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# Scottish Sanitary Survey Project



## Restricted Sanitary Survey Report

Loch Ryan North

DG 500

November 2010



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## Report Distribution – Loch Ryan North

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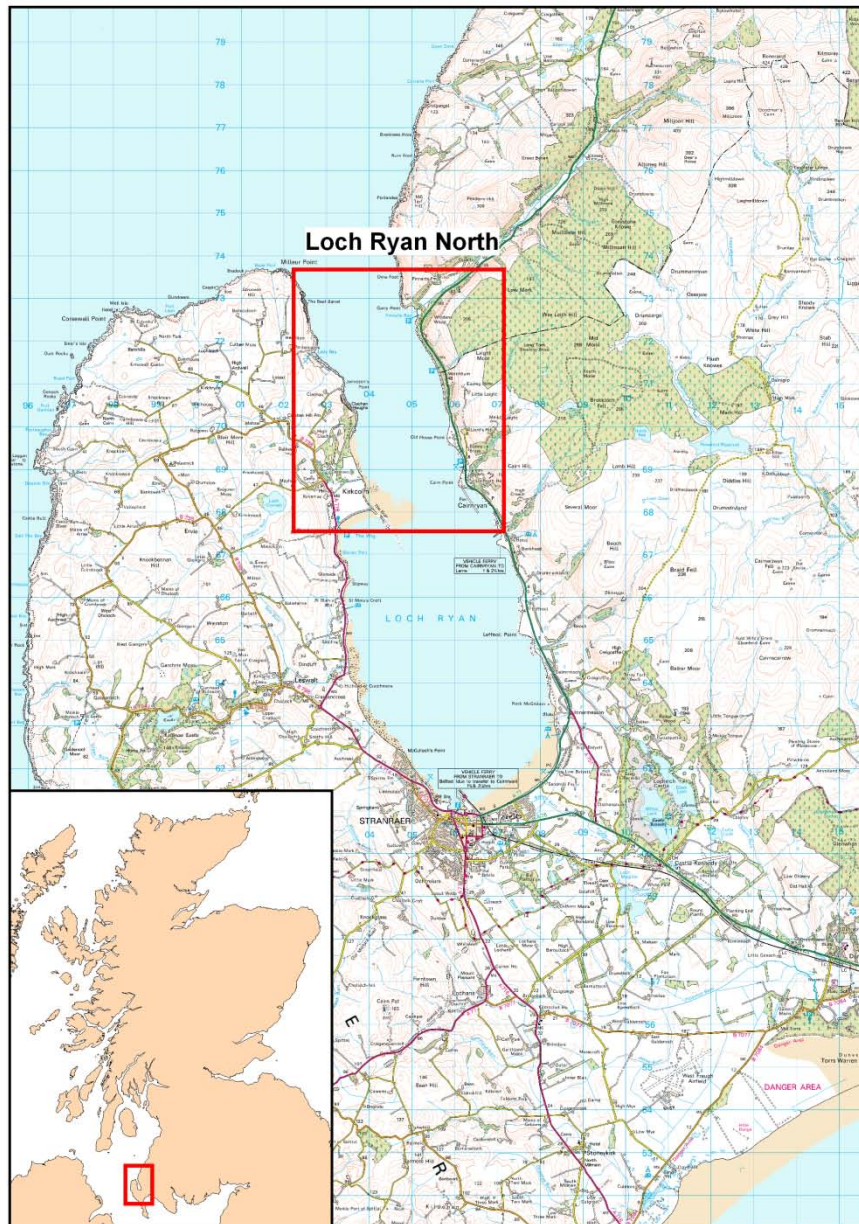
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# 1. Area Overview

Loch Ryan is a mainly shallow, sheltered sea loch on the western coast of Scotland (see Figure 1.1). It is a natural harbour that provides calm waters for ferries operating from Scotland to Northern Ireland. The loch is approximately 13 km long from north to south and 4.8 km wide, at its widest point. To the north of Loch Ryan is the Firth of Clyde and the Atlantic Ocean.

A restricted sanitary survey at Loch Ryan North was conducted in response to receipt of a full application to classify the north end of the loch for commercial harvest of razor clams (*Ensis* spp.).



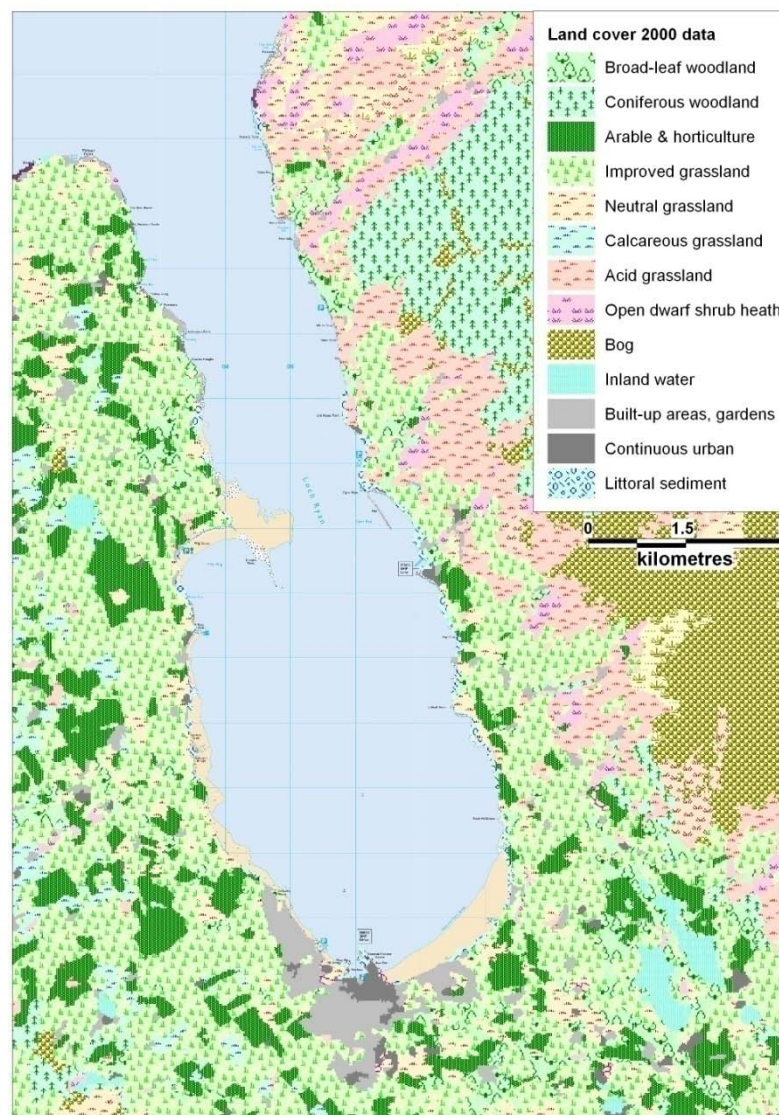
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Figure 1.1 Location of Loch Ryan North



## 1.1 Land Use

Land Cover 2000 data indicates that the land surrounding Loch Ryan is dominated by six main types of land cover: improved grassland, arable & horticulture, acid grassland, coniferous woodland, open dwarf shrub heath and bog. There are also smaller areas of broad-leaf woodland, calcareous grassland and littoral sediment. The west side of the loch is predominantly improved grassland with patches of arable and horticultural land. Inland of the east shore of the loch there is a large area of coniferous woodland to the north and a large area of bog to the south. Along the eastern coastline there are areas of improved grassland and some areas of arable and horticultural land, acid grassland, open dwarf shrub heath and neutral grassland. The large built up area to the south of the loch, is the town of Stranraer (see Figure 1.2). The settlements of Cairnryan and Kirkcolm are also shown. On the west side of the loch, the Landcover 2000 data shows there are smaller areas of built up land, which may be other village or camping grounds.



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Figure 1.2 Land Cover 2000 data for Loch Ryan North

The faecal coliform contribution would be expected to be highest from developed areas (approx  $1.2 - 2.8 \times 10^9$  cfu km<sup>-2</sup> hr<sup>-1</sup>), with intermediate contributions from the

improved grassland (approximately  $8.3 \times 10^8$  cfu km<sup>-2</sup> hr<sup>-1</sup>) and lowest from the other land cover types (approximately  $2.5 \times 10^8$  cfu km<sup>-2</sup> hr<sup>-1</sup>) (Kay *et al.* 2008). The contributions to the contamination of shellfish from all land cover types would be expected to increase significantly after marked rainfall events. This increase would be highest, at more than 100-fold, for improved grassland. For Loch Ryan, the highest contribution to contamination levels carried in surface runoff would be from primarily from the built-up area at the south end of loch and also the small settlements on the eastern and western shores. There would also be a significant contribution from the improved grassland, primarily on the western and south-eastern shores.

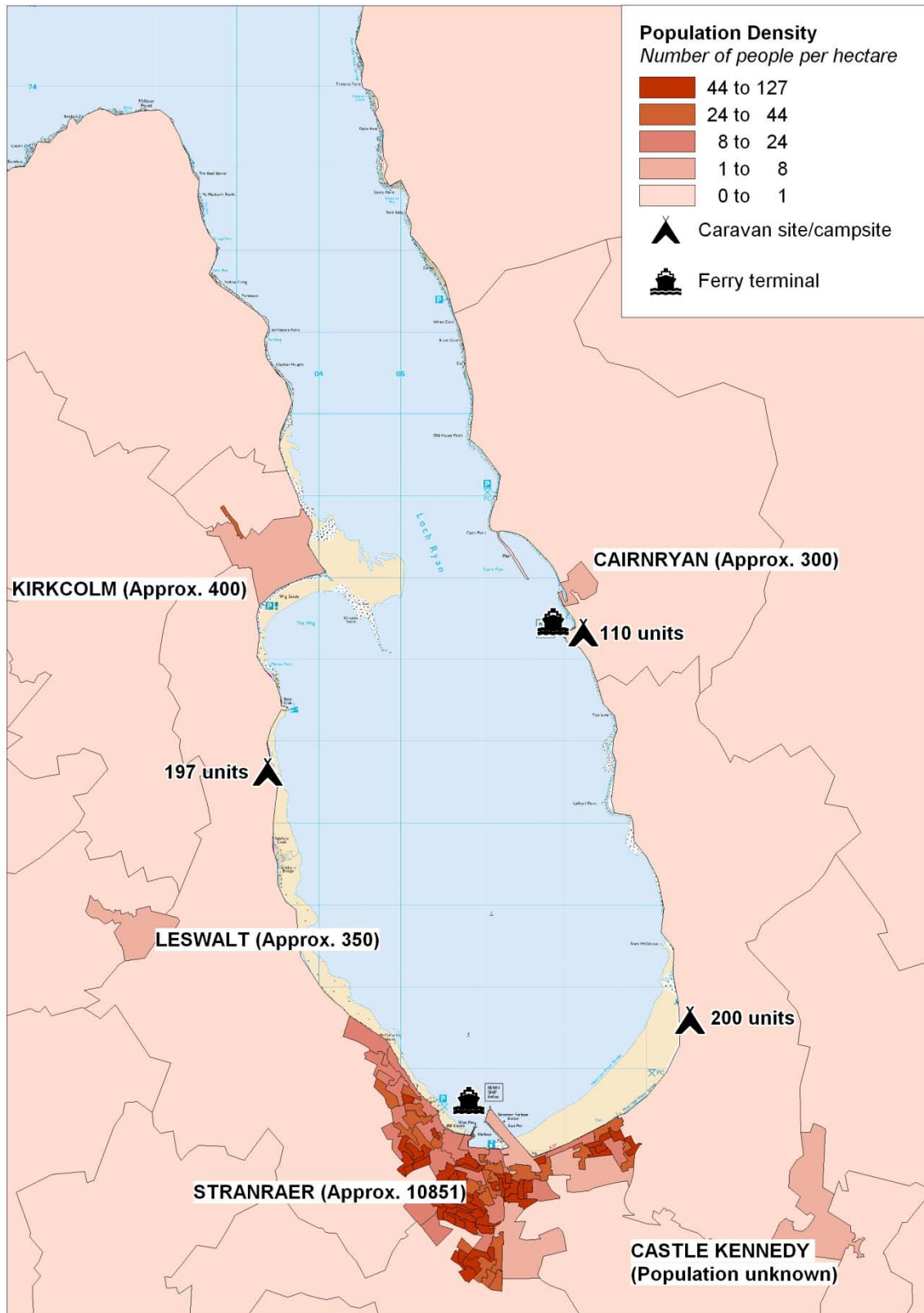
## 1.2 Human Population

Human population figures were obtained from the General Register Office for Scotland on the population within the census output areas in the vicinity of the Loch Ryan North production area. Figure 1.3 shows the population density of the census output areas that are adjacent to Loch Ryan.

There are four main settlements in the vicinity of Loch Ryan; Stranraer, Leswalt, Kirkcolm and Cairnryan. Stranraer is the largest town with a population of 10851 (2001). There is a ferry terminal in Stranraer that provides a ferry service to Belfast that operates once a day in each direction. East of Stranraer at NX 0845 6266, there is a caravan site with a licence for 200 units. The second largest settlement is the village of Kirkcolm located on the western coast with a population of 400 (2001). Halfway along the coast between Kirkcolm and Stranraer there is another caravan site located at NX 0344 6562, with a licence for 197 units. The village of Leswalt is located inland midway between Stranraer and Kirkcolm has a population of 350 (2001). On the opposite shoreline is the settlement of Cairnryan with a population of 300 (2001). At Cairnryan, there is second ferry terminal from which P&O ferries operate a year-round service between Cairnryan and Larne, Northern Ireland, with up to seven sailings a day in each direction.

Stenaline are currently in the process of constructing a new ferry terminal to the north of Cairnryan and will be moving their ferry operation from Stranraer port at the head of the loch. The new terminal is planned to be completed August 2011 and operational September 2011. A sewage treatment plant is being constructed on site and will also treat the sewage from Cairnryan village.

Due to the large size of Stranraer and the close proximity of Kirkcolm and Cairnryan to the production area, it is likely that sewage discharges from all three settlements will contribute to the faecal contamination of the shellfish bed. Due to the three large caravan sites, it is expected that the population in the area will increase significantly during the summer holiday months. The sewage from both of the ferries is taken off at their destinations Larne and Belfast, so this will not be a contributing factor.



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Figure 1.3 Population density of census output areas surrounding Loch Ryan

## 2. Fishery

The fishery at Loch Ryan North (DG 500 866 16) is comprised of a wild razor clam (*Ensis* spp.) bed.

The western site of the loch is currently harvested for razor clams. Natural razor beds are found in the sub-tidal sandy beds and are inaccessible other than by boat. The razors are hand dived and harvesting is planned to take place throughout the year.

To the south of the survey area is a natural oyster bed which is harvested seasonally and has an 'A' classification.

