Sanitary Survey Report
and
Sampling Plan
for Dungarvan

Produced by

AQUAFACT International Services Ltd

In conjunction with

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Glossary

ANOVA	Analysis Of Variance
ASP	Amnesic Shellfish Poisoning
ED	Electoral Divisions
Depuration	The process of purification or removal of impurities
DSP	Diarrhetic Shellfish Poisoning
E. coli	Escherichia coli
GIS	Geographical Information Systems
I-WeBS	Irish Wetland Bird Survey
MPN	Most Probable Number
p.e.	Population Equivalent
PSP	Paralytic Shellfish Poisoning
PSU	Practical Salinity Units
RMP	Representative Monitoring Point
SAC	Special Area of Conservation
SFPA	Sea Fisheries Protection Authority
SPA	Special Protection Area
WTP	Water Treatment Plant
WWTW	Waste Water Treatment Works

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 pathogen 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, waste-water 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 classified production area at Dungarvan Harbour, County Waterford. It identifies the existing representative monitoring points and new supporting sampling plans for pacific oysters in Dungarvan Harbour. It also sets out a representative monitoring point for a potential razor clam fishery should it become viable in the future. It also adjusts the boundaries for the classified production area in Dungarvan Bay.

2. Overview of the Fishery/Production Area

2.1. Description of the Area

Dungarvan Harbour Bivalve Mollusc Production Area (BMPA) is located along the Southern coast of Ireland in the Celtic Sea. Dungarvan Harbour is a 20.8km^2 shallow tidal bay with extensive mud and sand flats. The area is approximately 5.7km E-W at its widest point and approximately 5.3km N-S. The catchment area of the BMCPA is 202km^2 and the main freshwater source from this catchment is the Colligan River which flows through Dungarvan Town.

The majority of the bay is made up of intertidal sand and mudflats. A navigational channel runs easterly from between Abbey point and Cunnigar Point towards Ballynacourty. At Ballynacourty the channel turns south easterly out to Ballynacourty Point. Depths within the navigation channel range from 0.4 to 4.4m

The Dungarvan Harbour SPA (Site Code: IE004032) is contained within the harbour, while Helvick Head to Ballyquin SPA (Site Code: IE004192) and Helvick Head SAC (Site Code: IE000665) are located on the southern side of the Head and the Mid-Waterford Coast SPA (Site Code: IE004193) is located

at the northeast end of Clonea Strand (see Figure 2.1)

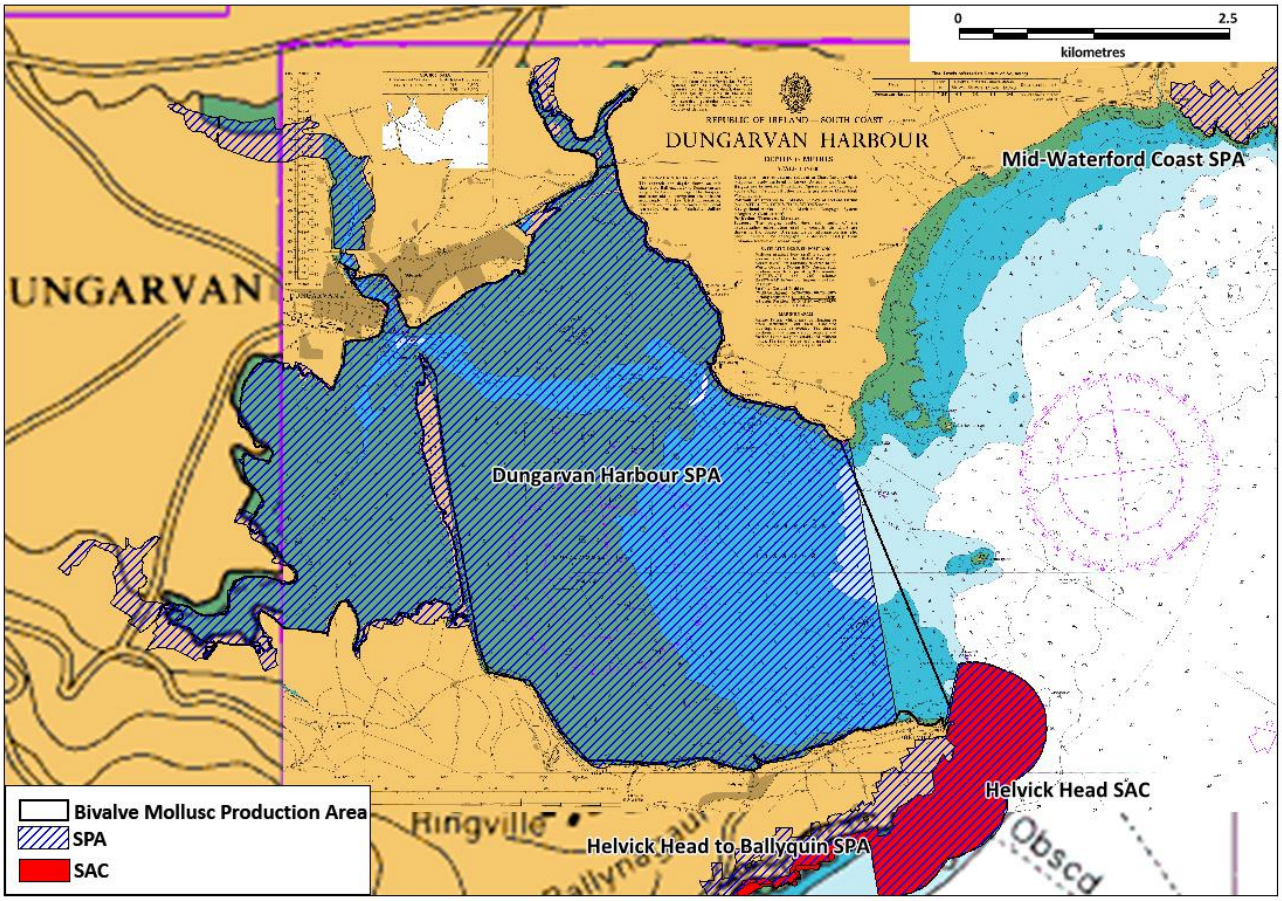

Figure 2.1: Location of Natura 2000 sites overlapping with the Dungarvan Harbour BMCPA.

The Dungarvan Harbour BMCPA supports a diversity of fish species. Species present include bass, pollack, flounder, dab, dogfish, rays, mackerel, sea trout, mullet, eels, cod, conger eel, gilthead bream, garfish, ballan wrasse and plaice (IFI, 2019).

The dominant land cover within the Dungarvan Harbour catchment is pastures accounting for 60.9% of the land area. Coniferous forest, peat bogs, moors and heathland account for a further 20.9%. The following land uses make up the remaining 18.2 % of the catchment; discontinuous urban fabric, transitional woodland-shrub, natural grasslands, land principally occupied by agriculture with significant areas of natural vegetation, non-irrigated arable land, broad-leaved forest, sport and leisure facilities, mixed forest, Industrial or commercial units, beaches, dunes, sands, mineral extraction sites and complex cultivation patterns.

The population of the catchment is approximately 15,318. The main towns/urban centres within the catchment are Dungarvan, Ballinroad and An Rinn.

2.2. Dungarvan Harbour Fishery

2.2.1. Location/Extent of Growing/Harvesting Area

The designated shellfish waters in Dungarvan Harbour cover an area of approximately 6.9km^2 and the Bivalve Mollusc Classified Production Area (BMCPA) covers c. 20.8km^2. Both can be seen in Figure 2.2.

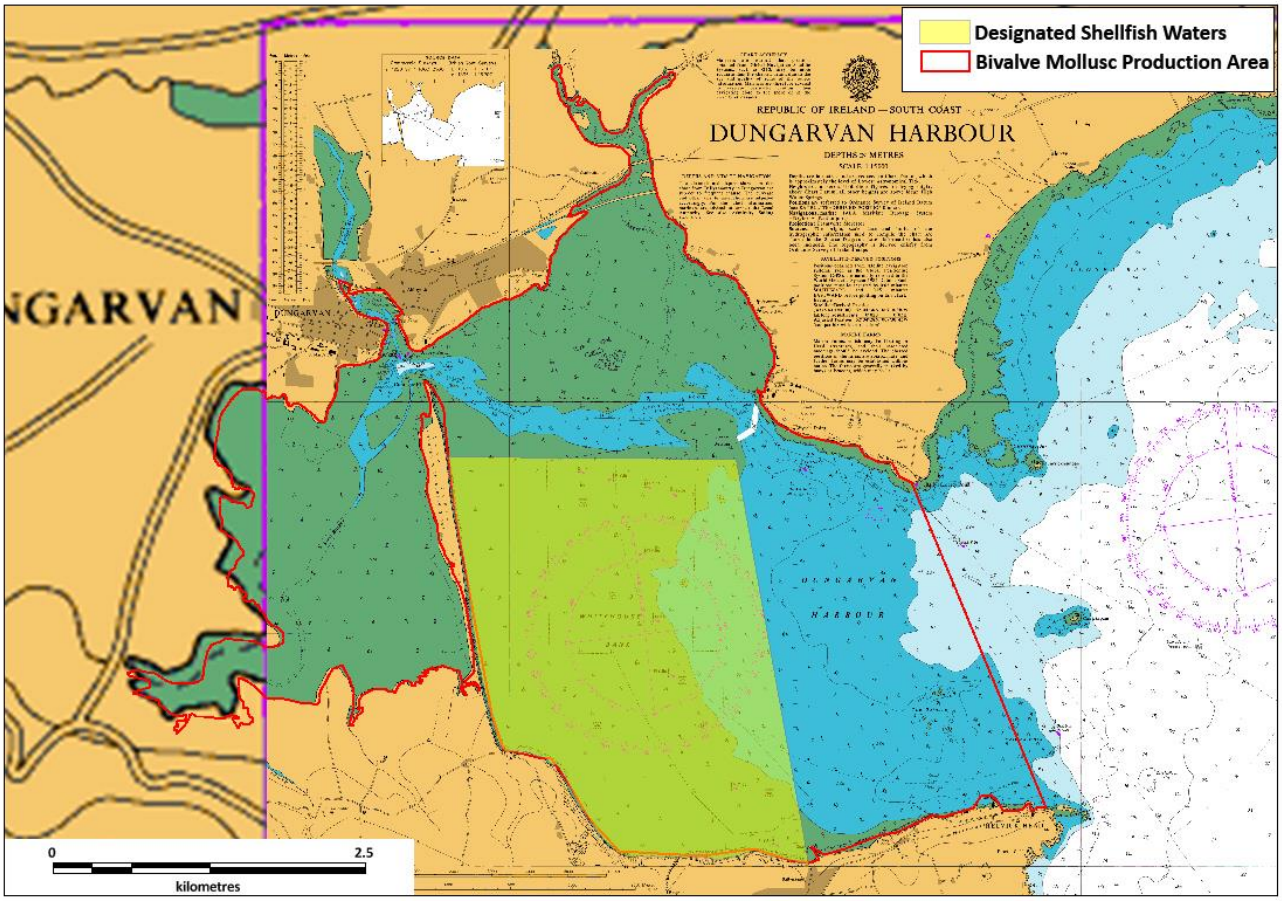

Figure 2.2: Bivalve Mollusc Classified Production Area and Designated Shellfish Waters within Dungarvan Harbour.

Figure 2.3 shows the current locations of licensed aquaculture sites within Dungarvan Harbour. All of the aquaculture sites are located on the intertidal sand and mudflats along Whitehouse Bank from Deadman sand down to the southern shore. The oysters account for 100% (2.38km^2) of the licensed area as the clam and periwinkle licensed areas are located within oyster areas.

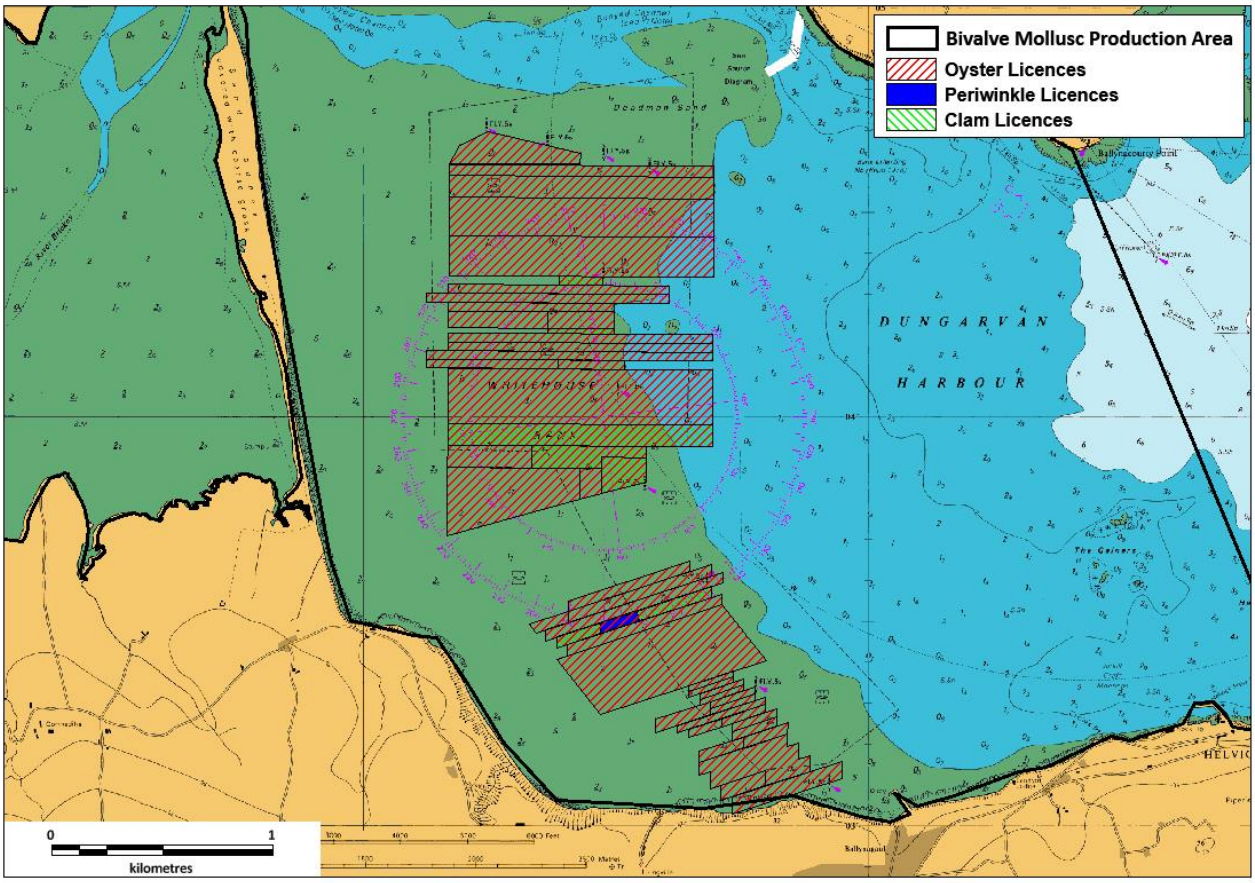

Figure 2.3: Licensed aquaculture sites within Dungarvan Harbour (Source: DAFM, 2019).

2.2.2. Description of Species

2.2.2.1. Pacific Oysters (Crassostrea gigas)

Distribution

Figure 2.4 shows the locations of licensed intertidal farmed Pacific oyster sites in Dungarvan Harbour. These farmed sites cover an area of 2.38km^2. The farms in Dungarvan Harbour are located on the intertidal sand and mudflats along Whitehouse bank.

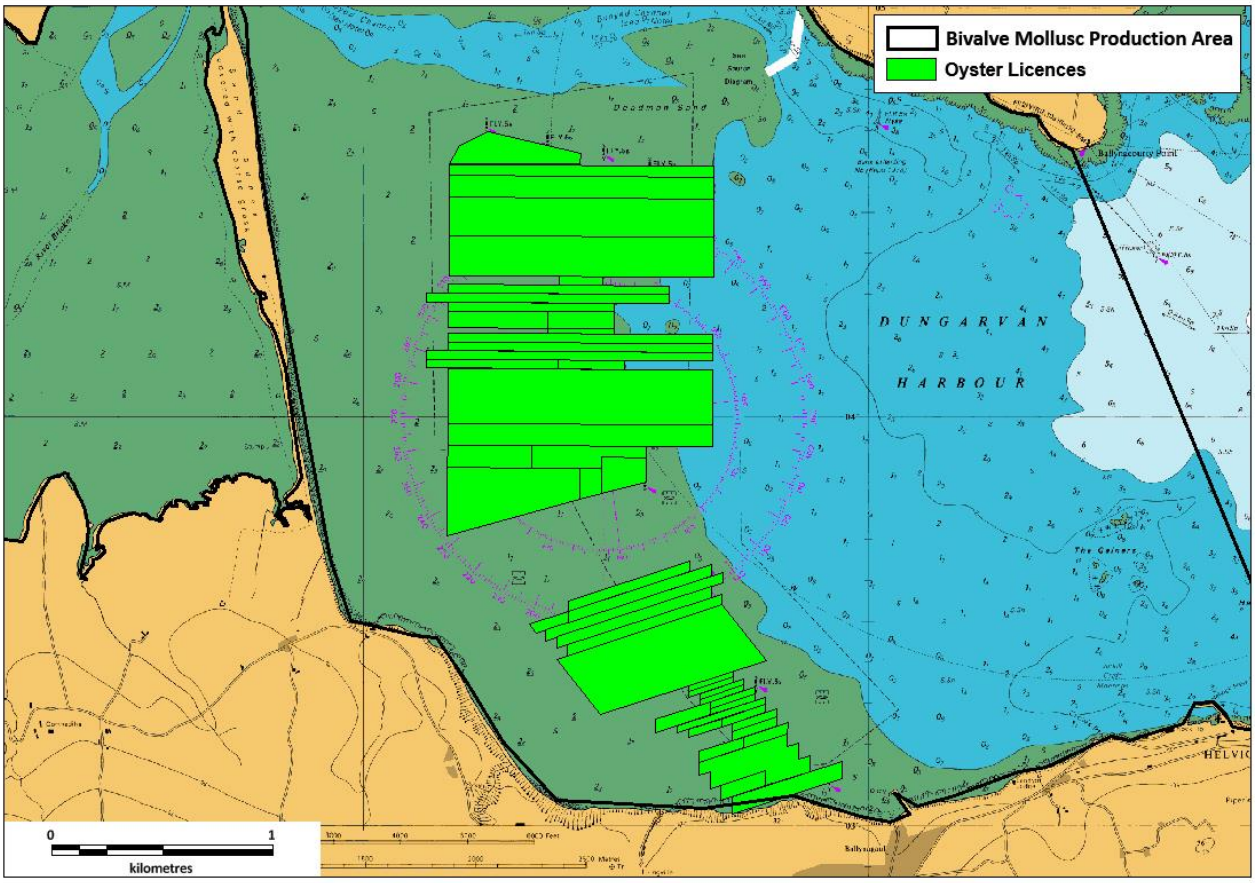

Figure 2.4: Licensed Pacific oyster harvesting sites in Dungarvan Harbour (Source: DAFM, 2019).

Fishery

All the oysters in the licensed areas are from farmed sources. The pacific oysters are grown using the bag and trestle method on the strand area along the eastern side of Cunnigar Spit. Trestles are accessed during the low tide periods using tractors and trailers. Average production of oysters between 2016 and 2018 period was approximately 1660 tonnes (Source: BIM). Marketable oysters are exported to France, China and Hong Kong amongst other destinations. Production of Pacific oysters is a year round activity with harvesting also taking place during most months of the year. Dungarvan is one of the main oyster production areas in Ireland with a nationally significant overall tonnage of exported oysters.

2.2.2.2. Clam Species Distribution

There are a number of licensed areas in the Dungarvan production area for which clams are also included in the allowed species list. Presently no clams are actively farmed on these licences. Figure 2.5 shows the licensed clam sites in Dungarvan Harbour. These farmed sites cover an area of 0.24km^2.

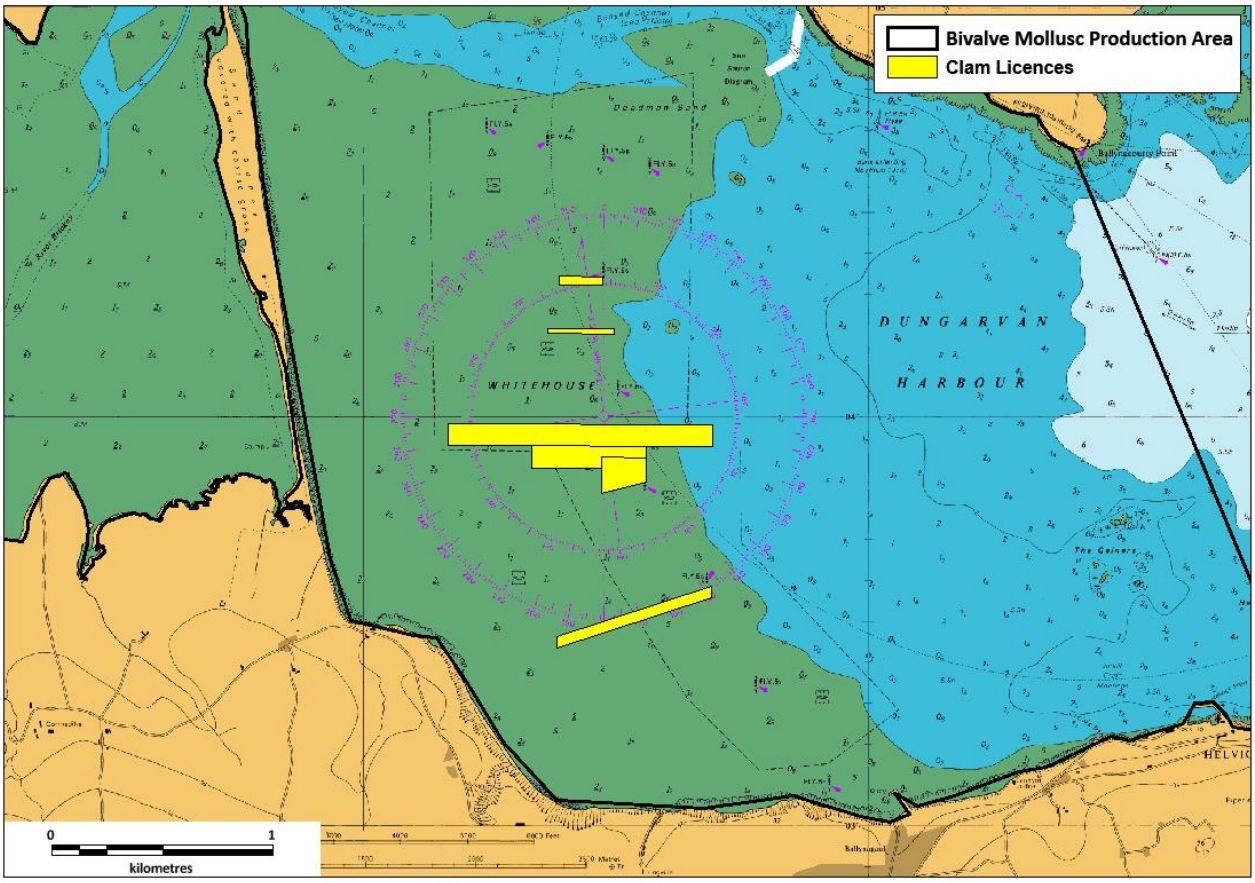

Figure 2.5: Licensed clam harvesting sites in Dungarvan Harbour (Source: DAFM, 2019).

Fishery

No commercial clam farming takes place within Dungarvan at the moment.

2.2.2.3. Razor-clams (Ensis siliqua)

Distribution

The distribution of Razor-clams in Dungarvan Harbour can be seen in Figure 2.6.

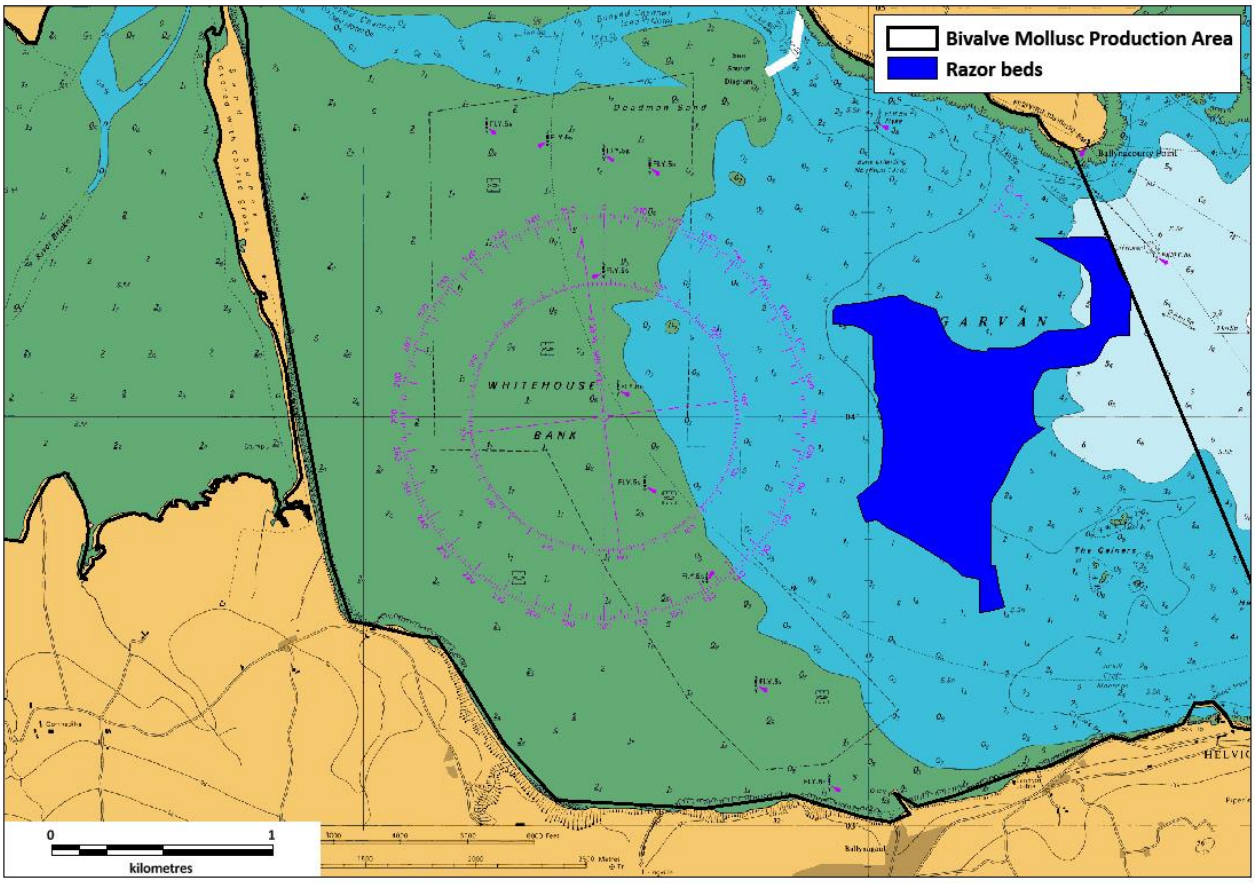

Figure 2.6: Razor-clam distribution in Dungarvan Harbour (Source: Marine Institute).

Fishery

There is currently no commercial fishery for razor-clams in Dungarvan Bay but there are naturally occurring beds of the razor-clam species *Ensis siliqua*. At the time of this report it is unclear if this bed is commercially viable in terms of the biomass of razor-clams or the suitability of the surrounding substrate for the use of dredges. In the event that the fishery were to become viable here then it is anticipated that a number of small boats would seek to operate a dredge fishery in the production area.

3. Overall Assessment of the Effect of Contamination on Shellfish

3.1. Human sewage/Human population

Dungarvan Harbour catchment has a population of 15,318 with over half of the population residing in the Dungarvan urban 1 and 2 electoral divisions (53%). In fact, 83% of the catchments population are located within the five electoral divisions that border the harbour. There are three urbans centres, the largest of which is Dungarvan Town with a population of 9,227, Ballinroad that of 1,161 and An Rinn with a population

of 499.

The 2016 census recorded 6,746 households in the catchment of which 8.4% are vacant and 5.1% are holiday homes. The sewage from over half (61.4%) of these households is connected to the public sewer/treatment system. The sewage from approximately on third 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 denser populated areas will be serviced by Dungarvan and Baile Na nGall treatment plants. The effectiveness of the private treatments 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 vast majority of the houses near the shoreline of the bay are serviced by Dungarvan and Baile Na nGall treatment plants (see Appendix 1 section 6.1.3). Therefore, a large proportion of contamination from septic tanks will enter the bay higher up in the catchment through the Colligan , Brickey and the Glendine rivers.

The Dungarvan WWTP is a secondary treatment facility with a design capacity of 25,000 PE (population equivalent) and is operating well below its capacity with a loading of 18,426 PE. Similarly, the Baile Na nGall WWTP is operating well below its 1600 PE design capacity at a loading of only 970 PE. Due to both of these treatment facilities working well below their designed capacity, there impact on shellfish quality will be reduced. In addition, the discharge for the Dungarvan WWTP is located 2km for the nearest licence area at the mouth of the bay. The Baile Na nGall plants discharge point though is located nearer the oyster farms and may be impacting contamination levels to some degree regardless of treatment levels.

Both WWTP's also have associated storm water overflows, four from the Dungarvan WWTP are clustered around the Dungarvan town area, of which three discharge directly into the production area and one discharges to a small drain which flows into the production area (see Appendix 1 section 6.1.3). Dungarvan WWTP also has a secondary discharge located in the northeast of the harbour which also discharges directly to the production area (See Figure 6.6). Baile Na nGall has a single storm water overflow located at the plant itself and two emergency overflows associated with pumping stations one at An Mota and the other at Baile Na nGall. Currently both appear to be flowing at intervals not indicative of emergency overflows and during the shoreline survey the discharge from the Baile Na nGall pumping station was noted as actively discharging

onto the foreshore. During the shoreline survey, water sampling of the small stream discharging onto the shore and nearby to the Mota pumping station returned a 16,000 cfu/100 ml ecoli result indicating high faecal contamination levels.

The two emergency overflows from the pumping stations of Mota and Baile Na nGall are of particular concern due to their immediate proximity to the licensed shellfish areas and the untreated nature of the discharge. It is expected that they are impacting contamination levels in the nearby oyster farms.

There are also a number of emergency overflows located on the Dungarvan sewer network system, some of these were identified during the shoreline survey also (See figure 6.7). It is evident that the emergency overflows from the Fr Twomey Road and Shandon pumping stations may also be discharging during storm events which will be adding to contamination levels in the production area arising from the Dungarvan urban zone (Nicholas O'Dwyer, 2018).

There are four industrial discharges within the catchment one is related to a waste facility which is not likely to be a significant source of bacterial load. The remaining three facilities are related to intensive agriculture two are for pigs farms and the other is a poultry farm (See figure 6.8). The discharge from these facilities is for run off due to rain from buildings and yards. The foul waste from the facilities is stored separately in tanks and other holding facilities for later dispersal onto land as organic liquid fertilizer and will be dealt with in the Agricultural section. There are also five section 4 discharges within the catchment although only two are in use. The two that are in use are from sewage treatment systems. One for a single dwelling and the other from holiday cottages. Both the industrial and section 4 discharges are within the catchment of the Colligan and Brickey rivers. Therefore, bacterial load from these discharges will add to the contamination levels entering the bay from these two rivers.

It is anticipated that surface water runoff from the hard surfaces within the Dungarvan urban area will be adding to contamination levels in waters reaching the production area. A large number of pipes/outflows were identified during the shoreline survey in and around the town area or associated housing and it is anticipated that at least some of these will be acting as conduits for surface water run-off. A number of locations around Dungarvan town showed signs of sewage contamination. Any contamination from these discharges will enter the production area through the Colligan River and Brickey River. Suggested evidence of this was seen in the elevated water sample results taken during the survey at two locations near Dungarvan Town (Figure 8.7 Abbeyside 600cfu/100ml, Cork road roundabout 360cfu/100ml).

A number of piers, moorings and a harbour were noted during the desktop and shoreline surveys. Helvick pier is a working fishing port and piers in Dungarvan town are used by a number of small open fishing craft and the adjoining basin is used as a mooring by a small number of pleasure craft. The pier at Ballynacourty is also used by a small number of boats. The majority of these boats, aside from a few larger trawlers in Helvick, would not have overnight facilities onboard. While data on sewage discharge levels from boating activities in the area is 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 60.9% of the Dungarvan Harbour catchment. Grasses and rough grazing account for 97% of the land used for farming in the catchment with only 3% being used for to grow crops.

There are 51,839 cattle in the catchment with the highest no of cattle occurring in Ringville (4,681). The density of cattle in the catchment is relatively high at 1.93 cows/ha of farmland, compared to the average national stocking density for cattle of 1.45 cows/ha of farmland. Significantly, much of the land surrounding the bay has high numbers of cattle. The shoreline survey identified eight locations were cattle were present near the shore. Seven of these were located within the Colligan River, River Brickey and the Glendine River estuaries. The remaining location was just west of Helvick pier (See figure 6.24 and Table 6.16).

There are 32,111 sheep in the catchment with the highest number of sheep occurring in Knockaunbrandaun (7,099) and Coumaraglin (6,704). The stocking density for sheep in the catchment (1.2 sheep/ha of farmland) is slightly higher than the national average of 1.04 sheep/ha. However, a significant proportion of the sheep (61.2%) are located in electoral divisions which are mostly outside the catchment. Making an estimate of the number of sheep within the catchment base on the percentage of each ED in the catchment the stocking density of sheep is 0.51 sheep/ha which is half of the national average.

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 spreading of slurry on pastures. Relatively few small scale agricultural drains were noted during the shoreline survey so it could be expected that the majority of this contamination from farm land (96.5% of the catchment) will enter the bay from the River

Brickey, Colligan River and the Glendine River. A water sample downstream of the Colligan River showed moderate levels of contamination. The remaining 3.5% will enter the bay between Cunnigar Spit and Helvick Head.

Whilst none of the oyster farms are located at the confluence of these rivers it is expected that agricultural contamination is influencing background levels of contamination to at least some degree.

3.3. Rivers and Streams

Dungarvan Harbour drains a catchment of 202.2km^2. The Colligan River drains 55.2% of the catchment. The Brickey River drains a further 28.7% of the catchment and two unnamed rivers flow into the northern end of the bay east of the Colligan and drain 11.9% of the catchment. The remaining 4.2% of the catchment drains in at Clonea Strand. The shoreline survey identified 14 separate streams or rivers of varying sizes within the Bay. A smaller number of field drains were also encountered.

As the Colligan River and River Brickey drain 83.9% of the catchment and join at Cunnigar Point they will contain a large proportion of the contamination emanating from those land uses upstream (See Appendix 1 section 6.1.5 for landuse details). Also, many of the discharges showing signs of enrichment were located within these two rivers. The open nature of the production area, as evidenced by high salinity readings in the proximity of the oyster licences and the relatively small size of the rivers though may lessen their potential impact on contamination levels (See Appendix 2 Section 7.7).

Of the smaller streams it is those discharging close to the licensed area that might be expected to have a bigger influence in contamination levels there. There are three that discharge onto the southern shore of the production area. All three were sampled during the shoreline survey, two showed low levels of contamination (See Appendix 3 Section 8.3). The stream at Ring appeared to be heavily contaminated, with a sampling result of E.coli 16,000 cfu/100ml. It can be anticipated that this stream, although small in size, will locally affect contamination levels.

The current (2010-2015) Water Framework Directive (WFD) status of the Colligan River is of moderate status as it enters the bay. The Brickey River is unassigned, however, the upper reaches of the river are designated as poor status (EPA, 2019a). The unnamed streams flowing into the eastern end of the bay have not been assigned a WFD status. The Colligan Estuary is of moderate status, while the Brickey Estuary has not been assigned a status. Dungarvan Harbour is a coastal water body and is currently assigned as high

status.

3.4. Movement of Contaminants

The majority of the bay is made up of intertidal sand and mudflats. A navigational channel runs easterly from between Abbey point and Cunnigar Point towards Ballynacourty. At Ballynacourty the channel turns south easterly out to Ballynacourty Point. Depths within the navigation channel range from 0.4 to 4.4m. Between Abbey Point and Cunnigar there is a deep pool of 8.9 to 9.7m due to high currents during flood and ebb tides. East of Whitehouse Bank out to the mouth of the bay between Helvick Head and Ballynacourty Point depths range from 0.2 to 6.6 m (See Figure 7.1). The bay has a relatively high tidal range (2.2m neaps -3.7 springs) allowing for a large water exchange with each tidal cycle. The largest source of freshwater input into the bay is from the Colligan River and River Brickey which account for 83.9% of the catchment and join at Cunnigar Point. The remaining freshwater flows directly into the bay from two unnamed streams in the northeast of the bay and account for 11.9% of the catchment (See Figure 7.4).

Basic tidal stream data are available for Dungarvan Harbour from the Admiralty Chart of the area (Admiralty Chart 2017). The Admiralty Chart gives currents of 2.5 knots at Cunnigar Point and currents of 1 to 1.5 knots along the channel from Cunnigar Point to Ballynacourty and parallel to the shore out to Ballynacourty Point. Irish Hydrodata Ltd. (1993) carried out a hydrographic survey of Dungarvan Harbour. Current with the channel were recorded between 0.3 Knots on neaps and 1 knots on the spring tide. Dye and drogues release at the mouth of the bay near Ballynacourty Point on a flood tide tended to follow the channel in a general northwesterly direction up to the town. However, when they were release further from the point and the winds were blowing from the north or northeast they drifted westerly towards Whitehouse Bank and then drifted north along Cunnigar Spit as far as the town. On Ebb tides the flow was generally southeasterly.

Discharges from the Dungarvan WWTP at Ballynacourty Point will in most cases be either push up towards the town on a flooding tide or out of the bay on an ebbing tide. When the winds are blowing from the north or north-east during a flooding tide the discharge may travel west across the licensed areas before travelling north up to the town. However, the prevailing wind for the area is from the southwest and only came from the north or northeast for 13.5% of the time between 2014 and 2018. Discharges from the Baile Na nGall WWTP will flow east out of the bay on the ebbing tide but will be pushed over the licensed areas on the flooding tide. The discharge from the small stream just west of the WWTP discharge which recorded a particularly high E. coli level will follow a similar pattern. When the prevailing southwest wind is blowing

the discharge from both of these sources will be somewhat diverted away to the northeast. The Colligan, Brickey and Glendine rivers are the mechanisms by which contamination from agricultural run-off from the majority of the catchment, industrial discharges and other discharges from Dungarvan town will enter the production area. In most cases discharges from these rivers will follow the channel from Cunnigar Point to Ballynacourty and then out to Ballynacourty Point and out of the bay. Therefore, avoiding the licensed shellfish areas. When the wind is blowing from the north or northeast on a flooding tide some of this contamination may be pushed over to the licensed areas. However, in other wind conditions this will not occur, in particular when the prevailing southwest wind is blowing contamination will be further restricted to the northeastern end of the bay away from the licensed areas.

Agricultural run-off from the land between Cunnigar spit and Helvic head, although comparatively low in volume compared to the rest of the catchment, may impact contamination levels in the shellfish of the licensed areas due to proximity to the trestles and the prevailing southwesterly wind.

3.5. Wildlife

Dungarvan Harbour supports a number of bird species including but not limited to Light-bellied Brent Goose, Black-tailed Godwit, Great Crested Grebe, Shelduck, Red breasted Merganser, Oystercatcher, Golden Plover, Grey Plover, Lapwing, Knot, Dunlin, Bar-tailed Godwit, Curlew, Redshank, Turnstone, Little Egret, Cormorant, Herring Gull, Kittiwake, Razorbill, Fulmar, Shag, Guillemot, Great Black-backed Gull and Black Guillemot (See Appendix 1 Section 6.1.6.2). There were four locations observed with birds present during the shoreline survey. These were all located around the Dungarvan town area, away from the oyster growing area and over 130 birds were recorded.

Dungarvan Harbour is routinely monitored by Bird Watch Ireland with peak numbers from 2011 to 2016 ranging from 9,445 to 17,714. 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). Whilst birds were not noted in the area of the oysters during the survey there is a lack of available data on there foraging locations within the bay and thus it is very difficult to base any RMP location on these bird numbers. I

Both common and grey seals are present within Dungarvan, with a number of haul-out sites for common

seals. No abundance data is available for either species. It is anticipated that impacts on contamination levels will be minimal from the numbers involved.

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, 255,000 overseas tourists visited Co. Waterford and 247,000 domestic tourists visited Co. Waterford (Failte Ireland, 2018b). The main tourist attractions in the catchment area Waterford Greenway, Dungarvan Castle, Waterford County Museum, Clonea Beach and the Comeragh Mountains. The Waterford Greenway is a popular attraction and so is likely to receive a high volume of tourists. The number of holiday homes is relatively small at only 5.1% (344 households) of the permanent households in the catchment. There are also two caravan parks located near Ballynacourty. 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 Dungarvan. As the area is a relatively popular for tourism it is possible that there could be a seasonal impact on the shellfish area from tourism.

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 Waterford the spreading of slurry or farmyard manure, which would be common place 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 be particularly the case with geese and wading birds. Where these birds are feeding or roosting close to the oyster licences there will be a consequential seasonal increase in potential contamination.

Analysis of rainfall data for the area has shown that August to March are the months with higher 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.

