Scottish Sanitary Survey Review

Clift Sound

SI 035, 036, 037 and 038

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Review Specification and Introduction

Sanitary surveys are used to demonstrate compliance with the requirements stated in Annex II (Chapter II Paragraph 6) of Regulation (EC) 854/2004, whereby if the competent authority decides in principle to classify a production or relay area it must:

- make an inventory of pollution sources of human/animal origin likely to be a contamination source for the production areas;
- examine the quantities of organic pollutants which are released during the different periods of the year, according to the seasonal variations of both human and animal populations in the catchment area, rainfall readings, wastewater treatment, etc.;
- determine the characteristics of the circulation of pollutants by virtue of current patterns, bathymetry and the tidal regime in the production area;
- establish a sampling programme of bivalve molluscs in the production area which is based on the examination of established data, and with a number of samples, a geographical distribution of the sampling points and a sampling frequency which must ensure that the results of the analysis are as representative as possible for the area considered.

The EURL Good Practice Guide (GPG) for the monitoring of bivalve molluscs harvesting areas recommends the re-evaluation of sanitary surveys every six years. Location, extent and nature of fisheries and faecal pollution sources may change over time and the review is conducted to determine whether the sampling plan and/or production area boundaries remain appropriate and protective of public health.

As specified by the Food Standards Agency, this review is comprised of a brief desktop search of publicly available information together with a shoreline survey. No additional data requests are submitted to external bodies. The review is intended to identify significant changes in:

- Historic microbiological data.
- Sewage treatment and sewerage infrastructure.
- Housing and development.
- Harvester operations.

The output of the review is a report identifying any new information that has been obtained and/or whether major elements of the original sanitary survey can be regarded as essentially unchanged. That report includes an overall assessment as to whether the production area/classification zone boundaries and/or RMPs should be modified from those recommended in the original report and if so, a description of

the revised boundaries and a revised sampling plan with the boundaries and RMP(s) locations.

A sanitary survey was undertaken in 2007 for Clift Sound. The survey was conducted to identify the location, extent and nature of the shellfishery and the potential sources of faecal contamination to the shellfishery, and to recommend boundaries and sampling plans for the production areas.

The output of the sanitary survey included a report and recommended sampling plans for the four production areas within the sound. These sampling plans are identified on the following pages alongside the recommended changes following findings from this review.

The present report constitutes a review of publicly available information in order to assess changes that have occurred since the 2007 sanitary survey report (see the Review Specification section for further detail). It is not intended to present detailed information relating to pollution sources that were identified in the previous report. This review should be read in conjunction with the 2007 sanitary survey report.

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Sampling Plan – Clift Sound: Booth

	2007 recommendations	2014 review	Changes
PRODUCTION AREA	Clift Sound: Booth	Clift Sound: Booth	No change
SITE NAMES	Booth	Booth	
SIN	SI-036-413-08	SI-036-413-08	
SPECIES	Common mussels	Common mussels	
TYPE OF FISHERY	Long-line aquaculture	Long-line aquaculture	
NGR OF RMP	HU 4020 3777	HU 4015 3777	Adjusted eastward to lie on eastern side of fishery
EAST	440200	440150	
NORTH	1137770	1137770	
TOLERANCE (M)	20	40	Amended to bring in line with current allowances for movement of mussel lines
DEPTH (M)	1-3	1-3	No change
METHOD OF SAMPLING	Hand	Hand	
FREQUENCY OF SAMPLING	Monthly	Monthly	
LOCAL AUTHORITY	Shetland Island Council	Shetland Island Council	
AUTHORISED SAMPLER(S)	Sean Williamson, George Williamson, Kathrym Winter, Marion Slater.	Sean Williamson, Marion Anderson, Agnes Smith, Alan Harpin, Vicki Smith	Change in staff
RECOMMENDED PRODUCTION AREA	The area bounded by HU 3991 3800 to HU 4059 3800 and HU 4044 3700 to HU 3983 3700 extending to MHWS	The area bounded by HU 3992 3800 to HU 4059 3800 and HU 4038 3655 to HU 3987 3655 extending to MHWS	Extended southward to incorporate seabed lease area south of Glendale

Sampling Plan – Clift Sound: Whal Wick

	2007 recommendations	2014 review	Changes
PRODUCTION AREA	Clift Sound: Whal Wick	Clift Sound: Whal Wick	No change
SITE NAME	Whal Wick	Wester Quarff	Moved RMP to new site within expanded production area
SIN	SI-038-416-08	TBD	Change to SIN of Wester Quarff site
SPECIES	Common mussels	Common mussels	No change
TYPE OF FISHERY	Long line aquaculture	Long-line aquaculture	
NGR OF RMP	HU 4023 3616	HU 4018 3532	Moved to Wester Quarff site
EAST	440230	440180	
NORTH	1136160	1135320	
TOLERANCE (M)	20	40	Amended to bring in line with current allowances for movement of mussel lines
DEPTH (M)	1-3	1-3	No change
METHOD OF SAMPLING	Hand	Hand	
FREQUENCY OF SAMPLING	Monthly	Monthly	
LOCAL AUTHORITY	Shetland Islands Council	Shetland Islands Council	
AUTHORISED SAMPLER(S)	Sean Williamson, George Williamson, Kathryn Winter, Marion Slater	Sean Williamson, Marion Anderson, Agnes Smith, Alan Harpin, Vicki Smith	Change in staff
RECOMMENDED PRODUCTION AREA	The area bounded by lines drawn from HU 3979 3600 to HU 4035 3600 and HU 4038 3670 to HU 3983 3670 extending to MHWS	The area bounded by lines drawn between HU 4038 3655 and HU 3987 3655 and between HU 4032 3520 to HU 3889 3513, and extending to MHWS	Northern boundary shifted south to agree with southern boundary of Clift Sound: Booth. Southern boundary extended to incorporate new areas

Sampling Plan – Clift Sound: East Hogaland

	2007 recommendations			2014 review	Changes
PRODUCTION AREA	Clift Sound: East Hogaland		Clift Sound: Streamsound	Clift Sound: East Hogaland	Streamsound and East Hogaland combined into one area
SITE NAME	East Hogaland		Streamsound	East Hogaland	Stream Sound combined with East Hogaland area
SIN	SI-035-414-08		SI-037-415-08	SI-035-414-08	
SPECIES	Common mussels		Common mussels	Common mussels	No change
TYPE OF FISHERY	Long line aquaculture		Long line aquaculture	Long-line aquaculture	
NGR OF RMP	HU 3927 3354	HU 3920 3337	HU 3933 3475	HU 3916 3339	Amended to represent the combined area
EASTING	439270	439200	439330	439160	
NORTHING	1133540	1133370	1134750	1133390	
SAMPLING TOLERANCE (M)	20		20	40	Amended to bring in line with current allowances for movement of mussel lines
DEPTH (M)	1-3		1-3	1-3	No change
METHOD OF SAMPLING	Hand		Hand	Hand	
FREQUENCY OF SAMPLING	Monthly		Monthly	Monthly	
LOCAL AUTHORITY	Shetland Islands Council		Shetland Islands Council	Shetland Islands Council	
AUTHORISED SAMPLER(S)	Sean Williamson, George Williamson, Kathryn Winter, Marion Slater		Sean Williamson, George Williamson, Kathryn Winter, Marion Slater	Sean Williamson, Marion Anderson, Agnes Smith, Alan Harpin, Vicki Smith	Change in staff
RECOMMENDED PRODUCTION AREA	Area bounded by lines drawn from HU 3917 3386 to HU 3983 3386 and HU 3958 3300 to HU 3900 3300 to HU 3900 3341 extending to MHWS		Area bounded by lines drawn from HU 3907 3490 to HU 3960 3423 to HU 3960 3423 to HU 3923 3423 extending to MHWS	Area bounded by lines drawn between HU 3907 3490 and HU 4005 3490 and HU 3957 3300 and HU 3876 3300, and extending to MHWS	Combined two production areas

Sampling Plan –Clift Sound: Houss

	pRMP Assessment	2014 review	Changes
PRODUCTION AREA	Clift Sound: Houss	Clift Sound: Houss	No change
SITE NAME	Houss	South Holms Geo	Monitoring moved to new site within expanded Houss production area
SIN	SI-633-1270-08	TBD	
SPECIES	Common mussels	Common mussels	No change
TYPE OF FISHERY	Long-line	Long-line	
NGR OF RMP	HU 3850 3197	HU 3857 3195	Moved to lie on recorded location of Houss mussel farm, kept at southwest corner
EAST	438500	438570	
NORTH	1131970	1131950	
TOLERANCE (M)	40 m	40 m	No change
DEPTH (M)	1	1-3	
METHOD OF SAMPLING	Hand	Hand	
FREQUENCY OF SAMPLING	Monthly	Monthly	
LOCAL AUTHORITY	Shetland Island Council	Shetland Island Council	
AUTHORISED SAMPLER(S)	Sean Williamson, Marion Anderson, Agnes Smith, Alan Harpin, Vicki Smith	Sean Williamson, Marion Slater, Agnes Smith, Alan Harpin, Vicki Smith	
RECOMMENDED PRODUCTION AREA	Area bounded by lines drawn between HU 3871 3273, HU 3953 3273, HU 3823 3165, HU 3923 3157 extending to MHWS	The area bounded by lines drawn between HU 3876 3300 and HU 3957 3300 and between HU 3802 3082 and HU 3808 3126 and between HU 3870 2900 and HU 3734 2900, and extending to MHWS	Area expanded southward to encompass the new South Holms Geo site

1. Area Description and Fishery

The location of Clift Sound is shown in Figure 1.1.

Figure 1.1 Location of Clift Sound

Four classified common mussel fisheries currently operate within Clift Sound and remain the same as those classified in the 2007 report. A fifth site assessed in the 2007 report (Uxness) was re-assigned to the Stream Sound production area and will not be addressed in this review. A new site (Houss) is currently undergoing

monitoring towards classification for 2014/2015 following a provisional RMP (pRMP) assessment in 2013. Details of these five fisheries are listed in Table 1.1.

Table 1.1 Currently monitored fisheries operating in Clift Sound

Production area	Site	SIN	Species	RMP
Clift Sound: Booth	Booth	SI-036-415-08	Mussels	HU 4020 3777
Clift Sound: Whal Wick	Whal Wick	SI-038-416-08	Mussels	HU 4022 3616
Clift Sound: Stream Sound	Stream Sound	SI-037-415-08	Mussels	HU 3932 3475
Clift Sound	East Hogaland	SI-035-414-08	Mussels	HU 3926 3353 and HU 3919 3336
Clift Sound: Houss	Houss	SI-633-1270-08	Mussels	HU 3850 3195

In the 2007 sanitary survey report, two alternative RMP locations were recommended for Clift Sound: East Hogaland with the intent that the data from parallel monitoring be reviewed when sufficient data had been accumulated and a single RMP selected.

Current RMPs as given in the FSAS 2013/2014 spreadsheet differ slightly from those recommended in the 2007 report for three out of the four presently classified production areas. These differences are listed in Table 1.2.

Table 1.2 Differences in RMPs for sites in Clift Sound

Site	2007 recommended RMP	2013/14 FSAS RMP
Whal Wick	HU 4023 3616	HU 4022 3616
Stream Sound	HU 3933 3475	HU 3932 3475
East Hogaland	HU 3927 3354 or HU 3920 3337	HU 3926 3353 or HU 3919 3336

Applications for two new fisheries in Clift Sound were received in November 2013, details of which are listed in Table 1.3. Estimated first harvest for both sites is December 2014, according to information provided by the harvester.

Table 1.3 New sites in Clift Sound

Production Area Name	Site Name	SIN	Equipment on site
Clift Sound South	South Holms Geo	SI-702-1524-08	1x264 m long-line
Clift Sound: Wester Quarff	Wester Quarff	SI-701-1522-08	1x310 m long-line
NA	Kallee Ness	NA	3 long-lines

NA = Not Assigned

No additional information on harvesting was obtained in the 2013 survey. Mussels are therefore expected to continue to take three years to reach market size, with new lines for spat settlement deployed from late May to early June. Production remains via suspended culture using double headed long-lines. Number and length of long-lines and length of droppers at individual sites during the 2007 and 2013 surveys are as follows:

All of the sites recorded in 2007 remain in production. The size of the farm at Booth has remained essentially the same size, the Streamsound and Whal Wick farms now cover a slightly smaller footprint than in 2007, and the East Hogaland site has expanded in area.

The mussel farm at Houss was recorded for the first time and consisted of 6 long-lines with droppers to 10-15 m depth. Two further new sites were recorded during the 2013 survey: a single line at Wester Quarff and three lines at Kallee Ness. At the time of writing this review, no application had yet been received for classification of the Kallee Ness site.

An application for classification of a site at South Holms Geo was received after the shoreline survey had been planned, and therefore this site was not visited during the shoreline survey as the planned route did not extend that far south.

For ease of mapping the fisheries, the Clift Sound area has been split into North and South regions in Figures 1.2 and 1.3. Current production area boundaries and RMPs stated by FSAS 2013/14, as well as those recommended from pRMP assessment for Houss are displayed, alongside farm boundaries from the two new applications. Site boundaries observed during the 2007 and 2013 surveys are also displayed in the figures.