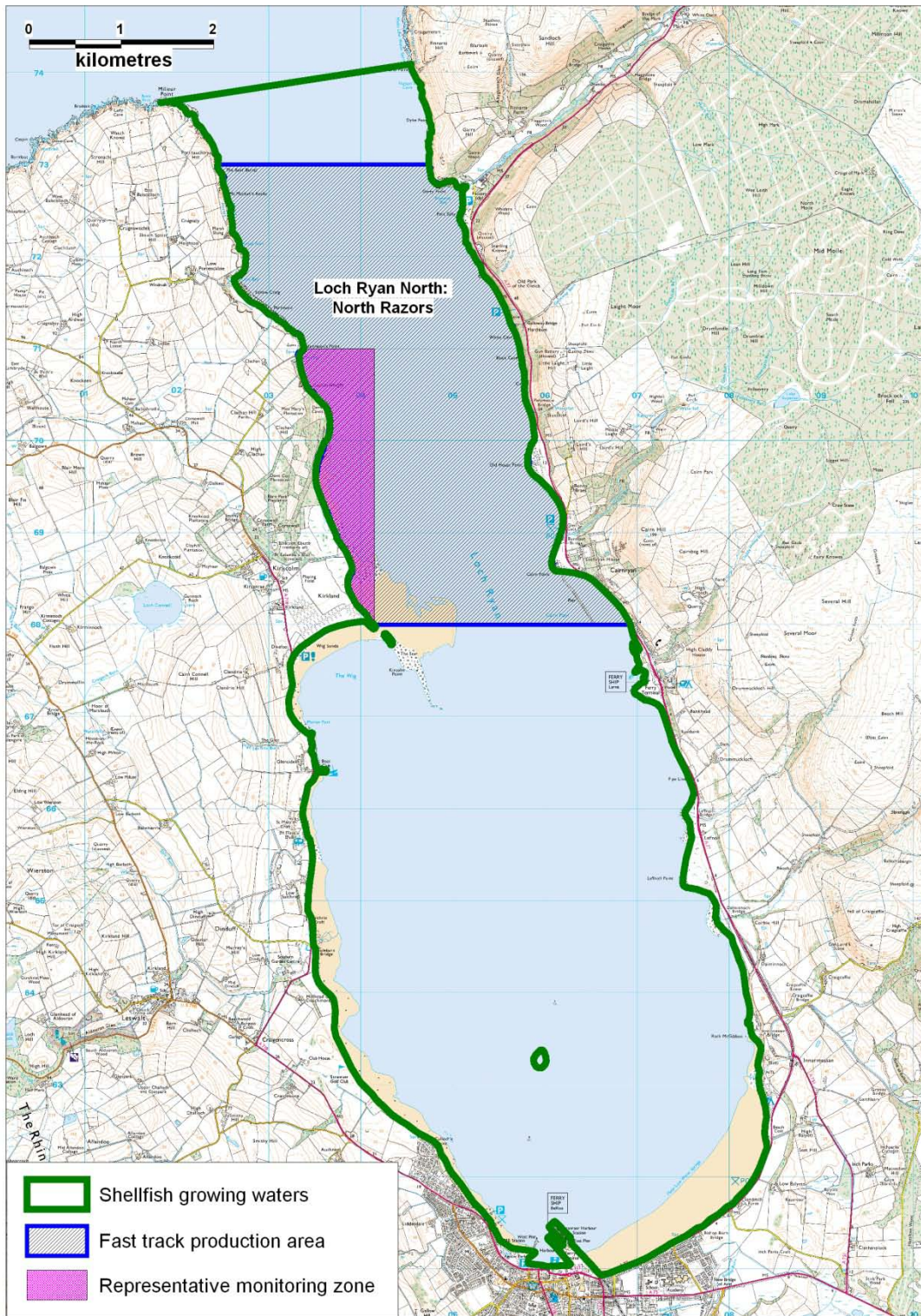
The razor clam fast track classification production area boundaries for Loch Ryan North were identified by the Food Standards Agency (FSA) as the area bounded by lines drawn between points NX 0240 7300 to NX 0475 7300 and between NX 0414 6800 to NX 0695 6800 extending to MHWS (see Figure 2.1). Due to the substantial Fast Track samples already submitted, the area has been given a provisional 'A' classification all year round, subject to continual monthly samples being submitted up until April 2010. Thereafter, to maintain classification throughout the year, a minimum of 6 separate samples in 6 separate months were to be collected within the classification period.

FSA Scotland had permitted for samples to be harvested from a representative monitoring zone located within the harvesting area boundary. This sampling area is defined by the points NX 0414 6800, NX 0414 7100, NX 0340 7100 extending to MHWS. The zone is approximately 8 km long on its eastern border and approximately 0.8 km wide on its northern border and is thought to cover the majority of the shellfish bed, although it does extend across the intertidal area.

The entire loch is designated as a shellfish growing water, which encompasses the area lying south of a line from NX 0181 7367 (Milleur Point) to NX 0454 7409 (Finnarts Point) and extending to MHWS (see Figure 2.1).

Loch Ryan also hosts a native oyster (*Ostrea edulis*) fishery. Due to the restricted scope of this survey, the native oyster fishery will not be addressed here.





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Figure 2.1 Loch Ryan North fishery

### 3. Sewage Discharges

Scottish Water identified community septic tanks (ST) and other sewage discharges for the area within 15 km of Loch Ryan (NX 0336 6456). These are detailed in Table 3.1 and shown mapped in Figure 3.1. A short glossary follows at the end of this section.

Table 3.1 Sewage discharges identified by Scottish Water

SEPA Discharge Consent No.	Discharge Name	NGR of Discharge	Type	Level of Treatment	Design PE/Flow vol	2011 plan
CAR/L/1003617	Kirkcolm WWTW	NX 0390 6880	Continuous, FE	-	327	○
CAR/L/1003635	Kirkcolm WWTW CSO	NX 0390 6880	Intermittent	-	150 m <sup>3</sup> /day	○
CAR/L/1003622	Cairnryan ST	NX 0700 6790	Continuous	-	-	▲
CAR/L/1003622	Cairnryan WWPS1	NX 0700 6790	Intermittent CSO/EO	-	-	▲
CAR/L/1003622	Cairnryan WWPS2	NX 0680 6820	Intermittent CSO/EO	-	-	▲
CAR/L/1003622	Cairnryan WWPS3	NX 0660 6840	Intermittent CSO/EO	-	-	▲
-	Stranraer Port Roddie WWTW	tbc	Continuous plus CSO/EO	-	-	○
-	Stranraer Auchneel Cres. surface water discharge	NX 0463 6246	Other	Surface water from separate system	-	
-	Stranraer Mayfield Avenue surface water discharge	NX 0489 6152	Other	Surface water from separate system	-	
WPC/W/22540	Stranraer Bishopton/Foreland Place WWPS	NX 0553 6148	Intermittent	-	-	○
-	Stranraer CSO to surface water discharge to harbour	NX 0604 6100	Intermittent	-	-	
73/65	Stranraer McMaster Rd/Cairnryan Rd CSO	NX 0739 6126	Intermittent	-	-	
WPC/W/17402 (CAR/L/1003618)	Leswalt WWTW	tbc	Continuous	-	-	○

- information not provided   ○ to be pumped to Scottish Water WWTW   ▲ to be pumped to Stena WWTW

Scottish Water Solutions are currently in the process of developing a new wastewater treatment for the area surrounding Loch Ryan. The overall objective is to provide wastewater collection, treatment and disposal for the following communities, which currently discharge into Loch Ryan: Stranraer, Kirkcolm, Leswalt and Cairnryan. The new proposals include the creation of two new waste water treatment works at Smithy Hill near Leswalt and at the Stena Line terminal, a pumping station at Cairnryan and a pumping station and storm tanks at Port Rodie, Stranraer. At Port Rodie, the plan is to convert the existing waste water treatment works to a pumping station and storm tanks. The new facility will collect waste from surrounding communities and pump it to the new treatment works. The existing Port Rodie building will be demolished and replaced with a new one. The planned outfall for these discharges will be to the North Channel. Construction began in summer 2010 and is due to be completed by spring 2012.

In addition, SEPA has provided consent information for the discharges listed in Table 3.2 below. The data has been thematically mapped in Figure 3.1.

Table 3.2 SEPA discharge consents

No.	Ref No.	NGR of Discharge	Discharge Type	Discharges to
1	CAR/R/1050231	NX 0560 7343	Sewage (Private) Primary	Altygunach Burn
2	CAR/R/1050232	NX 0546 7335	Sewage (Private) Primary	Unnamed watercourse
3	CAR/R/1050233	NX 0517 7275	Sewage (Private) Primary	Soakaway
4	CAR/R/1049606	NX 0640 6858	Sewage (Private) Primary	Soakaway
5	CAR/L/1003622	NX 0660 6840	Sewage (Public) E.O & C.S.O	Loch Ryan
6	CAR/L/1003357	NX 0706 6739	Sewage (Private) Secondary	Loch Ryan
7	CAR/R/1014406	NX 0729 6711	Sewage (Private) Primary	Loch Ryan
8	CAR/R/1014237	NX 0733 6708	Sewage (Private) Primary	Soakaway
9	CAR/R/1018760	NX 0842 6250	Sewage (Private) Unntreated	Soakaway
10	CAR/R/1033944	NX 0812 6177	Sewage (Private) Primary	Loch Ryan via partial soakaway
11	CAR/R/1033948	NX 0812 6177	Sewage (Private) Primary	Loch Ryan via partial soakaway
12	CAR/R/1033949	NX 0806 6128	Sewage (Private) Primary	Loch Ryan via partial soakaway
13	CAR/L/1003637	NX 0761 6142	Sewage (Public) C.S.O	CSO to Loch Ryan
14	CAR/S/1035132	NX 0690 6038	Surface water (other), commercial, industrial, other	SUDS, TE to Black Stank, Stranraer
15	CAR/L/1003462	NX 0553 6148	Sewage (Public) C.S.O	CSO to Loch Ryan
16	CAR/L/1003619	NX 0580 6140	Sewage (Private) Primary	FE to Loch Ryan
17	CAR/L/1003355	NX 0612 6054	Sewage (Public) C.S.O	CSO to Town Burn
18	CAR/R/1021307	NX 0434 5975	Sewage (Private) Primary	STE to Piltanton Burn
19	CAR/R/1018183	NX 0348 5926	Sewage (Private) Primary	STE to Crailoach Burn via partial soakaway
20	CAR/R/1081521	NX 0065 5906	Sewage (Private) Secondary	STW FE to unnamed tributary of Craigslove Burn
21	CAR/R/1011703	NW 9988 5947	Sewage (Private) Primary	STE to Knock and Maize Burn
22	CAR/R/1013675	NX 0006 6112	Sewage (Private) Untreated	STE to Green Burn
23	CAR/R/1072185	NX 0407 6193	Sewage (Private) Primary	STE to unnamed watercourse
24	CAR/R/1009819	NX 0494 6211	Sewage (Private) Primary	STE to Loch Ryan
25	CAR/L/1000892	NX 0419 6286	Other effluent, potable water treatment and supply	TE to Loch Ryan
26	CAR/R/1015161	NX 0062 6373	Sewage (Private) Secondary	PTP FE to unnamed watercourse
27	CAR/R/1043220	NX 0160 6379	Sewage (Private) Secondary	STW FE of Sole Burn
28	CAR/R/1074971	NX 0165 6383	Sewage (Private) Secondary	STE to unnamed tributary of Sole Burn
29	CAR/R/1027954	NX 0244 6404	Sewage (Private) Primary	STE to Sole Burn
30	CAR/L/1003636	NX 0211 6430	Sewage (Public) C.S.O	Leswalt STW, CSO to unnamed tributary of Sole Burn
31	CAR/L/1003618	NX 0215 6432	Sewage (Public) Secondary	Leswalt STW, FE to Sole Burn
32	CAR/R/1016516	NX 9931 6534	Sewage (Private) Primary	STE to unnamed tributary of Glengyre Burn
33	CAR/R/1019069	NX 0125 6609	Sewage (Private) Primary	STE to unnamed tributary of Sole Burn
34	CAR/L/1003635	NX 0310 6870	Sewage (Public) C.S.O	CSO to Corsewall Burn
35	CAR/L/1003634	NX 0390 6880	Sewage (Public) C.S.O	CSO to Loch Ryan
36	CAR/L/1003617	NX 0390 6880	Sewage (Public) Secondary	FE to Loch Ryan
37	CAR/R/1068603	NX 0231 6950	Sewage (Private) Primary	STE to Corsewall Burn
38	CAR/R/1068605	NX 0157 7013	Sewage (Private) Primary	STE to Corsewall Burn
39	CAR/R/1068608	NX 0145 7029	Sewage (Private) Primary	STE to Balloch a Rody
40	CAR/R/1068636	NX 0145 7029	Sewage (Private) Primary	STE to Balloch a Rody
41	CAR/R/1054529	NX 0340 6666	Sewage (Private) Primary	STE to soakaway, Kirkcolm
42	CAR/L/1003629	NX 075 617	Industrial, cheese processing waste	Loch Ryan`

\* No information on consented flow volumes was provided

The untreated discharge of cheese processing waste associated with CAR/L/1003629 is listed in the SEPA Shellfish Growing Waters site action plan for targeted improvement. SEPA identified that the current discharge was found to contain 5,000,000/100ml faecal coliforms which is approximately 5,000 times above permissible microbiological concentrations. Rennet, a microbiological starter culture for cheese making, is used in the process and the whey (which is then discharged as waste) will contain elevated concentrations of microbes.

During the shoreline survey four outfall pipes (two of which were dry at the time), one septic tank, three septic tank pumping stations and a sewage works were observed. The sewage works and two of the outfall pipes were located at Kirkcolm and the three pumping stations, a single septic tank and the remaining outfall pipe were observed at Cairnryan.

Sewage infrastructure recorded during the shoreline survey is listed in Table 3.3.

Table 3.3 Sewage discharge observations recorded during the shoreline survey

No.	Date	NGR	Description	Water sample Ref	<i>E. coli</i> result (cfu/100 ml)
1	01/09/2010	NX 03449 68690	Kirkcolm Sewage Works	No sample	NA
2	01/09/2010	NX 03891 68789	Sewage outfall pipe. Fresh water sample 1 (LR001). Sample taken at broken point of outlet pipe	LR001	>10000
3	01/09/2010	NX 03940 68799	End of outfall pipe	No sample	NA
4	01/09/2010	NX 03693 69159	Disused pipe - No flow, no signs of flow	No sample	NA
5	01/09/2010	NX02631 71768	Outfall pipe. Fresh water sample 2 (LR002).	LR002	50
6	02/09/2010	NX06584 68451	Septic tank pumping station 1.	No sample	NA
7	02/09/2010	NX06803 68217	Septic tank pumping station 2.	No sample	NA
8	02/09/2010	NX06990 67872	Sewage pumping station 3.	No sample	NA
9	02/09/2010	NX 06999 67853	Septic tank.	No sample	NA
10	02/09/2010	NX 06997 67819	Black outfall pipe – dry.	No sample	NA