Analysis of Sea Fishery Protection Authority *E. coli* results for the representative monitoring point found no significant variation between seasons (summer, autumn, winter or spring). Although there is no statistical difference between seasons, the SFPA have identified in recent years that on a number of occasions results in excess of the A classification limit have occurred between May and September, while the limit has not been exceeded between October and April. As such 'seasonal' classifications have been assigned based on this (See Appendix 3 Section 8.1 for details).

3.7. Shoreline survey

In total 123 features were identified, of which 14 rivers/streams were identified, 16 drains, 64 pipes, 2 discharges, 2 culverts, 3 piers, 1 marina, 3 WWTP, 4 discharges from WWTP and a WWTP pumping station.

Of the 14 streams and rivers and discharges 10 showed varying levels of enrichment. One unnamed stream which discharges near the licensed shellfish areas (Features 113 in Figure 6.24) recorded an *E. coli* result of 16,000 cfu/100 ml indicating sewage related contamination.

The majority of the waster water infrastructure was confirmed to be in place as described in the initial desktop study although in some instances overflows were not visible due to the discharges subsurface locations.

Of the drains identified seven were draining agricultural land. The largest majority of the drains encountered discharge to the River Brickey estuary which is unsurprising considering the pasture land surrounding this area.

The majority of the 64 pipes identified during the shoreline survey showed no signs of contamination and a sizeable portion were not flowing at the time of the survey. It is anticipated that many will be linked to surface water run off from the urban areas of Dungarvan. However, eight showed signs of some discolouration or enrichment and seven showed signs of obvious sewage contamination (Figure 6.24 Map ID 24, 27, 44, 46, 69, 86 and 87). The majority of the pipes showing signs of sewage contamination were located around the greater Dungarvan Town urban area. These discharges did not appear to be linked to the known sewage infrastructure nor didn't appear in the initial desktop investigation. .

In most cases the discharges showing contamination were located in or ultimately discharge to the Colligan, Brickey and Glendine estuaries and will follow the current patterns described in movement of contaminants above. Two of the discharges were located in the south of the bay near Baile Na nGall and are likely to impact on the licensed shellfish beds to some degree.

Numbers of cattle at the eight record locations varied from 20 to 100+ with more than 370 cattle recorded in total. Four locations were noted with birds present, with more than 130 bird observed in total. There were three piers record one of which had seven boats moored. A marina was also recorded which had 15 to 20 boats present.

Nine water sampling sites were sampled during the shoreline survey in October 2020 for bacteriological analysis. The highest *E. coli* result record was 16,000 cfu/100ml from a stream in the south west of the bay near the licensed shellfish areas. Two other water samples recorded *elevated E. coli* levels although not to the same extent. One was located at Abbey Point (600 cfu/100ml) and the other was located near the Cork road roundabout (360 cfu/100ml). There was 20+ cows grazing land adjoining the Cork road roundabout sampling point. The remaining six stations had low *E. coli* levels.

As part of the shoreline survey a bacteriological study of shellfish *E. coli* levels was also conducted. Monitoring took place from five sampling points within the licensed shellfish areas (See Figure 8.6). Each sampling location was sampled five times between October 2020 and January 2021. The *E. coli* results were low with all but two samples receiving an A classification. The two higher results at sampling points 2 and 5 were both 330 cfu/100ml which is B classification. Sampling point 2 (113.2 cfu/100ml) and 5 (146.6 cfu/100ml) also had the highest average *E.coli* levels over the 5 samples.

4. Amendments to BMPA

The boundary of the Dungarvan Harbour BMPA has been amended. The amendments have been made to the northern extent of the production area so as to exclude the urban areas around Dungarvan Town and Ballinaroad. A large number of the potential contamination sources identified during the shoreline area were located in this area including those showing evidence of sewage contamination and including a number of emission points belonging to the Dungarvan waste water infrastructure.

Further minor amendments have been made to exclude the areas which two pumping station overflows discharge impact at Baile Na nGall and An Mota. The amendments can be seen in Figure 4.1 below.

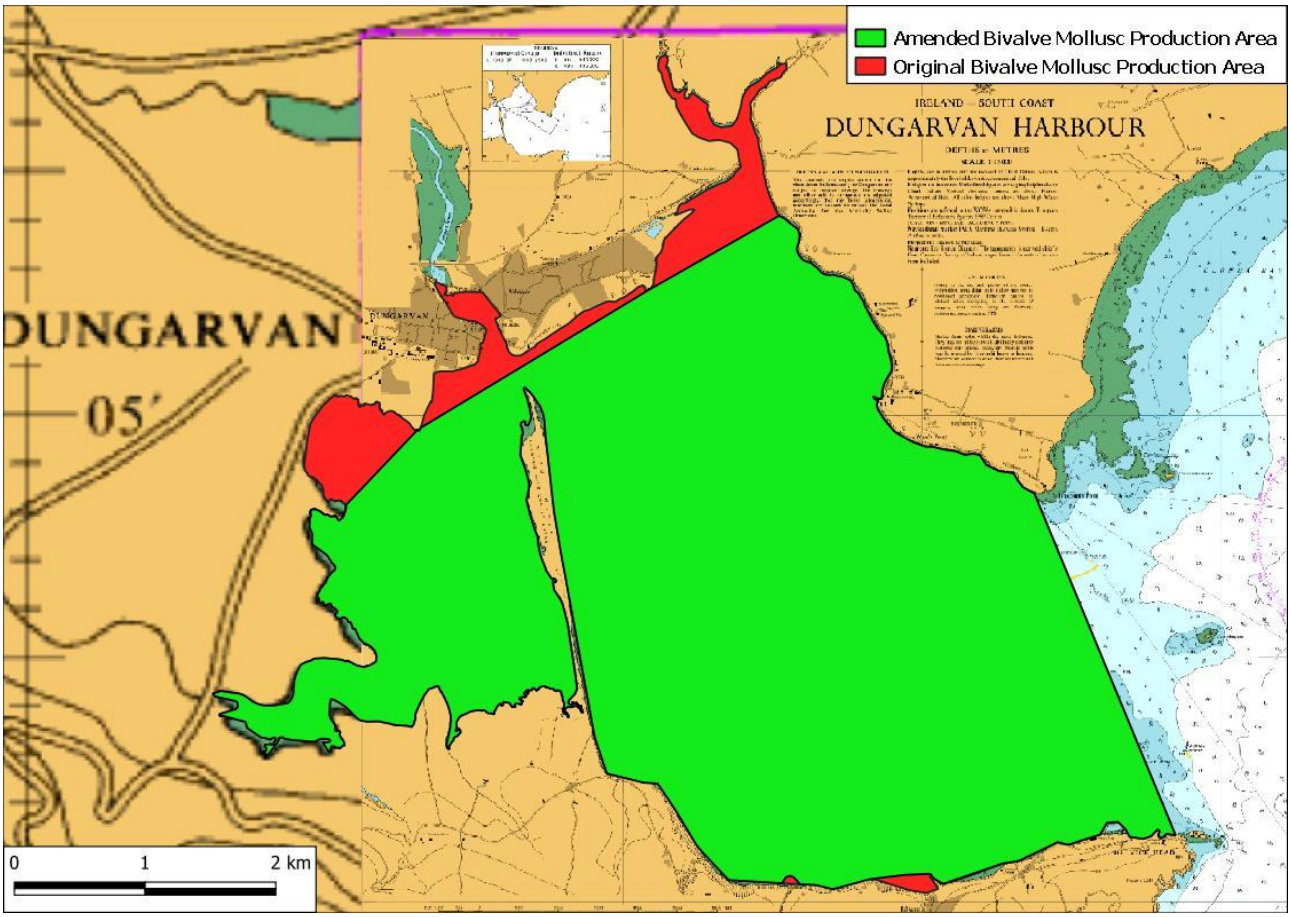

Figure 4.1: Amendments to Dungarvan Bivalve Mollusc Production Area.

5. RMPS and Sampling Plan

5.1. Pacific Oysters (Crassostrea gigas)

The location of the RMP 1 for oysters is 52.073052, -7.59317 (227,946.3E, 91,254.7N) and RMP 2 is 52.053906, -7.574407 (229,245.4E, 89,131.7N) both are shown in Figure 5.2. Prior to the sanitary survey two RMPs were also monitored due to the size of the area licensed for oysters. A bacteriological sampling programme was carried out during the shoreline survey to assist in the identification of the most suitable locations for the monitoring points. Three points were sampled in the larger group of Licence areas to the north and two in the smaller area to the south (See Appendix 3 Section 8.2 for more detail).

Based on this survey RMP 1 has been moved to the new location. This location recorded the highest individual and average *E. coli* levels in shellfish over the sampling period. When the winds are blowing from the north or north-east during a flooding tide the discharges from Dungarvan WWTP at Ballynacourty Point WWTP may travel west across the licensed areas before travelling north up to the town. Due to this the chosen location is the most suitable RMP for the northern licensed areas as it is likely to have the highest E.coli levels.

RMP 2 remains unchanged as the highest *E. coli* results were recorded at this point out of the two sampling points in the group of licenced areas to the south. This location is also close to those discharges associated with the overflows linked to the pumping stations at An Mota and Baile Na nGall. See section 7.2 for more detail.

12 – 18 individuals of market size (minimum shell length 7.5 cms) should be collected for bacteriological analysis. As harvesting can take place throughout the year, sampling needs to be on a monthly basis.

5.2. Razor-clams (Ensis siliqua)

The location of the RMP 3 is for razor clams is -7.551851 and 52.072905 (230,779.6E, 91,255.1N), and is shown on Figure 5.3 below. Currently there is no active Razor clam production in Dungarvan Harbour. However, the Marine Institute identified a bed of Razor clams (*Ensis siliqua*) within the bay.

In the event that a fishery is to commence, the RMP will be located in the eastern end of the bed. The reason for choosing this location is twofold. Firstly, this part of the bed is closest to the Dungarvan WWTP discharge. Secondly, any contamination from the Colligan River, River Brickey and two unnamed rivers in the northeast of the bay is likely to pass this point based on the dominant currents within the bay. These rivers have the highest possibility of containing contamination as they drain almost all of the catchment including Dungarvan town.

In terms of numbers of razor clams collected, this should be a minimum 10 individuals of market size for bacteriological analysis. Sampling frequency will be determined on the basis of the seasonality of the fishery.

Table 5.1: Coordinates of the Production Area.

Corner	Longitude	Latitude	Easting	Northing
NW	-7.62087	52.0924	226,035.7	93,396.13
NW	-7.61964	52.0921	226,120.5	93,360.1
E	-7.55409	52.0779	230,622.5	91,807.2
SE	-7.53835	52.0545	231,718.7	89,207.6

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

RMP	Site Code	Species	Longitude	Latitude	Easting	Northing
RMP 1	WD-DB-DB-B1	Oysters	-7.59317	52.073052	227946.3	91254.8
RMP 2	WD-DB-DB-B2	Oysters	-7.574407	52.053906	229245.4	89131.7
RMP 3	WD-DB-DB-Raz	Razor clams	-7.551851	52.072905	230779.6	91255.1

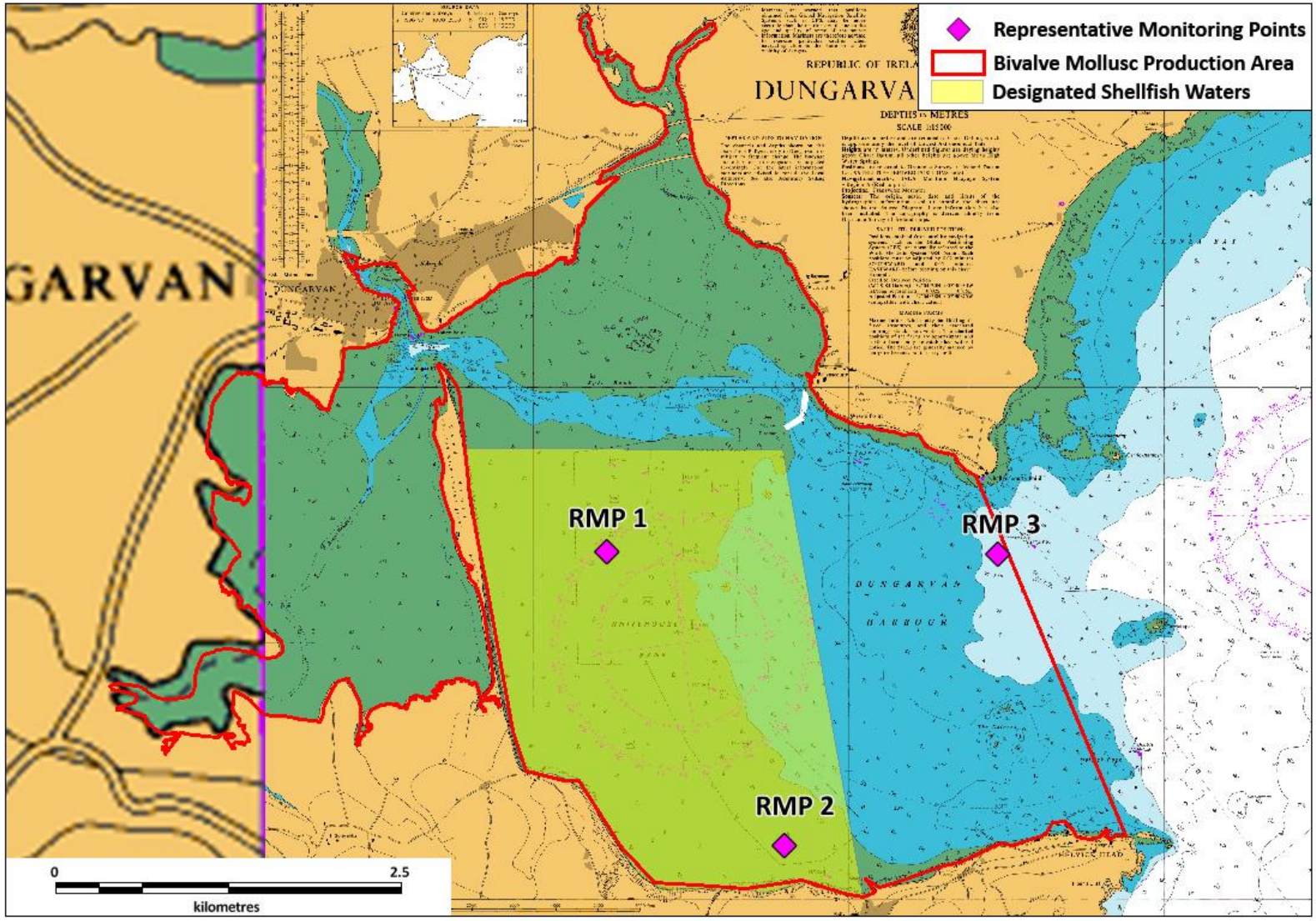

Figure 5.1: Bivalve Mollusc Classified Production Area and Designated Shellfish Waters within Dungarvan Harbour.

5.3. Species Specific RMP maps

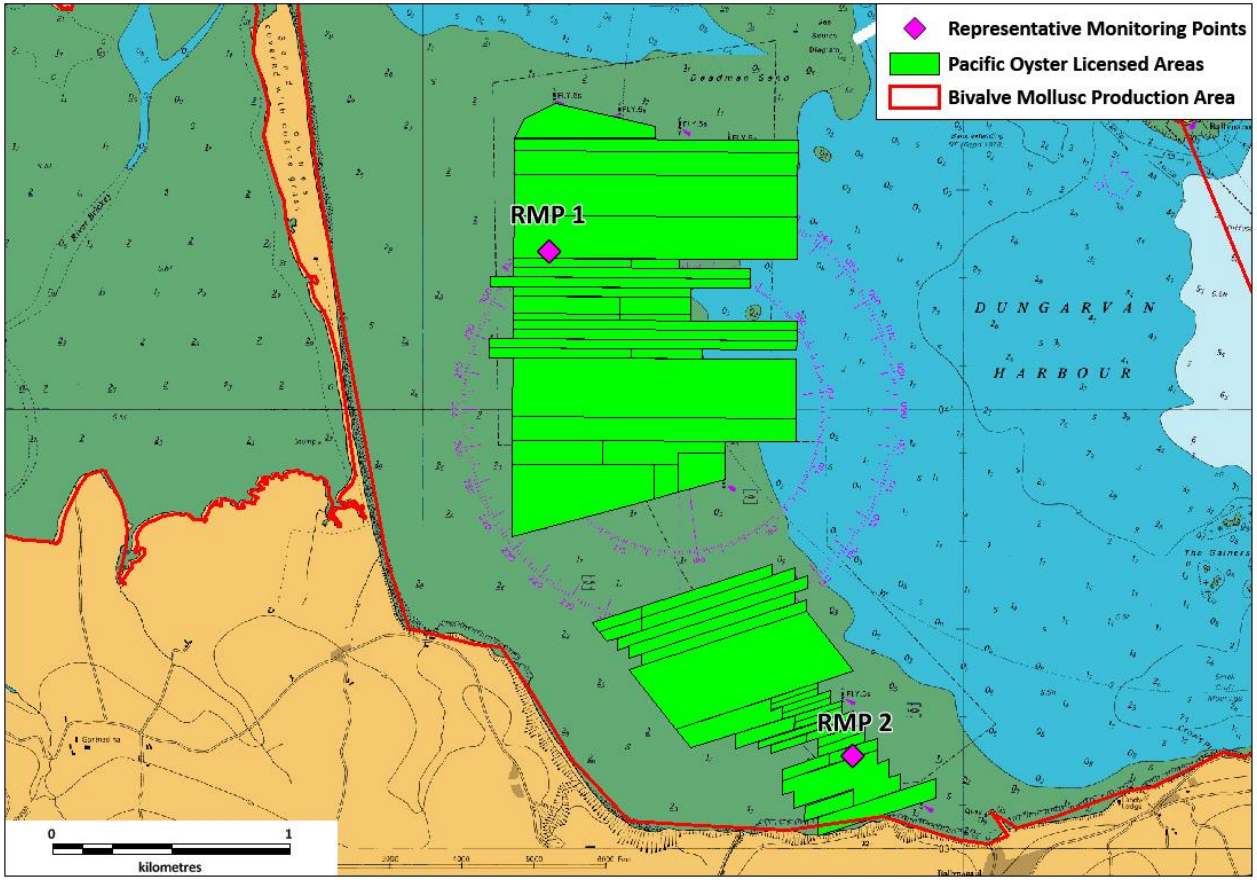

Figure 5.2: Location of the Oyster RMPs in relation to the Pacific Oyster Licensed Areas within Dungarvan Harbour.

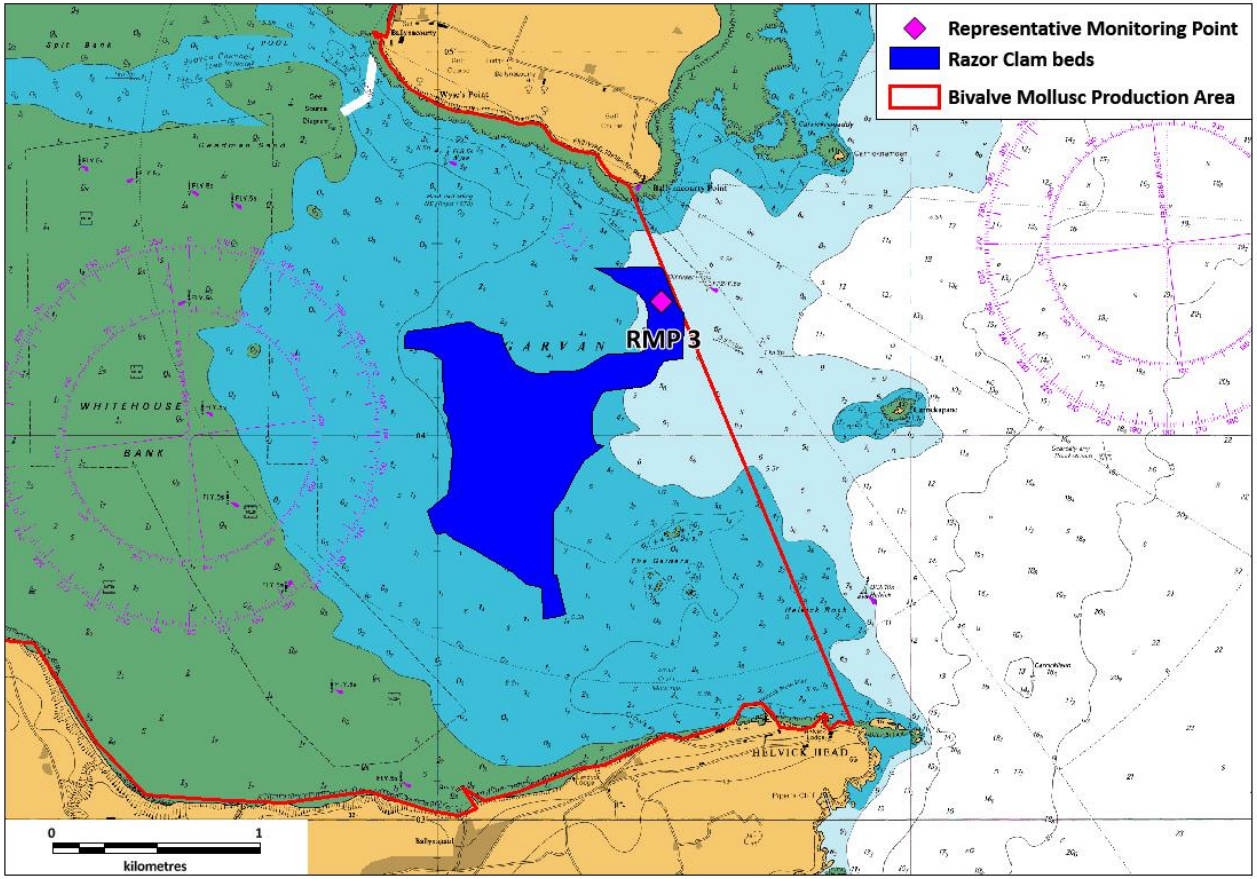

Figure 5.3: Location of the Razor clam RMP in relation to the Razor Clam Beds within Dungarvan Harbour.

5.4. General Sampling Method

All collection and transport of shellfish samples *for E.coli* testing under the Sampling Plan identified as part of the Dungarvan Harbour Sanitary Survey should follow the Sea Fisheries Protection Authority's own Code of Practice for the Microbiological Monitoring of Bivalve Mollusc Production Areas.

6. Appendix 1: Identification of Pollution Sources

This section attempts to document all pollution sources within the Dungarvan Harbour catchment area.

6.1. Desktop Survey

Pollution sources were considered within the catchment area of Dungarvan Harbour (see Figure 6.1). The catchment area covers an area of 202.2km^2, approximately 19km east west at its widest point and 23km north south at its longest point.

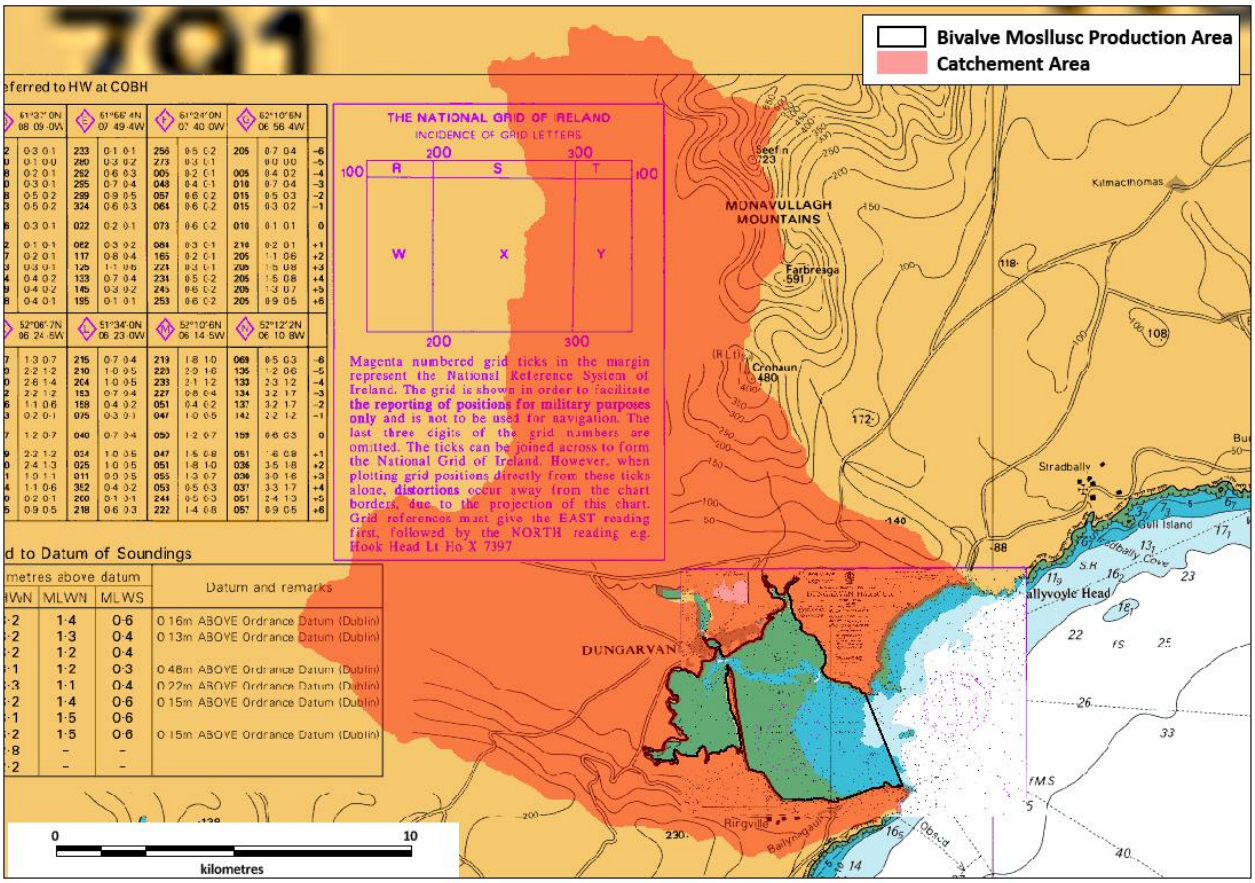

Figure 6.1: Dungarvan Harbour catchment area used for assessment of the pollution sources.

6.1.1. 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 areas. The population data were obtained through the Central Statistics Office (CSO) online Small Area Population Statistics (SAPS) (CSO, 2019a) Figure 6.3 shows the human population within Dungarvan Harbour catchment area and Table 6.1 shows these data in tabular form.

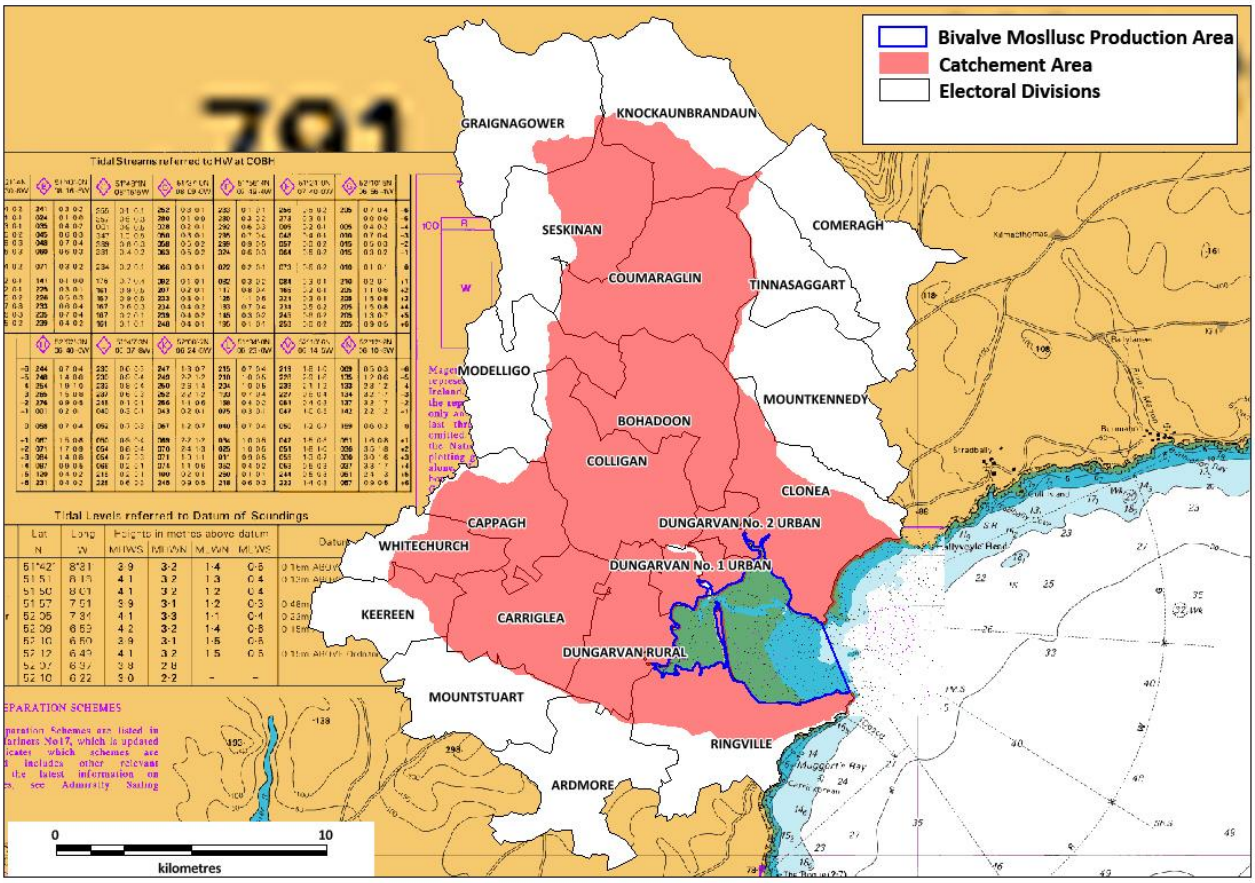

Figure 6.2: Electoral Divisions within the Dungarvan Harbour Catchment Area.

The Dungarvan Harbour Catchment Area overlaps 21 ED's (two in their entirety and 19 partially). The following ED's are entirely within the catchment Dungarvan No. 1 Urban and Dungarvan No. 2 Urban. The ED's that are partially within the catchment are Ardmore, Bohadoon, Cappagh, Carriglea, Clonea, Colligan, Comeragh, Coumaraglin, Dungarvan rural, Graignagower, Keereen, Knockaunbrandaun, Modelligo, Mountkennedy, Mountstuart, Ringville, Seskinan, Tinnasaggart, Whitechurch. Dungarvan Town with its two ED's (urban 1 and 2) contains by far the largest population (8,227) followed by Clonea (2,280), Dungarvan rural (1902) and Ringville (1,365).

These 21 ED's accommodate a total population of 19,073. As most of these ED's 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 in GIS and from this value the population size was calculated e.g. if 50% of ED lies within 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 areas is estimated at 15,318 people. Table 6.1 shows this estimation.

There are three main towns/urban centres within the catchment area Dungarvan (9,227), Ballinroad (1,161) and An Rinn (499).

There are 8,384 households within the 21 ED's within the catchment area. Of this, 8.7% are vacant (733) and a further 5.5% are holiday homes (460). Of the 6,746 houses actually within the catchment (based on the % of the ED within the catchment), 8.4% are vacant and 5.1% 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 Dungarvan Harbour system. Therefore, the highest levels of sewage and waste would be expected to enter through the Coligan River which drains 55.2% of the catchment. As holiday homes only account for 5.1% of the dwellings in the catchment they are unlikely to cause a significant increase in the sewage and waste water levels relative to the permanent population.

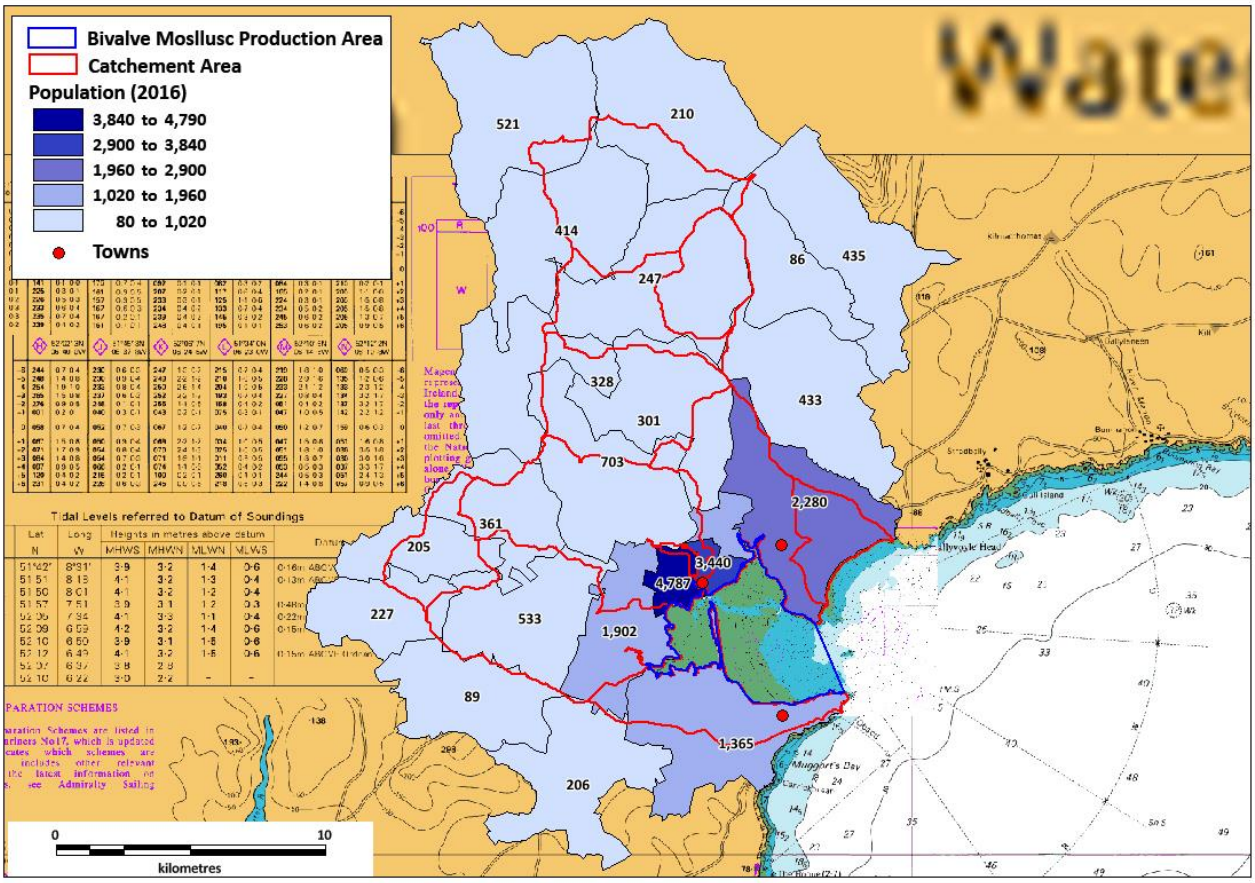

Figure 6.3: Human population within the Dungarvan Harbour Catchment Area (Source: CSO, 2019a).

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

Electoral Division	Population (2016)	% ED in Catchment	Estimated Population
Ardmore	206	1.00	2
Bohadoon	301	99.98	301
Cappagh	361	83.78	302
Carriglea	533	99.47	530
Clonea	2280	79.90	1822
Colligan	703	95.93	674
Comeragh	435	0.06	0
Coumaraglin	247	99.03	245
Dungarvan No. 1 urban	4787	100	4787
Dungarvan No. 2 Urban	3440	100	3440
Dungarvan rural	1902	99.15	1886
Graignagower	521	7.14	37
Keereen	227	23.84	54

Electoral Division	Population (2016)	% ED in Catchment	Estimated Population
Knockaunbrandaun	210	24.48	51
Modelligo	328	22.40	73
Mountkennedy	433	0.53	2
Mountstuart	89	1.30	1
Ringville	1365	55.68	760
Seskinan	414	53.18	220
Tinnasaggart	86	5.04	4
Whitechurch	205	60.86	125

Table 6.2: Households within the EDs in the Dungarvan Harbour Catchment Areas (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
Ardmore	95	69	13	12	1	1	0	0
Bohadoon	118	99	3	14	118	99	3	14
Cappagh	158	133	5	14	132	111	4	12
Carriglea	231	180	20	30	230	179	20	30
Clonea	974	769	144	46	778	614	115	37
Colligan	277	245	9	20	266	235	9	19
Comeragh	216	168	17	28	0	0	0	0
Coumaraglin	110	89	8	12	109	88	8	12
Dungarvan No. 1 Urban	2261	1913	68	227	2261	1913	68	188
Dungarvan No. 2 Urban	1512	1323	53	96	1512	1323	53	96
Dungarvan rural	747	657	7	68	741	651	7	67
Graignagower	230	190	9	29	16	14	1	2
Keereen	103	88	1	12	25	21	0	3
Knockaunbrandaun	84	69	5	7	21	17	1	2
Modelligo	118	108	1	7	26	24	0	2
Mountkennedy	168	147	2	18	1	1	0	0
Mountstuart	33	26	1	6	0	0	0	0
Ringville	618	478	80	47	344	266	45	26
Seskinan	208	168	9	27	111	89	5	14
Tinnasaggart	37	31	1	5	2	2	0	0
Whitechurch	86	70	4	8	52	43	2	5

* This figure includes those houses temporarily unoccupied on census night

6.1.2. Tourism

In 2017, 2.4 million tourists visited the south east Region of Ireland (Failte Ireland, 2018a). This figure was made up of 954,000 overseas tourists, 1,400,000 domestic tourists and 46,000 Northern Irish tourists. Of the overseas tourists, 255,000 and of the domestic tourists 247,000 visited Co. Waterford (Failte Ireland, 2018b). The main tourist attractions in the area are Waterford Greenway, Dungarvan Castle, Waterford County Museum, Clonea Beach, Ballyvoyle viaduct, St. Declan's Well and Church ruins, Lismore Castle Gardens, The Magic Road, Mahon Falls and the Comeragh Mountains.

The attractions located inside the catchment area include; Waterford Greenway, Dungarvan Castle, Waterford County Museum, Clonea Beach and the Comeragh Mountains. 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 south east region.

Several operators use the natural amenities in and adjacent to Dungarvan Harbour as a focal point for their aqua-tourism businesses. Two charter vessels (Dungarvan Offshore Charters and Dungarvan Bay Charter Boats) operate out of the bay offering offshore fishing, whale and bird watching and diving charters. Waveworld operate out of Clonea Beach offering a wide range of water sport and Dungarvan Harbour sailing club operate out of Dungarvan town. The Gold Coast Golf Club is located along the shoreline near Ballynacourty Point.

In addition to the above there is also a number of caravan/camping sites located along the shore of Dungarvan Harbour and a number of piers, quays and slips which provide sea access.

Increases in population in the local area due to tourism may result in an increase in the quantity of sewage discharged within the Dungarvan Harbour 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. The only monitored swimming area near the production area is Clonea beach, which is a Blue Flag beach. Clonea Beach is monitored for water quality by the EPA and has been classified as excellent for 2015, 2016, 2017 and 2018. In addition, waste can enter the area from recreational vessels.

6.1.3. 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 a 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.

6.1.3.1. Water Treatment Works

There are two waste water or sewage treatment works within the Dungarvan Harbour catchment. Both of which discharge directly to the sea (Dungarvan and Baile Na nGall). Figure 6.4 shows both Treatment Works within the Dungarvan Harbour catchment area and Table 6.3 shows the coordinates and facility capacities of each works (EPA, 2019b).

6.1.3.2. Continuous Discharges

Dungarvan WWTP is a secondary treatment facility with a design capacity of 25,000 PE (Population Equivalent) and is currently under capacity at 18,426 PE, the maximum discharge for this facility is 8,444 m^3/day. Baile Na nGall WWTP is a secondary treatment facility with a design capacity of 1,600 PE and is currently under capacity at 970 PE, at the time of writing there was no data for the maximum discharge from this facility. 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 Licences for each facility in terms of BOD (Biological Oxygen Demand), Ortho-Phosphate, Suspended Solids, Nitrogen and Ammonia. These emissions limits comply with the parameters of Shellfish Directive (2006/113/EC) and the Quality of Shellfish Waters Regulations 2006.

There is no geo-referenced database for septic tanks and on-site domestic waste water 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 6,980 permanent private households in the 21 EDs, 61.4% (4,283) were connected to a public sewer/treatment system and 34.2% (2,386) 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 3,218 and of this 67.6% (2,175) are on the public system while 27% (884) 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.

