Scottish Sanitary Survey Report

Sanitary Survey Report
Dunstaffnage Cockles
AB-696
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The hydrographic assessment and the shoreline survey and its associated report were undertaken by SRSL, Oban.

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Appendices

I. Executive Summary

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

The purpose of the sanitary survey is to demonstrate compliance with the requirements stated in Annex II (Chapter II Paragraph 6) of Regulation (EC) 854/2004. The sanitary survey results in recommendations on the location of RMPs, the frequency of sampling for microbiological monitoring, and the boundaries of the production areas deemed to be represented by the RMPs. A sanitary survey was undertaken on the cockle fishery at Dunstaffnage Cockles on the basis recommended in the European Union Reference Laboratory publication: "Microbiological Monitoring of Bivalve Mollusc Harvesting Area Guide to Good Practice: Technical Application" (https://eurlcefas.org/media/13831/gpg_issue-5_final_all.pdf). The survey was undertaken because this is a newly classified production area.

The shellfishery within the Dunstaffnage Cockles production area covers the intertidal areas within Dunstaffnage Bay and Camas Bruaich Ruaidhe on the southern side of the mouth of Loch Etive, near Oban on the west coast of Scotland.

There are several continuous and intermittent community sewage discharges in the vicinity of the mouth of Loch Etive, including a continuous discharge and two CSO/EOs located within the boundaries of the production area. A small number of private septic tanks also discharge within the production area. In addition, there is a perceived risk of overboard discharges from boats moored within the marina or moored or anchored elsewhere within Dunstaffnage Bay. Theimpacts from farm animals is thought to be minor but that from wildlife, predominantly seabirds and ducks, may be significant. Contamination will also arise from watercourses and areas of land drainage within both Dunstaffnage Bay and Camas Bruaich Ruaidhe.

Microbiological monitoring began at Dunstaffnage cockles in November 2013 and a limited number of results were available for analysis in support of the present assessment. All samples had been taken from an area to the east of Dunstaffnage Marina. No formal temporal analysis was possible but higher results had been seen between May and September than at other times. Results from cockle and seawater samples taken during the shoreline survey indicated the potential for higher levels of contamination to the west of Dunstaffnage Marina.

Due to the presence of a number of identified sources faecal contamination within the production area, it was not possible to recommend boundaries which excluded those sources without excluding a proportion of the intertidal area, and thus the potential fishery, within the two bays. On this basis, it is recommended that the present production area boundaries be maintained but the RMP be located to the west of Dunstaffnage Marina. If it is deemed acceptable to confine the production area to the vicinity of present harvesting activity, the boundaries can be redefined to exclude identified pollution sources and an RMP recommended in the vicinity of the historical sampling locations.

II. Sampling Plan

Production Area	Dunstaffnage Cockles
Site Name	Dunstaffnage Bay
SIN	AB-696-1511-04
Species	Common cockle
Type of Fishery	Wild harvest
NGR of RMP	NM 8813 3382
East	188130
North	733820
Tolerance (m)	50
Depth (m)	Not applicable
Method of Sampling	Hand
Frequency of Sampling	Monthly
Local Authority	Argyll & Bute Council
Authorised Sampler(s)	William MacQuarrie Christine McLachlan Ewan McDougall Allison Hardie Heather Harley
Production area	The area bounded by lines drawn between NM 8837 3452 and NM 9022 3450 and between NM 9022 3450 and NM 9022 3414, extending to MHWS.

III. Report

1 General Description

Dunstaffnage Bay at the mouth of Loch Etive on the western coast of Scotland. It is within the Argyll and Bute council area. The shellfish harvesting area under consideration within this report also includes Camas Bruaich Ruaidhe which is located approximately 1 km to the east of Dunstaffnage Bay.

Dunstaffnage Bay is approximately 1 km wide at its mouth and is approximately 1 km from head to mouth. The bay lies opposite the larger Ardmucknish Bay. Dunstaffnage Bay has a northeasterly aspect and the northwesterly side is sheltered by the island of Eilean Mòr.

Camas Bruaich Ruaidhe is approximately 0.5 km wide at its mouth and approximately 0.5 km from head to mouth. It also has a northeasterly aspect.

The village of Dunbeg lies at the head of Dunstaffnage Bay. Dunstaffnage Marina is isutated on the eastern side of the bay and the Scottish Association of Marine Science is based at the western side. There is little population in the immediate area of Camas Bruaich Ruaidhe although Dunstaffnage House is located inland from the bay. However, the large village of Connel is located to the east of Camas Bruaich Ruaidhe and the western outskirts of the village extend to approximately 100 m from the eastern edge of the bay.

A sanitary survey was undertaken on the classified fishery at Dunstaffnage Cockles on the basis recommended in the European Union Reference Laboratory publication: “Microbiological Monitoring of Bivalve Mollusc Harvesting Area Guide to Good Practice: Technical Application” (https://eurlcefas.org/media/13831/gpg_issue-5_final_all.pdf). This production area was selected for survey as it is a newly classified area.

A study had previously been undertaken with regard to faecal pollution sources impacting on the mussel fisheries within Loch Etive (Magill, *et al*., 2008). This study concentrated on sources located within the loch rather than the area around the Dunstaffnage Cockles production area although consideration was included of some sources in the vicinity of Connel Bridge and the then new Connel and Dunbeg Sewage Treatment Works.

Figure 1.1 **Location of Dunstaffnage Bay and Camas Bruaich Ruaidhe**

2 Fishery

The fishery at Dunstaffnage is a wild common cockle (*Cerastoderma edule*) fishery. Details of the site given in the application form are presented in Table 2.1. The site locations are given in Figure 2.1

Table 2.1 Dunstaffnage Cockles site details

Production area	Site	SIN	Species
Dunstaffnage Cockles	Dunstaffnage Bay	AB-696-1511-04	Common cockles

The presently defined production area at Dunstaffnage covers Dunstaffnage Bay and Camas Bruaich Ruaidhe; it is defined as the area bounded by lines drawn between NM 8837 3452, NM 9022 3450, NM 9022 3414 extending to MHWS. While the intertidal area could potentially be harvested by anybody, access is controlled by Dunstaffnage Estate. The current harvester harvests an area east of the marina in Dunstaffnage Bay.

During the shoreline survey, cockles were found at a number of intertidal locations within the production area but not at NM 8962 3445 where the substrate was identified to be stony and rocky. Historical surveys conducted in the bay and listed in the National Biodiversity Network (NBN) Gateway (https://data.nbn.org.uk/imt) reported the presence of cockles in the bay (Scottish Natural Heritage, 2011). Cockle presence locations from the NBN gateway and the shoreline survey are shown in Figure 2.

The shoreline survey identified that the local authority currently take weekly *Mytilus edulus* samples from NM 90120 34039 (within Camas Bruaich Ruaidhe). It is assumed that those samples are taken for biotoxin testing as the samples reported on the FSAS database as having been tested for *E. coli* are identified as cockles taken from the eastern side of Dunstaffnage Bay (see Section 11).

Figure 2.1 Dunstaffnage Cockle Fishery

3 Human Population

Information was obtained on the population within the vicinity of the Dunstaffnage Bay shellfishery from the General Register Office for Scotland. The last census was undertaken in 2011. The census output areas adjacent to the shellfish beds are shown in Figure 3.1 thematically mapped by the 2011 population densities. The population density is low to moderate along the coastline adjacent to the fishery.

The small village of Dunbeg, located on the southern shoreline of fishery, had an estimated population of 625 in 2011. The villages of Connel (population approximately 440) and North Connel (population approximately 370) are located either side of the Connel Bridge. The research and education facility of the Scottish Association of Marine Science (SAMS) is located in Dunbeg. The tourist attraction of Dunstaffnage Castle is located adjacent to that facility.

The Falls of Lora, in the vicinity of the Connel Bridge are a popular tourist attraction. Tourist accommodation is located in each of the three main villages (see Figure 3.1). Additional tourist accommodation is available in Oban located approximately 4 km south west of Dunstaffnage Bay. This accommodation may also be used by visitors to SAMS, which would present a year-round demand rather than a more strictly seasonal one.

The Oban and the Isles Airport is located to the west of North Connel and provides regular flights to the islands of Coll, Tiree, Colonsay and Islay (Oban and the Isles Airports, 2013). Dunstaffnage Marina is located on the eastern side of Dunstaffnage Bay and has a large number of pontoon moorings, 180 berths, a brokerage and a chandlery on site (Dunstaffnage Marina, 2015). Anchorages are located within Dunstaffnage Bay and Camas Bruaich Ruaidhe, within the extent of the production area (Clyde Cruising Club, 2007). There are four jetties in total, either side of the Connel bridge. During the shoreline survey approximately 42 moorings were observed in Dunstaffnage Bay.

Overall, the local population adjacent to the fishery is relatively low but the settlements in the area are concentrated along the coastline and there are a significant concentrations of boating activity within the two bays. Therefore human-related sources are likely to be important. The presence of tourist accommodation and boating facilities indicates that there is likely to be significant seasonal variation in that impact.

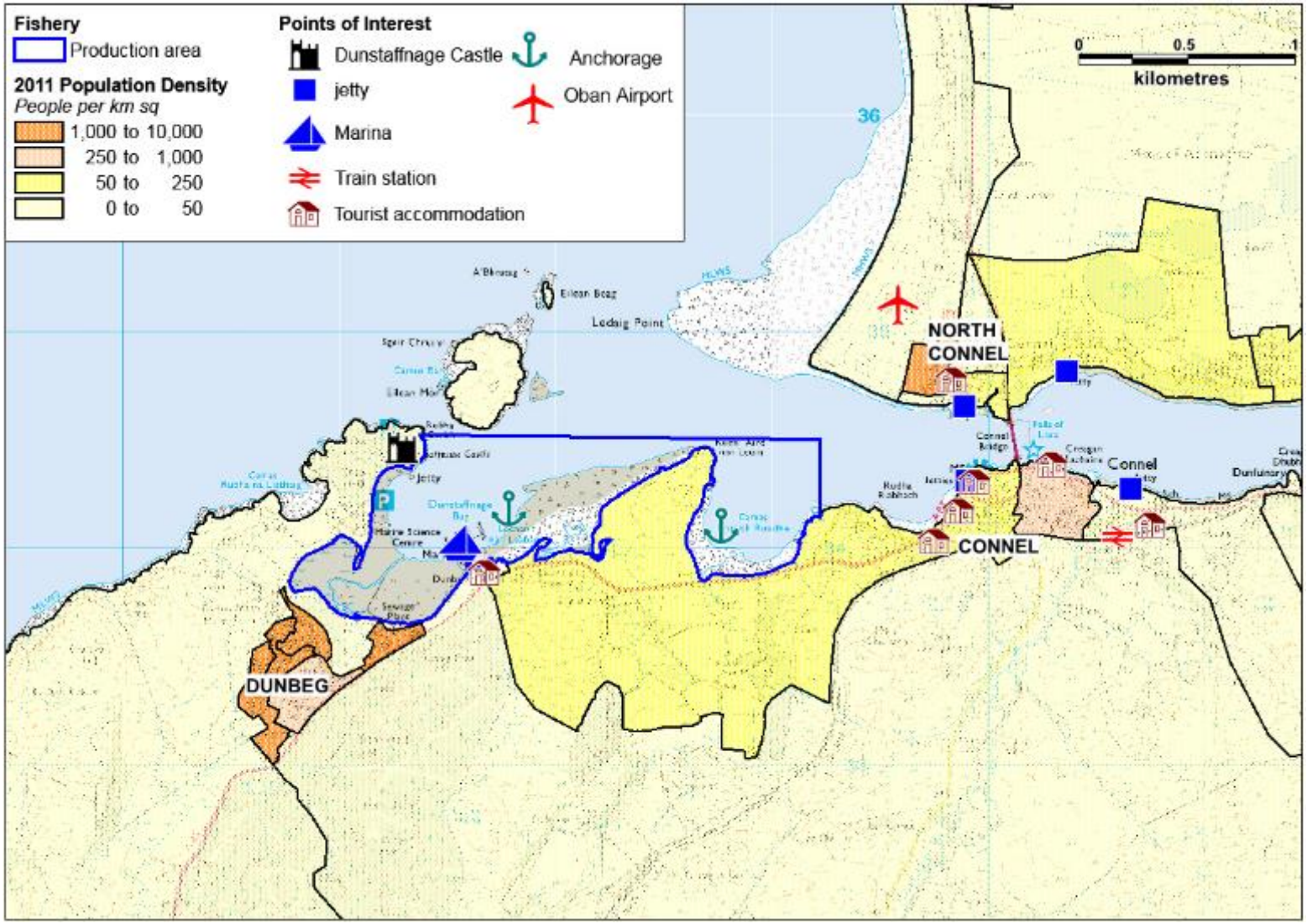

Figure 3.1 Population map for the area around Dunstaffnage Bay

4 Sewage Discharges

Information on sewage discharges within an area 7 km around NM 8300 3000 (Dunstaffnage Marina) was sought from Scottish Water and the Scottish Environment Protection Agency (SEPA). Data requested included the name, location, type, size (in either flow or population equivalent), level of treatment, sanitary or bacteriological data, spill frequency, discharge destination (to land, watercourse or sea), any available dispersion or dilution modelling studies, and whether improvements were in work or planned. No information was provided on bacteriological quality, sanitary quality, spill frequency or modelling studies.

Information on locations where sewage sludge is applied to land had been requested from SEPA: it was identified that little data was held on this and that the data that was held could not be made available for assessment within the sanitary survey programme.

Discharges which were considered to be potentially relevant to the assessment were sub-selected from this data and have been used in the assessment below. The locations of those discharges are shown in Figure 4.1.

4.1 Community Discharges

Community sewage discharges deemed to be relevant to the assessment were located in the outer part of Loch Etive and in Ardmucknish Bay.

Continuous Community Discharges

Information on seven public continuous outfalls was provided between Scottish Water and SEPA. Details of these discharges are given in Table 4.1 below.

Table 4.1. Continuous Community Discharges

Scottish Water						SEPA					
Discharge Name	**Licence number**	**Location**	**Treatment Level**	**PE**	**DWF m^3/day**	**Discharge Name**	**Licence number**	**Location**	**Treatment Level**	**PE**	**DWF (m3/day)**
Benderloch WWTW	CAR/L/1000364	NM 9010 3850	Secondary	400	88	Benderloch STW	CAR/L/1000364	NM 90080 38418	Secondary	400	88
Connel SEP	CAR/L/1010872	NM 8960 3450	Septic Tank	-	332.1	Connel & Dunbeg WwTW	CAR/L/1010872	NM 89600 34500	Primary	-	332.1
North Connel STW	CAR/L/1010883	NM 9059 3459	Septic Tank	-	84	North Connel WwTW	CAR/L/1010883	NM 90590 34590	Primary	-	84
Blackcrofts North Connel	-	NM 9237 3465	Septic Tank	12 Houses	-						
Achnacreemore SEP	-	NM930363	-	-	-						
*Consent surrendered/reconfigured as PS						Deirdre	CAR/L/1003310	NM 91236 34405	Untreated	-	-
*Consent surrendered/reconfigured as PS						Lora View	CAR/L/1003311	NM 90700 34600	Untreated	-	-

- = Data not provided. DWF=Dry Weather Flow, EO=Emergency Overflow, MDF=Mean Daily Flow, NA=not applicable, PE=Population Equivalent, ST= Septic Tank, WWPS =Waste Water Pumping Station. *Information provided by Scottish Water subsequent to consultation on the draft report.

One continuous community discharge is located within the extent of the production area, five discharges are located within Loch Etive to the east of the production area and one is located in Ardmucknish Bay to the north of the production area.

- Connel & Dunbeg STW (CAR/L/1010872) was reported to discharge at Rubh' Aird nan Leum, within the production area boundaries. The discharge is consented for a dry weather flow of 332.1 m^3/day.

- North Connel STW (CAR/L/1010883) discharges to Loch Etive, less than 1 km from the production area. It is consented for a dry weather flow of 84 m^3/day

- Blackcrofts North Connel, reported only by Scottish Water, discharges to Loch Etive, approximately 1.5 km from the production area. No flow or PE was given but the septic tank serves 12 houses. Assuming a PE of 5 per household this would give a PE of approximately 60.

- Achnacreemore Septic tank was reported by Scottish Water, but no discharge location was given. A National Grid Reference (NGR) in the name, which often refers to the asset location, is given as NM930363. This has been plotted as the discharge location in Figure 4.1. No PE or flow value is given for the discharge but it is noted as discharging to soakaway.

- Consents for Deirdre STW (CAR/L/1003310) and Lora View STW (CAR/L/1003311) were surrendered by Scottish water (SEPA notices issued on 13/03/2015). The functions of these sites has been changed to pumping stations under authorisations CAR/L/1010875 and CAR/L/1010883, respectively.

- Benderloch STW (CAR/L/1000364) discharges to Ardmucknish Bay approximately 7.1 km from the fishery. The works are licensed for a PE of 400 with a dry weather flow of 88 m^3/day.

Magill, *et al*. (2008) included reference to the Connel & Dunbeg STW. They noted that modelling undertaken for Scottish Water in the planning stages had deemed the discharge to comply with SEPA requirements in relation to shellfish waters. However, it is assumed that the evaluation related to compliance at the western boundary of the Loch Etive shellfish water. This lies at the eastern end of the narrows and is thus more than 2.5 km from the Dunstaffnage Cockles production area and more than 3 km from the discharge location.

Intermittent Community Discharges

Within the area shown in Figure 4.1, information was provided on six CSO/EOs, two CSOs and four EOs. These are listed in Table 4.2. Additional information was provided on several intermittent discharges within the Sound of Kerrera.

The information provided by SEPA and Scottish Water differed with respect to certain details, including locations, and these differences were not reconciled by requests for clarification. The locations given by the two data providers are given below in Table 4.2. The full lists given by the providers are included at Appendix 5 and 6.

Table 4.2 Intermittent Community Discharges

Licence number	Discharge Name	Discharge Type	SEPA Location	SW Location	Treatment Level SW
CAR/L/1026157	Ganavan	EO	NM 85920 32590	NM 8592 3259	10 mm screens
CAR/L/1010880	North Connel TPS 2	CSO/EO	NM 90610 34628	NM 9061 3164	6 mm screens
CAR/L/1010886	South Connel TPS 1	CSO/EO	NM 90970 34390	NM 9097 3439	6 mm screens
CAR/L/1010885	South Connel SPS1	CSO/EO	NM 91850 34230	NM 9185 3423	6 mm screens
CAR/L/1010882	North Connel	CSO/EO	NM 92130 34630	NM 9213 3463	6 mm screens
CAR/L/1010872	Connel & Dunbeg WwTW,	CSO/EO	NM 89600 34500	NM 8960 3450	6 mm screens
CAR/L/1010875	Connel SPS2 EO	EO	NM 91260 34430		
CAR/L/1010878	North Connel SPS2 EO	EO	NM 90710 34630		
-	Dunbeg Jane Road CSO	CSO		NM 8823 3390	
-	Dunbeg Jane Road WWPS	EO		NM 8801 3347	
-	Dunbeg Meadow Rd WWPS	CSO/EO		NM 8823 3390	
CAR/L/1000364	Benderloch CSO	CSO	NM 89958 38362	NM 9010 3850	6 mm screens

CSO=Combined Sewer Overflow EO= Emergency Overflow PS=Pumping Station- Data not given SW=Scottish Water

The intermittent discharges are shown on the map in Figure 4.1. Where the locations given by the different providers are nearly the same, the location given by SEPA has been used. The names given by SEPA have also been presented in Table 4.2: these differ in many instances from those given by Scottish Water.

Scottish Water gave information on one CSO (North Connel, 6 Mosspark CSO) but no licence number or discharge location. It was noted as being associated with Achnacreemore septic tank, therefore the location for this has also been used for the CSO.

Two combined CSO/EOs and one EO discharge either directly to the production area or to watercourses flowing into it.

Magill, *et al*. (2008) included reference to a Connel CSO located at NM 922 342. This location does not relate to any shown in Table 4.2. The reference may relate to licence number CAR/L/1010885 as this is geographically the closest in location to that given in the earlier report. A geometric mean concentration of 410,856 *E. coli*/100 ml was given for the bacteriological quality of the CSO but an absence of flow data precluded the authors from estimating a loading.

4.2 Consented Private Discharges – SEPA

SEPA also provided information regarding consented private discharges within the area covered on the map in Figure 4.1. Discharges relating to abstraction, impoundment or engineering works have been excluded from assessment, as they should not contribute any faecal input to the area. SEPA provided information on 182 sewage discharge consents in the area shown in Figure 4.2.

The consented PEs given for these discharges ranged from 5 to 150 but the majority were in the range 5 to 10. The discharge (CAR/L/1085662) with the largest consented PE (150) discharges to Loch Etive from North Connel. The reported location is approximately 1.5 km from the production area.

The majority of the consented private discharges were stated to go to soakaway or land. The effectiveness of soakaway systems depends on location and maintenance, and SEPA have identified previously that in remote areas, consents originally registered as discharging to land may have been diverted to sea or watercourses upon failure of the soakaway fields.

Sixteen of the discharges to land are within 100 m of mean high water springs (MHWS) and within 1km of the production area. These are considered most likely to have a direct impact at the production area and are listed in Table 4.3.

Registration is required for all new properties and upon sale of existing properties. Information provided by SEPA is considered to be correct at the time of writing; however there may be additional discharges that are not yet registered with SEPA.

Table 4.3 Private discharge consents within 100m of MHWS and 1 km of the fishery

Licence No.	NGR	Discharge Type	Discharges to	Op	PE
CAR/L/1009842	NM 88623 33872	Sewage (Private) Secondary	Dunstaffnage Bay	>	15
CAR/R/1012082	NM 90440 34190	Sewage (Private) Primary	Firth of Lorn	=	5
CAR/R/1016444	NM 91096 34304	Sewage (Private) Primary	Land	=	5
CAR/R/1034611	NM 90600 33970	Sewage (Private) Secondary	U/T of Ardmucknish	=	5
CAR/R/1039338	NM 90651 34070	Sewage (Private) Primary	Loch Etive	=	5
CAR/R/1039751	NM 90420 33960	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1039906	NM 90980 34360	Sewage (Private) Primary	Falls of Lora	=	5
CAR/R/1039920	NM 91025 34758	Sewage (Private) Primary	Loch Etive	=	6
CAR/R/1068593	NM 90770 34100	Sewage (Private) Untreated	Coastal Waters	=	6
CAR/R/1079832	NM 88790 33900	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1081769	NM 88821 33938	Sewage (Private) Secondary	Soakaway	=	15
CAR/R/1117296	NM 90820 34640	Sewage (Private) Untreated	Loch Etive	=	6
CAR/R/1121758	NM 90610 33950	Sewage (Private) Primary	UN/WC	=	5
CAR/S/1011729	NM 90330 33975	Sewage (Private) Secondary	Soakaway	=	20
CAR/R/1014205	NM 90486 34047	Sewage (Public) Primary	Land	=	8
CAR/R/1024422	NM 90660 34000	Sewage (Public) Primary	Coastal Waters	=	6

OP = Operator PE=Population Equivalent UN/WC =Unnamed Watercourse U/T = Unnamed Tributary

4.3 Shoreline Survey Discharge Observations

During the shoreline survey, 47 observations of potential sewage discharges and/or sewage-related infrastructure were recorded. These are shown in Table 4.3 and are mapped in Figures 4.2 and 4.3.

Table 4.4 Discharge-associated observations made during the shoreline survey

No.	NGR	Associated Photograph (Appendix 5)	Associated Water Sample (*E. coli*/100 ml)	Description
1	NM 88269 34386	Fig. 5		Dunstaffnage Castle visitors centre with public toilet plus nearby castle.
2	NM 88222 34345			Discharge pipe of 150 mm plastic, no flow, pipe broken at upshore end.
3	NM 88171 34193			Disused discharge pipe broken at the upper shore end, Dunstaffnage Castle car park.
4	NM 88148 34125			Discharge pipe and manhole cover ("Chieftan 600 cover") above MHWS with sound of running water. From septic tank for the Scottish Association for Marine Science according to SAMS Facilities Manager.
5	NM 88025 33457			Dunbeg, Meadow Road WWPS CSO (assumed to be)
6	NM 88031 33458			Dunbeg WWPS.
7	NM 88129 33717		1400	Combined emergency waste water overflow outfall pipe.
8	NM 88236 33636			Dunbeg, Meadow Road WWPS.
9	NM 88662 33927			Pipe, 150 mm diameter, running onto foreshore, no discharge present
10	NM 88673 33935			Metal pipe, 150 mm diameter, appears disused with no discharge.
11	NM 89000 33952			Dunbeg waste water pumping station.
12	NM 89513 34353			Manhole cover above beach in vicinity of indicated Connel SEP WWPS (& CSO). No pipes or other sign of Scottish Water installation.
13	NM 90595 34102			Resumption of shoreline walk at limit of accessibility. Small pipe discharging from concrete walling below HW level but inaccessible because of tide.
14	NM 90654 34089			Broken section of discharge pipe on shoreline, upper pipe in situ above shore line, no discharge.
15	NM 90707 34085			Broken sections of 150 mm diameter plastic pipe with several sections on intertidal area, no discharge.
16	NM 90744 34106			Broken sections of pipe on shore with no sign of discharge or source at HW level wall.
17	NM 90761 34136			Three discharge pipes at site indicated on survey plan as having sea discharge. No flow from any pipe but nearby tissue indicates current use.
18	NM 90783 34125			Manhole cover on HW level with no signage.
19	NM 90827 34194			Manhole cover on HW level with no signage.
20	NM 90851 34225			Manhole, damaged and with no cover, appearing disused. Broken section of discharge pipe on shore with no flow.
21	NM 90862 34264		1200	Nearby iron discharge pipe of 25 cm diameter, fractured and broken but with flow visible through a hole and running out to sea. Unplanned seawater sample taken at pipe break, DBSW7.
22	NM 90913 34302			Manhole on round, prefabricated concrete base at HWS level at top of old slipway and adjacent to pumping station.

No.	NGR	Associated Photograph (Appendix 5)	Associated Water Sample (*E. coli*/100 ml)	Description
23	NM 90946 34339	Fig. 13		Falls of Lora car park. Scottish Water control box and manhole covers (10 altogether) for pumping station.
24	NM 90982 34379			Large discharge pipe near Connell Bridge (50 cm diameter pipe).
25	NM 91020 34365	Fig. 14	1300000	Observations associated with WP 70: Active discharge at HW level from grass bank with no pipe visible. Flocculent material and flow spread down shore. Sample DBFW10 treated as contaminated.
26	NM 91064 34356	Fig. 15	13000	Unplanned freshwater sample DBFW11 marked as contaminated. Broken sections of 100 mm diameter iron discharge pipe with active flow from in situ pipe and presence of unaltered faecal matter at pipe end indicating direct discharge (no septic tank).
27	NM 91078 34360		2600000	Ceramic pipe with no flow but scum in pipe base and on rock wall below indicating [recent] discharge. see DBFW12 24l/min
28	NM 91150 34386		2000	Observations associated with WP 75: Plastic pipe beneath bridge east side 100 mm diameter with foam at end and smell. Flow slow. Flow not possible to capture and therefore not measurable. Estimated at between 1 and 2 L/min (part flow took 2 sec to fill 3
28	NM 91884 34703			Plastic outfall pipe of 100 mm diameter covered with rocks. End below LW not visible.
29	NM 91215 34373			Discharge pipe seen 50 m eastwards on inaccessible steep bedrock shore below dwelling.
30	NM 91384 34352			Plastic discharge pipe of about 150 mm diameter. Exposed rodding access joint seen from roadway above. End not visible.
31	NM 91652 34291			Old slipway with manhole covers. Metal pipe of 150 mm diameter visible at end of slipway but below sea level at time of team visit.
32	NM 91816 34244		14000	Observations associated with WP85: metal discharge pipe of about 150 mm diameter below Connel Primary school. Sample taken at break in pipe with flocculent material below.
33	NM 91864 34230			Discharge pipe of 20 cm diameter with end below LWS. Pipe situated below Scottish Water pumping station.
34	NM 91893 34200	Fig. 18		Scottish Water waste water pumping station with three sets of manholes. Control kiosk on shore side. Pipe at WP 87 immediately below.
35	NM 92007 34217			Small watercourse running under road from woods and fields south side of A85. Small plastic drainage pipe adjacent with no flow.
36	NM 92287 34295			Discharge pipe with no flow or discharge evidence. Pipe broken on mid shore.
37	NM 92381 34277			Manhole covers in garden of cottage (former boathouse converted to holiday dwelling).

No.	NGR	Associated Photograph (Appendix 5)	Associated Water Sample (*E. coli*/100 ml)	Description
39	NM 91563 34918			Metal manhole/access covers on shore side of road at top of access track observed at WP 108.
40	NM 91386 34932			Round, green access cover to probable septic tank in private garden.
41	NM 91410 34841			Small caravan above shore beside a gated access track to the shore. 'Osma' drain access cover at the top of the shore below the fence. No sign of any outfall pipe.
42	NM 91296 34882			Access cover and breather pipe indicating septic tank with soakaway in private garden.
43	NM 91086 34605			West side of Connel Bridge. Outfall pipe encased in cast concrete containing 150 mm diameter plastic pipe broken and damaged in places with no flow. Appears disused.
44	NM 90719 34644			Metal outfall pipe of 25 cm diameter with end below LWS and not visible. No sound of any flow.
45	NM 90616 34667			Pontoon section moored off shore near end of 20 cm diameter plastic outfall pipe weighed down with perforated concrete slabs.
46	NM 90563 34676			Outfall buoy array with radar reflectors marking outfall pipe.
47	NM 90524 34687			Second outfall buoy array with radar reflectors marking second outfall pipe. Concrete structure at top of shore marking probable emergence of second pipe. Both outfall buoy arrays anchored to shore with heavy chain running up beach.