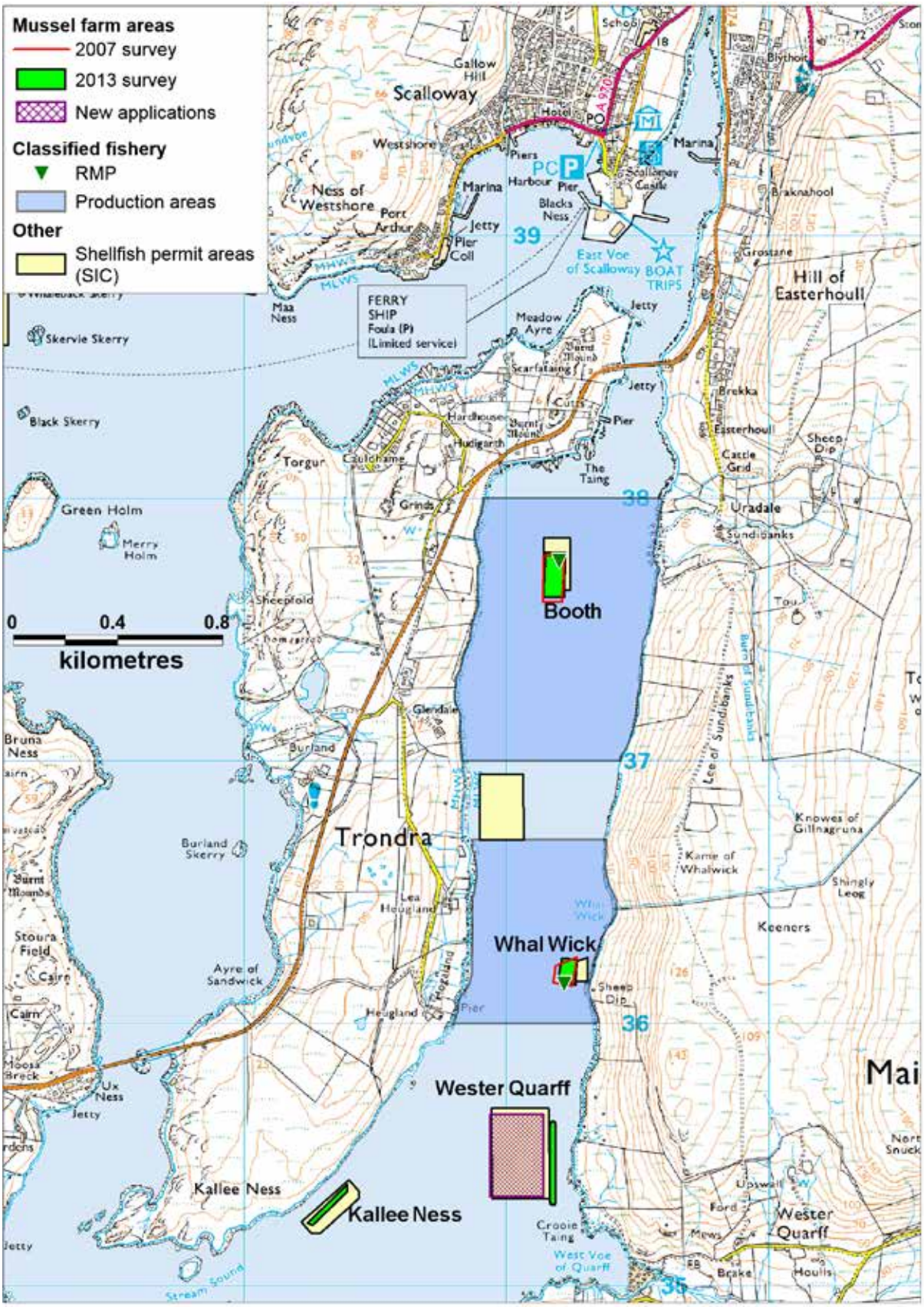

Figure 1.2 Clift Sound, northern production areas

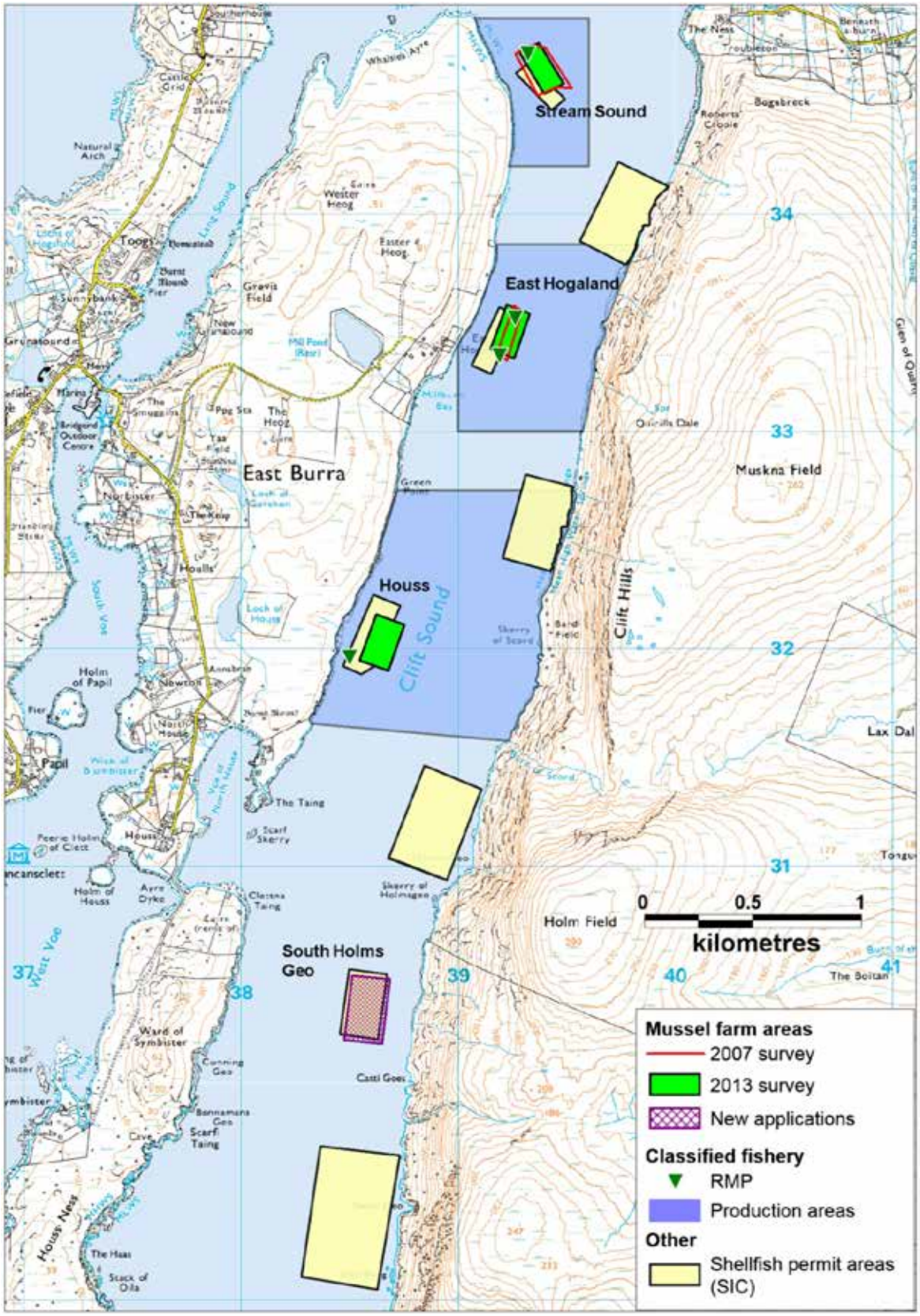

Figure 1.3 Clift Sound, southern production areas

2. Population and Human Sewage Impacts

2.1 Population

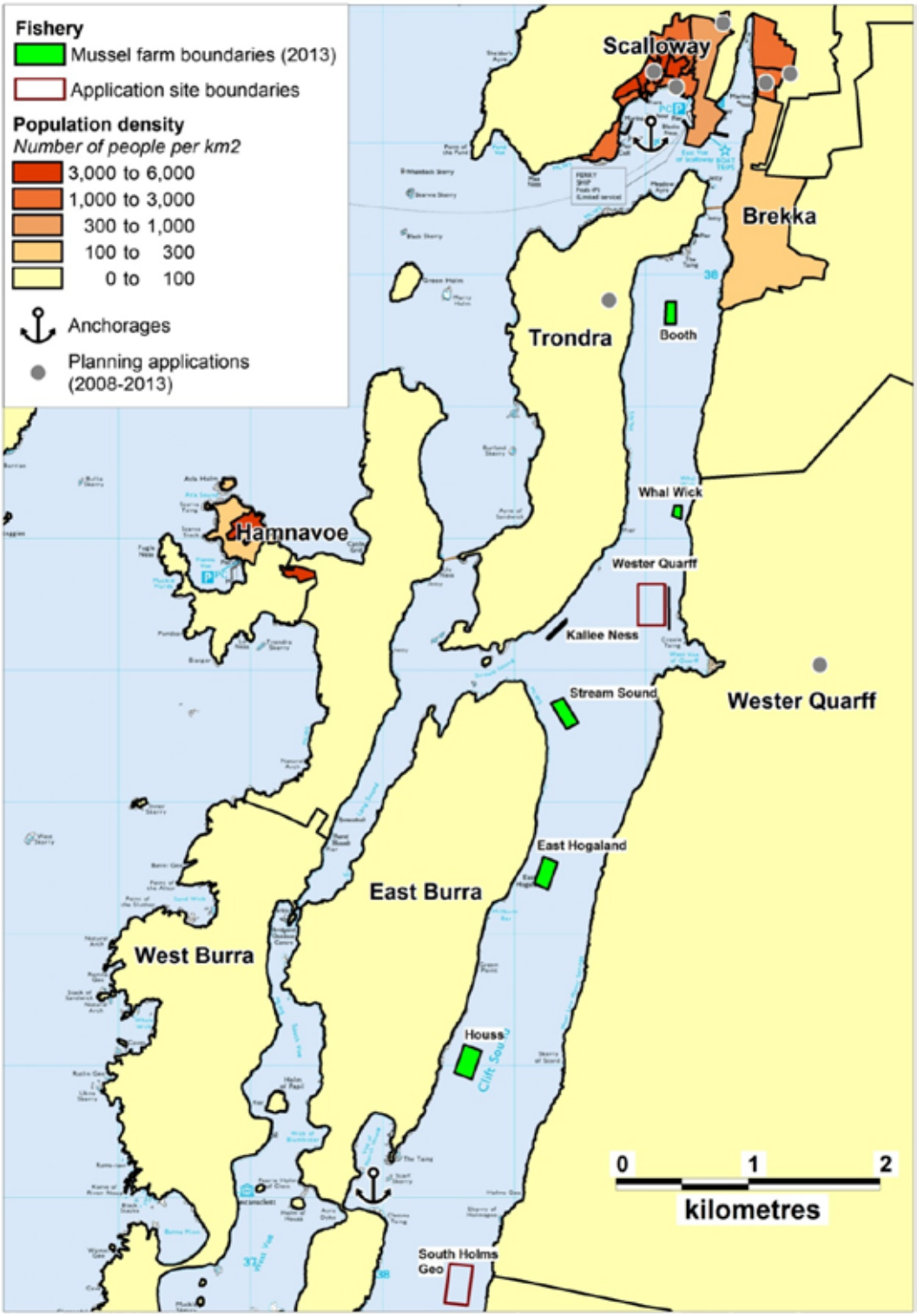

Figure 2.1 Current distribution of human population around Clift Sound

Population data from the General Register Office for Scotland from both the 2001 and 2011 censuses are shown in Table 2.1. Comparisons are complicated by changes in identifiers for some of the output areas. Total population counts for the Scalloway and Hamnavoe areas are provided for ease of comparison.

Table 2.1 Scottish Government Census data for years 2001 and 2011

2001 Census data		2011 Census data		
Output area	**Population**	**Output area**	**Population**	
60RD000018	66	S00059501	76	
60RD000147	92	S00059444	99	
60RD000133	133	S00059500	135	
60RD000149	188	S00059575	75	
60RD000142	210	S00059558	202	
60RD000146	168	S00059560	61	260
		S00059561	199	
Scalloway	769	Scalloway	813	
Hamnavoe	526	Hamnavoe	541	
Total	**2152**	***Total***	**2201**	

The overall population around Clift Sound has increased by just over 2% between 2001 and 2011. The majority of this increase was seen in Scalloway. Twenty-one planning applications were found for the Scalloway, Wester Quarff and Trondra areas since 2007. These applications were downloaded from the Shetland Island Council Planning Portal in November 2013 (http://pa.shetland.gov.uk/online-applications/), with full details listed in Appendix 1. The locations covered by the downloaded planning applications are plotted in Figure 2.1.

Fourteen of the 21 applications were for Scalloway, 11 of which were associated with septic tanks (ST). Ten were for new dwelling houses with planned connection to the public sewer network. The eleventh application included plans for a ST to go to soakaway in East Voe (east of Scalloway). The three other applications for Scalloway were for: a new childcare facility with public sewer connection; a B&B (no information on sewage facilities- assumed to be using an existing connection); a 'coastel' – an offshore housing barge. This was only for B.P. workers and although total capacity was 304 persons, occupancy was noted to vary depending on projects over the two year licence agreement. Discharges to sea were not permitted in the consent and information obtained from conversations held with the Shetland Island Council planning department indicated sewage received treatment onboard the barge, prior to being pumped off by Scottish Water and disposed of in land facilities.

Two of the applications were associated with new dwelling houses and associated STs in the Wester Quarff area; one ST was identified as discharging to a sea outfall and the other to a soakaway system. These STs lay just over 1 km west of the new Wester Quarff fishery.

The remaining five applications related to new dwelling houses along the western shore of Trondra; four with new ST to soakaways and the fifth to an existing ST. These applications lay within 500 m of the Booth site. No tourist accommodation was observed during the 2013 shoreline survey.

A mix of workboats serving local aquaculture farms and pleasure boats were seen in the sound. Workboats were observed in 2013 at piers in Houss (associated with the fish farm shore-base) and at Trondra. A new pontoon and four empty moorings were also observed at Wester Quarff.

2.2 Sewage Discharges

The 2007 report concluded that the most significant human sewage impacts to the sound would come from the permitted overflows associated with the East Voe pumping station (PS), which would impact the northern extent of Booth fishery intermittently, and from a private ST close to the Burn of Quarff (mid west shore), which may have impacted the southern extent of Whal Wick fishery. Stream Sound was also expected to receive contamination from North Toogs ST, located in Lang Sound. Original sewage information from Scottish Water and SEPA can be found in the original 2007 Sanitary Survey Report and the locations relating to the discharges are displayed in Figure 2.2. At the time of the 2007 report, there were planned upgrades to the Scottish Water assets around Scalloway that were not expected to significantly reduce contamination levels at any of the Clift Sound mussel farms. The exception was a suggested small reduction at Booth fishery, further to planned replacement of pipes at Blacksness Pier sewers in 2008. The public sewerage system at Scalloway includes five pumping stations with associated outfalls (Blackness, Blydoit, Seachest, Westshore, and Burn Beach). All except West Shore and Burn Beach are strictly emergency overflows and would be expected to spill only under exceptional circumstances. West Shore and Burn Beach also have combined sewer overflows, which would be expected to spill after heavy rainfall. Locations for these discharges are shown in Figure 2.1.

Discharge-related observations made during the 2013 survey are listed in Table 2.2, with locations displayed in Figure 2.2. During the 2007 survey, only six discharge-related observations were made on the land immediately adjacent to Clift Sound, with the majority of such observations made to the north around Scalloway and along the northern shoreline of Trondra.

Most of the sewage infrastructure and discharge related observations made in the 2013 shoreline survey related to STs, although it should be noted that four of these appeared to be in a disused state. The majority of STs were observed along western shoreline of Trondra, north of Clift Sound.

Table 2.2 Sewage discharge-related observations around Clift Sound from the 2013 shoreline survey

No.	NGR	Description
1	HU 4060 3847	Old septic tank disused at the edge of the escarpment
2	HU 4037 3835	Septic tank for house
3	HU 4034 3827	Concrete septic tank in a field next to a house located near the shore
4	HU 4028 3822	New house just up from the shore unable to locate the septic tank
5	HU 4019 3816	Concrete septic tank in a field next to a house just up from the shore. Old disused septic tank noted, stones built up leading to the shore
6	HU 3980 3720	Black plastic septic tank with a concrete lid. Vent pipe extruding from the ground beside the tank. Pipe observed at the shore leading to the beach, does not look to be in use as there is a break in the pipe and no discharge.
7	HU 3977 3710	Large concrete septic tank associated with a house on the hill, small crack down the side of the tank and some leakage
8	HU 3982 3620	Septic tank noted in the field further up the hill
9	HU 3974 3618	Large concrete septic tank
10	HU 3972 3616	New plastic septic tank possibly associated with structure mentioned below, as a similar structure present next to the septic tank
11	HU 3981 3613	Open plastic structure which water can be seen flowing. Vertical pipe extruding from the ground near the shore, not sure if the two are associated
12	HU 3969 3613	Old septic tank possibly disused, concrete with wooden lid. No running water heard
13	HU 3970 3612	An old possibly disused concrete septic tank up hill
14	HU 4055 3499	New green plastic septic tank associated with a new house above the road
15	HU 4041 3495	Concrete septic tank associated with house above the road
16	HU 3895 3341	Septic tank present, three houses in the area, one derelict
17	HU 3807 3146	Septic tank for SSF shore base. Man hole cover visible above the ground
18	HU 3771 3111	Concrete septic tank associated with two houses on the hill. Lid and side of tank cracked

Two malfunctioning septic tanks were observed along the west shoreline. One large concrete ST (No 7) on the mid-west Trondra shoreline was leaking from a crack. This ST is located less than 700 m southwest of Booth fishery and may contribute to diffuse contamination levels crossing within the Voe. The second was located at Houss, on the south end of East Burr. However, no discharge/leak was observed coming from the tank and it was unclear whether or not it was in use. This ST lies less than 1 km northwest of the new South Holms Geo site.

Overall, the sources of sewage contamination in the Clift Sound area do not appear to have changed significantly since the sanitary survey. The greatest potential for impact from sewage and septic tank discharges remains at the northern end of the sound, where there is a greater concentration of discharges. The southern end of the sound is less likely to be affected by human sewage. . Discharges from septic tanks at the northern end of Trondra and from CSOs and/or EOs in the Voe of Scalloway. Additional sources located along the south-east shore of Trondra will potentially affect the Wester Quarff, Whal Wick and possibly Kallee Ness fisheries.

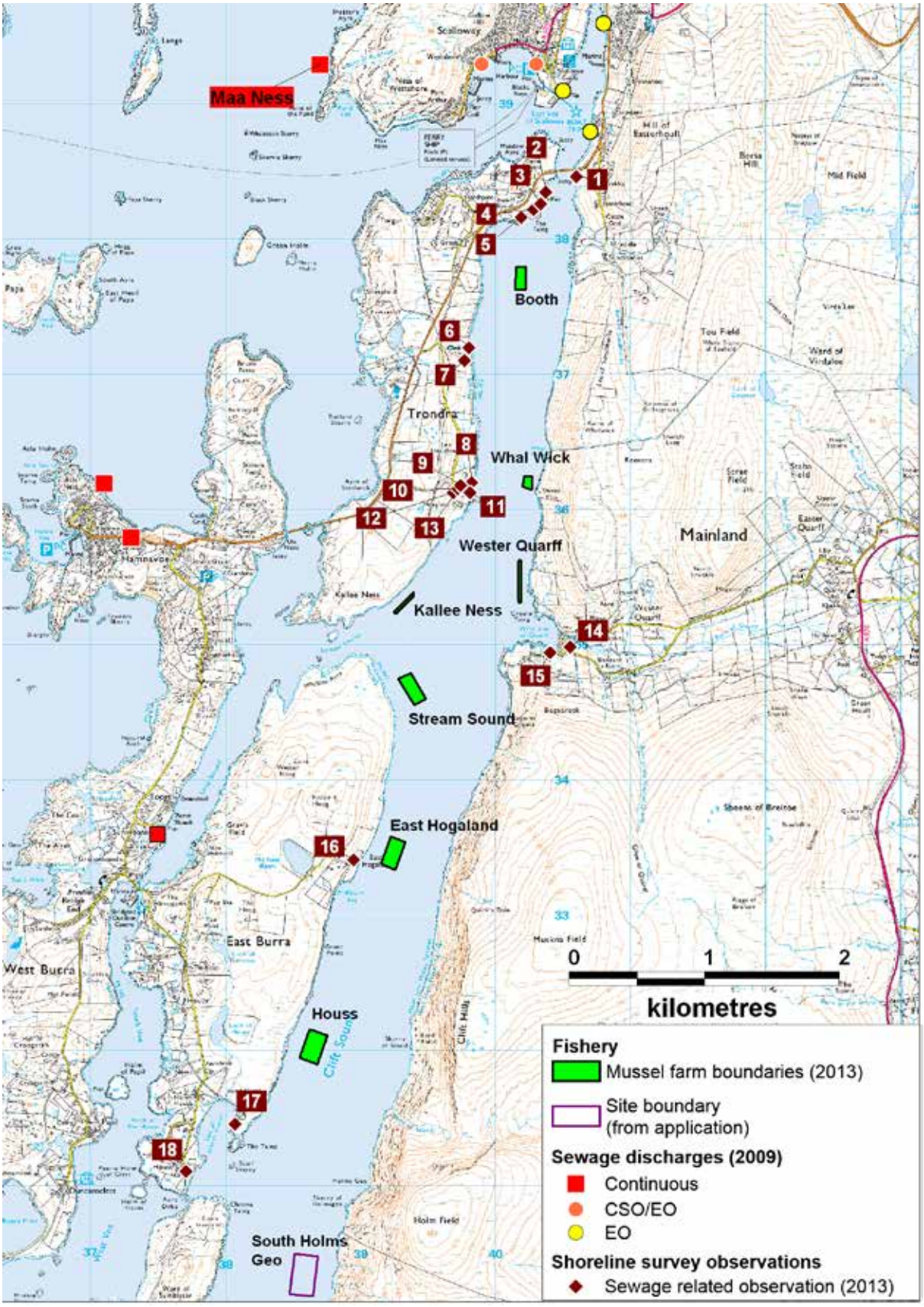

Figure 2.2 Map of public sewage discharge information from the 2007 sanitary survey report and 2013 shoreline survey observations

3. Farm Animal Population and Agricultural Impacts

No farm census data was provided by Scottish Government for the original sanitary survey report, as there were too few farms in the relevant parishes to ensure farm specific data could not be ascertained. That report therefore primarily considered the observations of the 2007 shoreline survey. For this review, additional information on agricultural based contamination sources has been obtained through a shoreline surveys conducted in 2013, and through a desk-based internet search. Shoreline survey observations only relate to the time of the surveys undertaken on the 4th & 5th September 2013. Figure 3.1 displays the locations of animals observed during the 2013 survey.

The 2007 sanitary survey report concluded that sheep represented a significant source of contamination to all of the fisheries, owing to their widespread distribution and shore access in many areas around the Sound. The contamination impacts were anticipated to be highest between May and September, when numbers are roughly double that in other periods (Shetland Agricultural Centre pers. comm.). Overall agricultural impacts were expected to be greatest at the southern extent of Whal Wick and northeast extent of Stream Sound fisheries; which were closest to the Wester Quarff area where there were significant areas of pasture and livestock (cattle and sheep) present in higher numbers than elsewhere.

The 2013 survey found sheep were still grazed widely around Clift Sound, with shore access specifically noted at Uradale (northeast), East Hogaland (southwest), and at Cutts (northwest). Cattle and sheep were seen on land at Wester Quarff, though were present in smaller numbers than noted in 2007. It was unclear whether this was due to seasonal variation or a decrease in the amount of kept livestock. Large numbers of sheep were also observed on land to the northwest of the voe, whilst modest numbers of poultry were also observed on land in southwest Trondra. Fewer ponies were observed to the northwest of the voe than had been seen in 2007. Horse faeces were also noted in the Wester Quarff area.

In 2013, a potato field and hay bales were noted at East Hogaland, with a cut hay field and hay bales also noted further south at Houss. Application of muck or slurry to the hay fields could potentially pose a risk of faecal contamination to the area, particularly if applied during or just before wet weather.

Uradale farm is located on the northeast side Clift Sound. In 2010 a total of 40 cattle were kept on the farm, with cows and calves kept housed during winter months (http://uradalefarm.blogspot.co.uk/p/uradale-farm.html). The farm also had 700 Shetland ewes. Lamb and beef is sold off each year between September and November.

Overall, highest contamination levels from agricultural sources are expected to enter from the northwestern extent of the area, which will have a significant impact on the

Booth fishery. This fishery will also be impacted from contamination entering from the eastern shore, from sheep kept on the foreshore. Sheep and poultry observed on the southern end of Trondra may also have some level of contamination impact on the Whal Wick fishery. Agricultural sources of faecal contamination are also expected to impact the southern end of the line at Wester Quarff, where it lies nearest agricultural land around the West Voe of Quarff. Although more spread out, there is still some agricultural activity around the shore to the west of the East Hogaland site and around the Voe of North Houss, to the southwest of the Houss site.