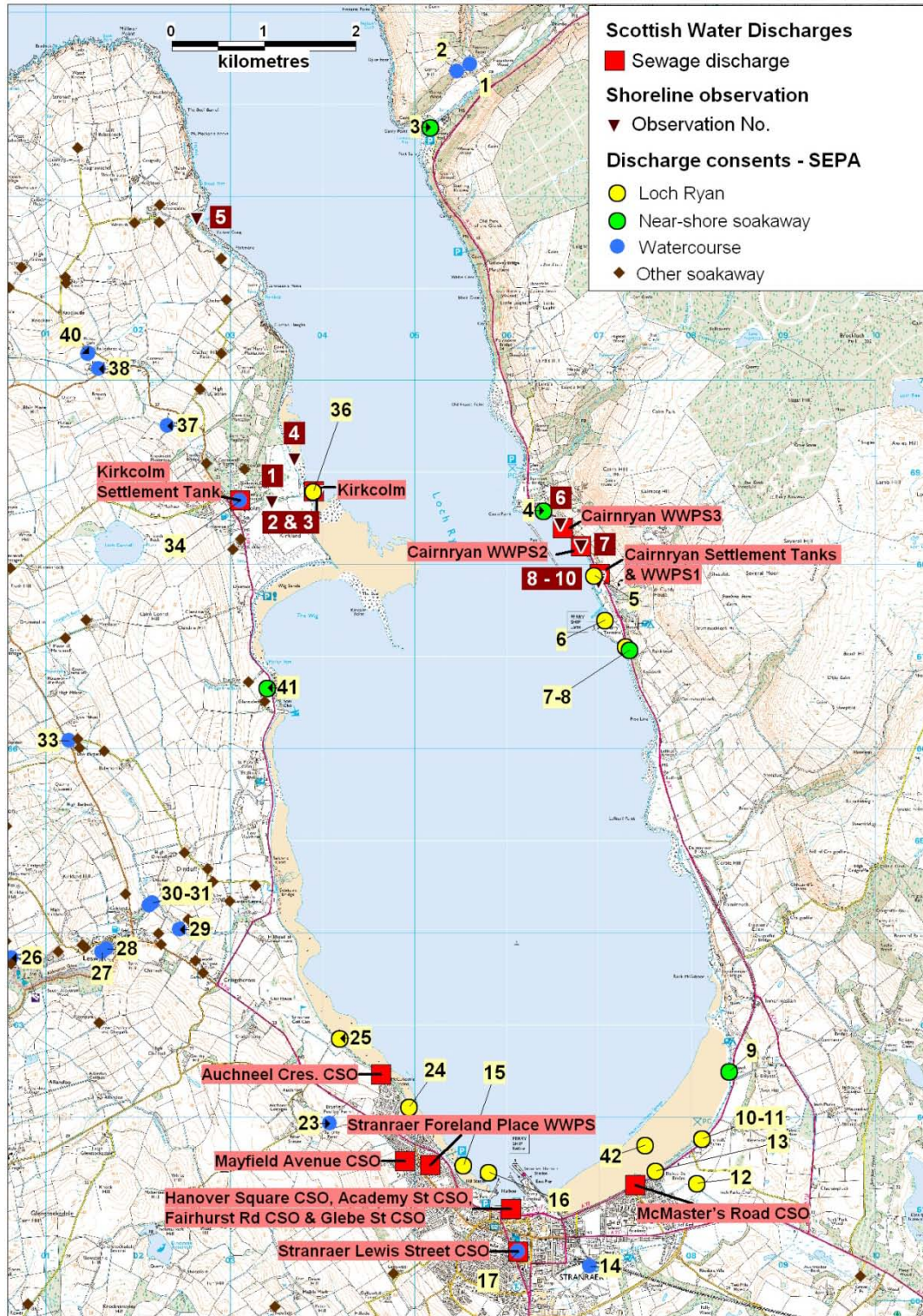
The water sample taken from the outfall pipe in observation 2 at Kirkcolm, had a very high result of >10000 *E. coli* cfu/100 ml. The most significant source of human sewage to the fishery within Loch Ryan will be the discharges in Kirkcolm, Cairnryan and Stranraer.

### Acronyms

CSO	Combined Sewer Overflow
DWF	Dry Weather Flow
FE	Final Effluent
PE	Population Equivalent
ST	Septic Tank
SUDS	Sustainable Urban Drainage System
TE	Trade Effluent
WWPS*	Wastewater Pumping Station

\* Also designated as simply pumping stations, or PS





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Figure 3.1 Loch Ryan sewage discharges

## 4. Animals

### 4.1 Livestock

Agricultural census data to parish level was provided by the Rural Environment, Research and Analysis Directorate (RERAD) for three of the five parishes surrounding Loch Ryan. The five parishes surrounding Loch Ryan are Ballantree, Inch, Stranraer (urban area), Leswalt and Kirkcolm (see Figure 4.1). Reported livestock populations for the parishes in 2009 are listed in Table 7.1. Data for the parish Leswalt is available but was not supplied to Cefas at the time of writing this report. The parish of Stranraer is an urban area. RERAD withheld data for reasons of confidentiality where the small number of holdings reporting would have made it possible to discern individual farm data. Any entries which relate to less than five holdings, or where two or fewer holdings account for 85% or more of the information, are replaced with an asterisk.

Table 4.1 Livestock numbers in Kirkcolm, Ballantree and Inch - 2009

Parish:	Kirkcolm		Ballantree		Inch		Leswalt		
<b>Total area (sq km):</b>	55.75		133.8		125.8		50.93		
<b>Year:</b>	2009		2009		2009		Data not available		
	<i>Holdings</i>	<i>Numbers</i>	<i>Holdings</i>	<i>Numbers</i>	<i>Holdings</i>	<i>Numbers</i>	<i>Holdings</i>	<i>Numbers</i>	<i>Total numbers</i>
<b>Pigs</b>	*	*	0	0	0	0			*
<b>Poultry</b>	7	117	*	*	*	*			*
<b>Cattle</b>	44	10095	19	5679	33	6802			22576
<b>Sheep</b>	15	4717	17	34874	14	15826			55417
<b>Horses and ponies</b>	*	*	*	*	5	23			*

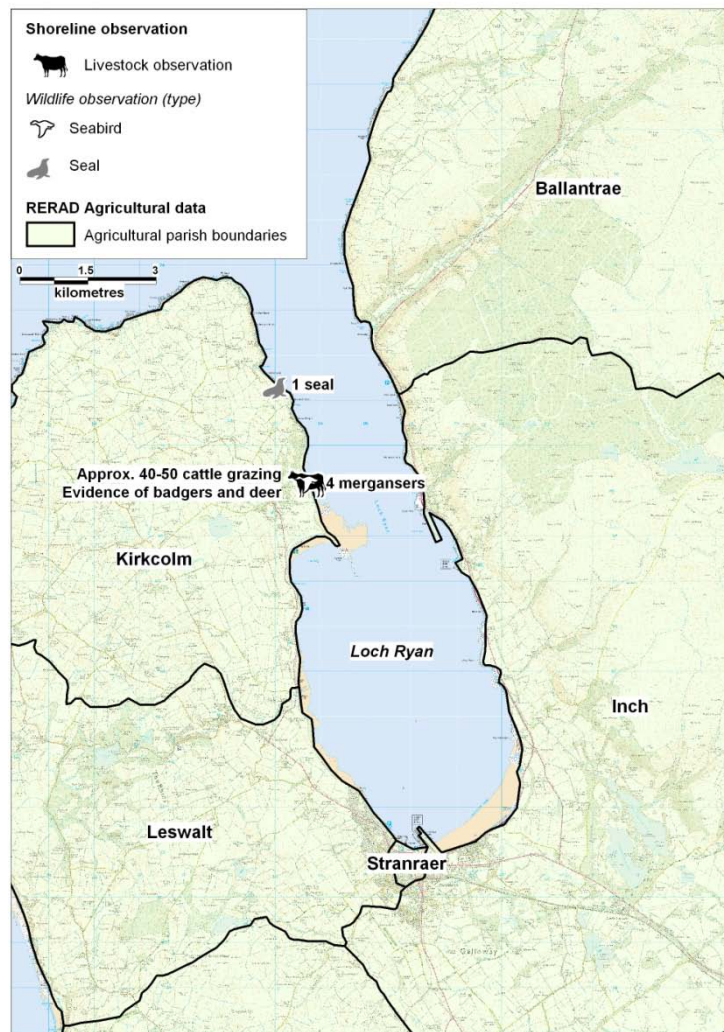
\* Data withheld for reasons of confidentiality

Livestock numbers on the surrounding land as a whole are likely to be at their highest during the summer months when calves and lambs are present. During the warmer months livestock may access streams to drink and cool off more frequently, leading to higher levels of faecal contamination in freshwater streams (like the streams adjacent to the Loch Ryan North production area) and the shellfish bed its self. During the shoreline survey approximately 40-50 cattle were observed grazing on the western shoreline of Loch Ryan, north of Kirkcolm. It is common during the winter months, for livestock, including dairy cattle to be kept in barns causing a likely increase in slurry production and higher runoff from hard standing areas, with a peak in slurry spreading in the spring: no specific information on this was available for the Loch Ryan area.



## 4.2 Wildlife

At the time of the shoreline survey various seabirds and wildfowl were observed along the north west shoreline, though, except for 4 mergansers no specific numbers were recorded. A single seal was also observed resting on rocks on the north western shoreline. In addition to mergansers, gulls, oyster catchers, ducks and geese were also observed on the western shoreline but numbers or location were not recorded. In the same area that mergansers were observed there was evidence of badgers and deer. It is possible that other animals including otters and other seabirds may be present in the area. The distribution and numbers of these species was not investigated. Impact from geese is likely to be highest on or near grass fields where they graze. Gulls may be found over much of the area and are as likely to deposit droppings on the sea as on land. Diffuse pollution from wildlife impacts is likely to be carried in streams via rainfall runoff.



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Figure 4.1 Livestock and wildlife observations and agricultural parish boundaries surrounding Loch Ryan

## 5. Rainfall

The nearest weather station is located at Castle Kennedy, approximately 3.1 km to the south west of Loch Ryan and 8.3 km south west of the Loch Ryan North production area. Daily rainfall values were purchased from the UK Meteorological Office for the period 1/1/2005 to 31/12/2009 inclusive for the Castle Kennedy weather station. The data set was complete for the whole period. Unless otherwise identified, the content of this section (e.g. graphs) is based on further analysis of this data undertaken by Cefas.

### 5.1 Rainfall at Castle Kennedy

High rainfall and storm events are commonly associated with increased faecal contamination of coastal waters through surface water run-off from land where livestock or other animals are present, and through sewer and waste water treatment plant overflows (e.g. Mallin et al, 2001; Lee & Morgan, 2003). The influence of rainfall on microbiological quality will depend on factors such as local geology, topography, land use and sewerage infrastructure. Figures 5.1 and 5.2 present box and whisker plots summarising the distribution of individual daily rainfall values by year and by month. The grey box represents the middle 50% of the observations, with the median marked as a line within the box. The whiskers extend to the largest or smallest observations up to 1.5 times the box height above or below the box. Individual observations falling outside the box and whiskers are represented by the symbol '\*'.

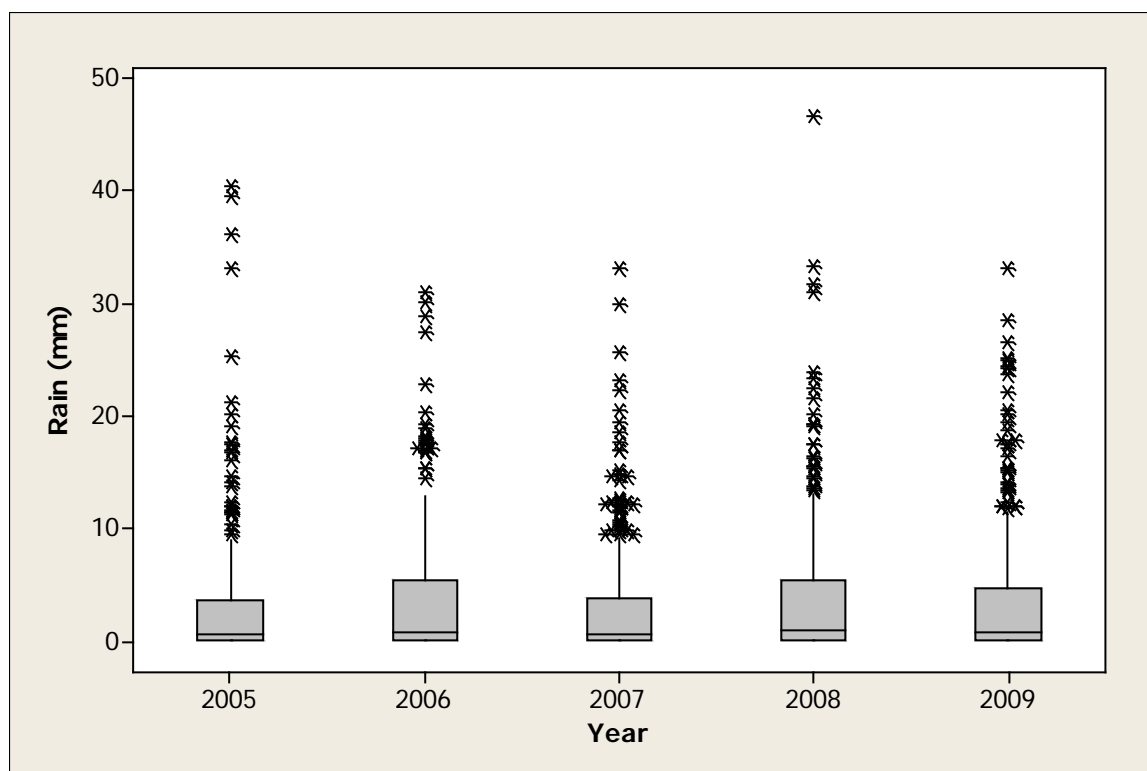


Figure 5.1 Box plot of daily rainfall values by year at Castle Kennedy, 2005-2009

Figure 5.1 shows that there was some variation in rainfall patterns between the years presented here, with 2005 and 2007 being marginally drier than 2006, 2008 and 2009. Extreme rainfall events were greater in 2005, an otherwise dry year, and in 2008.



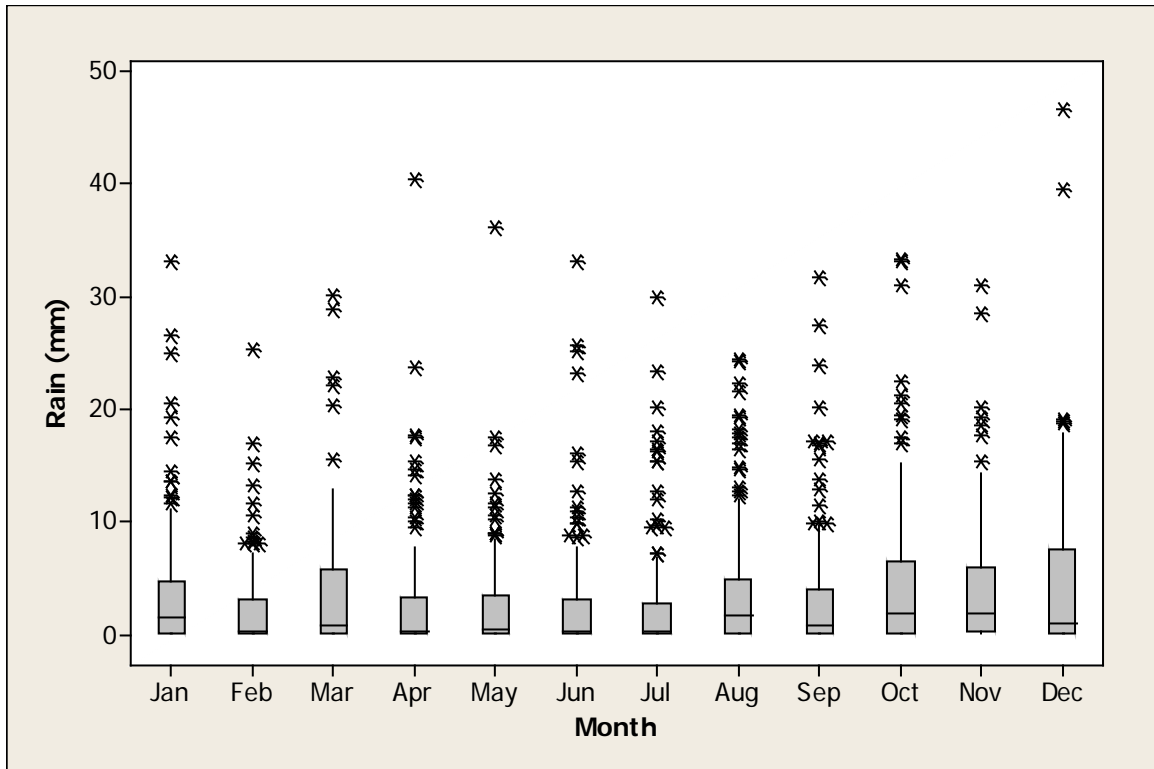


Figure 5.2 Box plot of daily rainfall values by month at Castle Kennedy, 2005-2009

Figure 5.2 indicates that the wettest months were October to December and March. February and April to July were the driest months. Days with high rainfall greater than 25 mm occurred during all months apart from February. For the period considered here (2005-2009), 52% of days experienced rainfall less than 1 mm, and 9% of days experienced rainfall of 10 mm or more. Extreme rainfall events (>3 mm) occurred in all months but February and August in this dataset. Rainfall of 40 mm or more in a day occurred during April (an otherwise dry month) and December.