Several of the observations reported relate to sewage discharges for which SEPA or Scottish Water provided information. Observations of the major community discharges are noted. Several instances of sanitary debris or unaltered faeces were recorded indicating several raw sewage inputs or active intermittent discharges with poor or no screening.

Samples taken at several locations suggest moderate to high levels of faecal input.

4.4 Summary

There will be direct impacts within the production area from sewage arising from the Connel & Dunbeg WWTW final effluent outfall, associated intermittent discharges and several private discharges located within the boundaries of the area. Additional contamination will arise from the community and private discharges located in the Connel and North Connel and could be carried to the shellfishery on the ebb tide.

Any effect on microbiological quality at the fishery arising from the community and private discharges located on the northern side of Ardmucknish Bay, and at the northern end of the Sound of Kerrera, will depend on particle transport distance and the degree of dilution and dispersion.

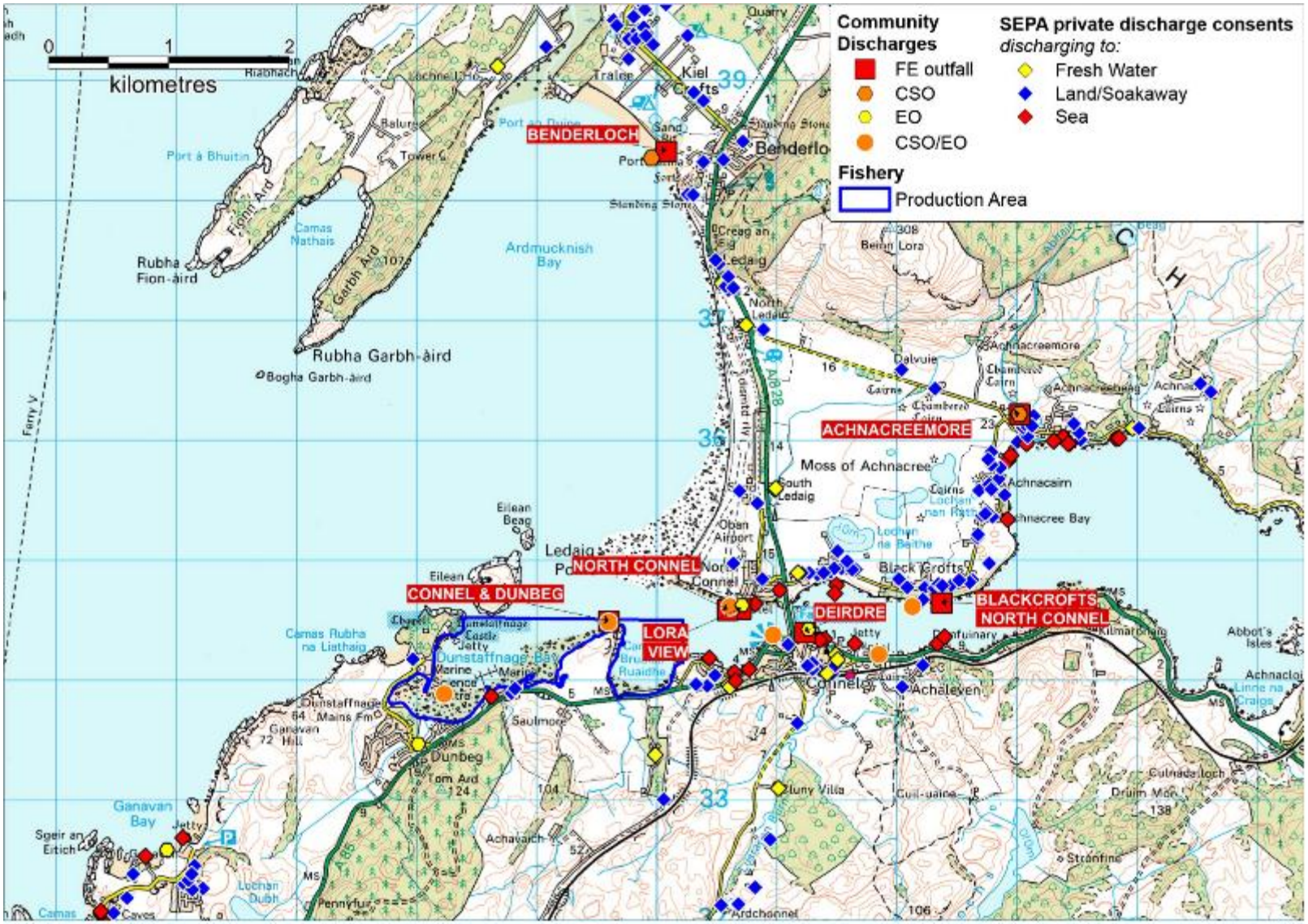

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Figure 4.1 Map of discharges in the broad vicinity of the Dunstaffnage Cockles production area

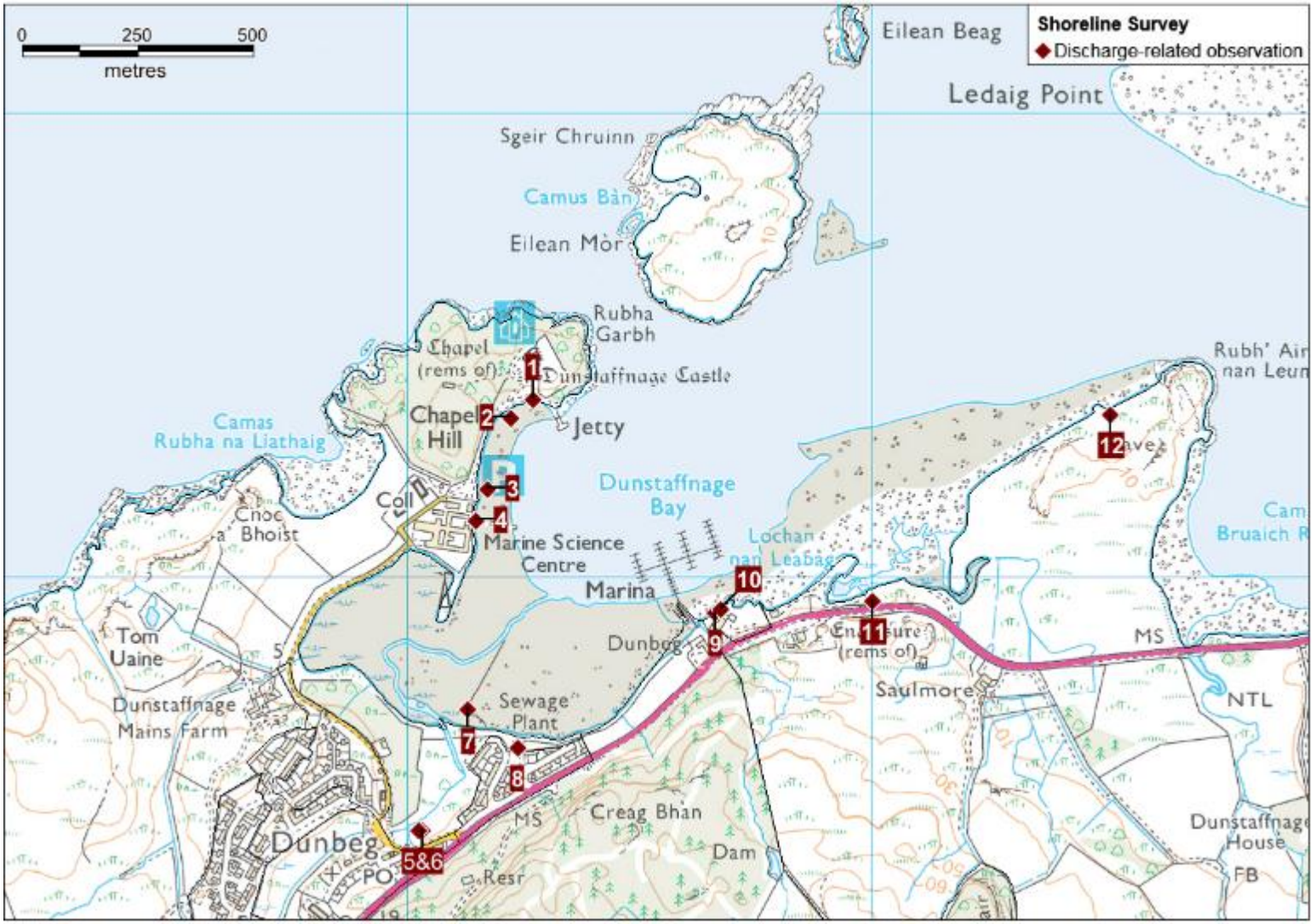

Figure 4.2 Map of discharge-related shoreline survey observations in the vicinity of Dunstaffnage Bay

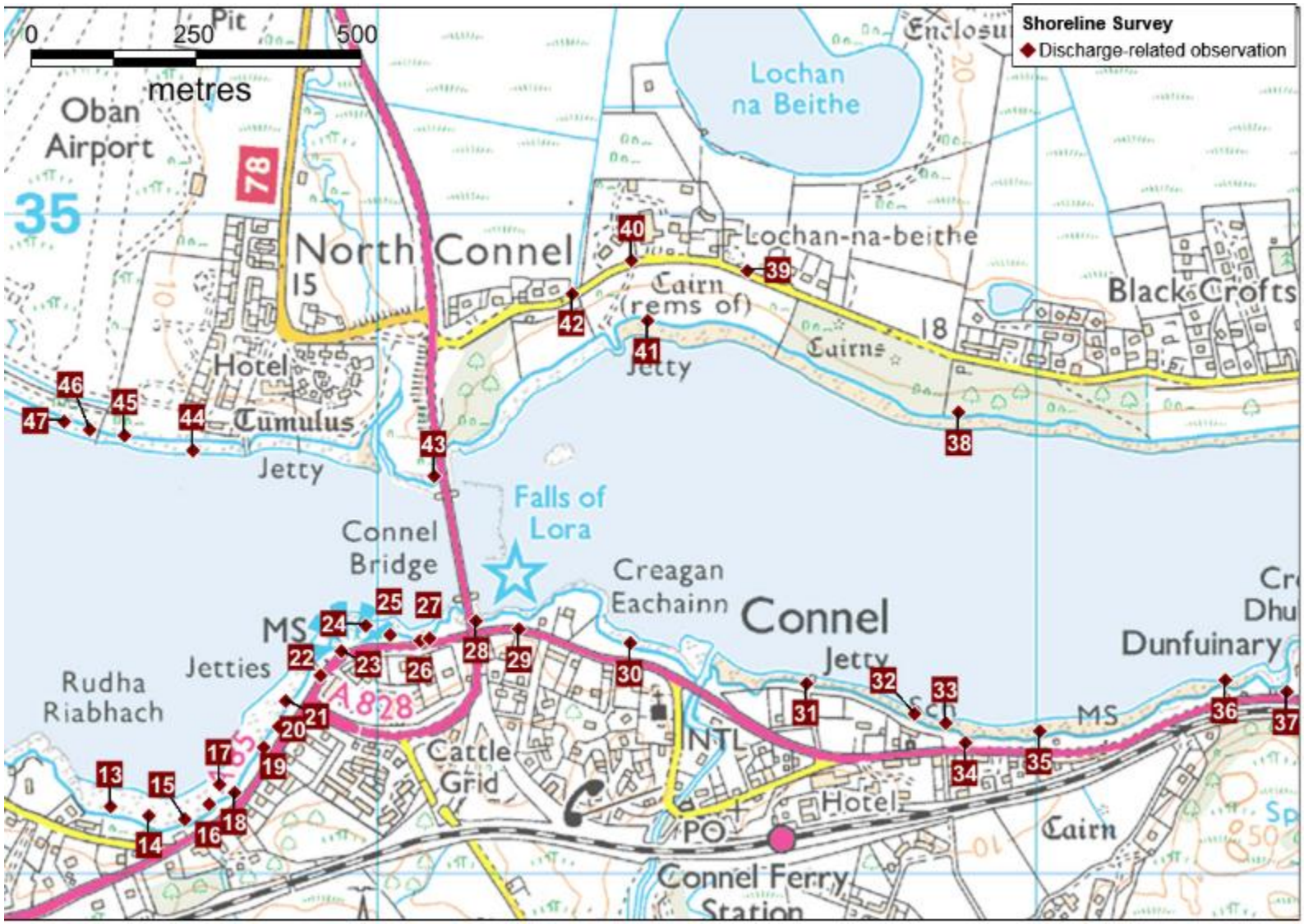

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Figure 4.3 Map of discharge-related shoreline survey observations in the vicinity of North Connel and Connel

5 Agriculture

Information on the spatial distribution of animals on land adjacent to or near the fishery can provide an indication of the potential amount of organic pollution from livestock entering the shellfish farm area. Agricultural census data to parish level was requested from the Scottish Government Rural Environment, Research and Analysis Directorate (RERAD) for the Ardchattan and Muckairn and Kilmore and Kilbride parishes. Reported livestock populations for the parishes in 2013 are listed in Table 5.1. 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 fewer than five holdings, or where two or fewer holdings account for 85% or more of the information, are replaced with an asterisk.

Table 5.1 Livestock numbers in the Ardchattan and Muckairn and Kilmore and Kilbride agricultural parishes, 2013

	Ardchattan and Muckairn		**Kilmore and Kilbride**	
	593 km^2		120 km^2	
	Holdings	Numbers	Holdings	Numbers
Pigs	*	*	5	22
Poultry	23	624	13	165
Cattle	46	1823	23	816
Sheep	40	14320	31	15049
Horses used in Agriculture	0	-	0	-
Other horses and ponies	14	50	11	47

* data withheld

The livestock census numbers for the two parishes relate to large geographic areas, therefore it is not possible to determine the spatial distribution of the livestock on the shoreline adjacent to the survey area or to identify how many animals are likely to impact the catchment around the shellfish farm. Although the figures are of little use in assessing the potential impact of livestock contamination to the shellfishery they do give an idea of the total numbers of livestock over the broader area.

Sheep were kept in large numbers in both parishes, while poultry and cattle were kept in modest numbers. Horses and pigs were either present in small numbers or numbers were not reported due to the small number of holdings present.

A source of spatially relevant information on livestock population in the area was the shoreline survey (see Appendix 5) which only relates to the time of the site visit on the 19th – 21st January 2015. Observations made during the survey are dependent upon the viewpoint of the observer some animals may have been obscured by the terrain.

The shoreline survey included comment that grazing was widespread around the area. However, no farm animals were observed along the survey route during the shoreline survey. Approximately five horses and horse hoof tracks were observed west of North

Connel. No farm animals were evident in publicly available aerial imagery of the area (https://www.bing.com/maps/).

A farm is located at Saulmore, inland and south of the fishery: this is stated to hold both cattle and sheep (http://www.naturalfoodfinder.co.uk/saulmore). The property marked as Dunstaffnage Mains Farm on the 1:25,000 Ordnance Survey map, on the southwestern side of Dunstaffnage Bay, is no longer an active farm.

Any impact from agricultural sources is therefore expected to be very small.

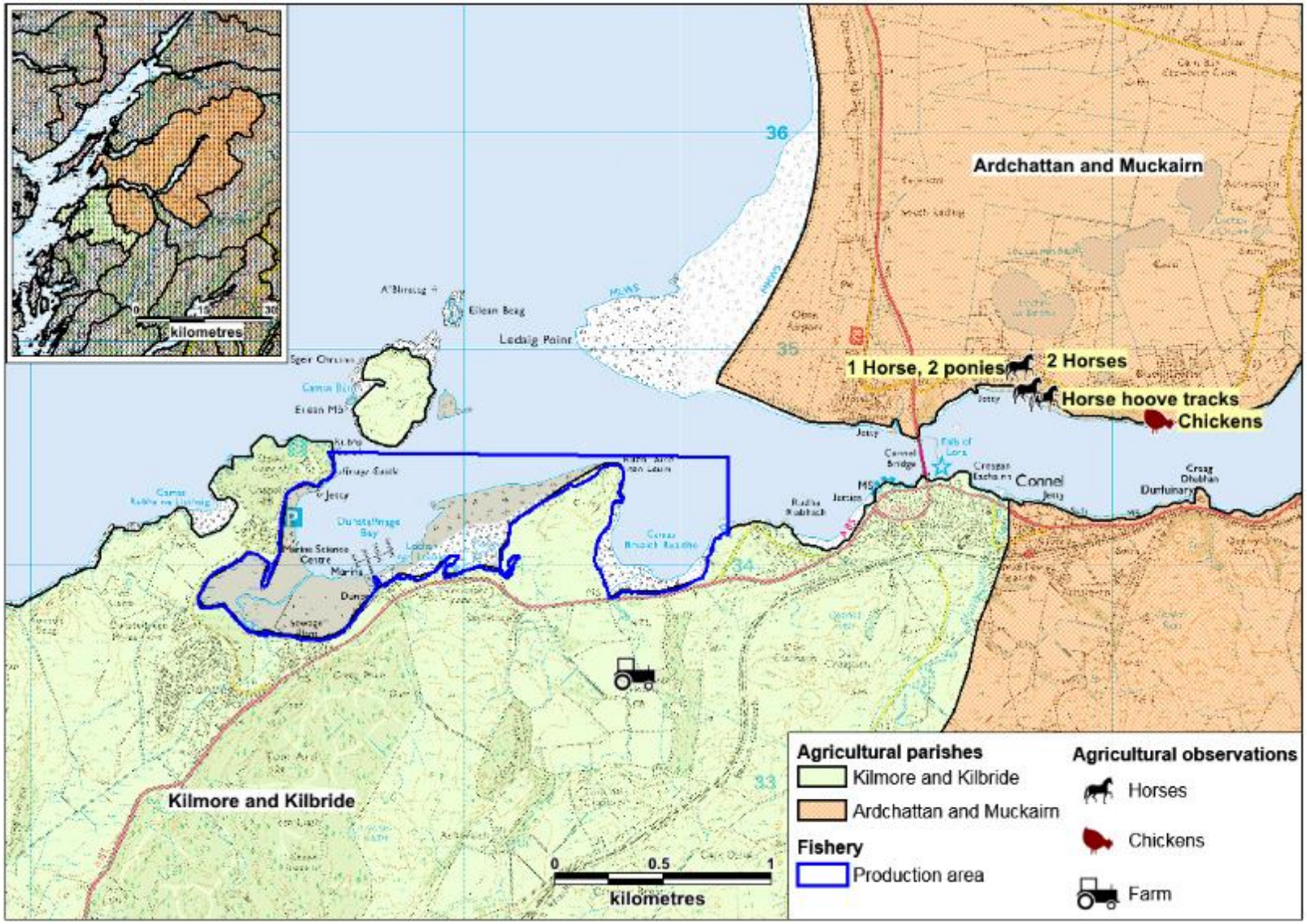

Figure 5.1 Livestock observations at Dunstaffnage Bay

6 Wildlife and domestic animals

Wildlife species present in and around the production area will contribute to background levels of faecal contamination at the fishery, and large concentrations of animals may constitute significant sources when they are present. Seals (pinnipeds), whales (cetaceans) and some seabirds may deposit faecal wastes directly into the sea, whilst birds and mammals present on land will contribute a proportion of any faecal indicator loading carried in diffuse run-off or watercourses.

The species for which information was potentially available and which could contribute to faecal indicator levels at the Dunstaffnage Cockles production area are considered below.

Pinnipeds

Up to 150seals were observed within a 10 km radius around Dunstaffnage in August surveys conducted between 2007 and 2011(SCOS, 2013). One common seal was observed at Camas Bruaich Ruaidhe during the shoreline survey.

Cetaceans

No information was found on cetacean sightings in the vicinity of the production area. However, as whale and dolphin watching excursions take place out of Oban, it is likely that some of these species may be present in the wider from time to time. No cetaceans were observed during the shoreline survey.

Seabirds

Seabird data was downloaded from the collated JNCC dataset from the website (JNCC, 2014) in March 2014. The dataset was then manipulated to show the most recent data where repetitions of counts were present. It should be appreciated that the sources of this data are varied, with some recorded as unknown or estimated, whilst some come from reliable detailed surveys such as those carried out for the Seabird 2000 report by Mitchell *et al.*, (2004). Most of the data for this area was reported from surveys in 2006 and 2009. Data applicable for the 5 km area around the production area are listed in Table 6.1.

The JNCC dataset indicated significant breeding colonies of seabirds, mainly gulls, were located in the area.

The largest colony was located at Eilean Mor on the northwest side of Dunstaffnage Bay. A smaller gull colony was located immediately north of there at Eilean Beag. To the east, around the Kilmaronag Islands, was another large gull colony and further east within Loch Etive were further moderate-sized colonies.

Wading birds and wildfowl, such as ducks, are also likely to be present in the area, however no specific count data was found for this area.

Birds were the most common wildlife observed during the shoreline survey. Species that were recorded in the largest numbers were ducks, herons, swans, shags, and gulls. Rafts of more than 30 mallard ducks each were seen in Dunstaffnage Bay and near Connel.

Table 6.1 Seabird counts within 5 km of Dunstaffnage Cockles production area

Common name	Species name	Count*	Qualifier	Accuracy
Common Gull	*Larus canus*	638	Occupied nests and territory	5 counts accurate, one count estimate, 1 count unknown
Black-Headed Gull	*Chroicocephalus ridibundus*	4	Occupied territory	Unknown
Herring Gull	*Larus argentatus*	1288	Occupied nests and territory	3 counts accurate, 2 counts unknown, 1 count estimate
Lesser Black-Backed Gull	*Larus fuscus*	202	Occupied nest and territory	1 count estimate, 1 count accurate
Great Black-Backed Gull	*Larus marinus*	42	Occupied nest and territory	3 counts accurate, 1 count estimate, 1 count accurate
Arctic Tern	*Sterna paradisaea*	52	Occupied territory	3 counts unknown
Common Tern	*Sterna hirundo*	132	Occupied nest and territory	4 counts unknown

*The counts have been adjusted where the method used was occupied nests/sites/territory to reflect the probable number of individual birds (i.e. counts of nests and occupied territory were doubled).

Otters

The National Biodiversity Network (NBN) (https://data.nbn.org.uk/) provided two records of the Eurasian otter (*Lutra lutra*) within 100 m^2 areas in the vicinity of Dunstaffnage. One related to an observation at Camas Bruaich Ruaidhe from 1997 and the other from 2013 related to Connel Bridge. No otters were observed during the shoreline survey.

Deer

The NBN (https://data.nbn.org.uk/) identified three records of roe deer in 100 m^2 areas within the vicinity of Dunstaffnage. Two records related to locations to the east of the production area: one at North Connel and other inland south of Connel. The third record related to a location to the southwest of Dunstaffnage Bay near Ganavan. Other deer species may be present in the area, however no deer were seen during the shoreline survey.

Rabbits

Although only one rabbit was observed during the survey, evidence of rabbits such as droppings, fur and rabbit holes/warrens were seen on several occasions both along the north and south shorelines. It should be noted that *E. coli* is usually only present inconsistently, and in low concentrations, in weaned healthy rabbits although this changes markedly in colonies suffering from *E. coli* enteritis (Peeters, et al., 1984). Therefore, most of the time rabbits will not contribute significant amounts of *E. coli* to the area.

Dogs

One dog and a large amount of dog mess were noted on the pathway above the shoreline near Oban Airport, at North Connel. There are anecdotal accounts that the area offers good dog walking routes (The Caravan Club, n.d.). No dogs or evidence of dogs was

observed on the shoreline or adjacent to the shoreline where the cockle beds are located and their impacts are therefore not expected to be significant.

Overall

Of the species investigated, the most significant identified source of wildlife contamination in the area is likely to be birds. Impacts from seabirds are expected to be higher during the breeding season, which largely falls between May and October, when seabird numbers in the area will more than double. The northwestern side of Dunstaffnage Bay may be exposed to the greatest contamination from this source, due to the colonies located on the islands nearby. Other impacts are expected from seals, otters, and deer . That from otters and deer will be mainly carried via watercourses.

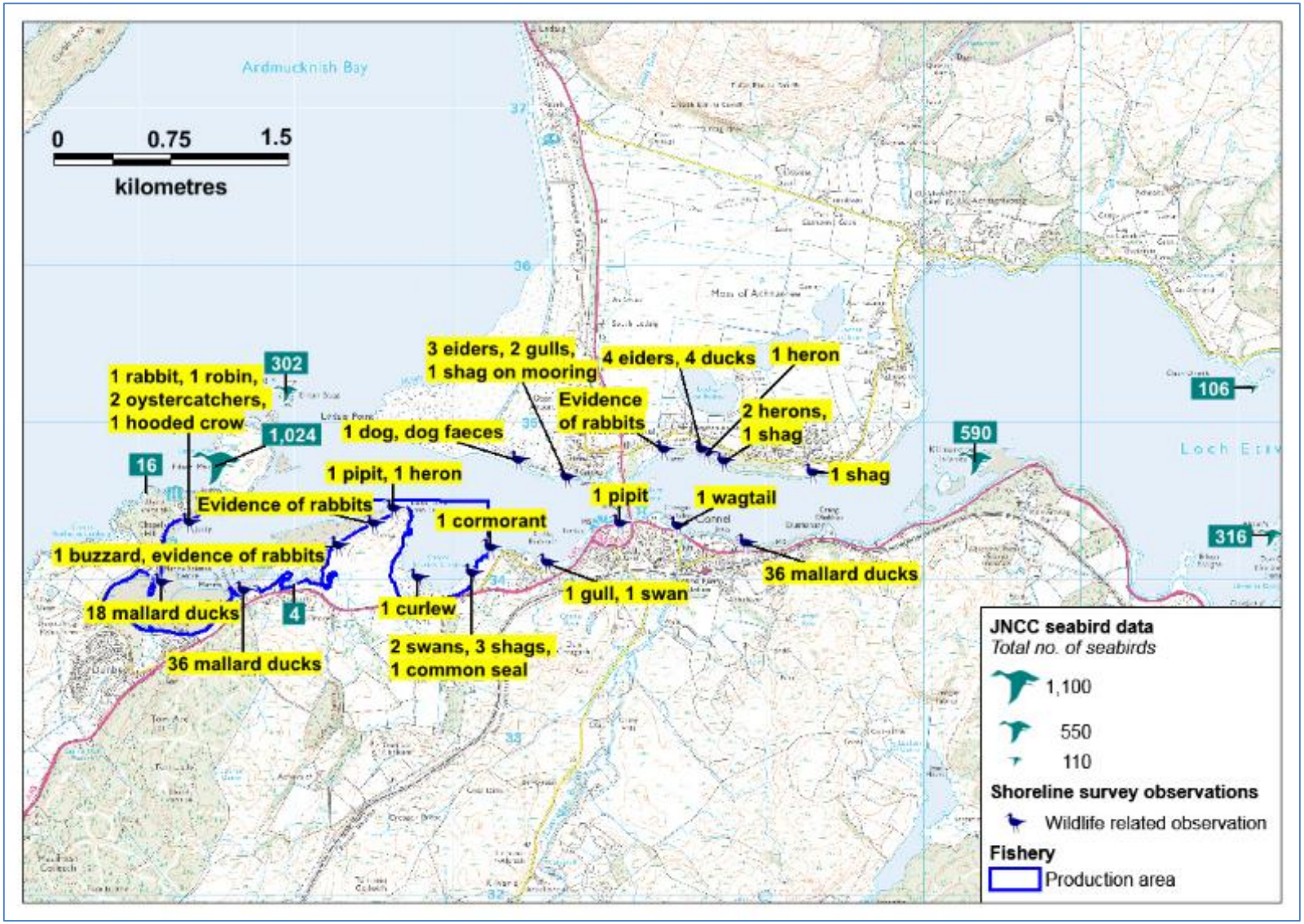

Figure 6.1 Map of wildlife distributions around Dunstaffnage Cockles production area

7 Land Cover

The Land Cover Map 2007 data for the area is shown in Figure 7.1. The predominant land cover types adjacent to the production area are improved grassland, rough grassland, coniferous woodland and broad leaved woodland. The shellfish bed is shown as rock and supra-littoral and littoral sediment. Oban airport and Dunbeg are represented as built-up areas but Connel, North Connel, and the area around the marine institute at Dunstaffnage are not. Broader expanses of the intertidal areas in Dunstaffnage Bay and Camas Bruaich Ruaidhe are represented as rock, rather than sediment, than would be expected from a combination of the Ordnance survey map, aerial imagery and the shoreline survey observations. It should also be noted that an area of freshwater is shown below MHWS on the eastern side of Dunstaffnage Bay and that Loch Etive above the Connel Bridge is also shown as freshwater. It therefore appears that some of the land cover types within this area have been misclassified.

Faecal indicator organism export coefficients for faecal coliform bacteria have been found to be approximately 1.2 – 2.8×10^9 cfu km^{-2} hr^{-1} for urban catchment areas, approximately 8.3×10^8 cfu km^{-2} hr^{-1} for areas of improved grassland and approximately 2.5×10^8 cfu km^{-2} hr^{-1} for rough grazing (Kay, *et al*., 2008). The contributions from all land cover types would be expected to increase significantly after rainfall events, however this effect would be particularly marked from improved grassland areas (roughly 1000-fold).

The highest potential contribution of contaminated run-off to the shellfish beds is from the areas of improved grassland located on the shorelines located around the two bays. This contribution would be expected to increase after rainfall events.