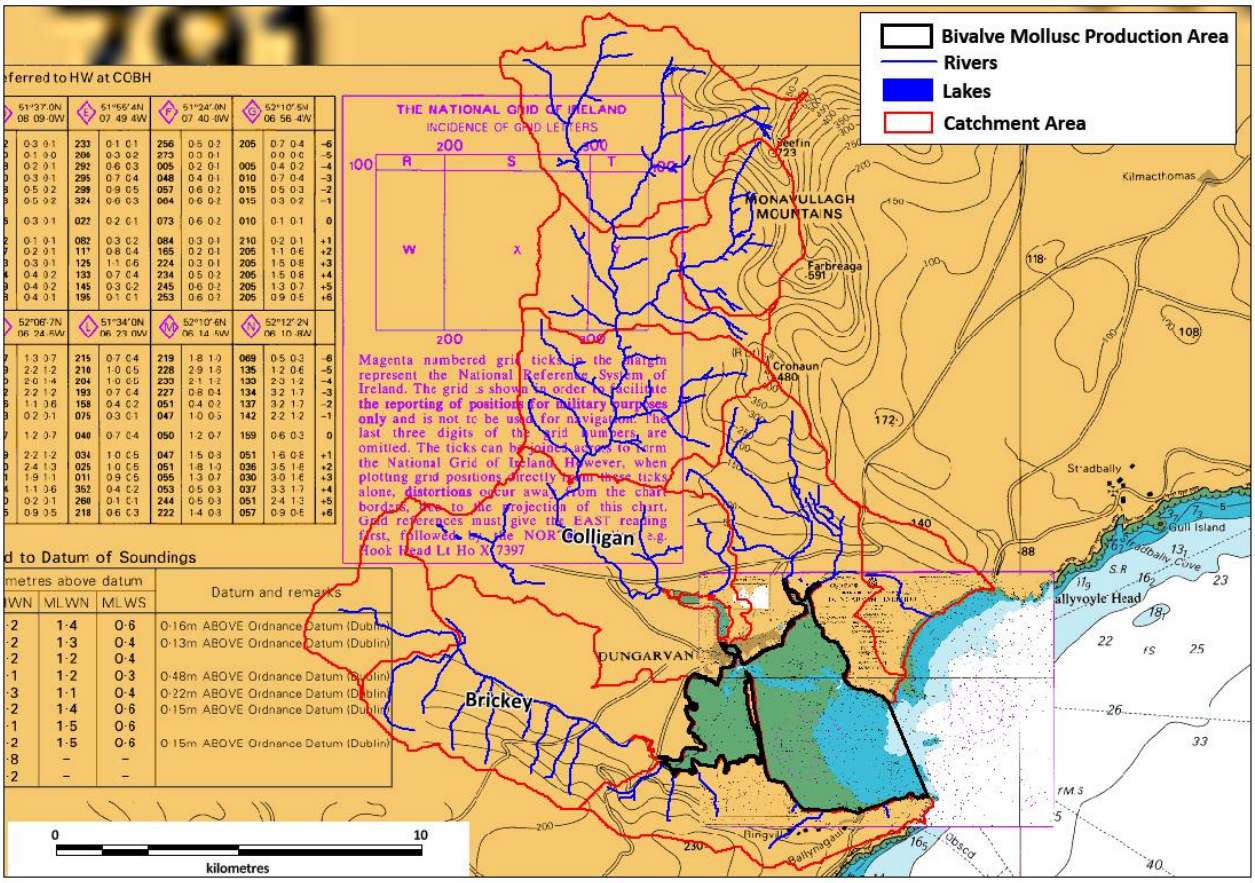

Figure 6.4: Sewage Treatment Works within the Dungarvan Harbour Catchment Area (Source: The EPA, 2019b).

Table 6.3: Sewage Treatment Works within the Dungarvan Harbour Catchment Area (Source: EPA, 2019b).

Name	Easting	Northing	Longitude	Latitude	p.e.	Designed p.e.
Dungarvan	230500	92150	52.080783	-7.555768	18426	25000
Baile Na nGall	230791	89140	52.053714	-7.551794	970	1600

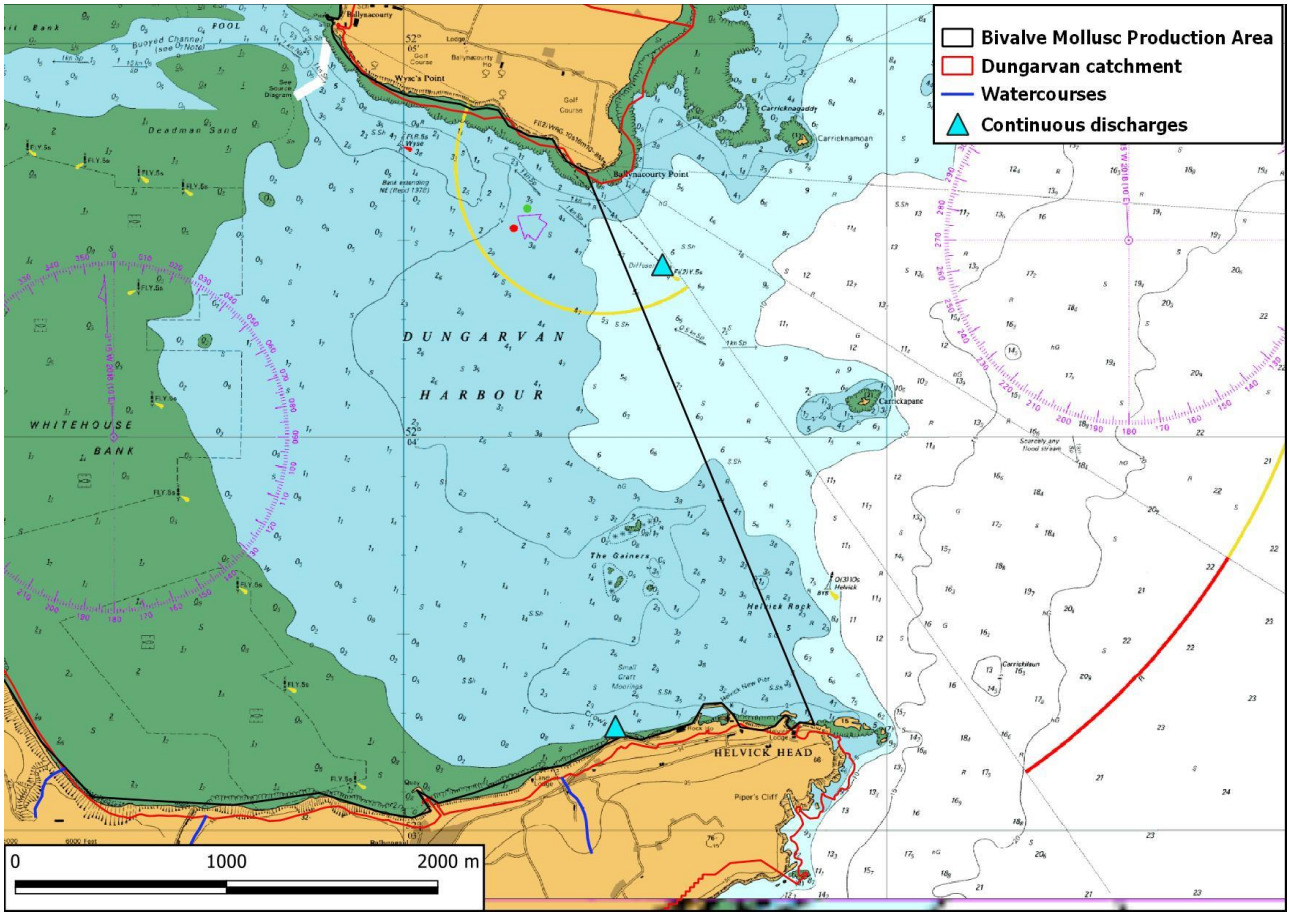

Figure 6.5: Continuous Discharges associated with the Sewage Treatment Works within the Dungarvan Harbour Catchment Area (Source: The EPA, 2019b).

Table 6.4: Continuous Discharges within the Dungarvan Harbour Catchment area (Source: EPA, 2019b). Map Codes refer to Figure 4.6.

Map Code	Name	Treatment	Easting	Northing	Longitude	Latitude	Receiving Body	Max Discharge/ day (m3)	DWF/ day (m3)
1	Dungarvan	2 - Secondary Treatment	230986	091374	-7.548748	52.073782	Dungarvan Harbour	8444	N/A
2	Baile Na nGall	2 - Secondary Treatment	230777	089193	-7.551993	52.054191	Dungarvan Harbour	N/A	N/A

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

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
Ardmore	68	0	49	18	18	1	1	0	0	0	0	0
Bohadoon	98	0	87	7	7	1	98	0	87	7	7	1
Cappagh	133	2	114	12	14	1	111	2	96	10	12	1
Carriglea	179	5	149	17	22	0	178	5	148	17	22	0
Clonea	767	506	223	15	521	1	613	404	178	12	416	1
Colligan	244	2	213	24	26	0	234	2	204	23	25	0
Comeragh	168	42	113	8	50	0	0	0	0	0	0	0
Coumaraglin	87	2	78	6	8	0	86	2	77	6	8	0
Dungarvan No. 1 Urban	1897	1760	18	0	1760	1	1897	1760	18	0	1760	1
Dungarvan No. 2 Urban	1317	1245	14	1	1246	1	1317	1245	14	1	1246	1
Dungarvan rural	656	352	242	26	378	1	650	349	240	26	375	1
Graignagower	189	51	121	6	57	1	13	4	9	0	4	0
Keereen	87	26	51	8	34	0	21	6	12	2	8	0
Knockaunbrandaun	69	1	62	6	7	0	17	0	15	1	2	0
Modelligo	108	1	99	5	6	0	24	0	22	1	1	0
Mountkennedy	145	3	122	17	20	0	1	0	1	0	0	0
Mountstuart	26	0	22	3	3	0	0	0	0	0	0	0
Ringville	475	259	173	24	283	1	264	144	96	13	158	1
Seskinan	166	25	131	6	31	0	88	13	70	3	16	0
Tinnasaggart	31	1	27	2	3	0	2	0	1	0	0	0
Whitechurch	70	0	63	4	4	0	43	0	38	2	2	0
Total	6980	4283	2171	215	4498	9	3218	2175	809	75	2250	4

6.1.3.3. 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 secondary discharge points. 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. In the Dungarvan sewer network some instances of overflows may be as a result of tidal influxes also. The details for the intermittent discharges can be seen in Table 6.6 and their locations can be seen in Figure 6.6. Flow rates for Dungarvan WWTP storm water overflow for March 2021 can be seen in Table 6.7.

Table 6.6: Rainfall dependent discharges (storm water overflows) within the Dungarvan Harbour Catchment area (Source: EPA, 2019b). Map Codes refer to Figure 6.6.

Map Code	Name	Discharge Point Code	Easting	Northing	Longitude	Latitude	Receiving Body
1	Dungarvan	SW16	225660	93321	-7.626347	52.091728	Colligan estuary
2	Dungarvan	SW17	226239	93116	-7.617915	52.089858	Colligan estuary
3	Dungarvan	SW18	226108	92714	-7.619857	52.086252	River Brickey
4	Dungarvan	SW19	226615	92807	-7.612454	52.087064	Colligan estuary
5	Dungarvan	SW20	228658	95010	-7.582465	52.106759	Glendine River
6	Baile Na nGall	SW2	229789	88805	-7.566500	52.050937	Dungarvan Harbour
7	An Mota	SW2	228733	88733	-7.5818317	52.050166	Unnamed Stream

Irish Water are currently undertaking 'Drainage Area Plan' studies and this may result in the reclassification of certain overflows as either storm water overflows or emergency overflows (2021)

Table 6.7: Flow rates for Dungarvan WWTP storm water overflow for the month of March 2021.

Date	Flows (metres cubed)
03/03/2021	768
04/03/2021	419
05/03/2021	293
06/03/2021	401
07/03/2021	146
08/03/2021	84
09/03/2021	558
10/03/2021	1431
13/03/2021	389
14/03/2021	162
16/03/2021	24

Date	Flows (metres cubed)
26/03/2021	856
27/03/2021	19
28/03/2021	554

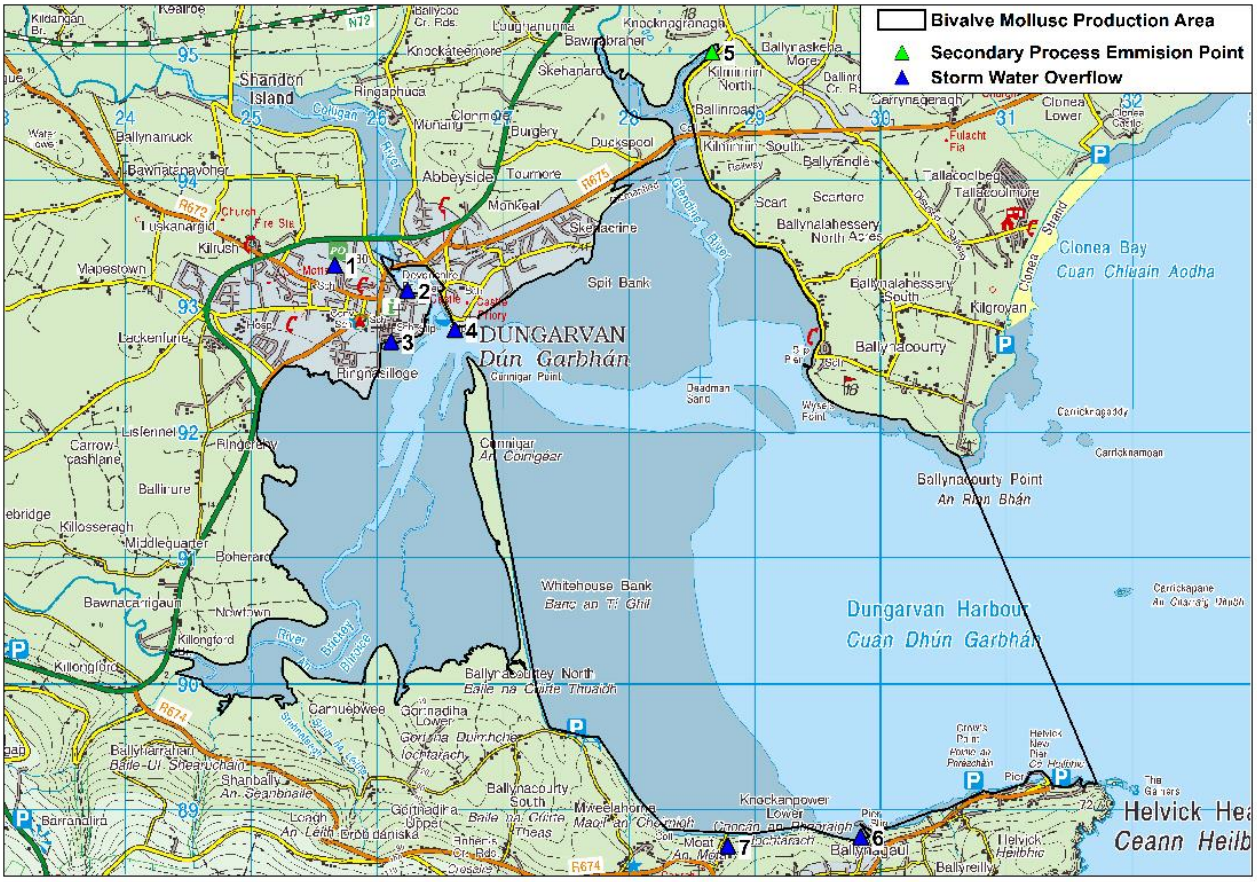

Figure 6.6: Rainfall Dependent Discharges associated with the Sewage Treatment Works within the Dungarvan Harbour Catchment Area (Source: The EPA, 2019b). Irish Water are currently undertaking 'Drainage Area Plan' studies and this may result in the reclassification of certain overflows as either storm water overflows or emergency overflows (2021)

In addition to the storm water overflows there are a number of emergency overflows belonging to Dungarvan WWTP. In total there are fourteen emergency overflows which can be seen in Figure 6.7 and the details can be seen in Table 6.8. These discharges are largely associated with relief points from pumping stations in the event of mechanical failure or power outage (Nicholas O'Dwyer, 2018).

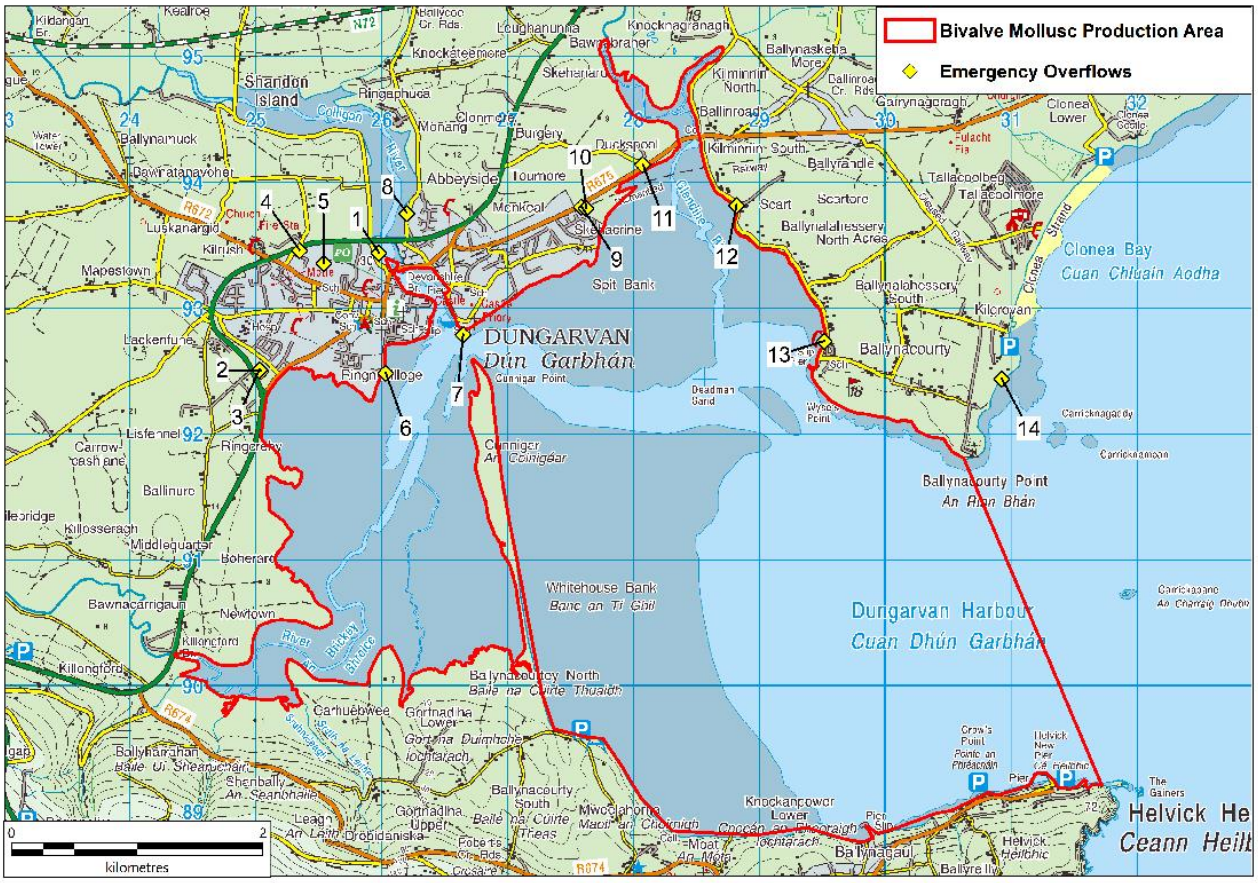

Figure 6.7: Emergency overflows within Dungarvan Harbour (Nicholas O'Dwyer, 2018). Irish Water are currently undertaking 'Drainage Area Plan' studies and this may result in the reclassification of certain overflows as either storm water overflows or emergency overflows (2021).

Table 6.8: details of the emergency overflows within Dungarvan Harbour.

Map ID	Discharge Point Code	Discharge Type	Easting	Northing	Longitude	Latitude	Receiving Body
1	SW2	Open Pipe	225974	93443	-7.62176	52.09281	Colligan Estuary
2	SW3	Curved Bill Check Valve	225037	92501	-7.63550	52.08439	Brickey Estuary
3	SW4	Curved Bill Check Valve	225026	92513	-7.63566	52.08450	Brickey Estuary
4	SW5	Open Pipe	225344	93462	-7.63095	52.09301	Colligan Estuary
5	SW6	Open Pipe	225537	93362	-7.62814	52.09210	Colligan Estuary
6	SW7	Non-return flap valve	226028	92489	-7.62104	52.08423	Brickey Estuary
7	SW8		226644	92794	-7.61203	52.08695	Dungarvan Harbour
8	SW9	Curved Bill Check Valve	226197	93758	-7.61848	52.09563	Colligan Estuary
9	SW10	Open Pipe	227583	93808	-7.59825	52.09601	Dungarvan Harbour
10	SW11	Open Pipe	227621	93797	-7.59770	52.09591	Dungarvan Harbour
11	SW12	Non-return flap valve	228071	94145	-7.59110	52.09902	Dungarvan Harbour
12	SW13	Curved Bill Check Valve	228818	93821	-7.58023	52.09607	Dungarvan Harbour
13	SW14	Curved Bill Check Valve	229514	92739	-7.57017	52.08631	Dungarvan Harbour
14	SW15	Curved Bill Check Valve	230924	92443	-7.54963	52.08357	Dungarvan Harbour

Irish Water are currently undertaking 'Drainage Area Plan' studies and this may result in the reclassification of certain overflows as either storm water overflows or emergency overflows (2021)

6.1.4. Industrial Discharges

Figure 6.8 shows the industrial discharges to water within the Dungarvan Harbour catchment area accounted for during the desk-based assessment (EPA, 2019c; EPA, 2019d). In total there are ten industrial discharges belonging to four facilities. The nature of the facilities is pig farming, poultry farming and waste. Details on these industrial discharges can be seen in Table 6.9 and Table 6.10. There are 5 Section 4 licences (see Figure 6.9) for the discharge of trade effluent, with two discharging directly into Dungarvan Harbour and the remaining three discharging to rivers within the catchment. Table 6.11 shows details of these Section 4 licences. Two of the section 4 discharges are for treated sewage one from a private dwelling and the other from holiday cottages and a pub (Figure 6.9 Map ID 1 & 3). The remaining three discharges are no longer in use.

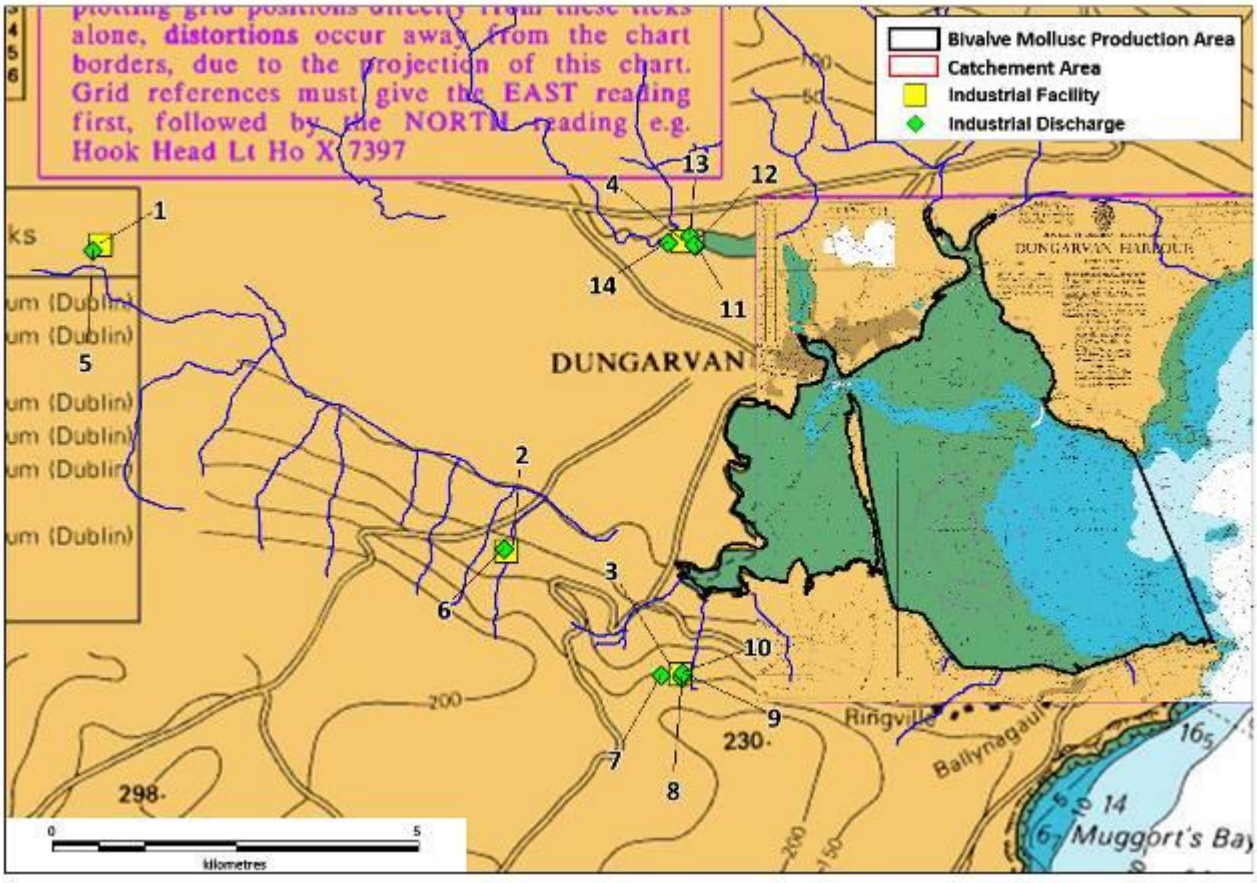

Figure 6.8: All industrial discharges within the Dungarvan Harbour Catchment Area (Source: (EPA, 2019c; EPA, 2019d).

Table 6.9: Industrial Facilities with discharges to water within the Dungarvan Harbour Catchment Area (Source: EPA, 2019c). Map Codes refer to Figure 6.8.

Map Code	Licence No.	Licence Type	Licence holder	Facility ad	Nature of facility	Longitude	Latitude	Easting	Northing
1	P0447	IEL	Private individual	Cappagh, Waterford	Pig Farm	Coordinates not given due to GDPR			
2	P0897	IEL	Private individual	Dungarvan, Waterford	Poultry Farming	Coordinates not given due to GDPR			
3	P0979	IPPC	Private individual	Ring, Waterford.	Pig Farm	Coordinates not given due to GDPR			
4	W0032	IEL	Waterford City & County Council	Dungarvan Waste Disposal Site, Ballynamuck Middle, Dungarvan, Waterford.	Waste facility	-7.644142	52.104141	224383.7	94719.6

Table 6.10: Details of Industrial discharges to water within the Dungarvan Harbour Catchment Area (Source: EPA, 2019c). Map Codes refer to Figure 6.8.

Map ID	Discharge Code	Licence Type	Licence holder	Longitude	Latitude	Easting	Northing
5	P0447-01_SW1_EW	IEL	Private individual	Coordinates not given due to GDPR			
6	P0897-01_SW1_EW	IEL	Private individual	Coordinates not given due to GDPR			
7	P0979-01_SW2_EW	IPPC	Private individual	Coordinates not given due to GDPR			
8	P0979-01_SW1_EW	IPPC	Private individual	Coordinates not given due to GDPR			
9	P0979-01_SW3_EW	IPPC	Private individual	Coordinates not given due to GDPR			
10	P0979-01_SW5_EW	IPPC	Private individual	Coordinates not given due to GDPR			
11	W0032-03_SWE3_EW	IEL	Waterford City & County Council	-7.641559	52.103589	224561	94659
12	W0032-03_SWE6_EW	IEL	Waterford City & County Council	-7.641645	52.103787	224555	94681
13	W0032-03_SW2_EW	IEL	Waterford City & County Council	-7.642687	52.104904	224483	94805
14	W0032-03_SWE1_EW	IEL	Waterford City & County Council	-7.647071	52.104063	224183	94710

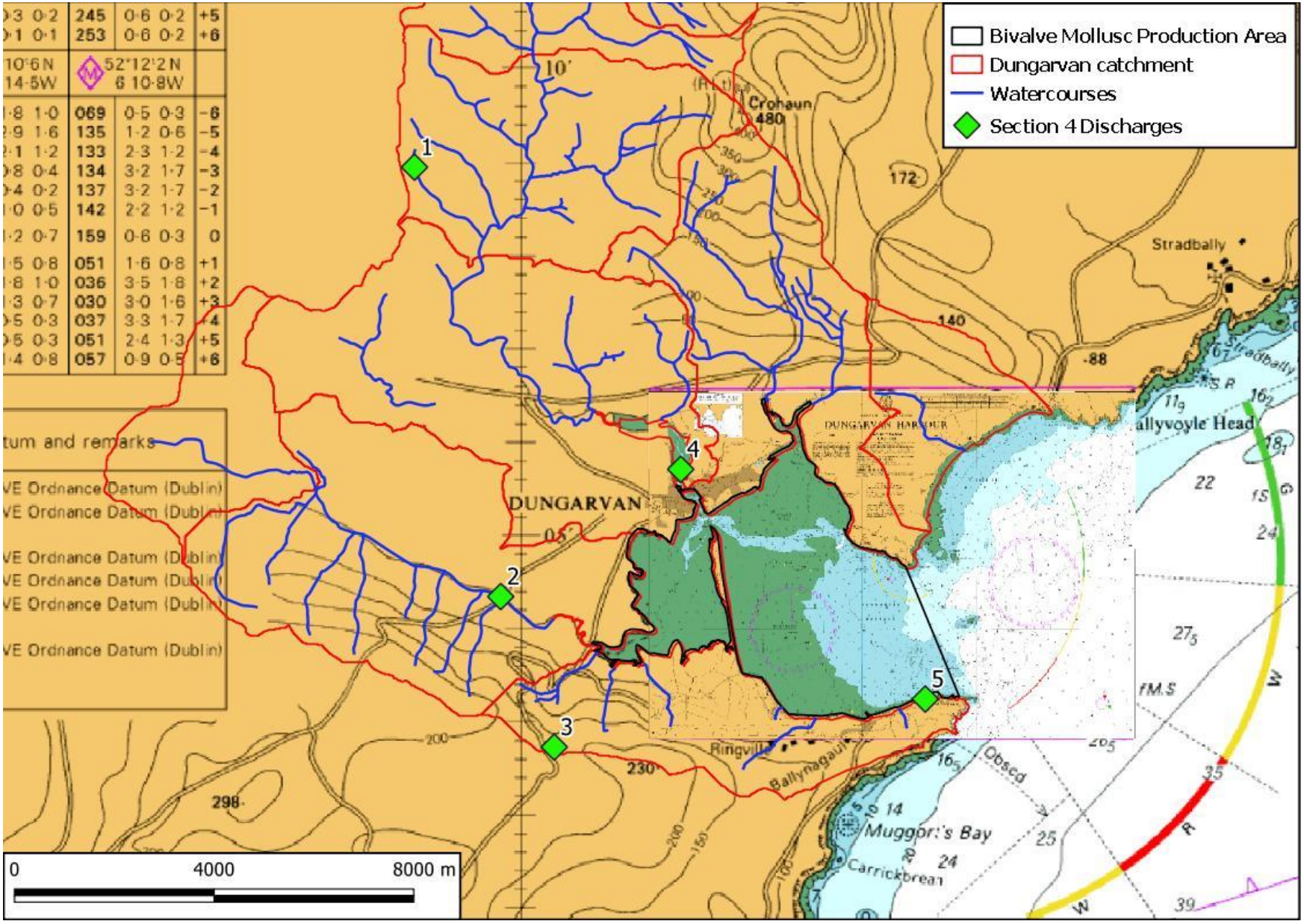

Figure 6.9: Section 4 discharges within the Dungarvan Harbour Catchment Area (Source: (EPA, 2019c; EPA, 2019d).

Table 6.11: Details on Section 4 discharges within the Dungarvan Harbour Catchment Area (Source: EPA, 2019d). Map Codes refer to Figure 6.9.

Map Code	File Reference	Licence holder	Type	Discharge (m^3/day)	Longitude	Latitude	Easting	Northing
1	WPW/01/2006	Private Individual	Single house sewage via septic tank and constructed wetland	1	Coordinates not given due to GDPR			
2	WPW/03/2007	Saltwater Life	Shellfish Processing water	None – not in use	-7.672955	52.072823	222475	91202
3	WPW/02/2006	The Seanachie Cottages Ltd.	Treated sewage from holiday cottages and pub.	35	-7.657338	52.045854	223560	88206
4	WP/04/81	G.A.A Ground	GAA grounds	None – now discharged to public sewer	-7.620434	52.095627	226063	93757
5	WPW/01/92	Meitheal Tra Na Rinne Teoranta	Shellfish Processing water	None – licence considered obsolete	-7.549103	52.054458	230980	89204

6.1.5. Landuse Discharges

Figure 6.10 shows the Corine landuse (EPA, 2019e) within the Dungarvan Harbour catchment area. Figure 7.4 shows all rivers/streams within the catchment area. Within the catchment area, land use is dominated by pastures (141.7km^2; 60.9%), followed by coniferous forest (16.9km^2; 7.8%), intertidal flats (13km^2; 6%), peat bogs (8.7km^2; 4%) and moors and heathland (6.6km^2; 3.1%) (See Figure 6.11). Forestry (coniferous, broad-leafed and mixed) makes up 9% of the land use in the area (19.3km^2).

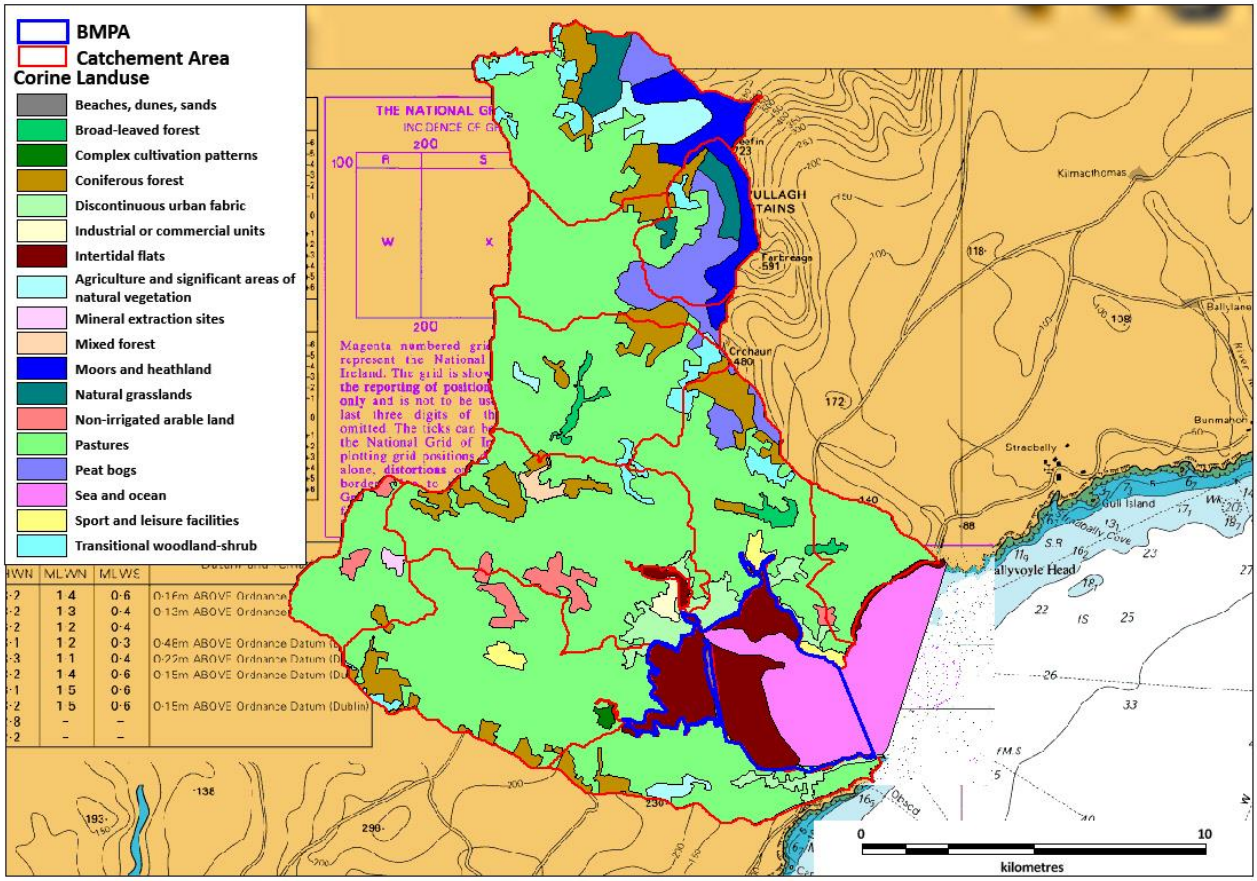

Figure 6.10: Landuse within the Dungarvan Harbour Catchment Area (Source: EPA, 2019e).

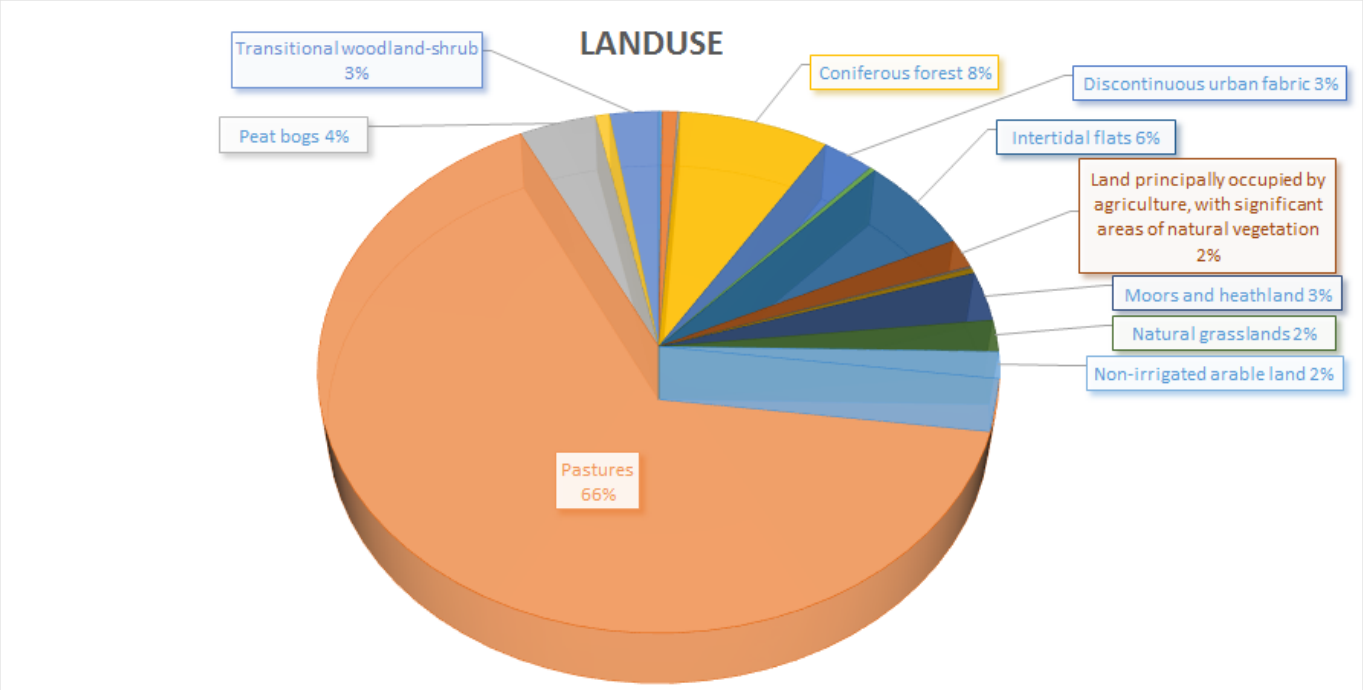

Figure 6.11: Breakdown of landuse within the Dungarvan Harbour Catchment Area (only landuse ≥1% is labelled).

Data from the Census of Agriculture 2010 (CSO, 2019b) can be seen in Figure 6.11 below. Figure 6.12 to Figure 6.19 show thematic maps for each category in Table 6.12. Although there are a small number of farms in the Dungarvan No. 1 Urban (3), Dungarvan No. 2 Urban (5) and Tinnasaggart (6) Eds. No data are available as data have been suppressed for reasons of confidentiality, where individual farm details might be identifiable when results are presented at ED level.

Numbers of farms within the catchment range from 3 in Dungarvan No. 1 Urban to 51 in Graignagower. The total area farmed within the catchment varies from 860 ha in Keereen to 2,324 ha in Graignagower. The average farm size ranges from 31.1 ha in Clonea to 55.5 ha in Ringville.

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 793 ha in Keereen to 2,324 ha in Graignagower. Total crops range from 0 ha in Graignagower and Knockaunbrandaun to 168 ha in Carriglea.

The total number of cattle within the catchment range from 1,490 in Knockaunbrandaun to 4,681 in Ringville. The total number of sheep within the catchment range from 4 in Dungarvan Rural to 7,099 in Knockaunbrandaun. The total number of horses within the catchment range from 4 at Ardmore to 157 in Dungarvan Rural.

The total area farmed in the entire ED's shown in Figure 6.12 to Figure 6.19 amounts to 26,858 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 GIS and from this value the area farmed was calculated *e.g.* if 50% of ED lies within 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 13,693 ha. This represents 51% of the area.

Table 6.12: Farm census data for all EDs within the Dungarvan Harbour Catchment Area (Source: CSO, 2019b).