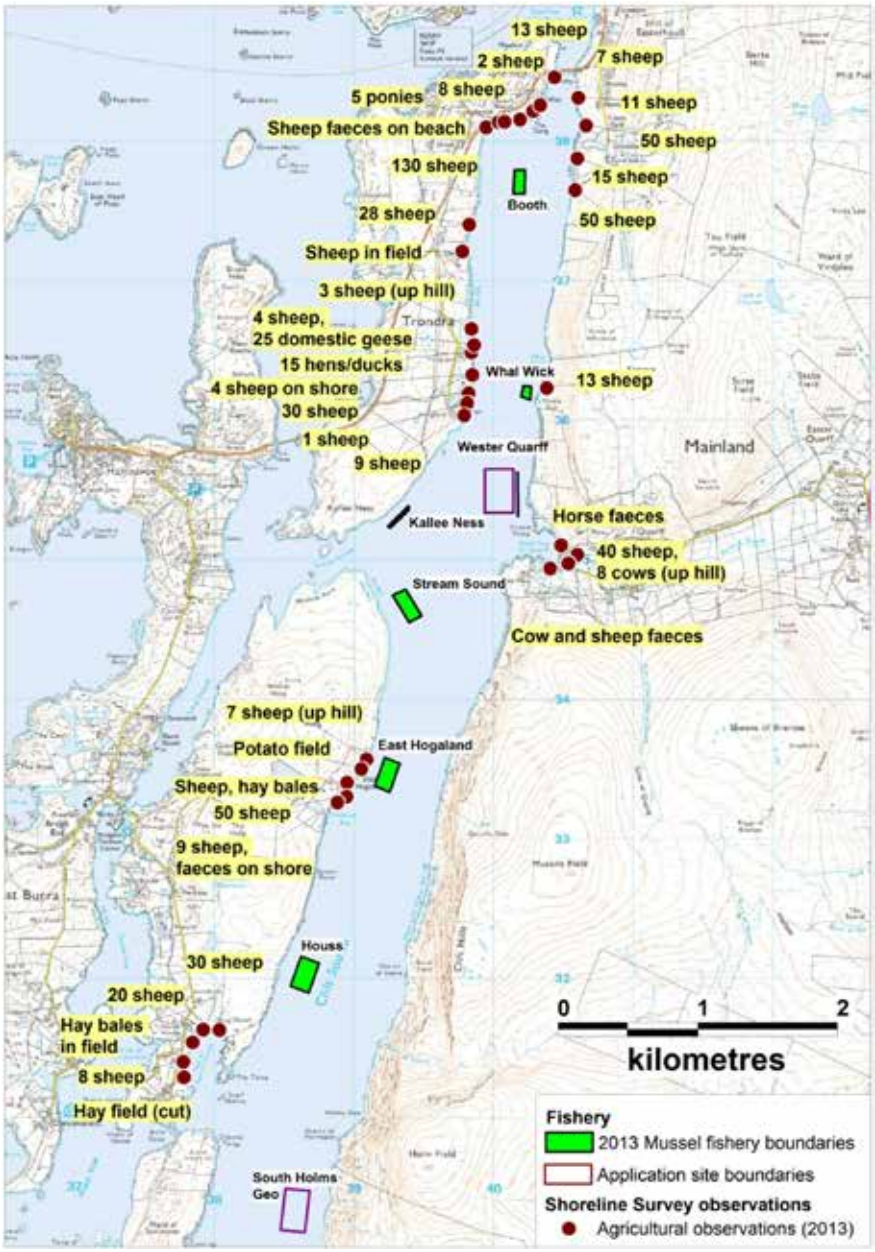

Figure 3.1 Map of farm animals and associated observations made during the 2013 shoreline survey

4. Wildlife

The 2007 sanitary survey report concluded that seabirds may contribute to faecal contamination at the mussel farms but that overall, the impact from wildlife was unpredictable.

For this review, information on pollution sources from wildlife has been obtained from Seabird 2000 data (Mitchell, et al., 2004), through shoreline surveys conducted in 2007 and 2013, and through a desk-based internet search. Shoreline survey observation information only relates to the time of the surveys undertaken in May and September 2007 and on the 4th & 5th September 2013. Wildlife observations are displayed in Figure 4.1.

Pinnipeds

Declines of up to 50% have now been documented in harbour seal populations around Shetland (Special Committee on Seals, 2012). In an aerial survey conducted in 2009, 3003 harbour seals were observed in Shetland, compared to 4883 seals seen in 2001(Special Committee on Seals, 2012). However, grey seal populations have been shown to be booming, with an estimated 3300 grey seal pups alone born in 2010 (Shetland and mainland Scotland) taken from aerial surveys (Special Committee on Seals, 2012). Grey seal colonies are mostly found along uninhabited, rocky shorelines but are shown to have very wide foraging ranges.

The Marine and Spatial Plan for the Shetland Islands (MSPS) (NAFC Marine Centre, 2012) highlights multiple common seal habitat areas are located less than 1 km southwest of Clift Sound, with another site located just south of the mouth of the sound (not included in Figure 4.1). No seals were observed during either shoreline survey.

Cetaceans

No records were found of whales or dolphins in Clift Sound, nor were these animals during either shoreline survey.

Seabirds

Seabird 2000 data for the entire Shetland area was presented in the 2007 report (Mitchell, et al., 2004). Observations specific to the area around Clift Sound are presented in Table 4.1 and displayed in Figure 4.1.

Table 4.1 Seabird 2000 census data for Clift Sound

Common name	Species	Count*	Type
Great black-backed gull	*Larus marinus*	140	Occupied territory and nests, Individuals on land
Common gull	*Larus canus*	107	Occupied territory and nests, individuals on land
Black headed gull	*Larus ridibundus*	8	Occupied territory and nests, individuals on land
European herring gull	*Larus argentatus*	778	Occupied territory and nests, individuals on land
Lesser black-backed gull	*Larus fuscus*	41	Individuals on land
Black guillemot	*Cepphus grylle*	160	Individuals on land
Northern fulmar	*Fulmarus glacialis*	2554	Occupied sites
Great skua	*Stercorarius skua*	155	Occupied territory
Parasitic jaeger	*Stercorarius parasiticus*	40	Occupied territory
Arctic tern	*Sterna paradisaea*	977	Occupied nests and individuals on land
European shag	*Phalacrocorax aristotelis*	41	Occupied nests and sites
Black legged kittiwake	*Rissa tridactyla*	244	Occupied nests

*Counts for occupied nests, sites and territory were doubled, with total counts given using the adjusted data.

The Seabird 2000 data identifies that Northern fulmars are the most common seabird reported around Clift Sound, with Arctic terns being the second most common. Many of the seabirds were noted at occupied nests, indicating that these populations may experience seasonal increases during the summer breeding season, which largely occurs between the months of May and September. During this time it is expected that the contamination impacts from birds would increase in fisheries located close to these breeding colonies.

The largest bird colonies were located along the west of Clift Sound, specifically at West Burra, where colonies of Northern fulmar, European herring gull and black-legged kittiwake were significant.

The MSPS indicates that there is a large amount of seabird habitat in the areas surrounding Clift Sound, but similarly highlights that the vast majority is located at West Burra (NAFC Marine Centre, 2012). The MSPS also highlights that the Clift Sound area is also has significant habitat for eider ducks, as well as other duck species.

Birds were the most common wildlife observed during the 2013 shoreline survey. Gulls were the most commonly observed (58 in total). Birds were observed on buoys at fisheries, in water, in flight or on fields adjacent to the shore. A significant number of shags were observed at Stream Sound fishery. Eider ducks were observed in water in the Wester Quarff area, with crab carcasses and shellfish shells on shore suggesting a feeding area.

Otters

There is a significant population of European Otters (*Lutra lutra*) present in Shetland. However, there is no identified otter habitat immediately around Clift Sound. No otters were observed during the 2013 shoreline survey.

Rabbits

Twenty-five rabbits were observed around the shoreline, with large numbers observed southwest of Trondra and at East Hogaland. 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). These observations have therefore not been included in Figure 4.1 as the rabbits should not normally pose a contamination risk to the fisheries.

Conclusions

Overall the wildlife impacts have been reassessed since the 2007 report, due to the availability of more specific data for the Clift Sound area. Impacts from birds continue to be the most significant contamination source entering the sound, with the largest colonies located at West Burra. Although fewer birds are known to inhabit areas immediately adjacent to the sound, it is likely that birds will use the entire Clift Sound area to forage and feed. Ducks and seals may also make significant contributions: again there are not expected to be significant differences in the level of impact between and across the various aquaculture sites.

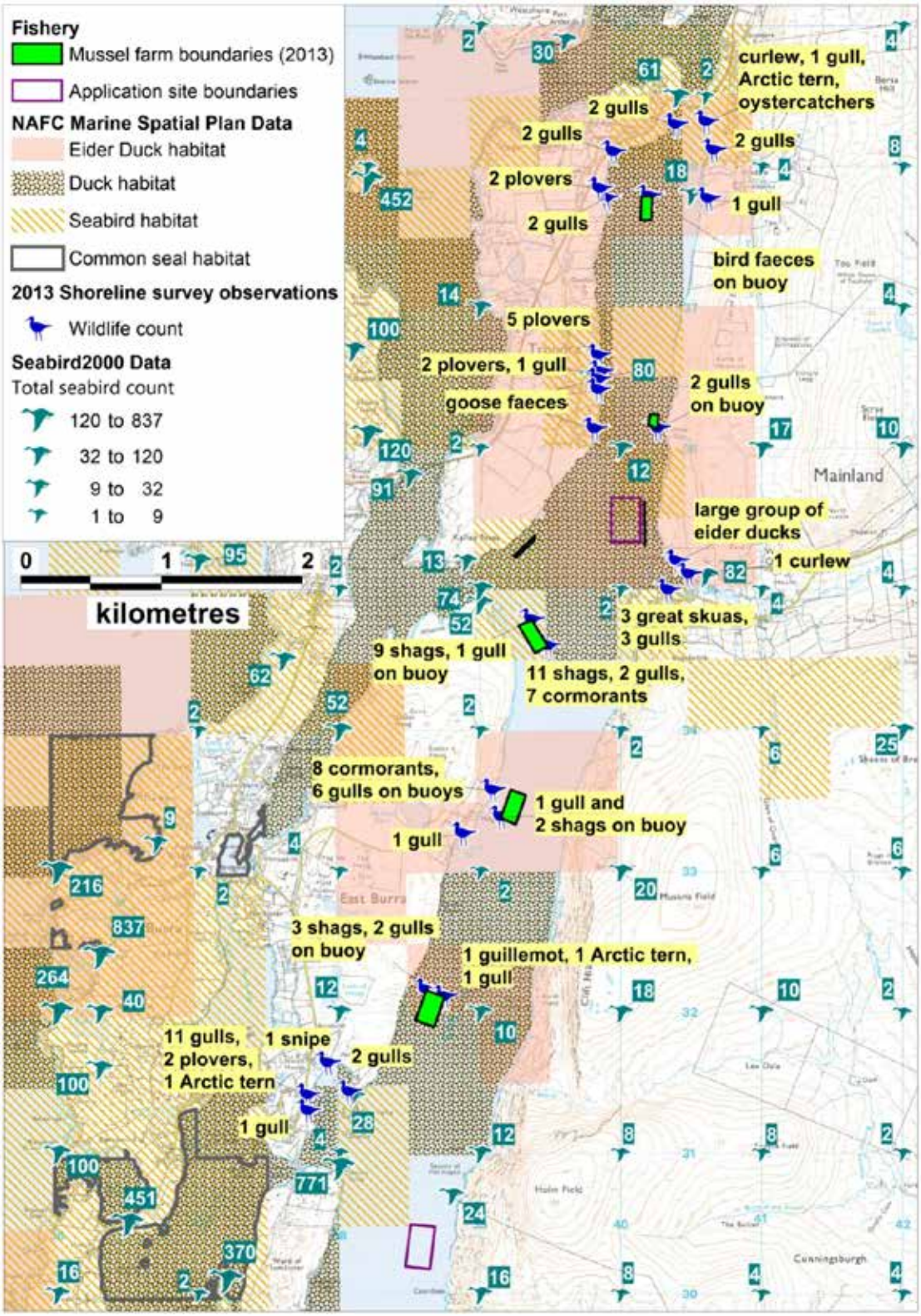

Figure 4.1 Map of wildlife around Clift Sound, including observations made during the 2013 shoreline survey

5. Watercourses

Only two watercourses were measured and sampled during the 2007 shoreline survey. The 2007 sanitary survey report concluded that a stream at the East Voe of Scalloway could impact on the microbiological quality of the mussel farm at Booth and that the Burn of Quarff could potentially impact the Stream Sound and Whal Wick sites.

For this review, information on the flows and microbiological loadings of watercourses estimated from the 2007 and 2013 shoreline surveys have been compared. Rainfall experienced during the shoreline surveys were as follows: dry and sunny in 2007 and mostly dry except for light showers on the second day of surveying in 2013.

A comparison of watercourse loadings estimated on the basis of the 2007 and 2013 shoreline survey measurements and *E. coli* concentrations is shown in Table 5.1. Watercourse loadings calculated from the 2013 survey measurements and results are displayed in Figure 5.1.

Only one of the two watercourses measured and sampled in the 2007 shoreline survey, was re-sampled during the 2013 shoreline survey. Nine additional freshwater inputs were measured and sampled in 2013 and a full list of flow measurements and sample results can be found in Appendix 2. Four areas of bog and five areas of land drainage were also noted during the 2013 survey.

Table 5.1 Watercourse loadings to Clift Sound estimated from measurements made during the 2007 and 2013 shoreline surveys

No.[1]	Description	NGR	2007 Loading (*E. coli* / day)	2013 Loading (*E. coli* / day)
-	Stream - East Voe of Scalloway	HU 4080 3995	$1.5x10^{10}$	-
1	Burn of Sundibanks	HU 4062 3778	-	$2.5x10^{9}$
2	Large watercourse	HU 4060 3788	-	$1.4x10^{9}$
3	Field drainage	HU 4064 3805	-	$2.3x10^{8}$
4	Burn of Quarff	HU 4060 3505	$3.8x10^{9}$	$1.0x10^{11}$
5	Small watercourse	HU 3804 3164	-	$7.1x10^{9}$
6	Very small watercourse	HU 3785 3155	-	$3.5x10^{9}$
7	Mill Pond Reservoir drainage	HU 3879 3318	-	$1.5x10^{9}$
8	Small watercourse	HU 3978 3722	-	$1.6x10^{9}$
9	Small watercourse	HU 3984 3649	-	$1.7x10^{8}$
10	Small watercourse	HU 3986 3785	-	$4.5x10^{9}$

[1]Numbers relate to those given in the labels in Figure 5.1

The loading for the Burn of Quarff in 2013 was much greater than that in 2007. This watercourse is expected to have the greatest impact on the southern extent of the Wester Quarff mussel farm which is located less than 500 m northeast of the mouth of the burn. There may also be some impact on the Whal Wick, Stream Sound and Kallee Ness sites.

Loadings calculated for the nine other watercourses observed in the 2013 shoreline survey showed low to moderate contamination levels. However, five of these are located within 600 m of the Booth mussel farm and therefore freshwater-borne contamination may have a significant impact at this site. Additional areas of land drainage and bog observed in the area may also represent sources during and following heavy rainfall. Direct run-off from steep hillsides, may also be important during such conditions.

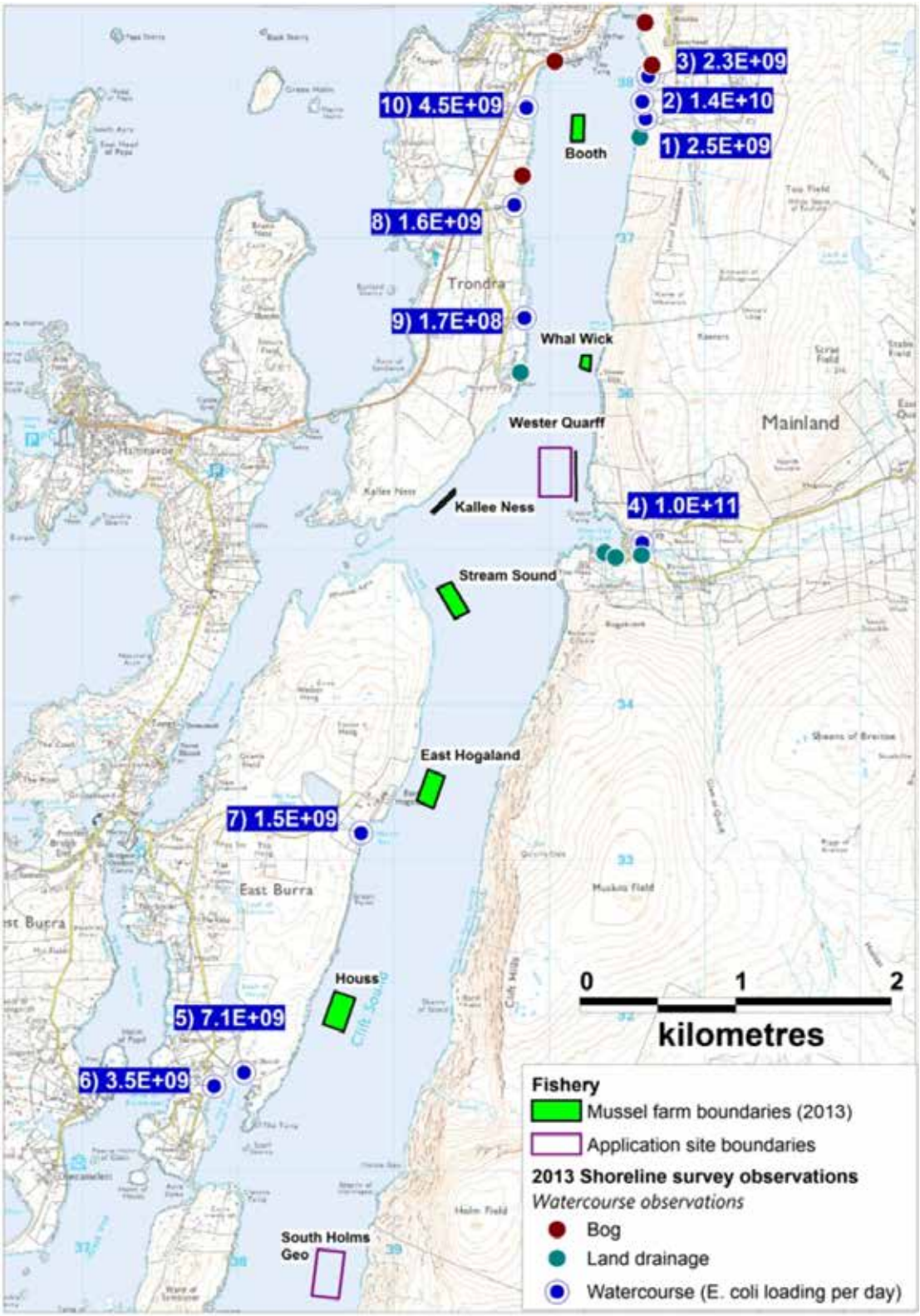

Figure 5.1 Watercourse loadings at Clift Sound, 2013 shoreline survey

Where the bacterial loading is labelled on the map, the scientific notation is written in digital format, as this is the only format recognised by the mapping software. So, where normal scientific notation for 1000 is $1x10^3$, in digital format it is written as 1E+03.

