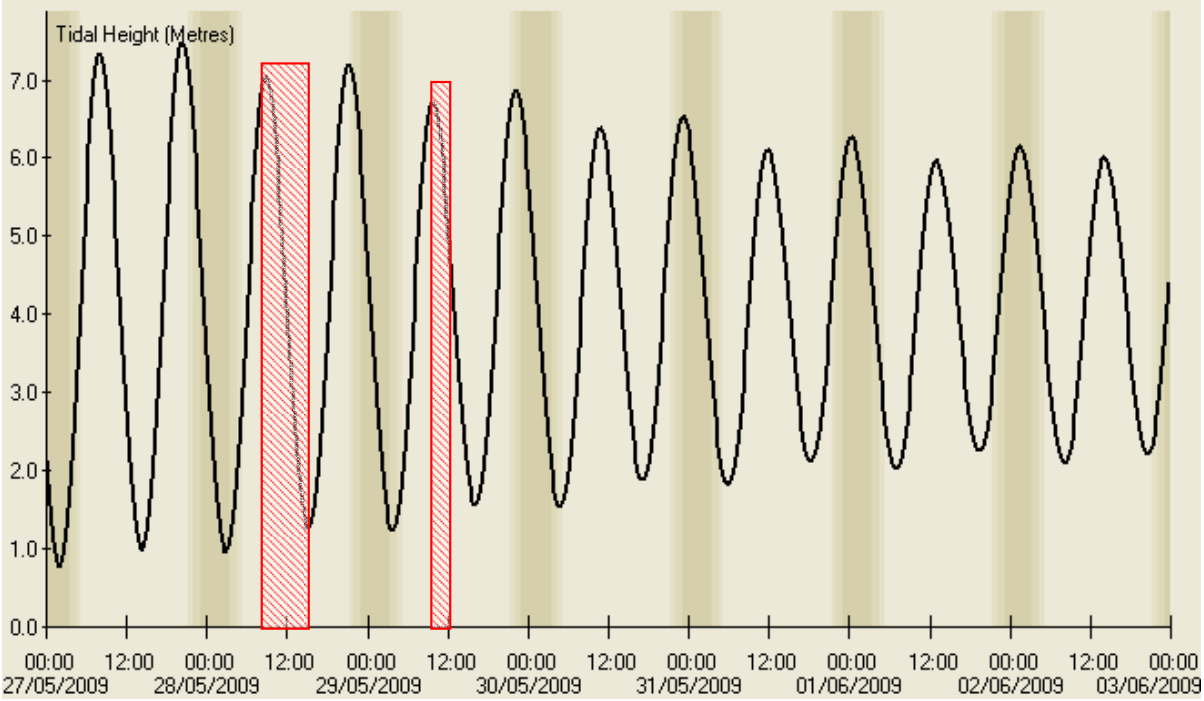

Figure XI.1 Tidal curve at Port Isaac.
Port Isaac is a Secondary Harmonic port.
Predicted heights are in metres above Chart Datum.
Republished with permission from Admiralty Total Tide (United Kingdom Hydrographic Office) by permission of Her Majesty's Stationery Office and the UK Hydrographic Office. © Crown copyright.
N.B. red box indicates period of shoreline survey.

Table XI.1 Information recorded during the shoreline survey.

1	**Bed name and ID/species**	Bed ID: TBA Bed name: Port Quin Bay Species: Pacific oysters (*C. gigas*), mussels (*Mytilus* spp.), king scallops (*Pecten maximus*)	
2	**Location of bed /Coordinates OSGB36 (Easting, Northing)**	93879/80646	93996/80651
		94038/80753	93871/80793
3	**Production area**	Port Quin Bay	
4	**Area of bed**	0.018km^2	
5	**Shellfish Waters Directive Flesh point**	n/a	
6	**Shellfish Waters Directive Water point**	n/a	
7	**Bathing Waters Directive Sampling points**	Polzeath: 193600/79200 Daymer Bay: 192830/77600	