It is likely that amount of rainfall dependent faecal contamination entering the production area will be higher on average during the autumn and winter months. High rainfall events can occur at any time of the year. However, these may result in a contaminated 'first flush' of pasture runoff which may be particularly acute during the summer when livestock numbers are likely to be highest and preceding dry periods may result in a build-up of faecal matter on pastures.

## 6. River Flow

There are no gauging stations on burns or streams along the Loch Ryan coastline. Loch Ryan is steep sided, especially along the eastern shoreline. The largest watercourse flowing into the loch is the Water of App, which discharges into the north east end of the loch and production area.

The watercourses listed in Table 6.1 were recorded and sampled and measured where possible, during the shoreline survey. The locations are shown on the map presented in Figure 6.1. Where the bacterial loading is labelled on the map, the scientific notation is written in digital format, as this is the only format recognised by the mapping software. So, where normal scientific notation for 1000 is  $1 \times 10^3$ , in digital format it is written as 1E+3.

Only the north end of the loch was surveyed, so not all streams were sampled, measured and recorded. The weather was dry during the survey period, though there had been heavy rainfall the week prior to the survey.

Table 6.1 Stream loadings and *E. coli* results for Loch Ryan North

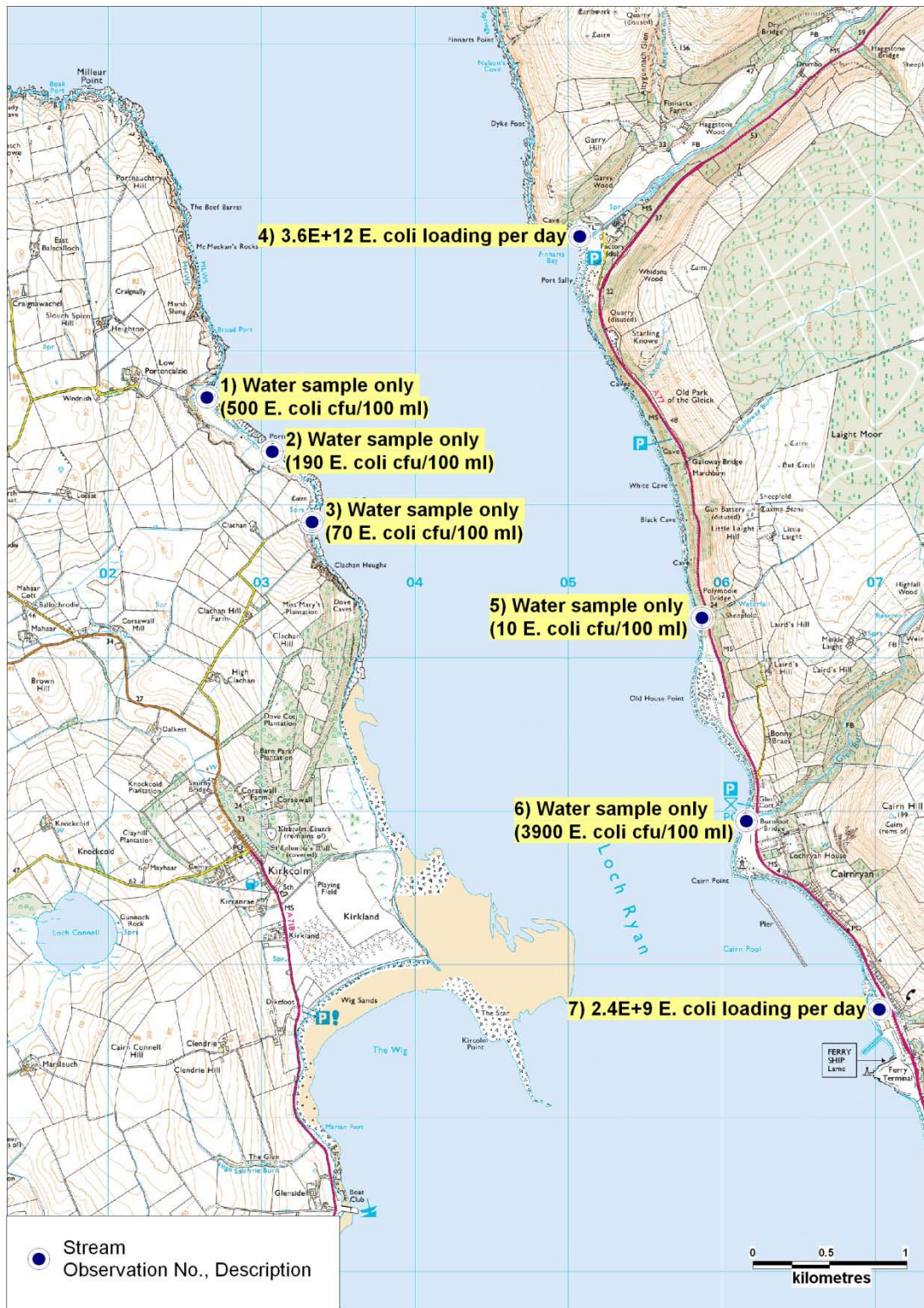
No	Sample number	Grid Ref	Description	Width (m)	Depth (m)	Flow (m/s)	Flow in m <sup>3</sup> /day	<i>E. coli</i> (cfu/100ml)	Loading ( <i>E. coli</i> per day)
1	LR003	NX 02643 71700	Stream	0.16 <sup>1</sup>	0.01	-	-	500	-
2	LR004	NX 03070 71347	Stream <sup>2</sup>	-	-	-	-	190	-
3	LR005	NX 03330 70888	Stream <sup>2</sup>	-	-	-	-	70	-
4	LR015	NX 05073 72750	Water of App	3.9	0.7 <sup>1</sup>	3.0	720000	140	$3.6 \times 10^{12}$
5	LR016	NX 05871 70264	Culvert <sup>2</sup>	1.7	-	-	-	10	-
6	LR017	NX 06162 68938	Glenburn <sup>2</sup>	1.0	0.45	-	-	3900	-
7	LR018	NX 07026 67709	Claddy House Burn	1.8	0.11 <sup>1</sup>	0.2	3400	70	$2.4 \times 10^9$

<sup>1</sup>Average

<sup>2</sup>Unable to measure dimensions and/or flow of stream

It was only possible to calculate loadings for the two larger burns. The Water of App had the largest *E. coli* loading of  $3.6 \times 10^{12}$  per day: it receives human sewage discharge via two private (primary) sewage discharges. The water sample taken from Glenburn showed the highest *E. coli* concentration at 3900 cfu/100 ml.

In general, loadings of streams would be expected to increase significantly following moderate to heavy rainfall and thus their potential effects on the microbiological quality of the razors would also increase. The dry stream would be expected to flow under such conditions. Given the steep sided nature of the land surrounding the loch, there is also the potential for direct run-off after rainfall. All of these would be potential pathways for contamination from animal faeces to enter the loch.



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Figure 6.1 Stream loadings and *E. coli* results at Loch Ryan North

## 7. Historical *E. coli* Monitoring Data

### 7.1 Validation

The *E. coli* results of all the razor samples taken from Loch Ryan from December 2007 to October 2010 were extracted from the database and validated according to the criteria described in the standard protocol for validation of historical *E. coli* data.

No samples were rejected on the basis of sampling date discrepancies. The two samples taken in 2007 were rejected on the basis of having no grid reference.

All *E. coli* results are reported in most probable number (MPN) per 100 g of shellfish flesh and intravalvular fluid.

### 7.2 Summary of sampling and results by species/monitoring point

A summary of the number of samples and the *E. coli* results is presented in Table 7.1.

Table 7.1 Summary of historical results from Loch Ryan, Loch Ryan Central, Loch Ryan Kirkland and Loch Ryan North

Sampling Summary <sup>1</sup>				
Production area	Loch Ryan	Loch Ryan Central	Loch Ryan Kirkland	Loch Ryan North
Site	Lady Bay	Lady Bay	North Scar	North Razors
Species	Razor clams	Razor clams	Razor clams	Razor clams
SIN	DG 412 812 16	DG 525 828 16	DG 459 866 16	DG 500 866 16
Total no of samples	4	3	2	6
n 2008	2	3	0	0
n 2009	2	0	2	0
n 2010	0	0	0	6
Results Summary				
Minimum	<20*	<20*	70	<20*
Maximum	20	1700	160	130
Median			85	65
Geometric mean			110	42

<sup>1</sup>Too few results were available for the derivation of other summary statistics



### 7.3 Temporal pattern of results

Figure 7.1 presents a scatter plot of the individual log *E. coli* results against date for all razor clam samples taken from Loch Ryan.

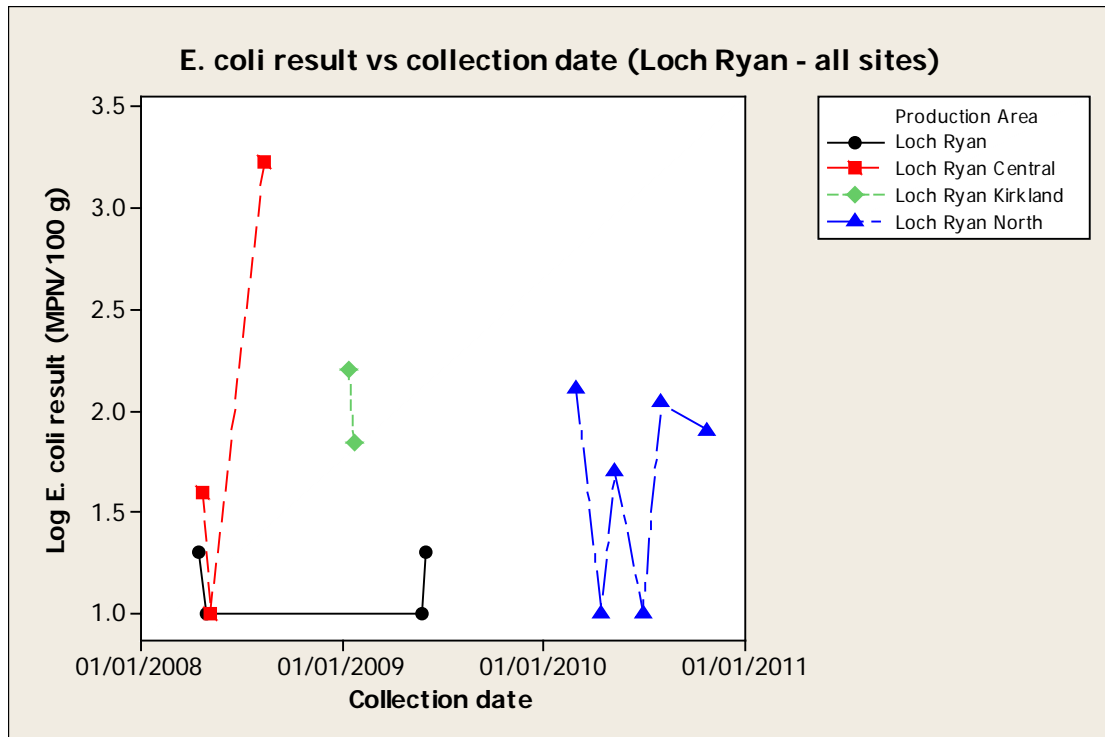
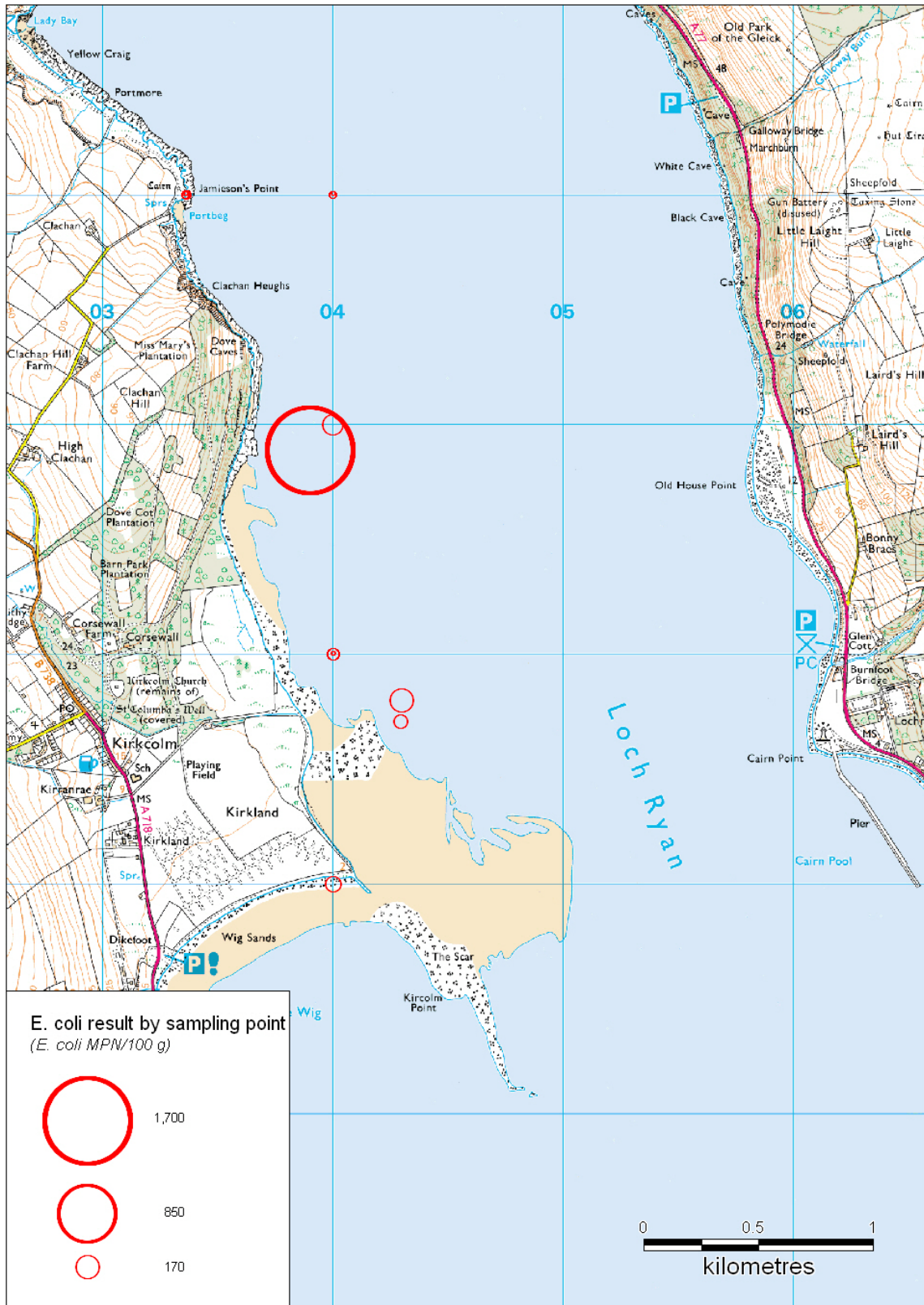


Figure 7.1 Scatter plot of *E. coli* result (MPN/100 g) for razor clams vs. collection date on log scale

No overall trends are apparent from Figure 7.1. A total of five samples were collected in 2008, four in 2009 and six in 2010. The sample with the highest result of 1700 *E. coli* MPN/100 g was taken in 2008.