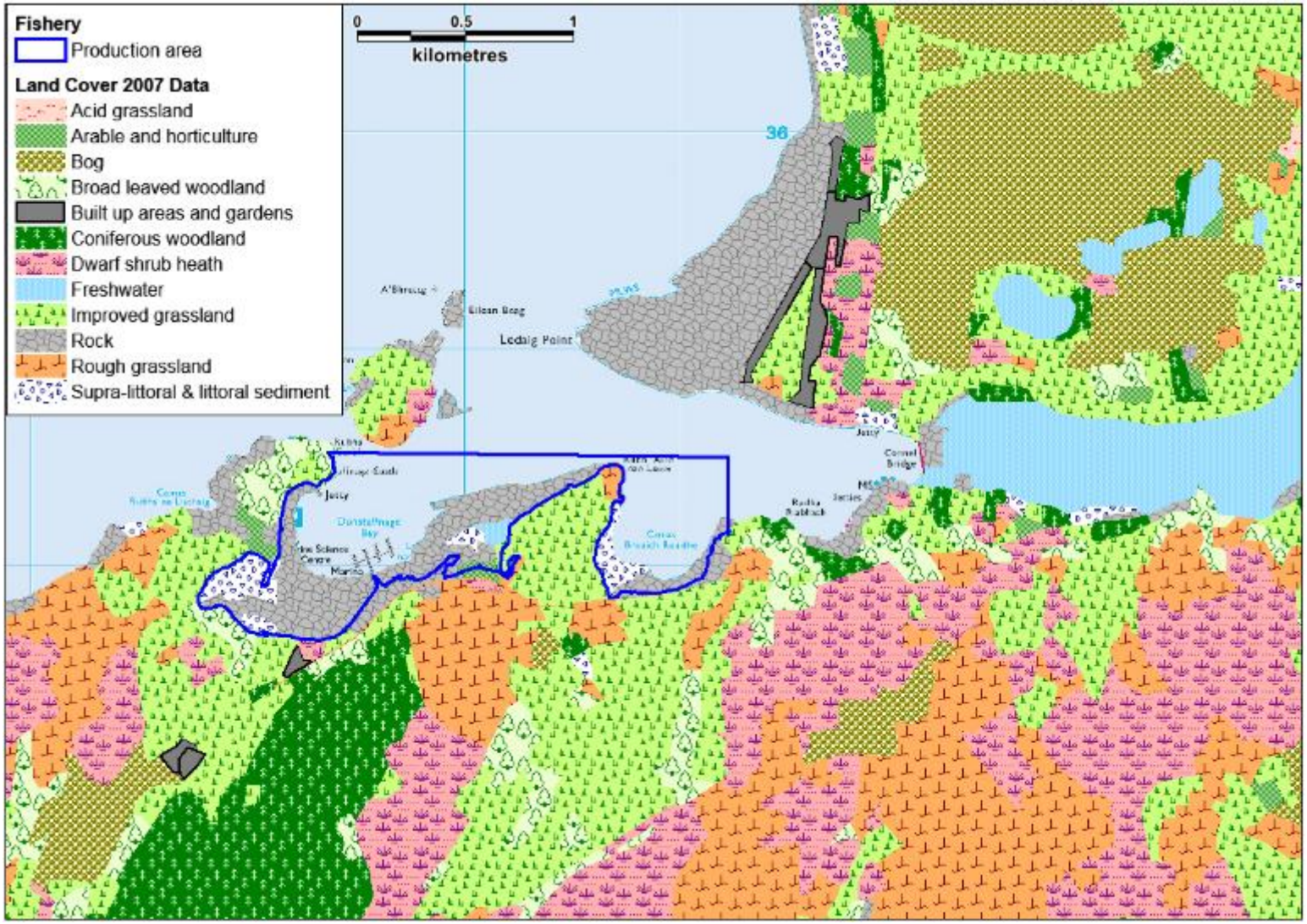

Figure 7.1 LCM2007 land cover data around the Dunstaffnage Cockles production area

8 Watercourses

The National River Flow Archive (http://www.ceh.ac.uk/data/nrfa/) contained no information on gauging stations on watercourses entering the vicinity of the production area.

Spot measurements of flow and microbial content were obtained during the shoreline survey conducted on the 19th – 21st January 2015. No precipitation was recorded in the 48 hrs prior to the survey. The watercourses listed in Table 8.1 are those recorded during the shoreline survey. Four land drainage pipes and one area of land drainage were recorded during the shoreline survey. The locations and loadings of measured watercourses are shown in Figure 8.1.

Table 8.1 Watercourses entering Dunstaffnage Bay

No.	Eastings	Northings	Description	Width (m)	Depth (m)	Flow (m^3/d)	Loading (*E. coli* per day)
1	187799	733864	Land drainage	0.28	0.02	23	2.0×10^6
2	187811	733835	Watercourse	0.46	0.04	277	6.0×10^7
3	188045	733701	Watercourse	4.30	0.15	12700	1.0×10^9
4	188387	733670	Watercourse	Not measured or sampled			
5	188481	733795	Land drainage pipe^	NA	NA	20	$<2.0 \times 10^6$
6	188553	733888	Land drainage pipe^	NA	NA	58	$<6.0 \times 10^6$
7	188550	733888	Land drainage pipe^	NA	NA	58	$<6.0 \times 10^6$
8	188636	733905	Watercourse	0.90	0.12	4120	$<4.1 \times 10^8$
9	189154	734028	Watercourse	1.80	0.80	20600	2.1×10^9
10	189680	733858	Watercourse	1.80	0.11	12200	7.3×10^9
11	190100	733956	Land drainage pipe^	0.15	0.03	552	$<5.5 \times 10^7$
12	191485	734298	Lusragan Burn	11.90	0.25	131000	4.5×10^{11}
13	192007	734218	Watercourse	Not measured or sampled			
14	192116	734235	Watercourse	Not measured or sampled			
15	190993	734661	Watercourse	1.65	0.11	3060	2.5×10^{10}

^Flow was calculated by recording the time it took to fill a measuring jug

In total, ten watercourses were recorded along the shoreline of the survey area. Three watercourses were deemed to be too small to be measured or sampled. The largest watercourse, Lusragan Burn, had the highest estimated *E. coli* loading of 4.5×10^{11}. This burn is located approximately 1.5 km east of the production area. All other watercourses had low to moderate estimated loadings. Four watercourses, three land drainage pipes and an area of land drainage discharged directly into the Dunstaffnage Bay. A watercourse and a land drainage pipe also discharge into Camas Bruaich Ruaidhe.

The average flow for Lusragan Burn has previously been stated to be 0.99 m^3/s (Magill, *et al*., 2008): this equates to approximately 85,500 m^3/d. The flow measured

during the shoreline survey was therefore higher than average despite no precipitation having been recorded in the two days prior to the survey.

Overall, freshwater inputs would be expected to provide moderate levels of contamination to the cockle beds, with the highest impact expected in the vicinity of the watercourse in each bay that had the highest loading.

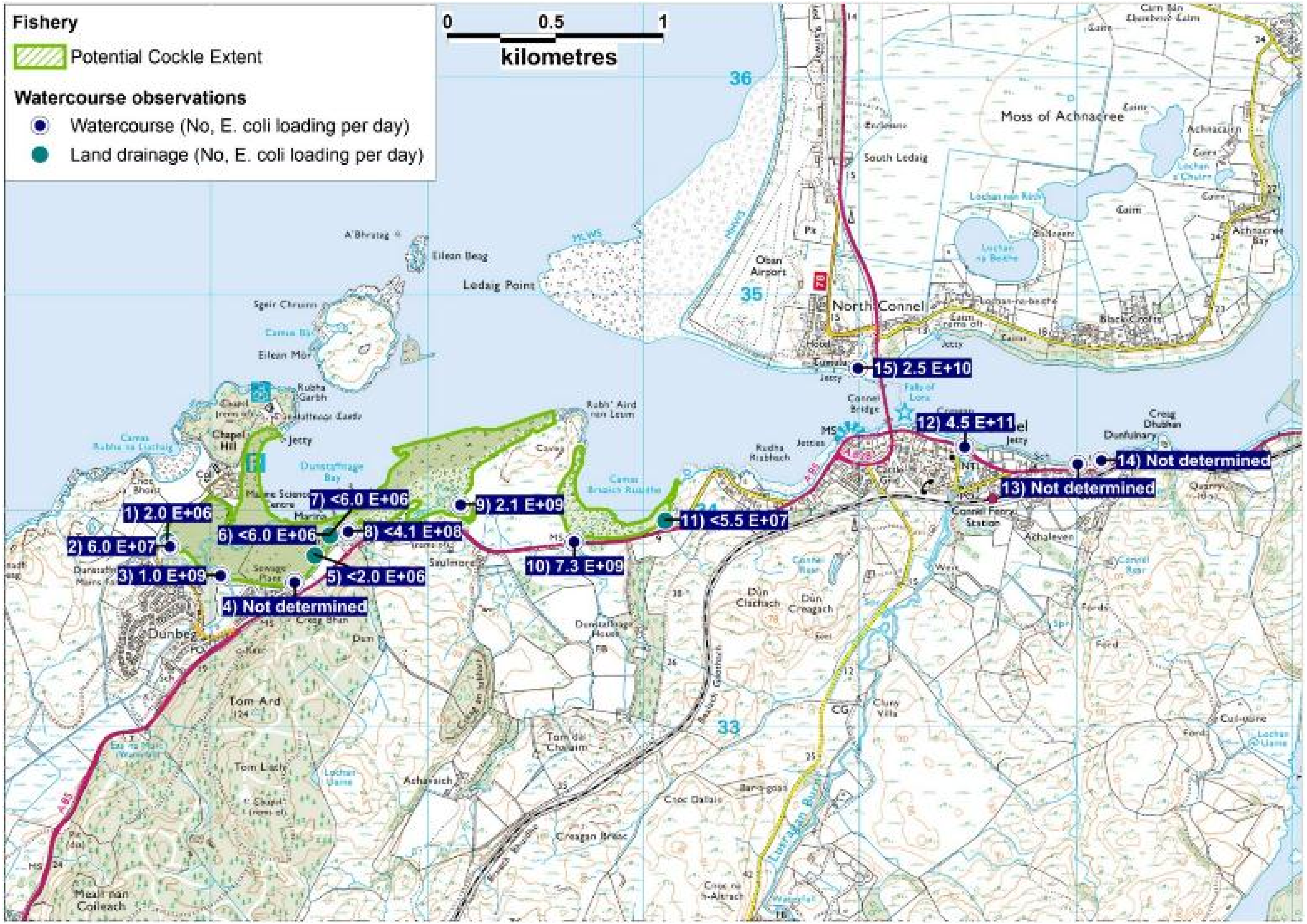

Figure 8.1 Map of watercourse loadings at Dunstaffnage Bay

9 Meteorological Data

The nearest weather station for which a nearly complete rainfall data set was available is located at Lismore: Frackersaig Farm, situated approximately 8 km to the north of the fishery. Rainfall data was available for January 2008 – November 2013 inclusive. Data for the following dates were excluded from the analysis as values were either estimated or accrued across date ranges: 11-14/01/2008, 31/03/2008, 01/04/2008, 04/06/2008, 05/06/2008, 16/06/2008-19/06/2008, 04/05/2009, 05/05/2009, 17/05/2009, 18/05/2009, 10/08/2009, 11/08/2009, 01/12/2010, 02/12/2010, 16/08/2011-20/08/2011, 22/08/2011, 29/10/2011, 30/10/2011, 22/08/2013, 29/10/2011, 30/10/2011, 22/08/2012, 23/08/2012, 04/12/2012 and 05/12/2012. Data for the entire month of December 2013 was unavailable.

The nearest wind station is situated in Tiree, located 90 km west of the production area. Conditions may differ between this station and the fisheries due to the distances between them. However, this data is still shown as it can be useful in identifying seasonal variation in wind patterns.

Data for these stations was purchased from the Meteorological Office. Unless otherwise identified, the content of this section (e.g. graphs) is based on further analysis of this data undertaken by Cefas. This section aims to describe the local rain and wind patterns in the context of the bacterial quality of shellfish in the vicinity of Dunstaffnage.

9.1 Rainfall

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 (Mallin, et al., 2001; Lee & Morgan, 2003). The box and whisker plots in Figures 9.1 and 9.2, present a summary of 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 at the midline. 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 *.

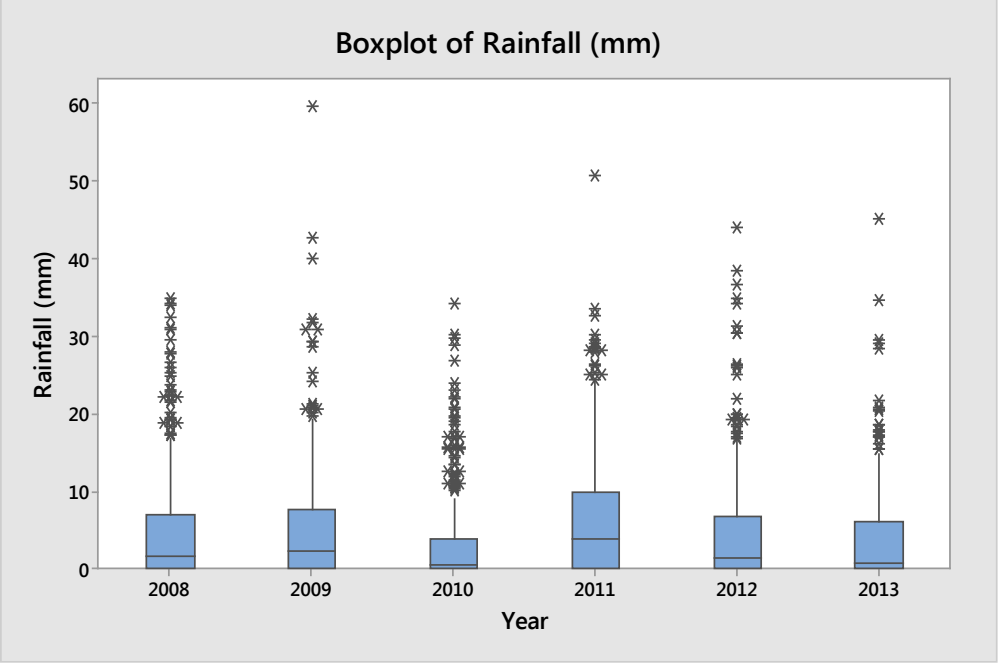

Figure 9.1 Box plot of daily rainfall values by year at Lismore: Frackersaig Farm (2008 – 2013)

Total rainfall values varied from year to year, with 2010 being the driest (1199 mm) and 2011 the wettest (2354 mm). High rainfall values exceeding 40 mm/d occurred in 2009, 2011, 2012 and 2013.

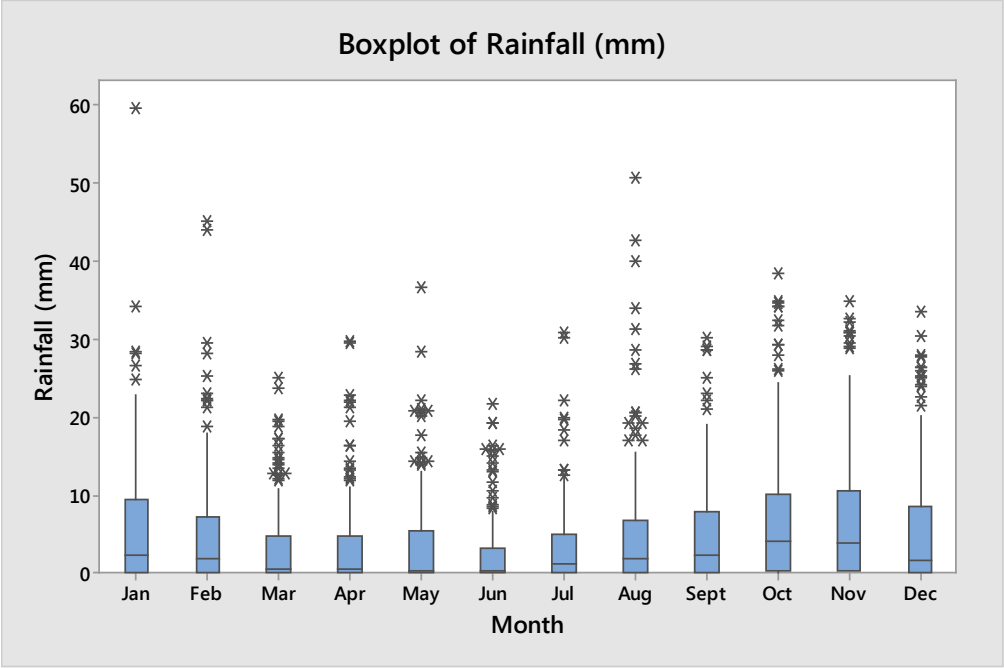

Figure 9.2 Box plot of daily rainfall values by month at Lismore: Frackersaig Farm (2008 – 2013)

Monthly rainfall totals over the period 2008-2013 were higher during the autumn and winter. Rainfall generally increased from August peaking in October (1348 mm). Weather was driest in June (429 mm). Rainfall values exceeding 40 mm/d were seen in January, February and August.

For the period considered here (2008 – 2013), 46 % of days received daily rainfall of less than 1 mm and 17 % of days received daily rainfall of over 10 mm. Care needs to be taken with the assessment of rainfall patterns by both year and month due to the excluded data.

It is expected that run-off due to rainfall will be higher during the autumn and winter months. However, extreme rainfall events leading to episodes of high runoff can occur in most months and when these occur during generally drier periods in late spring and summer, they are likely to carry higher loadings of faecal material that has accumulated on pastures when greater numbers of livestock were present.

9.2 Wind

Wind data was collected from Tiree and summarised in seasonal wind roses in Figure 9.3 and annually in Figure 9.4.

Overall, the winds were predominantly from between south-southeast and west. The strongest wind tended to be from the south. Seasonally, the strongest winds occurred during the autumn and winter. A greater proportion of northerly winds were seen in the spring and summer than in autumn and winter.

Wind is an important factor in the spread of contamination as it has the ability to drive surface water at about (3%) of the wind speed (Brown, 1991) so a gale force wind (34 knots or 17.2 m/s) would drive a surface water current of about 1 knot or 0.5 m/s. Therefore strong winds can significantly alter the pattern of surface currents. Strong winds also have the potential to affect tide height depending on wind direction and local hydrodynamics of the site. A strong wind combined with a spring tide may result in higher than usual tides, which will carry any accumulated faecal matter at and above the normal high water mark into the production area.

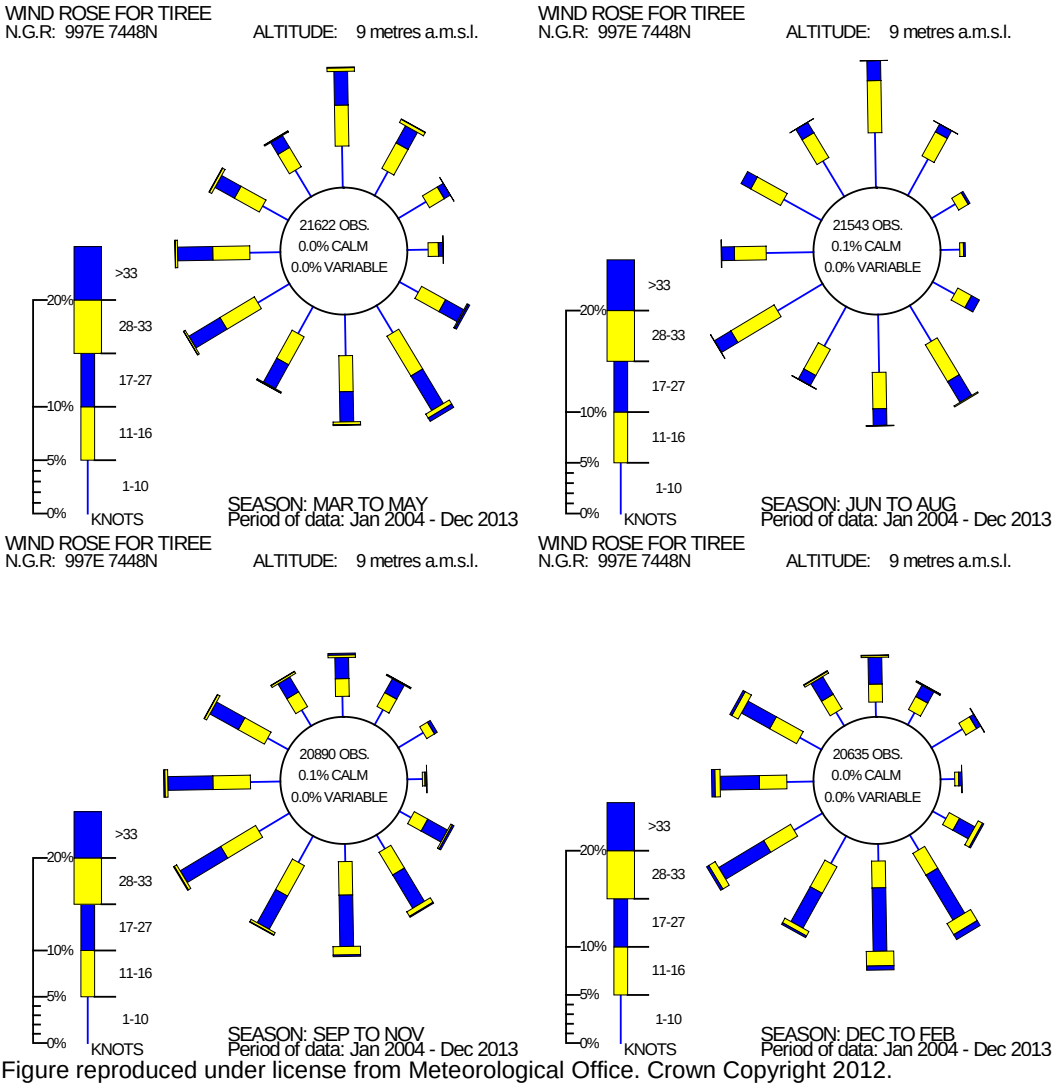

Figure 9.3 Seasonal wind roses for Tiree

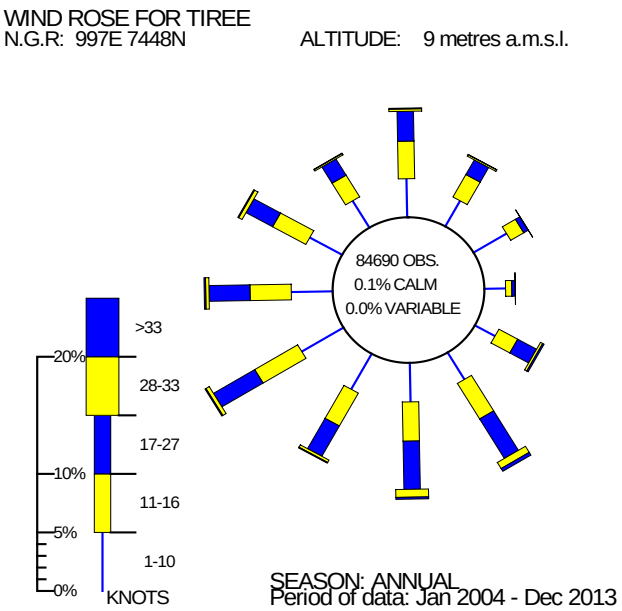

Figure 9.4 Annual wind rose for Tiree

10 Classification History

The Dunstaffnage Cockles production area has been classified as B common cockles (*Cerastoderma edule*) for the period from September 2014 to March 2015 inclusive.

11 Historical *E. coli* Data

11.1 Validation of historical data

Results for all samples assigned against the Dunstaffnage Cockles production area for the period 01/01/2013 to the 04/02/2015 were extracted from the FSAS database on 04/02/2015 and validated according to the criteria described in the standard protocol for validation of historical *E. coli* data. All *E. coli* results were reported as most probable number (MPN) per 100 g of shellfish flesh and intravalvular fluid.

All samples were reported as valid, were received at the laboratory within 48 hours since collection and had box temperatures of ≤8ºC. All samples plotted within the production area.

11.2 Summary of microbiological results

Summaries of sampling and results assigned to Dunstaffnage Cockles are listed in Table 11.1.

Table 11.1 Summary of historical sampling and results

Sampling Summary	
Production area	Dunstaffnage Cockles
Site	Dunstaffnage Bay
Species	Common cockles
SIN	AB-696-1511-04
Location	Various
Total no of samples	17
No. 2013	4
No. 2014	12
No. 2015	1
Results Summary	
Minimum	80
Maximum	9200
Median	230
Geometric mean	367
90 percentile	3760
95 percentile	9200
No. exceeding 230/100g	8 (47%)
No. exceeding 1000/100g	4 (24%)
No. exceeding 4600/100g	1 (6%)
No. exceeding 18000/100g	0

Sampling for classification has been taking place at Dunstaffnage Bay since November 2013. Nearly half the samples had results >230 *E. coli* MPN/100 g.

11.3 Overall geographical pattern of results

The reported sampling locations for all samples assigned to Dunstaffnage Cockles are shown on the map thematically in Figure 11.1. The symbols sizes are graduated proportional to the magnitude of the *E. coli* results.

All 17 samples were reported to have been taken on the intertidal area to the east of Dunstaffnage Marina.

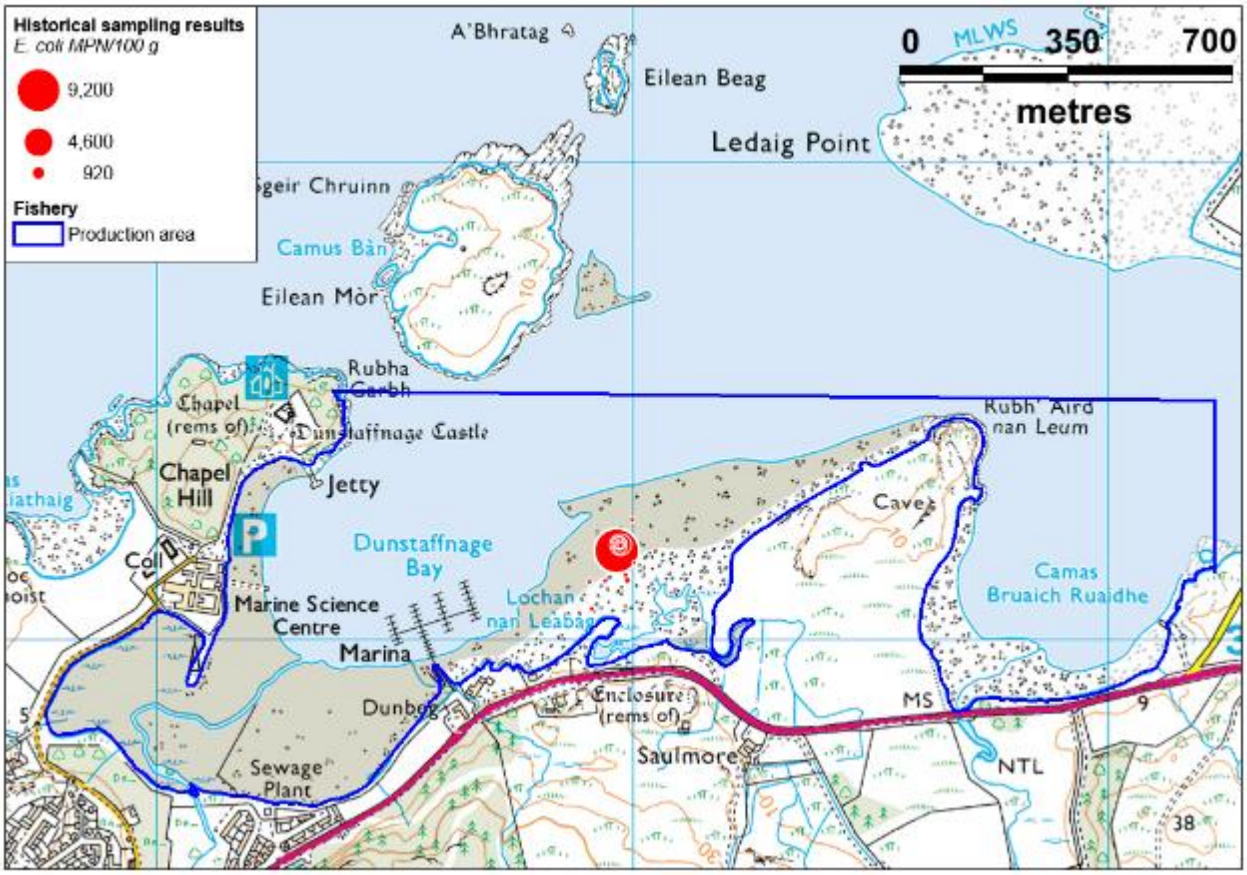

Figure 11.1 Map of reported sampling locations for common cockles at Dunstaffnage Bay

11.4 Overall temporal pattern of results

A scatterplot of *E. coli* results against date for Dunstaffnage Bay is presented in Figure 11.2.

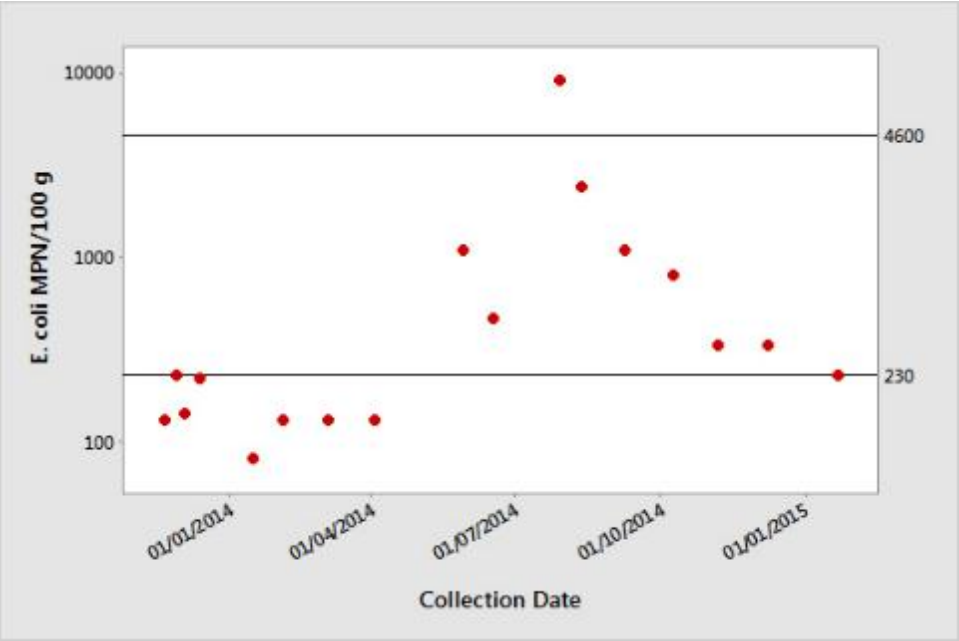

Figure 11.2 Scatterplot of *E. coli* results by collection date at Dunstaffnage Cockles

The highest result was from a sample taken in July 2014, with samples with other results >1000 *E. coli* MPN/100 g reported in May, August and September 2014.