ED Name	County	No. Farms	Area Farmed (ha)	Avg. Farm Size (ha)	Total Crops (ha)	Total Grass & Rough Grazing (ha)*	Cattle	Sheep	Horses
Ardmore	Waterford	26	1151	44.3	8	1143	2409	337	4
Bohadoon	Waterford	30	1524	50.8	1	1524	3483	1869	8
Cappagh	Waterford	34	1207	35.5	42	1165	2793	146	85
Carriglea	Waterford	33	1750	53.0	168	1582	3637	525	52
Clonea	Waterford	48	1491	31.1	74	1416	2635	412	22
Colligan	Waterford	46	1823	39.6	162	1660	4097	279	52
Comeragh	Waterford	38	1757	46.2	29	1728	2546	4716	32
Coumaraglin	Waterford	32	1203	37.6	1	1203	1806	6704	71
Dungarvan No. 1 urban#	Waterford	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dungarvan No. 2 Urban#	Waterford	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dungarvan rural	Waterford	37	1537	41.5	94	1443	3201	4	157
Graignagower	Waterford	51	2324	45.6	0	2324	4362	3119	38
Keereen	Waterford	22	860	39.1	67	793	1638	486	17
Knockaunbrandaun	Waterford	35	1881	53.7	0	1881	1490	7099	9
Modelligo	Waterford	29	1492	51.4	18	1475	4105	443	33
Mountkennedy	Waterford	37	1350	36.5	48	1302	2289	1974	20
Mountstuart	Waterford	22	928	42.2	3	925	1930	696	21
Ringville	Waterford	37	2053	55.5	35	2020	4681	483	53
Seskinan	Waterford	46	1514	32.9	11	1503	2651	2735	20
Tinnasaggart#	Waterford	6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Whitechurch	Waterford	22	1013	46.0	166	847	2086	84	35

* Total Grass and Rough Grazing was taken to be the sum of Total Pasture, Total Silage, Total Hay and Rough Grazing.
# Due to the small number of farms in these EDs some or all of the Census of Agriculture 2010 details are not being made available at the Electoral District level. Data has been suppressed for reasons of confidentiality, where individual farm details might be identifiable when results are presented at ED level.

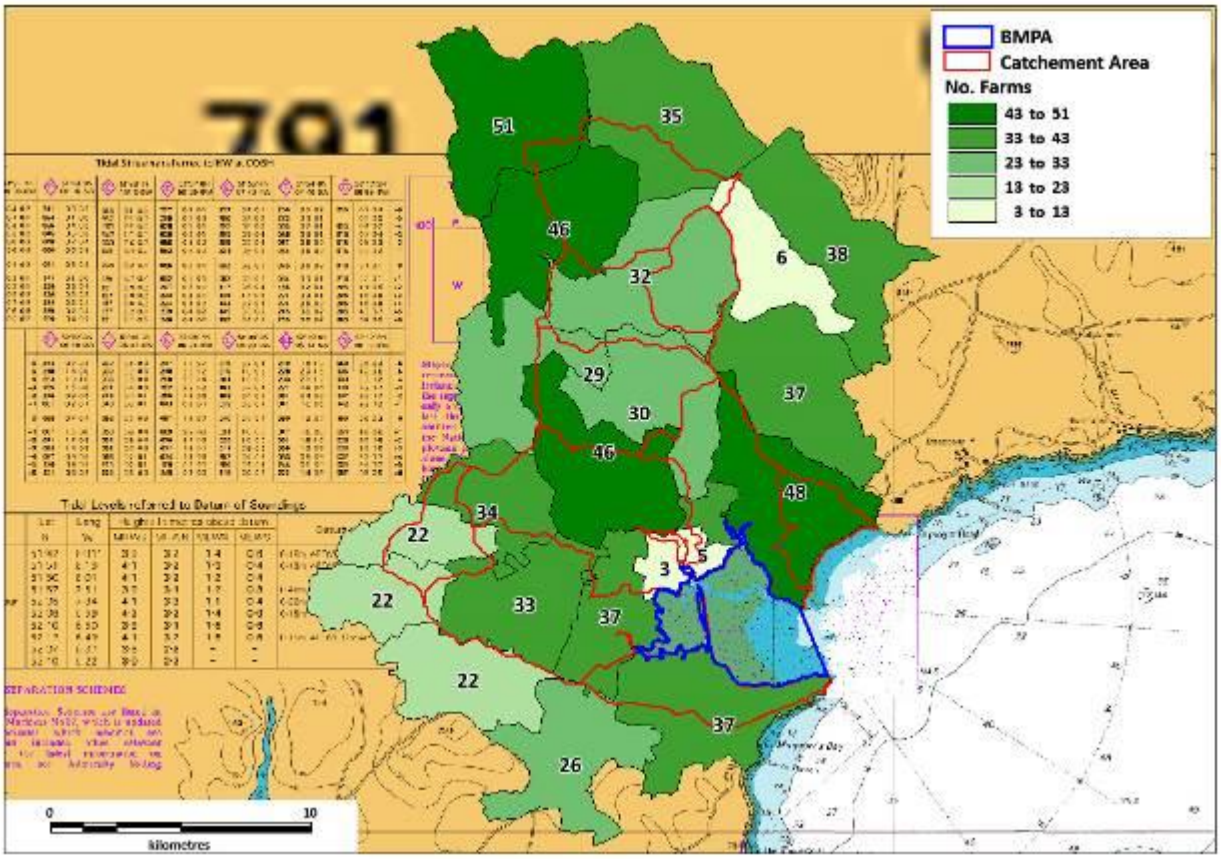

Figure 6.12: Number of farms within the Dungarvan Harbour Catchment Area (Source: CSO, 2019b).

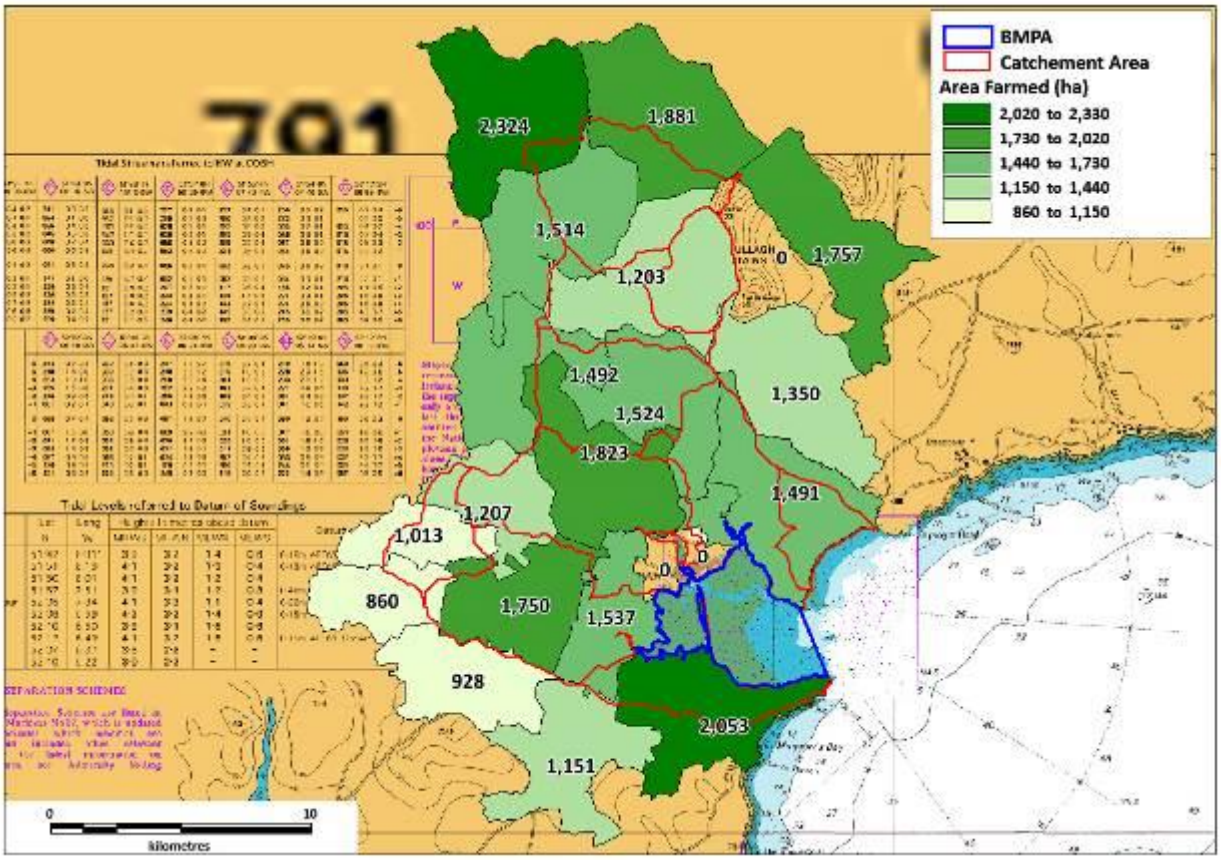

Figure 6.13: Area farmed (ha) within the Dungarvan Harbour Catchment Area (Source: CSO, 2019b).

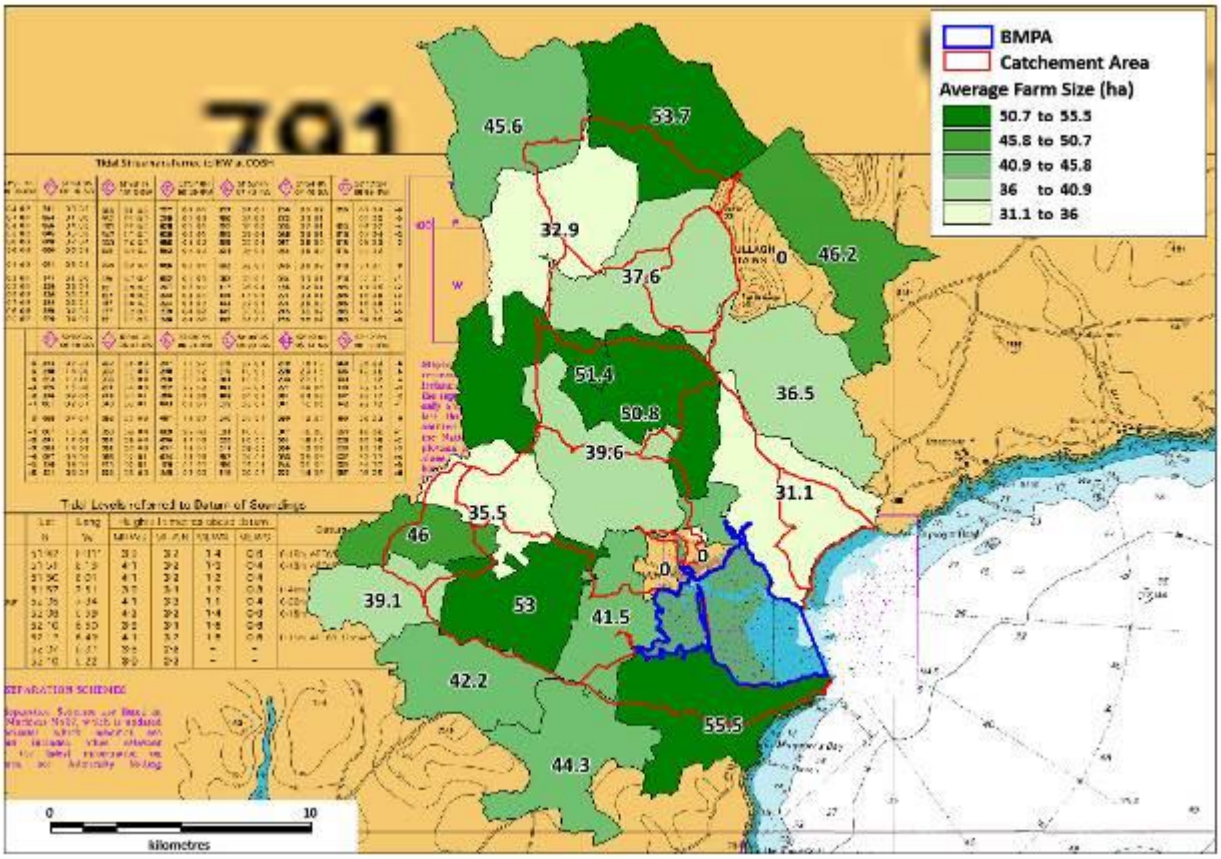

Figure 6.14: Average farm size (ha) within the Dungarvan Harbour Catchment Area (Source: CSO, 2019b).

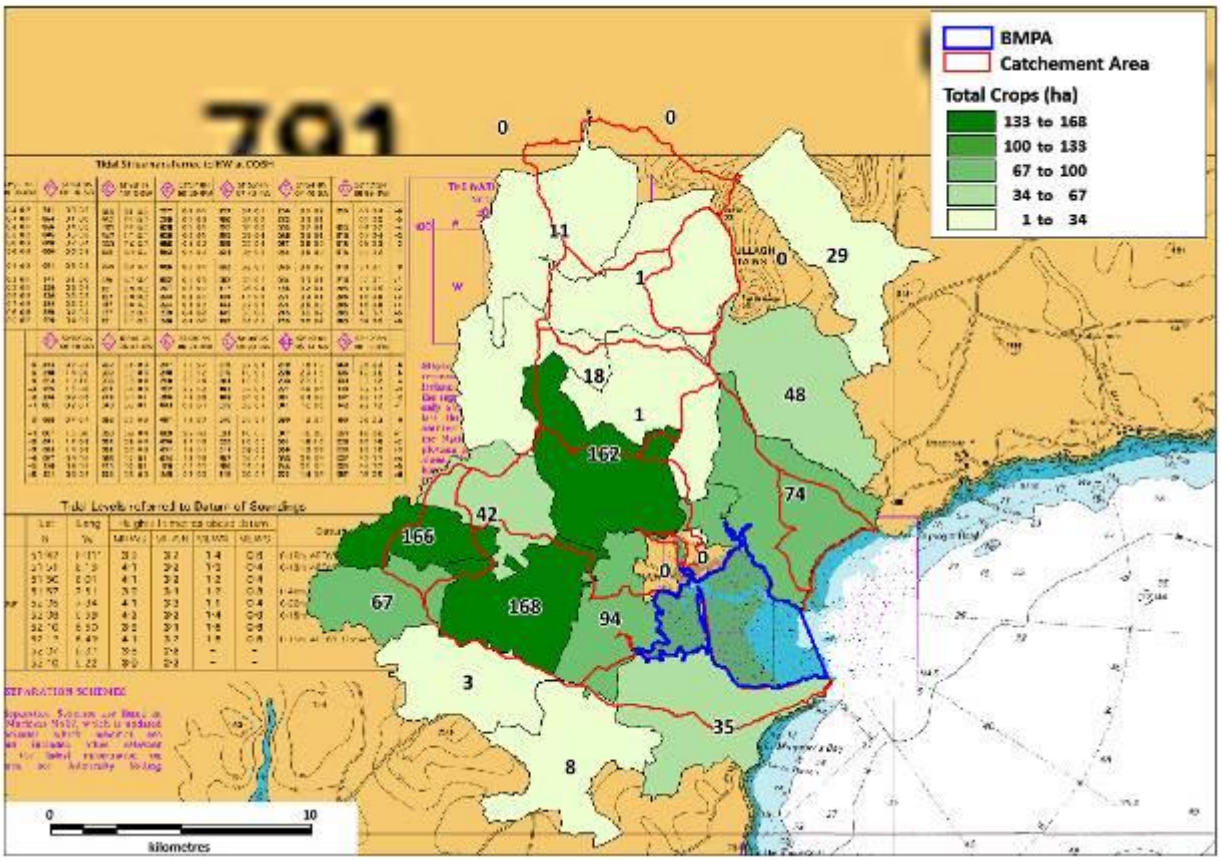

Figure 6.15: Total crops within the Dungarvan Catchment Area (Source: CSO, 2019b).

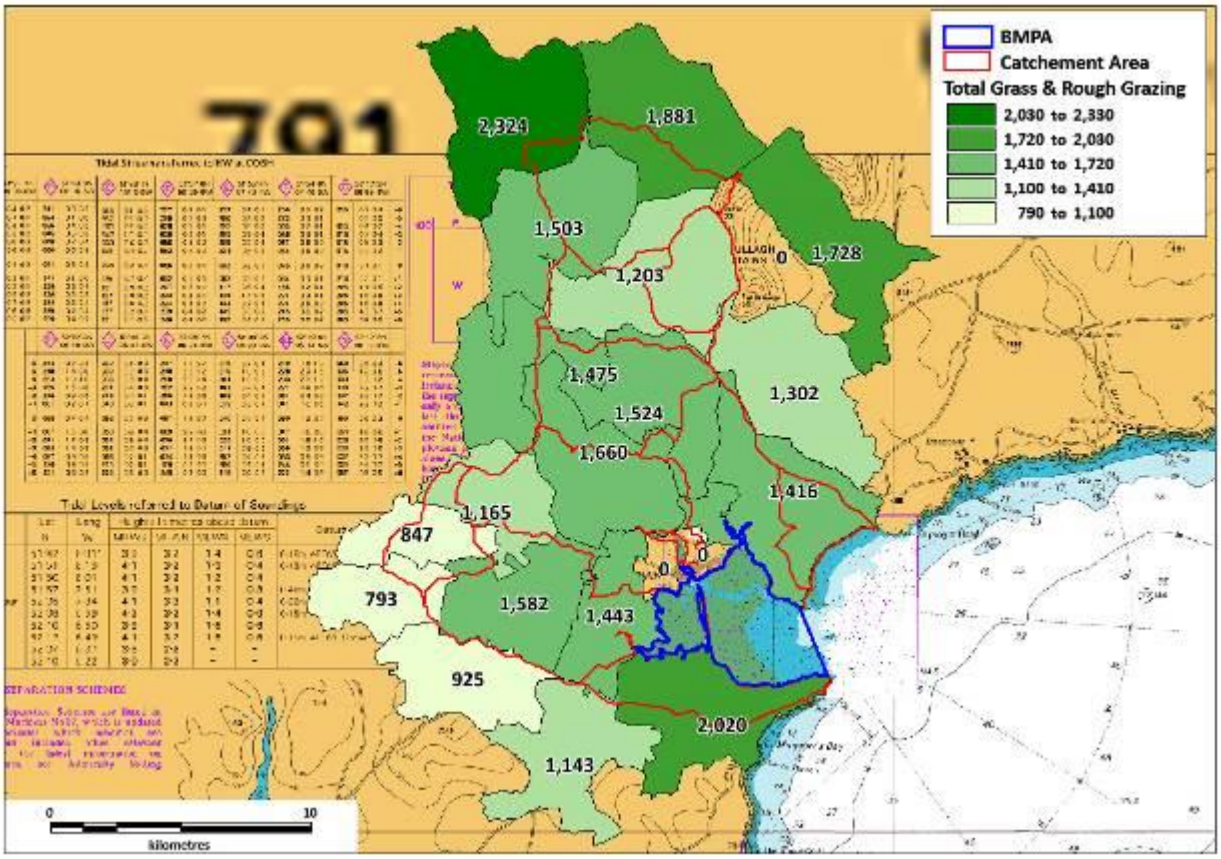

Figure 6.16: Total grass and rough grazing within the Dungarvan Harbour Catchment Area (Source: CSO, 2019b).

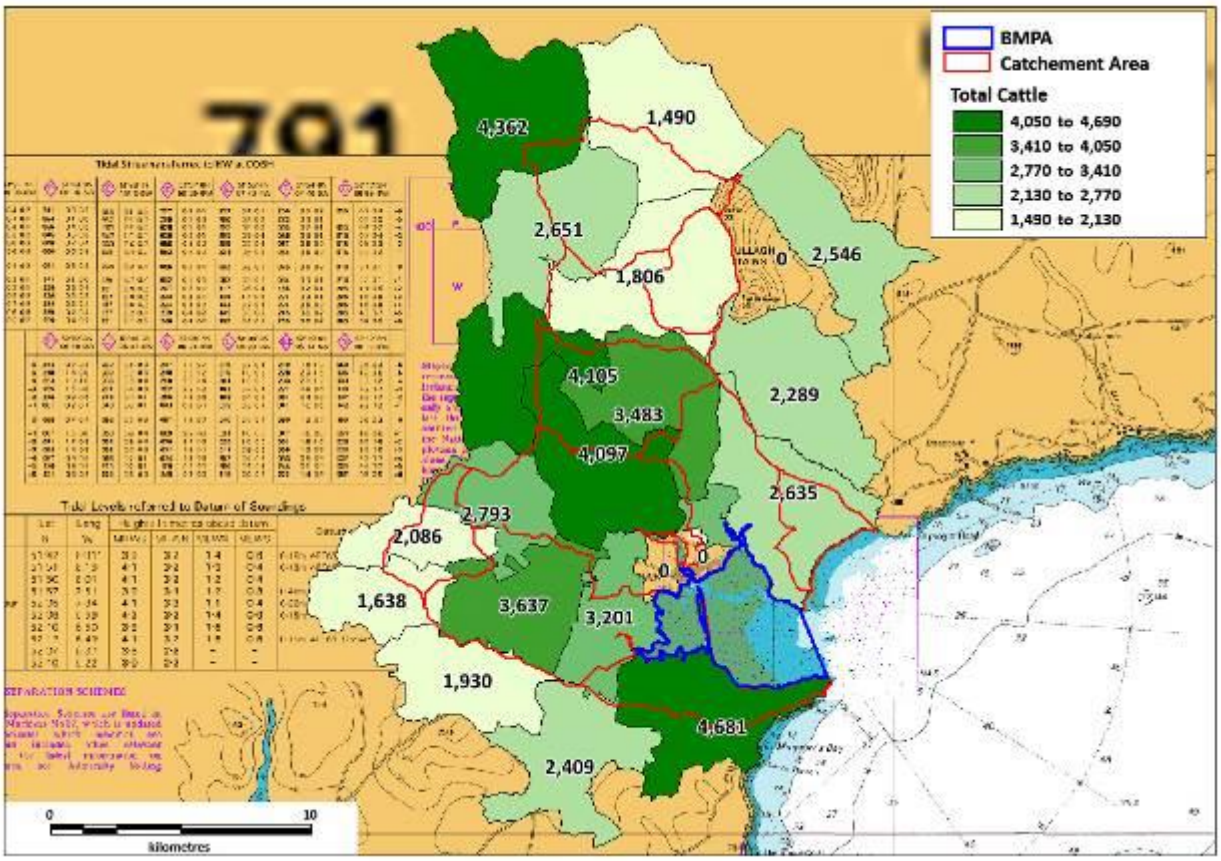

Figure 6.17: Cattle within the Dungarvan Harbour Catchment Area (Source: CSO, 2019b).

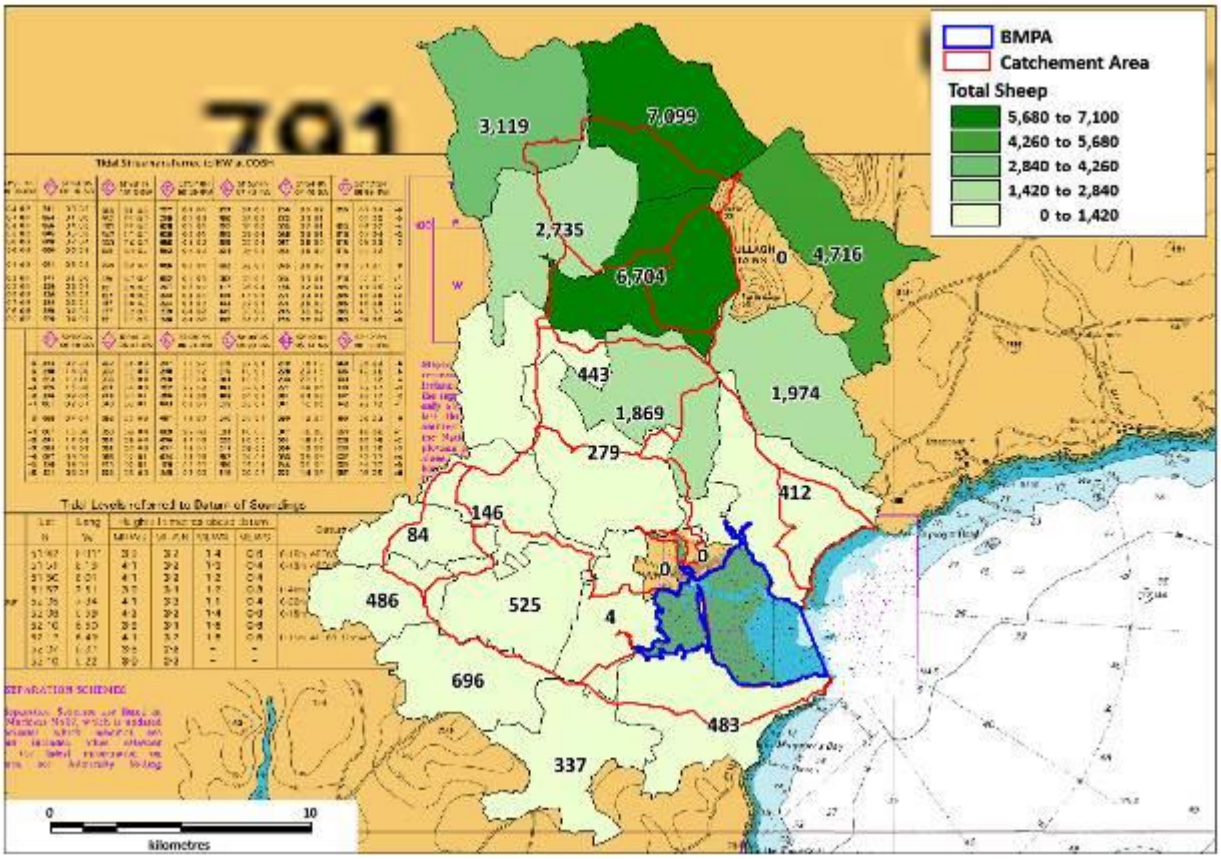

Figure 6.18: Sheep within the Dungarvan Harbour Catchment Area (Source: CSO, 2019b).

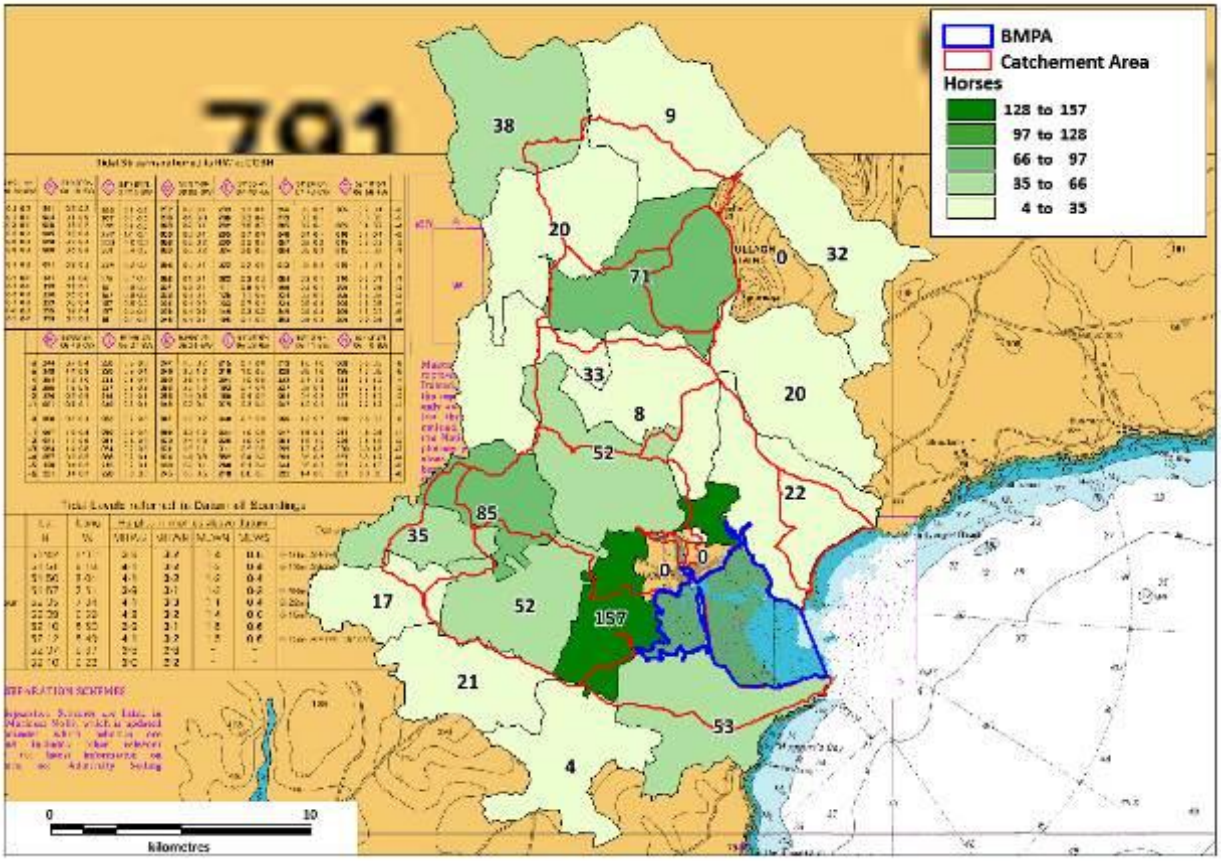

Figure 6.19: Horses within the Dungarvan Harbour Catchment Area (Source: CSO, 2019b).

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 6.13 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 6.13: 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

A large majority of livestock in the area are Cattle. Sheep are also present but in slightly lower numbers. The majority of agricultural land use in the area is total grass and rough grazing. Cattle are present in relatively large numbers throughout with the highest numbers in the central part of the catchment which is less mountainous while the highest numbers of sheep are present in the northern regions where it is more mountainous. Cattle and Sheep numbers would be expected to increase in spring following the birth of calves and lambs and decrease as they are sent to market. Therefore, larger quantities of livestock droppings will be deposited during this period, though it may not impact the fishery until washed into the sea during and/or after periods of rainfall unless deposited directly on the shoreline.

6.1.6. Other Pollution Sources

6.1.6.1. Shipping

Figure 6.20 shows all boat facilities and activities in Dungarvan Harbour. Table 6.14 details these facilities. There are no commercial ports in Dungarvan Harbour for cargo or imports, however, Helvick pier is a commercial fishing port. The piers in Dungarvan town itself are used by a number of small commercial craft and the adjoining basin is used as a mooring by a small number of pleasure craft.

There are no regular ferries operating in Dungarvan Harbour. There are several piers and slipways located along the shorelines of Dungarvan Harbour. All the piers are used frequently by a wide number of groups including recreational groups.

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.

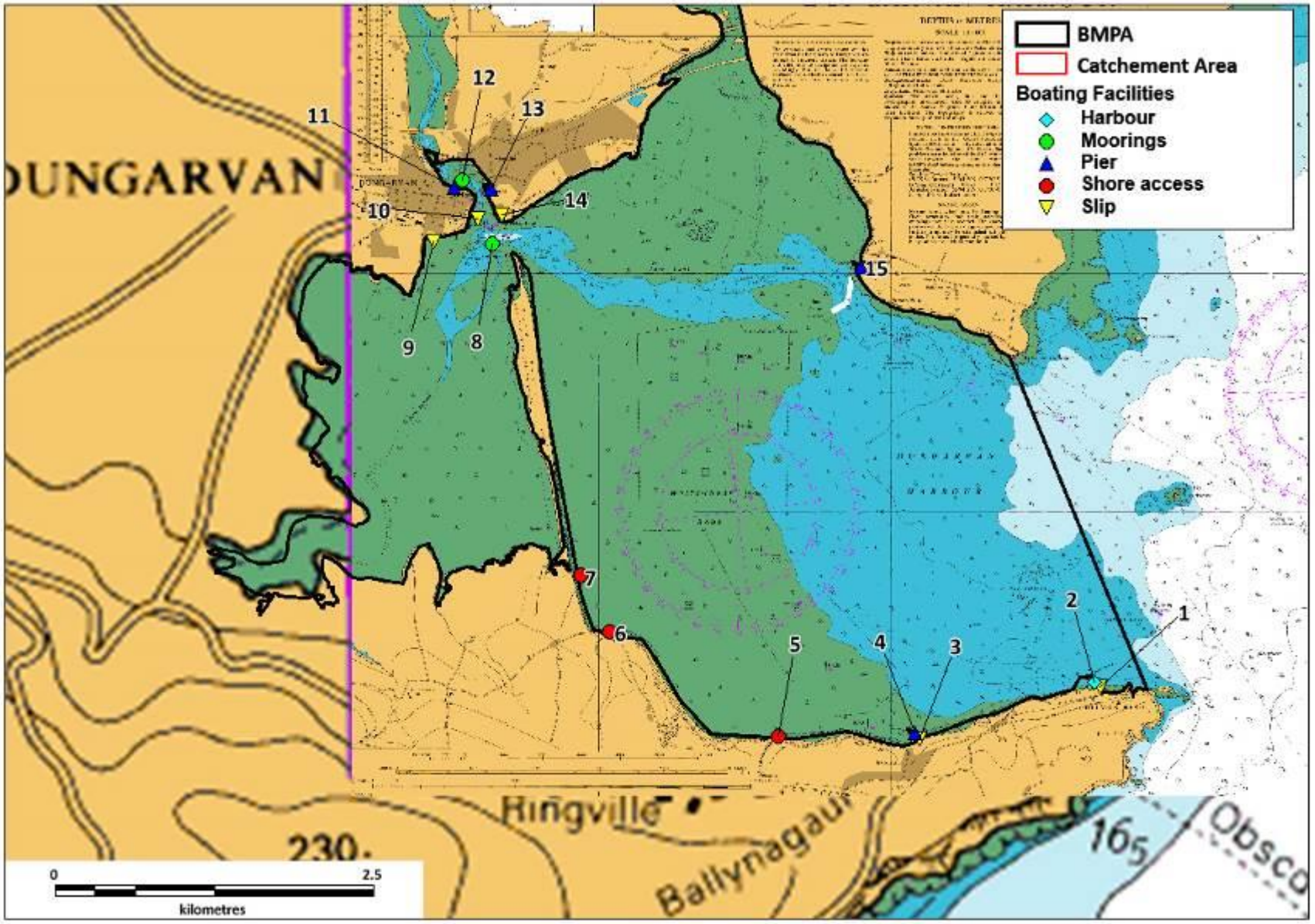

Figure 6.20: Location of all boating facilities and activities in Dungarvan Harbour.

Table 6.14: Boating facilities in the Dungarvan Harbour. Map Code refers to Figure 4.19.

Map Code	Feature	Use (if known)
1	Slip	RNLI and Helvick Harbour slips
2	Harbour	Helvick Harbour
3	Slip	
4	Pier	
5	Shore access	Access to shellfish beds
6	Shore access	Access to shellfish beds
7	Shore access	Access to shellfish beds
8	Moorings	Small craft moorings
9	Slip	
10	Slip	
11	Pier	
12	Moorings	Small craft moorings
13	Pier	
14	Slip	
15	Pier	
16	Shore access	

6.1.6.2. Birds

It is important to document the bird populations in the Dungarvan Harbour 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).

The Dungarvan Harbour SPA (Site Code: IE004032) is contained within the harbour, while Helvick Head to Ballyquin SPA (Site Code: IE004192) is located on the southern side of the Head and the Mid-Waterford Coast SPA (Site Code: IE004193) is located at the northeast end of Clonea Strand (see Figure 2.1)

The Dungarvan Harbour SPA is a shallow bay which encompasses the entirety of Dungarvan Harbour. There are four rivers which flow into the bay the Colligan, Brickey and two unnamed rivers. At low tide, extensive sand and mud flats are exposed. Dungarvan Harbour supports important concentrations of wintering waterbirds which are present in large numbers. The site is of international importance because it regularly supports an assemblage of over 20,000 wintering waterbirds. Furthermore, both Light-bellied Brent Goose (723) and Black-tailed Godwit (779) occur here in internationally important numbers. A further thirteen species occur here in nationally important numbers - Great Crested Grebe (53), Shelduck (538), Red breasted Merganser (52), Oystercatcher (767), Golden Plover (4,980), Grey Plover (444), Lapwing (3,233), Knot (698), Dunlin (4,984), Bar-tailed Godwit (1,068), Curlew (766), Redshank (731) and Turnstone (177). Little Egret, a species which has recently colonised Ireland, also occurs at this site. (NPWS, 2014).

Helvick Head to Ballyquin SPA is a linear site which encompasses the sea cliffs and land adjacent to the cliff edge between Helvick Head in the east and Ballyquin townland in the south-west. The site is designated due to its nationally important populations of Cormorant (65 pairs), Herring Gull (117 pairs) and Kittiwake (1,037 pairs) occur, as well as smaller populations of other breeding seabirds: Razorbill (28 pairs), Fulmar (135 pairs), Shag (6 pairs), Guillemot (664 pairs), Great Black-backed Gull (8 pairs) and Black Guillemot (10 individuals) (NPWS, 2015a)

Mid-Waterford Coast SPA is encompasses the areas of high coast and sea cliffs in Co. Waterford between Newtown Cove to the east and Ballyvoyle to the west. The site is designated due to the presence of a nationally important Peregrine population (10 pairs in 2002). The site also holds nationally important populations of Cormorant (79 pairs) and Herring Gull (147 pairs), as well as smaller populations of other breeding seabirds: Fulmar (246 pairs), Shag (14 pairs), Guillemot (27 pairs), Razorbill (4 pairs) and Black

Guillemot (15 individuals) (NPWS, 2015b)

Dungarvan Harbour is routinely surveyed by Birdwatch Ireland (through the I-WeBS [Irish Wetland Bird Survey] Project). The total peak counts for each season from 2011 to 2016 can be seen in Table 6.15.

Table 6.15: Total number of waterbirds in Dungarvan Harbour between 20011/12 and 2015/16 seasons (Source: BWI, 2019).

Site Name	2011/12	2012/13	2013/14	2014/15	2015/16	Mean
Dungarvan Harbour	9445	14021	17714	16142	17323	15072

Population levels of birds over the five years are fairly stable, with a low in the 2011/2012 season and a high in the 2013/2014 season. Bird numbers in the area increase during the winter months when the wintering waterfowl arrive. However, it is highly likely that these levels are low when compared with land-based discharges.

6.1.6.3. Aquatic Mammals

There are a number of records for both Common (*Phoca vitulina*) and Grey seals (*Haliochoerus grypus*) within Dungarvan Harbour (See Figure 6.21 and Figure 6.22). Other aquatic mammals are likely to occur in Dungarvan Harbour include Otter (*Lutra lutra*), Bottlenosed Dolphin (*Tursiops truncatus*) and Harbour Porpoise (*Phocoena phocoena*).

Figure 6.21: Common Seal recordings within Dungarvan Harbour (Biodiversity Ireland).

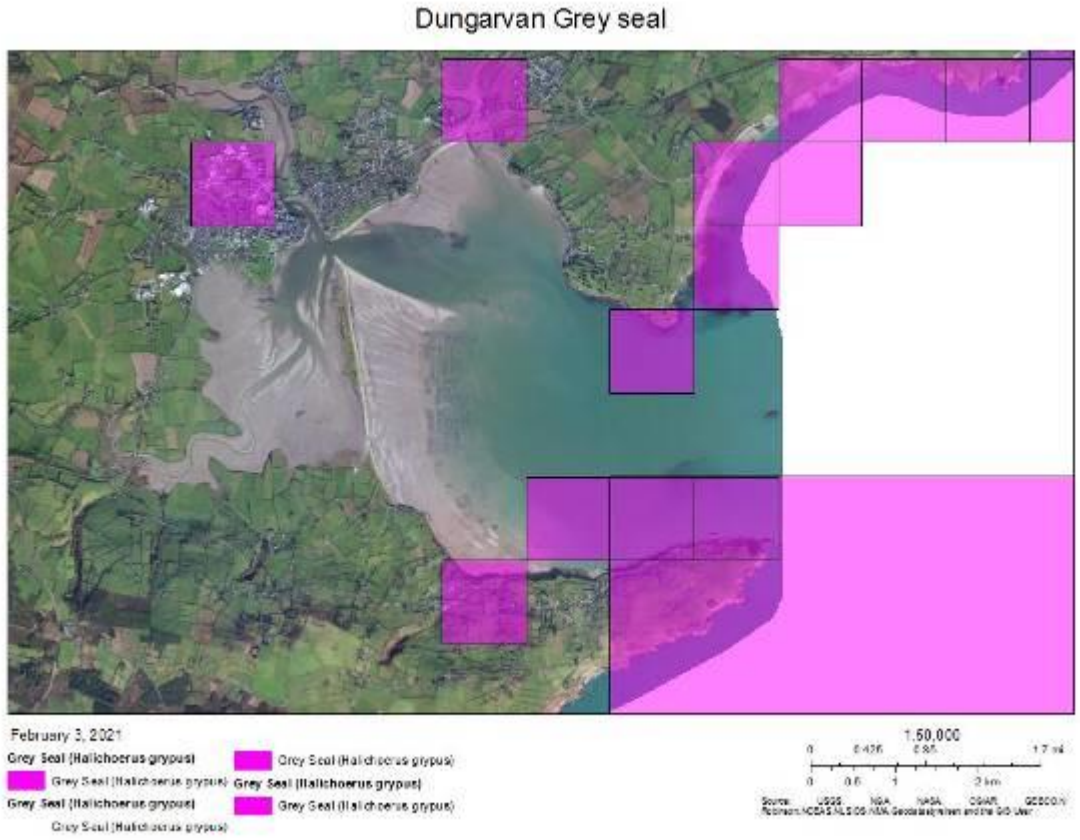

Figure 6.22: Grey Seal recordings within Dungarvan Harbour (Biodiversity Ireland).

No estimates of the volumes of seal faeces are available although it is reasonable to assume that what is ingested and not assimilated in the gut must pass. Assuming 6% of a median body weight for grey seals of 185kg, that would equate to 11.1kg consumed per day and probably very nearly that defecated. The concentration of *E. coli* and other faecal indicator bacteria contained in seal faeces has been reported as being similar to that found in raw sewage, with counts showing up to 1.21 x 104 CFU *E. coli* per gram dry weight of faeces (Lisle *et al.,* 2004). *Salmonella* and *Campylobacter* spp. have also been found in wild seals (Stoddard *et al.,* 2005).