8	**Applicant's details**	John Porter Camel Mussels 23 Pellew Close, Padstow, PL28 8EY ☎ 01841 534818	
9	**Cefas Officer**	Carlos Campos	
10	**Local Enforcement Authority Officers**	Sally Glover (Senior EHO) John Dickinson (Food Safety Officer) Cornwall Council Trevanion Road, Wadebridge, Cornwall, PL27 7NU ☎ 01208 893514	
11	**Date/time of survey**	28 May 2009 (08:20–16:30) 29 May 2009 (10:00–12:30)	
12	**Extent of survey area**	Trebetherick Rocks–Port Quin	
13	**Map/chart references**	UKHO Admiralty Chart 1168: Harbours on the North Coast of Cornwall UKHO Admiralty Chart 1156: Trevose Head to Hartland Point OS Explorer 106: Newquay & Padstow (Wadebridge, Port Isaac & St. Columb Major)	
14	**Predicted tides** 0544A Port Isaac (50°35'N, 4°50'W) Totaltide (BST)	High Water (time/height)	28 May 2009 08:49 (7.0m) 21:11 (7.2m) 29 May 2009 09:44 (6.7m) 22:07 (6.9m)
		Low Water (time/height)	28 May 2009 02:50 (1.0m) 15:09 (1.3m) 29 May 2009 03:46 (1.2m) 16:05 (1.6m)
15	**Weather forecast**	Met Office (28–29 May 2009): Wind: west or southwest 2 or 3, backing southeast 3 or 4 later Sea state: smooth or slight in East, slight or moderate in west Weather: fog patches at first Visibility: moderate or good, occasionally very poor at first	
16	**Air temperature**	20°C at 8:20 (28 May 2009) 17°C at 10:00 (29 May 2009)	
17	**Wind**	4 knots (28 May 2009) 11 knots (29 May 2009)	
18	**Precipitation**	28 May 2009: Preceeding 24h: none Preceeding 48h: none	
19	**Streams/springs**	Stream at Hayle Bay (93641/78910) sampled Stream at Hayle Bay (93708/78991) sampled Stream at Pentireglaze Haven (93576/79679) sampled Springs at Pentireglaze Haven (93563/79691) sampled Springs at Downhedge Cove (not sampled) Stream at Epphaven Cove (95847/79808) sampled Stream at Port Quin (97125/80523) sampled	

20	**River flows (gauged)**	There are no major rivers discharging to Port Quin Bay
21	**Significant sewage discharges (Cefas database)**	Discharge at Port Quin village (197130/80500) Emergency overflow (194830/78150) Emergency overflow (193660/78830) Emergency overflow (193460/79570)
22	**Discharges (observed)**	Discharge at Port Quin village (five pipes from wall 97137/80512) not discharging
23	**Boats/port**	Two fishing boats off The Mouls island Slipway at Port Quin village
24	**Dogs**	Two dogs at Pentireglaze Hevan Three dogs at Daymer Bay No dogs observed at Hayle Bay
25	**Other animals**	Sheep: Pentire Farm and fields adjacent to Porteath Sheep in steep sided land draining to stream at Pentireglaze Haven Birds: Flocks of seabirds on fields from Pentireglaze Hevan to Pentire Point and in cliffs at Sandinway Beach Rabbits in fields adjacent to Pentire Point Seabird colonies between Pentire Point and Rumps Point Woodland and farmland birds in woodland areas at Lundy Hole
26	**Strand line SRD**	Plastics and cans at Pentireglaze Haven beach

27	**Samples taken**	**Mussel sample from proposed BMPA** Location (Eastings/Northings): 93157/80666 Time: 07:30 Result: <20MPN *E. coli* 100g^{-1} FIL **Freshwater sample from stream at Hayle Bay** Location: 93708/78991 Time: 09:14 Result: 0CFU *E. coli* 100ml^{-1} **Freshwater sample from stream at Hayle Bay** Location: 93641/78910 Time: 10:18 Result: 3,100CFU *E. coli* 100ml^{-1} **Freshwater sample from stream at Pentireglaze Haven** Location: 93576/79679 Time: 09:37 Result: 0CFU *E. coli* 100ml^{-1} **Freshwater sample from springs at Pentireglaze Haven** Location: 93563/79691 Time: 10:01 Result: 0CFU *E. coli* 100ml^{-1} **Freshwater sample from stream at Lundy Bay** Location: 95847/79808 Time: 11:41 Result: 0CFU *E. coli* 100ml^{-1} **Freshwater sample from stream at Port Quin** Location: 97125/80523 Time: 12:11 Result: 0CFU *E. coli* 100ml^{-1}
28	**Bivalve harvesting activity**	Mussels recovered from bags by hand from boat
29	**Sewage related debris**	Sanitary debris at Pentireglaze Hevan beach (93563/79691)
30	**Water appearance**	Clear in Port Quin Bay Turbid in freshwater stream at Pentireglaze Hevan Clear in all other streams
31	**Human population**	Significant proportion of tourists in Polzeath area Recreational activities observed: surfing and bathing at Hayle Bay); dog walking at Daymer Bay; walking and birdwatching along the southwest coast path
32	**Topography**	Steep-sided valleys Port Quin Bay bordered by maritime cliffs and slopes
33	**Land use**	Suburban at New Polzeath; grassland at Pentire Point; arable in fields adjacent to Port Quin Bay