6. Meteorological data

Meteorological data had been purchased from the Meteorological Office for the survey period 01/01/2003 – 31/12/2006 for the analyses undertaken for the 2007 Clift Sound Sanitary Survey Report: rainfall box-plots and wind roses for 2003-2006 period are presented in that report and have not been reproduced here. Rainfall was recorded in total daily rainfall (mm) were taken from the Lerwick weather station, which lies 5 km NE of the Clift Sound production areas. Wind roses were also taken from the Lerwick weather station.

Meteorological data for this Review was purchased from the Meteorological Office in April 2013 for the period 01/01/2007 – 31/12/2012. Rainfall data from Lerwick was available for all of the survey days.

6.1 Rainfall

Storm events and high rainfall levels are commonly associated with increased faecal contamination of coastal waters through surface water run-off from land where livestock or wild animals are present and through sewer and waste water treatment plant (WWTP) overflows (Mallin, et al., 2001): (Lee & Morgan, 2003).

The Lerwick weather station rainfall dataset for 2007-2012 is presented by year in Figure 6.1 and by month in Figure 6.2.

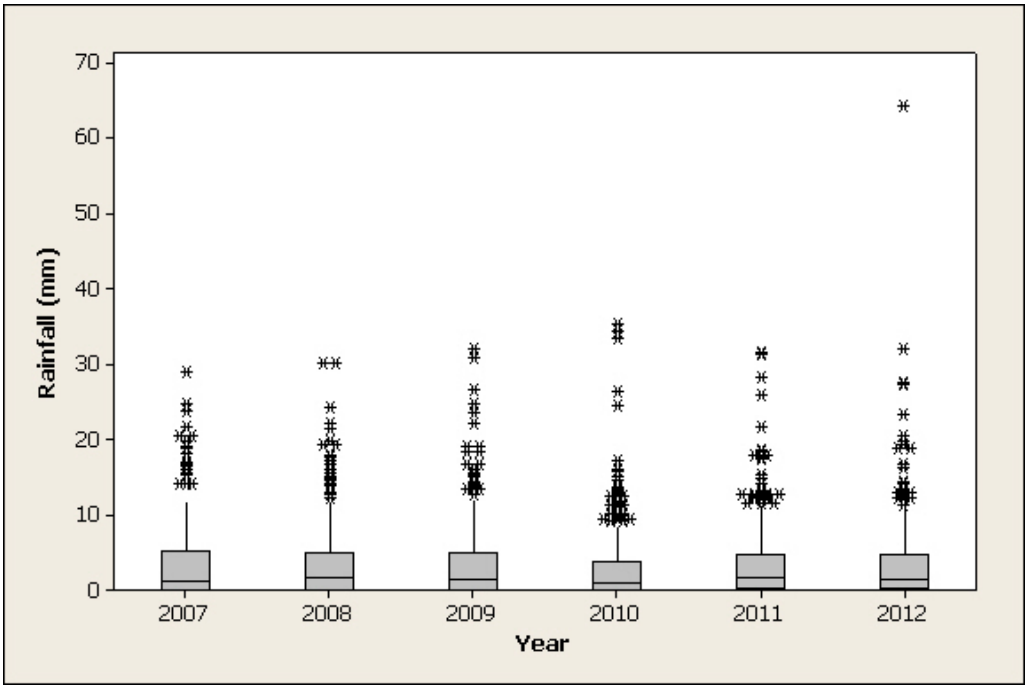

Figure 6.1 Boxplot of daily rainfall at Lerwick by year (2007-2012)

In both the 2003-2006 data set analysed in the 2007 sanitary survey report, and the 2007-2012 data set presented here, the majority of rainfall values were less than 10 mm/day. In the 2003-2006 period, there were wetter and drier years, with 2003 (1125 mm/yr) being

drier than 2005 (1358 mm/yr). This trend was similarly seen in the 2007 to 2012 period, with 2010 being the driest year (a total of 1085 mm) and 2009 the wettest (1284 mm), which were slightly lower than the highest and lowest rainfall levels in 2003-2006 dataset. High daily rainfall values of greater than 30 mm/d occurred in all years during this second period and an extreme rainfall event of nearly 70 mm/d was seen in 2012.

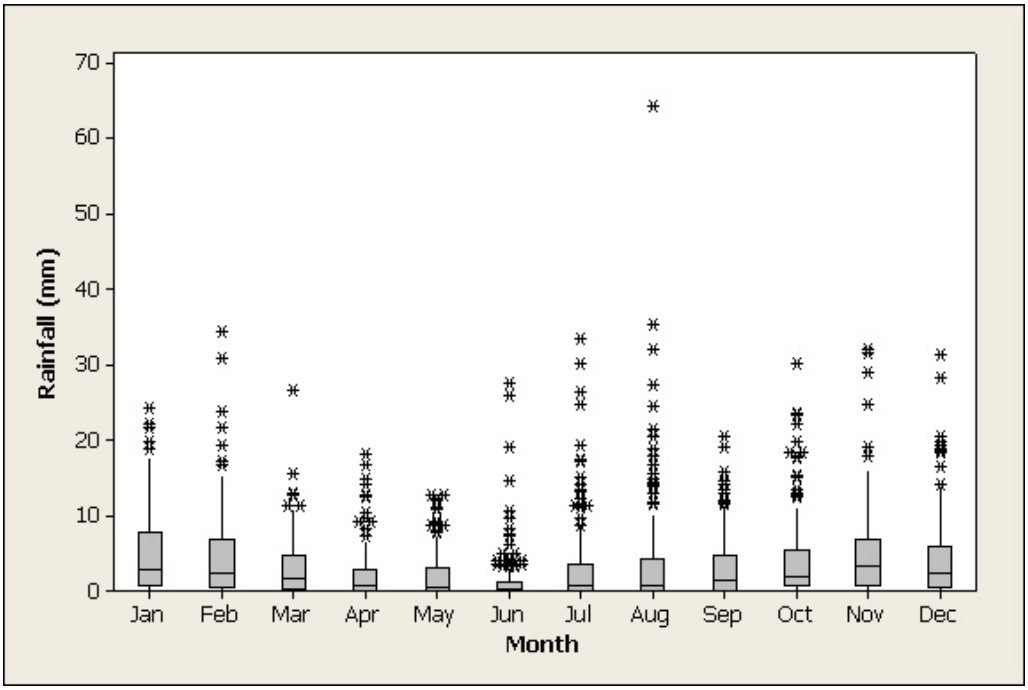

Figure 6.2 Boxplot of daily rainfall at Lerwick by month (2008-2012)

The 2003-2006 period showed a marked difference in rainfall by season, with October to January the wettest months, and April, May and July the driest. For 2007-2012, rainfall was lowest from April to June and highest from November to February. Rainfall values exceeding 30 mm/d were seen in February, July, August, October, November and December. The 2012 extreme event occurred in August.

6.2 Wind

Wind speed and direction drive surface water and currents that play an integral part in particulate dispersal. Winds typically drive surface water at ca. 3% of the wind speed (Brown, 1991) so a gale force wind (a minimum of 34 knots/17.2 m/s) would drive a surface water current of about 1 knot or 0.5 m/s.

Figure 6.3 shows seasonal wind roses for Lerwick for the period 2002-2011 while Figure 6.4 shows the annual wind rose for the same period. The local topography of steep cliffs and direction of Clift Sound is likely to cause a variation in wind patterns to those shown in the wind roses (Lerwick is located on the east coast of mainland Shetland, whilst Clift Sound is on the west coast).

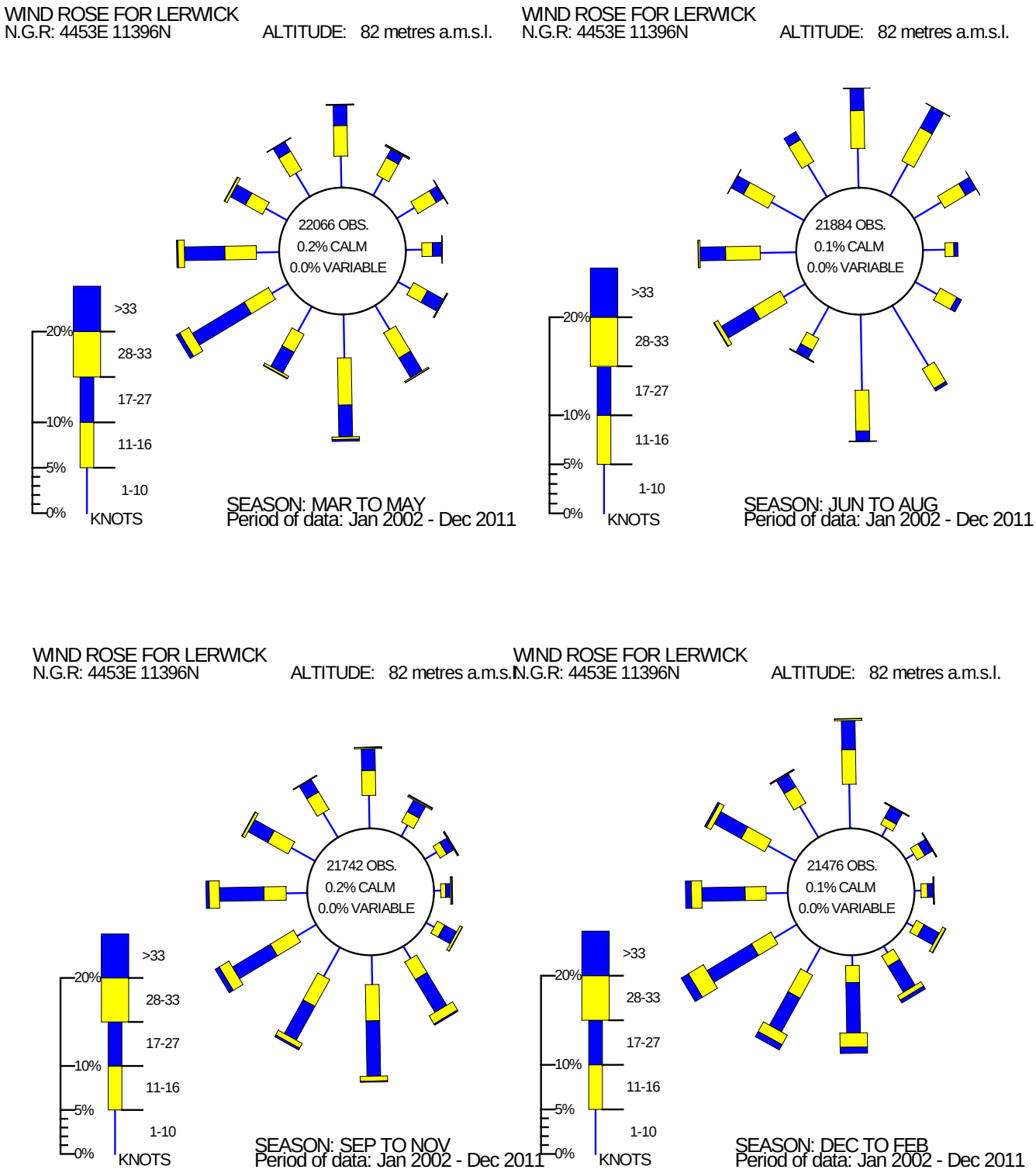

Figure 6.3 Seasonal wind roses for Lerwick (2002-2011)

Prevailing winds throughout all four seasons are between south and south-westerly particularly in autumn and winter. Strong north and north-easterly winds also occurred in summer. This is trend is seen in both datasets from 1996-2005 and 2002-2011.

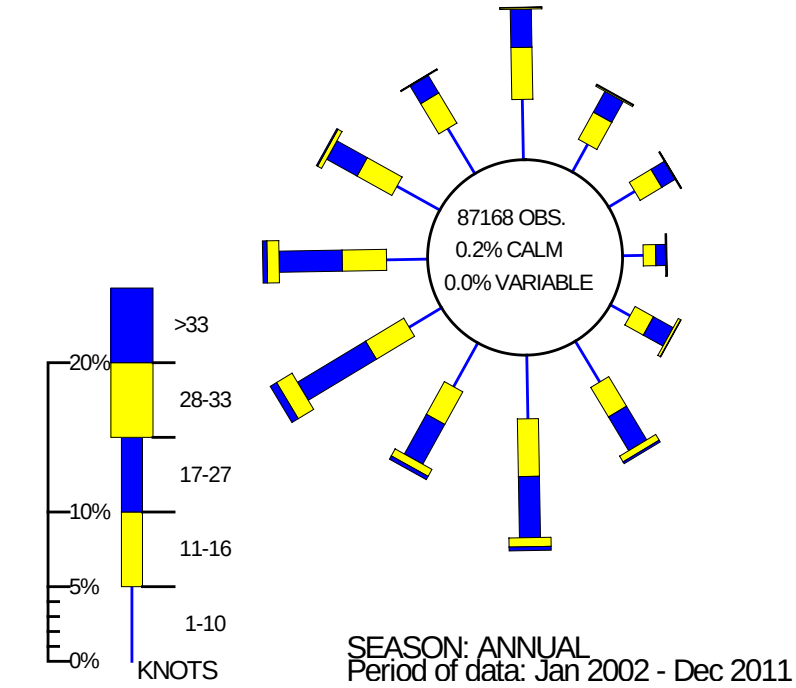

Figure 6.4 Annual wind rose for Lerwick (2002-2011)

The wind rose in Figure 6.4 shows that the overall prevailing annual wind direction is from the south and west. Winds are generally lighter during the summer months and strongest in the winter. Clift Sound is relatively sheltered by the steep sided cliffs around it, but is expected to be exposed to significant winds which are likely to aid dispersion as well as transport of faecal contaminants.

7. Historical *E. coli* Data

Results for Clift Sound sites Booth, Whal Wick, Stream Sound, East Hogaland, and Houss between 01/01/2007 and 31/10/2013 were extracted from the FSAS database and validated according to the criteria described in the standard protocol for validation of historical *E. coli* data. Data was extracted from the database in October 2013. Historical *E. coli* data used in the 2007 report had already been extracted and validated. For the purposes of this report, results from samples pre-dating 2001 were excluded. All *E. coli* results were reported as most probable number per 100 g of shellfish flesh and intravalvular fluid.

E. coli results recorded as 19/<20 were reassigned a value of 10 *E. coli* MPN/100 g and all results recorded as >18000 or 18100 were reassigned values of 36000 *E. coli* MPN/100 g for the purposes of statistical evaluation and graphical representation.

Clift Sound: Booth

Two samples recorded as rejected and one sample with a void result were excluded from further analysis. The remaining 71 samples were all received at the laboratory within 24 hours of collection and plotted within the production area. One sample did not have a box temperature recorded.

Clift Sound: Whal Wick

One sample was recorded as rejected and was excluded from further analysis. The remaining 71 samples were all received at the laboratory within 24 hrs of collection and plotted within the production area. One sample did not have a box temperature recorded.

Clift Sound: Stream Sound

One sample recorded as rejected and one sample with a void result were excluded from further analysis. The remaining 72 samples were at the laboratory within 24 hrs of collection and plotted within the production area. One sample did not have a box temperature recorded.

Clift Sound: East Hogaland

One sample recorded as rejected and one sample with a void result were excluded from further analysis. The remaining 70 samples were all received at the laboratory within 24 hrs of collection and plotted within <100 m of the production area.

Clift Sound: Houss

One sample was recorded as rejected and was excluded from further analysis. The remaining nine samples were all received at the laboratory within 24 hrs of collection.

7.1 Summary of microbiological results

Summary results for all sampled sites within Clift Sound are displayed in Table 7.1 to 7.5.

Table 7.1 Sampling summary results for Booth 2004-2013

Sampling Summary				
Production area	Clift Sound: Booth			
Site	Booth			
Species	common mussels			
SIN	SI-036-413-08			
Location	Various			
Years	2004-2006		2007-2013	
Total no. of samples	27		71	
	2004	7	2007	9
	2005	11	2008	9
	2006	9	2009	9
			2010	11
			2011	11
			2012	12
			2013	10
Results Summary				
Minimum	<20		<20	
Maximum	750		>18000	
Median	20		40	
Geometric mean	27		44	
90 Percentile	150		330	
95 Percentile	574		616	
No. Exceeding 230/100g	2 (7%)		9 (13%)	
No. Exceeding 1000/100g	0		2 (3%)	
No. Exceeding 4600/100g	0		1 (1%)	
No. Exceeding 18000/100g	0		1 (1%)	

Table 7.2 Sampling summary results for Whal Wick 2003-2013

Sampling Summary				
Production area	Clift Sound: Whal Wick			
Site	Whal Wick			
Species	Common mussels			
SIN	SI-038-416-08			
Location	Various			
Years	2003-2006		2007-2013	
Total no. of samples	41		71	
	2003	7	2007	8
	2004	11	2008	9
	2005	11	2009	9
	2006	12	2010	12
			2011	11
			2012	12
			2013	10
Results Summary				
Minimum	<20		<20	
Maximum	220		490	
Median	20		20	
Geometric mean	29		27	
90 Percentile	110		130	
95 Percentile	155		194	
No. Exceeding 230/100g	0		2 (3%)	
No. Exceeding 1000/100g	0		0	
No. Exceeding 4600/100g	0		0	
No. Exceeding 18000/100g	0		0	

Table 7.3 Sampling summary results forStream Sound 2007-2013

Sampling Summary				
Production area	Clift Sound: Stream Sound			
Site	Stream Sound			
Species	Common mussels			
SIN	SI-037-415-08			
Location	Various			
Years	2001-2006		2007-2013	
Total no. of samples	44		72	
	2001	4	2007	9
	2002	8	2008	9
	2003	8	2009	9
	2004	6	2010	12
	2005	7	2011	11
	2006	11	2012	12
			2013	10
Results Summary				
Minimum	<20		<20	
Maximum	9100		490	
Median	40		<20	
Geometric mean	45		20	
90 Percentile	265		110	
95 Percentile	3225		191	
No. Exceeding 230/100g	4 (9%)		2 (3%)	
No. Exceeding 1000/100g	3 (7%)		0	
No. Exceeding 4600/100g	1 (2%)		0	
No. Exceeding 18000/100g	0		0	

Table 7.4 Sampling summary results for East Hogaland 2007-2013

Sampling Summary		
Production area	Clift Sound	
Site	East Hogaland	
Species	Common mussels	
SIN	SI-035-414-08	
Location	Various	
Years	2007-2013	
Total no. of samples	70	
	2007	8
	2008	9
	2009	9
	2010	12
	2011	10
	2012	12
	2013	10
Results Summary		
Minimum	<20	
Maximum	490	
Median	<20	
Geometric mean	20	
90 Percentile	70	
95 Percentile	130	
No. Exceeding 230/100g	2 (3%)	
No. Exceeding 1000/100g	0	
No. Exceeding 4600/100g	0	
No. Exceeding 18000/100g	0	

Table 7.5 Sampling summary results for Houss 2013

Sampling Summary	
Production area	Clift Sound: Houss
Site	Houss
Species	Common mussels
SIN	SI-633-1270-08
Location	Various
Total no. of samples	9
2013	9
Results Summary	
Minimum	<20
Maximum	130
Median	20
Geometric mean	23
90 Percentile	130
95 Percentile	130
No. Exceeding 230/100g	0
No. Exceeding 1000/100g	0
No. Exceeding 4600/100g	0
No. Exceeding 18000/100g	0

Between 2001 and 2006, Stream Sound yielded the highest *E. coli* result and most results >230 *E. coli* MPN/100 g. Comparatively, between 2007-2013 the highest result (>18000 *E. coli* MPN/100 g) and most results >230 *E. coli* MPN /100 g were seen at Booth. There appeared to be a slight change at Whal Wick which yielded a small increase in *E. coli* levels with two results >230 *E. coli* MPN/100 g between 2007 and 2013 compared to none between 2001 and 2006. All sample results at Houss were <230 *E. coli* MPN/100 g.