All aquatic mammals that occur in the BMPA are likely to contribute to background levels of faecal contamination within the area particularly during the haul-out periods.

6.2. Shoreline Survey

6.2.1. Shoreline Survey Report

A shoreline survey was carried out by Sea Fisheries Protection Authority over 5 days between April and July 2019. Figure 6.23 shows the GPS (Global Positioning System) and photography sites accounted for during the 5 survey days. The whole shoreline was surveyed with the exception a very small section of the southern shoreline at the mouth of the River Brickey, access here was very difficult due to the soft terrain.

The aim of this survey was to identifypotential sources of contamination in the vicinity of the bivalve mollusc production area such as piped discharges, waste water 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, in the urban area around Dungarvan officer's utilised piers and walkways in order to survey those areas where access to the shoreline was restricted.

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.

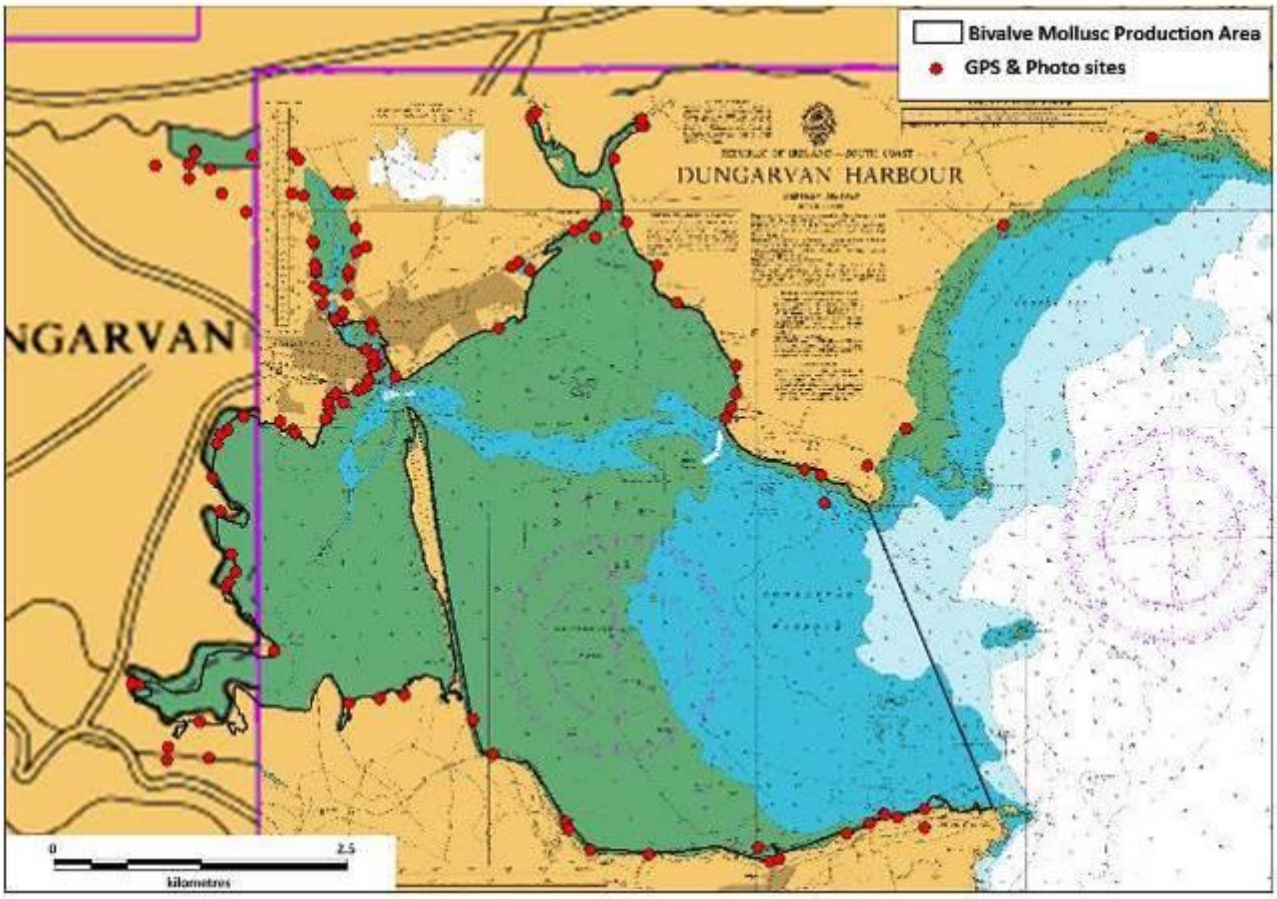

Figure 6.23: Locations of GPS and Photograph Sites.

Figure 6.24 and Figure 6.25 show the locations of all features observed during the shoreline survey. In total 123 features were identified, of which 14 rivers/streams were identified, 16 drains, 64 pipes, 2 discharges, 2 culverts, 3 piers, 1 marina, 3 WWTP, 4 discharges from WWTP and a WWTP pumping station. Figure 6.26 to Figure 6.39 show aerial imagery of the location of the features and Appendix 6 shows images of most of these features. Table 6.16 details all features identified and the numbering used is cross-referenced to Figure 6.26 to Figure 6.39 and Appendix 6.

Table 6.16: Features identified during the shoreline survey. Refer to Figure 6.26 – Figure 6.39 for locations and Appendix 6 for photographs.

Map Code	Observation	Comments	Longitude	Latitude	Easting	Northing
1	Old concrete pipe structure	Unused, no flow.	-7.51864	52.10591	233032.5	94942.2
2	Culvert	Water appears clean, no smell or colour.	-7.53696	52.09921	231782.0	94188.5
3	WWTP pipe	New construction, no flow. Crimped style opening.	-7.54912	52.08358	230959.5	92444.0
4	WWTP Plant	Wastewater treatment plant, in operation.	-7.55385	52.08077	230637.2	92129.4
5.1	Old pier	Very old pier, not in use.	-7.55317	52.07773	230680	91812
5.2	WWTP pipe	Primary discharge	-7.54883	52.07396	230986.0	91374.0
6	Plastic pipe	Small bore plastic pipe, no flow. Likely drainage from golf course	-7.55972	52.08006	230235.2	92047.9
7	Stone Pipe	No flow, likely water drainage from golf course	-7.56167	52.08052	230101.2	92098.3
8	Pier	No boats or berths evident	-7.57150	52.08439	229424.8	92524.9
9	Stone Pipe	Concrete pipe built into wall, likely water drain.	-7.57090	52.08522	229465.3	92617.5
10	WWTP Pipe	New construction, no flow. Crimped style opening.	-7.57020	52.08631	229512.6	92739.0
11	Plastic pipe	No flow, built into wall. Likely water drainage.	-7.57021	52.08843	229510.5	92974.9
12	Plastic pipe	No flow, built into wall. Likely water drainage.	-7.57769	52.09324	228994.7	93507.1
13	WWTP Pipe	New construction, no flow. Crimped style opening.	-7.58017	52.09607	228822.9	93821.1
14	Black pipe	Small bore plastic pipe. No flow.	-7.58391	52.09940	228564.5	94190.1
15	Cows	Cows, 20 + adjacent shore. Pasture and grazing land.	-7.58540	52.10428	228459.2	94732.6
16	WWTP pipe	Low flow, large bore concrete pipe	-7.58210	52.10687	228683.7	95022.1
17	WWTP Plant	Small treatment plant	-7.58175	52.10682	228707.7	95016.6
18	Stream	Stream from golfcourse, medium flow	-7.58197	52.10735	228692.3	95075.5
19	Stream	Stream, good flow. Marked on map.	-7.59517	52.10787	227787.6	95128.3
20	Stream	Stream through reed bed, medium flow	-7.59578	52.10740	227746.1	95075.7
21	Plastic pipe	No flow, likely water drainage	-7.58645	52.10075	228389.5	94339.4
22	Plastic pipe	Broken plastic piping, probably drainage. No colouration or smell.	-7.58925	52.09912	228198.7	94156.9

Map Code	Observation	Comments	Longitude	Latitude	Easting	Northing
23	Stone cut drain	Old stone cut drain, some flow.	-7.59033	52.09872	228124.9	94112.0
24	Stone Pipe	Old half buried stone pipe, good flow. Some grey colouration.	-7.58780	52.09824	228298.6	94059.5
25	Concrete pipe	Old precast concrete pipe, no flow. Possibly redundant. Near houses	-7.59596	52.09570	227741.0	93773.8
26	Pipe	Large pipe with cover flap, large drain across road flows into.	-7.59730	52.09638	227648.7	93848.9
27	Concrete pipe	Precast concrete pipe, low flow. Grey colouration.	-7.59823	52.09601	227585.4	93807.8
28	Plastic pipe	Large bore plastic pipe, tiny flow. No signs of enrichment. Drainage.	-7.59980	52.09130	227480.5	93282.7
29	Iron pipe	Old iron pipe, very small flow. No colouration or smell.	-7.61274	52.08763	226595.8	92869.5
30	Stream	Stream upwelling through mudflats, good flow.	-7.61561	52.09124	226396.9	93270.2
31	Pipe	5 plastic pipes with crimped ends, no flow.	-7.61538	52.09150	226412.5	93299.2
32	Discharge	Upwelling, leak through wall. Steady flow.	-7.61561	52.09166	226396.7	93316.9
33	Discharge	Stone structure, trickle flow. Some algae growth surrounding.	-7.61567	52.09164	226392.6	93314.7
34	Pipe	Concrete pipe set into wall, no flow, possibly redundant.	-7.62020	52.09197	226081.9	93349.7
35	Pipe	Plastic pipe, very low flow.	-7.61947	52.09210	226131.8	93364.5
36	Pipe	Crimped pipe end, no flow.	-7.61913	52.09247	226154.9	93405.8
37	Pipe	Old concrete pipe, low flow, undetermined use.	-7.61868	52.09383	226185.0	93557.3
38	Pipe	Old stone pipe, no flow, possibly redundant	-7.61843	52.09527	226201.3	93717.6
39	Pipe	WWTP related, narrowed ending. Very low flow, no signs of enrichment.	-7.61847	52.09565	226198.3	93759.9
40	Pipe	Plastic pipe, no flow, drainage.	-7.61747	52.09718	226265.9	93930.5
41	Cows	Beef cows on pasture, 20 +. Pasture and grazing.	-7.61625	52.09752	226349.4	93968.7
42	Pipe	Two blue pipes, small bore. Very low flow, likely water drainage.	-7.61765	52.09892	226252.6	94124.0
43	Pipe	Large bore pipe, no flow, likely water drainage from housing estate.	-7.61852	52.10163	226191.4	94425.3
44	Pipe	Small bore pipe, mesh opening. Medium flow, some grey colours.	-7.61953	52.10157	226122.2	94418.2
45	Pipe	Plastic pipe, good flow. Orange colour, houses to the rear. No odour.	-7.61992	52.10165	226095.4	94427.0
46	Pipe	Large pipe with flap, low flow. Odour of sewage. Black liquid discharge.	-7.62465	52.10420	225769.8	94709.0
47	Stream	Stream marked on map, good flow, signs of enrichment. Rear of housing estate.	-7.62545	52.10458	225714.8	94751.0

Map Code	Observation	Comments	Longitude	Latitude	Easting	Northing
48	Cows	Cows on pasture, 45 +. Pasture and grazing land.	-7.63055	52.10453	225365.4	94743.7
49	Pipe	Concrete pipe, low flow. Brown colour, possible farmyard discharge.	-7.63758	52.10485	224883.5	94776.9
50	Pipe	Narrow plastic pipe, unclear if discharging as half buried in substrate.	-7.63758	52.10467	224883.6	94756.8
51	Civic amenity pipe	Civic amenity site. Pipe also.	-7.64245	52.10370	224550.4	94647.2
52	River	Colligan River, good flow.	-7.63832	52.10382	224833.4	94662.0
53	Pipe	Plastic pipe, small bore, no flow. Likely drainage.	-7.63828	52.10272	224836.7	94539.6
54	Birds	Birds, gulls 25 +	-7.63578	52.10342	225007.6	94618.4
55	Pipe	Three small bore pipes, likely water drainage. Agricultural land to rear.	-7.63423	52.10162	225114.9	94418.6
56	Cows	Cows on pasture, 60 +. Pasture and grazing land.	-7.63127	52.10017	225318.5	94258.3
57	Pipe	Large concrete pipe, very low flow.	-7.62562	52.10162	225704.9	94421.6
58	Pipe	Two pipes, plastic and concrete. Possibly drainage from housing estate	-7.62412	52.10145	225807.8	94403.2
59	Pipe	Two pipes, plastic and concrete. Possibly drainage from housing estate	-7.62293	52.09790	225891.3	94008.6
60	Pipe	Two pipes, plastic and concrete. Possibly drainage from housing estate	-7.62287	52.09772	225895.6	93988.6
61	Pipe	Concrete pipe, low flow. Probably drainage from GAA grounds	-7.62265	52.09615	225911.5	93814.0
62	Drain	Road drain, very low flow.	-7.62258	52.09572	225916.6	93766.2
63	Drain	Road drain, very low flow.	-7.62255	52.09557	225918.7	93749.5
64	Pipe	Large concrete pipe and plastic pipe, low flow.	-7.62262	52.09450	225914.6	93630.4
65	Birds	Redshank 40 +	-7.62165	52.09412	225981.3	93588.5
66	Pipe	Old metal pipe with flap, no flow.	-7.62165	52.09312	225981.8	93477.2
67	Pipe	Plastic pipe in wall, no flow.	-7.61630	52.08964	226350.6	93091.9
68	Pipe	Pipe, metal. No flow.	-7.61526	52.08919	226422.1	93042.2
69	Pipe	Plastic pipe, no flow. Sewage odour from adjoining manhole covers.	-7.61522	52.08883	226425.1	93002.1
70	Marina	Marina in town, approx 15 to 20 boats	-7.61467	52.08849	226463.0	92964.5
71	Pipe	Pipe, no flow.	-7.61537	52.08855	226415.0	92970.9
72	Pipe	Stone pipe, no flow.	-7.61549	52.08832	226406.9	92945.3
73	Pipe	Large metal pipe, flap covering. Trickle flow.	-7.61597	52.08732	226374.5	92833.9

Map Code	Observation	Comments	Longitude	Latitude	Easting	Northing
74	Pipe	White pipe built into wall, no flow. Drainage.	-7.61636	52.08677	226348.1	92772.5
75	Pipe	White pipe built into wall, no flow. Drainage.	-7.61690	52.08662	226311.2	92755.6
76	Pipe	Stone pipe built into wall. Low flow, clear water.	-7.61732	52.08654	226282.5	92746.6
77	Pipe	Old stone pipe, no flow, broken. Possibly old sewage.	-7.61902	52.08555	226166.5	92635.8
78	Pipe	15 pipes, small bore. No flow, likely drainage from adjoining road.	-7.62005	52.08625	226095.5	92713.3
79	Pipe	Pipe built into wall, trickle flow. Some algae evident.	-7.62102	52.08557	226029.4	92637.3
80	Birds	Brent geese, 15 +	-7.62098	52.08504	226032.5	92578.3
81	Pipe	Old stone pipe, no flow.	-7.62075	52.08497	226048.3	92570.6
82	Pipe	Large concrete pipe, no recent flow. Lots of green algae. Beside sports centre	-7.62120	52.08429	226017.8	92494.8
83	Station	Waste water infrastructure station.	-7.62135	52.08433	226007.5	92499.2
84	Pipe	Plastic drainage pipe, no flow.	-7.62505	52.08325	225754.5	92377.7
85	Pipe	Plastic drainage pipe, no flow.	-7.62542	52.08346	225729.0	92401.0
86	Pipe	2 plastic pipes, trickle flow. Grey colour. Possible sewage.	-7.62698	52.08414	225621.7	92476.1
87	Pipe	Metal pipe, large bore. Grey colour discharge, steady flow. Sewage fungus.	-7.63148	52.08449	225313.0	92513.4
88	Birds	Birds. Godwits 50 +	-7.63344	52.08350	225179.2	92402.6
89	Stream	Stream/small river. WWTP possibly upstream.	-7.63444	52.08316	225110.8	92364.4
90	Pipe	Big pipe, medium flow. Some enrichment.	-7.63487	52.08242	225081.8	92281.9
91	Drain	Field drain.	-7.63537	52.07985	225048.9	91995.8
92	Cows	Cows 80+. Pasture and grazing land.	-7.63434	52.07727	225121.0	91709.1
93	Drain	Drain through agricultural land, trickle flow.	-7.63309	52.07397	225208.5	91342.3
94	Drain	Drain through agricultural land, trickle flow.	-7.63245	52.07258	225253.2	91187.8
95	Drain	Drain through agricultural land, trickle flow.	-7.63331	52.07179	225194.7	91099.6
96	Drain	Drain through marsh, trickle flow.	-7.63367	52.07143	225170.2	91059.5
97	Cows	Cows 20+. Pasture and grazing land.	-7.62769	52.06654	225583.0	90517.4
98	River	River Brickey, good flow of water.	-7.64536	52.06408	224372.6	90237.6
99	Drain	Drain of saltmarsh.	-7.64442	52.06393	224437.1	90221.2

Map Code	Observation	Comments	Longitude	Latitude	Easting	Northing
100	Cows	Cows, 25 +. Pasture/grazing land.	-7.64100	52.05812	224674.9	89575.9
101	Stream	Large stream, steady flow.	-7.64083	52.05915	224686.0	89690.6
102	Drain	Large drain, running off agricultural land through embankment.	-7.63694	52.06108	224951.7	89906.7
103	Animals	Cattle, 100 + animals. Pasture/grazing land.	-7.63585	52.05838	225028.0	89606.6
104	Stream	Stream through reeds, steady flow.	-7.61840	52.06256	226222.5	90077.9
105	Drain	Field drain.	-7.61446	52.06291	226492.5	90118.2
106	Drain	Field drain.	-7.61149	52.06318	226696.0	90149.4
107	Drain	Field drain.	-7.60293	52.06134	227284.2	89947.8
108	Pier	Seven boats moored here. Small pier.	-7.60293	52.06134	227284.2	89947.8
109	Stream	Steay flow	-7.60052	52.05865	227451.1	89649.4
110	Drain	Natural drain, trickle flow.	-7.59148	52.05341	228074.5	89069.8
111	Stream	Steay flow	-7.59102	52.05291	228106.4	89014.3
112	Drain	Trickle flow.	-7.58833	52.05129	228291.9	88835.1
113	Stream	Good flow, adjacent oyster production plant.	-7.58115	52.05099	228784.7	88804.5
114	Pipe	Long pipe discharging inter-tidally. Odour, likely waste water.	-7.56754	52.05152	229718.0	88868.9
115	WWTP	Likely pumping station linked to previous 114	-7.56608	52.05046	229818.8	88751.6
116	Culvert	Steady flow, lots of green algae/enrichment.	-7.56486	52.05059	229902.5	88766.6
117	Stream	Good flow	-7.56528	52.05134	229873.0	88850.2
118	Pipe	12 small pipes built into retaining wall	-7.55357	52.05334	230675.1	89077.3
119	Pipe	Waste water treatment plant pipe, running out subsea.	-7.55194	52.05406	230786.4	89158.1
120	WWTP	Wastewater treatment plant - Baillegaul	-7.55176	52.05398	230798.8	89149.2
121	Pipe	9 small pipes built into retaining wall	-7.55020	52.05385	230905.9	89135.4
122	Pipe	Old pipe, defunct. Probably linked to public toilets in past.	-7.54687	52.05300	231135.0	89042.3
123	Drain	Steay flow	-7.54681	52.05448	231138.0	89207.0

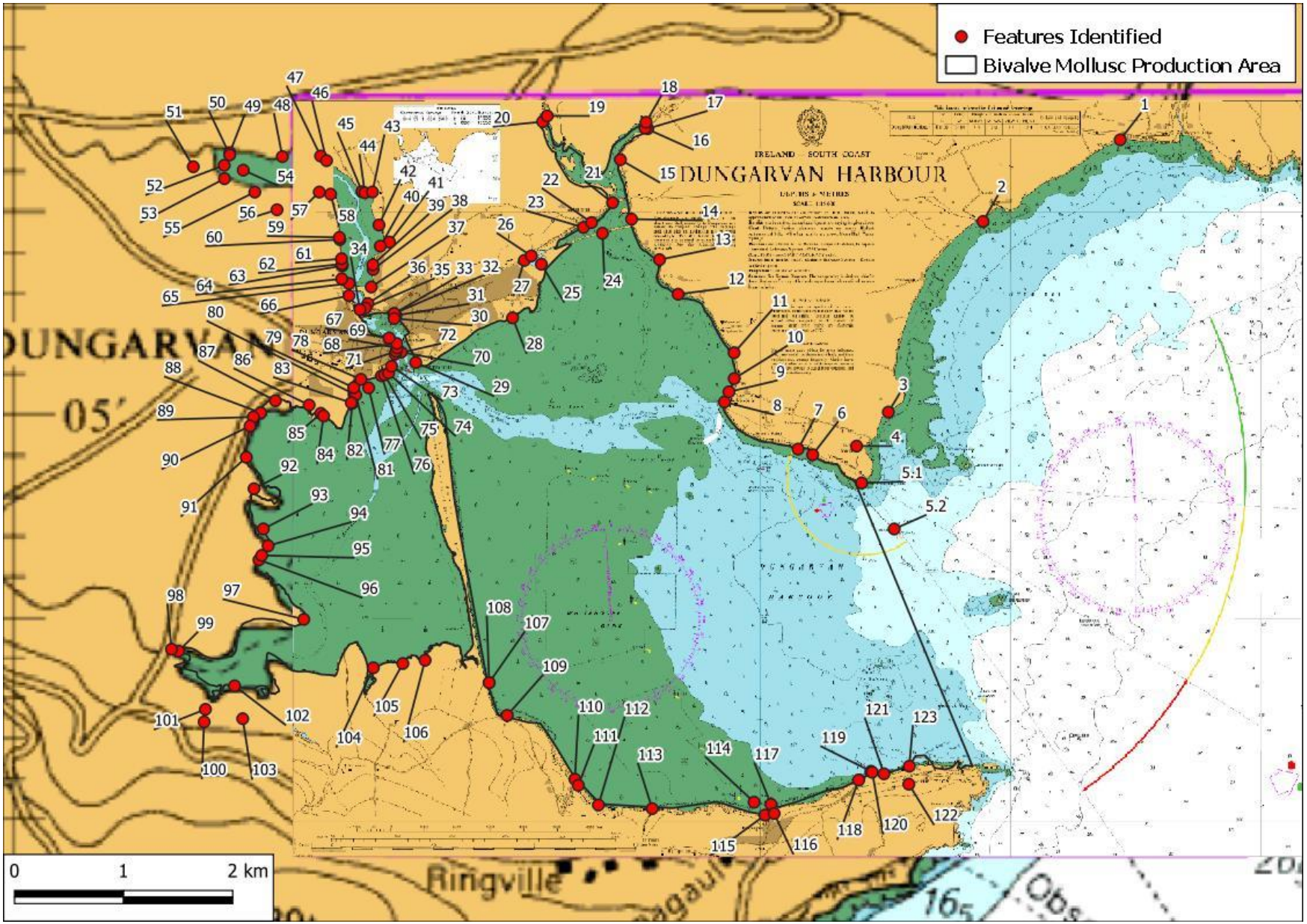

Figure 6.24: All features (numbering cross-reference to Table 6.16) identified during the shoreline survey.

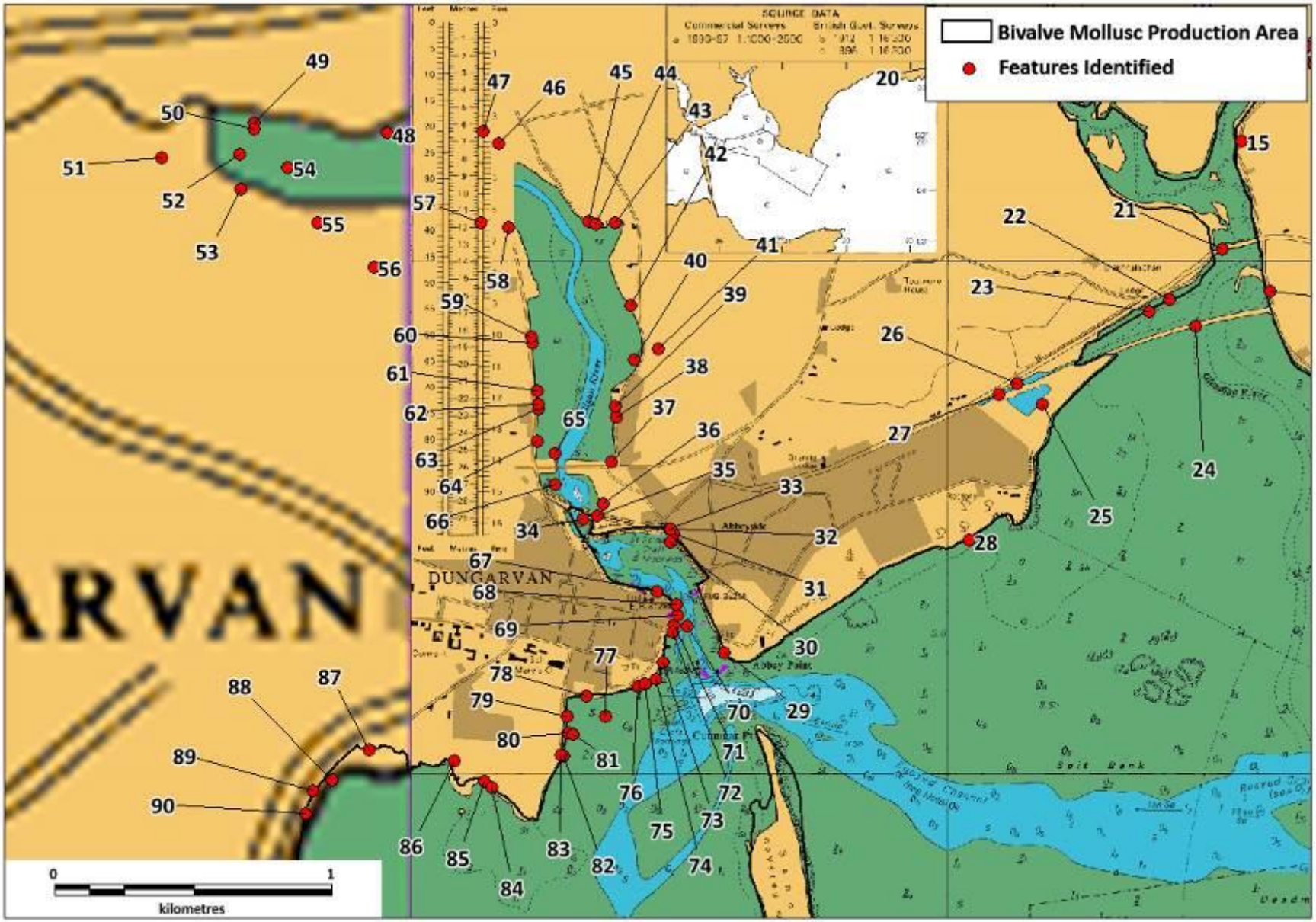

Figure 6.25: All features in Dungarvan town area (numbering cross-reference to Table 4.14) identified during the shoreline survey.

Figure 6.26: Features 1-3 (numbering cross-reference to Table 6.16) identified during the shoreline survey.

Figure 6.27: Features 4-7 (numbering cross-reference to Table 6.16) identified during the shoreline survey.

Figure 6.28: Features 8-11 (numbering cross-reference to Table 6.16) identified during the shoreline survey.

Figure 6.29: Features 12-13 (numbering cross-reference to Table 6.16) identified during the shoreline survey.

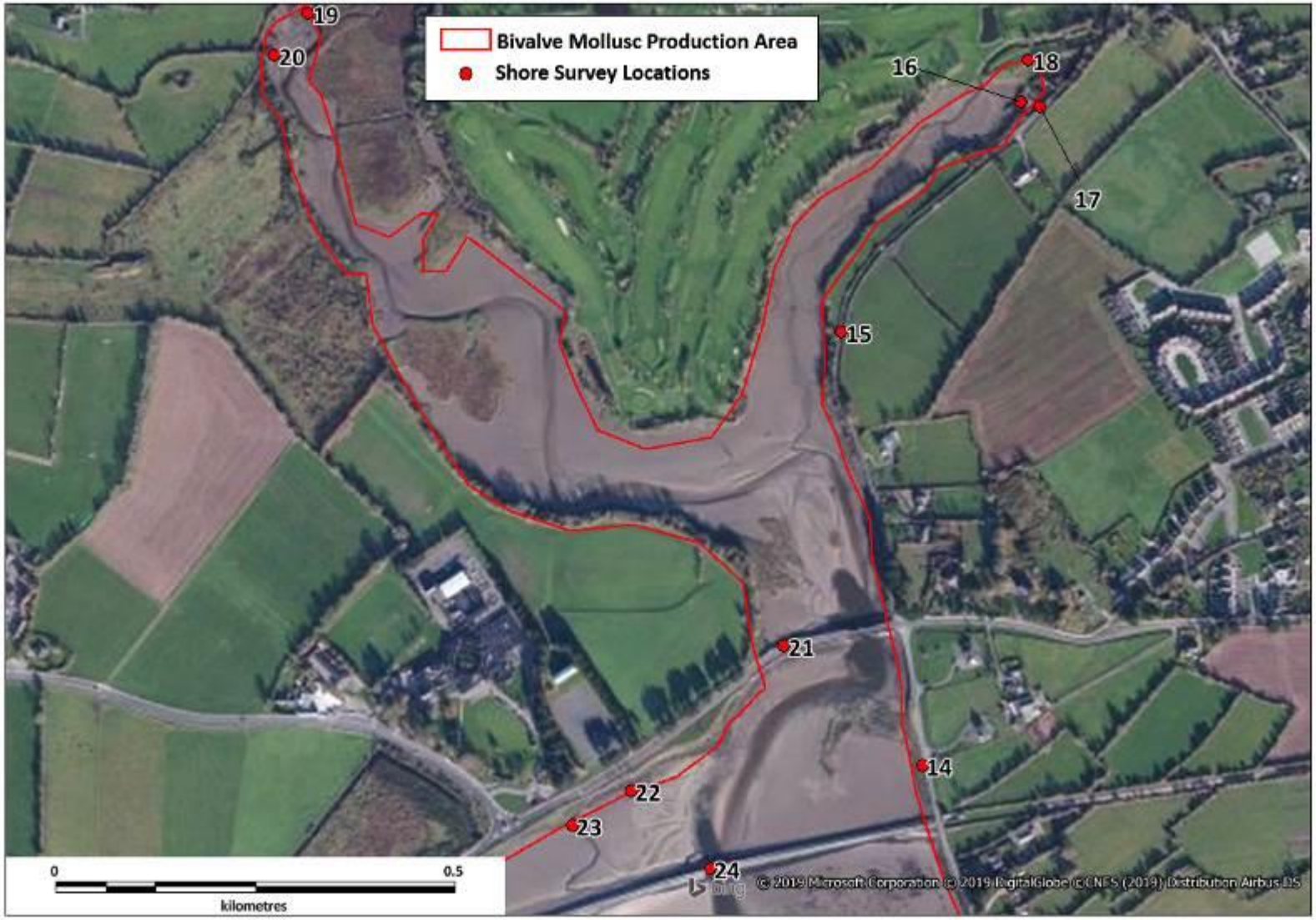

Figure 6.30: Features 14-24 (numbering cross-reference to Table 6.16) identified during the shoreline survey.

Figure 6.31: Features 25-28 (numbering cross-reference to Table 6.16) identified during the shoreline survey.

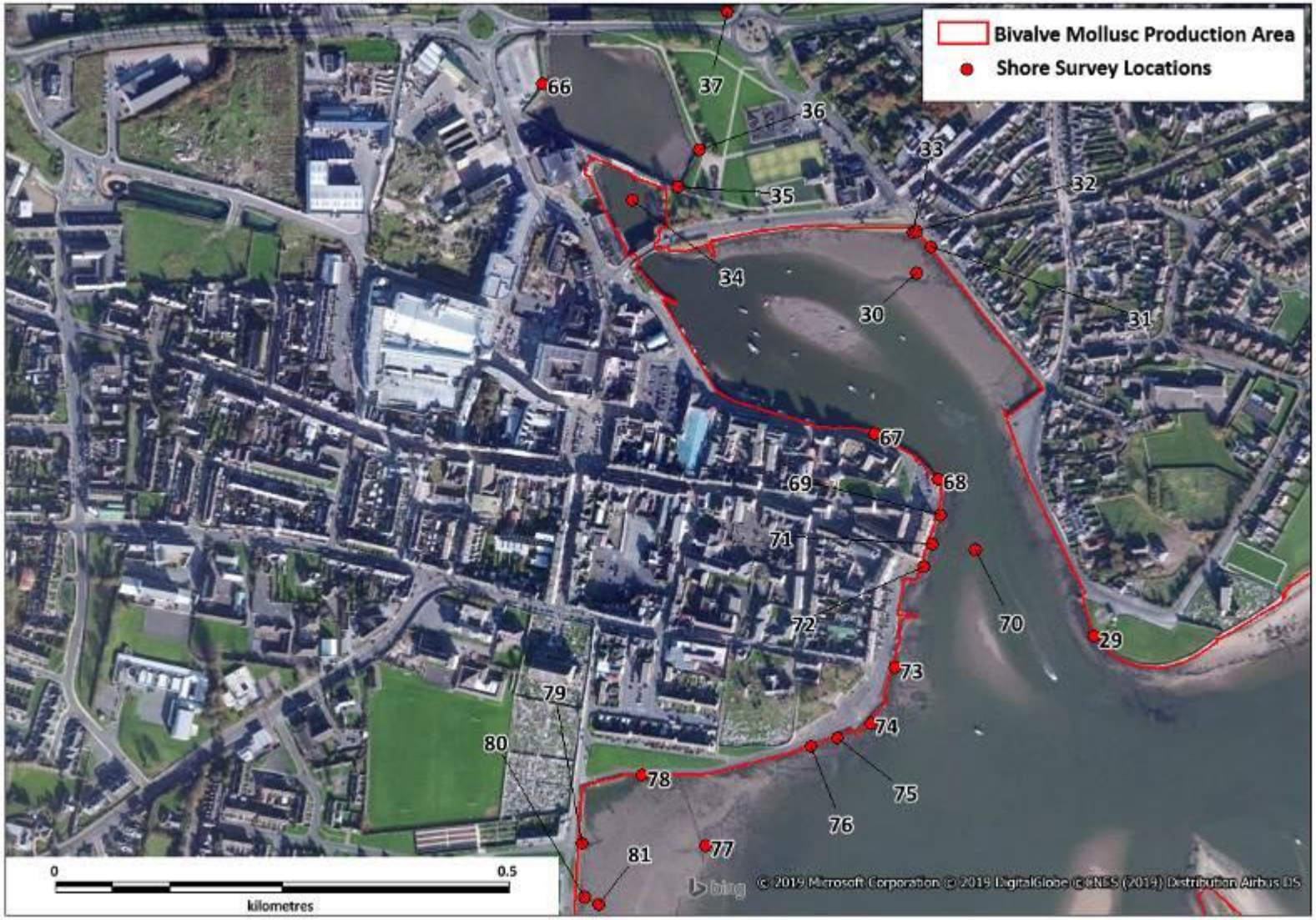

Figure 6.32: Features 29-37 and 66-81 (numbering cross-reference to Table 6.16) identified during the shoreline survey.

Figure 6.33: Features 38-65 (numbering cross-reference to Table 6.16) identified during the shoreline survey.

Figure 6.34: Features 82-91 (numbering cross-reference to Table 6.16) identified during the shoreline survey.

Figure 6.35: Features 92-97 (numbering cross-reference to Table 6.16) identified during the shoreline survey.

Figure 6.36: Features 98-103 (numbering cross-reference to Table 6.16) identified during the shoreline survey.

Figure 6.37: Features 104-109 (numbering cross-reference to Table 6.16) identified during the shoreline survey.

Figure 6.38: Features 110-117 (numbering cross-reference to Table 6.16) identified during the shoreline survey.

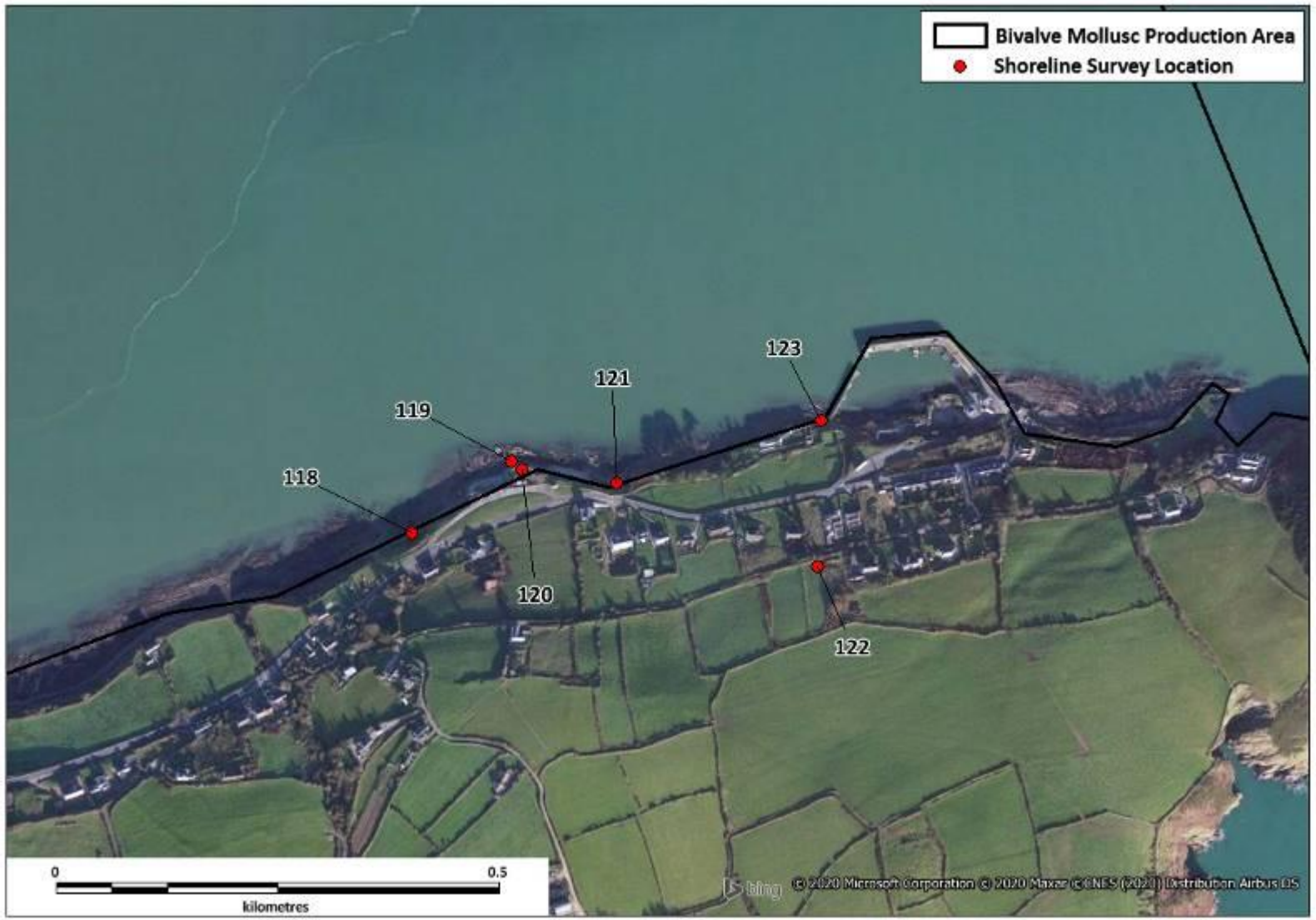

Figure 6.39: Features 117-123 (numbering cross-reference to Table 6.16) identified during the shoreline survey.

6.2.2. Locations of Sources

Figure 6.40 shows all watercourses discharging into Dungarvan Bay and Table 6.17 provides cross-referenced details for this map. Figure 6.41 shows all discharges in the Dungarvan Bay catchment area and Table 6.18 provides cross-referenced details for the WWTP, drain and pipe discharges.