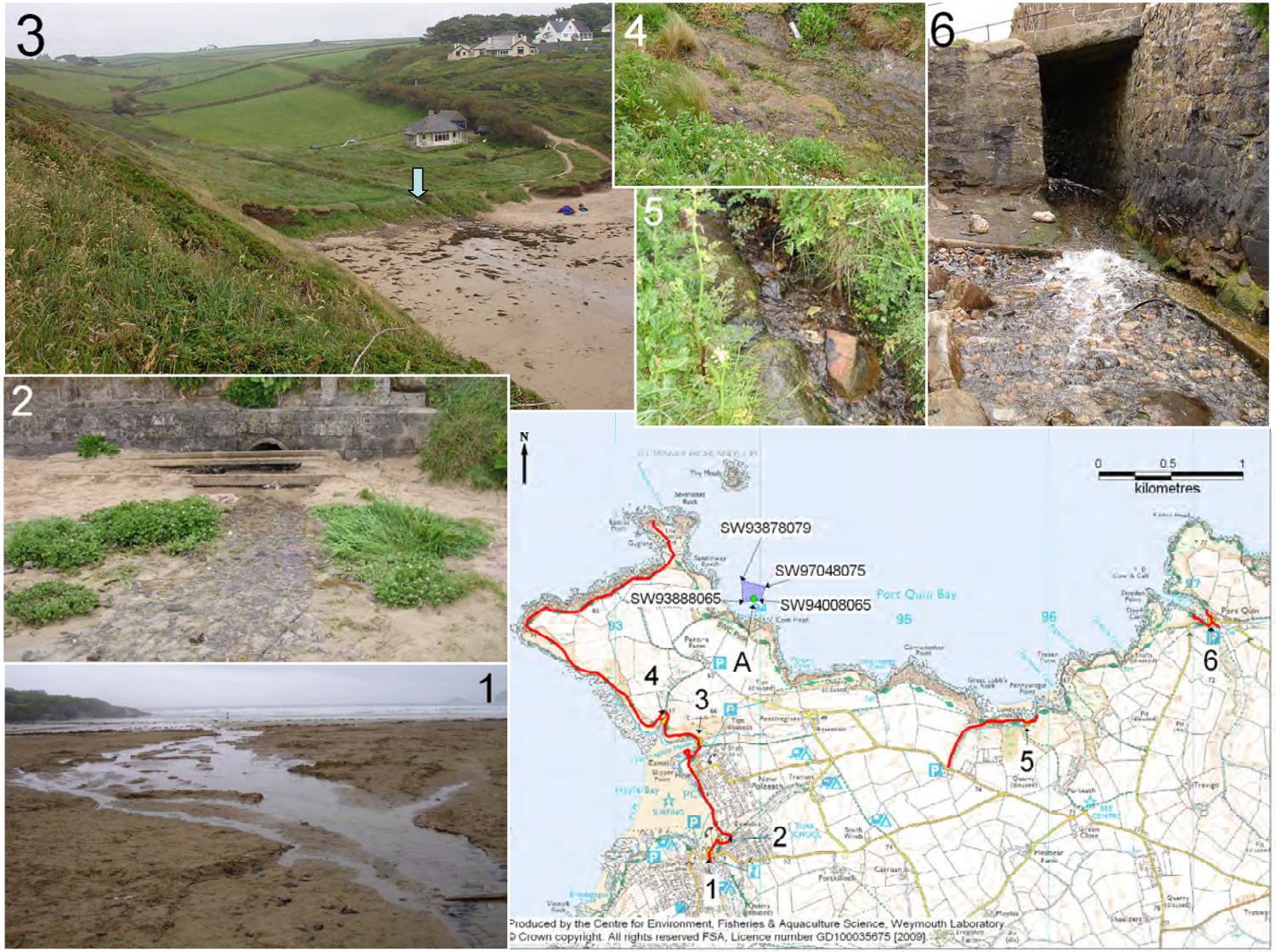

Figure XI.2 Area surveyed on 28 May 2009.
Red line represents area surveyed. Numbers are sites sampled. These