All sites have been class A across all months since 2007, except for Booth which was class B in January and February 2007.

7.2 Geographical patterns of results

Comparison between sites

Table 7.6 displays some of the summary statistics from Tables 7.1 to 7.4 to allow direct comparison of the extent of contamination at the four sites that had been monitored over the period 2007-2013.

Table 7.6 Comparison of selected summary statistics from four sites (2007-2013)

Site	Minimum	Maximum	Median	90%ile
Booth	<20	>18000	40	330
Whal Wick	<20	90	20	130
Stream Sound	<20	490	<20	110
East Hogaland	<20	490	<20	70

The median and 90%-ile values show that the level of contamination at Booth is slightly higher overall than at the other sites represented in Table 7.6. The maximum result seen at Booth is markedly higher than those seen at the other sites. Two results >1000 *E. coli* MPN/100 g were seen at Booth over the period in question while none was seen at the other three sites.

Comparison within sites

The locations of all samples taken between 01/01/2007 and 31/10/2013 assigned to Booth and Whal Wick fisheries are displayed in Figure 7.1. The size of the symbols is proportional to the magnitude of the *E. coli* result.

Two main areas have been sampled at the Booth fishery: one area immediately west of the RMP on the northwest side of the farm (42 samples) and the other to the south of this on the western edge of the farm. The highest result (>18,000 *E. coli* MPN/100 g) was seen in a sample taken within the latter area.

Three main areas have been used for sampling at the Whal Wick fishery: an area 160 m northeast of the RMP, one in the vicinity of the RMP at the present southern extent of the farm (33 samples) and another to the south of this (32 samples). The

three results ≥230 *E. coli* MPN/100 g were all associated with samples taken within the latter area.

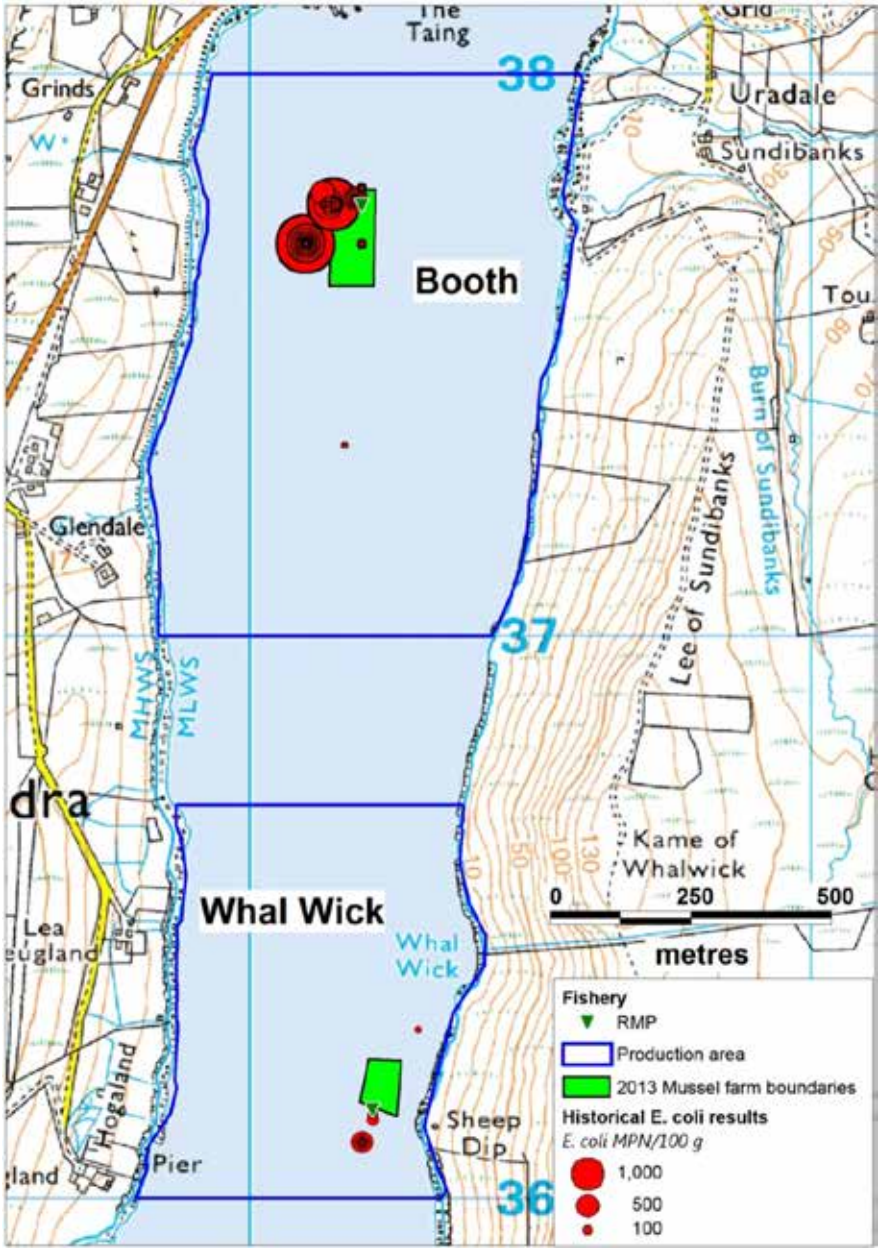

Figure 7.1 Sample results and locations of Booth and Whal Wick common mussel fisheries

The locations of all samples taken between 01/01/2007 and 31/10/2013 and assigned to East Hogaland, Stream Sound and Houss fisheries are displayed in Figure 7.2. The size of the symbols is proportional to the magnitude of the *E. coli* result.

Two main areas have been sampled at Stream Sound: an area in the vicinity of the RMP at the northern end of the lines (26 samples) and an area at the southwestern corner of the farm (39 samples). The highest result of 490 *E. coli* MPN/100 g was taken in the latter area.

The majority of samples (54 samples) at East Hogaland have been taken within 70 m of the northern RMP (HU 3926 3353). No samples have been taken at the southern RMP (HU 3919 3336) though 14 samples were taken in the vicinity of the southern extent of the farm. The highest result was associated with a sample taken in the northern area of sampling on 06/08/2008.

The current RMP (HU 3850 3197) at the Houss fishery lies approximately 50 m west of the present farm location. All samples recorded against locations at the southwestern corner of the farm close to the RMP. Distances between sampling locations were too small to justify further assessment.

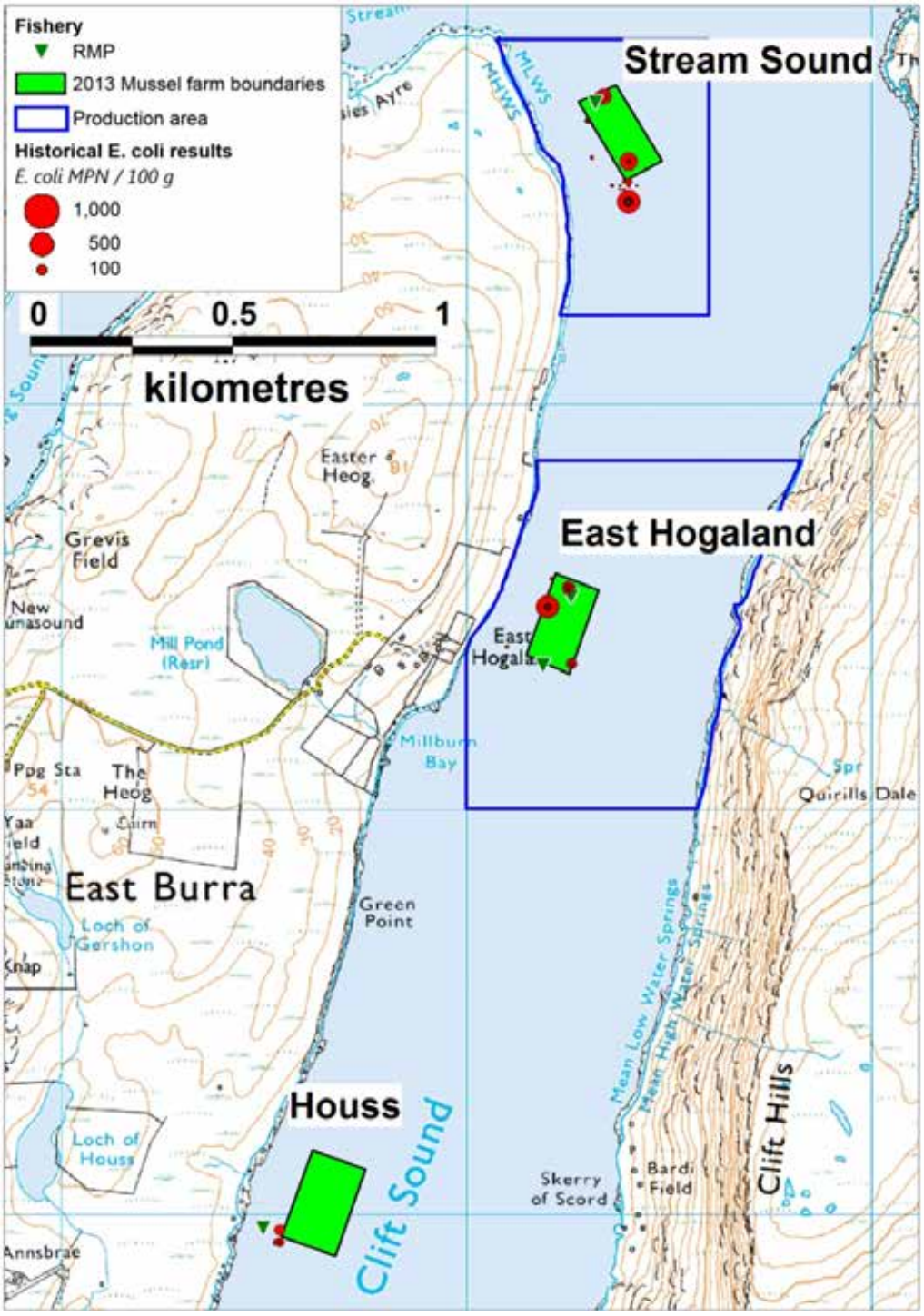

Figure 7.2 Sample results and locations of Stream Sound, East Hogaland and Houss common mussel fisheries

7.3 Temporal patterns of results

The trends of *E. coli* sampling results for all five of the production areas in Clift Sound, have been analysed for the years between the previous sampling period (2001-2006) and the current sampling period (2007-2013).

In order to test for significant differences between samples taken over the two sampling periods, the following statistical analyses were carried out on the statistical software package Minitab:

A two sample t-test (using $\log_{10}$ transformed *E. coli* data) to determine whether there was a statistically significant difference between *E. coli* results between the two sampling periods.

A Fisher's Exact Test to test for a significant difference in the observed and expected *E. coli* results above the critical levels of 230 and 1000 *E. coli* MPN/ 100 g from both sampling periods. This test was used instead of a Chi-squared test as two cells had expected counts at less than five in the three sites that had been results from both sampling periods.

Temporal trends for all five sites are displayed in Figures 7.3-7.7, followed by results from the t-test and Fisher's Exact Test. The figures are fitted with lowess trend lines. These allow for locally weighted regression scatter plot smoothing. At each point in the dataset an estimated value is fitted to a subset of the data, using weighted least squares. The approach gives more weight to points near to the x-value where the estimate is being made and less weight to points further away. In terms of the monitoring data, this means that any point on the lowess line is influenced more by the data close to it (in time) and less by the data further away. A trend line helps to highlight any apparent underlying trends or cycles.

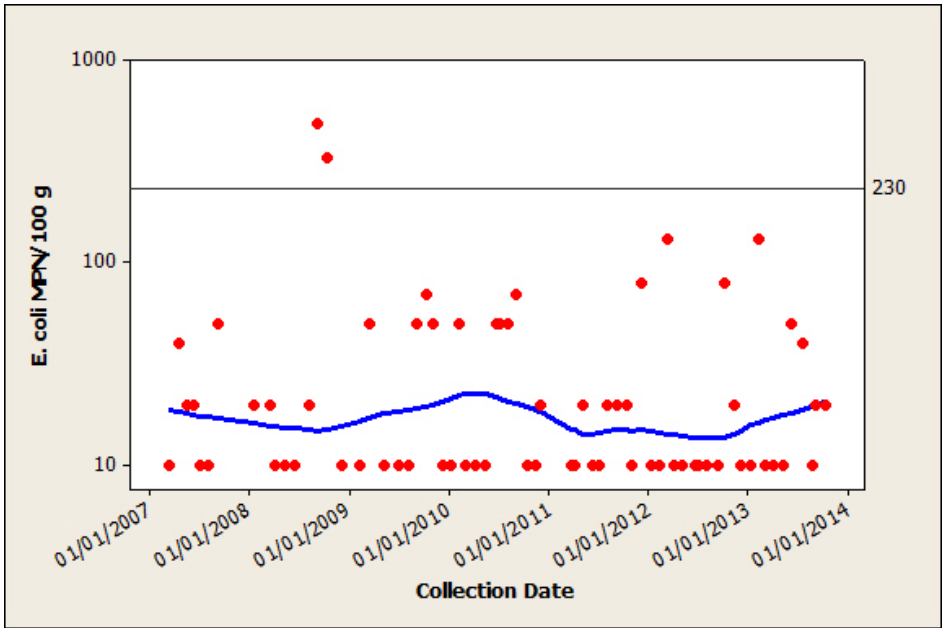

Figure 7.3 Scatterplot of East Hogaland *E. coli* results by date (2001-2013)

Contamination levels at East Hogaland have been predominantly low across the sampling period, with the majority of sample results <100 *E. coli* MPN/100 g.

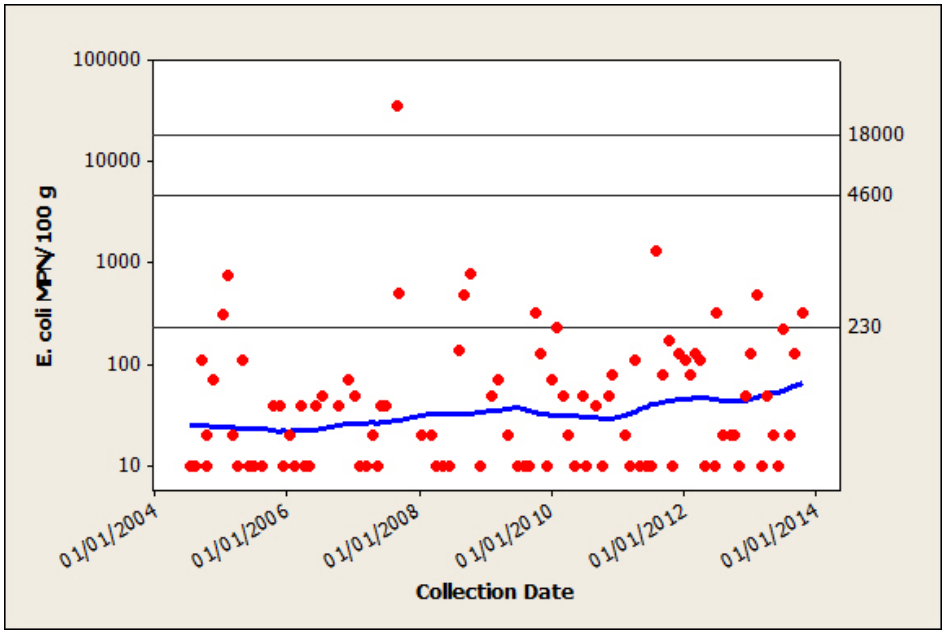

Figure 7.4 Scatterplot of Booth *E. coli* results by date (2001-2013)

Contamination levels across the sampling period at Booth have shown gradually very slight increase, despite the majority of results continuing to be low at <100 *E. coli* MPN/100 g. The highest result, >18000 *E. coli* MPN/100 g, was from a sample taken in 2007 .

No significant difference was found between Booth common mussel log transformed *E. coli* results from the two survey periods (Two sample t-test, t = -1.60, DF = 62, p = 0.114).

Table 7.7 Results above and below 230 and 1000 *E. coli* MPN /100 g at Booth

		E. coli MPN/100g			*E. coli* MPN/100g		
		≤230	>230	**Total**	≤1000	>1000	**Total**
2001-2007	Observed	25	2	27	27	0	27
2008-2013	Observed	62	9	71	69	2	71
	Total	87	11	98	96	2	98

No statistically significant difference was found between sampling results ≤230 and >230 *E. coli* MPN/100 g between sampling periods (Fisher's Exact Test, p = 0.722).

No statistically significant difference was found between sampling results ≤1000 and >1000 *E. coli* MPN/100 g between sampling periods (Fisher's Exact Test, p = 1).

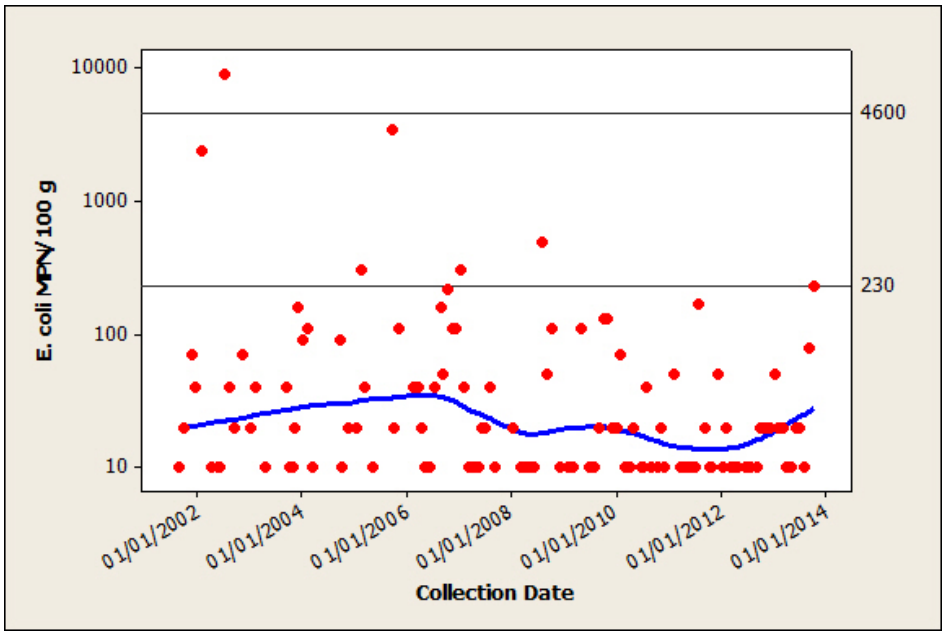

Figure 7.5 Scatterplot of Stream Sound *E. coli* results by date (2001-2013)

Contamination levels at Stream Sound have varied somewhat over the sampling period, and the number of results below the limit of detection has increased over time. The three highest results (>1000 *E. coli* MPN/100 g) were from samples taken in 2002 and 2005, and there have been no results >230 *E. coli* MPN/100 g since 2008.