### 7.4 Geographical pattern of results

Figure 7.2 shows a thematic map with the *E. coli* results plotted at the sampling locations of razor clams at Loch Ryan. Monitoring results were higher in the southern half of the production area. The plotted location of one of the samples fell just to the south-east of the production area and RMZ boundaries and the plotted locations of two of the samples fell just to the east of the RMZ boundaries. However, the sampling locations were only recorded to the nearest 100 m.



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Figure 7.2 *E. coli* result (MPN/100 g) by sampling location for razor clams at Loch Ryan

## 8. Bathymetry and Hydrodynamics

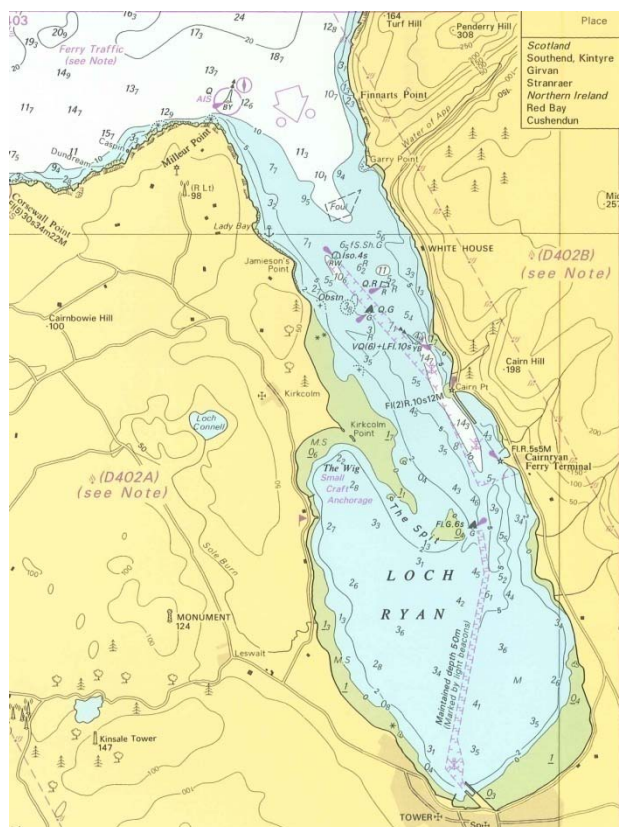


Figure 8.1 Loch Ryan hydrographic chart<sup>1</sup>

Figure 8.2 Loch Ryan OS Map<sup>2</sup>

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Loch Ryan is approximately 15 km long. Edwards and Sharples (1991) identify that there is one sill within the loch. The sill runs across the loch at the point of the top of the western shore drying area. There is a basin within the loch that is a maximum of approximately 15 m in depth: this lies off the eastern shore opposite The Spit. Depths also increase to more than 10 m at the mouth of the loch. The hydrographic chart in Figure 8.1 shows there is a significant drying area (also marked as shellfish beds on the chart) at both the south-eastern end of the loch and on the western side in the vicinity of the razor clam bed, where this forms The Spit. There is also drying area on the south-western side of the loch. Depths in the region of the of the razor fishery range up to about 5 m. The southern end of the loch past the spit are generally shallow (<5 m), apart from an area south of the Cairnryan ferry terminal, where depths reach up to 8 m and the ferry channel down to Stranraer has a maintained depth of 5 m. Figure 8.2 shows the Ordnance Survey map of Loch Ryan, with the locations of tidal diamonds plotted.

The two tidal curves in Figure 8.3 are for the port of Stranraer, the standard harmonic port located at the head of Loch Ryan. These have been output from UKHO TotalTide. The first is for seven days beginning 00.00 GMT on 20<sup>th</sup> August 2010. The second is for seven days beginning 00.00 GMT on 27<sup>th</sup> August 2010. Together they show the

predicted tidal heights over high/low water for the full neap/spring tidal cycle during which the shoreline survey was undertaken.

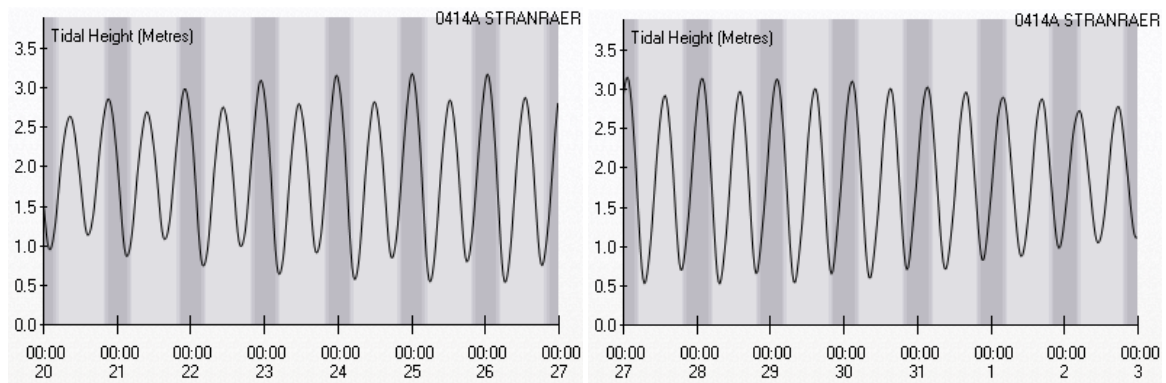


Figure 8.3 Tidal curves for Stranraer

The following is the UKHO summary description for Stranraer:

The tide type is Semi-Diurnal.

MHWS	3.2 m
MHWN	2.7 m
MLWN	1.0 m
MLWS	0.4 m

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Predicted heights are in metres above chart datum. The tidal range at spring tide is therefore approximately 2.8 m and at neap tide 1.7 m.

## 8.1 Currents

Tidal stream information available was from TotalTide for four tidal diamonds (SN0441E, SN041F, SN041G, SN041H) located in Loch Ryan (see Figure 8.2). The tidal diamond information is given below in Tables 8.1 to 8.4. The associated spring tidal streams are shown in Figure 8.4 (flood tide) and Figure 8.5 (ebb tide).



Table 8.1 Tidal diamond for station SN041E (North tidal diamond)

Time	Direction	Spring rate (m/s)	Neap Rate (m/s)
-06h	018°	0.15	0.10
-05h	110°	0.21	0.15
-04h	135°	0.31	0.21
-03h	154°	0.36	0.21
-02h	161°	0.46	0.31
-01h	161°	0.41	0.26
HW	167°	0.26	0.21
+01h	212°	0.10	0.10
+02h	299°	0.26	0.15
+03h	325°	0.41	0.26
+04h	336°	0.51	0.31
+05h	345°	0.46	0.31
+06h	357°	0.26	0.15

Table 8.2 Tidal diamond for station SN041F

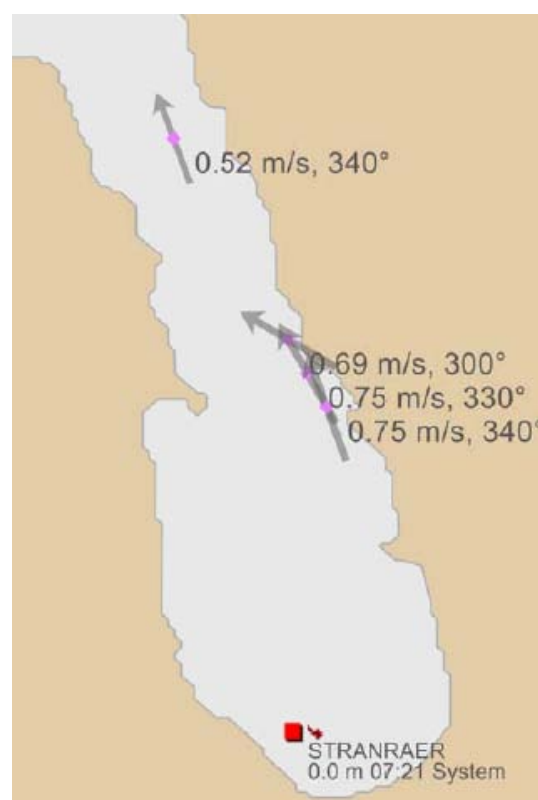
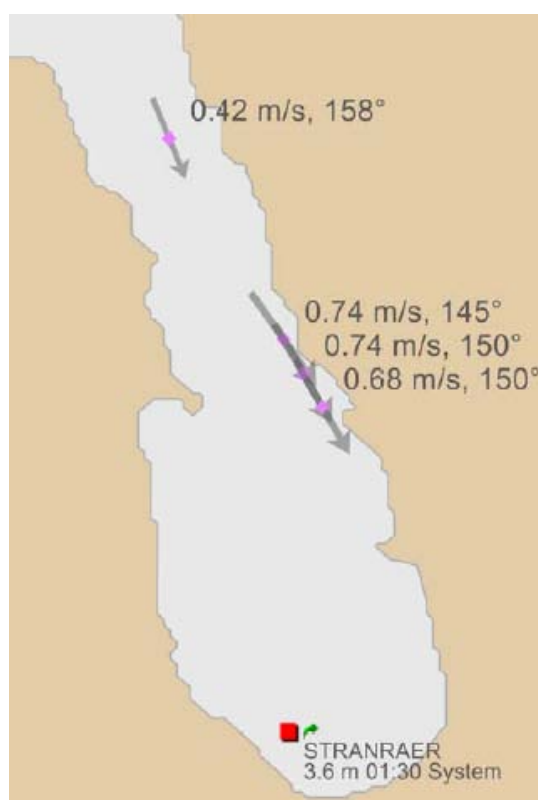
Time	Direction	Spring rate (m/s)	Neap Rate (m/s)
-06h	145°	0.31	0.21
-05h	145°	0.57	0.36
-04h	145°	0.67	0.41
-03h	145°	0.51	0.31
-02h	145°	0.31	0.21
-01h	145°	0.10	0.05
HW		0.00	0.00
+01h	300°	0.15	0.10
+02h	300°	0.31	0.21
+03h	300°	0.62	0.36
+04h	300°	0.62	0.36
+05h	300°	0.31	0.21
+06h	145°	0.21	0.10

Table 8.3 Tidal diamond for station SN041G

Time	Direction	Spring rate (m/s)	Neap Rate (m/s)
-06h	150°	0.26	0.15
-05h	150°	0.51	0.31
-04h	150°	0.67	0.41
-03h	150°	0.57	0.36
-02h	150°	0.41	0.26
-01h	150°	0.21	0.10
HW		0.00	0.0
+01h	330°	0.26	0.15
+02h	330°	0.46	0.31
+03h	330°	0.67	0.41
+04h	330°	0.46	0.26
+05h	330°	0.15	0.10
+06h	150°	0.15	0.10

Table 8.4 Tidal diamond for station SN041H

Time	Direction	Spring rate (m/s)	Neap Rate (m/s)
-06h	150°	0.15	0.10
-05h	150°	0.41	0.26
-04h	150°	0.62	0.36
-03h	150°	0.62	0.36
-02h	150°	0.46	0.26
-01h	150°	0.26	0.15
HW		0.00	0.00
+01h	340°	0.31	0.15
+02h	340°	0.57	0.36
+03h	340°	0.67	0.41
+04h	340°	0.36	0.21
+05h	340°	0.10	0.05
+06h	150°	0.10	0.05



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Figure 8.4 Spring flood tide at Loch Ryan

Figure 8.5 Spring ebb tide at Loch Ryan

The tidal stream predictions from TotalTide indicate that the peak current speeds off the eastern shore of the loch are in the order of 0.7 m/s (1.4 knots). Under these conditions, contaminants would travel approximately 10 km over a flood or ebb tide, ignoring any dilution or dispersion. The streams in the vicinity of the basin (and the eastern side of the fishery) run parallel to the shore throughout the flood and ebb tides. Towards the loch mouth, this bidirectional flow is modified to some extent.

The Clyde Cruising Club Sailing Directions and Anchorages for Firth of Clyde (2007) identifies that the tides are less than 1.5 knots in either direction in the channel between the shoal extending from the west shore and two cables off the east shore between Cairn Pt and Cairnryan ferry terminal. It identifies that streams are weak

further with the loch beyond The Spit and that a strong tide can be experienced at the end of The Spit, especially with an ebb tide.

Edwards and Sharples (1991) give a current speed at the sill of 23 cm/s (0.23 m/s). They also gave a flushing period for the loch of 1 day.

There is no information on the modification of flows within the bay formed by The Spit.

Due to the aspect of Loch Ryan, northerly winds are likely to increase flood currents, reduce ebb currents, and prolong high tides.

Edwards and Sharples (1991) give the fresh to tidal flow ratio as 3 with a predicted salinity reduction of 0.1 ppt. ratio Salinities recorded during the shoreline survey ranged from 34 to 36.2 ppt., confirming little fresh water influence.

## **8.2 Conclusions**

At the razor clam bed, the seabed shelves gradually from the drying area towards the basin off the eastern shore. There will be limited dilution of contaminants on the western side of the bed but a greater level on the eastern side. Contaminants will generally be carried parallel to the shore and the greatest impact on the fishery will be from sources of the western side of the loch. Although contamination associated with sources on the eastern side of the loch would not be taken over the razor bed on a first flood or ebb tide, they could be carried there on a returning tide. The relatively large predicted tidal excursion means that any major sources of contamination at the head (or mouth) of the loch could impact at the razor clam bed, especially during spring tides. Contamination arising from sources adjacent to the fishery will be carried across the razor clam bed on the ebbing tide.

## 9. Shoreline Survey Overview

A restricted shoreline survey of the Loch Ryan North shoreline was undertaken by staff from Dumfries and Galloway Council on the 1<sup>st</sup> September 2010.

Sewage works and two outfall pipes were located in Kirkcolm on the western shoreline and the three pumping stations, a single septic tank and another outfall pipe were observed in Cairnryan on the eastern shoreline.

Livestock were only observed in one location surrounding the loch during the shoreline survey. Approximately 40-50 cattle were observed grazing on the western shoreline of Loch Ryan, north of Kirkcolm.

During the survey 4 mergansers were observed in the water on the west shoreline of the production area. A single seal was also observed resting on rocks on the north western shoreline. In addition to mergansers, gulls, oyster catchers, ducks and geese were also observed along the western shoreline but numbers or exact locations were not recorded.