11.5 Summary and conclusions

Sampling at Dunstaffnage Cockles has been undertaken since November 2013. Nearly half of the results have been >230 *E. coli* MPN/100 g. The highest result was from a sample taken in July 2014. All samples have been taken at the intertidal area to the east of Dunstaffnage Marina.

12 Designated Waters Data

Shellfish Waters Protected Areas

The production area does not lie within a designated shellfish water protected area. The main body of Loch Etive constitutes the Loch Etive Shellfish Waters Protected Area but this lies to the east of the narrows.

Bathing Waters

There are no designated bathing waters in the vicinity of the production area.

13 Bathymetry and Hydrodynamics

13.1 Introduction

13.1.1 The Study Area

Dunstaffnage Bay is situated in Argyll and Bute on the west coast of Scotland, approximately 4 km to the northeast of Oban. The assessment area is comprised of Ardmucknish and Dunstaffnage Bays in the west and the western end of Loch Etive in the east (Figure 13.1). These components are separated by a narrow channel characterised by a tidal race at the Falls of Lora. This channel is approximately 180 m in width at its narrowest point.

To the west, the assessment area is open to the Firth of Lorn, a large body of water with direct connection across the Scottish Shelf to the North East Atlantic Ocean in the west. East of the assessment area lies the body of Loch Etive, a fjordic sea loch fed at the eastern end by the River Etive.

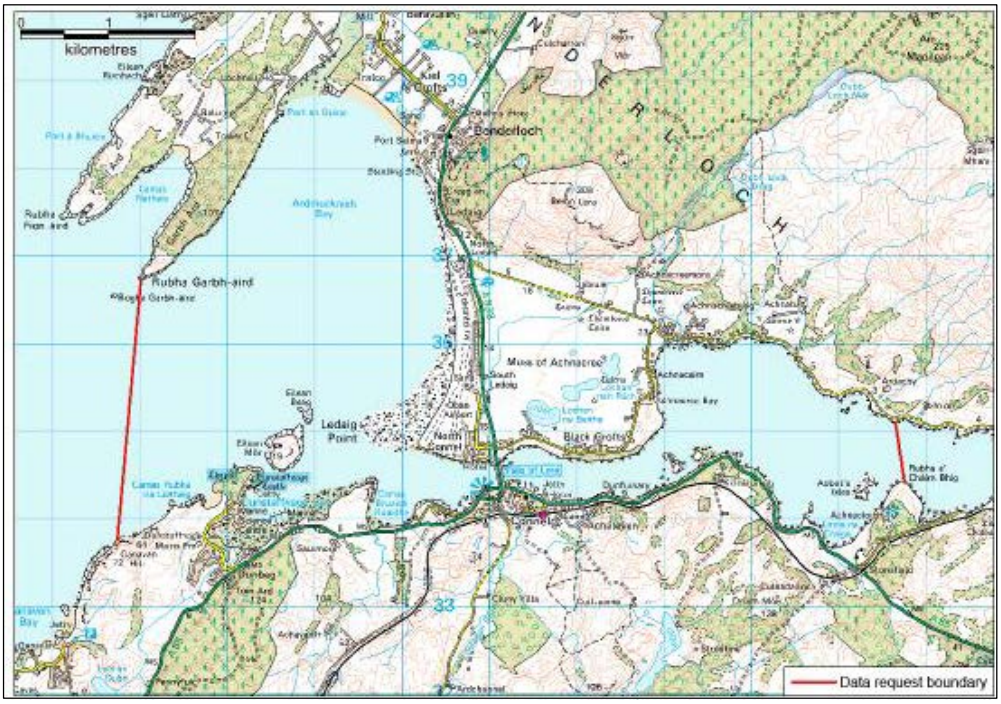

Figure 13.1 Extent of the Dunstaffnage Bay hydrographic study area

The Dunstaffnage Bay assessment area is topographically complex and is characterised by narrow channels and small islands such as Eilean Mòr, Eilean Beag, and the Abbot's Isles. Large intertidal areas can be found to the west of the village of North Connel at Ledaig Point, and within Dunstaffnage Bay.

Dunstaffnage Bay itself is approximately 0.8 km^2 in area, and approximately half of this area is exposed at low tide. A map of Dunstaffnage Bay can be found in Figure 13.2.

Coordinates for Dunstaffnage Bay: 56.452842 N, -5.433127 W

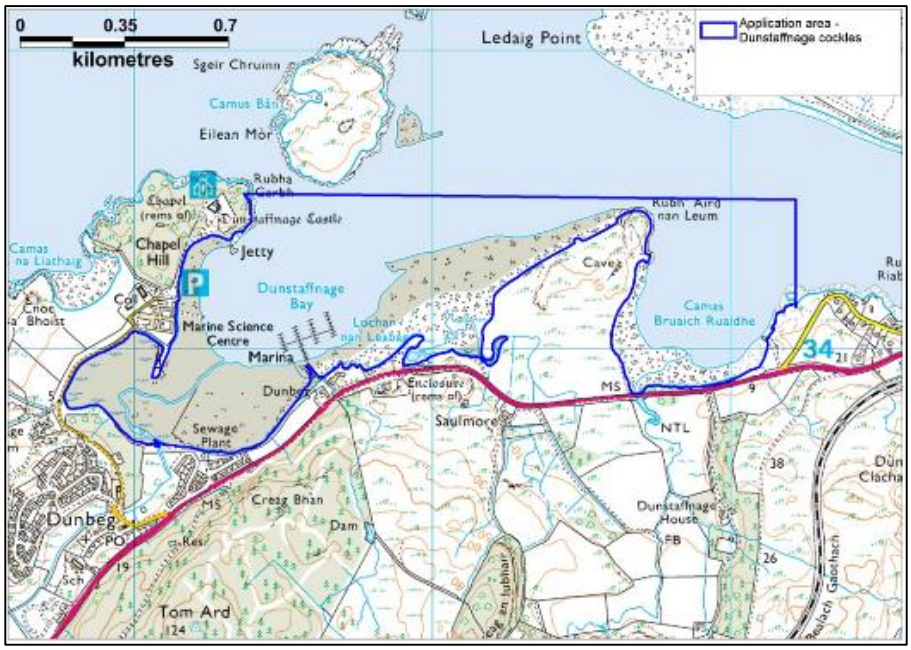

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Figure 13.2 Dunstaffnage Bay application area for cockles

13.2 Bathymetry and Hydrodynamics

13.2.1 Bathymetry

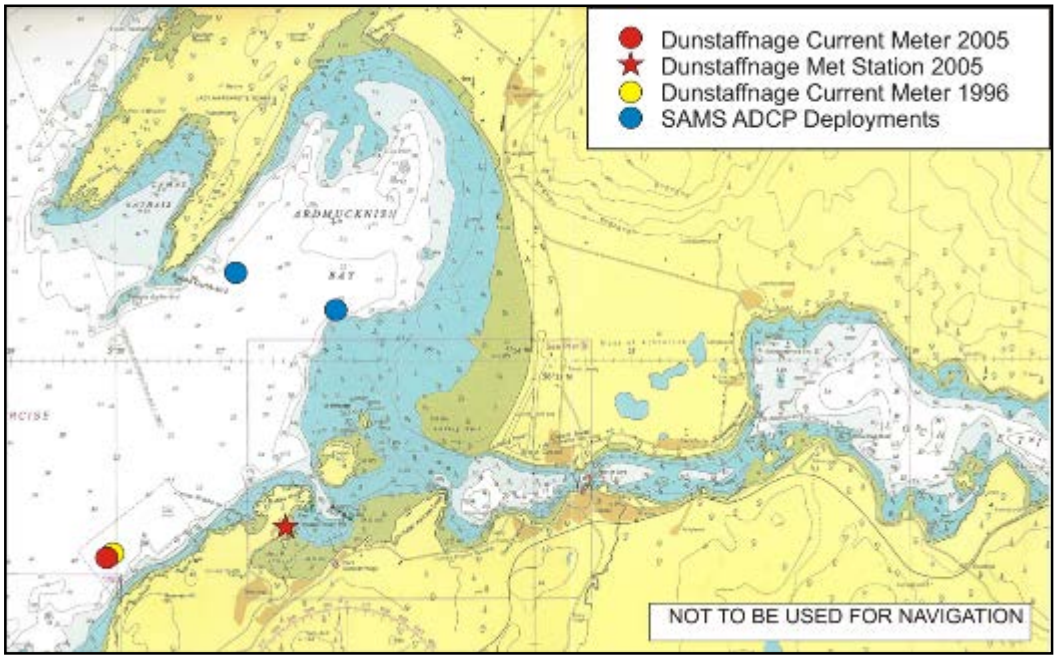

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Figure 13.3 Admiralty chart (2388, Edition 2, year 2012) extract for the Dunstaffnage Bay assessment area. Locations of current meter deployments and weather stations within and adjacent to the assessment area are shown.

Figure 13.3 shows the bathymetry of the Dunstaffnage assessment area. In the western part of the assessment area, bathymetry generally gently slopes from east to west towards

the main body of Ardmucknish Bay, where depths reach a maximum of 49 m. Dunstaffnage Bay, to the south of Ardmucknish Bay, is overall relatively shallow, but is characterised by a deeper, linear channel between Eilean Mòr and Rubha Garbh which reaches 16.2 m in depth.

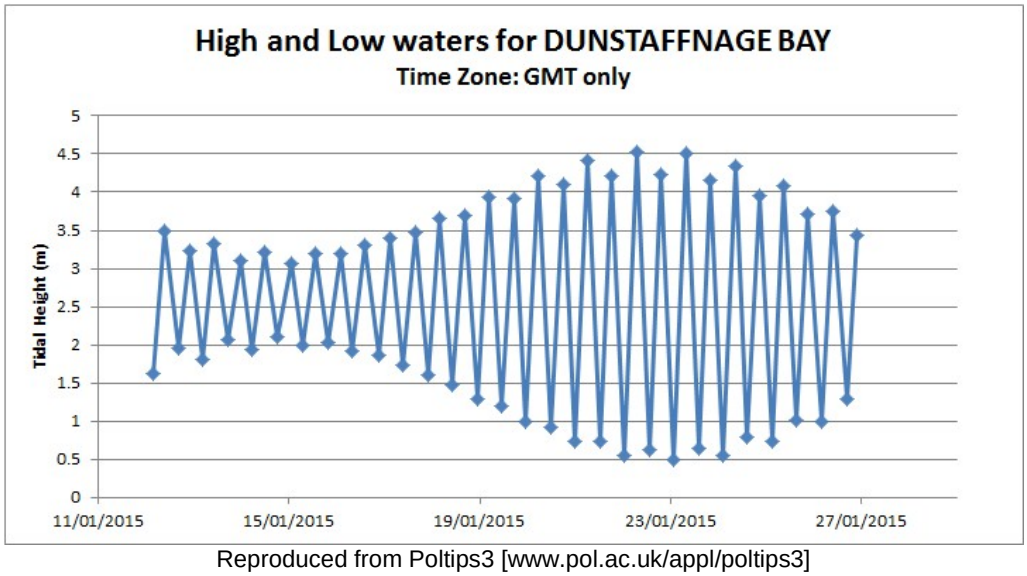
Moving eastwards into Loch Etive, water depths increase to a maximum of 42 m to the east of Rubh'Aird nan Lea. Further east, a shallow sill is found at the Falls of Lora (4 m in depth, (Edwards & Sharples, 1986)), with another deep area immediately adjacent, reaching 21 m in depth. Three further sills are found in Loch Etive within the assessment area: immediately east of the aforementioned deep area (5 m depth), at the Kilmaronag Narrows (5 m depth), and at the narrowing in the loch to the east of the Abbots Isles at Rubh'a'Chàirn (8 m depth, (Edwards & Sharples, 1986)).

The Dunstaffnage assessment area is characterised by several small islands and shallow or intertidally exposed rocks, predominantly found at the mouth of, and within Loch Etive. A substantial area of intertidal cobbles and sand is found along the northern and eastern coastline of Ardmucknish Bay. This intertidal area is widest at Ledaig Spit.

13.2.2 Tides

Data on tidal information is provided based on tidal characteristics determined from Dunstaffnage Bay, within the assessment area.

Standard tidal data for Dunstaffnage Bay, centred around the survey date of 19th January 2014, are shown in Figure 13.4. Tidal predictions for Dunstaffnage Bay indicate that in this region the tidal characteristics are semi-diurnal, with a well-developed spring-neap cycle.



Reproduced from Poltips3 [www.pol.ac.uk/appl/poltips3]

Figure 13.4 Two week tidal curve for Dunstaffnage Bay.

Tidal heights in Oban, data from Poltips3 [www.pol.ac.uk/appl/poltips3]:

Mean High Water Springs = 4.10 m
Mean Low Water Springs = 0.80 m
Mean High Water Neaps = 3.00 m
Mean Low Water Neaps = 1.90 m

This gives an approximate tidal volume of water within the assessment area during each tidal cycle of:

Springs: 6.24×10^7 m^3
Neaps: 2.08×10^7 m^3

13.2.3 Tidal Streams and Currents

There are no published tidal diamonds within the assessment area but the strength and direction of the currents are known locally to be highly variable throughout the assessment area with many eddies formed in the flow.

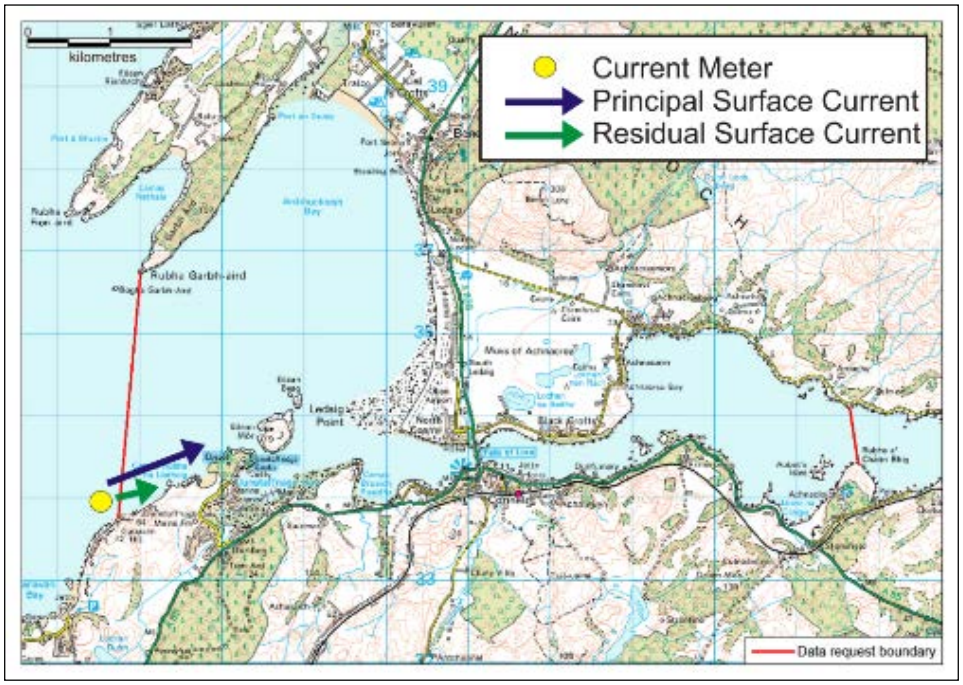


Figure 2.3 – Map showing 2005 Dunstaffnage Fish Farm current meter sample site and the Dunstaffnage Bay assessment area. Using the surface principal current amplitude and the assumption of a uniform sinusoidal tide, the cumulative transport distance and residual transport distance, and direction that might be expected during each phase of the tide is shown above. The boundary of the assessment area is indicated by the red line. 1996

Data were obtained from SEPA for current meter deployments in 1996 and 2005 at the Dunstaffnage Fish Farm, immediately to the west of the Dunstaffnage assessment area (Scottish Association for Marine Science, 1997; SAMS Research Services Ltd., 2006). No specific coordinates were given for the 1996 current meter deployment, and so it was assumed that the deployment location was similar to the survey carried out in 2005. The location of these deployments is shown in Figure 13.3. For clarity, in Figure 13.4, cumulative transport distances are only illustrated for the 2005 survey. Calculated transport distances for the 1996 survey are slightly less than in 2005.

Further unpublished current meter data were available from the Scottish Association for Marine Science for short deployments at two locations in Ardmucknish Bay (Figure 13.3). While these deployments did not span the requisite 2-week tidal cycle, the data do provide

useful information about water circulation patterns in Ardmucknish Bay and are discussed as a general characterisation of the assessment area.

The 1996 survey at the Dunstaffnage Fish Farm site was carried out between 12/12/1996 and 07/01/1997, spanning a period of 26 days and therefore captured a spring-neap cycle. No information was available regarding the depth of current meter deployment, or the depth of relevant surface, midwater, and bottom measurement bins. The overall water depth at the deployment location is not described, but is likely to be in the vicinity of 35 m, given the deployment location (assumed to be at the Dunstaffnage Fish Farm). A summary of the current meter data obtained at the Dunstaffnage Fish Farm is presented in Table 13.1.

Mean current speeds recorded in the 1996 Dunstaffnage Fish Farm deployment were similar across all depths. Current speeds showed some spring-neap variation, particularly at midwater and bottom depths. Current flows were more strongly directional at midwater and near the sea bed than at the sea surface (Scottish Association For Marine Science, 1997). At all depths currents flowed along a north-easterly – south-westerly axis, parallel to the adjacent coastline. While weak near-surface residual currents followed a similar heading, stronger midwater and nearbed residual currents had a somewhat more easterly heading (flowing east-northeast). No meteorological data was available to complement this survey.

Table 13.1 Dunstaffnage Fish Farm current data measured in 1996

	Near-bed	Midwater	Surface
Mean Speed (ms^{-1})	0.049	0.054	0.048
Maximum Speed (ms^{-1})	0.230	0.190	0.230
Principal Axis Amp & Dir (ms^{-1}) & (^oM)	0.135 (27.7)	0.104 (31.0)	0.135 (46.4)
Residual speed (ms^{-1})	0.029	0.044	0.005
Residual direction (^oM)	68.6	59.0	29.0

In 2005 an acoustic Doppler current profiler was deployed near the Dunstaffnage Fish Farm (56°27′00.13″N 005°27′52.30″W) 1 m above the seabed in 40 m water depth. Current data were obtained over 22 days at three depths: 35 m, 28 m, and 3 m above the seabed (SAMS Research Services Ltd. 2006). Measurements encompassed a full spring-neap tidal cycle between 09/11/2005 and 01/12/2005. Current data from Dunstaffnage Bay are summarised in Table 13.2.

Table 13.2 Dunstaffnage Fish Farm current data measured in 2005

	Near-bed (3 m above seabed)	Mid-water (28 m above seabed)	Surface (35 m above seabed)
Mean Speed (ms^{-1})	0.083	0.066	0.077
Maximum Speed (ms^{-1})	0.236	0.285	0.400
Principal Axis Amp & Dir (ms^{-1}) & (^oM)	0.100 (52)	0.093 (64)	0.096 (69)
Residual speed (ms^{-1})	0.065	0.040	0.042
Residual direction (^oM)	45.8	66.4	76.9

Mean current speeds measured in 2005 at Dunstaffnage are similar throughout the water column, but are slightly greater near the seabed. However, maximum recorded current speeds were observed near the sea surface. Some spring-neap variation in tidal currents was observed, but current speeds were also likely influenced by two strong wind events occurring on 11/11/2005 and 24/11/2005, which may have increased current speeds, particularly near the sea surface.

Mean currents generally flowed in an east north-easterly direction, with a gradually decreasing easterly component with depth. Residual currents were strongest near the seabed and flowed in a similar direction, again becoming somewhat more northerly in direction with depth.

Meteorological data were also recorded during the Dunstaffnage Fish Farm current meter deployment in 2005. Winds rarely dropped below 10 ms^{-1} over the first six days of current meter deployment, and high wind speeds were also recorded on the 24th of November. Wind speeds averaged 8.6 knots over the duration of current meter deployment, and the residual wind direction was west north-westerly.

Current meter data recorded at the Dunstaffnage Fish Farm site in 1996 and 2005 are in broad agreement. In both surveys, currents flowed in similar directions (in parallel with the adjacent shoreline). However, recorded current speeds were substantially greater in 2005, and may have been a result of local topography, though this is difficult to assess as no geographical coordinates were provided for the 1996 survey.

Data from two additional short term current meter deployments in Ardmucknish Bay provide further context to current flows in the assessment area. These deployments were carried out in 2011 between the 8th and 10th of February. Currents at the western deployment location were observed to flow in a southwest to northeast direction, in parallel with the adjacent shoreline. At the eastern deployment location, on the other hand, the strongest currents flowed in an easterly direction, suggesting a clockwise tidal circulation within Ardmucknish Bay (M. Toberman, SAMS, *pers. comm.*). These strong currents were predominantly observed near the surface (< 10 m depth), while currents deeper in the water column were weaker.

It is difficult to assess the flushing potential of the Dunstaffnage Bay assessment area as no complete current meter deployments were available within the assessment area. However, it is suggested that the area may be relatively well flushed given the highly energetic nature of flow over sills within Loch Etive (for example the Falls of Lora) and numerous narrow channels and islands which are likely to enhance flow speeds and dispersion. Ardmucknish Bay is relatively open to the southern part of Loch Linnhe and the Firth of Lorn, and will be exposed predominantly to waves generated within the Firth of Lorn. This suggests that dispersion may be rapid within the assessment area. However, it is important to note that the nature of current flows will vary substantially throughout the assessment area.

Using the largest recorded mean surface principal current of 0.135 ms^{-1} and assuming a uniform sinusoidal tide, the cumulative transport that might be expected during each phase of the tide (approximately 6 hours) has been estimated as 1.9 km. No distinction is made here for springs and neaps.

13.2.4 River/Freshwater Inflow

No major rivers flow into the Dunstaffnage Bay assessment area, but the eastern boundary of the assessment area is open to the main body of Loch Etive, which is fed by the rivers Etive, Esragan, Awe, Nant, Noe, Liver, and Kinglass. Riverine input of freshwater into Loch Etive has been estimated to be between 2.4×10^6 and 3.6×10^7 m^3 day^{-1}, 60% of which is through the River Awe (Edwards & Edelsten, 1977).

Numerous small burns and rivers also flow into Loch Etive, supplying fresh water to the assessment area. The assessment area itself is also fed by further small streams and burns, including Abhainn Achnacree and Allt an t-Siornain along the northern shoreline and Lusragan Burn along the southern shoreline. There is also a freshwater discharge at the southwest corner of Dunstaffnage Bay

The rainwater catchment area for Loch Etive is larger than that of any other Scottish fjord (Edwards & Edelsten, 1977). The annual precipitation in the area is approximately 2500 mm and the annual freshwater runoff is estimated as 3037.5 M m^3 yr^{-1} (Edwards & Sharples, 1986).

13.2.5 Meteorology

The meteorological station at Frackersaig Farm, Lismore is the nearest weather station and is situated approximately 8 km to the north of the Dunstaffnage Bay application area. Rainfall data was available for the period from January 2008 to November 2013 inclusive.

While 2010 generally had the lowest daily rainfall, the highest rainfall for this time period was recorded in 2011 (2354 mm). Very high rainfall events of > 40 mm d^{-1} occurred once in 2009, 2011, 2012 and 2013 while rainfall events of > 30 mm d^{-1} were recorded in all years. These rainfall events (>30 mm d^{-1}) occurred in all months except March and June. Daily rainfall values varied seasonally, and were generally lower in late spring and in the summer months (March - July) with the lowest of them being June and higher in winter months (October - January). For the duration of the dataset (2008-2013), daily rainfall below 1 mm occurred on 46% of days, while daily rainfall above 10 mm occurred on 17% of days.

Run-off due to rainfall is expected to be higher in autumn and winter months. However, it must also be noted that substantial rainfall events occurred in summer months also and consequently that high run-off can occur throughout the year.

Wind data were obtained from Tiree, located 90 km to the west of the assessment area. Given the distance between these two locations and varying topography, wind statistics may not be directly transferrable to the specific production area around Dunstaffnage Bay. They are, however, valuable in providing the general pattern of the seasonal wind conditions. Data collected between January 2004 and December 2013 indicate that the predominant wind direction is from the south-southwest and west and the strongest winds tended to be from the south. Seasonally the strongest winds occurred during autumn and winter. Typically the wind came from around the south and west predominantly and in lesser proportion from the north and southeast, throughout the year whilst the summer also saw winds from the north in a slightly higher proportion than in winter. Nevertheless, local wind direction in Dunstaffnage Bay are likely to be somewhat influenced by the surrounding topography.

13.2.6 Model Assessment

Due to the paucity of data in the vicinity of the assessment area and the unconstrained nature of the study area, it was not considered appropriate to set up a box model run for the Dunstaffnage assessment area.

There are numerical models running for the assessment area and these tools could be used if a highly quantitative assessment of flow and exchange is required.

13.3 Hydrographic Assessment

13.3.1 Surface Flow

The site and meteorological data indicate that the discharge of freshwater into the surface will be highly variable around the assessment area and seasonal. In particular, the freshwater discharge into the area through Loch Etive is highly seasonal and one of the biggest contributions by volume. Therefore the role of freshwater is likely to be highly localised. A distinct freshwater layer may develop across much of the area under periods of calm weather and/or heavy rainfall but otherwise it will probably be well mixed. Due to the tidal conditions and the potential for mixing, such a layer would probably be short-lived.

The assessment area of Dunstaffnage is relatively complex in terms of bathymetry and flow. Tidal flows are relatively fast in the area and dispersion is likely to be high. From the current meter record outside Dunstaffnage Bay the flow is relatively uniform and aligned along the coast. In general, the flood tide at this location will transport water to the northeast whilst the ebb will transport it to the southwest. Additionally, there is a significant jet of water discharging from Loch Etive on the ebb and a strong inflow to the loch on the flood. The effect of this is the development of significant eddies and persistent local circulations in the adjacent bays. There is no single measure of net transport that would capture the complexity in flow for this location.

Surface residual flows would be enhanced by prevailing winds from either the southwest or from the east, blowing out of Loch Etive. Again, the concept of a simple residual flow is highly problematic in such a non-uniform location with the magnitude and direction of such a flow varying considerably across the assessment area.

13.3.2 Exchange Properties

Tidal flow will dominate the exchange properties of the Dunstaffnage assessment area. Given the relatively open nature and relatively strong current flow it is likely to have a small flushing time. There general pattern of anti-clockwise circulation within Dunstaffnage Bay may cause greater retention of material within that system but this is speculative and no measurements exist to confirm it.

It is expected that in general the Dunstaffnage assessment area be a well flushed system throughout most of the year with surface contaminants being effectively dispersed in the residual flow.

There are just two full data sets available for a rather complex area and these lie outside the formal assessment area. The paucity of additional hydrographic data renders the confidence level of this assessment as LOW.

14 Shoreline Survey Overview

The shoreline survey was conducted between the 19th and 21st January 2015. Weather was stormy until 48 hours prior to the survey. All three survey days were dry and predominantly calm, with air temperatures increasing from 1 to 5ºC.

The fishery consisted of two wild cockle beds, one at Dunstaffnage Bay and the other at Camas Bruaich Ruaidhe. Cockles ranged in size but were reasonably abundant at both sites. Five cockle samples were taken and returned results varying between <18 and 130 *E. coli* MPN/100 g. The local sampling officer stated that the original harvester, a Mr MacArthur, had been unable to access the shoreline to harvest the cockles, due to a dispute over shore access with the land owner. A new harvester (Mr S. Pattison) had however received permission and was actively harvesting an area to the east of Dunstaffnage Marina.

Human population was concentrated west of Dunstaffnage Bay in Dunbeg and east at North Connel and Connel. A recently built housing estate consisting of 50 newly occupied dwellings was noted further west of the bay, whilst the Scottish Marine Institute complex (SAMS-Scottish Association for Marine Science) and Dunstaffnage Castle Visitor Centre & carpark were noted to the northwest. Dunstaffnage Marina and Poppy's Garden Centre were noted on the eastern side of the bay.

Guest house accommodation was noted in Connel and North Connel, with two holiday houses noted further east at Dunfuinary. The survey team also noted that some of the observed houses may have been second/holiday homes with part-time occupancy.

Community sewage discharges and associated infrastructure was observed at Dunstaffnage Bay, Connel and North Connel. The majority of sewage related observations related to dry and or disused/broken pipes and were predominantly noted in the Connel and North Connel areas. Several active discharges were also noted along the southern shoreline. An audibly flowing discharge pipe from a ST was noted northwest of Dunstaffnage Bay. To the western extent of Connel, toilet paper was noted below three dry discharge pipes and nearby a seawater sample taken adjacent to a broken pipe discharging to sea returned a result of 1200 *E. coli* cfu/100 ml. Further east, three actively flowing discharge pipes were noted; an active discharge on the grassy shore returned a freshwater sample of 1300000 *E. coli* cfu/100 ml, a broken iron pipe discharging unaltered faecal matter returned a freshwater sample result of 13000 *E. coli* cfu/100 ml and finally a ceramic pipe with a small discharge returned a result of 2600000 *E. coli* cfu/100 ml. Two freshwater samples were taken from discharging pipes to the east of Connel, and returned results of 2000 and 14000 *E. coli* cfu/100 ml.