A significant difference was found between Stream Sound common mussel log transformed *E. coli* results from the two survey periods (Two sample t-test, t = 3.07, DF = 62, p = 0.003). Higher results were generally taken in the 2001-2006 sampling period.

Table 7.8 Results above and below 230 and 1000 *E. coli* MPN /100 g at Stream Sound

	E. coli MPN/100g			*E. coli* MPN/100g		
	≤230	>230	**Total**	≤1000	>1000	**Total**

2001-2007	Observed	40	4	44	41	3	44
2008-2013	Observed	70	2	72	72	0	72
	Total	110	6	116	113	3	116

No statistically significant difference was found between sampling results ≤230 and >230 *E. coli* MPN /100 g between sampling periods (Fisher's Exact Test, p = 0.198).

No statistically significant difference was found between sampling results ≤1000 and >1000 *E. coli* MPN/100 g between sampling periods (Fisher's Exact Test, p = 0.052).

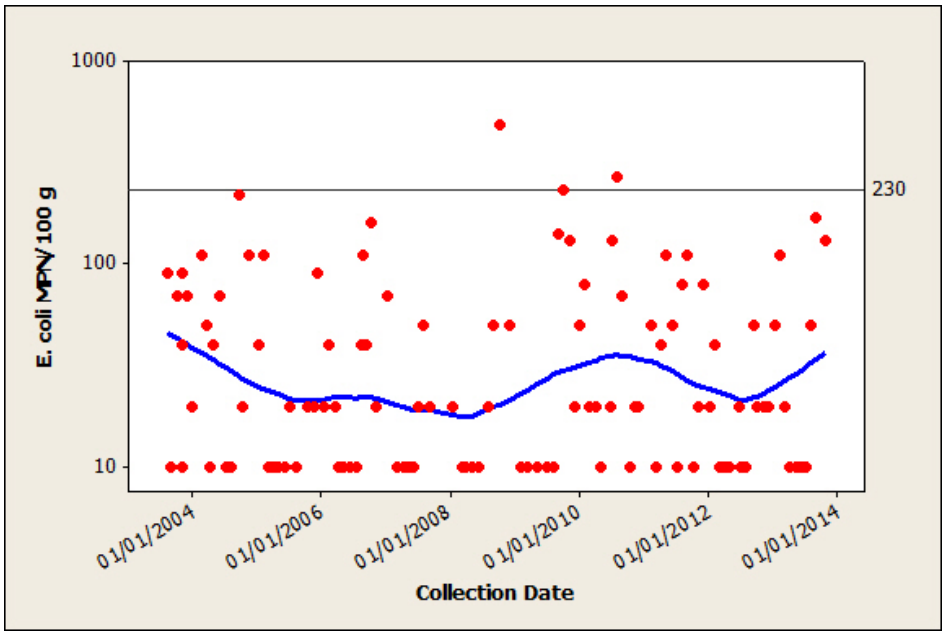

Figure 7.6 Scatterplot of Whal Wick *E. coli* results by date (2001-2013)

Results have been generally low across the sampling period, with only slight variations in the trend line.

No significant difference was found between Whal Wick common mussel log transformed *E. coli* results from the two survey periods (Two sample t-test, t = 0.38, DF = 87, p = 0.708).

Table 7.9 Results above and below 230 and 1000 *E. coli* MPN /100 g at Whal Wick

		***E. coli* MPN/100g**		
		≤230	>230	**Total**
2001-2007	Observed	41	0	41
2008-2013	Observed	69	2	71
	Total	110	2	112

No statistically significant difference was found between sampling results ≤230 and >230 *E. coli* MPN/100 g between sampling periods (Fisher's Exact Test, p = 0.531).

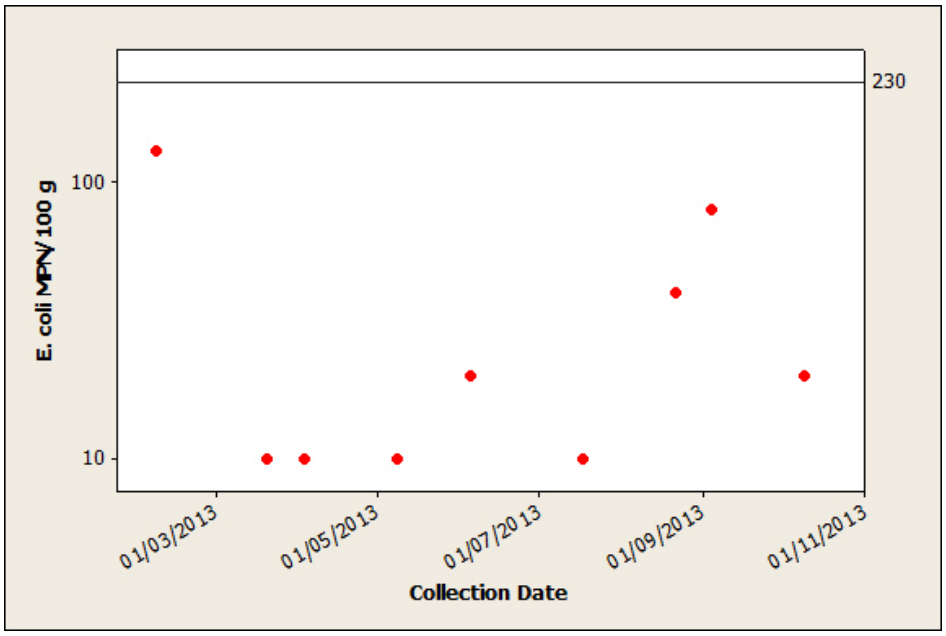

Figure 7.7 Scatterplot of Houss *E. coli* results by date (2001-2013)

There was insufficient data available for Houss to allow assessment of any trend.

Possible pollution event

A period of elevated results occurred from August to October 2008 that appears to correspond to a pollution event, or series of events, over the period. During the three month span, the highest results since 2007 were recorded at East Hogaland, Whal Wick, and Stream Sound, and the third and fifth highest results since 2007 were recorded at Booth. Results outside this period (except at Booth) have been much lower.

Conclusions

Overall, contamination levels have been predominantly low at all sampled sites over the 2007-2013 sampling period, with the majority of results <230 *E. coli* MPN/100 g. Average and peak results were higher at Booth than at other sites, which also had the most results >230 *E. coli* MPN/100 g. A significant difference between sampling periods was only found at Stream Sound, with the average of the *E. coli* results for 2001-2006 higher than that for 2007- 2013.

8. Movement of contaminants

The main conclusions of the 2007 sanitary survey report with respect to movement of contaminants were as follows:

- A large dilution will occur at the head and edges of the sound where the sea floor shelves steeply. This will depend on the degree of stratification at point of pollutant entry and depth of pollutant entry

- Tidal effects are likely to be the most significant in narrow areas e.g. at the head and between Trondra and East Burra. These areas will experience increased currents during ebb and flood tides

- Wind and density will play more of a role in pollutant dispersal outside of these width restricted areas

No new information could be found from an internet search on the local bathymetry or hydrography of Clift Sound. However, data was obtained from the British Oceanographic Data Centre (BODC) website for 1 current meter deployment and 7 conductivity/temperature/depth (CTD) recorder deployments in Clift Sound. The data sets had been collected by Fisheries Research Services, Aberdeen. The deployment locations are shown in Figure 8.1. A summary graph of the current meter data is shown in Figure 8.2: this relates to a 28 day record series. The current meter summary shows that the current directions in the southern part of Clift Sound are generally weak but markedly bimodal and aligned in the general orientation of the sound. Currents tend to flow more strongly to the south and the north. The maximum current speed to the south was 17.7 cm/s and to the north was 9.5 cm/s. At those speeds, the maximum excursion over a single tide would be approximately 2.5 km and 1.4 km respectively.

The salinity results from the CTD deployments were all between 34.7 and 35.3 practical salinity units (psu). The recordings for each deployment were made at a range of depths and there was therefore no evidence of significant freshwater influence or stratification.

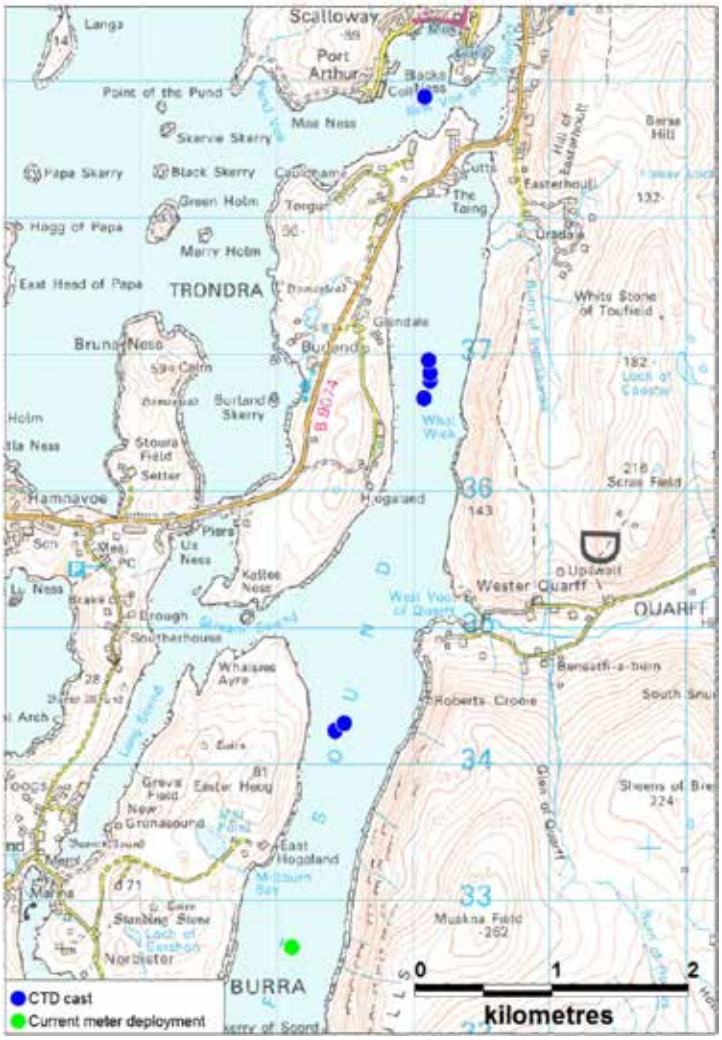

Figure 8.1 Locations of Fisheries Research Services observations (data from BODC)

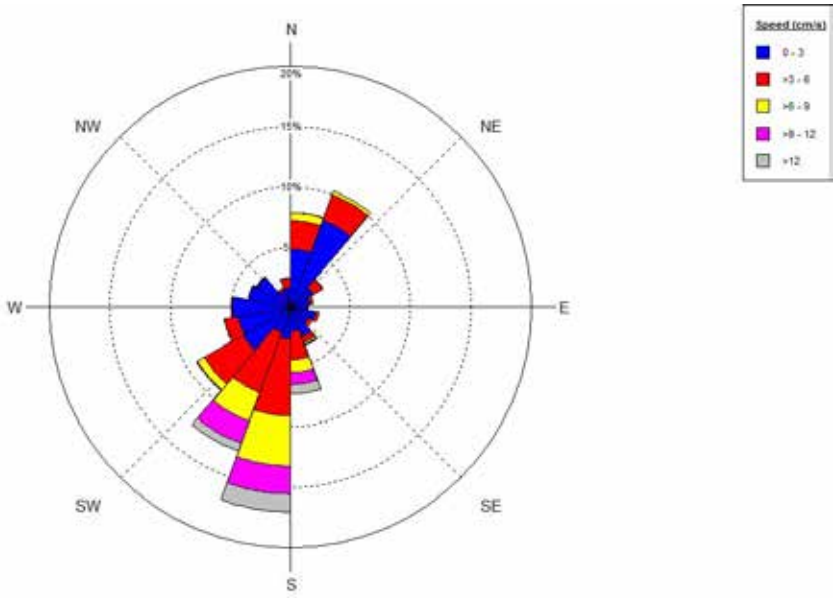

Figure 8.2 Current meter data summary

9. Overall Assessment

This assessment considers the information obtained since the 2007 report and the potential changes in extent and location of faecal contamination.

Human sewage Impacts

Human population has modestly increased in most areas around Clift Sound except at Wester Quarff, where a large decrease of more than 50% was noted. The majority of planning applications were for the Scalloway area and planned to connect to the community sewer. One application in East Voe area had a new ST to soakaway, which may contaminate the northern extent of Booth fishery. Applications for new dwelling houses were also made to Trondra (5) and Wester Quarff (2) areas, with the majority with new ST to soakaways. One application in Wester Quarff was for a ST outfall to sea outfall, which may impact the southern extent of the new Wester Quarff fishery which lies <1 km to the northwest.

Double the number of private STs were noted in the 2013 shoreline survey. One of these STs appeared to be malfunctioning at the time of the survey and another appeared to be cracked but not leaking. The leaking tank was located approximately 600 m southwest of the Booth mussel farm, and approximately 50 m from the shoreline. The cracked tank was located in Houss. These may contribute to contamination in the immediate area but, due to the small anticipated loading and distance from the nearest fishery, may not cause an impact there. The greatest concentration of observed septic tanks was along the shore of Trondra, north and west of the Booth and Whal Wick sites. Those to the north of Booth were situated very near the shoreline and are presumed to discharge to sea. These are likely to be significant sources of faecal contamination to the Booth mussel farm. Most of those to the west of Whal Wick were located further inland.

A septic tank was observed approximately 220 m west of the southern end of the East Hogaland site, and it is the most significant potential source of human faecal contamination to that mussel farm. However, any discharge from the tank is likely to be very small and any impact will depend on the amount of dilution and dispersion that occur between the outfall and the mussel farm. It is expected that any impact would be minor.

Of signficance to the Houss site is the septic tank for the shore base at Houss, which was located with 10 m of MHWS. This tank is likely to discharge to sea, though no outlet pipe was observed. It represents the closest source of human sewage to the Houss mussel farm, which lies just over 1 km away. However, any sewage arising from sources around Houss, including the shore base, is likely to receive significant dilution before reaching either the Houss or South Holms Geo sites.

Agricultural impacts

The main agricultural activity in the area continues to be extensive sheep production, with animals noted to have access to shore around Uradale, East Hogaland, and Cutts. A greater number of sheep were seen in 2013 to the northwest of Booth than were seen in 2007. The greatest concentration of observed farms and livestock remains around the head of the sound, to the northeast and northwest of the Booth site. Fewer sheep and cattle were noted around the Wester Quarff area, however it is not clear whether this represents an actual reduction in the number of livestock kept in the area, or just a coincidence related to the timing of the survey and point of view of the surveyor. All of the sites will be subject to some faecal contamination from agricultural sources, with the Booth site likely to be most impacted due to its location nearer the north end of the sound. Livestock were also noted on the shore to both the east and west of the Whal Wick site. The Wester Quarff site could potentially be impacted by sources arising from the West Voe of Quarff, south of the mussel farm. Crops and livestock along the shore west of East Hogaland are most likely to affect that site. Stream Sound and Houss lie over 1 km away from identified agricultural sources, and therefore any contamination arising from these sources is likely to have received significant dilution prior to reaching the mussel farms.

Wildlife Impacts

Seabird 2000 data has been reassessed and large seabird colonies are now known to be found along both East and West Burra and Hamnavoe. NAFC data indicated there was a large amount of habitat around the sound suitable for herring gulls, arctic terns and fulmars, as well as eider ducks. Seabirds were seen in small numbers throughout the area during the 2013 survey, with birds seen in flight, in water and on the buoys at all sites except Wester Quarff and Kallee Ness. Expected impacts from seals, cetaceans and deer remain unchanged since 2007. NAFC data also indicates common seal habitat lies around West Burra and at the mouth of Clift Sound, the latter of which lies approximately 1.1 km from the new South Holms Geo site.

Seasonal Variation

Agricultural impacts are likely to vary with season. Information on Uradale Farm indicated that livestock (sheep and cattle) are sent to market in the autumn. Seasonal variations are also expected in wildlife numbers, specifically seabirds, with the summer breeding season occurring broadly between May and September.

Watercourses

The largest watercourse in the area is the Burn of Quarff: this will have the greatest impact on the new Wester Quarff fishery and a lesser impact at Kallee Ness. Lesser impacts are expected at Stream Sound and Whal Wick. New freshwater sources were noted within 1 km of the Booth mussel farm, where they are anticipated to impact the northern extents of the site.

Movement of contaminants

Data from BODC shows that tidal currents, at least in the southern part of Clift Sound, tend to follow the general orientation of the Sound and that contaminants would be taken a maximum of 2.5 km to the south and 1.4 km to the north during a single tidal excursion. There is no evidence of significant stratification in the Sound.

Analysis of Results

Historical *E. coli* results

Results in the area tend to be generally low, with the majority less than 230 *E. coli* MPN/100 g. Those at Booth, at the northern end of the sound, tended to be higher than results at the other sites. No significant change in the extent of contamination has occurred over the period since 2001.

Shoreline Survey results

No mussel or seawater samples were taken at the Kallee Ness or Wester Quarff sites. At the other sites, mussel samples were taken at the top and bottom of lines respectively. The highest *E. coli* result in mussels (790 MPN/100 g) was seen at the surface at Whal Wick and the second highest (700 MPN/100 g) was seen at depth at Booth. Apart from at Whal Wick, higher results were seen at depth than at the surface at each site.

The highest seawater results came from a sample taken at the Stream Sound site and from a sample taken from the shore near Trondra: however, these were still low at 3 *E. coli* cfu/100 ml.

Conclusions

The conclusions from the 2007 report indicated that the following were the main potential sources of faecal contamination to the fishery at Clift Sound:

- Contamination from community STs at Maa Ness and North Toogs. Contamination from North Toogs ST was expected to have the greatest impact on Stream Sound fishery, though it was unclear whether contamination from Maa Ness would impact any of the fisheries specifically
- High impacts from sheep, with access to shore possible in many areas. Highest agricultural impacts were expected at Whal Wick from the Wester Quarff area
- Impacts from birds are expected at all sites
- High levels of rainfall during autumn and winter months

- Poorly draining soil allowing for high levels of surface runoff. Contamination from ST soakaways, livestock and wildlife would flush into surrounding watercourses or seawater

- Freshwater inputs from Burn of Quarff; containing community ST effluent and agricultural sources of contamination

- Wind direction will be more significant role than tidal movement in movement of contaminants, except in areas of topographic constriction e.g. Stream Sound and Booth

Conclusions from this review are as follows:

- The largest concentration of livestock was found around the north end of the Sound. Contamination arising from grazing sheep and other diffuse agricultural pollution is expected to therefore be highest at the north end of the sound, within the Booth production area.