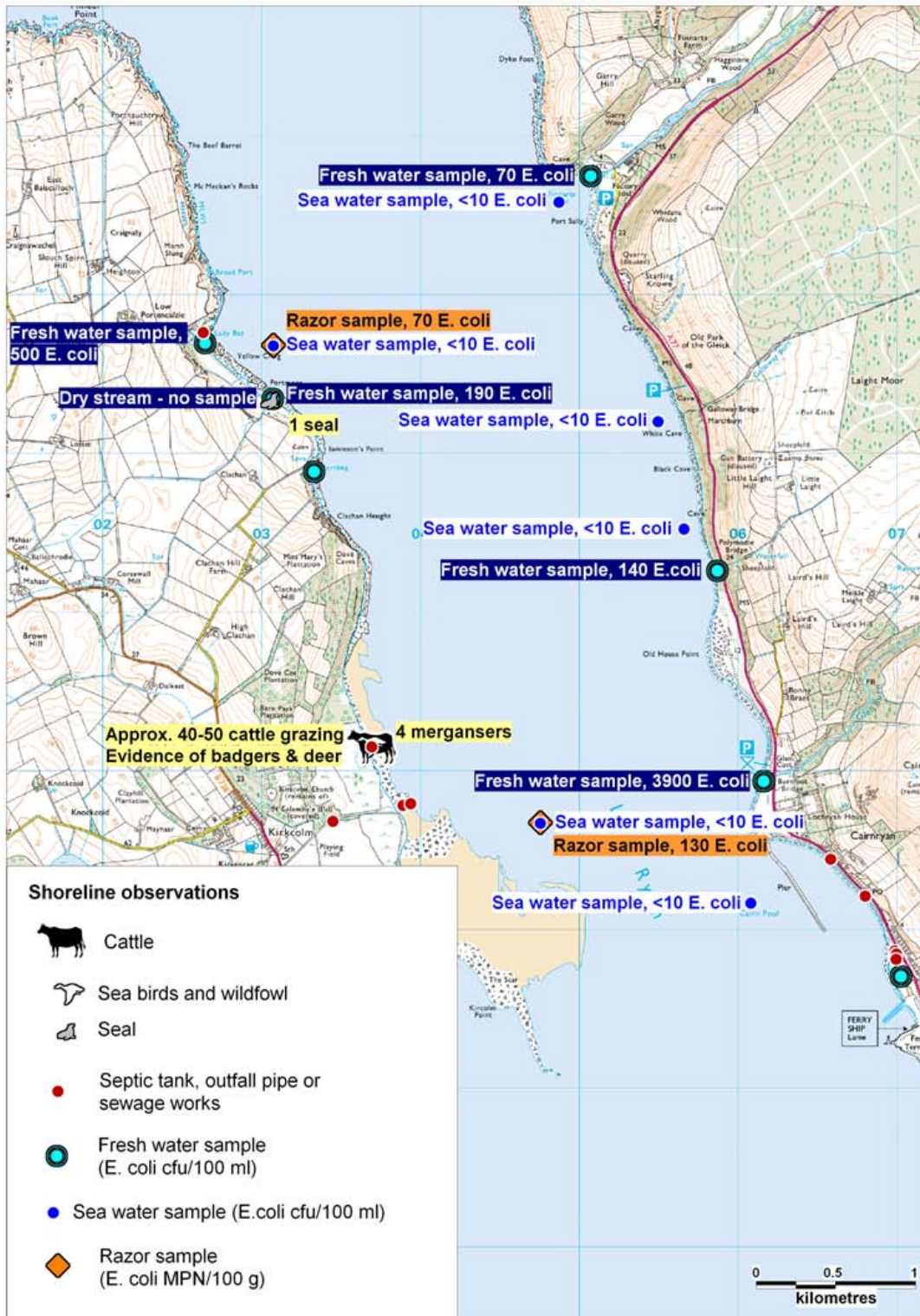
Sub-surface seawater samples were taken from several points along the Loch Ryan North coastline. Four samples were taken along the eastern shoreline and the remaining two were taken at the same location as the razor samples. All the results were below the limit of detection of the test, at <10 *E. coli* cfu/100 ml. Salinities recorded during the shoreline survey ranged from 34 to 36.2 ppt.

Freshwater samples were taken at most of the streams draining into the survey area and discharge measurements were taken where possible. The Glenluce burn freshwater sample had the highest result of 3900 *E. coli* cfu/100 ml. The streams were of varying size and drained areas of arable and grazing land.

Razor clam samples were collected from two points within the production area. The sample taken at the north west end of the site had a result of 70 *E. coli* MPN/100 g and the sample taken from the south west end of the site had a result of 130 *E. coli* MPN/100 g.

A map is provided in Figure 9.1 that shows the relative locations of the most significant findings of the shoreline survey.





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Figure 9.1 Summary of shoreline observations

## **10. Overall Assessment**

### **Fishery**

Natural razor beds are found in the sub tidal sandy beds of Loch Ryan and are inaccessible other than by boat. The area of interest has been identified as being largely confined to the previously identified RMZ. The razor clams are hand dived and harvesting is planned to take place throughout the year. To the south of the production area there is a natural oyster bed which is harvested seasonally and has an 'A' classification.

### **Human sewage inputs**

Human sewage is likely to directly impact the razor bed. On the east and west shorelines of the fishery, adjacent to the production area are the towns of Cairnryan and Kirkcolm. Both towns have numerous sewage discharges that discharge directly into the present production area, Cairnryan on the eastern shore and Kirkcolm on the western. South of the production area is the large town of Stranraer, which also has numerous sewage discharges discharging into the loch. In total there are fifteen Scottish Water sewage discharges entering the loch. However, of these only two are continuous, the remaining are all intermittent so will not be operating except under spill conditions. In addition to the towns, there are three large caravan sites with a combined total of approximately 507 units, so it is expected that the population in the area will increase significantly during the summer holiday months.

Four outfall pipes, one septic tank, three septic tank pumping stations and a sewage works were observed during the shoreline survey.

There are two ferry routes operating within the loch, one from Stranraer to Belfast and the other from Cairnryan to Larne. Both ferry routes run directly over the production area. However, the sewage from both of the ferries is taken off at their destinations of Larne and Belfast, so this will not be a contributing factor.

The proposed changes to sewage treatment and discharge arrangements in the area are likely to alter the way that human sewage inputs affects water quality within the loch. However, the changes will not take place in the near future and therefore will not be considered within the present assessment.

### **Agricultural inputs**

RERAD data indicated cattle and sheep predominate in the agricultural parishes around the loch, with the former being somewhat more numerous than the latter in the parish of Kirkholm. Consistent with this, approximately 40-50 cattle were observed on the western shoreline of the production area during the shoreline survey. Faecal contamination from cattle and sheep will impact on the western side of the present production area where the razor clam bed is located.

### **Wildlife inputs**

Mergansers, gulls, oyster catchers, ducks and geese were observed on the western coast of the loch during the shoreline survey. A single seal and evidence of badgers

and deer were also observed on the same shoreline. As most seabirds will roost and nest on land or at the coastline, any contamination is likely to be greater near to the coast. Faecal contamination from the deer and other land animals is likely to be carried via stream runoff to the sea. On present evidence, the impact from these sources is likely to be markedly less than that from human and agricultural sources.

### **Rivers and streams**

The locations of eight streams/burns were recorded at the northern end of Loch Ryan during the shoreline survey. One of these streams was dry, two were sampled and measured for flow and the remaining were only sampled. The Water of App on the north-eastern shoreline had a high loading of  $3.6 \times 10^{12}$  *E. coli* per day. The other stream measured and sampled, located south of the production area on the eastern shoreline also had a moderate loading of  $2.4 \times 10^9$  *E. coli* per day. Water samples taken from the remaining five streams had results ranging from 10 to 3900 *E. coli* cfu/100 ml, two of which were  $>230$  *E. coli* cfu/100 ml.

It must be noted that only a section of the shoreline was surveyed (that directly adjacent to the production area) and the Ordnance Survey map indicates that there are more potential freshwater inputs to the loch further south. Overall it is expected that contaminated freshwater inputs, like the Water of App will have an impact on water quality within the present razor clam production area. However, given that the razor clam bed lies in the western half of that area, it is more likely that any effects on the bacteriological quality of the razor clams themselves will be derived from the small streams on the western shore.

### **Rainfall**

Rainfall patterns at Castle Kennedy (the nearest rainfall station) show that seasonal variation in rainfall levels occurs and the wettest months were between December to January and March. An increase in rainfall may be expected to wash a flush of bacteria from the surrounding land into the production area, particularly when high rainfall events occur after a dry period. The impact of such events is likely to be most acute nearest where the streams enter the loch.

### **Analysis of results**

Historical *E. coli* monitoring results were available for Loch Ryan from 2008 to present. Due to the limited number (15) of results available at the time of the data analysis, it was not possible to determine whether there were any seasonal effects. The highest result (1700 *E. coli* MPN/100 g) was obtained from the northern half of the present RMZ. There appeared to be no general geographical trend in the other results which were all much lower than this (maximum: 160 *E. coli* MPN/100 g).

During the shoreline survey, razor clam samples were collected from two points within the loch. The sample taken at the north end of the production area had a result of 70 *E. coli* MPN/100 g and the sample taken at the southern end of the production area had a slightly higher result of 130 *E. coli* MPN/100 g.

Sea water samples were taken from six points within the boundaries of the present production area and all returned results of  $<10$  *E. coli* cfu/100 ml, less than the limit of detection of the test as used.

## **Movement of contaminants**

Due to the strongly bimodal direction of the tidal streams in the vicinity of the razor fishery, contamination arising from sources on the eastern bank is unlikely to impact to any extent on the razor bed itself and sources on the western bank will be more significant. Dilution of faecal contamination near to the shore will be limited. The predicated transport distance over a tidal cycle means that contamination arising in the vicinity of Stranraer and Leswalt may reach the razor bed.

## **Other considerations**

Construction of the new ferry terminal north of Cairnryan, to be opened in 2011, is likely to cause disturbance of sediment. Contaminants, including bacteria and viruses, located in the sediment may then impact on the eastern side of the razor clam fishery.

## **Overall conclusions**

Of the identified sources of contamination on the western side of the loch, in the vicinity of the identified razor clam fishery, those most likely to affect the fishery are the public and private sewage discharges at Kirkholm and the farm animals, both located towards the middle of the shore adjacent to the fishery, and the small streams located to the north of the fishery. Other sewage discharges on the southern and south-western shores may impact the southern end of the razor bed towards the end of spring ebb tide. However, they will be subject to significant dilution by the time they reach the fishery. Sources on the eastern side of the loch have the potential to impact on the water quality on the eastern side of the current production area but it has been identified that this part of the production area is not presently used for the commercial gathering of razors.



## 11. Recommendations

### Production area

The recommended production area is the area bounded by lines drawn between NX 0330 7117 and NX 0414 7117 and between NX 0414 7117 and NX 0488 6800 and between NX 0488 6800 and NX 0413 6800 extending to MHWS. This area encompasses the extent of the known razor clam fishery and excludes potential sources of contamination on the eastern shore of the loch and to the north of the present fishery.

### RMZ

The recommended monitoring zone is the area bounded by lines drawn between the following points: NX 0370 6930; NX 0410 6930; NX 0440 6865; NX 0400 6865. This is the area known to be covered by the present razor fishery and is close to the main identified sources of contamination on the western shore. The area should be large enough to allow samples to be obtained on an ongoing basis.

The location of samples obtained within the RMZ should be recorded to 10 m accuracy and the results assessed spatially at such time as the sanitary survey is reviewed.

### Tolerance

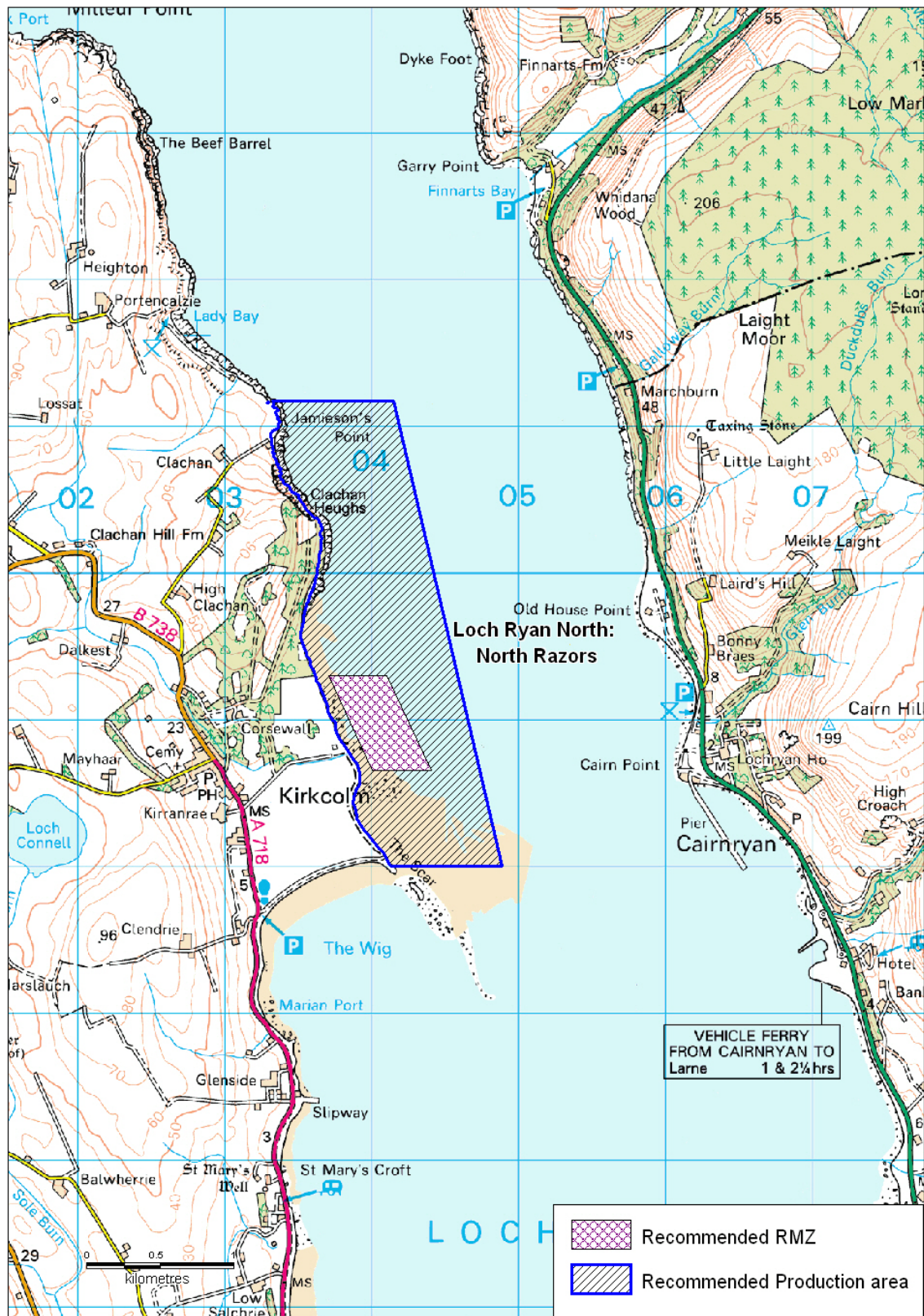
A tolerance is not applicable as an RMZ has been recommended instead of an RMP.

### Depth

Specification of depth is not appropriate as the samples will be hand-gathered by diving.

### Frequency

Given the limited number of results available to date, samples should be obtained on a monthly basis until sufficient results are available on which to base a further review of the frequency.