Forty-two predominantly empty moorings were counted in Dunstaffnage Bay and staff from the marina stated there were 120 yachts stored ashore and a further 20 at the pontoons. These boats would be slipped and moored in the summer. A RIB was also seen at the Falls of Lora, which is popular with power boats and kayakers in the summer.

No farm animals were observed during the survey, though eight horses and hoof prints were noted northwest of the bridge. Chickens were seen on an individual property to the east of North Connel. A farm is known to be located at Saulmore, with sheep and beef cattle farming known to occur in the area.

The surrounding land outside the villages is predominantly woodland with grazing said to be present throughout the area (although no grazing animals were recorded). A commercial coniferous forestry plantation was recorded on the hills southeast of Dunbeg to the east of the A85. Houses at North Connel are set back from the lochside by farmland and sloping crofting ground, with Oban airport situated northwest of the Connel Bridge. Dunstaffnage Castle and the Scottish Marine Institute buildings are situated northwest of Dunstaffnage Bay, whilst the marina and Poppy's garden centre are situated to the east.

Measurements and freshwater samples were taken at nine watercourses encountered during the survey. Sample results were low to moderate, varying between <10 and 830 *E. coli* cfu/100 ml.

Birds were the main wildlife observed. Species identified included mallard ducks which were the most frequently observed, curlew, wagtail, oystercatcher, eider, shag, cormorant, gull, swan, heron, hooded crow, robin buzzards, and rock pipit. One rabbit was seen, though evidence of rabbits (e.g. droppings, fur and burrows) was noted on three separate occasions. A common seal was also observed briefly near a pontoon at Connell, whilst a dog and several piles of dog faeces were noted along the shore path adjacent to Oban airport.

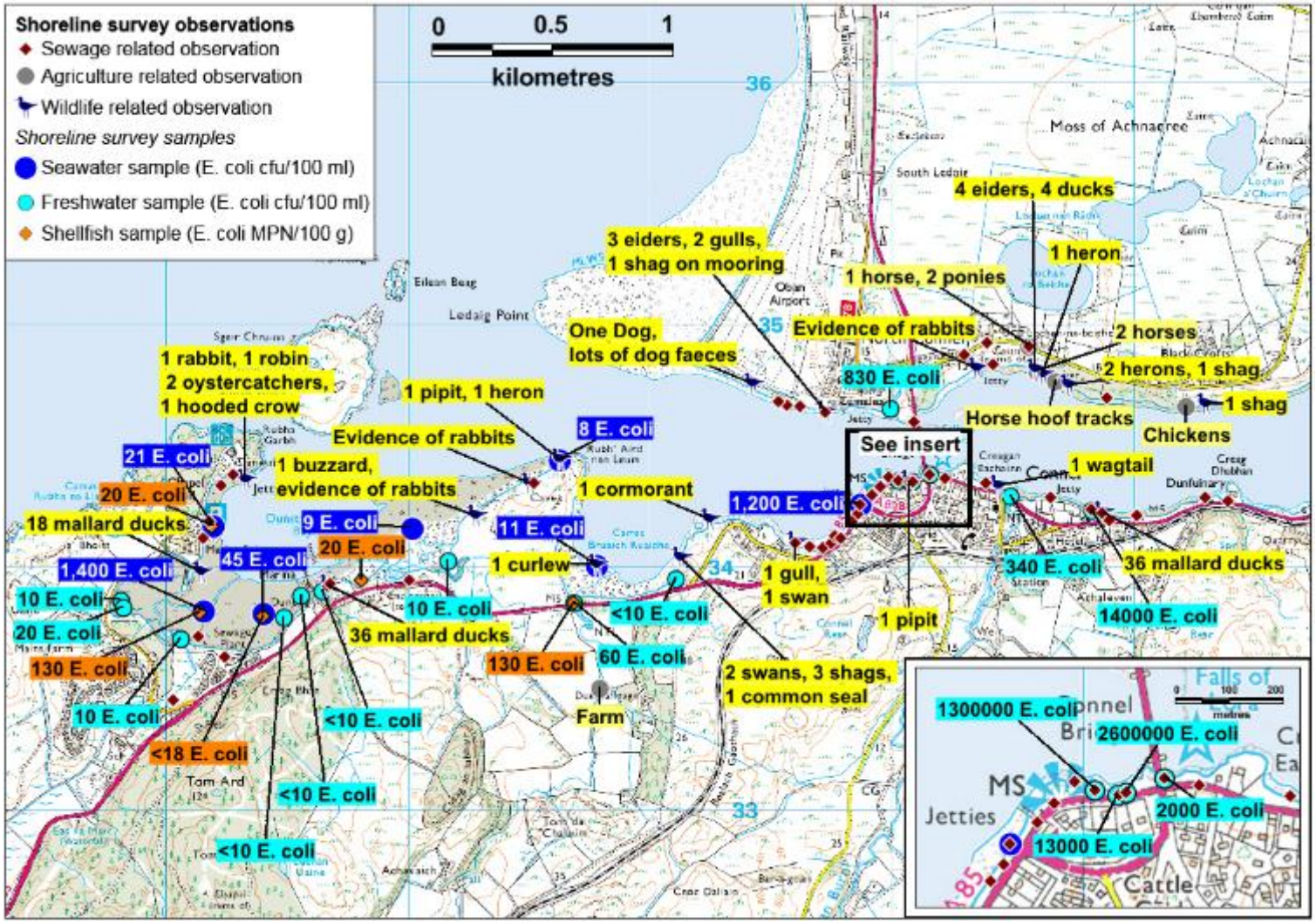


Figure 14.1 Summary of shoreline survey observations for Dunstaffnage Cockles

15 Bacteriological Survey

A bacteriological survey was not undertaken for Dunstaffnage Cockles due to the uncertainty of the availability of sufficient animals at fixed points throughout the area.

16 Overall Assessment

Fishery

During the shoreline survey, cockles were found at a number of intertidal locations within the production area but not immediately west of Rubh' Aird nan Leum and the Connel & Dunbeg sewage discharge, where the substrate was identified to be stony and rocky.

Historical surveys conducted in the bay reported the presence of cockles in the southern part of Dunstaffnage Bay and at the head of Camas Bruaich Ruaidhe (Scottish Natural Heritage, 2011).

Human sewage impacts

Human population is mainly located in the village of Dunbeg, at the head of Dunstaffnage Bay, and in the villages of Connel and North Connell, located to the east and northeast of Camas Bruaich Ruaidhe respectively. There are community and private sewage discharges associated with all of these settlements, as well as within Ardmucknish Bay, to the north of Dunstaffnage Bay.

Direct sewage impacts within the production area will be associated with the Connel and Dunbeg WWTW final effluent outfall, associated intermittent discharges and several private discharges located within the boundaries of the production area. Additional contamination will be associated with the community and private discharges located in the Connel and North Connel area. It is not clear whether there will be any impact, or contribution to background *E. coli* levels, from the discharges within Ardmucknish Bay.

Agricultural impacts

There is conflicting information regarding the occurrence of farm animals within the area. The shoreline survey report identified that grazing was widespread through the area. However, no farm animals were recorded during the shoreline survey, only some horses and some domestic chickens on the north shore of Loch Etive. No farm animals were visible in aerial images accessed for this sanitary survey. On the basis of the available evidence, the potential for faecal impact from animal sources is considered to be low.

Wildlife and pet impacts

The most significant source of wildlife contamination in the area is considered to beseabirds and ducks. The greatest impact may be on the northwestern side of Dunstaffnage Bay due to the colonies located on the nearby islands. Seals are present in the area, and one was seen at Camas Bruach Ruaidhe during the shoreline survey. These animals are therefore expected to contribute to background levels of contamination in the area, and may directly deposit faeces to the cockle beds when present. However, any contamination from otters and deer will be mainly carried via watercourses.

Seasonal variation

Impacts from human sources are likely to be higher during the summer due to tourism and an increase in boating activity. Impacts from seabirds are expected to be higher during the breeding season, which largely falls between May and October, when seabird numbers in the area will more than double. The populations of wading birds and ducks are likely to show a different seasonality to seabirds, with larger numbers present in autumn and winter than in other seasons.

Watercourses

Watercourses are expected to contribute moderate amounts of contamination to both bays, primarily associated with the main watercourse at the head of each bay. Any impact may be greater after rainfall.

Movement of contaminants

Currents within the two bays are expected to be complex and thus it is difficult to predict the movement of contaminants. Anti-clockwise circulation was noted to occur in Dunstaffnage Bay in particular. and a similar gyre may occur in Camas Bruaich Ruaidhe. However, there were no specific measurements to confirm the conditions under which this circulation operates or the strength of the circulatory flows. The estimated maximum particle transport distance in the area is 1.9 km, however due to complexities of circulation at the shellfisheries, particles are unlikely to be carried in a straight line from the source This means that contamination from discharges in the area of Connel would be likely to reach the vicinity of the production area on an ebb tide but it is not clear whether that contamination would enter the bays. Contamination arising within the bays would be taken over the intertidal area on the ebb tide. Anti-clockwise circulation in Dunstaffnage Bay may result in contaminants from the Connel & Dunbeg discharge being carried westward and then southward into the main body of the bay.

Temporal and geographical patterns of sampling results

There are too few results available to determine whether there are any temporal trends although the highest results were seen between May and September 2014. All of the classification samples had been taken within a relatively small area to the east of Dunstaffnage Marina and no spatial variation could be determined.

The two highest cockle results (both 130 *E. coli* MPN/100 g) from samples taken during the shoreline survey were from a sample taken towards the centre of the intertidal area in Dunstaffnage Bay (to the west of the marina) and from a sample taken at the head of Camas Bruaich Ruaidhe. The former sample location was associated with a high seawater result of 1400 *E. coli* MPN/100 g.

Conclusions

It is expected that contamination associated with sources located within the production area will predominate within the two bays. These sources are:

- the continuous and intermittent community discharges at Rubh' Aird nan Leam

- the intermittent community discharge within Dunstaffnage Bay
- private sewage discharges located within Dunstaffnage Bay
- boats moored within Dunstaffnage Bay
- watercourses located within both bays
- seabirds and ducks, with seabirds associated with nesting areas on the northwest side of Dunstaffnage Bay predominating.

Information on the movement of contaminants is insufficient to determine whether the community discharges located at Rubh' Aird nan Leam will have a greater impact within one or other of the two bays. In the absence of that information, it is concluded that there are more sources potentially affecting Dunstaffnage Bay and that the greatest impact may be to the west of the marina.

17 Recommendations

Given the close proximity of continuous and intermittent community discharges, private sewage discharges, the marina and boat moorings and contaminated watercourses to the intertidal areas containing the cockles, it is not possible to redefine the production area to exclude such significant sources while including all of the potential cockle harvesting areas. In order to encompass the latter, it will be necessary to maintain the present definition of the production area. With respect to spatial assessment of contamination, this indicates that the combined effects will be greatest within Dunstaffnage Bay, to the west of Dunstaffnage Marina.

A summary of the recommendations is presented in map form in Figure 17.1.

It would be possible to redefine the production area to include only that part of the intertidal area within Dunstaffnage Bay that is currently being used for harvesting. This could be defined to exclude the identified pollution sources. In that case, the location of the recommended RMP would be re-evaluated and would be likely to be in the vicinity of the cockle sampling undertaken to date.

Production area

The recommended production area is: the area bounded by lines drawn between NM 8837 3452 and NM 9022 3450 and between NM 9022 3450 and NM 9022 3414, extending to MHWS.

RMP

It is recommended that the RMP be located at NM 8813 3382.

Tolerance

It is recommended that a tolerance of 50 m be applied. This will allow for some variability in density of stocks in the area.

Depth of sampling

Not applicable.

Frequency

It is recommended that monthly sampling be continued.

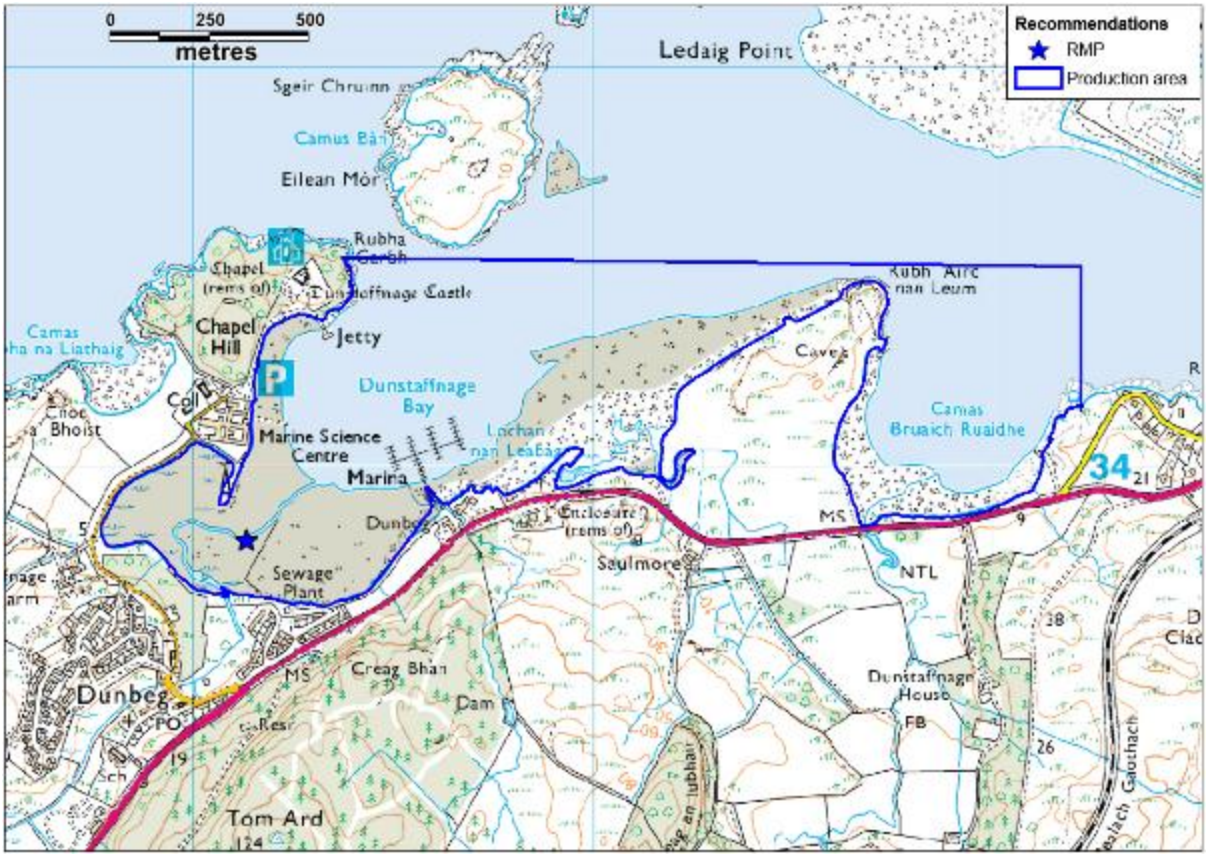


Figure 17.1 Map of recommendations at Dunstaffnage Cockles

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19 List of Figures and Tables

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1. General Information on Wildlife Impacts
2. Tables of Typical Faecal Bacteria Concentrations
3. Hydrographic Section Glossary
4. Shoreline Survey Report
5. SEPA Discharge Consents
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1. General Information on Wildlife Impacts

Pinnipeds

Two species of pinniped (seals, sea lions, walruses) are commonly found around the coasts of Scotland: These are the European harbour, or common, seal (*Phoca vitulina vitulina*) and the grey seal (*Halichoerus grypus*). Both species can be found along the west coast of Scotland.

Common seal surveys are conducted every 5 years and an estimate of minimum numbers is available through Scottish Natural Heritage.

According to the Scottish Executive, in 2001 there were approximately 119,000 grey seals in Scottish waters, the majority of which were found in breeding colonies in Orkney and the Outer Hebrides.

Adult Grey seals weigh 150-220 kg and adult common seals 50-170 kg. They are estimated to consume between 4 and 8% of their body weight per day in fish, squid, molluscs and crustaceans. No estimates of the volume of seal faeces passed per day were available, though it is reasonable to assume that what is ingested and not assimilated in the gut must also pass. Assuming 6% of a median body weight for harbour seals of 110kg, that would equate to 6.6kg 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 1.21×10^4 CFU (colony forming units) *E. coli* per gram dry weight of faeces (Lisle *et al* 2004).

Both bacterial and viral pathogens affecting humans and livestock have been found in wild and captive seals. *Salmonella* and *Campylobacter* spp., some of which were antibiotic-resistant, were isolated from juvenile Northern elephant seals (*Mirounga angustirostris*) with *Salmonella* found in 36.9% of animals stranded on the California coast (Stoddard, et al., 2005) *Salmonella* and *Campylobacter* are both enteric pathogens that can cause acute illness in humans and it is postulated that the elephant seals were picking up resistant bacteria from exposure to human sewage waste.

One of the *Salmonella* species isolated from the elephant seals, *Salmonella typhimurium*, is carried by a number of animal species and has been isolated from cattle, pigs, sheep, poultry, ducks, geese and game birds in England and Wales. Serovar DT104, also associated with a wide variety of animal species, can cause severe disease in humans and is multi-drug resistant (Poppe, et al., 1998)

Cetaceans

As mammals, whales and dolphins would be expected to have resident populations of *E. coli* and other faecal indicator bacteria in the gut. Little is known about the concentration of indicator bacteria in whale or dolphin faeces, in large part because the animals are widely dispersed and sample collection difficult.

A variety of cetacean species are routinely observed around the west coast of Scotland. Where possible, information regarding recent sightings or surveys is gathered for the production area. As whales and dolphins are broadly free ranging, this is not usually possible to such fine detail. Most survey data is supplied by the Hebridean Whale and Dolphin Trust or the Shetland Sea Mammal Group and applies to very broad areas of the coastal seas.

It is reasonable to expect that whales would not routinely affect shellfisheries located in shallow coastal areas. It is more likely that dolphins and harbour porpoises would be found in or near fisheries due to their smaller physical size and the larger numbers of sightings near the coast.

Birds

Seabird populations were surveyed all over Britain as part of the SeaBird 2000 census. These counts are investigated using GIS to give the numbers observed within a 5 km radius of the production area. This gives a rough idea of how many birds may be present either on nests or feeding near the shellfish farm or bed.

Further information is gathered where available related to shorebird surveys at local bird reserves when present. Su\rveys of overwintering geese are queried to see whether significant populations may be resident in the area for part of the year. In many areas, at least some geese may be present year round. The most common species of goose observed during shoreline surveys has been the Greylag goose. Geese can be found grazing on grassy areas adjacent to the shoreline during the day and leave substantial faecal deposits. Geese and ducks can deposit large amounts of faeces in the water, on docks and on the shoreline.

A study conducted on both gulls and geese in the northeast United States found that Canada geese (*Branta canadiensis*) contributed approximately 1.28×10^5 faecal coliforms (FC) per faecal deposit and ring-billed gulls (*Larus delawarensis*) approximately 1.77×10^8 FC per faecal deposit to a local reservoir (Alderisio & DeLuca, 1999). An earlier study found that geese averaged from 5.23 to 18.79 defecations per hour while feeding, though it did not specify how many hours per day they typically (Gauthier & Bedard, 1986)

Waterfowl can be a significant source of pathogens as well as indicator organisms. Gulls frequently feed in human waste bins and it is likely that they carry some human pathogens.

Deer

Deer are present throughout much of Scotland in significant numbers. The Deer Commission of Scotland (DCS) conducts counts and undertakes culls of deer in areas that have large deer populations.

Four species of deer are routinely recorded in Scotland, with Red deer (*Cervus elaphus*) being the most numerous, followed by Roe deer (*Capreolus capreolus*), Sika deer (*Cervus nippon*) and Fallow deer (*Dama dama*).

Accurate counts of populations are not available, though estimates of the total populations are >200,000 Roe deer, >350,000 Red deer, < 8,000 Fallow deer and an unknown number of Sika deer. Where Sika deer and Red deer populations overlap, the two species interbreed further complicating counts.

Deer will be present particularly in wooded areas where the habitat is best suited for them. Deer, like cattle and other ruminants, shed *E. coli*, *Salmonella* and other potentially pathogenic bacteria via their faeces.

Otters

The European otter (*Lutra lutra*) is present around Scotland with some areas hosting populations of international significance. Coastal otters tend to be more active during the day, feeding on bottom-dwelling fish and crustaceans among the seaweed found on rocky inshore areas. An otter will occupy a home range extending along 4-5km of coastline, though these ranges may sometimes overlap (Scottish National Heritage, n.d.). Otters primarily forage within the 10 m depth contour and feed on a variety of fish, crustaceans and shellfish (Paul Harvey, Shetland Sea Mammal Group, personal communication).

Otters leave faeces (also known as spraint) along the shoreline or along streams, which may be washed into the water during periods of rain.

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2. Tables of Typical Faecal Bacteria Concentrations

Summary of faecal coliform concentrations (cfu $100ml^{-1}$) for different treatment levels and individual types of sewage-related effluents under different flow conditions: geometric means (GMs), 95% confidence intervals (CIs), and results of t-tests

Indicator organism	**Base-flow conditions**				**High-flow conditions**			
Treatment levels and specific types: Faecal coliforms	*n*[c]	Geometric mean	Lower 95% CI	Upper 95% CI	*n*[c]	Geometric mean	Lower 95% CI	Upper 95% CI
Untreated	252	1.7×10^{7} * (+)	1.4×10^{7}	2.0×10^{7}	282	2.8×10^{6} * (-)	2.3×10^{6}	3.2×10^{6}
Crude sewage discharges	252	1.7×10^{7} * (+)	1.4×10^{7}	2.0×10^{7}	79	3.5×10^{6} * (-)	2.6×10^{6}	4.7×10^{6}
Storm sewage overflows					203	2.5×10^{6}	2.0×10^{6}	2.9×10^{6}
Primary	127	1.0×10^{7} * (+)	8.4×10^{6}	1.3×10^{7}	14	4.6×10^{6} (-)	2.1×10^{6}	1.0×10^{7}
Primary settled sewage	60	1.8×10^{7}	1.4×10^{7}	2.1×10^{7}	8	5.7×10^{6}		
Stored settled sewage	25	5.6×10^{6}	3.2×10^{6}	9.7×10^{6}	1	8.0×10^{5}		
Settled septic tank	42	7.2×10^{6}	4.4×10^{6}	1.1×10^{7}	5	4.8×10^{6}		
Secondary	864	3.3×10^{5} * (-)	2.9×10^{5}	3.7×10^{5}	184	5.0×10^{5} * (+)	3.7×10^{5}	6.8×10^{5}
Trickling filter	477	4.3×10^{5}	3.6×10^{5}	5.0×10^{5}	76	5.5×10^{5}	3.8×10^{5}	8.0×10^{5}
Activated sludge	261	2.8×10^{5} * (-)	2.2×10^{5}	3.5×10^{5}	93	5.1×10^{5} * (+)	3.1×10^{5}	8.5×10^{5}
Oxidation ditch	35	2.0×10^{5}	1.1×10^{5}	3.7×10^{5}	5	5.6×10^{5}		
Trickling/sand filter	11	2.1×10^{5}	9.0×10^{4}	6.0×10^{5}	8	1.3×10^{5}		
Rotating biological contactor	80	1.6×10^{5}	1.1×10^{5}	2.3×10^{5}	2	6.7×10^{5}		
Tertiary	179	1.3×10^{3}	7.5×10^{2}	2.2×10^{3}	8	9.1×10^{2}		
Reed bed/grass plot	71	1.3×10^{4}	5.4×10^{3}	3.4×10^{4}	2	1.5×10^{4}		
Ultraviolet disinfection	108	2.8×10^{2}	1.7×10^{2}	4.4×10^{2}	6	3.6×10^{2}		

comparing base- and high-flow GMs for each group and type.

Source: (Kay, et al., 2008b)

Table 3 – Geometric mean (GM) and 95% confidence intervals (CIs) of the GM faecal indicator organism (FIO) concentrations (cfu/100ml) under base- and high-flow conditions at the 205 sampling points and for various subsets, and results of paired t-tests to establish whether there are significant elevations at high flow compared with base flow

FIO	*n*	**Base Flow**			**High Flow**		
Subcatchment land use		Geometric mean	Lower 95% CI	Upper 95% CI	Geometric mean[a]	Lower 95% CI	Upper 95% CI
Total coliforms							
All subcatchments	205	5.8×10^3	4.5×10^3	7.4×10^3	7.3×10^{4}**	5.9×10^4	9.1×10^4
Degree of urbanisation							
Urban	20	3.0×10^4	1.4×10^4	6.4×10^4	3.2×10^{5}**	1.7×10^5	5.9×10^5
Semi-urban	60	1.6×10^4	1.1×10^4	2.2×10^4	1.4×10^{5}**	1.0×10^5	2.0×10^5
Rural	125	2.8×10^3	2.1×10^3	3.7×10^3	4.2×10^{4}**	3.2×10^4	5.4×10^4
Rural subcatchments with different dominant land uses							
≥75% Imp pasture	15	6.6×10^3	3.7×10^3	1.2×10^4	1.3×10^{5}**	1.0×10^5	1.7×10^5
≥75% Rough Grazing	13	1.0×10^3	4.8×10^2	2.1×10^3	1.8×10^{4}**	1.1×10^4	3.1×10^4
≥75% Woodland	6	5.8×10^2	2.2×10^2	1.5×10^3	6.3×10^{3}*	4.0×10^3	9.9×10^3
Faecal coliform							
All subcatchments	205	1.8×10^3	1.4×10^3	2.3×10^3	2.8×10^{4}**	2.2×10^4	3.4×10^4
Degree of urbanisation							
Urban	20	9.7×10^3	4.6×10^3	2.0×10^4	1.0×10^{5}**	5.3×10^4	2.0×10^5
Semi-urban	60	4.4×10^3	3.2×10^3	6.1×10^3	4.5×10^{4}**	3.2×10^4	6.3×10^4
Rural	125	8.7×10^2	6.3×10^2	1.2×10^3	1.8×10^{4}**	1.3×10^4	2.3×10^4
Rural subcatchments with different dominant land uses							
≥75% Imp pasture	15	1.9×10^3	1.1×10^3	3.2×10^3	5.7×10^{4}**	4.1×10^4	7.9×10^4
≥75% Rough Grazing	13	3.6×10^2	1.6×10^2	7.8×10^2	8.6×10^{3}**	5.0×10^3	1.5×10^4
≥75% Woodland	6	3.7×10	1.2×10	1.2×10^2	1.5×10^{3}**	6.3×10^2	3.4×10^3
Enterococci							
All subcatchments	205	2.7×10^2	2.2×10^2	3.3×10^2	5.5×10^{3}**	4.4×10^3	6.8×10^3
Degree of urbanisation							
Urban	20	1.4×10^3	9.1×10^2	2.1×10^3	2.1×10^{4}**	1.3×10^4	3.3×10^4
Semi-urban	60	5.5×10^2	4.1×10^2	7.3×10^2	1.0×10^{4}**	7.6×10^3	1.4×10^4
Rural	125	1.5×10^2	1.1×10^2	1.9×10^2	3.3×10^{3}**	2.4×10^3	4.3×10^3
Rural subcatchments with different dominant land uses							
≥75% Imp. pasture	15	2.2×10^2	1.4×10^2	3.5×10^2	1.0×10^{4}**	7.9×10^3	1.4×10^4
≥75% Rough Grazing	13	4.7×10	1.7×10	1.3×10^2	1.2×10^{3}**	5.8×10^2	2.7×10^3
≥75% Woodland	6	1.6×10	7.4	3.5×10	1.7×10^{2}**	5.5×10	5.2×10^2
[a] Significant elevations in concentrations at high flow are indicated: **po0.001, *po0.05.							
[b] Degree of urbanisation categorised according to percentage built-up land: 'Urban' (X10.0%), 'Semi-urban' (2.5–9.9%) and 'Rural' (o2.5%).							

Source: (Kay, et al., 2008a)

Table 4 - Comparison of faecal indicator concentrations (average numbers/g wet weight) excreted in the faeces of warm-blooded animals

Animal	Faecal coliforms (FC) number	Excretion (g/day)	FC Load (numbers/day)
Chicken	1,300,000	182	2.3×10^8
Cow	230,000	23,600	5.4×10^9
Duck	33,000,000	336	1.1×10^{10}
Horse	12,600	20,000	2.5×10^8
Pig	3,300,000	2,700	8.9×10^8
Sheep	16,000,000	1,130	1.8×10^{10}
Turkey	290,000	448	1.3×10^8
Human	13,000,000	150	1.9×10^9

Source: (Gauthier & Bedard, 1986)

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3. Hydrographic Assessment Glossary

The following technical terms may appear in the hydrographic assessment.

Bathymetry. The underwater topography given as depths relative to some fixed reference level e.g. mean sea level.

Hydrography. Study of the movement of water in navigable waters e.g. along coasts, rivers, lochs, estuaries.

MHW. Mean High Water, The highest level that tides reach on average.

MHWN. Mean High Water Neap, The highest level that tides reach on average during neap tides.

MHWS. Mean High Water Spring, The highest level that tides reach on average during spring tides

MLW. Mean Low Water, The lowest level that tides reach on average.

MLWN. Mean Low Water Neap, The lowest level that tides reach on average during neap tides.

MLWS. Mean Low Water Spring, The lowest level that tides reach on average during spring tides.

Tidal period. The dominant tide around the UK is the twice daily one generated by the moon. It has a period of 12.42 hours. For near shore so-called rectilinear tidal currents then roughly speaking water will flow one way for 6.2 hours then back the other way for 6.2 hours.

Tidal range. The difference in height between low and high water. Will change over a month.