correspond to results given in Table XI.1 - 27.

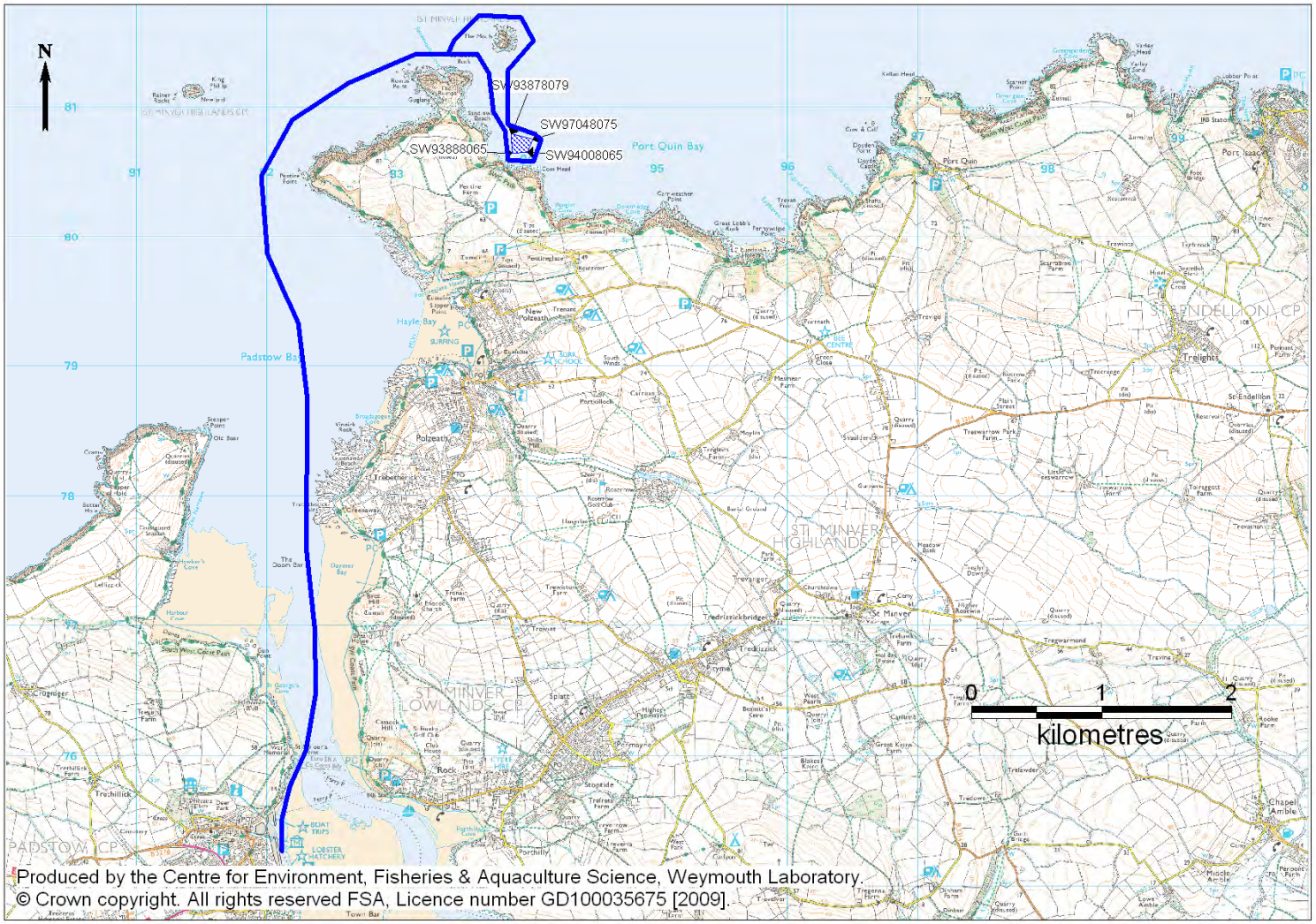

Figure XI.3 Area surveyed by boat on 29 May 2009.