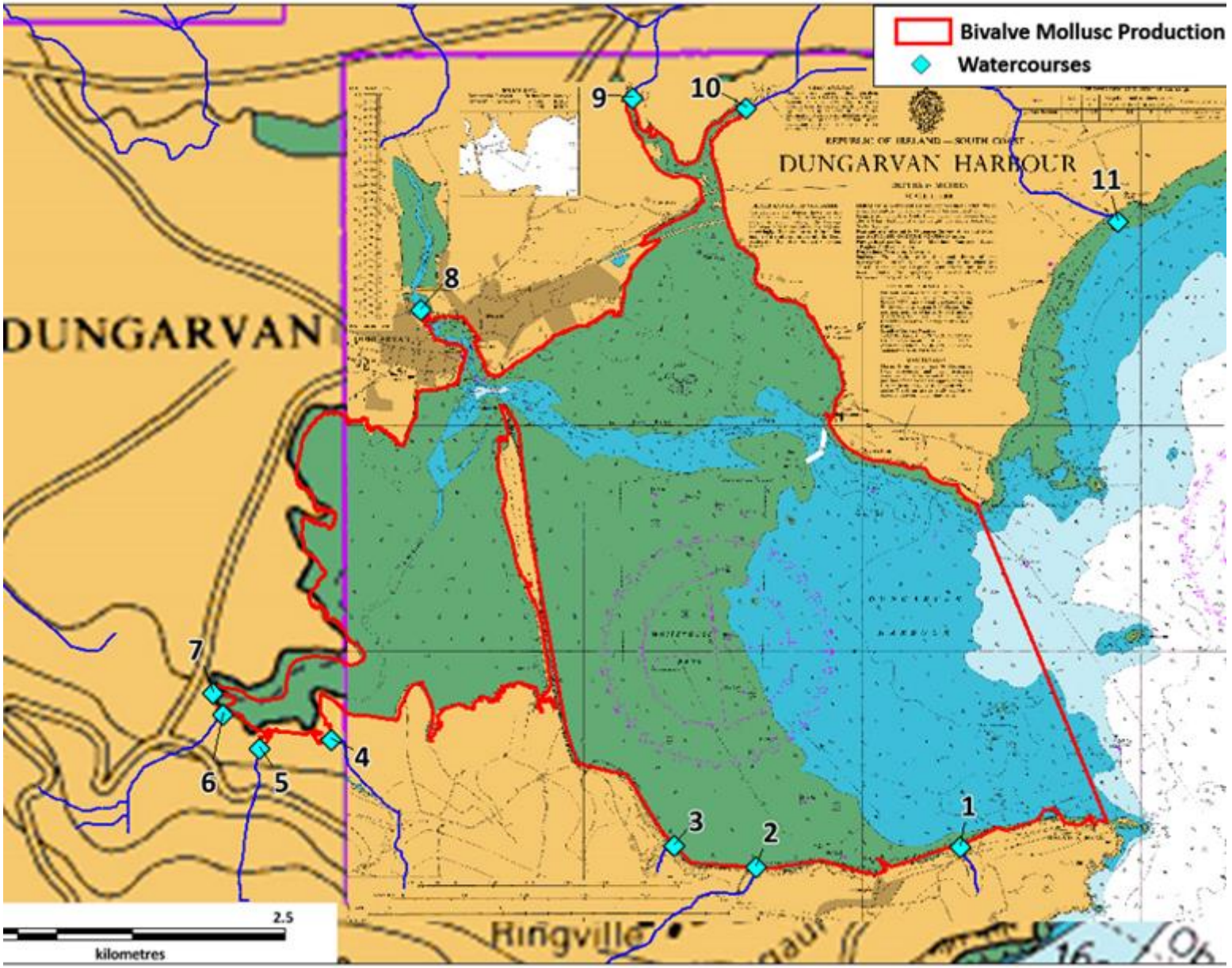

Figure 6.40: Location of all watercourses discharging into Dungarvan Harbour.

Table 6.17: Cross-referenced table for Figure 6.40 Watercourses.

Map ID	Watercourse
1	Unnamed river
2	Unnamed river
3	Unnamed river
4	Unnamed river
5	Unnamed river
6	Unnamed river
7	Brickey River
8	Colligan River
9	Unnamed river
10	Unnamed river
11	Unnamed river

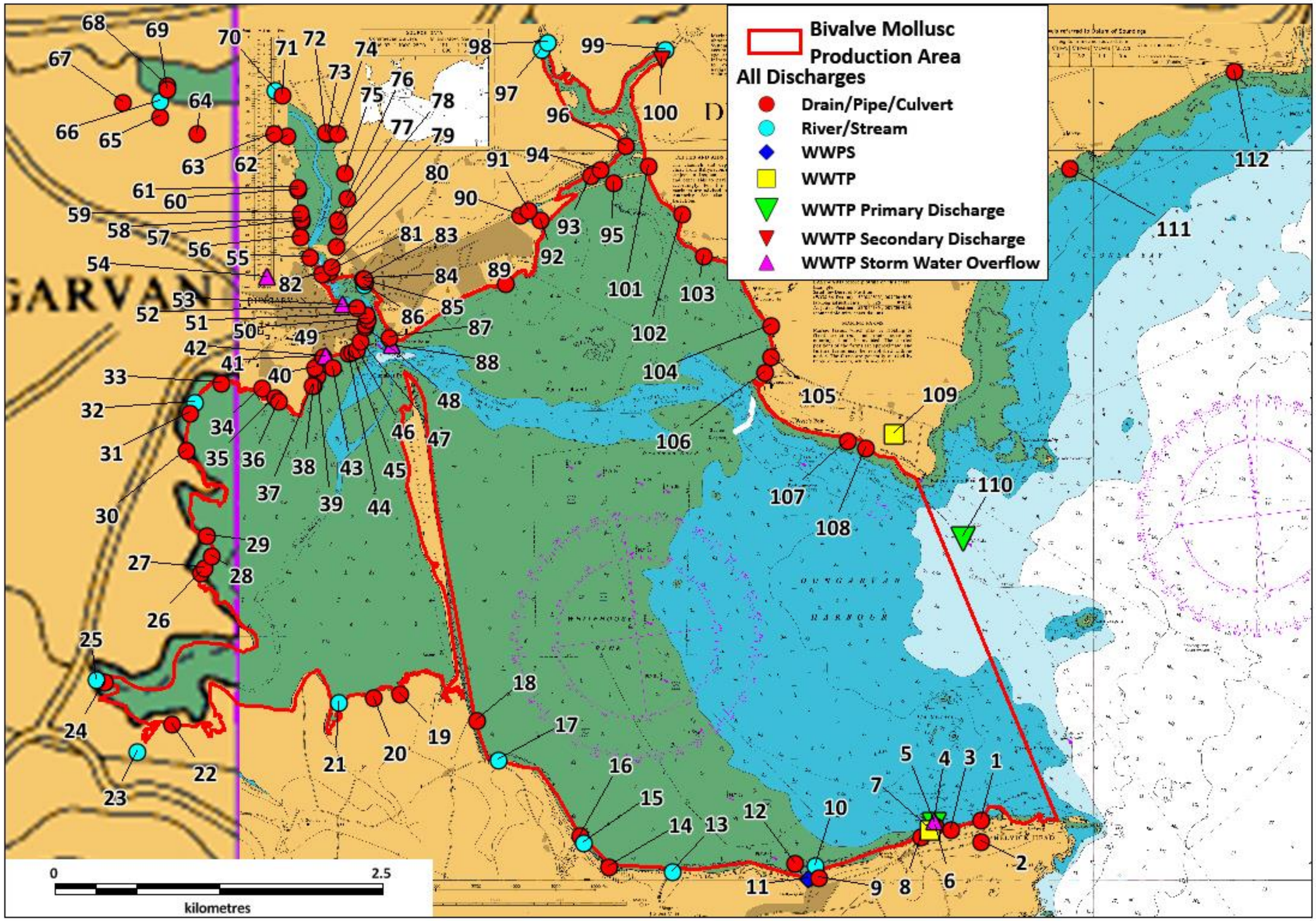

Figure 6.41: Locations of all discharges within the Dungarvan Harbour Catchment Area.

Table 6.18: Cross-referenced table for Figure 6.41 Discharges.

Map ID	Discharge	Description	Latitude	Longitude	Easting	Northing
1	Drain	Steady flow	52.05448	-7.54681	231138.0	89207.0
2	Pipe	Old pipe, defunct. Probably linked to public toilets in past.	52.05300	-7.54687	231135.0	89042.3
3	Pipe	9 small pipes built into retaining wall	52.05385	-7.55020	230905.9	89135.4
4	WWTP Primary Discharge	Primary Effluent Emission Point	52.05437	-7.55207	230777.0	89192.9
5	WWTP Storm Water Overflow	Storm Water Overflow	52.05437	-7.55207	230777.0	89192.9
6	Pipe	Waste water treatment plant pipe, running out subsea.	52.05406	-7.55194	230786.4	89158.1
7	WWTP	Facility	52.05385	-7.55247	230750.2	89134.5
8	Pipe	12 small pipes built into retaining wall	52.05334	-7.55357	230675.1	89077.3
9	Culvert	Steady flow, lots of green algae/enrichment.	52.05059	-7.56486	229902.5	88766.6
10	Stream	Good flow	52.05134	-7.56528	229873.0	88850.2
11	WWPS	Likely pumping station linked to previous 114	52.05046	-7.56608	229818.8	88751.6
12	Pipe	Long pipe discharging inter-tidally. Odour, likely waste water.	52.05152	-7.56754	229718.0	88868.9
13	Stream	Good flow, adjacent oyster production plant.	52.05099	-7.58115	228784.7	88804.5
14	Drain	Trickle flow.	52.05129	-7.58833	228291.9	88835.1
15	Stream	Steady flow	52.05291	-7.59102	228106.4	89014.3
16	Drain	Natural drain, trickle flow.	52.05341	-7.59148	228074.5	89069.8
17	Stream	Steady flow	52.05865	-7.60052	227451.1	89649.4
18	Drain		52.06134	-7.60293	227284.2	89947.8
19	Drain	Field drain.	52.06318	-7.61149	226696.0	90149.4
20	Drain	Field drain.	52.06291	-7.61446	226492.5	90118.2
21	Stream	Stream through reeds, steady flow.	52.06256	-7.61840	226222.5	90077.9
22	Drain	Large drain, running off agricultural land through embankment.	52.06108	-7.63694	224951.7	89906.7
23	Stream	Large stream, steady flow.	52.05915	-7.64083	224686.0	89690.6
24	Drain	Drain of saltmarsh.	52.06393	-7.64442	224437.1	90221.2

Map ID	Discharge	Description	Latitude	Longitude	Easting	Northing
25	River	River Brickey, good flow of water.	52.06408	-7.64536	224372.6	90237.6
26	Drain	Drain through marsh, trickle flow.	52.07143	-7.63367	225170.2	91059.5
27	Drain	Drain through agricultural land, trickle flow.	52.07179	-7.63331	225194.7	91099.6
28	Drain	Drain through agricultural land, trickle flow.	52.07258	-7.63245	225253.2	91187.8
29	Drain	Drain through agricultural land, trickle flow.	52.07397	-7.63309	225208.5	91342.3
30	Drain	Field drain.	52.07985	-7.63537	225048.9	91995.8
31	Pipe	Big pipe, medium flow. Some enrichment.	52.08242	-7.63487	225081.8	92281.9
32	Stream	Stream/small river. WWTP possibly upstream.	52.08316	-7.63444	225110.8	92364.4
33	Pipe	Metal pipe, large bore. Grey colour discharge, steady flow. Sewage fungus.	52.08449	-7.63148	225313.0	92513.4
34	Pipe	2 plastic pipes, trickle flow. Grey colour. Possible sewage.	52.08414	-7.62698	225621.7	92476.1
35	Pipe	Plastic drainage pipe, no flow.	52.08346	-7.62542	225729.0	92401.0
36	Pipe	Plastic drainage pipe, no flow.	52.08325	-7.62505	225754.5	92377.7
37	Station	Waste water infrastructure station.	52.08433	-7.62135	226007.5	92499.2
38	Pipe	Large concrete pipe, no recent flow. Lots of green algae. Beside sports centre	52.08429	-7.62120	226017.8	92494.8
39	Pipe	Old stone pipe, no flow.	52.08497	-7.62075	226048.3	92570.6
40	Pipe	Pipe built into wall, trickle flow. Some algae evident.	52.08557	-7.62102	226029.4	92637.3
41	Pipe	15 pipes, small bore. No flow, likely drainage from adjoining road.	52.08625	-7.62005	226095.5	92713.3
42	WWTP Storm Water Overflow	Storm Water Overflow	52.08626	-7.61987	226108.0	92713.9
43	Pipe	Old stone pipe, no flow, broken. Possibly old sewage.	52.08555	-7.61902	226166.5	92635.8
44	Pipe	Stone pipe built into wall. Low flow, clear water.	52.08654	-7.61732	226282.5	92746.6
45	Pipe	White pipe built into wall, no flow. Drainage.	52.08662	-7.61690	226311.2	92755.6
46	Pipe	White pipe built into wall, no flow. Drainage.	52.08677	-7.61636	226348.1	92772.5
47	Pipe	Large metal pipe, flap covering. Trickle flow.	52.08732	-7.61597	226374.5	92833.9
48	Pipe	Stone pipe, no flow.	52.08832	-7.61549	226406.9	92945.3
49	Pipe	Pipe, no flow.	52.08855	-7.61537	226415.0	92970.9
50	Pipe	Plastic pipe, no flow. Sewage odour from adjoining manhole covers.	52.08883	-7.61522	226425.1	93002.1

Map ID	Discharge	Description	Latitude	Longitude	Easting	Northing
51	Pipe	Pipe, metal. No flow.	52.08919	-7.61526	226422.1	93042.2
52	Pipe	Plastic pipe in wall, no flow.	52.08964	-7.61630	226350.6	93091.9
53	WWTP Storm Water Overflow	Storm Water Overflow	52.08986	-7.61793	226239.0	93116.0
54	WWTP Storm Water Overflow	Storm Water Overflow	52.09173	-7.62636	225660.0	93321.0
55	Pipe	Old metal pipe with flap, no flow.	52.09312	-7.62165	225981.8	93477.2
56	Pipe	Large concrete pipe and plastic pipe, low flow.	52.09450	-7.62262	225914.6	93630.4
57	Drain	Road drain, very low flow.	52.09557	-7.62255	225918.7	93749.5
58	Drain	Road drain, very low flow.	52.09572	-7.62258	225916.6	93766.2
59	Pipe	Concrete pipe, low flow. Probably drainage from GAA grounds	52.09615	-7.62265	225911.5	93814.0
60	Pipe	Two pipes, plastic and concrete. Possibly drainage from housing estate	52.09772	-7.62287	225895.6	93988.6
61	Pipe	Two pipes, plastic and concrete. Possibly drainage from housing estate	52.09790	-7.62293	225891.3	94008.6
62	Pipe	Two pipes, plastic and concrete. Possibly drainage from housing estate	52.10145	-7.62412	225807.8	94403.2
63	Pipe	Large concrete pipe, very low flow.	52.10162	-7.62562	225704.9	94421.6
64	Pipe	Three small bore pipes, likely water drainage. Agricultural land to rear.	52.10162	-7.63423	225114.9	94418.6
65	Pipe	Plastic pipe, small bore, no flow. Likely drainage.	52.10272	-7.63828	224836.7	94539.6
66	River	Colligan River, good flow.	52.10382	-7.63832	224833.4	94662.0
67	Civic amenity pipe	Civic amenity site. Pipe also.	52.10370	-7.64245	224550.4	94647.2
68	Pipe	Concrete pipe, low flow. Brown colour, possible farmyard discharge.	52.10485	-7.63758	224883.5	94776.9
69	Pipe	Narrow plastic pipe, unclear if discharging as half buried in substrate.	52.10467	-7.63758	224883.6	94756.8
70	Stream	Stream marked on map, good flow, signs of enrichment. Rear of housing estate.	52.10458	-7.62545	225714.8	94751.0
71	Pipe	Large pipe with flap, low flow. Odour of sewage. Black liquid discharge.	52.10420	-7.62465	225769.8	94709.0
72	Pipe	Plastic pipe, good flow. Orange colour, houses to the rear. No odour.	52.10165	-7.61992	226095.4	94427.0
73	Pipe	Small bore pipe, mesh opening. Medium flow, some grey colours.	52.10157	-7.61953	226122.2	94418.2
74	Pipe	Large bore pipe, no flow, likely water drainage from housing estate.	52.10163	-7.61852	226191.4	94425.3
75	Pipe	Two blue pipes, small bore. Very low flow, likely water drainage.	52.09892	-7.61765	226252.6	94124.0
76	Pipe	Plastic pipe, no flow, drainage.	52.09718	-7.61747	226265.9	93930.5

Map ID	Discharge	Description	Latitude	Longitude	Easting	Northing
77	Pipe	WWTP related, narrowed ending. Very low flow, no signs of enrichment.	52.09565	-7.61847	226198.3	93759.9
78	Pipe	Old stone pipe, no flow, possibly redundant	52.09527	-7.61843	226201.3	93717.6
79	Pipe	Old concrete pipe, low flow, undetermined use.	52.09383	-7.61868	226185.0	93557.3
80	Pipe	Crimped pipe end, no flow.	52.09247	-7.61913	226154.9	93405.8
81	Pipe	Plastic pipe, very low flow.	52.09210	-7.61947	226131.8	93364.5
82	Pipe	Concrete pipe set into wall, no flow, possibly redundant.	52.09197	-7.62020	226081.9	93349.7
83	Discharge	Stone structure, trickle flow. Some algae growth surrounding.	52.09164	-7.61567	226392.6	93314.7
84	Discharge	Upwelling, leak through wall. Steady flow.	52.09166	-7.61561	226396.7	93316.9
85	Pipe	5 plastic pipes with crimped ends, no flow.	52.09150	-7.61538	226412.5	93299.2
86	Stream	Stream upwelling through mudflats, good flow.	52.09124	-7.61561	226396.9	93270.2
87	Iron pipe	Old iron pipe, very small flow. No colouration or smell.	52.08763	-7.61274	226595.8	92869.5
88	WWTP Storm Water Overflow	Storm Water Overflow	52.08707	-7.61247	226615.0	92807.0
89	Plastic pipe	Large bore plastic pipe, tiny flow. No signs of enrichment. Drainage.	52.09130	-7.59980	227480.5	93282.7
90	Concrete pipe	Precast concrete pipe, low flow. Grey colouration.	52.09601	-7.59823	227585.4	93807.8
91	Pipe	Large pipe with cover flap, large drain across road flows into.	52.09638	-7.59730	227648.7	93848.9
92	Concrete pipe	Old precast concrete pipe, no flow. Possibly redundant. Near houses	52.09570	-7.59596	227741.0	93773.8
93	Stone cut drain	Old stone cut drain, some flow.	52.09872	-7.59033	228124.9	94112.0
94	Plastic pipe	Broken plastic piping, probably drainage. No colouration or smell.	52.09912	-7.58925	228198.7	94156.9
95	Stone Pipe	Old half buried stone pipe, good flow. Some grey colouration.	52.09824	-7.58780	228298.6	94059.5
96	Plastic pipe	No flow, likely water drainage	52.10075	-7.58645	228389.5	94339.4
97	Stream	Stream through reed bed, medium flow	52.10740	-7.59578	227746.1	95075.7
98	Stream	Stream, good flow. Marked on map.	52.10787	-7.59517	227787.6	95128.3
99	Stream	Stream from golf course, medium flow	52.10735	-7.58197	228692.3	95075.5
100	WWTP Secondary Discharge	Secondary Process Emission Point	52.10676	-7.58248	228658.0	95010.0
101	Black pipe	Small bore plastic pipe. No flow.	52.09940	-7.58391	228564.5	94190.1
102	WWTP Pipe	New construction, no flow. Crimped style opening.	52.09607	-7.58017	228822.9	93821.1

Map ID	Discharge	Description	Latitude	Longitude	Easting	Northing
103	Plastic pipe	No flow, built into wall. Likely water drainage.	52.09324	-7.57769	228994.7	93507.1
104	Plastic pipe	No flow, built into wall. Likely water drainage.	52.08843	-7.57021	229510.5	92974.9
105	WWTP Pipe	New construction, no flow. Crimped style opening.	52.08631	-7.57020	229512.6	92739.0
106	Stone Pipe	Concrete pipe built into wall, likely water drain.	52.08522	-7.57090	229465.3	92617.5
107	Stone Pipe	No flow, likely water drainage from golf course	52.08052	-7.56167	230101.2	92098.3
108	Plastic pipe	Small bore plastic pipe, no flow. Likely drainage from golf course	52.08006	-7.55972	230235.2	92047.9
109	WWTP	Facility	52.08099	-7.55645	230458.8	92152.7
110	WWTP Primary Discharge	Primary Effluent Emission Point	52.07396	-7.54883	230986.0	91374.0
111	Culvert	Water appears clean, no smell or colour.	52.09921	-7.53696	231782.0	94188.5
112	Old concrete pipe structure	Unused, no flow.	52.10591	-7.51864	233032.5	94942.2

7. Appendix 2: Hydrography/Hydrodynamics

7.1. Simple/Complex Models

A hydrographic survey of Dungarvan Harbour was carried out in 1993 by Irish Hydrodata Ltd. The results from this survey along with the information found below have been used to describe the hydrodynamics of Dungarvan harbour.

7.2. Depth

The majority of the bay is made up of intertidal sand and mudflats. A navigational channel runs easterly from between Abbey point and Cunnigar Point towards Ballynacourty. At Ballynacourty, the channel turns south easterly out to Ballynacourty Point. Depths within the navigation channel range from 0.4 to 4.4m (Admiralty Chart 2017). Between Abbey Point and Cunnigar there is a deep pool of 8.9 to 9.7m due to high currents during flood and ebb tides. East of Whitehouse Bank out to the mouth of the bay between Helvick Head and Ballynacourty Point depths range from 0.2 to 6.6 m. Figure 7.1 shows water depth in the area.

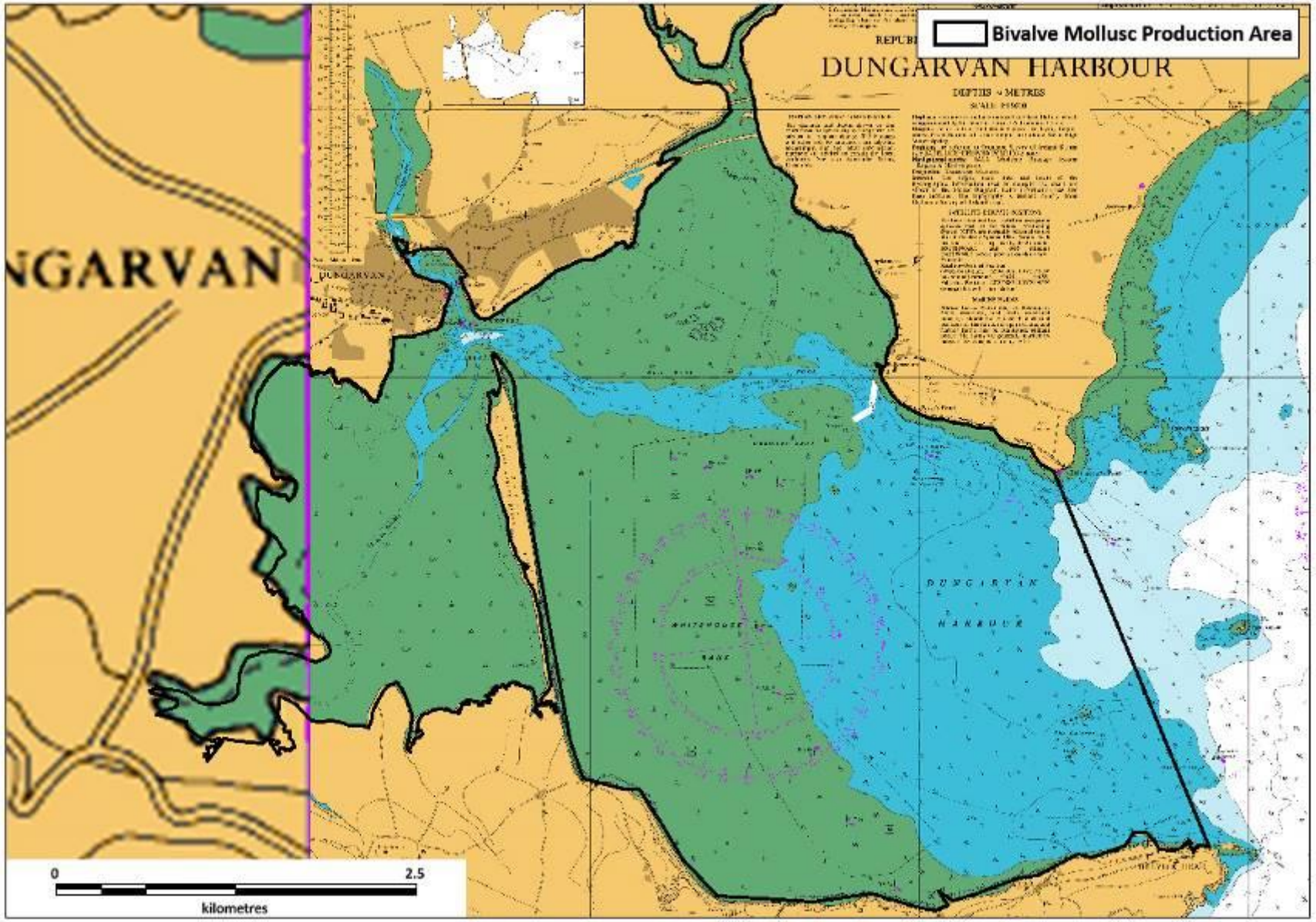

Figure 7.1: Depths in Dungarvan Harbour (Source: Admiralty Chart 2017).

7.3. Tides & Currents

Predicted spring and neap tidal ranges in Dungarvan Harbour are in the region of 3.7 and 2.2m respectively (Admiralty Chart 2017). Irish Hydrodata Ltd. (1993) monitored current speed at two locations. The first location was midway between Cunnigar Point and Ballynacourty and the second was near Ballynacourty Point (Figure 7.2). Peak current speeds at the first location ranged from 0.4-0.5m/s during spring tides and 0.15-0.2m/s during neaps. At the second location peak current speeds ranged from 0.3-0.4m/s during spring tides and 0.15-0.2m/s during neaps. During spring tides ebb ran for 3.7hrs and flood rand 8.75hrs. While during neaps ebb ran for 4.6hrs and flood ran for 8.3hrs. Tidal flow direction on ebb tides was northeasterly at the start and then changing to south easterly towards low water. The flow direction for flood tides was southwesterly for the first two hours and changing to westerly for the remainder of the tide. The current speeds recorded by Irish Hydrodata Ltd. are similar to those displayed on the Dungarvan Harbour admiralty chart. The admiralty chart also shows stronger currents of up to 2.5knots in the channel north of Cunnigar point. Irish Hydrodata Ltd. (1993) carried out a dye and drogue survey of the bay. Dye and drogues release at the mouth of the bay near Ballynacourty Point on a flood tide tended to follow the channel in a general northwesterly direction up to the town. However, when they were release further from the point and the winds were blowing from the north or northeast they drifted westerly towards Whitehouse Bank and then drifted north along Cunnigar Spit as far as the town. On Ebb tides the flow was generally southeasterly.

Table 7.1: Dungarvan Harbour tidal characteristics (Source: Admiralty Chart No. 2017).

Admiralty Chart 2017 Levels (m CD)	MHWS	MHWN	MLWN	MLWS
Dungarvan Harbour	4.1	3.3	1.1	0.4

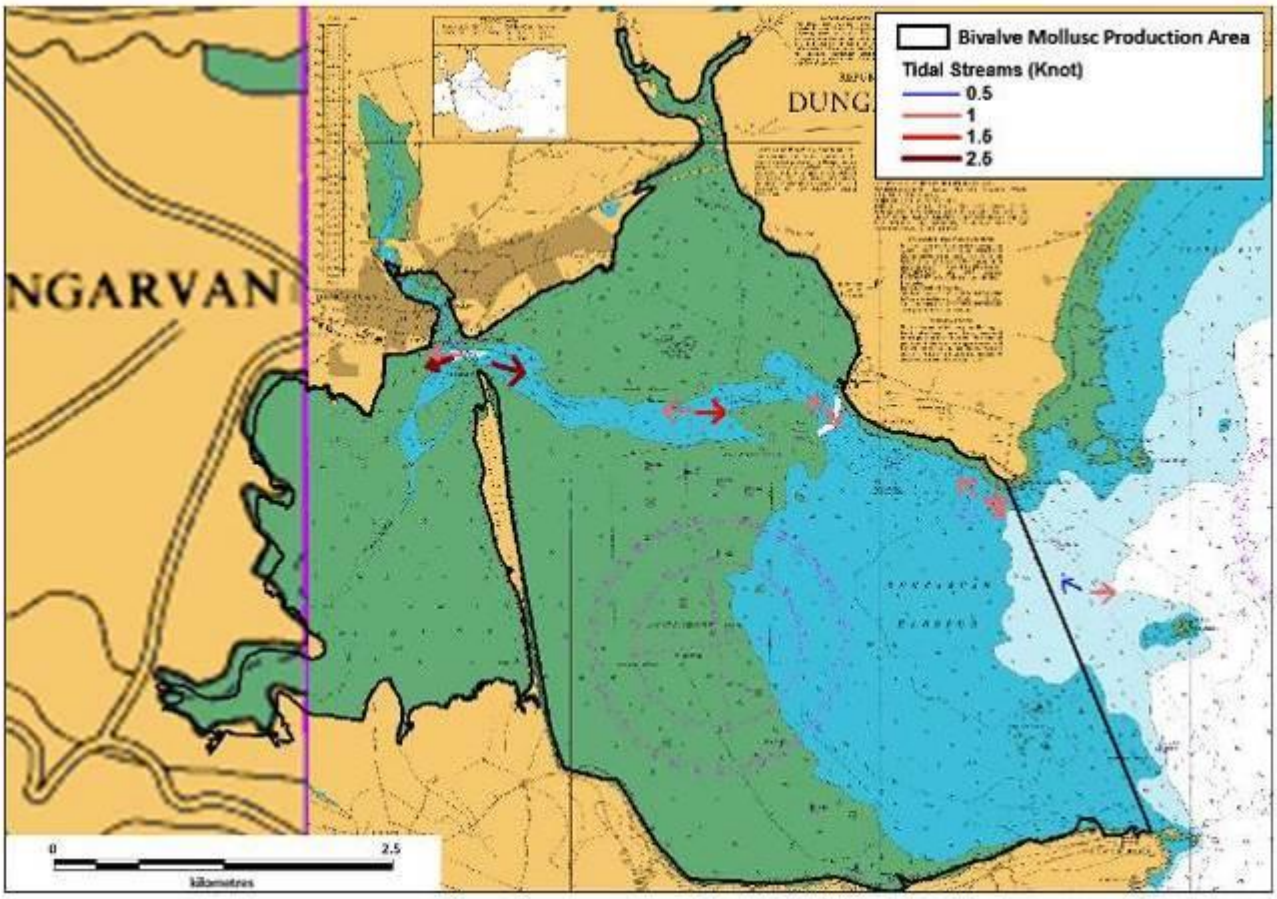

Figure 7.2: Tidal streams within Dungarvan Harbour (Admiralty Chart No. 2017).

7.4. Wind and Waves

Wind data from 2014 to 2018 from the Roaches Point station (Met Eireann, 2019a) (Co. Cork, located approximately 52km south west of Dungarvan Harbour) are displayed in Table 7.2 below and wind roses for each year can be seen in Figure 7.3 below. In 2014, 19.2% of the wind came from the south, while 18.5% came from the southwest and 16.9% from the west. The strongest winds came from the west (49kn). In 2015, 21% of the wind came from the southwest, 17.9% from the south and 16.5% from the northwest. The strongest winds (47kn) came from the south. In 2016, 18.2% of the wind came from the south, 17.6% came from the northwest and 17.6% came from the southwest. The strongest winds (42kn) came from the south. In 2017, 21.1% of the winds came from the southwest, with 19.2% coming from the south and 18.1% coming from the northwest. The strongest winds (59kn) came from the south. In 2018, 20.1% of the wind came from the south, 18.8% came from the southwest and 13.9% came from the west. The strongest winds (43kn) came from the south. It can be seen from the 2014-2018 wind rose diagramme that the prevailing wind direction is southwest.

Table 7.3 shows the seasonal averages from 2014 to 2018. 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 (14.6kn), followed by autumn (12.1kn) and spring (11.5kn), with 10.5kn in summer.

Table 7.2: Wind speed and direction data for Roaches Point from 2014-2018 (Source: Met Eireann, 2019a).

	2014		2015		2016		2017		2018	
Month	**Mean Speed (knots)**	**Max 10-min Mean Direction (°)**	**Mean Speed (knots)**	**Max 10-min Mean Direction (°)**	**Mean Speed (knots)**	**Max 10-min Mean Direction (°)**	**Mean Speed (knots)**	**Max 10-min Mean Direction (°)**	**Mean Speed (knots)**	**Max 10-min Mean Direction (°)**
January	15.5	231.9	16.1	245.5	15.6	212.3	11.7	197.1	14.9	221.0
February	18.5	198.2	12.1	241.4	14.0	219.3	14.8	198.6	13.5	216.1
March	12.4	218.7	13.5	220.6	12.1	218.4	13.4	207.4	11.8	191.3
April	11.1	186.3	10.4	179.3	12.3	200.0	10.2	233.7	12.0	178.3
May	11.0	237.7	13.0	236.1	9.6	181.6	10.4	165.5	9.0	182.3
June	9.1	192.7	10.6	208.7	10.2	224.3	12.4	220.7	8.7	183.3
July	9.7	226.8	12.3	213.2	9.7	226.8	10.3	223.9	9.5	240.0
August	11.6	257.1	11.1	216.1	11.3	229.7	10.3	235.5	10.1	242.9
September	8.0	149.3	10.5	228.7	12.4	222.7	12.6	227.0	11.6	237.0
October	14.2	192.9	10.4	159.0	10.9	148.4	13.4	223.9	12.2	238.1
November	12.1	205.3	15.9	227.7	11.2	211.0	11.4	260.0	15.4	164.7
December	13.5	250.3	19.1	189.4	11.8	186.5	13.1	258.1	14.4	191.0

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 Roaches Point wind data (Source: Met Eireann, 2019a).

Season	2014	2015	2016	2017	2018	5 Year Average
Winter	15.9	15.7	13.8	13.2	14.3	14.6
Spring	11.5	12.3	11.3	11.3	10.9	11.5
Summer	10.1	11.3	10.4	11.0	9.4	10.5
Autumn	11.4	12.3	11.5	12.5	13.1	12.1

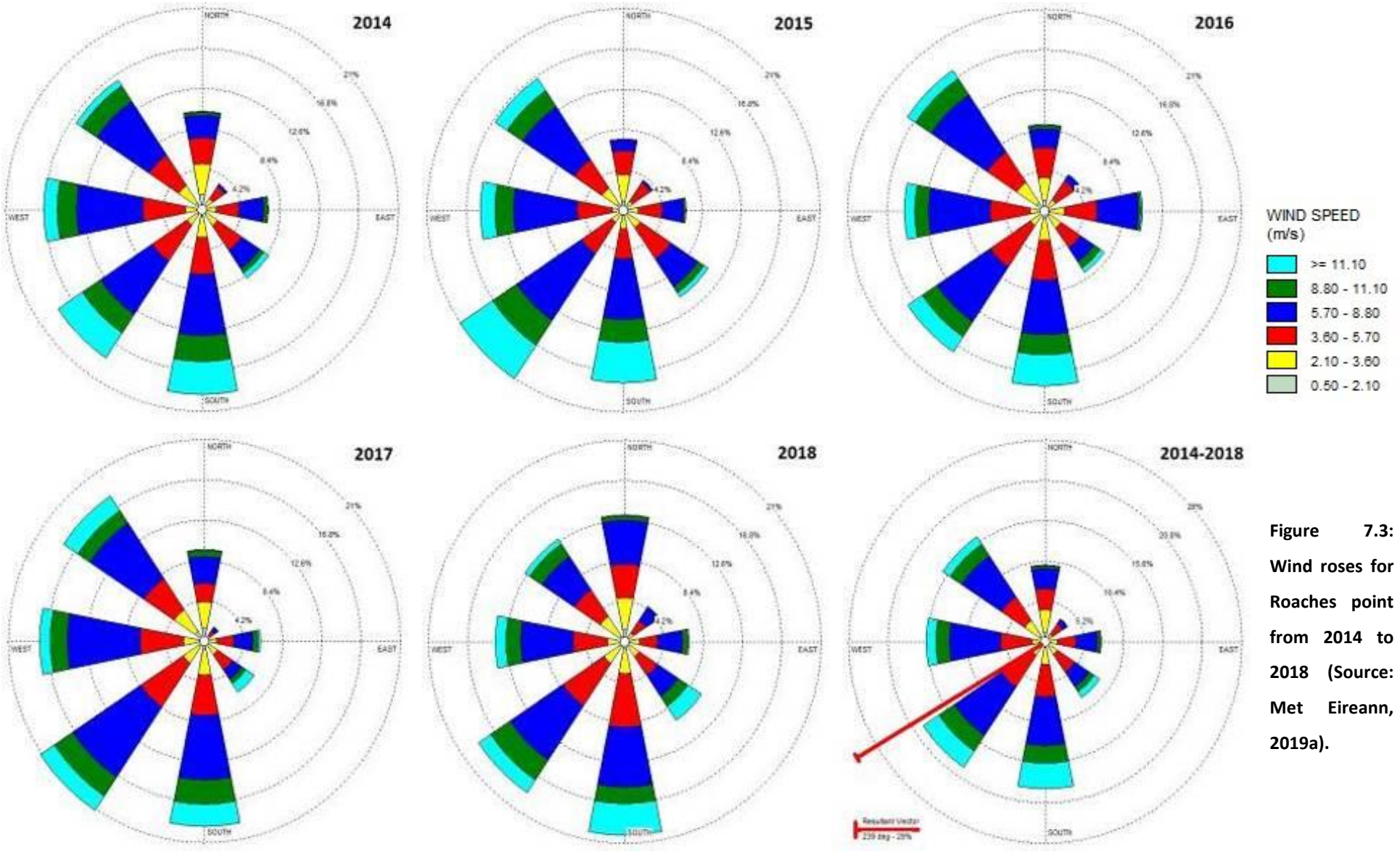

Figure 7.3: Wind roses for Roaches point from 2014 to 2018 (Source: Met Eireann, 2019a).

Wind conditions affect the hydrodynamic conditions in Dungarvan Harbour 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 waves depends on:

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

7.5. River Discharges

Dungarvan Harbour drains a catchment of 202.2km^2, 55.2% of this flows through the Colligan River. The Colligan River is approximately 18km long and flows from the Comeragh Mountains into the harbour. The Brickey River drains a further 28.7% of the catchment and flows into the western side of the Bay. The Brickey River joins the Colligan River at Dungarvan town. The Glendine River drains 11.9% of the catchment in the north east of the Bay. The remaining 4.2% of the catchment drains in at Clonea Strand (See Figure 7.4).

The current (2010-2015) WFD status of Dungarvan Harbour and its associated freshwater sources can be seen in Figure 7.5. Of the river systems flowing directly into the Dungarvan Harbour BMCPA, the Colligan River is of moderate status as it enters the Bay. The Brickey River is unassigned, however, the upper reaches of the river are designated as poor status. The Glendine River has not been assigned a WFD status. The Colligan Estuary is of moderate status, while the Brickey Estuary has not been assigned a status. Dungarvan Harbour is a coastal water body and is currently assigned as high status.

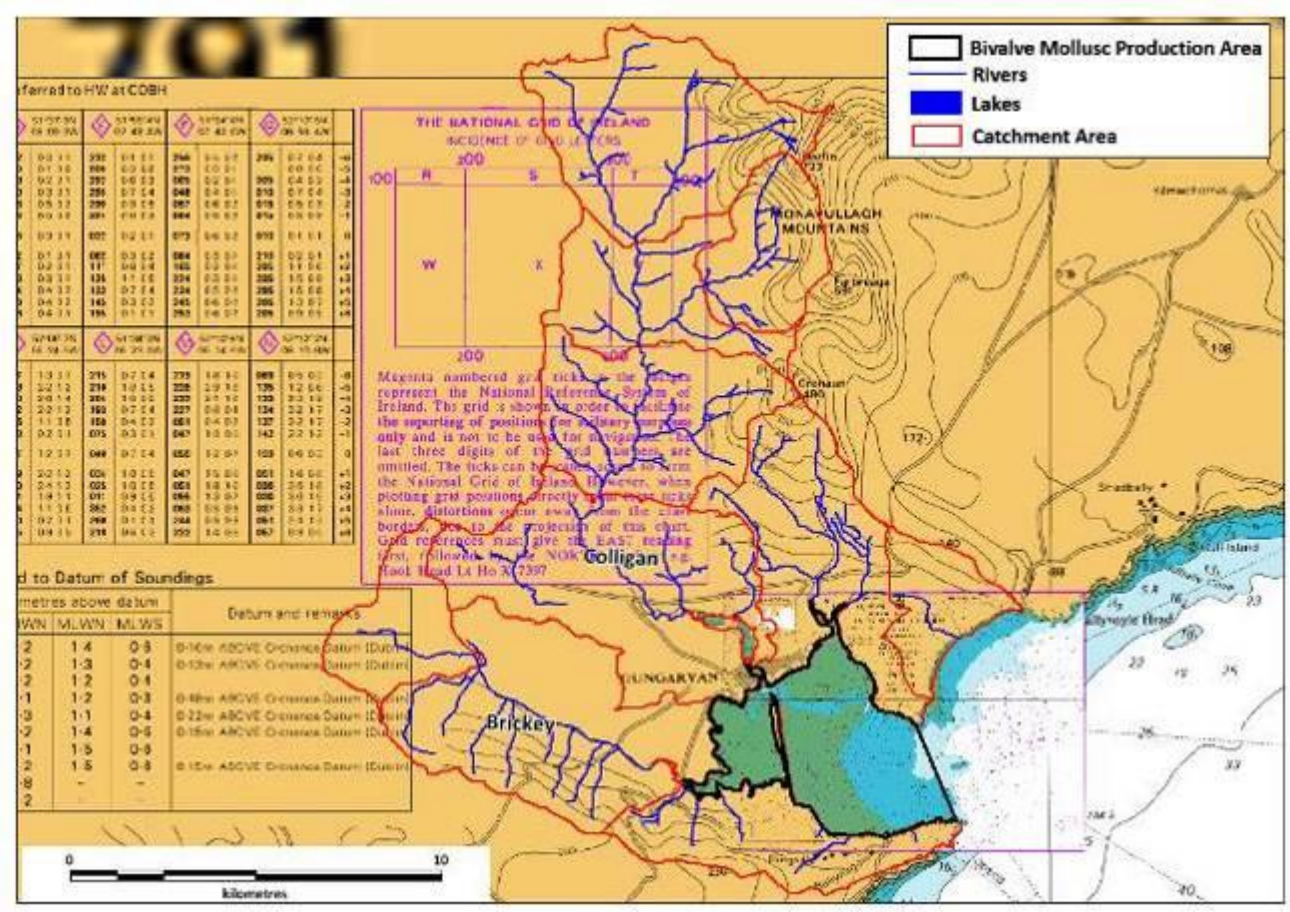

Figure 7.4: Rivers, streams and lakes in the catchment areas (Source: EPA, 2019a).