Tidal excursion. The distance travelled by a particle over one half of a tidal cycle (roughly~6.2 hours). Over the other half of the tidal cycle the particle will move in the opposite direction leading to a small net movement related to the tidal residual. The excursion will be largest at Spring tides.

Tidal residual. For the purposes of these documents it is taken to be the tidal current averaged over a complete tidal cycle. Very roughly it gives an idea of the general speed and direction of travel due to tides for a particle over a period of several days.

Tidal prism. The volume of water brought into an estuary or sea loch during half a tidal cycle. Equal to the difference in estuary/sea loch volume at high and low water.

Spring/Neap Tides. Spring tides occur during or just after new moon and full moon when the tide-generating force of the sun acts in the same direction as that of the moon, reinforcing it. The tidal range is greatest and tidal currents strongest during spring tides.

Neap tides occur during the first or last quarter of the moon when the tide-generating forces of the sun and moon oppose each other. The tidal range is smallest and tidal currents are weakest during neap tides.

Tidal diamonds. The tidal velocities measured and printed on admiralty charts at specific locations are called tidal diamonds.

Wind driven shear/surface layer. The top metre or so of the surface that generally moves in the rough direction of the wind typically at a speed that is a few percent (~3%) of the wind speed.

Return flow. A surface flow at the surface may be accompanied by a compensating flow in the opposite direction at the bed.

Stratification. The splitting of the water into two layers of different density with the less dense layer on top of the denser one. Due to either temperature or salinity differences or a combination of both.

4. Shoreline Survey Report

Report Title	Dunstaffnage Bay Shoreline Survey Report
Project Name	Shellfish Sanitary Surveys
Client/Customer	Cefas
SRSL Project Reference	00561_B0067

Document Number	B0067_Shoreline 0048

Revision History

Revision	Changes	Date
A	First version for internal review	09/02/2015
B	Second version for internal review	09/02/2015
01	First formal issue to Cefas	10/02/2015
02	Second formal issue to Cefas with corrections incorporated from Issue01	27/02/2015

	Name & Position	Date
Author	Peter Lamont, Lars Brunner	09/02/2015
Checked	Andrea Veszelovszki	24/02/2015
Approved	Mark Hart	27/02/2015

SRSL, Scottish Marine Institute, Oban, Argyll, PA37 1QA, tel 01631 559 470, www.samsrsl.co.uk

Production area:	Dunstaffnage Cockles
Site name:	Dunstaffnage Bay
SIN:	AB-696-1511-04
Harvester	Douglas MacArthur
Species:	common cockles
Local Authority:	Argyll and Bute Council
Status:	Existing area
Date Surveyed:	19th – 21st January 2015
Surveyed by:	Peter Lamont, Lars Brunner, Andrea Veszelovszki
Existing RMPs:	Pontoon to the west of Connel (NM 90088 34070)

Area Surveyed:

1. Shoreline north of pontoon east of Dunstaffnage Castle to Dunfuinary, east of Connel village.

2. Shoreline on the north shore of Loch Etive from Oban Airport to a point to the east of Black Crofts

Weather

In the previous week there were strong west and north-westerly winds with rain. These conditions eased considerably to calm conditions in the two days before the start of the survey accompanied by a temperature drop to zero and sub-zero conditions.

Monday 19th January 2015 – Dry, calm and sunny with little or no wind. Temperatures starting at around -1, increasing to around 0 during the day.

Tuesday 20th January 2015 – Dry, sunny with no wind, remaining so throughout the day. Temperatures were recorded to be between 2 to 3 degrees.

Wednesday 21st January 2015 – Dry with F2 easterly wind to start with decreasing to calm later. Almost complete cloud cover. Temperatures were recorded to be between 1 and 5 degrees.

Stakeholder engagement during the survey

The harvester indicated in the survey plan, Mr Douglas MacArthur was not available to meet during the survey, as he was not actively harvesting the production area due to a dispute with the local Dunstaffnage Estate.

The local authority Sampling Officer Ewan McDougall was not available during the survey as he was occupied with other work but prior to the survey he provided useful information regarding the current state of the production area, information that a regular RMP was in use by their team and the availability of cockles (Note, that information in the survey plan was different to actual state of production area. See more in Fishery section).

Fishery

The fishery in the survey area is for common cockles (*Cerastoderma edule*). These are present naturally and appeared to the team to be extensively distributed throughout most of the survey area. The cockles occurred with reasonable abundance and a good distribution of sizes at all of the sample points with the exception of WP48, Fig. 10, which was very stony & rocky. The team had been advised that there were few if any cockles in this vicinity (Waypoint 48) but at the time of the visit there was little shore exposed to search.

Empty cockle shells were present in low to medium quantity at all of the sampling points.

The original classification application for the production area (information as provided by the Sampling Officer) had been submitted by Mr Douglas MacArthur, but due to an access dispute with the owner of the land above the high water mark (Dunstaffnage Estate) he could not gain access to the shoreline to harvest the area. A new harvester, Mr Stan Pattison, has received permission and actively harvests from the area around the garden centre noted at WP34 (see Fig. 9).

As the site is registered as a production area by the FSA, the local authority have been taking weekly samples of mussels (*Mytilus edulis*) from a pontoon located at the eastern end of the production area - WP56, Fig. 13.

Sewage Sources

The entire area around the Dunstaffnage Bay survey area is largely inhabited, and consists of a mixture of villages, isolated dwellings and farmland. To the west of the bay, the village of Dunbeg consists of semi-detached private dwellings with Scottish Water WWPS & CSO running into Dunstaffnage Bay (Fig. 8, Waypoint 16). At the northern end of the bay, the Scottish Marine Institute complex (SAMS-Scottish Association for Marine Science), Fig. 6, and Dunstaffnage Castle Visitor Centre & car park, Fig. 5, are also present. North of Dunbeg, to the west of the bay is a new housing estate of 50 dwellings completed and occupied in 2014. To the south of the bay there is a marina development with pontoons which were largely unoccupied at the time of survey. The survey team, being local, can affirm that this marina and bay is very busy in the summer months. The team were informed by marina staff that there were 120 boats in storage on the hard with an additional 20 on pontoons. Most of these are slipped and moored during the summer months in effect acting like second homes. During the summer the pontoons are fully occupied. The marina has onshore showering and toilet facilities.

The eastern edge of the bay fringes the western end of Loch Etive. This area consists of farmland and rough ground before the village of Connel begins. Discharge pipes are present in Connel village, west of Connel Bridge, some of which are broken and detached and many appear abandoned, while others adjacent to Connel Bridge were observed as being active (Figs. 15, 16 and 17, WP70 to 74). There are also Scottish Water WWPS & CSOs present at two different locations in Connel village west and east of the south end of Connel Bridge and one in North Connel, east of the north end of the bridge (Figs. 14, 19 and 22, WPs 68, 95 and 127). Two subtidal outfalls are present to the west of Connel Bridge both with outfalls below low water at the time of the team visit. The first, at waypoint 116 (Fig. 20) had no sound of running water and was metal of about 25 cm diameter with a fork junction on the high shore running onshore in the direction of the housing estate. The second was of plastic of about 20 cm diameter and weighed down at the low tide end with perforated concrete blocks. Opposite at the top of the shore, was a short access track and gate (no adjacent dwellings observed).

Seasonal Population

The area around the bay has a fairly constant resident population year round, but the summer months bring an increase in tourists passing through the area. Tourist visitors are concentrated around the Dunstaffnage Castle Visitor Centre & car park and at Dunstaffnage Marina. The tidal rapids at the Falls of Lora form a spectacle that is also attractive to visitors and the small car park created by the Scottish Water pumping station there (Fig. 14) is a popular viewpoint during the summer.

There are no B&B's in Dunbeg, but there are two hotels, several B&B's and some self-catering properties present in Connel village and North Connel. The team observed two holiday houses at Dunfuinary. Second homes are common in the Oban area and it is to be expected that some of the homes in the survey area will be second homes with part-time occupancy.

Poppies Garden Centre (Waypoint 33) has a restaurant open during the day that is popular all year round.

Boats/Shipping

The survey was carried out in winter (January) when most moorings are vacant and yachts and other leisure craft are stored ashore. The team were informed by staff at Dunstaffnage Marina that there were 120 yachts stored ashore with 20 on the pontoon. Dunstaffnage Bay is more sheltered than elsewhere on the survey and has the largest number of moorings (42 were counted).

Both power boats and kayakers make use of the tidal rapids at the Falls of Lora, especially in the summer. On the day of the survey a party in a RIB power boat were training in the ebbing currents upstream and downstream of the bridge.

Farming and Livestock

No livestock was directly observed on the survey route, although there is an active farm present at Saulmore, to the east of Dunstaffnage Bay and livestock farming does occur in the area with sheep and beef cattle.

Horses were observed in North Connel with a total of eight being counted and some hoof prints were seen along the North Connel shore east of the bridge (Waypoint 103).

Land Use

The survey area has a variety of land uses. To the west and south of Dunstaffnage Bay there is a mixture of farmland, woodland and business use (Scottish Marine Institute, Fig. 6), turning to a mixture of residential and forest/rough ground at Dunbeg. Dunstaffnage Marina and Poppies Garden Centre to the southeast of the bay then gives way to a mix of rough round and farmland until Connel village starts at the western mouth of Loch Etive. The presence of a few broken clay pigeons in the vicinity of waypoints 46 and 47 indicates possible use of this area for target shooting. Normally clays would be launched out to sea and there would be no evidence onshore. From here the survey route consists of residential properties on both the north and south side of the loch, with those on the north side set back from the lochside by farmland and sloping crofting ground. A small airport is present in North Connel (Oban Airport) to the west of the bridge, on flat land bordering the shoreline.

In North Connel, west of Connel Bridge to the south of the airport, dog walking is frequently practised along a shoreside path where the team encountered numerous dog faeces.

Land Cover

Outside the villages present, the land cover is predominantly rural with native woodland and grazing present through the survey area. There is a commercial coniferous forestry plantation on the hills to the southeast of Dunbeg to the east of the A85.

Watercourses

The largest watercourse on the survey route was the Lusragan Burn, running into Loch Etive through Connel (Fig. 18, WP81/82). Other larger streams include the unnamed stream running through Dunbeg (Fig. 7, WP14) and the stream running into the bay of Camas Bruaich Ruaidhe, Fig. 12, WP54-55 passing Dunstaffnage House further inland. Other small streams were noted on the survey route, and these are noted in the shoreline observations in Table 1.

Wildlife/Birds

A variety of common birds were observed the most numerous of which were mallards, observed in small flocks of up to 36. A total of 94 ducks were counted over the three days but these could have included the same flocks. Other birds included: curlew (1), wagtail (1), oystercatcher (2), eider (7), shag (6), cormorant (1), gull (3), swan (3), heron (4), hooded crow (1), robin (1) and rock pipit (2). Single buzzards were seen on two occasions hunting on the higher ground above Saulmore Farm and just opposite, over the flat ground at the east of the bay north of the A85. Although only one rabbit was seen there was recent evidence in several places in the form of fresh droppings beside burrows and also the fresh fur remaining from a buzzard kill (Fig. 10). Some mole hills were encountered in the same area. One common seal was observed briefly near the pontoon at waypoint 56.

Specific observations made during the survey are mapped in Figures 1-4 and listed in Table 1. Water and shellfish samples were collected at the locations marked on Figures 3 and 4. Bacteriology results are given in Tables 2 and 3.

Photographs are presented in Figures 5 to 22.

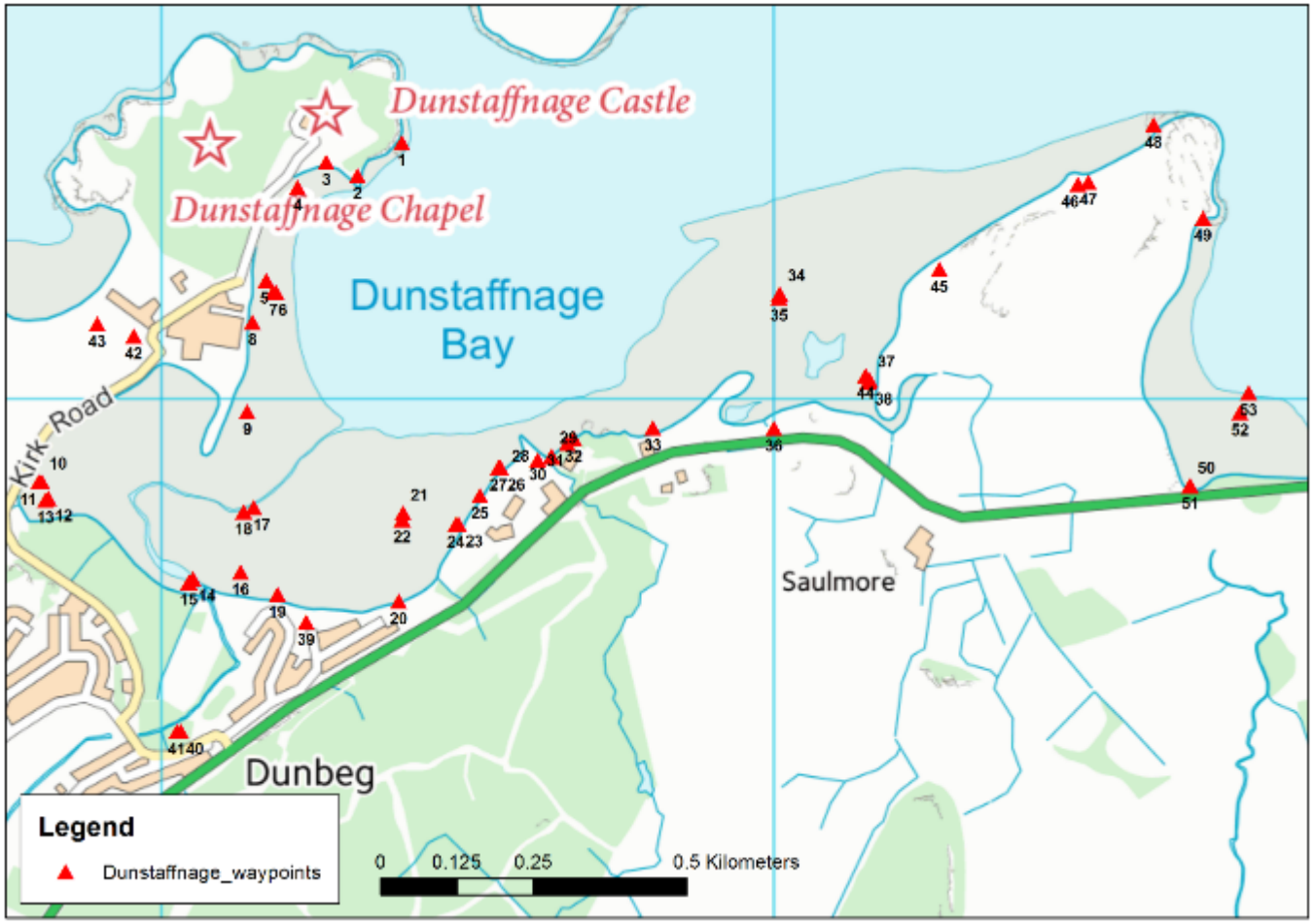

Figure 1. Dunstaffnage Bay waypoints_west

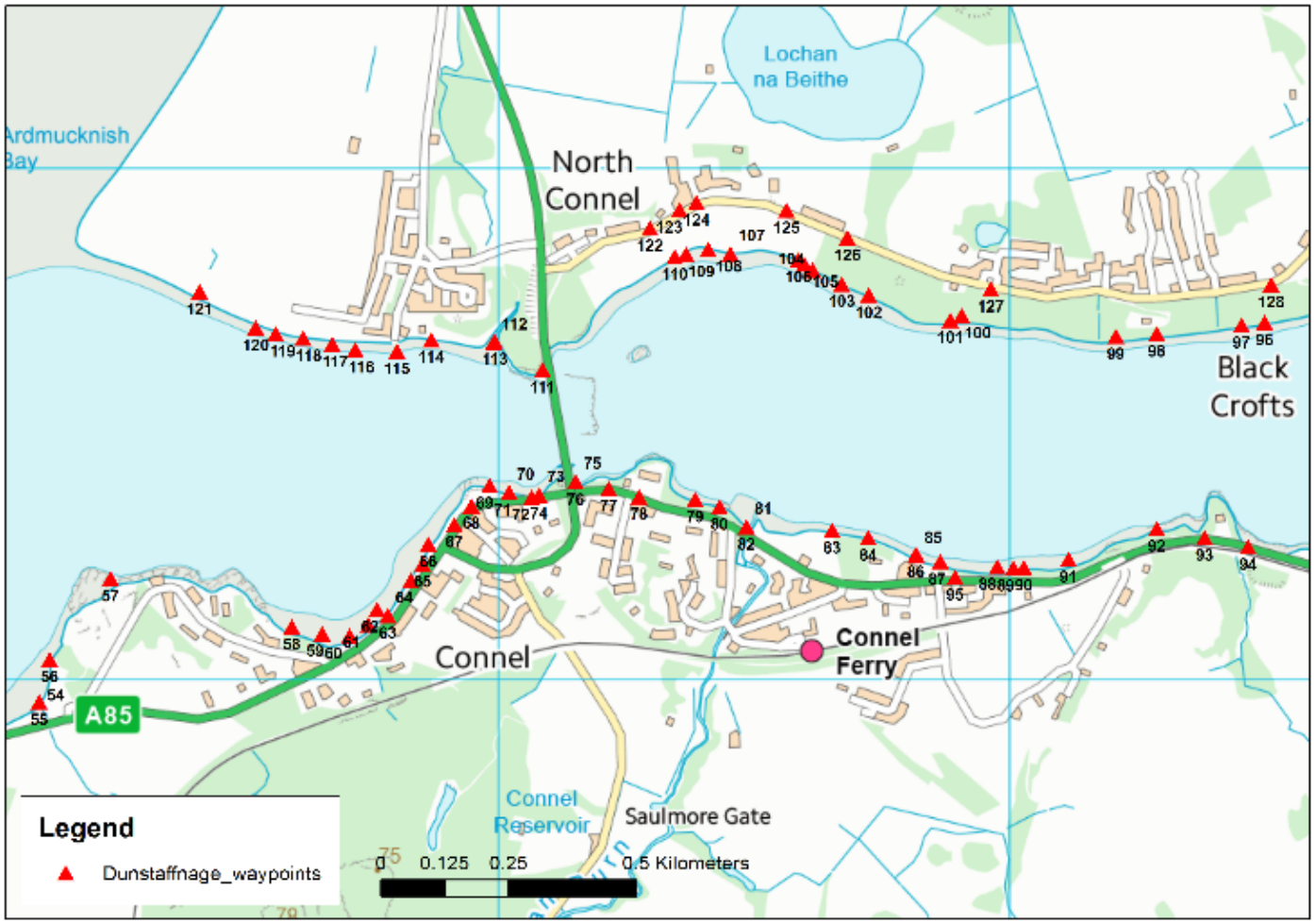

Figure 2. Dunstaffnage Bay waypoints_east

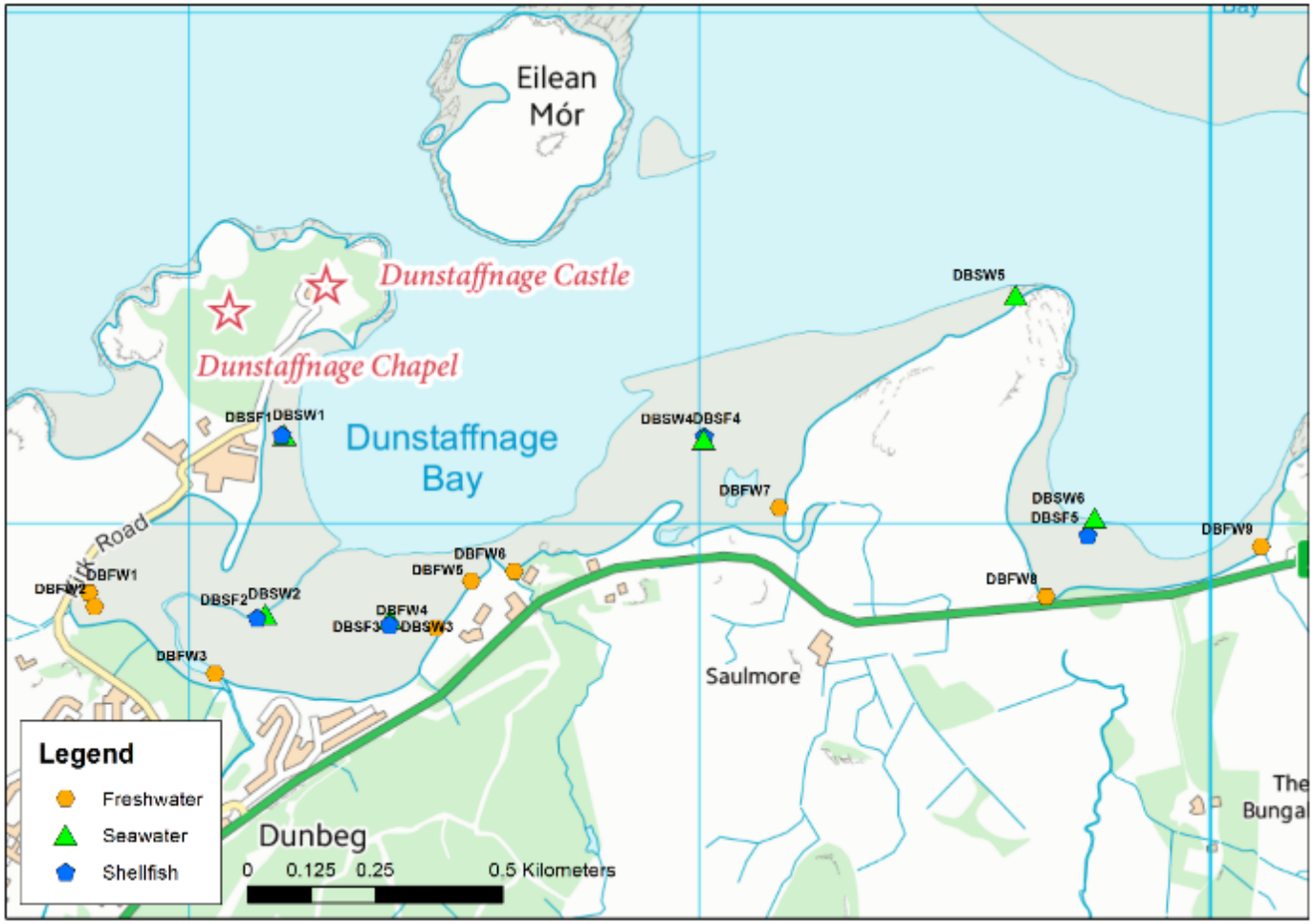

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Figure 3. Dunstaffnage Bay samples_west

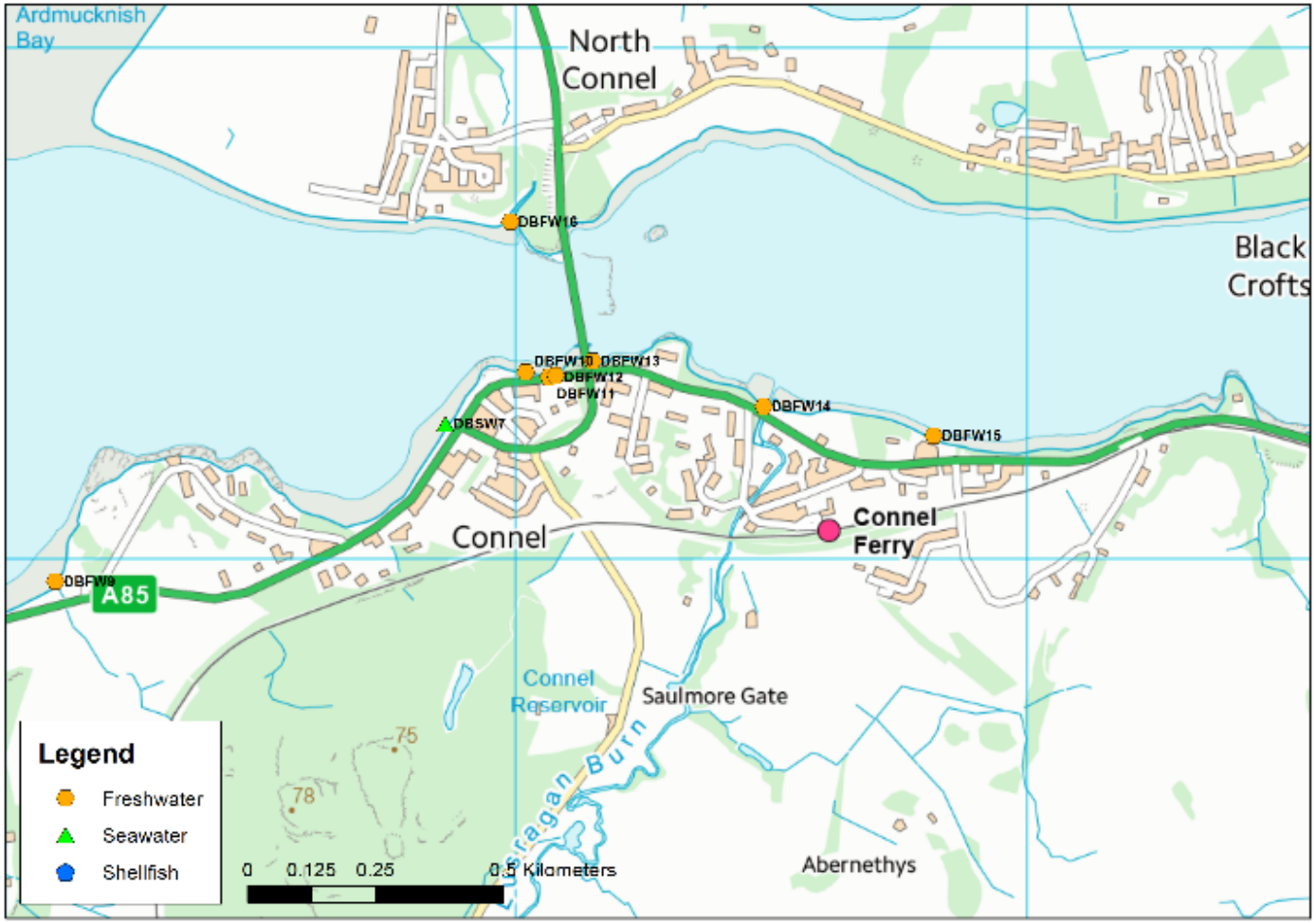

Figure 4. Dunstaffnage Bay samples_east

Table 1 Shoreline Observations

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
1	19/01/2015	9:48	NM 88392 34418	188392	734418			Start of survey, shore east of Dunstaffnage Castle.
2	19/01/2015	9:55	NM 88320 34364	188320	734364			Pontoon belonging to the Scottish Association for Marine Science; Research vessel 'Calanus' moored alongside plus RIB 'Tritonia'. Wildlife: 1 rabbit, 1 robin, 2 oystercatchers, 1 hooded crow.
3	19/01/2015	9:57	NM 88269 34386	188269	734386	Fig. 5		Uphill from shore about 100 m, Dunstaffnage Castle visitors centre with public toilet plus nearby castle.
4	19/01/2015	9:59	NM 88222 34345	188222	734345			Discharge pipe of 150 mm plastic, no flow, pipe broken at upshore end.
5	19/01/2015	10:04	NM 88171 34193	188171	734193			Disused discharge pipe broken at the upper shore end, Dunstaffnage Castle car park.
6	19/01/2015	10:06	NM 88187 34173	188187	734173		DBSW1	Planned seawater sample DBSW1.
7	19/01/2015	10:32	NM 88182 34174	188182	734174		DBSF1	Planned shellfish sample DBSF1.
8	19/01/2015	10:38	NM 88148 34125	188148	734125			Discharge pipe and manhole cover (“Chieftan 600 cover”) above MHWS with sound of running water. From septic tank for the Scottish Association for Marine Science according to SAMS Facilities Manager. Boats: 1 small dinghy, 6 rowing boats around top of SAMS concrete slipway.
9	19/01/2015	10:45	NM 88140 33979	188140	733979	Fig. 6		Photograph of overall SAMS plus Malin House site. Wildlife: 18 mallard ducks and drakes.

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
10	19/01/2015	10:52	NM 87804 33865	187804	733865		DBFW1	Unplanned freshwater sample DBFW1. New housing estate (about 50 dwellings) upstream of land drain.
11	19/01/2015	10:52	NM 87799 33864	187799	733864			Observations associated with WP10: width 28 cm, depth 2 cm, flow 0.048 m/sec, SD0.012.
12	19/01/2015	11:01	NM 87815 33838	187815	733838		DBFW2	Planned freshwater sample DBFW2 From former Dunstaffnage Mains Farmhouse.
13	19/01/2015	11:01	NM 87811 33835	187811	733835			Observations associated with WP12: width 46 cm, depth 4 cm, flow 0.174 m/sec, SD 0.004.
14	19/01/2015	11:11	NM 88051 33707	188051	733707	Fig. 7	DBFW3	Planned freshwater sample DBFW3 from unnamed stream running through the village of Dunbeg.
15	19/01/2015	11:11	NM 88045 33701	188045	733701			Observations associated with WP14: width 430 cm, depth (1) 10 cm, flow 0.211 m/sec, SD 0.013; depth (2) 19 cm, flow 0.260 m/sec, SD 0.021. Flow measured at third distances.
16	19/01/2015	11:18	NM 88129 33717	188129	733717	Fig. 8		Combined emergency waste water overflow outfall pipe running onshore in the direct of the Dunbeg Meadow Road WWPS. This is a relatively new installation with metal surge flap at the pipe end and no flow was observed during the team visit.
17	19/01/2015	11:27	NM 88150 33823	188150	733823		DBSW2	Planned seawater sample DBSW2.
18	19/01/2015	11:34	NM 88134 33816	188134	733816		DBSF2	Planned shellfish sample DBSF2.
19	19/01/2015	11:43	NM 88189 33681	188189	733681			Boats; 14 small craft on shore below Dunbeg village.