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List of Abbreviations

AONB	Area of Outstanding Natural Beauty
BMPA	Bivalve Mollusc Production Area
CD	Chart Datum
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CFU	Colony Forming Units
CZ	Classification Zone
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
E. coli	*Escherichia coli*
EC	European Community
EEC	European Economic Community
EO	Emergency Overflow
FIL	Fluid and Intravalvular Liquid
FSA	Food Standards Agency
GM	Geometric Mean
ISO	International Organization for Standardization
km	Kilometre
LEA (LFA)	Local Enforcement Authority formerly Local Food Authority
M	Million
m	Metres
ml	Millilitres
mm	Millimetres
MPN	Most Probable Number
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
OSGB36	Ordnance Survey Great Britain 1936
PS	Pumping Station
RMP	Representative Monitoring Point
WGS84	World Geodetic System 1984

Glossary

Bathing Water	Element of surface water used for bathing by a large number of people. Bathing waters may be classed as either EC designated or non-designated OR those waters specified in section 104 of the Water Resources Act, 1991.
Bivalve mollusc	Any marine or freshwater mollusc of the class Pelecypoda (formerly Bivalvia or Lamellibranchia), having a laterally compressed body, a shell consisting of two hinged valves, and gills for respiration. The group includes clams, cockles, oysters and mussels.
Classification of bivalve mollusc production or relaying areas	Official monitoring programme to determine the microbiological contamination in classified production and relaying areas according to the requirements of Annex II, Chapter II of EC Regulation 854/2004.
Coliform	Gram negative, facultatively anaerobic rod-shaped bacteria which ferment lactose to produce acid and gas at 37°C. Members of this group normally inhabit the intestine of warm-blooded animals but may also be found in the environment (e.g. on plant material and soil).
Discharge	Flow of effluent into the environment.
EC Directive	Community legislation as set out in Article 189 of the Treaty of Rome. Directives are binding but set out only the results to be achieved leaving the methods of implementation to Member States, although a Directive will specify a date by which formal implementation is required.
Emergency Overflow	A system for allowing the discharge of sewage (usually crude) from a sewer system or sewage treatment works in the case of equipment failure.
Escherichia coli (E. coli)	A species of bacterium that is a member of the faecal coliform group (see below). It is more specifically associated with the intestines of warm-blooded animals and birds than other members of the faecal coliform group.
E. coli O157	E. *coli* O157 is one of hundreds of strains of the bacterium *Escherichia coli*. Although most strains are harmless, this strain produces a powerful toxin that can cause severe illness. The strain O157:H7 has been found in the intestines of healthy cattle, deer goats and sheep.
Faecal coliforms	A group of bacteria found in faeces and used as a parameter in the Hygiene Regulations, Shellfish and Bathing Water Directives, *E. coli* is the most common example of faecal coliform. Coliforms (see above) which can produce their characteristic reactions (e.g. production of acid from lactose) at 44°C as well as 37 °C. Usually, but not exclusively, associated with the intestines of warm-blooded animals and birds.
Geometric mean	The geometric mean of a series of N numbers is the N^{th} root of the product of those numbers. It is more usually calculated by obtaining the mean of the logarithms of the numbers and then taking the anti-log of that mean. It is often used to describe the typical values of a skewed data such as one following a log-normal distribution.
Hydrodynamics	Scientific discipline concerned with the mechanical properties of liquids.
Hydrography	The study, surveying, and mapping of the oceans, seas and rivers.
Sewage	Sewage can be defined as liquid, of whatever quality that is or has been in a sewer. It consists of waterborne waste from domestic, trade and industrial sources together with rainfall from subsoil and surface water.
Sewer	A pipe for the transport of sewage.
Sewerage	A system of connected sewers, often incorporating inter-stage pumping stations and overflows.
Waste water	Any waste water but see also “sewage”.

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