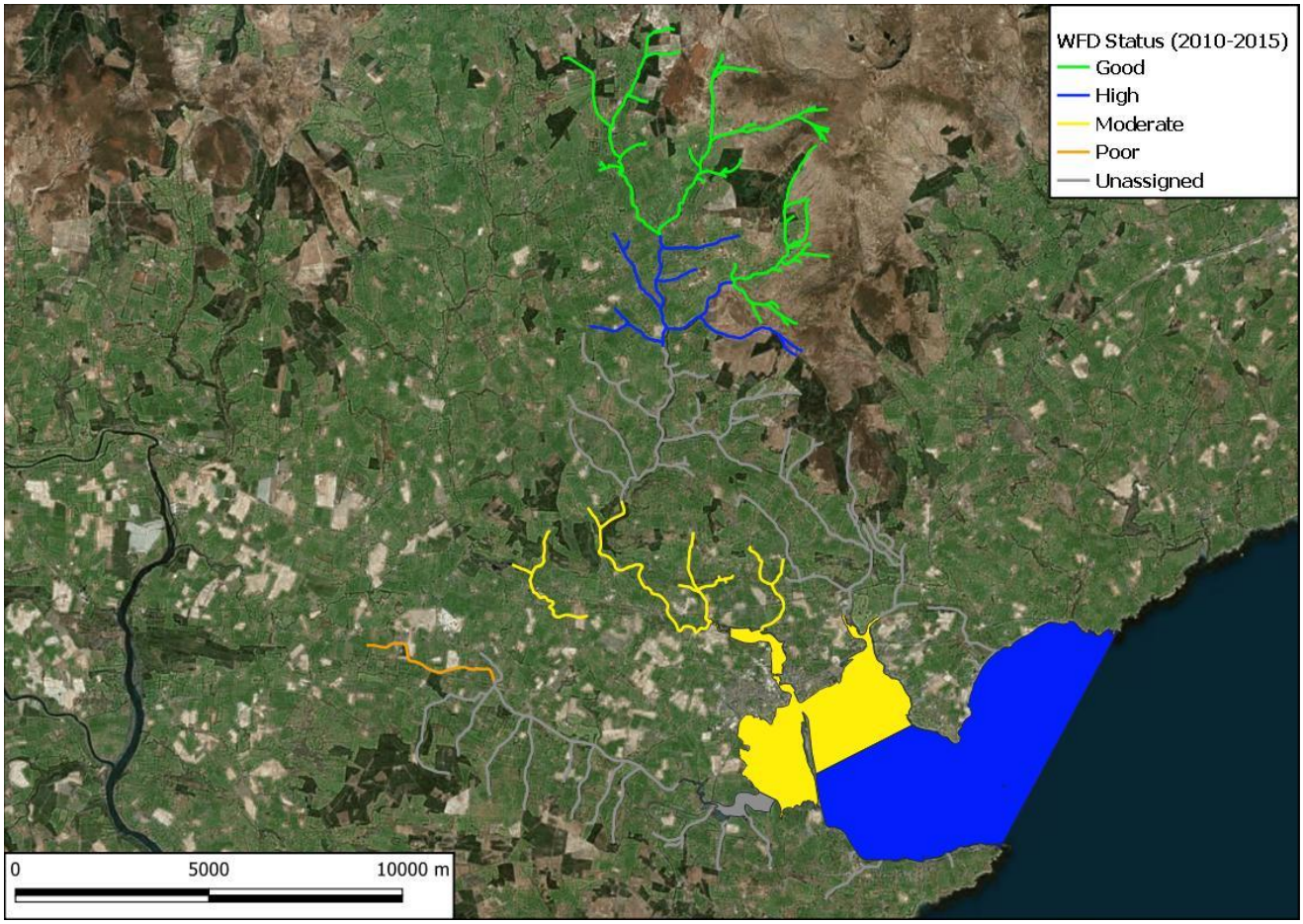

Figure 7.5: WFD Status of the coastal, transitional, lake and river waterbodies in the catchment area (Source EPA, 2019a).

7.6. Rainfall Data

7.6.1. Amount & Time of Year

Figure 7.6 shows the average monthly rainfall data for Ireland (Met Eireann, 2019b) from 1981 to 2010. The wettest months in the Dungarvan Harbour 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 Cork Airport station which is located c. 62km southwest of the Dungarvan Harbour production area (Figure 7.7 shows the location of the Cork Airport station). During the period 1981 to 2010, average rainfall at Cork Airport was lowest in April (76.5mm) and highest in October (138.2mm). The greatest daily total ranged from a low of 34.2 in April to a high of 73.2mm in July. Table 7.5 shows the seasonal averages at Cork Airport from 1981 to 2010. Lowest average rainfall over the 30 year period was in spring and summer (85.5mm) with the highest average rainfall experienced in winter (120.8mm).

Table 7.4: Monthly average rainfall at Cork Airport from 1981 to 2010 (Source: Met Eireann, 2019c).

Average Rainfall (mm)	Month	Greatest Daily Total (mm)
131.4	January	45.7
97.8	February	49.9
97.6	March	55.2
76.5	April	34.2
82.3	May	34.9
80.9	June	59.7
78.8	July	73.2
96.8	August	60.9
94.6	September	58.9
138.2	October	52.1
120	November	47.9
133.1	December	41.9
1227.9	Year	73.2

Table 7.5: Average seasonal rainfall values (mm) from 1981-2010 at Cork Airport (Source: Met Eireann, 2019c).

Season	Average
Spring	85.5
Summer	85.5
Autumn	117.6
Winter	120.8

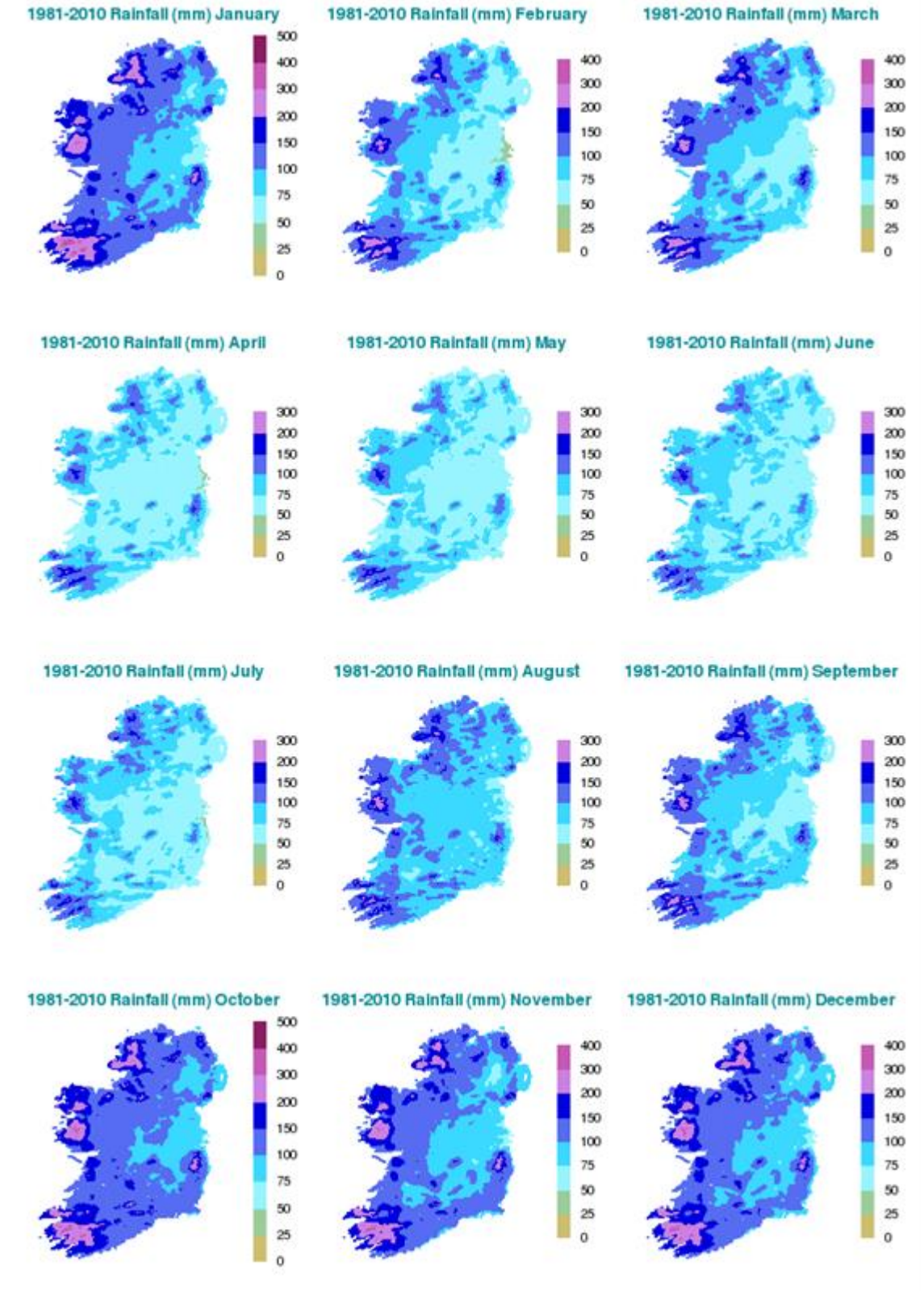

Figure 7.6 Average monthly rainfall (mm) data from 1981 to 2010 for Ireland (Source: Met Eireann, 2019b).

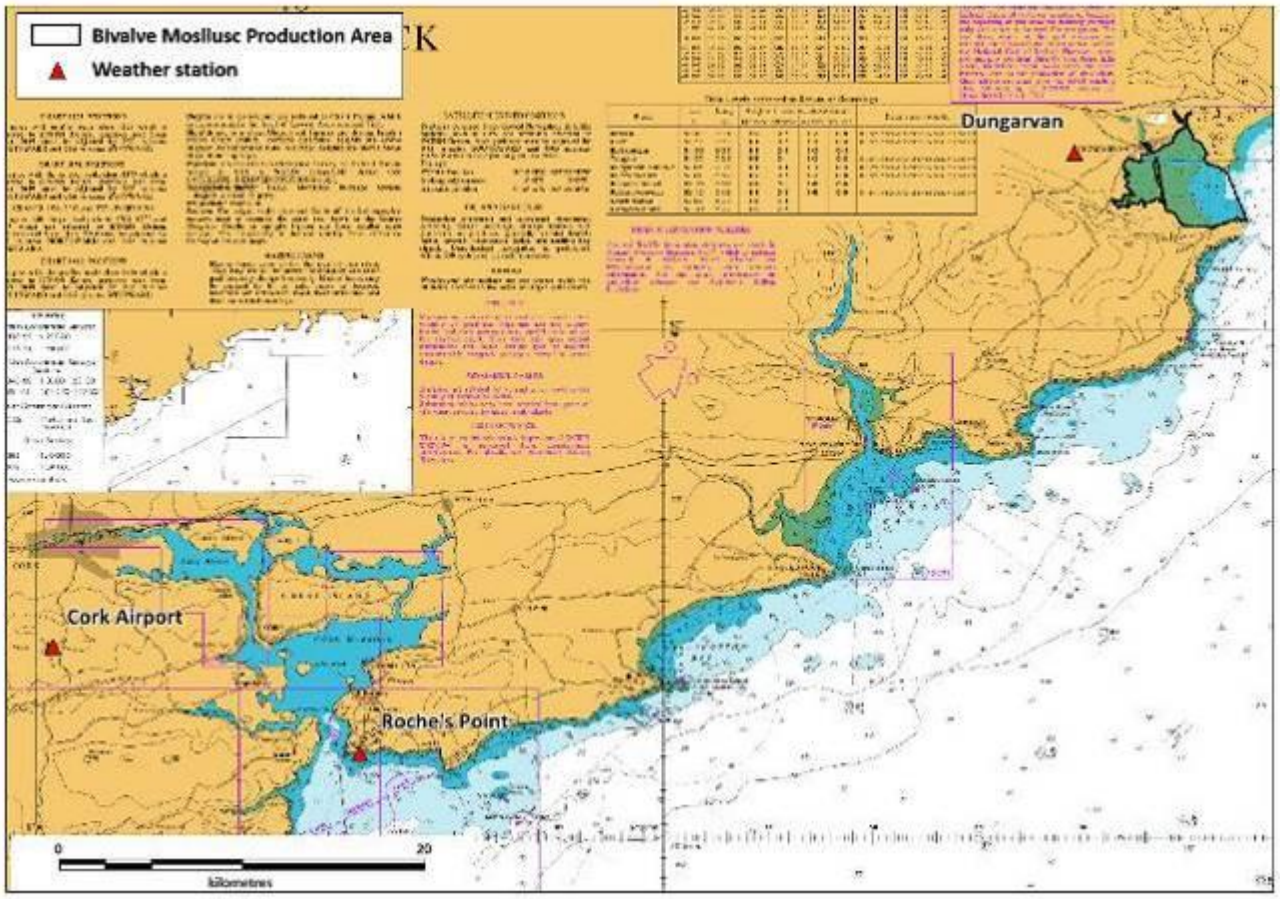

Figure 7.7: Location of Met Eireann weather stations in relation to the Dungarvan Harbour production area.

Table 7.6 shows total monthly rainfall at the Dungarvan Met Eireann station (see Figure 7.7), located 3km to the west of the Dungarvan Bay production area from 2014 to 2018 (Met Eireann, 2019d).

Dungarvan weather station is located to the west of the town 3km from the shore of the inner bay. Maximum monthly rainfall was in December 2015 (395.7mm) and the lowest monthly rainfall was June 2018 (13.8mm). The 5-year average monthly rainfall ranged from a low of 60.6mm in June to a high of 188.1mm in December. Annual averages ranged from 97.1mm in 2017 to 112.8mm in 2015.

Table 7.7 shows the total seasonal rainfall at Dungarvan from 2014-2018 (Met Eireann, 2019d). The following seasonal fluctuations were observed from 2014-2018: In 2014, summer was the driest season and winter was the wettest, in 2015 spring was the driest and winter was the wettest. In 2016, summer was the driest and winter was the wettest. In 2017, spring was the driest and autumn was the wettest and in 2018 summer was the driest and autumn was the wettest. Over the five years, the summer of 2018 was the driest season and the winter of 2016 was the wettest season.

Table 7.6: Total monthly rainfall (mm) data at Dungarvan, Co. Waterford, from 2014 to 2018 (Source: Met Eireann, 2019d).

Year	2014	2015	2016	2017	2018	Monthly 5-yr Average
Jan	179.1	93.8	247.3	65.5	134.9	144.1
Feb	243.9	53.8	238.2	119.3	56.6	142.4
Mar	105.2	89.1	61.8	104.4	131.3	98.4
Apr	113.4	20.4	98.2	15.4	165.6	82.6
May	52.3	149.2	82.2	86.1	61.1	86.2
Jun	56.6	50	58.4	124.3	13.8	60.6
Jul	27.7	127.3	40.3	69.9	50.2	63.1
Aug	105.7	89.6	69.6	82.8	53.8	80.3
Sep	14.8	77.3	93.6	151.5	93	86.0
Oct	171.9	79.3	50.5	130	70.5	100.4
Nov	192.7	128.5	37.7	74	277.4	142.1
Dec	45.6	395.7	123.1	141.5	234.7	188.1
Annual Average	109.1	112.8	100.1	97.1	111.9	-

Table 7.7: Total seasonal rainfall (mm) at Dungarvan from 2014-2018 (Source: Met Eireann, 2019d).

Station	Season/Year	2014	2015	2016	2017	2018
Dungarvan	Spring	270.9	258.7	242.2	205.9	358
	Summer	190	266.9	168.3	277	117.8
	Autumn	379.4	285.1	181.8	355.5	440.9
	Winter	468.6	543.3	608.6	326.3	426.2

7.6.2. Frequency of Significant Rainfalls

Figure 7.8 shows the average monthly rainfall at Cork Airport from 1981-2010 and Figure 3.9 shows the 5 year monthly average rainfall at Dungarvan weather station. Over the 30-year period from 1981 to 2010, October was the wettest month followed closely by December and then January and November. Over this period, July followed by August had the greatest daily rainfall. Over the past 5 years at Dungarvan, December has been the wettest month followed closely by January, February and. June and July were the driest months.

For the 5-year 2014-2018 period, average greatest daily rainfall at Dungarvan was 23.6mm, with a maximum of 58.2mm. Over the same period, the number of wet days (rainfall >1mm) a month averaged at 13 with the maximum number of 30 days/month.

Met Eireann have developed a depth duration frequency model for the estimation of point rainfall frequencies (Fitzgerald, 2007; Met Eireann, 2019e). For a 1 in 100 year return period, 31.2mm of rain would be expected over 1 hour and 122.4mm over 24 hours. Whiles these would be extreme uncommon events, the model predicts that once a year 11.6mm would fall in 1 hour and 45.7mm 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 waste water 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. However, as can be seen in the data above (Table 7.4), 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 has accumulated on pastures where greater numbers of livestock are present.

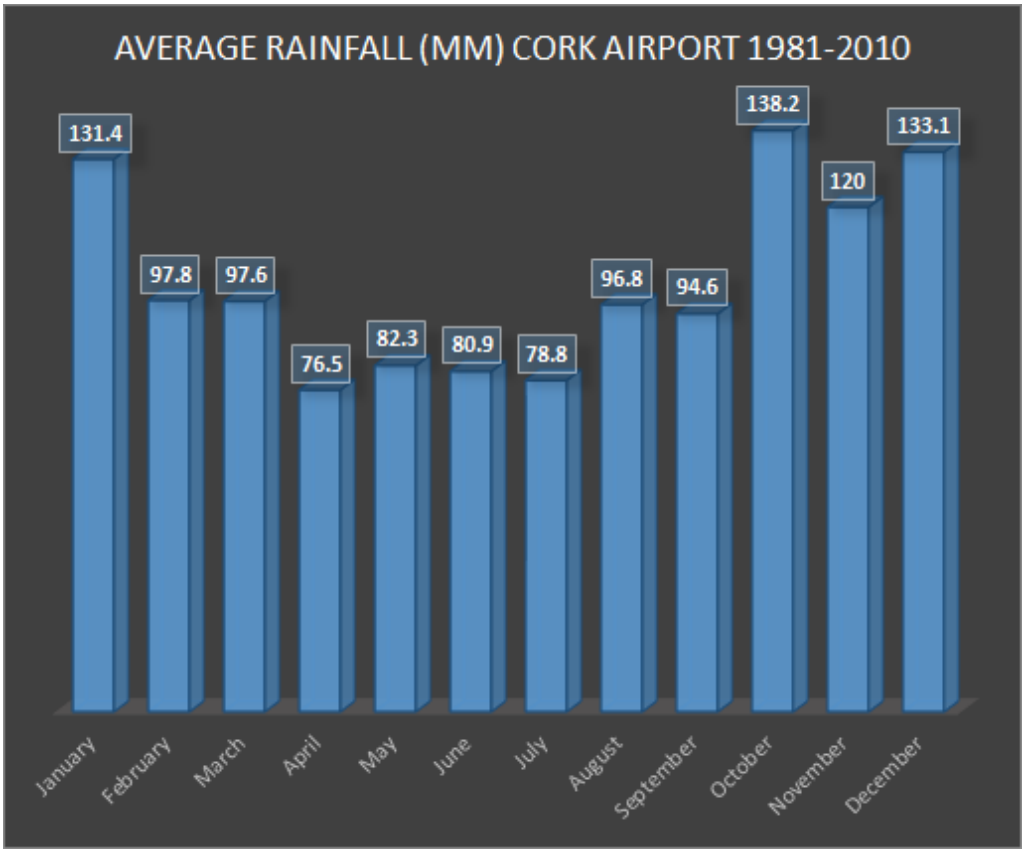

Figure 7.8: Average monthly rainfall (mm) at Cork Airport from 1981-2010 (Source: Met Eireann, 2019c).

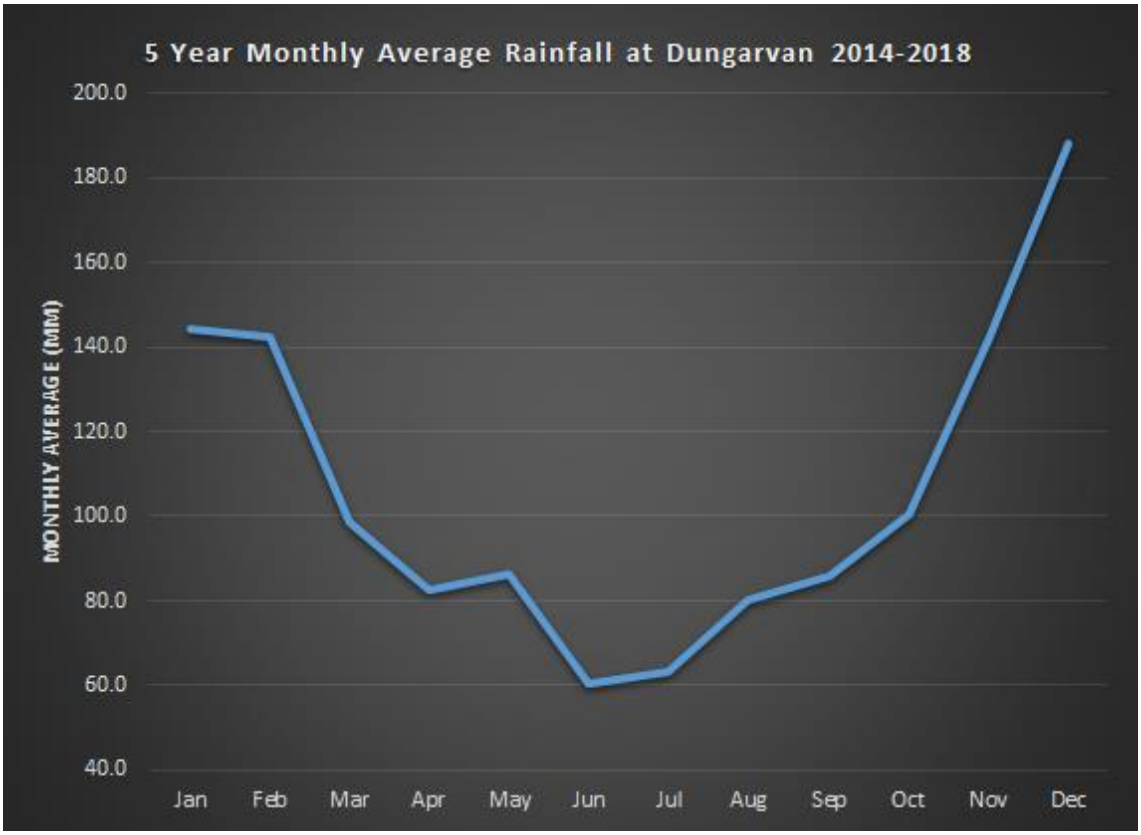

Figure 7.9: 5 year monthly average rainfall (mm) at Dungarvan weather station from 2014-2018 (Source: Met Eireann, 2019d).

7.7. Salinity

Dungarvan Bay production area has a stable high salinity due to the open nature of the bay and a relatively small freshwater influence. The salinity is effected by the stage of the tide and the flow rate of the Colligan, Brickey and Glendine rivers. The salinity in the outer bay in the area of the aquaculture sites ranges from 33.82 to 34.09PSU (Marine, 2019). Irish Hydrodata Ltd. (1993) recorded salinities between 28-34ppt near Cunnigar Point and 33-34ppt near Ballynacourty.

7.8. Turbidity

The turbidity of Dungarvan Bay is generally low due to its sandy nature and high connectivity with marine waters. Turbidity near the aquaculture sites ranges from 1.9 to 2.8 NTU (Marine, 2019).

7.9. Residence Times

Unfortunately no residence time data for Dungarvan Harbour were available at the time of writing of this report. However, due to the exposed nature of the outer bay where the designated shellfish waters are located, the residence time is likely to be relatively short.

7.10. Discussion

The majority of the bay is made up of intertidal sand and mudflats. A navigational channel runs easterly from between Abbey point and Cunnigar Point towards Ballynacourty. At Ballynacourty the channel turns south easterly out to Ballynacourty Point. Depths within the navigation channel range from 0.4 to 4.4m. Water movements generally follow the main channel on both the flood and ebb tides. However, on a flood tide with a north-easterly wind the flow is pushed westerly onto Whitehouse Bank and then moves north along Cunnigar spit. The prevailing wind in the area is south-westerly. The Colligan and Brickey Rivers drain over 80% of the catchment. The wettest period in the Dungarvan area is between October and January, while the driest occur between April and July. The highest levels of run-off would be expected during the wetter months. However, when high rainfall events occur during generally drier periods in spring and summer months, they are likely to carry higher loadings of faecal material which has accumulated on pastures where greater numbers of livestock are present. Salinity in the bay is stable with salinities near Cunnigar Point ranging from 28–34ppt and 33-34ppt near Ballynacourty Point.

8. Appendix 3: Shellfish and Water Sampling

8.1. Historical Data

8.1.1. Shellfish Water Quality

The Marine Institute carry out quarterly water quality monitoring as part of the Shellfish Waters Directive in Dungarvan Harbour. All sampling are confined to the oyster aquaculture area. The EPA carry out monitoring under the Water Framework Directive results. 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 Fishery 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 two location in the Dungarvan Harbour production area for classification purposes. Figure 8.1 shows the location of these sampling sites Table 8.1 shows the coordinates.

Table 8.1: Coordinates of sampling sites within the Dungarvan Harbour Production Area.

Sample Code	Species	Latitude	Longitude
WD-DB-DB-B1	Pacific Oysters	52.0747	-7.5872
WD-DB-DB-B2	Pacific Oysters	52.0539	-7.5744

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.

An A classification allows for the product to be placed directly on the market, whereas a B or C classification requires the product to go through a process of depuration, heat treatment or relaying before it can be placed on the market. Table 8.2 summarises this system. Table 8.3 shows the current and historical (back to 2014) classifications within Dungarvan Harbour. For the 2019-2020 period, Dungarvan Harbour is classified

as A for Oysters (*Seasonal A 01 Oct - 01 April reverts to Class B at other times)

Table 8.2: Classification system for shellfish harvesting areas.

Classification			Permitted Levels	Outcome
	A	<230	Not exceeding 230 *E. coli* 100g flesh/liquid in 80% of samples. Not exceeding 700 *E.coli* 100 g in remaining 20% of samples	May go direct for human consumption if end product standard met.
	B	<4600	Not exceeding 4,600 *E. coli* 100g flesh/liquid in 90% of samples. Not exceeding 46,000 *E.coli* 100 in remaining 10% of 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* 100g flesh in all samples	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

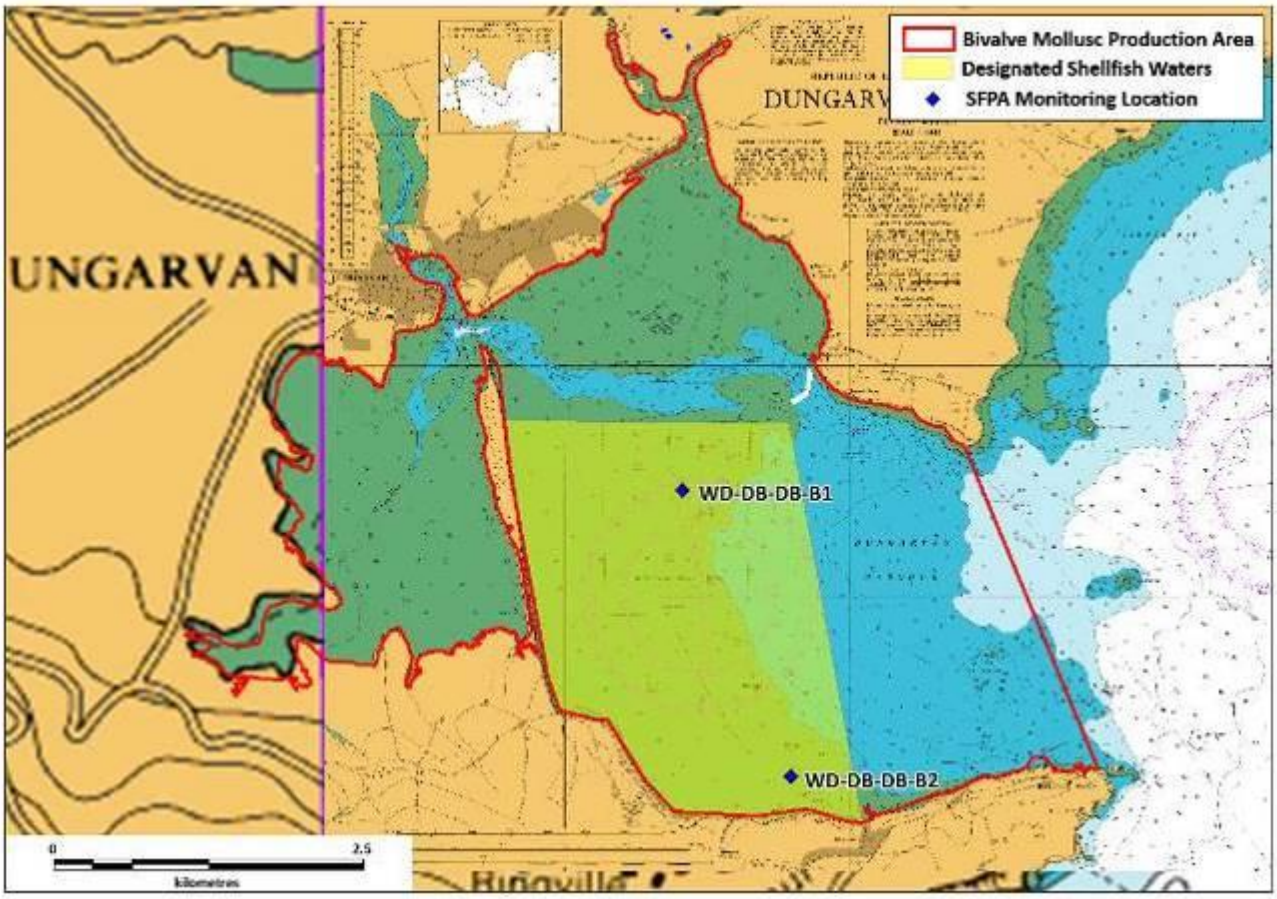

Figure 8.1: Locations of SFPA shellfish monitoring points for classification purposes.

Table 8.3: Current and historical classification of shellfish beds in Dungarvan Harbour (2014 – 2019).

Boundaries	Bed Name	Species	Classification					
			2014	2015	2016	2017	2018	2019
Helvick Head to Ballynacourty Point	All Beds	Oysters	B	B	B	A*	A**	A#

*Seasonal A 01 Aug- 01 May reverts to Class B at other times.

**Seasonal A 01 Oct - 01 May reverts to Class B at other times.

#Seasonal A 01 Oct - 01 April reverts to Class B at other times.

Table 8.4 and Table 8.5 list the *E. coli* results for oysters from Dungarvan Harbour from 2014 to January 2019 (where available). Figure 8.2 and Figure 8.3 show these data in graphical form.

As shown in Table 8.3 above, Dungarvan Harbour oysters had a seasonal **B** classification in from 2014 to 2016 in 2017 it changed to a seasonal **A** classification from 01 August to 01 May, in 2018 it had a seasonal A classification from 01 October to 01 of May and for 2019 it has a seasonal A classification from 01 October to 01 of April.

Table 8.6 shows the summary statistics for the *E. coli* historical data from the 2 shellfish monitoring sites from 2014 to January 2019. The geometric mean of *E. coli* levels was slightly higher for Oysters at the B1 sampling point, however, the B2 sampling point has only been monitored since 2016. Table 8.7 shows the variations of the annual geometric means of *E. coli* for the shellfish beds that had at least 5 samples per year from the year 2014. Figure 8.4 shows the trend in geometric mean from 2014 to 2018 for both sampling points in Dungarvan Harbour. The geometric mean for sampling point B1 ranged from 23.24 MPN/100ml in 2015 to 70 MPN/100ml in 2014. The geometric mean for Sampling point B2 could only be calculated for 2017 and 2018 due to insufficient data and was 34.69MPN/100ml and 34.07 MPN/100ml respectfully.

There was no statistical difference between the oyster *E. coli* results and season for either sampling Location B1 or B2 (one-way ANOVA, B1: $p = 0.8450$, B2: $p = 0.6543$, Appendix 2). There was also no difference between the two monitoring locations (one-way ANOVA, Locations: $p = 0.5322$, Appendix 2).

Table 8.4: *E. coli* results from Dungarvan Harbour oysters sampling point B1 from 2014 to January 2019 (Source: SFPA)

Date	MPN *E. coli* /100g	Category	Date	MPN *E. coli* /100g	Category
7-Jan-14	50	A	17-Nov-16	45	A
4-Feb-14	130	A	12-Dec-16	110	A
2-Apr-14	130	A	5-Jan-17	61	A
12-May-14	230	A	16-Feb-17	230	A
3-Jun-14	20	A	23-Feb-17	18	A
9-Jun-14	20	A	8-May-17	18	A
1-Jul-14	170	A	22-May-17	18	A
8-Sep-14	61	A	10-Jul-17	790	B
4-Nov-14	45	A	24-Aug-17	18	A
2-Dec-14	78	A	4-Sep-17	18	A
6-Jan-15	45	A	5-Oct-17	78	A
4-Mar-15	20	A	2-Nov-17	45	A
1-Apr-15	18	A	4-Dec-17	18	A
18-Jun-15	18	A	3-Jan-18	18	A
14-Jul-15	18	A	12-Feb-18	45	A
18-Aug-15	18	A	12-Mar-18	18	A
16-Sep-15	45	A	24-Apr-18	18	A
14-Oct-15	20	A	22-May-18	330	B
7-Jan-16	130	A	20-Jun-18	18	A
12-Feb-16	20	A	2-Jul-18	18	A
7-Apr-16	45	A	20-Aug-18	20	A
16-May-16	68	A	4-Oct-18	45	A
7-Jun-16	790	B	1-Nov-18	18	A
4-Jul-16	18	A	19-Nov-18	20	A
20-Jul-16	78	A	17-Dec-18	45	A
14-Sep-16	45	A			

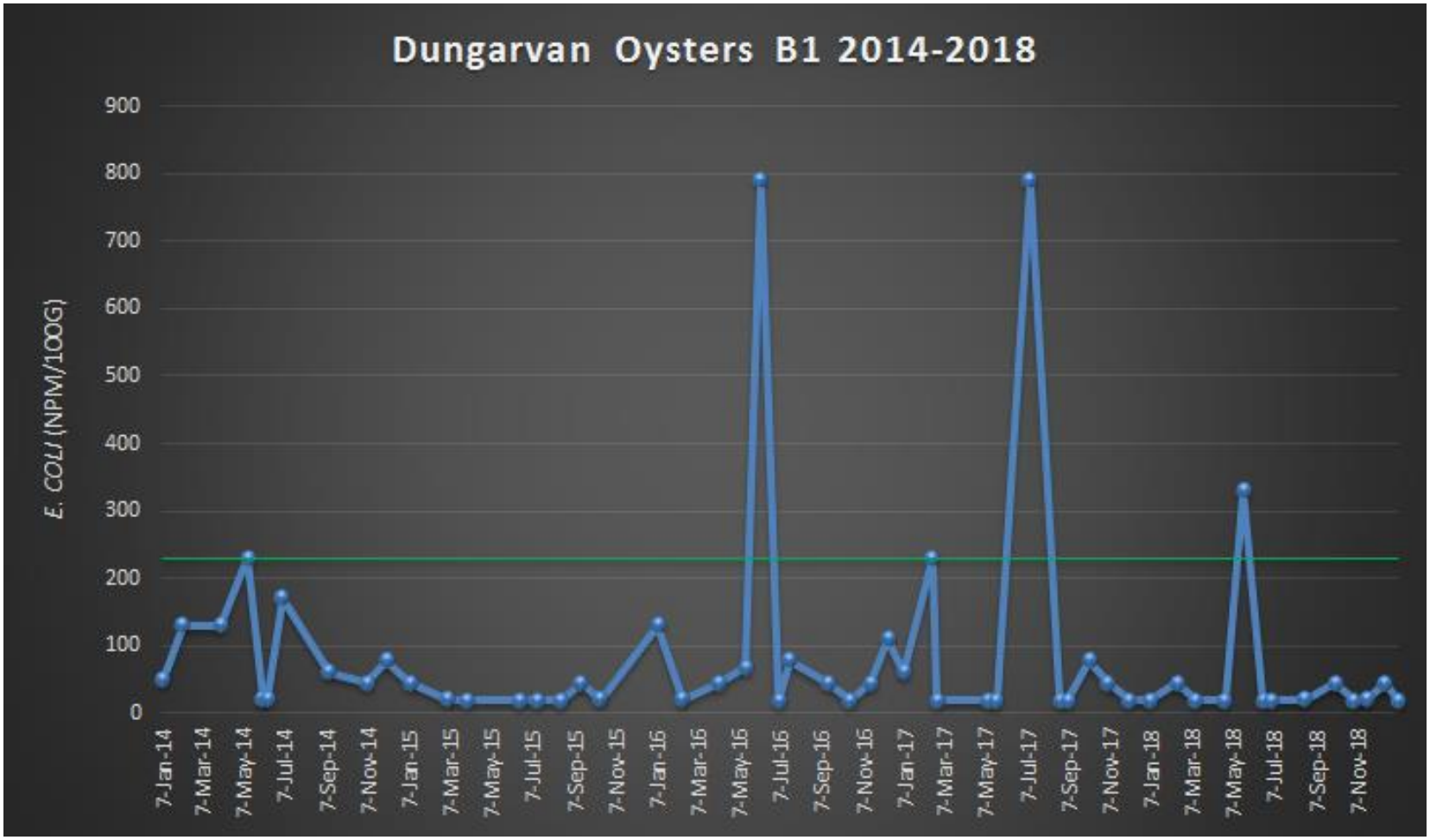

Figure 8.2: *E. coli* levels from oysters at Dungarvan Harbour sampling point B1 from 2014 to 2019 (Source: SFPA).

Table 8.5: *E. coli* results from Dungarvan Harbour oysters sampling point B2 from 2014 to January 2019 (Source: SFPA)

Date	MPN *E. coli* /100g	Category	Date	MPN *E. coli* /100g	Category
18-Aug-16	20	A	3-Jan-18	230	A
16-Mar-17	18	A	12-Feb-18	20	A
6-Apr-17	18	A	15-Mar-18	68	A
28-Apr-17	18	A	25-Apr-18	230	A
15-Jun-17	45	A	22-May-18	18	A
21-Jun-17	20	A	20-Jun-18	18	A
10-Jul-17	20	A	2-Jul-18	18	A
24-Jul-17	78	A	20-Aug-18	20	A
24-Aug-17	490	B	4-Oct-18	18	A
7-Sep-17	130	A	1-Nov-18	18	A
5-Oct-17	18	A	19-Nov-18	20	A
3-Nov-17	18	A	17-Dec-18	45	A
4-Dec-17	18	A	4-Jan-19	170	A

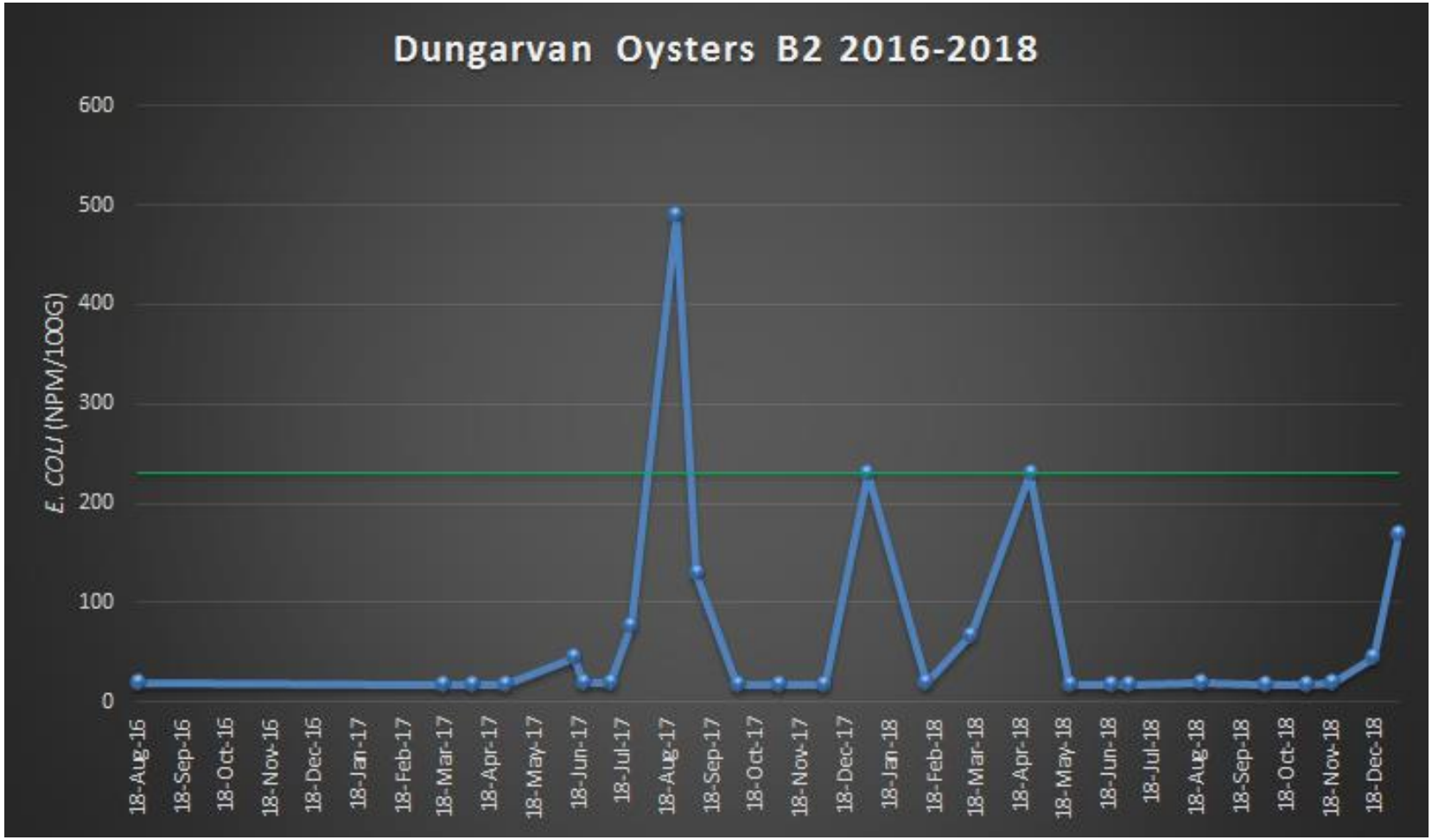

Figure 8.3: *coli* levels from oysters at Dungarvan Harbour sampling point B2 from 2014 to 2019 (Source: SFPA).