- A greater number of septic tanks was observed during the recent survey, and one of these were seen to be malfunctioning. Failing septic systems will pose a risk to water quality, mainly in the near vicinity of the tank. The greatest extent of contamination from human sewage sources is most likely at Booth, where there are septic tanks very near the shore north of the mussel farm and the East Voe of Scalloway (which receives overflows from the Scalloway sewage network) flows into the north end of Clift Sound.

- Large numbers of breeding seabirds are present between May and September, particularly around the outer part of the sound to the south of Houss. These are likely to contribute to background levels of faecal contamination found in the southern parts of the sound during the summer months, particularly at South Holms Geo, where there are few other potential sources of faecal contamination.

- Additional areas of land drainage and four moderately contaminated watercourses noted within 1 km of Booth fishery are expected to contribute to contamination levels on the east and west extents of the fishery respectively.

10. Recommendations

This review has found changes to the spatial distribution of faecal contamination sources entering into Clift Sound at all sites. Recommended changes for individual sites are therefore discussed separately and include recommended RMPs and production areas for the three new sites. The recommended sampling plans are as follows and are displayed in Figures 10.1 and 10.2.

Clift Sound: Booth

Production Area	The area bounded by lines drawn between HU 3992 3800 to HU 4059 3800 and HU 4038 3655 to HU 3987 3655, and extending to MHWS.
RMP	HU 4020 3777
Depth	1-3 m
Tolerance	40 m
Frequency	Monthly
Reasons:	A southward extension of the production area has been recommended in order to include a seabed lease to the south of Glendale. No change is recommended to the RMP location. The tolerance has been expanded in line with more recent recommended tolerances for long line farms.

Clift Sound: Whal Wick

Production Area	The area bounded by lines drawn between HU 4038 3655 and HU 3987 3655 and between HU 4032 3520 to HU 3889 3513, and extending to MHWS
RMP	HU 4018 3532
Depth	1-3 m
Tolerance	40 m
Frequency	Monthly
Reasons:	A southward shift of the northern boundary has been recommended to accommodate the southward extension of the Booth production area to the north. The southern boundary has been extended to incorporate two new sites at Wester Quarff and Kallee Ness. It is recommended that the RMP be relocated to the southeastern extent of the mussel farm at Wester Quarff in order to better represent contaminants arising from the vicinity of the West Voe of Quarff. As with the Booth area, the recommended sampling tolerance has been expanded to 40 metres.

Clift Sound: Stream Sound

Production Area	The area bounded by lines drawn between HU 3907 3490 to HU 4005 3490 to HU 3957 3300 to HU 3876 3300, and extending to MHWS.
RMP	HU 3916 3339
Depth	1-3 m
Tolerance	40 m
Frequency	Monthly
Reasons:	The production area has been extended southward to merge with the East Hogaland production area. There was no significant difference between monitoring results at the East Hogaland and Stream Sound RMPs. However, the East Hogaland site lies closer to recorded human and agricultural sources of faecal contamination along the adjacent west shore, and therefore the recommended RMP is at the southwest corner of the East Hogaland mussel farm.

Clift Sound: Houss

Production Area	The area bounded by lines drawn between HU 3876 3300 and HU 3957 3300 and between HU 3802 3082 and HU 3808 3126 and between HU 3870 2900 and HU 3734 2900, and extending to MHWS
RMP	HU 3857 3195
Depth	1-3 m
Tolerance	40 m
Frequency	Monthly
Reasons:	The area extends southward to include the new site at South Holms Geo and also incorporates three other as yet unused shellfish leases within the outer reaches of Clift Sound. The recommended RMP is shifted eastward to lie on southwest corner of the recorded mussel farm location at Houss, which lies nearer the likely path of contamination arising from habitation and livestock around Houss and the Voe of North House under prevailing wind conditions.

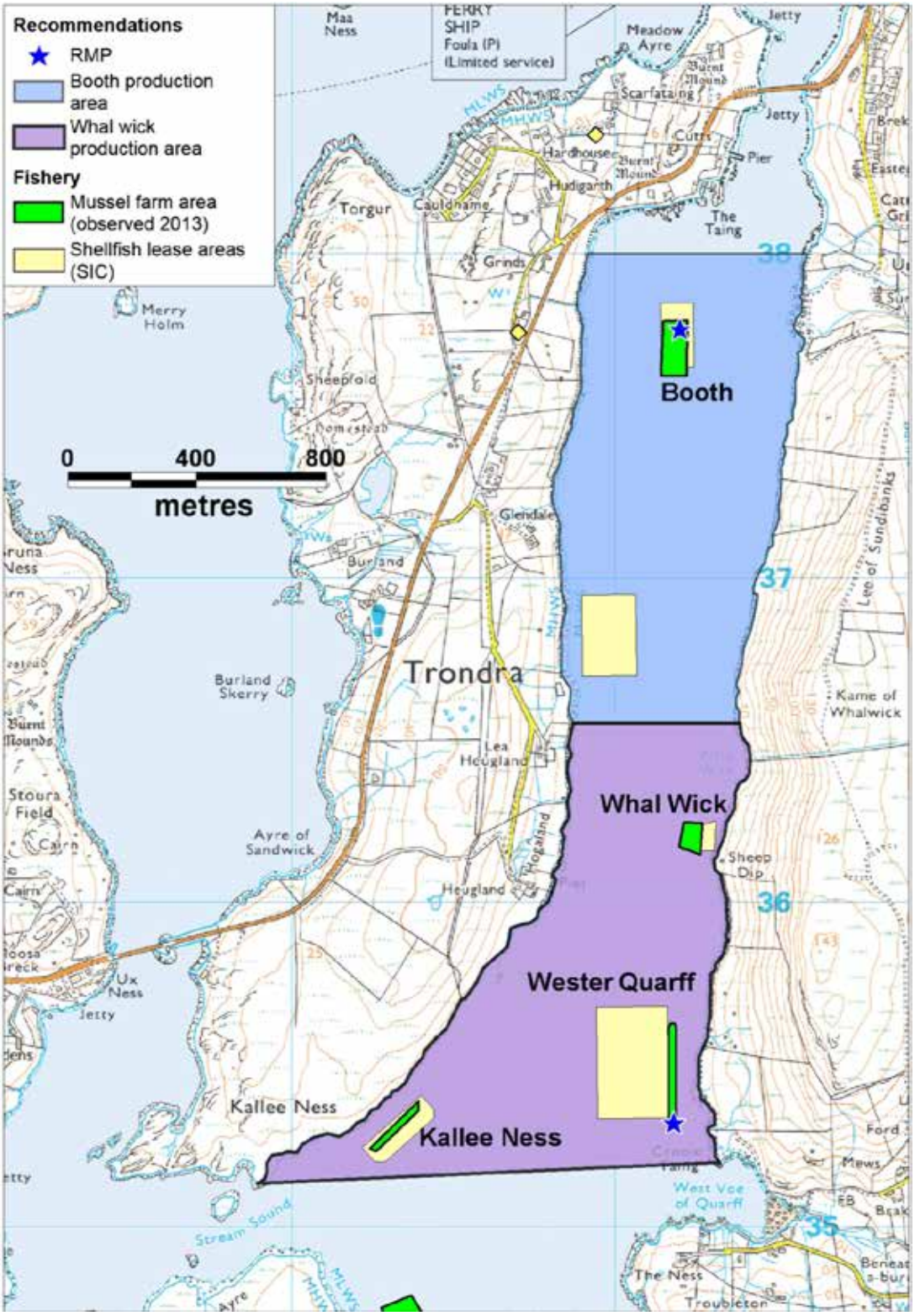

Figure 10.1 Recommended production area boundaries and RMPs for sites located in the northern extent of Clift Sound

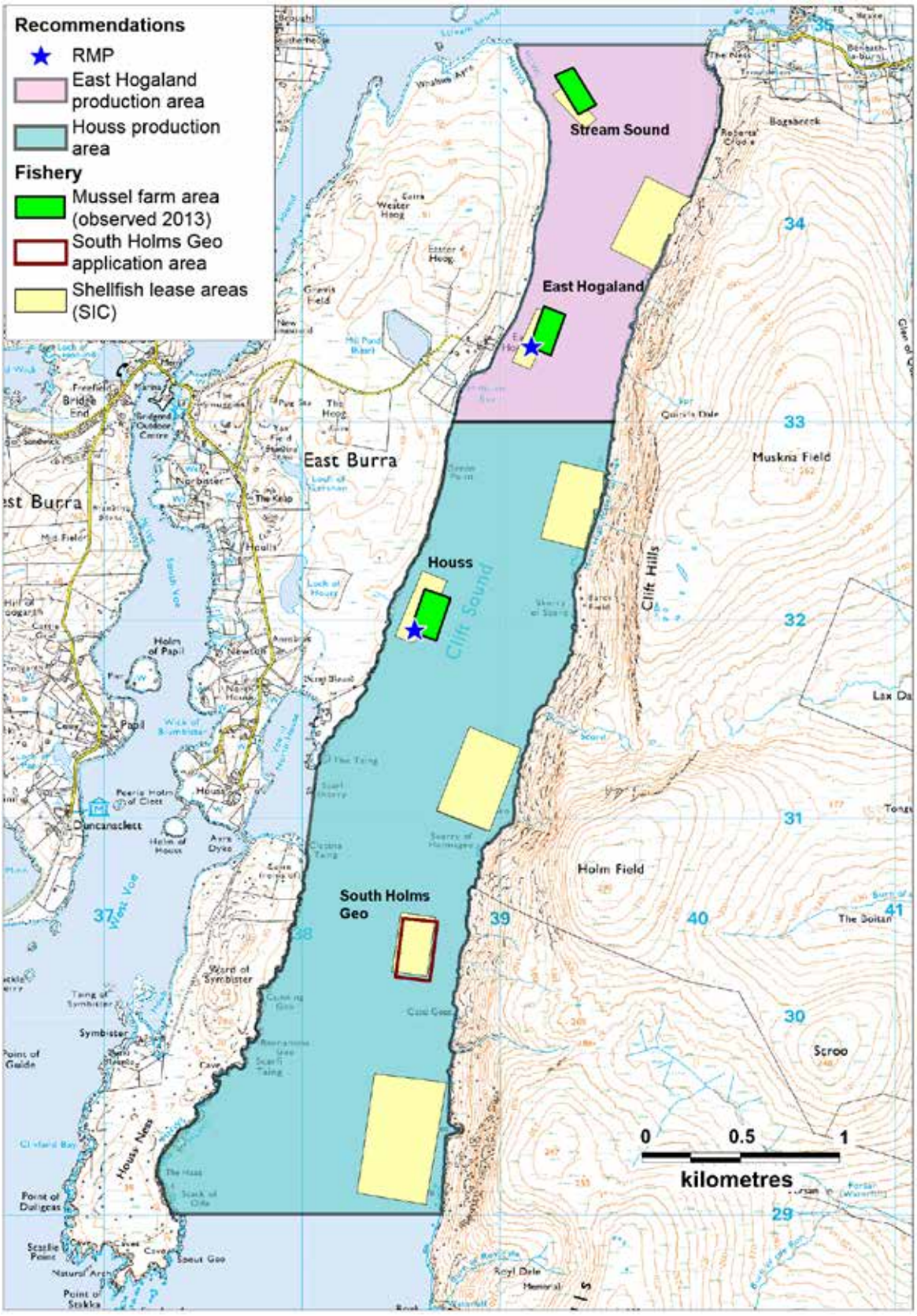

Figure 10.2 Recommended production area boundaries and RMPs for sites located in the southern extent of Clift Sound

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12. List of Figures and Tables

Appendices

1. List of planning applications
2. Shoreline Survey Report 2013

Appendix 1

Planning Applications

Planning applications expected to change the human population and overall faecal loading to Clift Sound are listed in Table 1.

Table 1 Planning applications to areas around Clift Sound

Location	Date	Ref No	Description	Area
Wester Quarff	Feb-10	2010/47/PCD	Erect detached dwellinghouse	The Quarry Wester Quarff Quarff ZE2 9EZ
	Aug-09	2009/247/PCD	Erect single storey dwellinghouse, septic tank and sea outfall	Adjacent to Adjacent to Lamnaberg Wester Quarff Quarff ZE2 9EZ
Easterhoull	Aug-11	2011/249/PPP	Erect dwellinghouse and garage (planning permission in principle)	Easterhoull Scord Scalloway Shetland ZE1 0UR
Trondra	Jan-13	2013/003/PPF	Erect 3bedroom dwellinghouse, grant subject to conditions	Grindidale Trondra Shetland ZE1 0XL
	Apr-12	2012/132/PPF	Erect dwellinghouse and garage, install Suds, soakaway and install 3 house septic tank and infiltration system, grant subject to conditions	Old School Road Trondra Shetland ZE1 0XL
	Feb-12	2012/038/PPF	Erect a dwelling house subject to conditions	Plot 3 Old School Road Trondra Shetland ZE1 0XL
	Feb-11	2011/240/PPF	Erect single detached dwellinghouse with new access, septic tank and soakaway, grant subject to conditions	Site 2 Old School Road Trondra Shetland ZE1 0XL
	May-08	2008/189/PCD	To erect dwellinghouse, garage and stable block	The Booth Trondra ZE1 0XL
Scalloway	Aug-13	2013/303/PPF	Erect dwellinghouse and integral garage	Scord East Voe Scalloway Shetland ZE1 0UR
	May-13	2013/190/PPF	Change of use of ground floor to cafe/restaurant and change of use of first floor to Bed & Breakfast and alter rear extension	Former Museum Main Street Scalloway Shetland ZE1 0TR
	Apr-13	2013/019/WL	By BP: To moor a 'Coastel' (floating accommodation facility) for a period of up to two years, for up to 340 persons though this is subject to change depending on projects	East Pier, Blacksness, Scalloway Harbour:
	Jul-12	2012/256/PPF	Erect a dwellinghouse and relocate viewing point	Scord East Voe Scalloway Shetland ZE1 0UR
	Nov-11	2011/351/PPF	Change of use from retail to a childcare facility	Former Post Office Main Street Scalloway Shetland ZE1 0TR

	Jun-11	2011/167/PCO	Renew outline planning permission 2008/180/PCO, to erect dwellinghouse	adjacent to Kiloora Houl Road Scalloway ZE1 0XA
	Jun-11	2011/161/PCO	Permission in Principle for dwellinghouse	Scord East Voe Scalloway ZE1 0UR
	Jan-11	2011/22/PCD	Erect 2 bedroomed attached dwellinghouse and double garage	1 Hogalee East Voe Scalloway ZE1 0UU
	Nov-10	2010/406/PCD	Erect new dwellinghouse	Scord East Voe Scalloway ZE1 0UR
	Aug-10	2010/312/PCD	Erect new building to incorporate pharmacy and retail on ground floor and also residential flat on first floor	Adjacent to Kiln Bar Main Street Scalloway ZE1 0TR
	Aug-10	2010/295/PCO	Erect dwellinghouse (Planning Permission in Principle)	New Dwellinghouse Utnabrake Scalloway ZE1 0UP
	Apr-08	2008/164/PCD	To erect dwellinghouse	Site North Of Ramnaberg East Voe Scalloway ZE1 0UR
	Mar-08	2008/103/PCD	To erect 1.5 storey dwellinghouse	Adjacent to 22 Houl Road Scalloway ZE1 0XA

Appendix 2

Shoreline Survey Report

Production Area:	Clift Sound	
Site Names:	Booth	
	Whal Wick	
	Stream Sound	
	East Hogaland	
	Clift Sound Houss	
SIN:	Booth:	SI-036-413-08
	Whal Wick:	SI-038-416-08
	Stream Sound:	SI-037-415-08
	East Hogaland:	SI-035-414-08
	Clift Sound Houss:	SI-633-1270-08
Harvesters:	Blueshell Mussels – Michael Laurenson	
	(Stream Sound, East Hogaland & Clift Sound Houss)	
	East Voe Shellfish – Kenny Pottinger	
	(Booth & Whal Wick)	
Local Authority:	Shetland Islands Council	
Status:	Existing area	
Date surveyed:	4 & 5 September 2013	
Surveyed by:	Sean Williamson (Hall Mark Meat Hygiene Ltd.)	
	Vicki Smith (SSQC Ltd.)	
	We are grateful to Kenny Pottinger for providing assistance during the marine survey work.	
Existing RMPs:	Booth:	HU 4020 3777 (*E.coli*)
	Whal Wick:	HU 4022 3616 (*E.coli*)
	Stream Sound:	HU 3932 3475 (Biotoxin and *E.coli*)
	East Hogaland:	HU 3926 3353 (*E.coli*)
	Clift Sound Houss:	HU 3850 3195 (*E.coli*)

Area Surveyed: See Figures 1.1 and 1.2

Specific observations made on site are mapped in Figures 1.1 and 1.2 and listed in Table 1. Water and shellfish samples were collected at the locations marked on Figures 2.1, 2.2, 3.1 and 3.2. Bacteriology results are given in Tables 2 and 3. Salinity profiles are presented in Table 4 with profile locations marked on Figures 2.1 and 2.2. Photographs are presented in Figures 4-21.

Weather

Wednesday 4 September 2013

Cloudy conditions through the day, initially with an F3 southerly breeze increasing to F4 during the afternoon for the shoreline walk. Dry overnight with the wind decreasing to F3 from the south-south east.

Thursday 5 September 2013

A light south westerly breeze (F2) persisted through the day with overcast conditions and light rain showers, these more common during the morning.

Preceding the shoreline survey, Monday 2 September was an overcast day with light rain in the morning. Westerly winds increased from F4 in the morning to a fresh breeze (F5) for the remainder of the day, decreasing overnight. Tuesday 3 September started partly cloudy becoming overcast with light rain persisting until the early afternoon. F2/F3 westerly winds built to F4 southerly winds through the day, dropping to calm conditions and scattered cloud overnight.

Fishery

The location of the mussel lines from all five fisheries are mapped in Figures 1.1 and 1.2. Also mapped are the locations of mussel lines of another two sites in the production area which have planning permission but are yet to be classified. All fisheries had stocked mussel lines on site at the time of the survey. Harvesting was not occurring at any of the fisheries at this time.

The Booth fishery consisted of eight mussel lines running parallel to the shoreline (Figure 4). All lines were double headed longlines with 6 metre droppers on the northern third of the lines and 8 metre droppers on the southern two thirds of the lines. Two mussel samples were collected from the north end of the site, sixth line in from the western shore, taken from the top and bottom of a mussel line. The site is licenced for eight 160 metre twin-headline longlines.

The Whal Wick fishery consisted of six mussel lines running parallel to the shoreline (Figure 5). All lines were double headed longlines with 4 metre droppers on the three eastern lines closest to the shore and 8m droppers on the three western lines. Two mussel samples were collected just south of the north east corner of the site from the line nearest the shore taken from the top and bottom of a mussel line. The site is licenced for nine twin-headline longlines, ranging in length from 70-95 metres.

The Stream Sound, East Hogaland and Clift Sound Houss fisheries are operated by Blueshell Mussels on behalf of SI Seafarms Ltd.

The Stream Sound fishery consisted of six mussel lines running parallel to the western shoreline (Figure 6). All lines were double headed longlines with 10-15 metre droppers. Two mussel samples were collected just north of the south east

corner of the site from the line furthest from the shore taken from the top and bottom of a mussel line. The site is licenced for six 180 metre twin-headline longlines.