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
20	19/01/2015	11:47	NM 88387 33670	188387	733670			Small watercourse running directly off hillside (from east of the A82).
21	19/01/2015	11:51	NM 88394 33814	188394	733814		DBSW3	Planned seawater sample DBSW3.
22	19/01/2015	12:01	NM 88393 33803	188393	733803		DBSF3	Planned shellfish sample DBSF3.
23	19/01/2015	12:07	NM 88484 33796	188484	733796			Unplanned freshwater sample from drainage pipe, DBFW4.
24	19/01/2015	12:07	NM 88481 33795	188481	733795		DBFW4	Observations associated with WP23: 150 mm pipe inside a larger plastic pipe within an area marked as a discharge point in the survey plan. Flow measured by jug as 2 litres in 8.8 sec. = 13.6 L/min.
25	19/01/2015	12:13	NM 88520 33842	188520	733842			Slipway from Dunstaffnage Marina, some groundwater run-off.
26	19/01/2015	12:15	NM 88553 33888	188553	733888			Unplanned freshwater sample from drainage discharge pipe below marina, DBFW5. Plastic pipe of 100 mm diameter, flow measured by jug at 2 litres in 3 sec. = 40 L/min.
27	19/01/2015	12:15	NM 88550 33888	188550	733888		DBFW5	Observations associated with WP26: plastic pipe 100 mm diameter, flow measured by jug at 2 litres in 3 seconds = 40 L/min.
28	19/01/2015	12:22	NM 88614 33900	188614	733900			Dunstaffnage Marina main slipway with above shore base with offices, restaurant and carpark. Hard standing adjoining to the south housing 120 boats with 20 boats on pontoons below. Two yachts moored on buoys with 42 other moorings in the bay.

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
29	19/01/2015	12:28	NM 88637 33907	188637	733907		DBFW6	Planned freshwater sample DBFW6.
30	19/01/2015	12:28	NM 88636 33905	188636	733905			Observations associated with WP29: width 90 cm, depth 12 cm, flow 0.441 m/sec., SD 0.016.
31	19/01/2015	12:35	NM 88662 33927	188662	733927			Pipe, 150 mm diameter, running onto foreshore, no discharge present. Wildlife: flock of 36 mallard ducks and drakes.
32	19/01/2015	12:38	NM 88673 33935	188673	733935			Metal pipe, 150 mm diameter, appears disused with no discharge.
33	19/01/2015	12:42	NM 88802 33953	188802	733953			Poppies Garden Centre with associated carpark. No pipes observed and septic tank not seen.
34	19/01/2015	13:00	NM 89009 34171	189009	734171	Fig. 9	DBSF4	Planned shellfish sample DBSF4.
35	19/01/2015	13:00	NM 89008 34165	189008	734165		DBSW4	Planned seawater sample DBSW4.
36	19/01/2015	13:13	NM 89000 33952	189000	733952			Dunbeg waste water pumping station.
37	19/01/2015	13:20	NM 89156 34031	189156	734031		DBFW7	Planned freshwater sample DBFW7.
38	19/01/2015	13:20	NM 89154 34028	189154	734028			Observations associated with WP37: width 180 cm, depth (1) 8 cm, flow 0.175 m/sec., SD 0.004; depth (2) 8 cm flow 0.156 m/sec., SD 0.002. Flow measured at third distances.
39	19/01/2015	13:51	NM 88236 33636	188236	733636			Dunbeg, Meadow Road WWPS.

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
40	19/01/2015	13:59	NM 88031 33458	188031	733458			Dunbeg WWPS.
41	19/01/2015	14:04	NM 88025 33457	188025	733457			Dunbeg, Meadow Road WWPS CSO (assumed to be)
42	19/01/2015	14:40	NM 87954 34102	187954	734102			WP not used.
43	19/01/2015	15:23	NM 87895 34122	187895	734122			WP not used.
44	20/01/2015	9:08	NM 89149 34037	189150	734038			Start of shore survey day 2.
45	20/01/2015	9:13	NM 89269 34211	189270	734212	Fig. 10		Broken clay pigeons on grass indicating possible leisure use of this area. Wildlife: rabbit fur from raptor kill, 1 buzzard overhead. Evidence of rabbits - burrows and droppings.
46	20/01/2015	9:19	NM 89496 34349	189496	734350			Wildlife: more rabbit droppings and burrows. Mole hills.
47	20/01/2015	9:20	NM 89513 34353	189513	734353			Manhole cover above beach in vicinity of indicated Connel SEP WWPS (& CSO). No pipes or other sign of Scottish Water installation.
48	20/01/2015	9:31	NM 89619 34446	189619	734447	Fig. 11		Planned seawater sample DBSW5. No cockles found for planned shellfish sample. Wildlife: 1 pipit, 1 heron.
49	20/01/2015	9:41	NM 89700 34294	189700	734295			Two yachts at moorings in bay.
50	20/01/2015	9:49	NM 89678 33857	189679	733858		DBFW8	Planned freshwater sample DBFW8.

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
51	20/01/2015	9:49	NM 89679 33857	189680	733858			Observations associated with WP50: width 180 cm. Depth (1) 10 cm, depth (2) 13 cm, depth (3) 10 cm uniform current flow at 0.714 m/sec., SD 0.011. Depths measured at quarter distances.
52	20/01/2015	10:09	NM 89760 33977	189761	733977		DBSF5	Planned shellfish sample DBSF5.
53	20/01/2015	10:10	NM 89774 34010	189775	734010		DBSW6	Planned seawater sample DBSW6. Wildlife: 1 curlew.
54	20/01/2015	10:35	NM 90100 33955	190100	733956		DBFW9	Planned freshwater sample DBFW9 from Camas Bruaich Ruaidhe.
55	20/01/2015	10:35	NM 90100 33955	190100	733956	Fig. 12		Observations associated with WP55: drain pipe 45 cm diameter, width of flow 15 cm, depth 3 cm, flow 1.421 m/sec, SD 0.039.
56	20/01/2015	10:41	NM 90120 34039	190121	734039	Fig. 13		Pontoon with one boat moored alongside and two leisure boats on moorings nearby with five other unoccupied moorings. Car parking onshore with small hut. Wildlife: 2 swans, 3 shags, 1 common seal.
57	20/01/2015	10:49	NM 90240 34197	190240	734197			Shoreline beyond (east of) WP 57 not accessible due to steep bedrock and private land with dwellings close by. Wildlife: 1 cormorant.

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
58	20/01/2015	11:12	NM 90595 34102	190595	734103			Resumption of shoreline walk at limit of accessibility. Small pipe discharging from concrete walling below HW level but inaccessible because of tide. Unoccupied moorings number 14 in the bay before Connell Bridge with 2 yachts moored. Wildlife: 1 gull, 1 swan.
59	20/01/2015	11:16	NM 90654 34089	190654	734090			Broken section of discharge pipe on shoreline, upper pipe in situ above shore line, no discharge.
60	20/01/2015	11:19	NM 90707 34085	190708	734085			Broken sections of 150 mm diameter plastic pipe with several sections on intertidal area, no discharge. Road drain immediately above with 40 cm diameter pipe (no flow).
61	20/01/2015	11:21	NM 90744 34106	190745	734107			Broken sections of pipe on shore with no sign of discharge or source at HW level wall.
62	20/01/2015	11:25	NM 90761 34136	190761	734137			Three discharge pipes at site indicated on survey plan as having sea discharge. No flow from any pipe but nearby tissue indicates current use.
63	20/01/2015	11:28	NM 90783 34125	190783	734125			Manhole cover on HW level with no signage.
64	20/01/2015	11:31	NM 90827 34194	190828	734194			Manhole cover on HW level with no signage.
65	20/01/2015	11:32	NM 90851 34225	190851	734226			Manhole, damaged and with no cover, appearing disused. Broken section of discharge pipe on shore with no flow.

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
66	20/01/2015	11:35	NM 90862 34264	190862	734264		DBSW7	Old, ruined, stone built slipway and adjacent road drain culvert. Nearby iron discharge pipe of 25 cm diameter, fractured and broken but with flow visible through a hole and running out to sea. Unplanned seawater sample taken at pipe break, DBSW7, in case of contamination. Flow slight but not physically measurable.
67	20/01/2015	11:43	NM 90913 34302	190914	734303			Manhole on round, prefabricated concrete base at HWS level at top of old slipway and adjacent to pumping station. No signage.
68	20/01/2015	11:45	NM 90946 34339	190946	734340	Fig. 14		Falls of Lora car park. Scottish Water control box and manhole covers (10 altogether) for pumping station.
69	20/01/2015	11:48	NM 90982 34379	190982	734379			Large discharge pipe near Connell Bridge (50 cm diameter pipe).
70	20/01/2015	11:51	NM 91020 34365	191020	734365		DBFW10	Unplanned freshwater sample DBFW10.
71	20/01/2015	11:51	NM 91020 34365	191020	734365	Fig. 15		Observations associated with WP 70: Active discharge at HW level from grass bank with no pipe visible. Flocculent material and flow spread down shore. Sample DBFW10 treated as contaminated.
72	20/01/2015	11:56	NM 91064 34356	191065	734356	Fig. 16	DBFW11	Unplanned freshwater sample DBFW11 marked as contaminated. Broken sections of 100 mm diameter iron discharge pipe with active flow from in situ pipe and presence of unaltered faecal matter at pipe end indicating direct discharge (no septic tank). Wildlife: 1 pipit

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
73	20/01/2015	12:04	NM 91078 34360	191079	734360			Ceramic pipe with no flow but scum in pipe base and on rock wall below indicating some current discharge.
74	20/01/2015	12:05	NM 91078 34359	191079	734359	Fig. 17	DBFW12	Unplanned freshwater sample DBFW12 marked as contaminated. Pipe 150 mm diameter with flow and smell present. Flow measured at 24 L/min from 2 litre jug filling in 5 seconds.
75	20/01/2015	12:15	NM 91150 34387	191151	734387		DBFW13	Unplanned freshwater sample DBFW13 marked as contaminated.
76	20/01/2015	12:15	NM 91150 34386	191151	734386			Observations associated with WP 75: Plastic pipe beneath bridge east side 100 mm diameter with foam at end and smell. Flow slow. Flow not possible to capture and therefore not measurable. Estimated at between 1 and 2 L/min (part flow took 2 sec to fill 30 ml vial).
77	20/01/2015	12:24	NM 91215 34373	191216	734373			Discharge pipe seen 50 m eastwards on inaccessible steep bedrock shore below dwelling.
78	20/01/2015	12:27	NM 91274 34357	191275	734358			Shore eastwards below dwelling and Connell Surgery not accessible.
79	20/01/2015	12:30	NM 91384 34352	191384	734352			Plastic discharge pipe of about 150 mm diameter. Exposed rodding access joint seen from roadway above. End not visible.
80	20/01/2015	12:32	NM 91432 34337	191433	734338			Connel Surgery with pharmacy and coffee shop. Shore below not accessible. One wagtail.
81	20/01/2015	12:38	NM 91484 34298	191485	734298		DBFW14	Planned freshwater sample from Lusragan Burn, DBFW14.

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
82	20/01/2015	12:38	NM 91484 34298	191485	734298	Fig. 18		Observations associated with WP81: width 11.9 m, depth (1) 32 cm flow 0.507 m/sec, SD 0.016; depth (2) 24 cm, flow 0.579 m/sec, SD 0.030; depth (3) 25 cm, flow 0.540 m/sec, SD 0.017; depth (4) 20 cm, flow 0.400 m/sec, SD 0.019. Flow measured at one fifth intervals across stream.
83	20/01/2015	12:54	NM 91652 34291	191652	734291			Old slipway with manhole covers. Metal pipe of 150 mm diameter visible at end of slipway but below sea level at time of team visit. Falls of Lora Hotel opposite across A85 roadway.
84	20/01/2015	12:57	NM 91722 34277	191723	734277			Dry culvert drain with no flow.
85	20/01/2015	13:01	NM 91818 34241	191818	734241		DBFW15	Unplanned freshwater sample DBFW15 marked as contaminated.
86	20/01/2015	13:03	NM 91816 34244	191817	734245			Observations associated with WP85: metal discharge pipe of about 150 mm diameter below Connel Primary school. Sample taken at break in pipe with flocculent material below.
87	20/01/2015	13:08	NM 91864 34230	191864	734231			Discharge pipe of 20 cm diameter with end below LWS. Pipe situated below Scottish Water pumping station. Wildlife: 36 mallard ducks.
88	20/01/2015	13:13	NM 91976 34220	191976	734220			Plastic pipe 150 mm diameter with end at LW. Flow clear with no smell and about 20 ml/sec = 1.2 L/min. Barnacles growing inside pipe end and no sign of any discharge material. Not sampled.

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
89	20/01/2015	13:14	NM 92007 34217	192007	734218			Small watercourse running under road from woods and fields south side of A85. Small plastic drainage pipe adjacent with no flow.
90	20/01/2015	13:17	NM 92028 34218	192028	734218			Abandoned boatshed.
91	20/01/2015	13:19	NM 92115 34234	192116	734235			Small watercourse not sampled.
92	20/01/2015	13:24	NM 92287 34295	192288	734295			Discharge pipe with no flow or discharge evidence. Pipe broken on mid shore. Emerging from Dunfuinary holiday cottage.
93	20/01/2015	13:30	NM 92381 34277	192382	734278			Manhole covers in garden of cottage (former boathouse converted to holiday dwelling).
94	20/01/2015	13:32	NM 92466 34259	192467	734260			Eastern limit of survey walk.
95	20/01/2015	13:40	NM 91893 34200	191894	734200	Fig. 19		Scottish Water waste water pumping station with three sets of manholes. Control kiosk on shore side. Pipe at WP 87 immediately below.
96	21/01/2015	9:26	NM 92499 34698	192500	734698			Start of shore survey day 3 at North Connel.
97	21/01/2015	9:30	NM 92453 34693	192454	734693			New track leading down to shore with recently excavated level area for possible future house site.
98	21/01/2015	9:34	NM 92288 34676	192288	734676			Abandoned and damaged boat drifted onto shore. Wildlife: 1 shag flying by.

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
99	21/01/2015	9:37	NM 92208 34671	192209	734671			Relatively new house immediately above shore with outbuildings. No visible outfall or septic tank evidence observed. Chicken coop and chickens within property.
100	21/01/2015	9:44	NM 91906 34711	191906	734712			Dwelling uphill on south side of B road. Small shed in ground 30 m from shore.
101	21/01/2015	9:45	NM 91884 34703	191884	734703			Plastic outfall pipe of 100 mm diameter covered with rocks. End below LW not visible.
102	21/01/2015	9:50	NM 91724 34751	191724	734752			Wildlife: 2 herons flying off shore, 1 shag on water.
103	21/01/2015	9:53	NM 91671 34773	191671	734774			Horseshoe tracks on shoreside grass.
104	21/01/2015	9:54	NM 91614 34801	191614	734801			Wildlife: 1 heron on shore.
105	21/01/2015	9:55	NM 91598 34812	191598	734812			Fenced field above shore with two medium heavy horses (cobs) and shelter uphill by roadside.
106	21/01/2015	9:56	NM 91586 34821	191586	734821			Boats: 2 moored yachts with 4 unoccupied moorings and one floating pontoon section. Wildlife: 4 eiders on water (2 drakes and 2 ducks) with 4 other ducks.
107	21/01/2015	10:00	NM 91453 34832	191454	734833			Pontoon section on upper shore.
108	21/01/2015	10:02	NM 91410 34841	191411	734842			Small caravan above shore beside a gated access track to the shore. Drain access cover (with moulded brand name “Osma”) at the top of the shore below the fence. No sign of any outfall pipe.

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
109	21/01/2015	10:04	NM 91367 34831	191367	734832			Inflatable dinghy on the track secured to a fencepost. More parts of pontoon on the shore above the fence.
110	21/01/2015	10:06	NM 91344 34826	191344	734826			Section of lower shore fenced with portable security fencing to exclude from site of former pontoon. Dry run off ditch from field to upper shore. Wildlife: rabbit burrows at the top of the shore.
111	21/01/2015	10:16	NM 91086 34605	191086	734606			West side of Connel Bridge. Outfall pipe encased in cast concrete containing 150 mm diameter plastic pipe broken and damaged in places with no flow. Appears disused.
112	21/01/2015	10:25	NM 90989 34659	190990	734660		DBFW16	Unplanned freshwater sample DBFW16.
113	21/01/2015	10:31	NM 90992 34660	190993	734661			Observations associated with WP112: width 165 cm, depth (1) 11 cm, flow 0.195 m/sec, SD 0.015; depth (2) 17 cm, flow 0.245 m/sec, SD 0.030. Flow measured at third intervals across the stream.
114	21/01/2015	10:36	NM 90868 34664	190868	734665			Boats: 1 moored yacht with 13 unoccupied moorings nearby. Five dwellings immediately above shore with hotel above and small village surrounding of greater than 50 dwellings.
115	21/01/2015	10:38	NM 90800 34642	190801	734642			Old, stone built slipway.

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
116	21/01/2015	10:42	NM 90719 34644	190720	734645	Fig. 20		Metal outfall pipe of 25 cm diameter, forked at the top of the shore, with end below LWS and not visible. No sound of any flow. Wildlife: 3 eiders and 2 gulls on the water (tide ebbing east-west) and 1 shag on mooring.
117	21/01/2015	10:46	NM 90673 34656	190674	734656			Concrete shed on upper shore with fishing gear inside.
118	21/01/2015	10:49	NM 90616 34667	190617	734668			Outfall pipe, plastic, about 20 cm diameter, weighed down with perforated concrete slabs on lower shore. Pontoon section moored off shore nearby. Gate and short access track above at top of shore.
119	21/01/2015	10:54	NM 90563 34676	190563	734676			Buoy array with radar reflectors for Connel airport.
120	21/01/2015	10:55	NM 90524 34687	190524	734688	Fig. 21		Second buoy array with radar reflectors. Concrete structure at top of shore. Both buoy arrays anchored to shore with heavy chain running up beach.
121	21/01/2015	11:00	NM 90414 34759	190415	734759			Western limit of North Connel shore walk. Dog walker on shore top path with dog. Dog faeces very common on shore top path. End of shore walk.
122	21/01/2015	11:18	NM 91296 34882	191296	734883			Access cover and breather pipe indicating septic tank with soakaway in private garden.
123	21/01/2015	11:21	NM 91354 34918	191354	734919			Dry ditch at edge of garden ground possibly connected to ditch at WP110.
124	21/01/2015	11:22	NM 91386 34932	191387	734933			Round, green access cover to probable septic tank in private garden.

No.	Date	Time	NGR Position	East	North	Associated Photograph	Associated Sample	Description
125	21/01/2015	11:25	NM 91563 34918	191563	734918			Metal manhole/access covers on shore side of road at top of access track observed at WP 108. Livestock: 1 horse and 2 ponies in field on north side of road.
126	21/01/2015	11:28	NM 91682 34864	191683	734864			Newly built apartment block still under construction.
127	21/01/2015	11:33	NM 91962 34764	191963	734764	Fig. 22		Scottish Water waste water pumping station and small control building on south side of road opposite North Connel Village Hall. Metal access cover for clean water supply 10 m eastwards.
128	21/01/2015	11:42	NM 92512 34772	192512	734773			Livestock: 4 horses in field on north side of road. End of observations.

Photographs referenced in the table can be found attached as Figures 5 - 22.

Sampling

Seawater, freshwater and shellfish samples were collected at the sites marked in Figures 3 and 4. Five freshwater samples were marked as contaminated. Some originated from domestic (samples 11 and 13) or school (sample 15) outfall pipes while the remaining two (samples 10 and 12) were suggestive of domestic outfalls due to the proximity of dwellings in line across the roadway and the nature of materials or smell in the outflow. Sample 11, originating from an iron pipe appeared to be direct discharge (no septic tank) due the presence of unaltered faecal matter at the pipe end.

All the samples were transferred to Biotherm boxes with ice packs and posted to Glasgow Scientific Services (GSS) for *E. coli*. analyses from Oban Post Office and were processed at the laboratory the following day. On Monday the 19th January seven freshwater, four seawater and four cockle samples were posted with the temperature on arrival at the laboratory being recorded as 3.6°C. On Tuesday 20th January eight freshwater, three seawater and one shellfish sample were posted with the temperature on arrival at the laboratory being recorded as 3.3°C. Five of these freshwater samples were from outfall pipes and marked as contaminated. On Wednesday 21st January one freshwater sample from North Connel was posted in a smaller Biotherm box with the temperature on arrival being recorded as 0.7°C.

Seawater samples were tested for salinity by GSS and the results were reported in mg Chloride per litre. These results have been converted to parts per thousand (ppt) using the following formula:

$$\text{Salinity (ppt)} = 0.0018066 \times Cl^{-} \text{ (mg/L)}$$

Table 2. Water Sample Results

No.	Date	Sample	Grid Ref	Type	E. coli (cfu/100ml)	Salinity (ppt)
1	19/01/2015	DBFW1	NM 87804 33865	Freshwater	10	
2	19/01/2015	DBFW2	NM 87815 33838	Freshwater	20	
3	19/01/2015	DBFW3	NM 88051 33707	Freshwater	10	
4	19/01/2015	DBFW4	NM 88481 33796	Freshwater	<10	
5	19/01/2015	DBFW5	NM 88550 33888	Freshwater	<10	
6	19/01/2015	DBFW6	NM 88637 33907	Freshwater	<10	
7	19/01/2015	DBFW7	NM 89156 34031	Freshwater	10	
8	20/01/2015	DBFW8	NM 89678 33857	Freshwater	60	
9	20/01/2015	DBFW9	NM 90100 33955	Freshwater	<10	
10	20/01/2015	DBFW10	NM 91020 34365	Freshwater*	1300000	
11	20/01/2015	DBFW11	NM 91064 34356	Freshwater*	13000	
12	20/01/2015	DBFW12	NM 91078 34359	Freshwater*	2600000	
13	20/01/2015	DBFW13	NM 91150 34387	Freshwater*	2000	
14	20/01/2015	DBFW14	NM 91484 34298	Freshwater	340	
15	20/01/2015	DBFW15	NM 91818 34241	Freshwater*	14000	
16	21/01/2015	DBFW16	NM 90989 34659	Freshwater	830	
17	19/01/2015	DBSW1	NM 88187 34173	Seawater	21	18.97
18	19/01/2015	DBSW2	NM 88150 33823	Seawater	1400	1.55
19	19/01/2015	DBSW3	NM 88394 33814	Seawater	45	18.61
20	19/01/2015	DBSW4	NM 89008 34165	Seawater	9	17.05
21	20/01/2015	DBSW5	NM 89619 34446	Seawater	8	26.02
22	20/01/2015	DBSW6	NM 89774 34010	Seawater	11	26.74
23	20/01/2015	DBSW7	NM 90862 34264	Seawater	1200	15.88

* Classified by the survey team as contaminated. Detection limits 1000-10,000,000.

Table 3. Shellfish Sample Results

No.	Date	Sample	Grid Ref	Type	Sample depth (m)	E. coli (MPN/100g)
1	19/01/2015	DBSF1	NM 88182 34174	Shellfish	n/a	20
2	19/01/2015	DBSF2	NM 88134 33816	Shellfish	n/a	130
3	19/01/2015	DBSF3	NM 88393 33803	Shellfish	n/a	<18
4	19/01/2015	DBSF4	NM 89009 34171	Shellfish	n/a	20
5	20/01/2015	DBSF5	NM 89760 33977	Shellfish	n/a	130

Salinity Profiles

The fishery is a wild one consisting of cockle beds exploited at low tide. No CTD profiles were required or taken.

Photographs

Figure 5. Dunstaffnage Castle and Visitor Centre. Waypoint 3.

Figure 6. Scottish Marine Institute complex (Malin House, The European Marine Science Park building on the left). Waypoint 9.

Figure 7. Unnamed watercourse passing through Dunbeg village. Waypoint 14.

Figure 8. Dunbeg combined waste water overflow pipe end. Waypoint 16.

Figure 9. Site of shellfish sample DBSF4 off Poppies Garden Centre. WP34.

Figure 10. Rabbit fur from raptor kill on grass north east of Poppies Garden Centre (left of centre in the distance). Waypoint 45.

Figure 11. Site of seawater sample DBSW5 and unsuccessful attempt at cockle sample. Waypoint 48.

Figure 12. Unnamed stream running into Camas Bruaich Ruaidhe (site of freshwater sample DBFW8). Waypoint 50.

Figure 13. Pontoon, site of local authority mussel sample source. Waypoint 56.

Figure 14. Scottish Water WWPS at south west side of Connel Bridge. Waypoint 68**.**

Figure 15. Site of unplanned freshwater sample DBFW10, Connel village.

Waypoints 70 and 71.

Figure 16. Site of unplanned freshwater sample DBFW11, Connel village.

Waypoint 72.

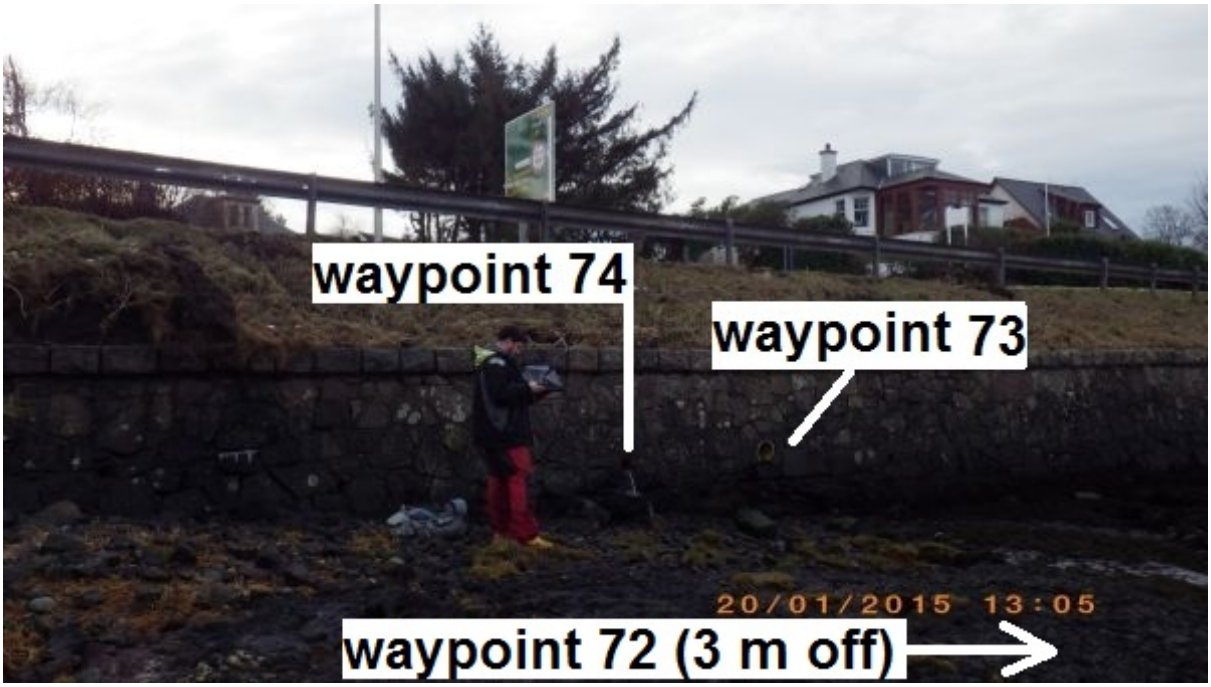

Figure 17. Site of unplanned freshwater samples DBFW11 and 12, Connel village, southwest side of Connel Bridge. Waypoints 73 and 74.

Figure 18. Lusragan Burn, Connel village, site of planned freshwater sample DBFW14. Waypoints 81 and 82.

Figure 19. Scottish Water WWPS, Connel village, east of the south end of Connel Bridge. Waypoint 95.

Figure 20. Outfall pipe, North Connel, with end at subtidal level. Watpoint 116.

Figure 21. Buoy array at end of Oban Airport. Heavy chain and concrete anchoring block on shore (inset image). Waypoint 120.

Figure 22. Scottish Water WWPS, North Connel, east of the Connel Bridge. Waypoint 127.