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Figure 11.1 Recommendations for Loch Ryan North

## 12. References

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2. Comparative Table of Boundaries and RMPs
3. Restricted Shoreline Survey Report
4. SEPA Discharge Consents – Soakaways

### Sampling Plan for Loch Ryan North

PRODUCTION AREA	Loch Ryan North
SITE NAME	North Razors
SIN	DG 500 866 16
SPECIES	Razor clams ( <i>Ensis</i> spp)
TYPE OF FISHERY	Wild
BOUNDARY POINTS OF RMZ	NX 0370 6930; NX 0410 6930; NX 0440 6865; NX 0400 6865
TOLERANCE (M)	N/A
DEPTH (M)	N/A
METHOD OF SAMPLING	Hand dived
FREQUENCY OF SAMPLING	Monthly
LOCAL AUTHORITY	Dumfries & Galloway Council
AUTHORISED SAMPLER(S)	Kirsty McGuigan, Matthew Murdoch
LOCAL AUTHORITY LIAISON OFFICER	Kirsty McGuigan

### Comparative Table of Boundaries and RMPs – Loch Ryan North

PRODUCTION AREA	Loch Ryan North
SPECIES	Razor clams ( <i>Ensis</i> spp)
SIN	DG 500 866 16
EXISTING BOUNDARY	The area bounded by lines drawn between points NX 0240 7300 to NX 0475 7300 and between NX 0414 6800 to NX 0695 6800 extending to MHWS.
EXISTING SAMPLING AREA (RMZ)	The area defined by the points NX 0414 6800, NX 0414 7100, NX 0340 7100 extending to MHWS.
RECOMMENDED BOUNDARY	The area bounded by lines drawn between NX 0330 7117 and NX 0414 7117 and between NX 0414 7117 and NX 0488 6800 and between NX 0488 6800 and NX 0413 6800 extending to MHWS.
RECOMMENDED RMZ	The area bounded by lines drawn between the points: NX 0370 6930, NX 0410 6930, NX 0440 6865 and NX 0400 6865.
COMMENTS	Both the production area and the RMZ have been reduced in size.

## Shoreline Survey Report

Production area: Loch Ryan North  
 Site name: North Razors (DG 500 866 16)  
 Species: Razor clams  
 Harvester: John Mitchell  
 Local Authority: Dumfries & Galloway Council  
 Status: New application

Date Surveyed: 1<sup>st</sup> & 2<sup>nd</sup> September 2010  
 Surveyed by: 1<sup>st</sup> September: M Murdoch (Dumfries & Galloway Council), K McGuigan (Dumfries & Galloway Council),  
 Observer: M Price-Hayward (Cefas)  
 Existing RMP: N/A  
 Area Surveyed: See Figure 1.

### Weather

Dry and sunny with SE winds, average 13.5 knots. Air temp 17<sup>0</sup>C. Seas were very calm throughout the survey period.

### Site Observations:

#### Fishery

The western side of the loch is currently fished for Razor clams (*Ensis* sp.). Natural razor clam beds are found in the sub tidal sandy beds and are inaccessible other than by boat. The razors are harvested all year round.

To the south of the survey area is a natural oyster bed which was not included in this survey.

### Sewage/Faecal Sources

#### Human

The area of highest human population in the vicinity of the Loch Ryan North fishery is the town of Stranraer, approximately 7 km south of the production area at the head of the loch. There is also Kirkcolm on the south-western shore of the fishery and on the south-eastern shoreline is the settlement of Cairnryan. Kirkcolm has a sewage treatment works and three additional outfall pipes were observed in this area. On the eastern shoreline close to Cairnryan an additional four septic tank outflows were observed. Dog walkers were observed on the south west shoreline of the production area.

#### Livestock

Agricultural land covers the south western shoreline of the fishery and approximately 40 – 50 cattle were observed in a field adjacent to the production area. Horse manure was also observed on the beach in this area. No other livestock was observed at the time of the shoreline survey.

### Seasonal Population

There are three caravan sites situated around Loch Ryan, so a seasonal fluctuation in human population in the area is likely. On the eastern shoreline is a caravan site at Cairnryan that has licences for 110 units and further south, outside of the production area and close to the head of the loch is another



caravan site that has licences for 200 units. On the western shoreline there is a further caravan site at Wig Bay that has licences for 197 units.

### **Boats/Shipping**

There is a ferry terminal at Cairnryan, that receives 10 ferries a day to and from Larne, Northern Ireland. Stenaline are in the process of constructing a new ferry terminal just north of Cairnryan, due to be completed August 2011 and operational September 2011. A sewage treatment plant is being constructed on site that will also treat the sewage from Cairnryan. The plans have changed since submission and it is understood they will be changed again so the exact location of the sewage treatment plant is unknown at present. There is also a once daily return ferry from the Stranraer ferry terminal to Belfast.

### **Land Use**

The land use surrounding the production area is primarily agricultural with a mix of arable and grazing land. There is an 18 hole golf course just south of the survey area on the western shore. The southwest shoreline north near Kirkland is used by dog walkers and horse droppings were observed on the beach there.

### **Wildlife/Birds**

On the western coast of the loch various gulls, oyster catches, ducks and geese were seen. Mergansers were also seen in the loch. A badger set was evident on the upper shoreline, and evidence of rabbits and deer were also found. Large numbers of razor clam, oyster and mussel shells were found on the shoreline. A seal was seen on rocks on the north western shoreline.

### **General observations**

Recorded observations apply to the date of survey only. Animal numbers were recorded on the day from the observer's point of view. This does not necessarily equate to total numbers present as natural features may obscure individuals and small groups of animals from view.

Dimensions and flows of watercourses were estimated at the most convenient point of access and not necessarily at the point at which the watercourses enter the loch.



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Figure 1. Shoreline observations

Table 1 Shoreline Observations

No	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
1	01/09/2010	10:11	NX 03853 68753	203853	568753			Stagnant pond, large numbers of rabbit droppings surrounding the pond (Courswell burn flows into this).
2	01/09/2010	10:24	NX 03449 68690	203449	568690	Figure 4		Kirkcolm Sewage Works.
3	01/09/2010	10:35	NX 03891 68789	203891	568789	Figure 5	FW LR001	Sewage outfall pipe. Fresh water sample 1 (LR001). Sample taken at broken point of outfall pipe. Wind S.E. 13.5 knots. Temp 170C.
4	01/09/2010	10:39	NX 03940 68799	203940	568799	Figure 6		End of outfall pipe.
5	01/09/2010	10:58	NX 03693 69159	203693	569159	Figure 7		Disused pipe - No flow, no signs of flow. Mussels growing inside pipe. Horse manure on beach, badger set, various gulls evident, 4 mergansers in sea, evidence of deer. Beach commonly used for dog walking. Agricultural land surrounding survey area – one field with approximately 40-50 cattle grazing.
6	01/09/2010	12:41	NX02631 71768	202631	571768		FW LR002	Fresh water sample 2 (LR002). Outfall pipe at Lady Bay, no flow to measure. Large numbers of razor shells on shore.
7	01/09/2010	12:57	NX02643 71700	202643	571700	Figure 8 & figure 9	FW LR003	Small stream fresh water sample 3 (LR003): Depth 0.01-0.02 m, width 0.10 – 0.22 m. Flow measurement not possible.
8	01/09/2010	13:18	NX 02961 71396	202961	571396			Evidence of stream – dry. Dog walkers x 2 on beach, 3 dogs.
9	01/09/2010	13:23	NX 03070 71347	203070	571347	Figure 10	FW LR004	Spring fresh water sample 4 (LR004). not able to take flow – too winding and pebbly. Seaweed and razor and mussel shells in stream. Seal on rocks.
10	01/09/2010	13:45	NX03330 70888	203330	570888		FW LR005	Small stream, fresh water sample 5 (LR005).
11	01/09/2010	13:54	NX 03315 70944	203315	570944		FW LR006	Runoff from soakaway, fresh water sample (contaminated) 6 (LR006).
12	02/09/2010	10:04	NX05073 72750	205073	572750	Figure 11	FW LR015	Stream, fresh water sample 7 (LR015): Width 3.9 m, depth 0.50 – 0.90 m. Flow (pooh stick method) 3.04m/s.
13	02/09/2010	10:12	NX05055 72799	205055	572799			Unknown fixed structure – no pipe work evident nearby, cover for tank from disused food factory.
14	02/09/2010	10:24	NX05109 72398	205109	572398	Figure 12		New culvert - Horse manure on shoreline.
15	02/09/2010	10:31	NX 05261 72734	205261	572734	Figure 13		Disused seafood factory (has not been in use for 6-7 years).
16	02/09/2010	11:10	NX05871 70264	205871	570264	Figure 14	FW LR016	Culvert – fresh water sample 8 (LR016). Flow measurement not possible. Width 1.74m.
17	02/09/2010	11:44	NX 06162 68938	206162	568938	Figure 15	FW LR017	Stream. Fresh water sample 9 (LR017): Width 1 m, depth 0.45 m, Flow measurement not possible – too many obstructions.



No	Date	Time	NGR	East	North	Associated photograph	Associated sample	Description
18	02/09/2010	11:57	NX06584 68451	206584	568451			Septic tank pumping station 1.
19	02/09/2010	12:02	NX06803 68217	206803	568217	Figure 16		Septic tank pumping station 2.
20	02/09/2010	12:08	NX06990 67872	206990	567872	Figure 17		Sewage pumping station 3.
21	02/09/2010	12:09	NX 06999 67853	206999	567853	Figure 18		Septic tank.
22	02/09/2010	12:13	NX06997 67819	206997	567819	Figure 19		Black outfall pipe – dry.
23*	02/09/2010	12:16	NX 07026 67709	207026	567709	Figure 20	FW LR018	Fresh water sample 10 (LR018) Glenburn. Width 1.8 m, depth 0.10 – 0.12 m flow (pooh stick method) 0.2m/s.
24*	02/09/2010		NX 0307371685	203073	571685		Razor LR007, SW LR008	Razor sample LR007 & Sea water sample LR008
25*	02/09/2010		NX 0475668676	204756	568676		Razor LR009, SW LR010	Razor sample LR009 & Sea water sample LR010
26*	02/09/2010		NX 0549771207	205497	571207		SW LR011	Sea water sample LR011
27*	02/09/2010		NX 0566070531	205660	570531		SW LR012	Sea water sample LR012
28*	02/09/2010		NX 0608168173	206081	568173		SW LR013	Sea water sample LR013
29*	02/09/2010		NX 0487472590	204874	572590		SW LR014	Sea water sample LR014

Photographs referenced in the table can be found attached as Figures 4 – 20.

\* Observations 24-29 were made by the harvester, who collected shellfish and water samples from these points.

## Sampling

Water and shellfish samples were collected at sites marked in the maps in figures 2 and 3.

Razor samples were collected from two points along the western shoreline of the Loch Ryan North production area.

Bacteriology results follow in Tables 2 and 3.

Samples of seawater were tested for salinity by the laboratory using a salinity meter under controlled conditions. These results are shown in Table 2, given in units of grams salt per litre of water. This is the same as parts per thousand (ppt).

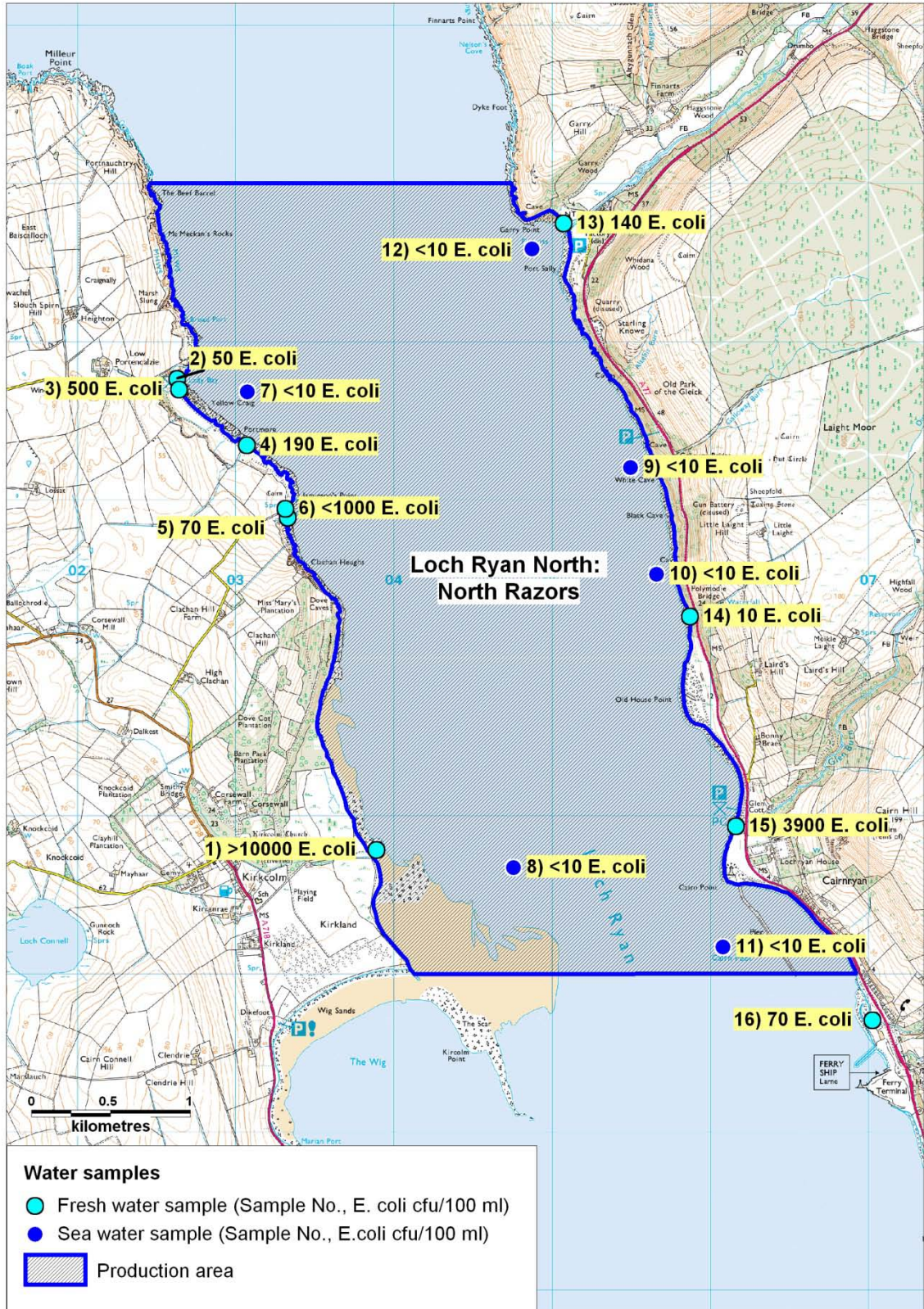
Table 2 Water sample results

No.	Date	Sample	Grid Ref	Type	<i>E. coli</i> (cfu/100ml)	Salinity (g/L)
1	01/09/2010	LR001	NX 03891 68789	Fresh water	>10000	
2	01/09/2010	LR002	NX 02631 71768	Fresh water	50	
3	01/09/2010	LR003	NX 02643 71700	Fresh water	500	
4	01/09/2010	LR004	NX 03070 71347	Fresh water	190	
5	01/09/2010	LR005	NX 03330 70888	Fresh water	70	
6	01/09/2010	LR006	NX 03315 70944	Fresh water	<1000	
7	02/09/2010	LR008	NX 03073 71685	Sea water	<10	34.0
8	02/09/2010	LR010	NX 04756 68676	Sea water	<10	35.8
9	02/09/2010	LR011	NX 05497 71207	Sea water	<10	35.6
10	02/09/2010	LR012	NX 05660 70531	Sea water	<10	35.1
11	02/09/2010	LR013	NX 06081 68173	Sea water	<10	36.2
12	02/09/2010	LR014	NX 04874 72590	Sea water	<10	35.6
13	02/09/2010	LR015	NX 05073 72750	Fresh water	140	
14	02/09/2010	LR016	NX 05871 70264	Fresh water	10	
15	02/09/2010	LR017	NX 06162 68938	Fresh water	3900	

Table 3 Shellfish sample results

No.	Date	Sample	Grid Ref	Type	<i>E. coli</i> (cfu/100ml)
1	02/09/2010	LR007	NX 03073 71685	Razor clam	70
2	02/09/2010	LR009	NX 04756 68676	Razor clam	130