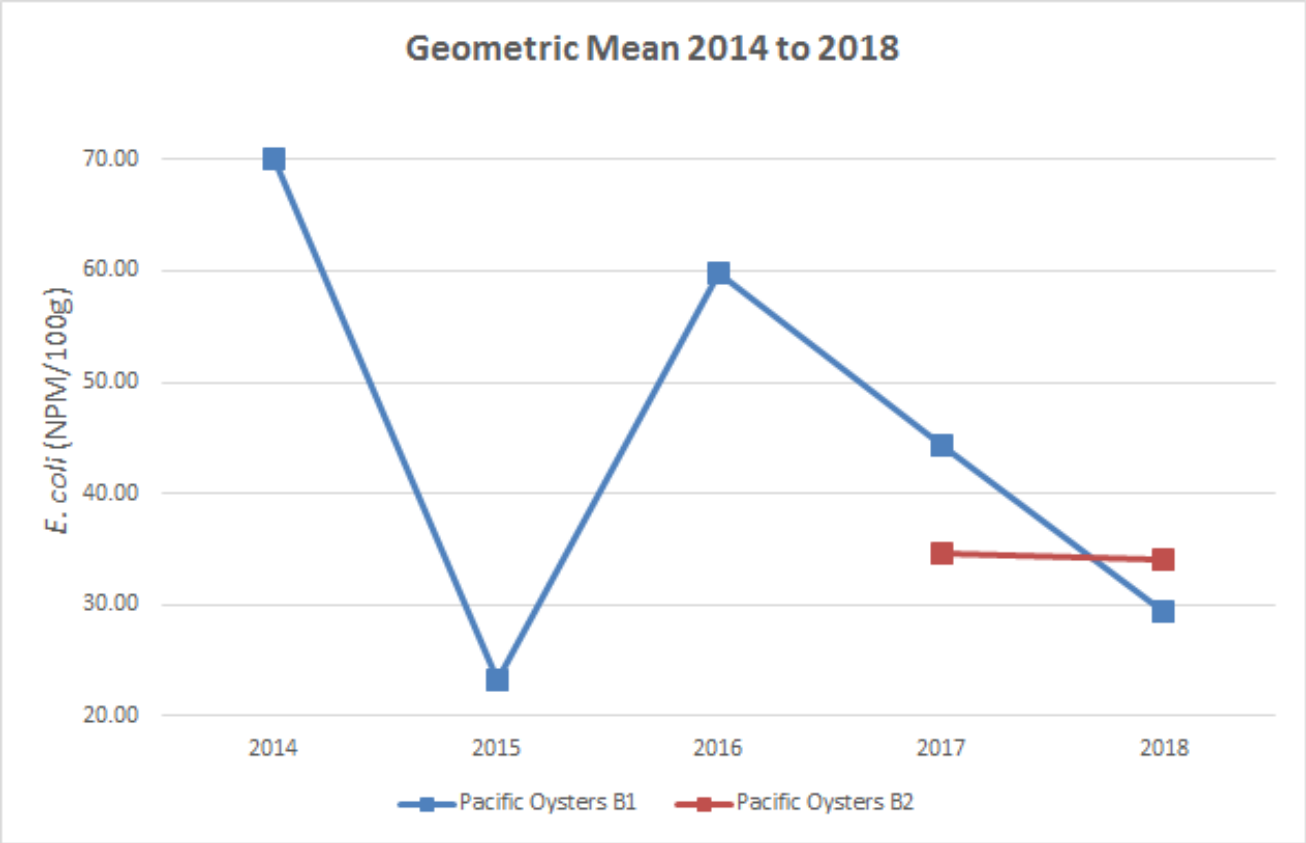

Figure 8.4: Trend in geometric mean of *E. coli* levels from 2014 to 2018 for both Pacific Oyster sampling locations in Dungarvan Harbour.

Table 8.6: Summary statistics of historical *E. coli* data monitored from shellfish beds in Dungarvan Harbour.

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)
WD-DB-DB-B1	Pacific Oyster	07/01/2014	04/01/2019	18	790	83.89	41.79
WD-DB-DB-B2	Pacific Oyster	18/08/2016	04/01/2019	18	490	69.38	35.81

Table 8.7: Variation of annual geometric means of *E. coli* (MPN/100g) from shellfish beds monitored in Dungarvan Harbour.

Code	Species	2014	2015	2016	2017	2018
WD-DB-DB-B1	Pacific Oyster	70.0	23.2	59.9	44.4	29.4
WD-DB-DB-B2	Pacific Oyster				34.7	34.1

In addition to *E. coli* monitoring carried out by SFPA, the Marine Institute (MI) conduct 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 monitor 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 2014 to 2018, there have been 14 biotoxin related closures. There have been no closures since 14th July 2015 for Pacific Oysters.

8.1.3. Norovirus (NoV)

Sampling of pacific oysters (Crassostrea gigas) for norovirus contamination hwas been undertaken by the Marine Institute in conjunction with Irish Water and also by private individuals farming oysters in Dungarvan Bay. Norovirus has been detected during these studies demonstrating that faecal contamination is impacting oysters within the bay.

8.2. Current Data

8.2.1. Sampling Sites & Methodology

Nine water sampling sites were sampled within the Dungarvan Harbour BMCPA in October 2020 by Sea Fisheries Protection Authority staff. The locations of these sites can be seen in Figure 8.5 and Table 8.8 shows the station coordinates. There was 14.4 mm of rain over the previous 48 Hours

Shellfish sampling was also carried out by Sea Fisheries Protection Authority staff at a number of sampling locations spread throughout the active oyster growing area. Five sampling points were each sampled 5 times between October and January. The locations, date of sampling and rainfall over the previous 48 hours can be seen in Figure 8.6 and Table 8.9. The sampling points were distributed within the licensed shellfish areas. Sampling points 1, 4 and 5 were located in the licence areas along Whitehouse Bank and sampling pints 2 and 3 were located in the licence areas in the south of the bay.

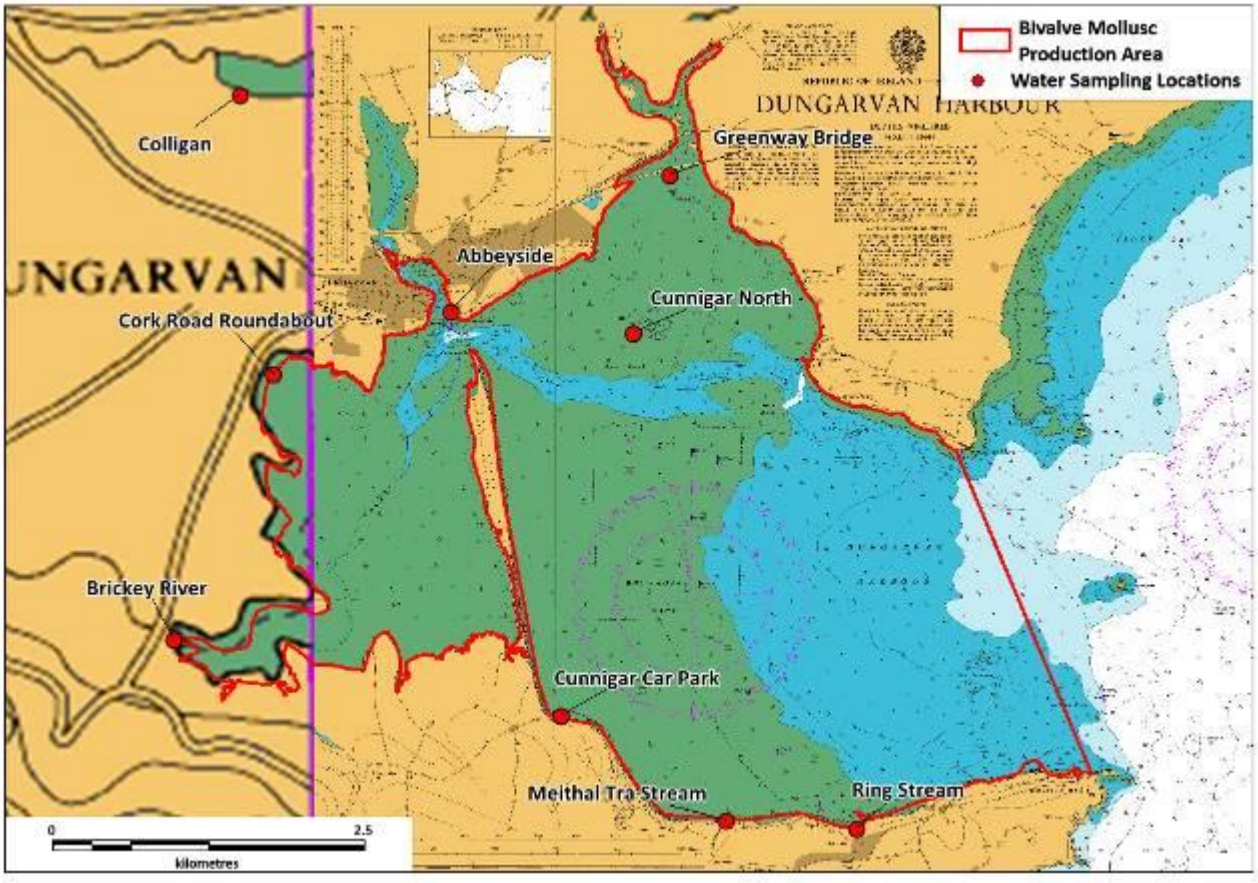

Figure 8.5: Water sampling sites

Table 8.8: Water sample coordinates with date of sampling.

Station	Latitude	Longitude	Sampling Date
Cunnigar North	52.08647	-7.59194	30/10/2020
Greenway Bridge	52.09793	-7.58767	30/10/2020
Abbeyside	52.08799	-7.61333	30/10/2020
Colligan	52.10366	-7.63795	30/10/2020
Cork Road Roundabout	52.08342	-7.63404	30/10/2020
Ring Stream	52.05053	-7.56577	30/10/2020
Meithal Tra Stream	52.05106	-7.58111	30/10/2020
Cunnigar Car Park	52.05866	-7.60041	30/10/2020
Brickey River	52.0642	-7.64572	30/10/2020

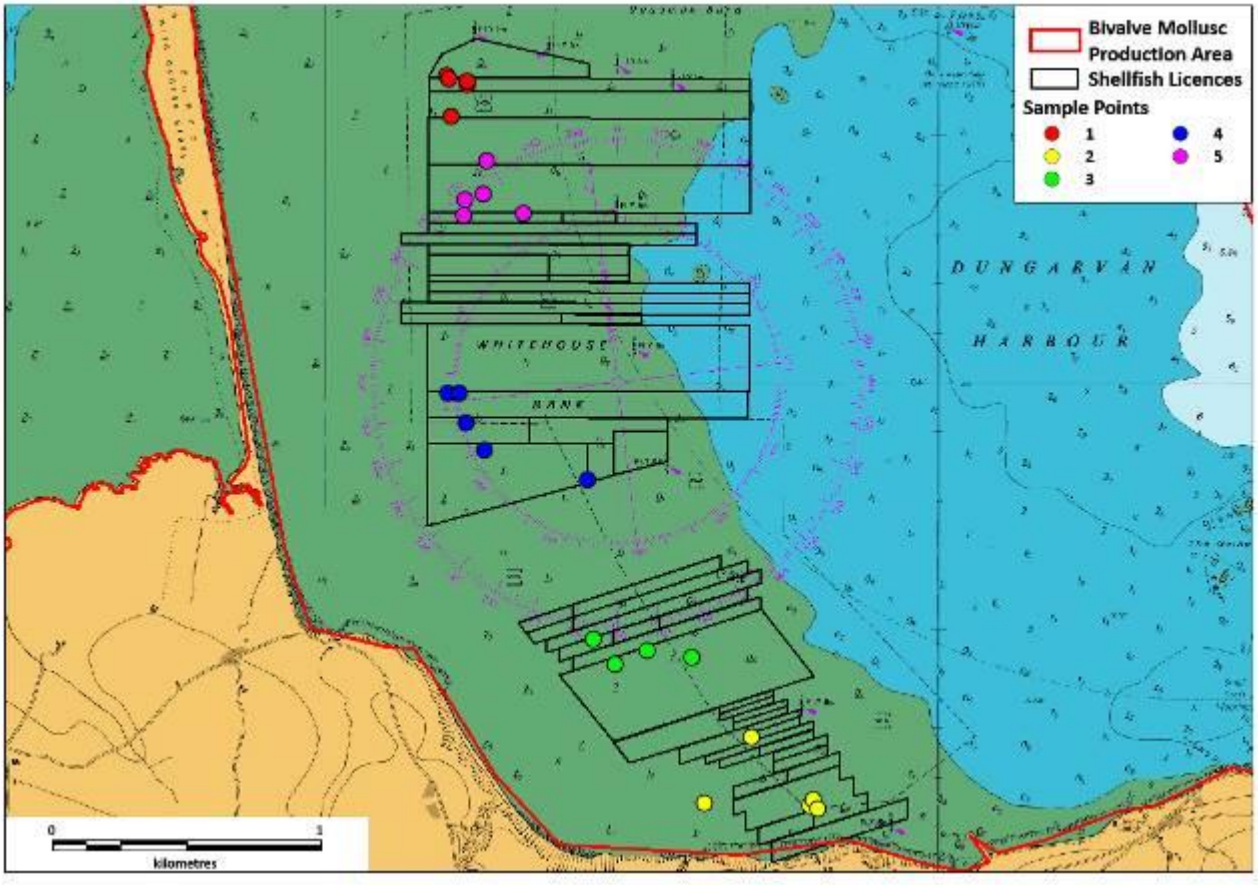

Figure 8.6: Shellfish sampling points.

Table 8.9: Shellfish sample coordinates with date of sampling.

Sampling Point	Latitude	Longitude	Sampling Date	48 hr Rainfall (mm)
1	52.07601	-7.59415	02/10/2020	15.1
1	52.07711	-7.59322	29/10/2020	11.5
1	52.07739	-7.59436	26/11/2020	11.2
1	52.07729	-7.59422	17/12/2020	12.8
1	52.07723	-7.59322	14/01/2021	11.3
2	52.052757	-7.574582	02/10/2020	15.1
2	52.055072	-7.577783	29/10/2020	11.5
2	52.052973	-7.57439	26/11/2020	11.2
2	52.05283	-7.580307	17/12/2020	12.8
2	52.052664	-7.574167	14/01/2021	11.3
3	52.057751	-7.581005	02/10/2020	15.1
3	52.058363	-7.586344	29/10/2020	11.5
3	52.057512	-7.585183	26/11/2020	11.2
3	52.057512	-7.585183	17/12/2020	12.8
3	52.057994	-7.583469	14/01/2021	11.3
4	52.06377	-7.5867	02/10/2020	15.1
4	52.06474	-7.59233	29/10/2020	11.5
4	52.06668	-7.59428	26/11/2020	11.2
4	52.06568	-7.59331	17/12/2020	12.8

Sampling Point	Latitude	Longitude	Sampling Date	48 hr Rainfall (mm)
4	52.06666	-7.59367	14/01/2021	11.3
5	52.07277	-7.59018	02/10/2020	15.1
5	52.07451	-7.59216	29/10/2020	11.5
5	52.07321	-7.59334	26/11/2020	11.2
5	52.0734	-7.59237	17/12/2020	12.8
5	52.07268	-7.59346	14/01/2021	11.3

8.2.2. Microbial Analysis Results

Table 8.10 shows the water sample analysis results and Figure 8.7 shows the magnitude of the *E. coli* results. The highest *E. coli* result by far was record at Meithal Tra Stream (16,000 cfu/100ml) which was an order of magnitude higher than the next highest result. The next two highest results were at Abbeyside (600cfu/100ml) and the Cork Road Roundabout Stations (360 cfu/100ml). The remaining stations were all below 220 cfu/100ml.

Table 8.11 shows the shellfish sample analysis results and Figure 8.8 shows the magnitude of the *E. coli* results. Of the three sampling points within the Whitehouse Bank licence areas point 5 had both the highest result (330 cfu/100ml) and highest average over the 5 samples (147 cfu/100ml). From the two sampling points within the licence areas to the south of the bay point 2 had both the highest result (330 cfu/100ml) and highest average over the 5 samples (113.2 cfu/100ml).

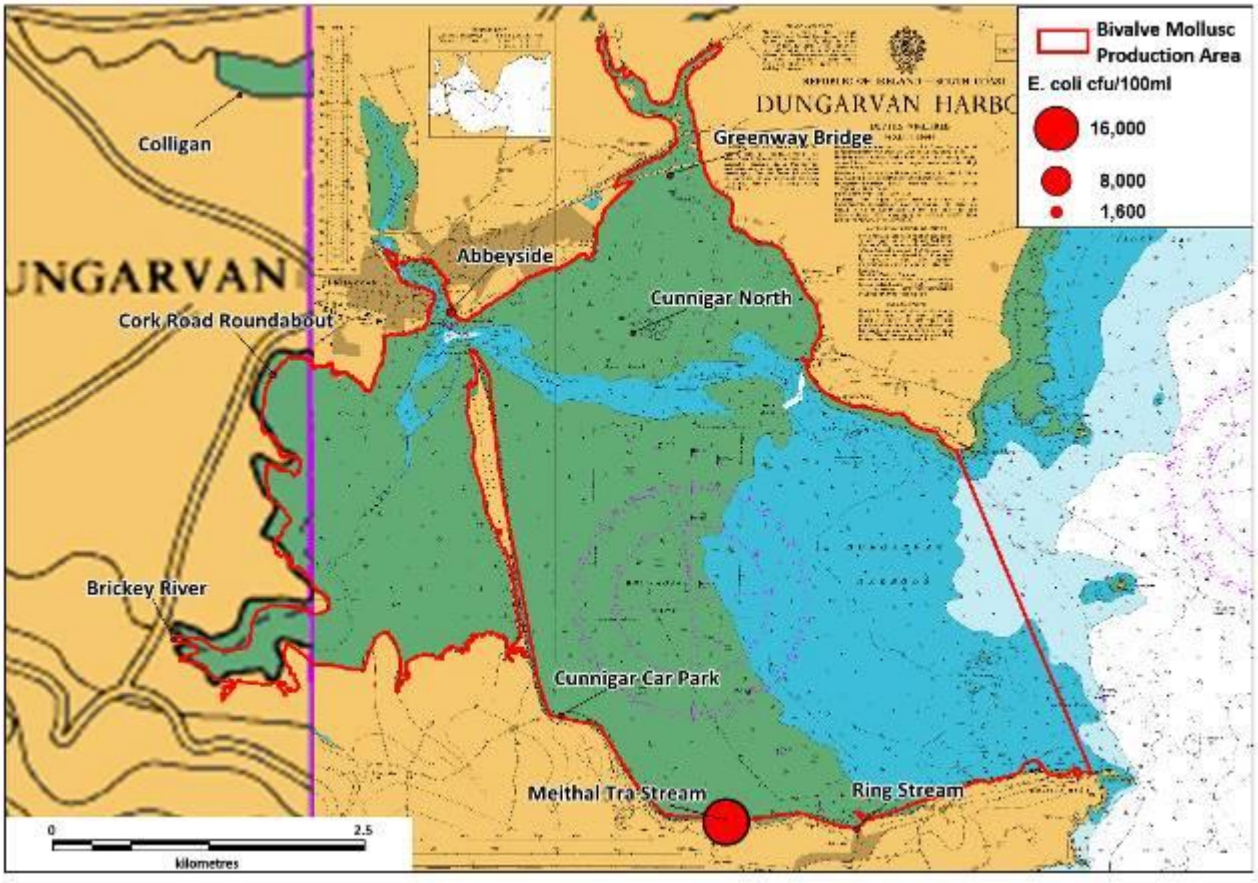

Figure 8.7: Magnitude *of E. coli* results from the shore survey water samples.

Table 8.10: Water *E. coli* results for Dungarvan Harbour.

Station No.	***E. coli* (cfu/ 100ml)**
Cunnigar North	55
Greenway Bridge	220
Abbeyside	600
Colligan	3
Cork Road Roundabout	360
Ring Stream	160
Meithal Tra Stream	16000
Cunnigar Car Park	1
Brickey River	54

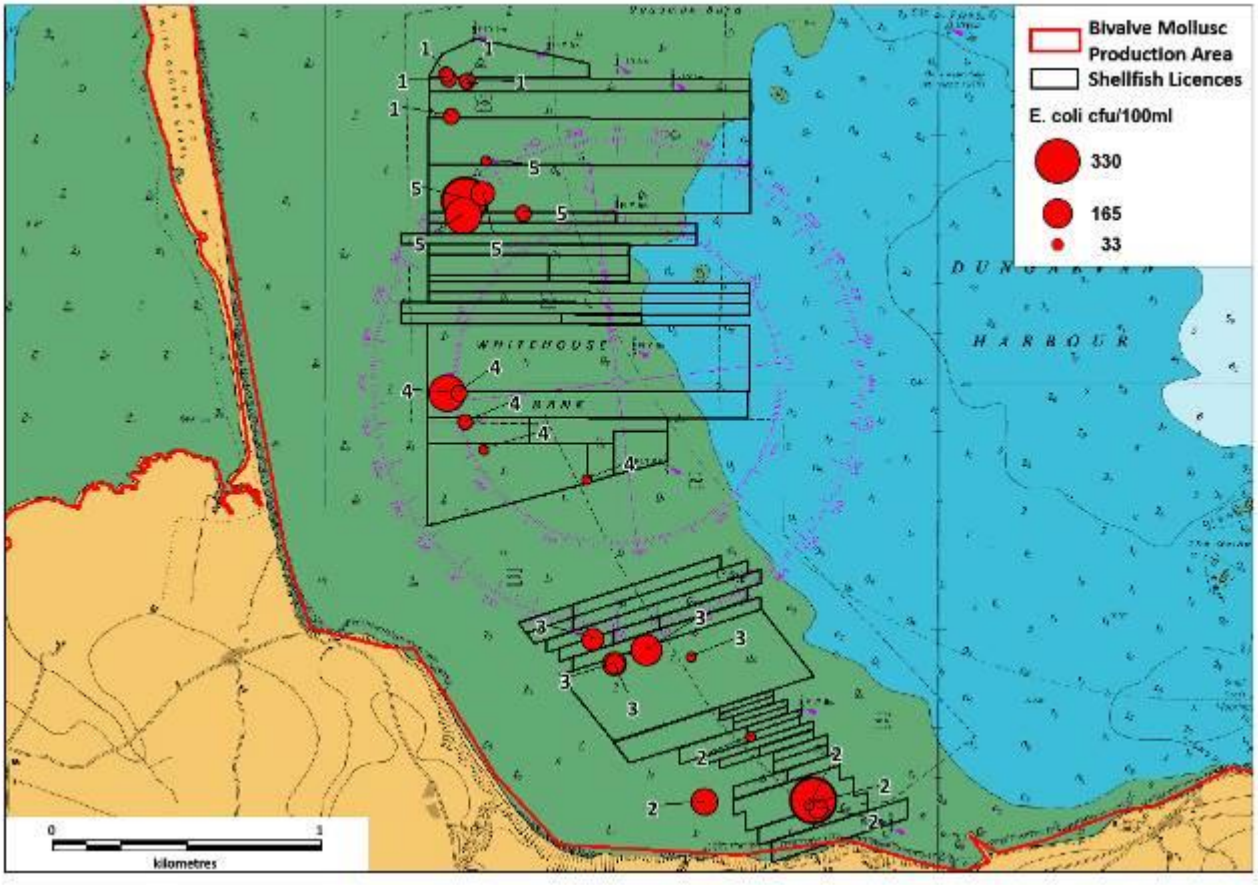

Figure 8.8: Magnitude of *E. coli* results from the shore survey shellfish samples.

Table 8.11: Shellfish *E. coli* results for Dungarvan Harbour.

Station No.	*E. coli* (cfu/ 100ml)	Date of sampling
1	45	02/10/2020
1	<18	29/10/2020
1	40	26/11/2020
1	45	17/12/2020
1	45	14/01/2021
2	20	02/10/2020
2	<18	29/10/2020
2	330	26/11/2020
2	130	17/12/2020
2	68	14/01/2021
3	<18	02/10/2020
3	93	29/10/2020
3	68	26/11/2020
3	110	17/12/2020
3	170	14/01/2021
4	<18	02/10/2020
4	20	29/10/2020
4	230	26/11/2020
4	40	17/12/2020

Station No.	*E. coli* (cfu/ 100ml)	Date of sampling
4	45	14/01/2021
5	45	02/10/2020
5	<18	29/10/2020
5	330	26/11/2020
5	110	17/12/2020
5	230	14/01/2021

9. Appendix 4: Statistical analysis

One way ANOVA: Log *E. coli* vs Season Oyster B1 (Oyster Flesh results 2014-2018)

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Summer	14	22.84491	1.631779	0.369195
Autumn	13	20.14727	1.54979	0.048365
winter	15	25.46657	1.697772	0.129436
spring	11	18.21831	1.65621	0.231615

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.158579	3	0.05286	0.27241	0.844994	2.793949
Within Groups	9.508164	49	0.194044			
Total	9.666743	52				

One way ANOVA: Log *E. coli* vs Season Oyster B2 (Oyster Flesh results 2014-2018)

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Summer	9	14.09785	1.566428	0.223485
Autumn	6	8.554505	1.425751	0.115071
winter	5	8.860339	1.772068	0.255013
spring	6	9.317475	1.552913	0.207929

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.330867	3	0.110289	0.548585	0.654346	3.049125
Within Groups	4.422931	22	0.201042			
Total	4.753798	25				

One way ANOVA: Log *E. coli* vs Location (Oyster Flesh results 2014-2018)

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
B1 log	53	86.67705	1.635416	0.185899
B2 log	26	40.83017	1.570391	0.190152

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.073753	1	0.073753	0.393814	0.532158	3.965094
Within Groups	14.42054	77	0.187281			

		14.4942	
Total		9	78

10. Appendix 5: Shoreline Survey Images

Map Codes for Features Identified During Shore Survey

Map Code	Observation	Map Code	Observation
1	Old concrete pipe structure	62	Drain
2	Culvert	63	Drain
3	WWTP pipe	64	Pipe
4	WWTP Plant	65	Birds
5.1	Old pier	66	Pipe
5.2	WWTP pipe (no image)	67	Pipe
6	Plastic pipe	68	Pipe
7	Stone Pipe	69	Pipe
8	Pier	70	Marina
9	Stone Pipe	71	Pipe
10	WWTP Pipe	72	Pipe
11	Plastic pipe	73	Pipe
12	Plastic pipe	74	Pipe
13	WWTP Pipe	75	Pipe
14	Black pipe	76	Pipe
15	Cows	77	Pipe
16	WWTP pipe	78	Pipe
17	WWTP Plant	79	Pipe
18	Stream	80	Birds
19	Stream	81	Pipe
20	Stream	82	Pipe
21	Plastic pipe	83	Station
22	Plastic pipe	84	Pipe
23	Stone cut drain	85	Pipe
24	Stone Pipe	86	Pipe
25	Concrete pipe	87	Pipe
26	Pipe	88	Birds

Map Code	Observation	Map Code	Observation
27	Concrete pipe	89	Stream
28	Plastic pipe	90	Pipe
29	Iron pipe	91	Drain
30	Stream	92	Cows
31	Pipe	93	Drain
32	Discharge	94	Drain
33	Discharge	95	Drain
34	Pipe	96	Drain
35	Pipe	97	Cows
36	Pipe	98	River
37	Pipe	99	Drain
38	Pipe	100	Cows
39	Pipe	101	Stream
40	Pipe	102	Drain
41	Cows	103	Animals
42	Pipe	104	Stream
43	Pipe	105	Drain
44	Pipe	106	Drain
45	Pipe	107	Drain
46	Pipe	108	Pier
47	Stream	109	Stream
48	Cows	110	Drain
49	Pipe	111	Stream
50	Pipe	112	Drain
51	Civic amenity pipe	113	Stream
52	River	114	Pipe
53	Pipe	115	WWTP
54	Birds	116	Culvert
55	Pipe	117	Stream
56	Cows	118	Pipe
57	Pipe	119	Pipe
58	Pipe	120	WWTP

Map Code	Observation	Map Code	Observation
59	Pipe	121	Pipe
60	Pipe	122	Pipe
61	Pipe	123	Drain


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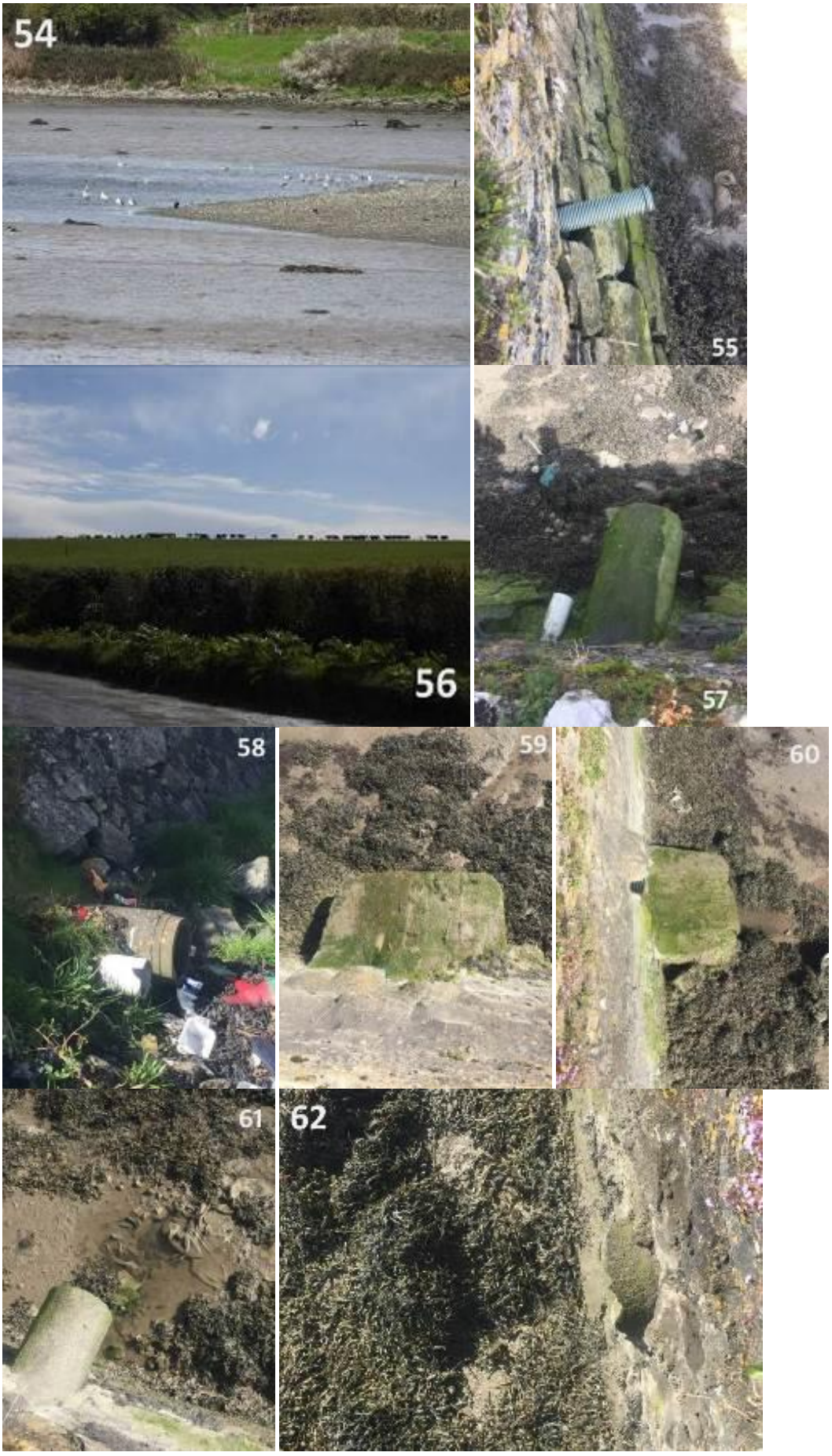
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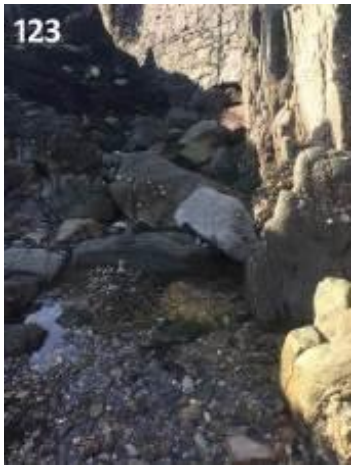
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11. Appendix 6: Species Specific Representative Monitoring Points

Dungarvan Harbour

Bivalve Mollusc Classified Production Area

Pacific Oyster Monitoring Information

Site Name: Dungarvan Harbour

Site Identifier: WD-DB-DB-1 WD-DB-DB-2

Monitoring Point Coordinates

RMP 1 **RMP 2**

Latitude: 52.073052 **Longitude:** -7.59317 **Latitude:** 52.053906 **Longitude:** -7.574407

Species: Crassostrea gigas

Sample Depth: Surface **Sample Frequency:** Monthly

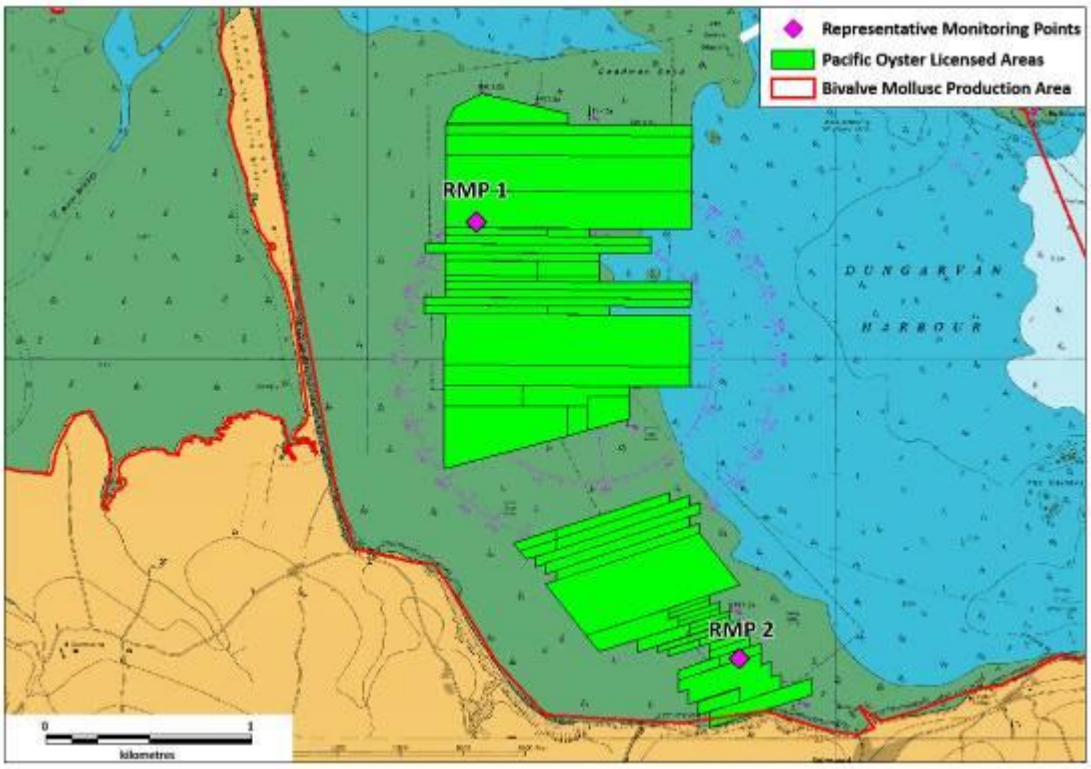
Responsible Authority: Sea Fisheries Protection Authority

Authorised Samplers: SFPA Port Office Dunmore East.

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

Sampling Size: Minimum 10 market sized animals.

Sampling Method: Taken from trestles at point.



Dungarvan Harbour

Bivalve Mollusc Classified Production Area

Razor Clams Monitoring Information

Site Name: Dungarvan Harbour

Site Identifier: WD-DB-DB-RZ

Monitoring Point Coordinates

Latitude: 52.072905 **Longitude:** -7.551851

Species: *Ensis siliqua*

Sample Depth: Sea bed **Sample Frequency:** Frequency dependant on fishery opening

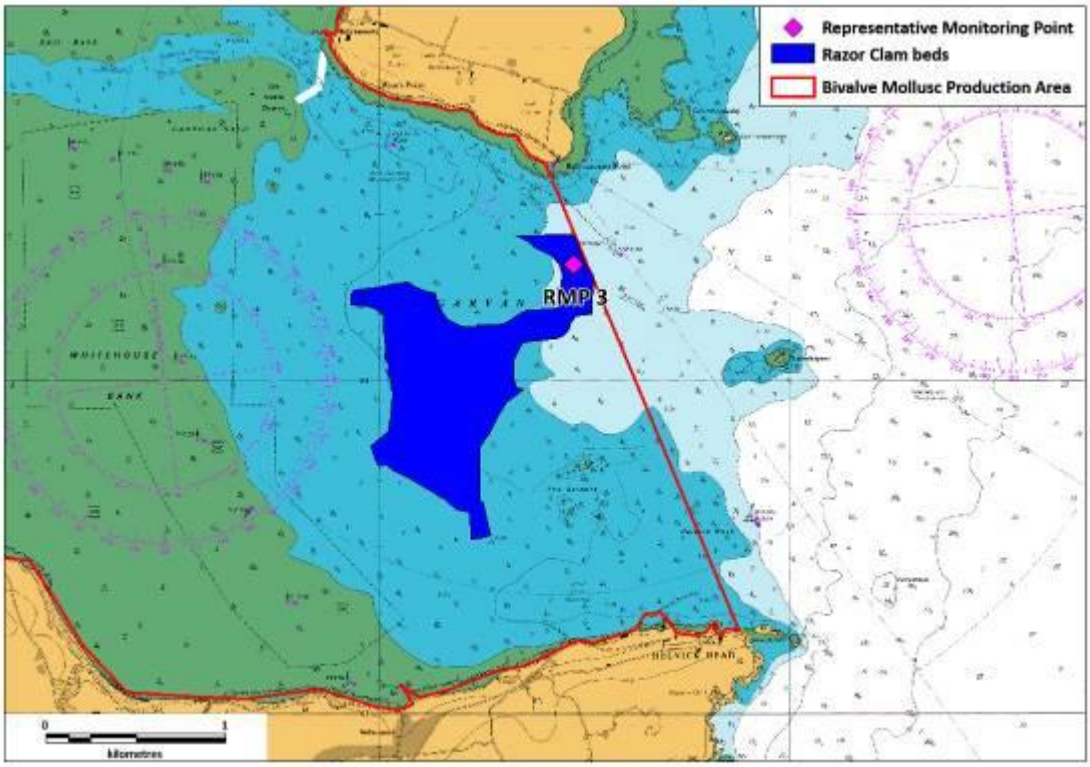
Responsible Authority: Sea Fisheries Protection Authority

Authorised Samplers: SFPA Port Office Dunmore East

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

Sampling Size: Minimum 10 market sized animals

Sampling Method: Taken from dredge at point



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