5. SEPA Discharge Consents

Licence No.	NGR	Discharge Type	Discharges to	Op	PE
CAR/L/1003316	NM 86052 32694	Sewage (Private) Primary	Ganavan Bay	=	100
CAR/L/1009842	NM 88623 33872	Sewage (Private) Secondary	Dunstaffnage Bay	>	15
CAR/L/1085662	NM 91500 34800	Sewage (Private) Primary	Loch Etive	=	150
CAR/R/1009285	NM 84511 30847	Sewage (Private) Primary	Ardantrive Bay	=	6
CAR/R/1009869	NM 90690 35583	Sewage (Private) Secondary	Soakaway	=	10
CAR/R/1010988	NM 87540 29880	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1012082	NM 90440 34190	Sewage (Private) Primary	Firth of Lorn	=	5
CAR/R/1013629	NM 85399 32030	Sewage (Private) Primary	Firth of Lorn	=	5
CAR/R/1013701	NM 89876 39797	Sewage (Private) Primary	Allt an Duine Mhoir	=	5
CAR/R/1014140	NM 85380 32040	Sewage (Private) Primary	Firth of Lorn	=	5
CAR/R/1014557	NM 85370 32080	Sewage (Private) Primary	Camas Ban	=	5
CAR/R/1014806	NM 85335 31871	Sewage (Private) Primary	Firth of Lorn	=	5
CAR/R/1015011	NM 88140 29580	Sewage (Private) Primary	Land	=	12
CAR/R/1015462	NM 85840 28304	Sewage (Private) Primary	U/T of Scroba Burn	=	5
CAR/R/1015834	NM 92240 34790	Sewage (Private) Primary	Land	=	5
CAR/R/1015925	NM 93056 36112	Sewage (Private) Primary	Land	=	6
CAR/R/1016022	NM 92028 34856	Sewage (Private) Primary	Land	=	5
CAR/R/1016245	NM 85412 31935	Sewage (Private) Primary	Soakaway	=	8
CAR/R/1016438	NM 91360 34090	Sewage (Private) Primary	Land	=	5
CAR/R/1016444	NM 91096 34304	Sewage (Private) Primary	Land	=	5
CAR/R/1016602	NM 91014 33105	Sewage (Private) Primary	Lusragan Burn	=	6
CAR/R/1016811	NM 85340 31760	Sewage (Private) Primary	Land	=	18
CAR/R/1017171	NM 90469 31399	Sewage (Private) Secondary	Lusragan Burn	=	6
CAR/R/1017596	NM 89210 40720	Sewage (Private) Primary	Soakaway	=	8
CAR/R/1018319	NM 89670 39464	Sewage (Private) Primary	Land	=	5
CAR/R/1018409	NM 90987 35596	Sewage (Private) Primary	UN/WC	=	10
CAR/R/1018768	NM 91420 34061	Sewage (Private) Secondary	Lusragan Burn	=	6
CAR/R/1019181	NM 93530 36010	Sewage (Private) Primary	Land	=	6
CAR/R/1019519	NM 89790 39370	Sewage (Private) Primary	Land	=	6
CAR/R/1019543	NM 92710 35380	Sewage (Private) Primary	Land	=	5
CAR/R/1020567	NM 89970 39900	Sewage (Private) Primary	Land	=	5
CAR/R/1020698	NM 84326 28053	Sewage (Private) Secondary	Soakaway	=	14
CAR/R/1020769	NM 93440 35980	Sewage (Private) Primary	Loch Etive	=	6
CAR/R/1020884	NM 89883 39830	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1021159	NM 91460 34060	Sewage (Private) Secondary	Soakaway	=	6
CAR/R/1021257	NM 93060 36200	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1021347	NM 93030 36260	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1021717	NM 90600 37330	Sewage (Private) Primary	Land	=	6
CAR/R/1021730	NM 92630 34840	Sewage (Private) Primary	Land	=	8
CAR/R/1022555	NM 88690 29790	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1022604	NM 84666 29214	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1022606	NM 87532 29912	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1022607	NM 84750 29250	Sewage (Private) Primary	U/T of Sound of Kerrera	=	5

CAR/R/1024633	NM 87487 30028	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1024658	NM 92047 33950	Sewage (Private) Primary	Soakaway	=	15
CAR/R/1024775	NM 91420 34061	Sewage (Private) Primary	Lusragan Burn	=	20
CAR/R/1025910	NM 92770 35870	Sewage (Private) Primary	Land	=	5
CAR/R/1026572	NM 91300 34100	Sewage (Private) Secondary	Land	=	6
CAR/R/1026580	NM 91300 34150	Sewage (Private) Secondary	Land	=	6
CAR/R/1027839	NM 94031 36114	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1028139	NM 86220 32270	Sewage (Private) Primary	Soakaway	=	7
CAR/R/1028813	NM 87480 29930	Sewage (Private) Primary	Soakaway	=	7
CAR/R/1029131	NM 89080 39290	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1029589	NM 91340 34890	Sewage (Private) Primary	Soakaway	=	7
CAR/R/1029857	NM 91540 34940	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1030773	NM 87940 30721	Sewage (Private) Primary	Alltan Tartach	=	5
CAR/R/1034046	NM 90740 31770	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1034129	NM 84540 30890	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1034580	NM 89572 30353	Sewage (Private) Secondary	U/T of Dig Bharrain	=	5
CAR/R/1034611	NM 90600 33970	Sewage (Private) Secondary	U/T of Ardmucknish	=	5
CAR/R/1035111	NM 88987 29975	Sewage (Private) Secondary	U/T of Dig Bharrain	=	6
CAR/R/1036100	NM 89837 40107	Sewage (Private) Secondary	Allt an Duine Mhoir	=	6
CAR/R/1037061	NM 84680 29110	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037153	NM 92685 35587	Sewage (Private) Primary	Soakaway		5
CAR/R/1037166	NM 90258 38061	Sewage (Private) Primary	Soakaway	=	14
CAR/R/1037168	NM 90307 38054	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037178	NM 91480 34940	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037182	NM 88090 29500	Sewage (Private) Primary	Soakaway	=	16
CAR/R/1037183	NM 86099 32313	Sewage (Private) Primary	U/T of Firth of Lorn	=	5
CAR/R/1037184	NM 88126 29559	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037247	NM 90542 37315	Sewage (Private) Primary	UN/WC	=	5
CAR/R/1037276	NM 87381 30073	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1037291	NM 92930 35838	Sewage (Private) Primary	Loch Etive	=	5
CAR/R/1037304	NM 90539 32130	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037309	NM 90518 37479	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037312	NM 91660 34930	Sewage (Private) Primary	Soakaway	=	7
CAR/R/1037362	NM 92800 35370	Sewage (Private) Primary	Soakaway	=	7
CAR/R/1037392	NM 92606 34823	Sewage (Private) Primary	Soakaway	=	8
CAR/R/1037395	NM 87397 30055	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037422	NM 92759 35409	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037459	NM 92320 36440	Sewage (Private) Primary	Land	=	5
CAR/R/1037465	NM 85370 32060	Sewage (Private) Primary	Firth of Lorn	=	5
CAR/R/1037471	NM 89892 39761	Sewage (Private) Primary	Alt an Duine Mhoir	=	5
CAR/R/1037480	NM 93064 36194	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1037491	NM 92678 35220	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037492	NM 92234 34775	Sewage (Private) Primary	Soakaway	=	5

CAR/R/1037493	NM 92925 35349	Sewage (Private) Primary	Loch Etive	=	5
CAR/R/1037529	NM 92090 34780	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037561	NM 86109 31095	Sewage (Private) Primary	Soakaway	=	8
CAR/R/1037578	NM 89420 30320	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1037592	NM 93829 36019	Sewage (Private) Primary	Loch Etive	=	7
CAR/R/1037699	NM 93070 36140	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037707	NM 90202 40173	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037716	NM 87910 29920	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037722	NM 89860 39670	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1037726	NM 85380 28990	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037812	NM 90600 37260	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037919	NM 89890 39450	Sewage (Private) Primary	Soakaway	=	21
CAR/R/1037979	NM 86133 32261	Sewage (Private) Primary	Soakaway		5
CAR/R/1037980	NM 86111 32296	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1037981	NM 86067 32305	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1038076	NM 90130 31300	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1038089	NM 89140 40660	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1038116	NM 91450 34910	Sewage (Private) Primary	Soakaway	=	20
CAR/R/1038123	NM 90260 39400	Sewage (Private) Primary	Soakaway	=	15
CAR/R/1038129	NM 90573 37294	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1038157	NM 85740 32540	Sewage (Private) Primary	Firth of Lorn	=	10
CAR/R/1038170	NM 90261 39381	Sewage (Private) Primary	Soakaway	=	15
CAR/R/1038198	NM 86133 32261	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1038203	NM 82433 28789	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1038218	NM 86100 32340	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1038222	NM 92315 34771	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1038224	NM 86126 32389	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1038246	NM 79581 27030	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1038293	NM 84043 29958	Sewage (Private) Primary	Sound of Kerrera	=	10
CAR/R/1038294	NM 84060 30070	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1038302	NM 87650 30280	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1038417	NM 86150 32460	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1038486	NM 89810 39390	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1038576	NM 92790 35907	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1038577	NM 90890 36930	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1038598	NM 91172 33649	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1038991	NM 91212 34900	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039117	NM 93520 36070	Sewage (Private) Primary	Land	=	5
CAR/R/1039167	NM 91628 34931	Sewage (Private) Primary	Soakaway	<=	15
CAR/R/1039174	NM 90388 38838	Sewage (Private) Primary	Soakaway	<=	15
CAR/R/1039187	NM 92770 34980	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039211	NM 92851 35673	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1039235	NM 92991 35993	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1039308	NM 85340 31870	Sewage (Private) Primary	Camas Ban	=	6
CAR/R/1039338	NM 90651 34070	Sewage (Private) Primary	Loch Etive	=	5
CAR/R/1039346	NM 91496 34219	Sewage (Private) Primary	Lusragan Burn	=	5
CAR/R/1039448	NM 86596 29768	Sewage (Private) Primary	U/T of Alltan Tartach	=	5

CAR/R/1039477	NM 87599 30607	Sewage (Private) Primary	Land	=	5
CAR/R/1039480	NM 92862 35777	Sewage (Private) Primary	Soakaway	=	7
CAR/R/1039511	NM 89765 39355	Sewage (Private) Primary	Soakaway	<=	15
CAR/R/1039553	NM 89960 39850	Sewage (Private) Primary	Land	=	6
CAR/R/1039544	NM 92350 34810	Sewage (Private) Primary	Land	=	6
CAR/R/1039551	NM 92250 34180	Sewage (Private) Primary	Land	=	5
CAR/R/1039572	NM 90921 32672	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039581	NM 89749 39757	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039591	NM 90390 38330	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039611	NM 85640 32390	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039613	NM 82782 28664	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039615	NM 92740 35395	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039616	NM 82890 28670	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039618	NM 86430 31640	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1039620	NM 85300 31610	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039624	NM 85300 31620	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039627	NM 85475 32067	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039630	NM 85590 32190	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039635	NM 81060 26868	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039637	NM 80885 26348	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039639	NM 81704 27322	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1039640	NM 93104 36171	Sewage (Private) Primary	Land	<=	50
CAR/R/1039647	NM 90880 34850	Sewage (Private) Primary	Land	<=	50
CAR/R/1039650	NM 93140 36210	Sewage (Private) Primary	Land	=	6
CAR/R/1039677	NM 82360 28740	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039678	NM 82290 28680	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039679	NM 80170 28340	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039680	NM 81890 29170	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1039686	NM 80650 27060	Sewage (Private) Primary	Soakaway	=	20
CAR/R/1039749	NM 89817 39561	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039751	NM 90420 33960	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1039764	NM 89970 39309	Sewage (Private) Primary	Soakaway	=	8
CAR/R/1039787	NM 93025 36188	Sewage (Private) Secondary	Soakaway	=	6
CAR/R/1039831	NM 89832 39356	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1039844	NM 89810 39540	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1039847	NM 92220 34130	Sewage (Private) Primary	Soakaway	=	8
CAR/R/1039906	NM 90980 34360	Sewage (Private) Primary	Falls of Lora	=	5
CAR/R/1039917	NM 90748 36968	Sewage (Private) Primary	Ledaig Burn	=	5
CAR/R/1039920	NM 91025 34758	Sewage (Private) Primary	Loch Etive	=	6
CAR/R/1039959	NM 92175 34641	Sewage (Private) Primary	Loch Etive	=	25
CAR/R/1039984	NM 86619 29730	Sewage (Private) Primary	Alltan Tartach	=	6
CAR/R/1039990	NM 92790 35804	Sewage (Private) Primary	Land	=	6
CAR/R/1040010	NM 90600 37370	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1040018	NM 90640 37280	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1040066	NM 92671 35195	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1040074	NM 91510 35084	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1040110	NM 89767 39187	Sewage (Private) Primary	Land	=	6
CAR/R/1040386	NM 90555 38347	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1040504	NM 87610 29890	Sewage (Private) Primary	Soakaway	=	5

CAR/R/1040753	NM 89050 29710	Sewage (Private) Primary	Soakaway	<=	20
CAR/R/1040770	NM 93475 36146	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1040773	NM 94530 36480	Sewage (Private) Primary	Soakaway	=	8
CAR/R/1040775	NM 94619 36411	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1040782	NM 89190 40680	Sewage (Private) Primary	Soakaway	=	7
CAR/R/1040796	NM 91180 34902	Sewage (Private) Primary	UN/WC	=	6
CAR/R/1041106	NM 90310 38910	Sewage (Private) Primary	Soakaway	=	30
CAR/R/1041534	NM 91360 34350	Sewage (Private) Secondary	Falls of Lora	=	12
CAR/R/1041588	NM 87948 30262	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1042339	NM 93390 36036	Sewage (Private) Primary	Loch Etive	=	7
CAR/R/1042668	NM 90840 35480	Sewage (Private) Primary	Soakaway	=	30
CAR/R/1042807	NM 92455 34800	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1044188	NM 92380 34793	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1045223	NM 92043 36597	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1046285	NM 85880 28445	Sewage (Private) Primary	Soroba Burn	=	5
CAR/R/1046508	NM 92220 34680	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1048201	NM 93852 36024	Sewage (Private) Primary	Loch Etive	=	7
CAR/R/1049653	NM 91256 34128	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1049654	NM 89850 39800	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1057525	NM 85901 28444	Sewage (Private) Primary	Soroba Burn	=	5
CAR/R/1062989	NM 91490 34130	Sewage (Private) Primary	Soakaway	=	30
CAR/R/1068593	NM 90770 34100	Sewage (Private) Untreated	Coastal Waters	=	6
CAR/R/1074694	NM 90947 32678	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1076356	NM 85820 28460	Sewage (Private) Primary	Soakaway	=	8
CAR/R/1076615	NM 85832 28372	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1079227	NM 88960 30120	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1079832	NM 88790 33900	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1079862	NM 91487 34731	Sewage (Private) Primary	Loch Etive	=	5
CAR/R/1081644	NM 84860 30860	Sewage (Private) Primary	Sound of Kerrera	=	6
CAR/R/1081769	NM 88821 33938	Sewage (Private) Secondary	Soakaway	=	15
CAR/R/1082500	NM 93962 36109	Sewage (Private) Secondary	Allt Tigh Dhonnchaidh	=	5
CAR/R/1082582	NM 88680 29981	Sewage (Private) Secondary	Soakaway	=	15
CAR/R/1083550	NM 92020 34850	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1083790	NM 87309 30112	Sewage (Private) Secondary	Alltan Tartach	=	5
CAR/R/1085372	NM 86402 31330	Sewage (Private) Primary	UN/WC	=	5
CAR/R/1085417	NM 90080 39640	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1085700	NM 93130 36129	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1086857	NM 84464 27951	Sewage (Private) Primary	UN/WC	=	13
CAR/R/1086894	NM 82810 27430	Sewage (Private) Untreated	Sound of Kerrera	=	5
CAR/R/1088158	NM 92520 34840	Sewage (Private) Primary	Soakaway	=	11
CAR/R/1089002	NM 89883 39809	Sewage (Private) Primary	Allt an Duine Mhoir	=	5
CAR/R/1089060	NM 89205 30161	Sewage (Private) Secondary	U/T of Dig Bharrain	=	5
CAR/R/1090026	NM 89230 40700	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1092283	NM 93083 35981	Sewage (Private) Primary	Loch Etive	=	5

CAR/R/1093903	NM 82734 28666	Sewage (Private) Primary	U/T of Sound of Kerrera	=	8
CAR/R/1094227	NM 89910 39380	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1094250	NM 93430 35980	Sewage (Private) Primary	Coastal Waters	=	5
CAR/R/1094673	NM 88674 29715	Sewage (Private) Secondary	U/T of Dig Bharrain	=	8
CAR/R/1095399	NM 85225 31364	Sewage (Private) Primary	Oban Bay	=	13
CAR/R/1095459	NM 90720 38500	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1095619	NM 92954 35881	Sewage (Private) Primary	Loch Etive	=	6
CAR/R/1095759	NM 88675 39126	Sewage (Private) Primary	UN/WC	=	5
CAR/R/1095791	NM 81731 27368	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1095871	NM 81130 26940	Sewage (Private) Primary	Soakaway	=	5
CAR/R/1096209	NM 89640 39510	Sewage (Private) Primary	Soakaway	=	8
CAR/R/1097470	NM 84822 29382	Sewage (Private) Primary	UN/WC	=	5
CAR/R/1099103	NM 87310 30430	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1100341	NM 89991 33384	Sewage (Private) Primary	UN/WC	=	5
CAR/R/1100983	NM 92770 35640	Sewage (Private) Primary	Land	=	6
CAR/R/1100984	NM 92790 35600	Sewage (Private) Primary	Land	=	6
CAR/R/1102723	NM 90993 35607	Sewage (Private) Primary	Ledaig Burn	=	6
CAR/R/1102753	NM 88916 29933	Sewage (Private) Secondary	U/T of Dig Bharrain	=	5
CAR/R/1103746	NM 90080 39720	Sewage (Private) Primary	Soakaway	=	9
CAR/R/1104560	NM 91586 34999	Sewage (Private) Primary	Soakaway	=	15
CAR/R/1104804	NM 93310 36000	Sewage (Private) Untreated	Loch Etive	=	6
CAR/R/1105346	NM 90680 32140	Sewage (Private) Primary	Land	=	8
CAR/R/1106230	NM 90080 39730	Sewage (Private) Secondary	U/T of Allt an Duine Mhoir	=	8
CAR/R/1106852	NM 88900 29620	Sewage (Private) Primary	Soakaway	=	8
CAR/R/1107994	NM 92760 35850	Sewage (Private) Primary	Land	=	7
CAR/R/1108005	NM 88130 29490	Sewage (Private) Secondary	UN/WC	=	5
CAR/R/1111342	NM 92340 34310	Sewage (Private) Secondary	Loch Etive	=	5
CAR/R/1111711	NM 94020 36110	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1111795	NM 91508 34179	Sewage (Private) Primary	Lustagan Burn/Black Lochs	=	15
CAR/R/1113552	NM 85370 32080	Sewage (Private) Primary	Camas Ban	=	5
CAR/R/1113758	NM 88360 29450	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1114293	NM 86644 29742	Sewage (Private) Secondary	Allt Tartach	=	15
CAR/R/1114386	NM 91400 34350	Sewage (Private) Untreated	Loch Etive	=	7
CAR/R/1115018	NM 90640 34980	Sewage (Private) Primary	Land	=	5
CAR/R/1115182	NM 93310 36000	Sewage (Private) Primary	Loch Etive	=	7
CAR/R/1117296	NM 90820 34640	Sewage (Private) Untreated	Loch Etive	=	6
CAR/R/1117804	NM 83190 27590	Sewage (Private) Secondary	Soakaway	=	10
CAR/R/1120787	NM 93090 36040	Sewage (Private) Primary	Soakaway	=	10
CAR/R/1120937	NM 90490 37510	Sewage (Private) Primary	Land	=	5
CAR/R/1121197	NM 92400 34370	Sewage (Private) Untreated	Loch Etive	=	8
CAR/R/1121758	NM 90610 33950	Sewage (Private) Primary	UN/WC	=	5
CAR/R/1122063	NM 92900 35550	Sewage (Private) Primary	Soakaway	=	8
CAR/R/1122389	NM 89810 39990	Sewage (Private) Primary	Soakaway	=	5

CAR/R/1122956	NM 90059 33010	Sewage (Private) Secondary	Soakaway	=	5
CAR/R/1123477	NM 91360 34340	Sewage (Private) Untreated	Loch Etive	=	15
CAR/R/1123643	NM 90822 32277	Sewage (Private) Primary	Soakaway	=	6
CAR/R/1124152	NM 91269 34902	Sewage (Private) Primary	Soakaway	=	6
CAR/S/1011729	NM 90330 33975	Sewage (Private) Secondary	Soakaway	=	20
CAR/S/1015890	NM 86540 27070	Sewage (Private) Tertiary	Allt Criche	=	33
CAR/S/1021079	NM 91390 34900	Sewage (Private) Secondary	Soakaway	<=	50
CAR/S/1079282	NM 87970 34180	Sewage (Private) Secondary	Soakaway	=	45
CAR/S/1085444	NM 89900 39600	Sewage (Private) Secondary	Soakaway	=	24
CAR/S/1107891	NM 83080 27560	Sewage (Private) Tertiary	Soakaway	<=	25
CAR/R/1122261	NM 89810 30570	Sewage (Public) Primary	Soakaway	=	5
CAR/R/1014205	NM 90486 34047	Sewage (Public) Primary	Land	=	8
CAR/R/1024422	NM 90660 34000	Sewage (Public) Primary	Coastal Waters	=	6
CAR/R/1109422	NM 91650 34310	Sewage (Public) Primary	Loch Etive	=	50
CAR/R/1037642	NM 91220 34380	Sewage (Public) Untreated	Loch Etive	=	5
CAR/L/1000364	NM 90080 38418	Sewage (Public) Secondary	Ardmucknish Bay	=	400
CAR/L/1003310	NM 91236 34405	Sewage (Public) Untreated	Loch Etive	=	0
CAR/L/1003311	NM 90700 34600	Sewage (Public) Untreated	Loch Etive	=	0
CAR/L/1010872	NM 89600 34500	Sewage (Public) Primary	Firth of Lorn	=	0
CAR/L/1003475	NM 85185 30824	Sewage (Public) Secondary	Oban Bay	=	13597
CAR/L/1010883	NM 90590 34590	Sewage (Public) Primary	Loch Etive	=	0
CAR/L/1026157	NM 85508 29727	Sewage (Public) Combined Sewer Overflow (CSO)		NA	NA
CAR/L/1026157	NM 85508 29727	Sewage (Public) Combined Sewer Overflow (CSO)		NA	NA
CAR/L/1026157	NM 85793 30010	Sewage (Public) Combined Sewer Overflow (CSO)		NA	NA
CAR/L/1026157	NM 85793 30010	Sewage (Public) Combined Sewer Overflow (CSO)		NA	NA
CAR/L/1026157	NM 85871 30609	Sewage (Public) Combined Sewer Overflow (CSO)		NA	NA
CAR/L/1026157	NM 85871 30609	Sewage (Public) Combined Sewer Overflow (CSO)		NA	NA
CAR/L/1026157	NM 86044 29338	Sewage (Public) Combined Sewer Overflow (CSO)		NA	NA
CAR/L/1026157	NM 86044 29338	Sewage (Public) Combined Sewer Overflow (CSO)		NA	NA
CAR/L/1026157	NM 86413 28473	Sewage (Public) Combined Sewer Overflow (CSO)		NA	NA
CAR/L/1026157	NM 86413 28473	Sewage (Public) Combined Sewer Overflow (CSO)		NA	NA
CAR/L/1000364	NM 89958 38362	Sewage (Public) Combined Sewer Overflow (CSO)		NA	NA
CAR/L/1000889	NM 85920 32590	Sewage (Public) Emergency Overflow (EO)		NA	NA
CAR/L/1010875	NM 91260 34430	Sewage (Public) Emergency Overflow (EO)		NA	NA
CAR/L/1010878	NM 90710 34630	Sewage (Public) Emergency Overflow (EO)		NA	NA

CAR/L/1026157	NM 85920 32590	Sewage (Public) Emergency Overflow (EO)		NA	NA
CAR/L/1026157	NM 85920 32590	Sewage (Public) Emergency Overflow (EO)		NA	NA
CAR/L/1026157	NM 85623 30556	Sewage (Public) Emergency Overflow (EO)		NA	NA
CAR/L/1026157	NM 85795 29907	Sewage (Public) Emergency Overflow (EO)		NA	NA
CAR/L/1026157	NM 86818 29881	Sewage (Public) Emergency Overflow (EO)		NA	NA
CAR/L/1026157	NM 84810 29460	Sewage (Public) Emergency Overflow (EO)		NA	NA
CAR/L/1010880	NM 90610 34628	Sewage (Public) Emergency Overflow (EO)		NA	NA
CAR/L/1010886	NM 90970 34390	Sewage (Public) Emergency Overflow (EO)		NA	NA
CAR/L/1010885	NM 91850 34230	Sewage (Public) Emergency Overflow (EO)		NA	NA
CAR/L/1010882	NM 92130 34630	Sewage (Public) Emergency Overflow (EO)		NA	NA
CAR/L/1010872	NM 89600 34500	Sewage (Public) Emergency Overflow (EO)		NA	NA

LS=Land/Soakaway, SW= Seawater Body, FW= Freshwater Body, PE= Population Equivalent, - = Not applicable

6. Scottish Water Discharges

Name	Licence	Dicharge Location	Type	Treatment	Consented Flow	Overflow	Storage
ACHNACREEMORE SEP NM930363		NM930363					
DUNGALLAN TERRACE SEP NM842291	CD12219	NM 8420 2910	FE	septic tank			0
OBAN GALLANACH SPS 1998 NM848294	CAR/L/1026157	NM 8481 2946	EO	6 mm screens	storage 6m3	n/a	0
GALLANACH PUMPING STATION	CAR/L/1026157	NM 8483 2942	CSO	6 mm screens	105 m3	12	0
Gallanach SPS CSO	CAR/L/1026157	NM 8483 2942	CSO	6 mm screens	105 m3	12 l/s	0
Gallanach SPS EO	CAR/L/1026157	NM 8483 2942	EO	6 mmscreens		n/a	0
CORRAN ESPLANADE PS	CAR/L/1026157	NM 849 306	CSO	6 mm screens	4998	160 l/s	0
OBAN WWTW 2000 NM867314	CAR/L/1003475	NM 8490 3060	FE	secondary	4958		26600
OBAN MANOR HOUSE WWPS	CAR/L/1026157	NM 8518 2982	EO	6 mm screens	storage 6m3	n/a	0
Manor House SPS EO	CAR/L/1026157	NM 8518 2982	EO	6 mm screens		n/a	0
OBAN, ALMA CRESCENT CSO	CAR/L/1026157	NM 8555 2972	CSO	15mm screen	2 m3	23 l/s	0
OBAN HERITAGE CENTRE SPS 1992 NM858299	CAR/L/1026157	NM 8580 2993	EO				0
Heritage Centre SPS EO	CAR/L/1026157	NM 8580 2993	EO				
OBAN, CORRAN PARK WWPS 1997 NM857306	CAR/L/1026157	NM 8581 2998	EO	15 mm screens	4998	n/a	0
OBAN GEORGE ST CSO NM859299	CAR/L/1026157	NM 8581 2998	CSO	10 mm screens	4998	900	0
CORRAN ESPLANADE PS	CAR/L/1026157	NM 8581 2998	CSO	10 mm screens	4998	160 l/s	0
George Street CSO	CAR/L/1026157	NM 8581 2998	CSO	10 mm screens	4998	900 l/s	0
Corran Parks SPS EO	CAR/L/1026157	NM 8581 2998	EO	15 mm screens			n/a
OBAN GANAVAN WWPS 2003 NM859323	CAR/L/1026157	NM 8592 3259	EO	10 mm screens	storage 7 m3	n/a	0
Ganavan SPS EO	CAR/L/1026157	NM 8592 3259	EO	10 mm screens			n/a
DUNBEG MEADOW RD WWPS CSO NM881336		NM 881336	CSO				
KILMORE WWTW NM883257	CAR/L/1000611	NM 882 258	FE	secondary	25 m3		120
KILMORE, KILMORE STW CSO	CAR/L/1000611	NM 8820 2580	CSO	6 mm screens		25 m3	1 l/s
CONNEL SEP WWPS CSO NM890339	CAR/L/1010872	NM 8960 3450	CSO	6 mm screens	332.1	2 l/s	0
CONNEL SEP NM890339	CAR/L/1010872	NM 8960 3450	FE	septic tank	332.1		0
CONNEL SEP WWPS NM890339	CAR/L/1010872	NM 8960 3450	EO	6 mm screens	332.1		0

Name	Licence	Dicharge Location	Type	Treatment	Consented Flow	Overflow	Storage
BENDERLOCH WWTW 1976 NM903384	CAR/L/1000364	NM 9010 3850	FE	secondary	88		400
BENDERLOCH, BENDERLOCH CSO		NM 9010 3850	CSO				0
BENDERLOCH, BENDERLOCH STW CSO	CAR/L/1000364	NM 9010 3850	CSO	6 mm screens	88	6 l/s	0
NORTH CONNEL SEP WWTW	CAR/L/1010883	NM 9059 3459	FE	sepic tank	84		0
CONNEL NORTH SPS NO1 NM906347	CAR/L/1010880	NM 9061 3464	EO	6 mm screens	84		0
CONNEL NORTH SPS NO1 NM906347 CSO	CAR/L/1010880	NM 9061 3464	CSO	6 mm screens	84	8 l/s	0
CONNEL NORTH SPS NO2 NM907347	CAR/L/1010878	NM 9071 3463	EO	6 mm screens	1.5		0
CONNEL SOUTH SPS NO1 NM909343	CAR/L/1010886	NM 9097 3439	EO	6 mm screens	89.7		0
CONNEL STH SPS1 CSO NM909343	CAR/L/1010886	NM 9097 3439	CSO	6 mm screens	89.7	23 l/s	0
CONNEL SOUTH SPS NO2 NM913344	CAR/L/1010875	NM 9126 3443	EO	6 mm screens	2		0
CONNEL SOUTH ACHALEVEN SPS NM919342	CAR/L/1010885	NM 9185 3423	EO	6 mm screens	40		0
CONNEL, ACHALEVEN CSO	CAR/L/1010885	NM 9185 3423	CSO	6 mm screens	40	7 l/s	0
CONNEL NORTH SPS NO3 NM920348	CAR/L/1010882	NM 9213 3463	EO	6mm screens	23.6		0
CONNEL NORTH SPS NO3 NM920348 CSO	CAR/L/1010882	NM 9213 3463	CSO	6mm screens	23.6	7 l/s	0
BLACKCROFTS NORTH CONNEL SEP NM923348		NM 9237 3465	FE	septic tank	12 houses		0
(associated with Achnacreemore ST		soakaway	CSO				0
NORTH CONNEL, 6 MOSSPARK CSO							
DUNBEG JANE ROAD CSO 2013 NM880334			CSO				0
DUNBEG JANE ROAD WWPS NM880335			EO				0
DUNBEG MEADOW RD WWPS CSO NM881336			CSO				0
DUNBEG MEADOW RD WWPS NM882336			EO				0