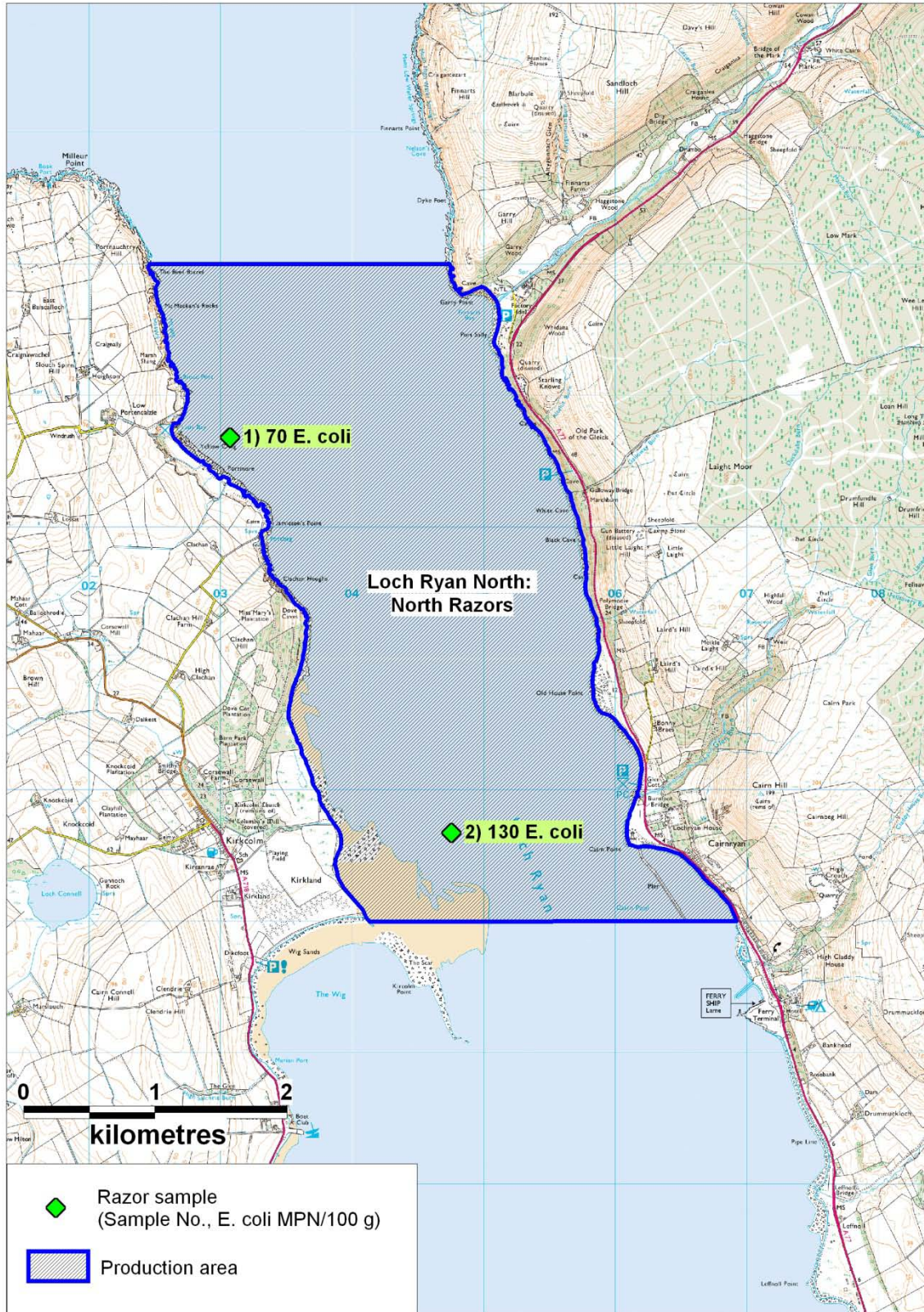




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Figure 3. Water sample results





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 Figure 4 Shellfish sample results



## Photographs



Figure 4. Kirkcolm sewage works



Figure 5. Sewage outfall pipe, location of water sample LR001





Figure 6. End of outfall pipe



Figure 7. Disused pipe



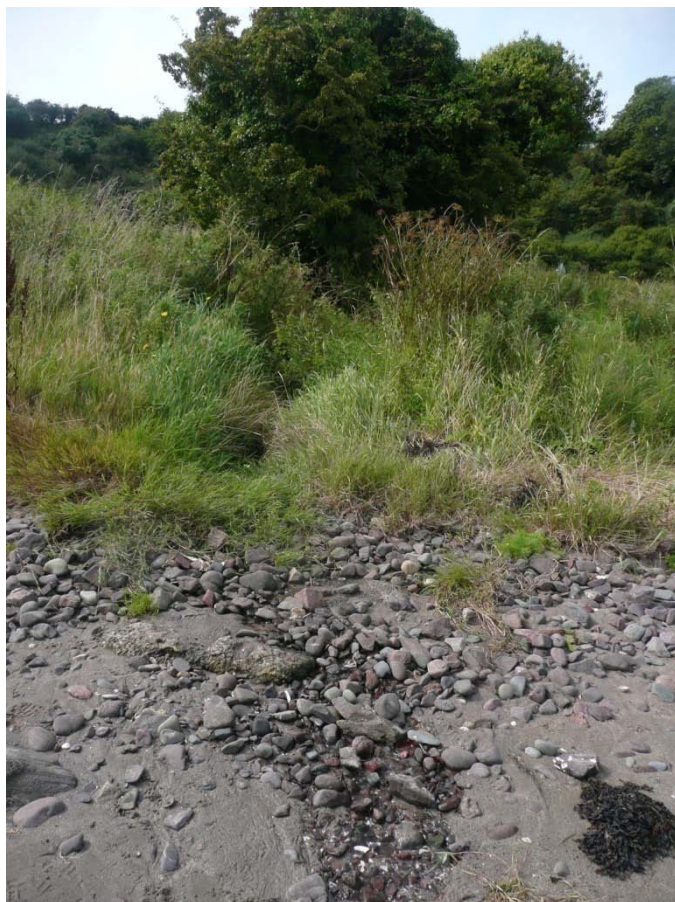


Figure 8. Small fresh water stream, location of water sample LR003



Figure 9. Goose Barnacles





Figure 10. Seal bathing on rocks



Figure 11. Stream, location of water sample LR015





Figure 12. New culvert



Figure 13. Disused seafood factory





Figure 14. Culvert, location of water sample LR016



Figure 15. Stream, location of water sample LR017





Figure 16. Septic tank outflow 2



Figure 17. Septic tank outflow 3





Figure 18. Septic tank



Figure 19. Black outfall pipe – dry





Figure 20. Glenburn, location of water sample LR018

## SEPA Discharge Consents – Soakaways

No.	Ref no.	Activity Actual	Type	National Grid Reference
1	CAR/R/1075606	Sewage (Private) Primary	Soakaway	NX 03276 64508
2	CAR/R/1075609	Sewage (Private) Primary	Soakaway	NX 02990 64340
3	CAR/R/1075611	Sewage (Private) Primary	Soakaway	NX 02810 64550
4	CAR/R/1074994	Sewage (Private) Primary	Soakaway	NX 02750 64690
5	CAR/R/1019613	Sewage (Private) Primary	Soakaway	NX 02501 64863
6	CAR/R/1052059	Sewage (Private) Primary	Soakaway	NX 02544 64139
7	CAR/R/1074625	Sewage (Private) Primary	Soakaway	NX 02620 63690
8	CAR/R/1022029	Sewage (Private) Primary	Soakaway	NX 02707 63562
9	CAR/R/1052027	Sewage (Private) Secondary	Soakaway	NX 02216 63987
10	CAR/R/1074319	Sewage (Private) Primary	Soakaway	NX 02250 63870
11	CAR/R/1070743	Sewage (Private) Primary	Soakaway	NX 01858 64416
12	CAR/R/1051760	Sewage (Private) Primary	Soakaway	NX 03370 66510
13	CAR/R/1051271	Sewage (Private) Primary	Soakaway	NX 01429 63836
14	CAR/R/1052873	Sewage (Private) Primary	Soakaway	NX 01399 63860
15	CAR/R/1051391	Sewage (Private) Primary	Soakaway	NX 01392 63862
16	CAR/R/1054483	Sewage (Private) Primary	Soakaway	NX 03196 66722
17	CAR/R/1018687	Sewage (Private) Primary	Soakaway	NX 01630 65970
18	CAR/R/1069799	Sewage (Private) Primary	Soakaway	NX 01134 63794
19	CAR/R/1071961	Sewage (Private) Primary	Soakaway	NX 01570 63020
20	CAR/R/1054520	Sewage (Private) Primary	Soakaway	NX 01360 66000
21	CAR/R/1021903	Sewage (Private) Primary	Soakaway	NX 01340 66100
22	CAR/R/1030980	Sewage (Private) Primary	Soakaway	NX 00570 65150
23	CAR/R/1069767	Sewage (Private) Primary	Soakaway	NX 00560 63900
24	CAR/R/1069923	Sewage (Private) Primary	Soakaway	NX 00616 63657
25	CAR/R/1072222	Sewage (Private) Primary	Soakaway	NX 00118 64919
26	CAR/R/1018125	Sewage (Private) Primary	Soakaway	NX 01210 67200
27	CAR/R/1054507	Sewage (Private) Primary	Soakaway	NX 01430 67390
28	CAR/R/1073011	Sewage (Private) Primary	Soakaway	NX 03024 68159
29	CAR/R/1069856	Sewage (Private) Primary	Soakaway	NX 03110 68274
30	CAR/R/1072476	Sewage (Private) Primary	Soakaway	NW 99725 65632
31	CAR/R/1019718	Sewage (Private) Primary	Soakaway	NX 00257 66972
32	CAR/R/1073745	Sewage (Private) Primary	Soakaway	NX 00610 67957
33	CAR/R/1017385	Sewage (Private) Primary	Soakaway	NX 00390 61330
34	CAR/R/1068645	Sewage (Private) Primary	Soakaway	NX 03151 69030
35	CAR/R/1051761	Sewage (Private) Primary	Soakaway	NX 04770 60294
36	CAR/R/1068626	Sewage (Private) Primary	Soakaway	NX 02741 69095
37	CAR/R/1052125	Sewage (Private) Primary	Soakaway	NX 03481 59935
38	CAR/R/1009295	Sewage (Private) Primary	Soakaway	NX 02360 59644
39	CAR/R/1009296	Sewage (Private) Primary	Soakaway	NX 02360 59644
40	CAR/R/1052506	Sewage (Private) Primary	Soakaway	NX 00798 59963
41	CAR/R/1016695	Sewage (Private) Primary	Soakaway	NW 99650 60680
42	CAR/R/1068615	Sewage (Private) Primary	Soakaway	NX 02670 69900
43	CAR/R/1068611	Sewage (Private) Primary	Soakaway	NX 02900 70290
44	CAR/R/1073918	Sewage (Private) Primary	Soakaway	NW 97897 66634

45	CAR/R/1073906	Sewage (Private) Primary	Soakaway	NW 97896 66658
46	CAR/R/1034874	Sewage (Private) Primary	Soakaway	NW 97490 65450
47	CAR/R/1070824	Sewage (Private) Primary	Soakaway	NW 99493 59820
48	CAR/R/1034289	Sewage (Private) Primary	Soakaway	NX 04747 58591
49	CAR/R/1034290	Sewage (Private) Primary	Soakaway	NX 04732 58576
50	CAR/R/1070826	Sewage (Private) Primary	Soakaway	NW 99720 59523
51	CAR/R/1072164	Sewage (Private) Primary	Soakaway	NX 06147 58933
52	CAR/R/1027232	Sewage (Private) Primary	Soakaway	NW 98201 68187
53	CAR/R/1068621	Sewage (Private) Primary	Soakaway	NX 02956 70872
54	CAR/R/1022357	Sewage (Private) Tertiary	Soakaway	NX 05750 58630
55	CAR/R/1022362	Sewage (Private) Primary	Soakaway	NX 05750 58630
56	CAR/R/1025508	Sewage (Private) Primary	Soakaway	NW 98224 68599
57	CAR/R/1066549	Sewage (Private) Primary	Soakaway	NX 05990 58560
58	CAR/R/1053272	Sewage (Private) Primary	Soakaway	NW 96980 66060
59	CAR/R/1071426	Sewage (Private) Secondary	Soakaway	NX 02900 71320
60	CAR/R/1034510	Sewage (Private) Primary	Soakaway	NX 01212 71049
61	CAR/R/1034511	Sewage (Private) Primary	Soakaway	NX 01207 71113
62	CAR/R/1053612	Sewage (Private) Primary	Soakaway	NX 03608 57600
63	CAR/R/1031933	Sewage (Private) Primary	Soakaway	NX 00600 71000
64	CAR/R/1015313	Sewage (Private) Primary	Soakaway	NW 98190 69510
65	CAR/R/1031932	Sewage (Private) Primary	Soakaway	NX 00730 71220
66	CAR/R/1057518	Sewage (Private) Primary	Soakaway	NX 06450 58060
67	CAR/R/1068147	Sewage (Private) Primary	Soakaway	NX 02226 71711
68	CAR/R/1068037	Sewage (Private) Primary	Soakaway	NX 01958 71704
69	CAR/R/1063382	Sewage (Private) Primary	Soakaway	NX 02230 71900
70	CAR/R/1080097	Sewage (Private) Primary	Soakaway	NX 00030 71203
71	CAR/R/1079106	Sewage (Private) Primary	Soakaway	NW 97520 59660
72	CAR/R/1072092	Sewage (Private) Primary	Soakaway	NX 00270 57540
73	CAR/R/1078575	Sewage (Private) Primary	Soakaway	NW 99450 57940
74	CAR/R/1035413	Sewage (Private) Primary	Soakaway	NX 09836 60263
75	CAR/R/1054295	Sewage (Private) Primary	Soakaway	NW 98187 70509
76	CAR/R/1011794	Sewage (Private) Primary	Soakaway	NW 97120 69410
77	CAR/R/1071541	Sewage (Private) Primary	Soakaway	NX 01189 56950
78	CAR/R/1076493	Sewage (Private) Primary	Soakaway	NX 00110 71840
79	CAR/R/1016382	Sewage (Private) Primary	Soakaway	NW 97200 69660
80	CAR/R/1009684	Sewage (Private) Primary	Soakaway	NX 01340 72520
81	CAR/R/1055558	Sewage (Private) Primary	Soakaway	NX 07742 57491
82	CAR/R/1071528	Sewage (Private) Primary	Soakaway	NW 99372 57137
83	CAR/R/1071518	Sewage (Private) Primary	Soakaway	NX 00631 56418
84	CAR/R/1021981	Sewage (Private) Primary	Soakaway	NW 98590 71870
85	CAR/R/1075902	Sewage (Private) Primary	Soakaway	NX 05163 55989
86	CAR/R/1072097	Sewage (Private) Primary	Soakaway	NX 05140 55980
87	CAR/R/1071406	Sewage (Private) Primary	Soakaway	NW 99000 56950
88	CAR/R/1056103	Sewage (Private) Primary	Soakaway	NX 05285 55872
89	CAR/R/1072128	Sewage (Private) Primary	Soakaway	NX 05635 55916
90	CAR/R/1072120	Sewage (Private) Primary	Soakaway	NX 05620 55910

91	CAR/R/102004	Sewage (Private) Primary	Soakaway	NX 11026 59715
92	CAR/R/1054162	Sewage (Private) Primary	Soakaway	NX 05835 55770
93	CAR/R/1038622	Sewage (Private) Primary	Soakaway	NX 01810 55540