The East Hogaland fishery consisted of eight mussel lines running parallel to the shoreline (Figure 7). All lines were double headed longlines with 10-15 metre droppers. Two mussel samples were collected just north of the south west corner of the site from the line closest to the shore taken from the top and bottom of a mussel line. The site is licenced for eight 220 metre twin-headline longlines.

The Clift Sound Houss fishery consisted of six mussel lines running parallel to the shoreline (Figure 8). All lines were double headed longlines with 10-15 metre droppers. Two mussel samples were collected mid-way along the furthest west line closest to the shore taken from the top and bottom of a mussel line. The site is licenced for six 200 metre twin-headline longlines.

Sewage/Faecal Sources

On the eastern shoreline there were two main dwelling areas at Uradale, at the north end of Clift Sound near the Booth fishery and Wester Quarff, found approximately mid-way down Clift Sound. Five houses were observed from the shore on the Uradale walk with most dwellings located some distance from the shore with no septic tanks identified in this area. On approaching the end of the walk towards the Scalloway-Trondra bridge a large grouping of approximately 20 houses in the Sundibanks area were present which extended north past the end of the bridge. It is known a further two houses and a farm are located further east in the Uradale area but these buildings could not be seen from the shore. In the Wester Quarff area six dwellings were noted on the southern shore of the voe surveyed. Two septic tanks were identified in this area; a plastic septic tank (Figure 9) and a concrete septic tank (Figure 10) both located in fields below the road servicing houses above the road. Further east, still in the Wester Quarff area approximately 15 houses were observed some distance from the shore.

On the western shoreline five areas where dwellings were present were surveyed. On East Burra, furthest south in the Clift Sound production area, five houses were observed around the Voe of North House, two of which were present some distance from the shore above the road. A concrete septic tank, which had a crack down one side and across the lid was identified servicing the two houses present at the southern end of the voe (Figure 11). A manhole cover associated with a septic tank which serviced the Scottish Sea Farms Ltd. shore base at the northern end of the voe was also located (Figure 12). Two dwellings were present in the East Hogaland area near the shore adjacent to the East Hogaland fishery, with a septic tank servicing both houses identified (Figure 13). Moving north to Trondra, in the Hogaland area adjacent to the Whal Wick fishery, five houses were identified with four septic tanks located however two of these looked to be disused. Further north in the Glendale area five houses were observed with two septic tanks identified. One of the tanks was plastic and the other concrete however the concrete tank had a crack

down one side with some leakage present (Figure 14). At the north end of Trondra four dwellings were observed near the shore with three of the four septic tanks identified. Eight houses were noted above the road, six at the southern end and two at the northern end of the Trondra survey near the Scalloway-Trondra bridge.

Sample analysis

Twelve freshwater samples were obtained from watercourses on the shoreline survey, ten of which were outlined on the sampling plan and two were additional samples not outlined in the plan. The additional samples were taken from a large field drain near Uradale on the eastern shoreline, north east of the Booth fishery and from a large pool of stagnant water on the western shoreline north of the Booth fishery. Of the twelve watercourses sampled, three were found to have *E.coli* levels between 80-160 cfu/100ml, three had levels between 400-900 cfu/100ml, four watercourses had levels between 2000-3200 cfu/100ml and two had *E.coli* levels of 4600 and 5200 cfu/100ml. The two samples with the highest *E.coli* counts were from the Hogaland area on the eastern shoreline with the Whal Wick fishery located across the Sound near the western shoreline. The first sample, with a count of 4600 cfu/100ml, was obtained from a small pool of stagnant water that looked to be part of a field drain however no water was flowing (Figure 15). The drain was found to be coming down from houses with a septic tank located near the drain. The second sample, with a count of 5200 cfu/100ml, was obtained from a field drain leading down from a house and associated out buildings (Figure 16). There was a small water flow present through vegetation with water discharging from a pipe to the shore

Six seawater samples were obtained from the five fisheries and one from the pier at Cutts, Trondra on the western shoreline, all of which were outlined on the survey plan. All the seawater samples obtained had *E.coli* levels between <1-3 cfu/100ml.

Two mussel samples were obtained from all five fisheries from the top and bottom of a mussel line. Samples were obtained from the north end of the Booth fishery, three lines in from the eastern side of the site. The sample obtained from the top of the mussel line was found to have a count of 230 *E.coli* MPN/100g with the bottom sample returning levels of 700 *E.coli* MPN/100g. The samples from the Whal Wick fishery were taken from a mussel line just south of the north east corner of the site. The sample obtained from the top of the mussel line recorded a count of 790 *E.coli* MPN/100g with the bottom sample returning levels of 230 *E.coli* MPN/100g. Samples from the Stream Sound fishery were obtained from a mussel line just north of the south east corner of the site. The sample obtained from the top of the mussel line was found to have a count of 50 *E.coli* MPN/100g with the bottom sample returning levels of 130 *E.coli* MPN/100g. The East Hogaland mussel samples were obtained from a mussel line just north of the south west corner of the site. The sample obtained from the top of the mussel line recorded a count of 20 *E.coli* MPN/100g with the bottom sample returning levels of 130 *E.coli* MPN/100g. The samples obtained from the Clift Sound Houss fishery were from the line furthest west, nearest the

shoreline, mid-way along the line. The sample obtained from the top of the mussel line recorded a count of 20 *E.coli* MPN/100g with the bottom sample returning levels of 80 *E.coli* MPN/100g.

Salinity profiles were collected at all five fisheries, from the north ends of the Booth and Whal Wick fisheries and the south ends of the East Hogaland and Stream Sound fisheries. The Clift Sound Houss salinity profile was taken mid-way along the furthest west line of the site. All profiles obtained showed <0.19 ppt decrease in salinity from 10 metres to the surface which is within the accuracy of the probe used (± 0.35 ppt). Salinity ranged from 34.78 ppt at the Booth fishery to 35.31 ppt at the Clift Sound Houss fishery.

Temperature profiles were recorded from the five fisheries with two of the profiles showing no change in temperature from 10m to the surface and the other three profiles showing a slight increase in temperature (0.1-0.2°C) from 10 metres to the surface. Temperature ranged from 12.2°C recorded at the Clift Sound Houss fishery to 12.9°C present at the Booth fishery.

Salinities of the seawater samples analysed at the laboratory showed salinities ranging from 33.82-34.18 PSU, slightly below full strength sea water.

Seasonal population

There is no known self-catering or bed and breakfast properties in the Clift Sound area.

Boats/Shipping

Boat traffic in the Clift Sound area is largely associated with mussel and salmon farming and also leisure boats. East Voe Shellfish who own the Booth and Whal Wick fisheries have workboats berthed at East Voe and Lang Sound which are used to service their sites and collect samples for biotoxin and *E.coli* testing from all the sites in the Clift Sound area. This company had a large workboat on site at the Whal Wick fishery at the time of the boat survey. Scottish Sea Farms Ltd. who own the majority of the salmon fisheries in the Clift Sound area have two shore bases, one at the Voe of North House and the other at Uxness in Lang Sound which they use to service their sites. The shore base at the Voe of North House had two large workboats and one small workboat berthed at the pier at the time of the survey (Figure 17). All the other boats observed on the survey were associated with leisure use. Of the seven areas surveyed along the eastern and western shoreline five of the areas had leisure boats present on the shore or berthed at pontoons. The vessels included a number of rowing boats, small and large motor boats, a yacht and a canoe (Figure 18). There were four moorings present in the West Voe of Quarff however no boats were using the moorings at the time of the survey. The moorings may be used more frequently in the summer months.

Farming and Livestock

The land on the shoreline survey was dominated by rough grazing. On the eastern shoreline 13 sheep were observed during the boat work grazing on the hill adjacent to the Whal Wick fishery. In the Uradale area 126 sheep were observed on open grazing land with access to the shore. In the Wester Quarff area 40 sheep were grazing in a fenced area with no access to the shore however sheep faeces were noted on five occasions near the shore where animals would have been able to access the shore. On the western shoreline sheep were observed in all five areas where dwellings were present. A total of 363 sheep were noted with approximately 300 of these being located in fenced areas with no access to the shore (Figure 19). Smaller numbers of sheep observed in the North House, Glendale and Hogaland areas had access to the shore however in these areas steep escarpments may have prevented access to the shore. At most locations however sheep faeces were observed near the shore outside the fenced areas.

Five Shetland ponies were observed in a fenced area near the shore just north of the Booth fishery (Figure 20). Equine faeces were also observed in the Wester Quarff area on a small path along a cliff edge where owners may have been riding their horses or ponies.

Eight cows were observed in a fenced area above the road in the Wester Quarff area. Cow faeces were also noted on two occasions in Wester Quarff near the shore in an area where animals would have been able to access the shore.

Land Use and Land Cover

Rough grassland dominated both the eastern and western shorelines of the production area. Wet boggy areas were noted in the Uradale area on the eastern shoreline and the Glendale area on the western shoreline. Thistles were present in high numbers amongst the grassland in the Uradale area, with heather noted amongst the grassland in the Wester Quarff and Glendale areas. Hay bales and hay fields which had been cut where present in the North House and East Hogaland areas with a field used to grow potatoes noted in the East Hogaland area.

Both shorelines were characterised by undulating landscape alternating between steep cliffs and escarpments with no access to the shore, to lowland areas with small stony beaches where access to the shore was possible. Ferns were present on the small stony beaches in the Wester Quarff and North House areas. The majority of animals grazing were largely observed in fenced areas however livestock faeces were noted on a number of occasions outside fenced areas near the shore.

There was little rainfall in the days preceding the shoreline walk with wet boggy areas noted on four occasions on the shoreline walk.

Watercourses

Twelve watercourses were sampled during the shoreline survey, ten of which were on the sample plan. Two watercourses which were not outlined in the plan, one near

Uradale of the eastern shore, north east of the Booth fishery and the other on the western shoreline north of the Booth fishery. Flow rate was recorded at ten of the twelve watercourses sampled. Flow rate was not recorded at two watercourses sampled due to insufficient flow found in the watercourses. Flow rate was also recorded at two additional locations on the eastern shoreline, a small watercourse at Uradale and a secondary field drain at Wester Quarff.

Wildlife/Birds

A number of bird species were observed during the Clift Sound boat work and shoreline walks. Most commonly observed were gulls (58 in total) which were seen in all areas surveyed; on buoys at the fisheries or in the water, in flight or observed in fields near the shore. Shags were observed at three fisheries during the boat work with a large number being observed (27 animals) at the Stream Sound fishery on buoys or in flight. 30 domestic geese and 15 hens and ducks were noted in the Hogaland area, with 25 of the geese taking to the water (Figure 21) and the other animals observed in fenced areas next to houses. Goose faeces were also noted on five occasions on the shore in the Hogaland area. A large group of eider ducks were observed in the water near the shore in the Wester Quarff area. Other bird species noted along the shoreline walks and around the fisheries included curlews, great skuas, artic terns, a guillemot, snipe, crow and oystercatcher. Most of the birds observed were seen in flight but some were observed in the water or on the shore. Crab carcasses and shells were noted near the shore on three occasions in the East Hogaland, Glendale and Uradale areas which could indicate an area where birds may have been feeding.

Twenty five rabbits and one dead rabbit were observed on the shoreline walks around Clift Sound with rabbit holes being found in large numbers on the western shoreline in the East Hogaland and Glendale areas.

General observations

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

Dimensions and flows of watercourses are estimated at the most convenient point of access and not necessarily at the point at which the watercourse enters the sound.

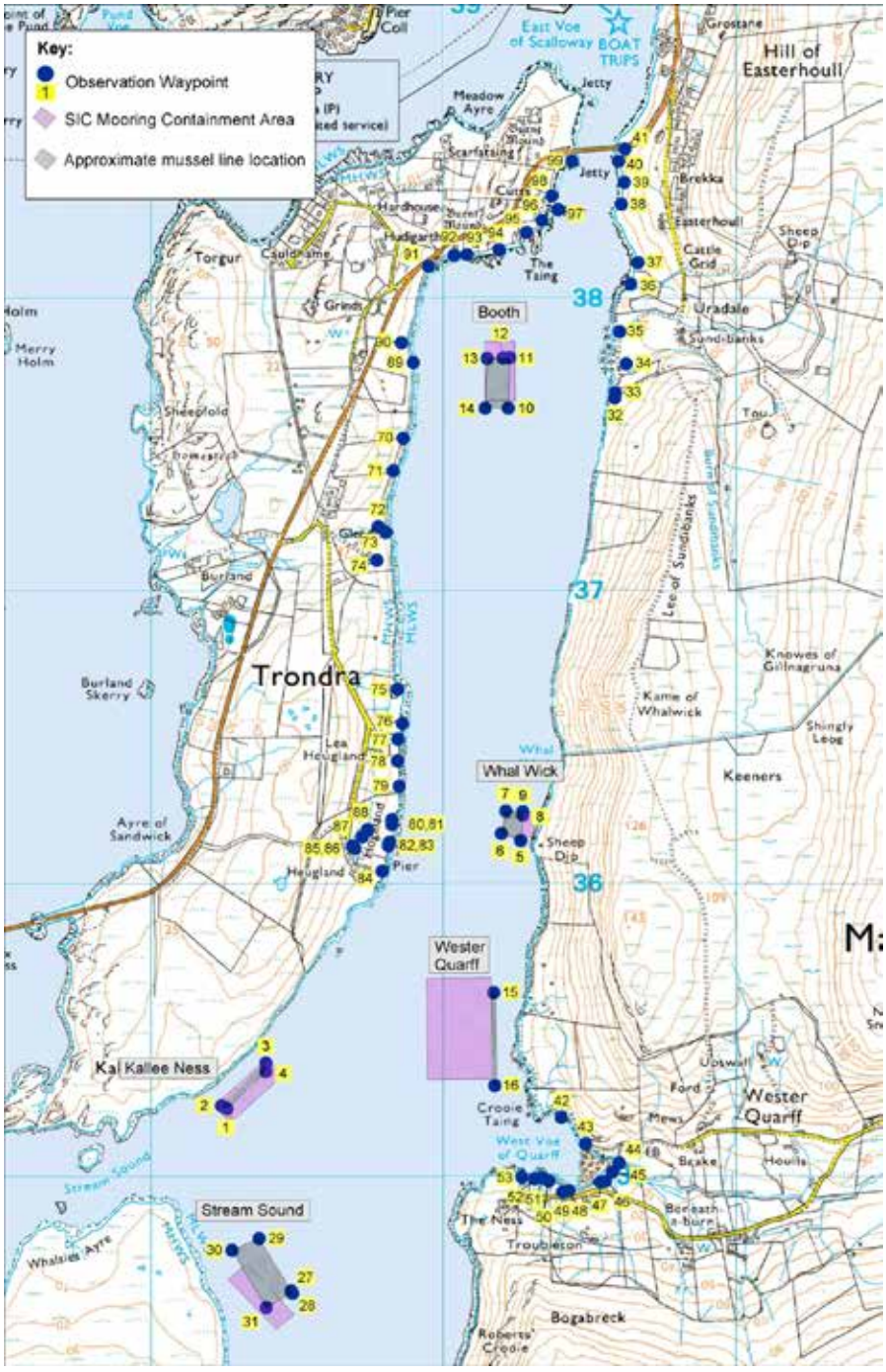

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Figure 1.1 Map of shoreline observations Clift Sound (north)

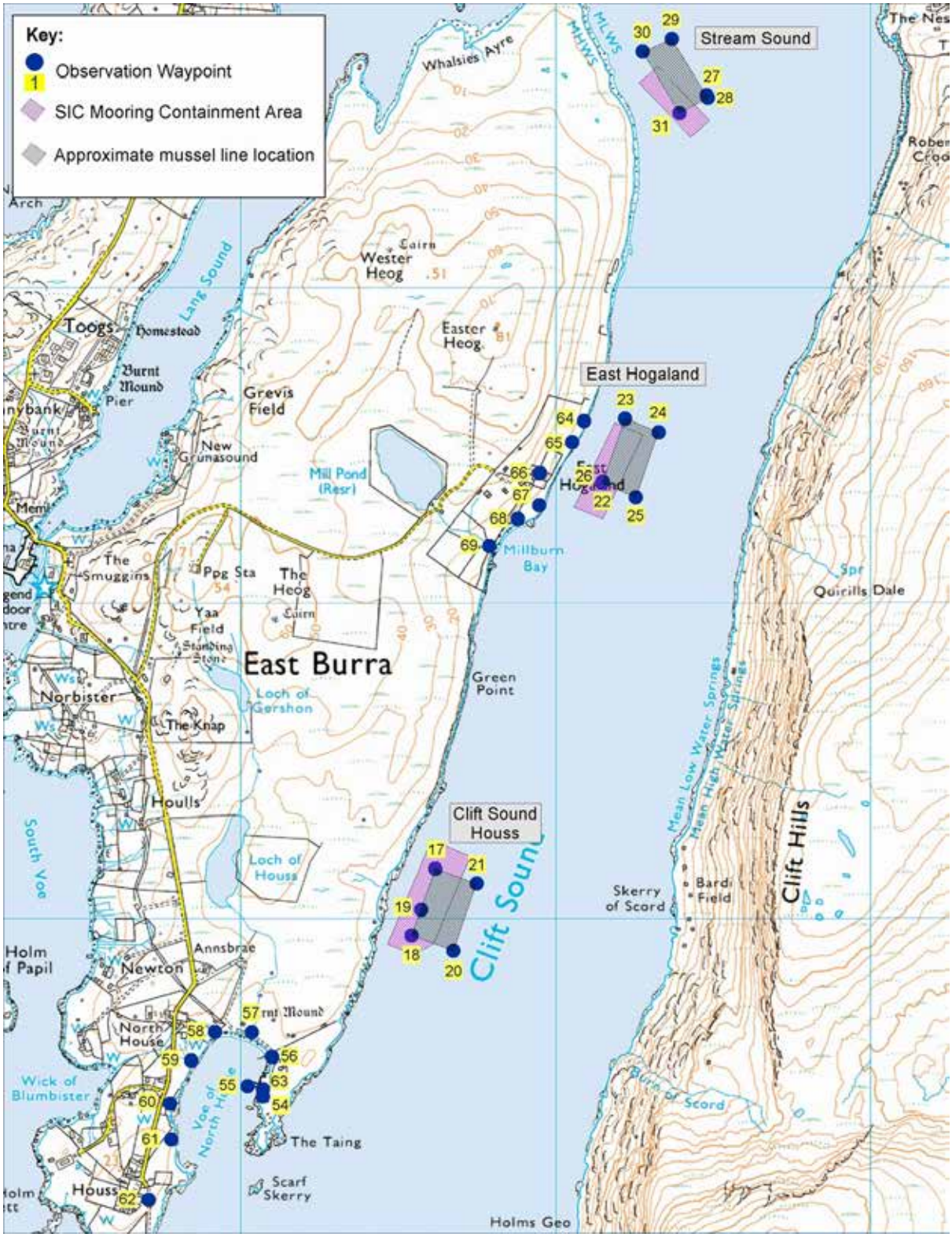

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Figure 1.2 Map of shoreline observations Clift Sound (south)

Table 1 Shoreline Observations

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
1	04/09/2013 08:52	HU 39260 35231	439260	1135231			Boat work. Weather: Cloudy, fresh breeze. Sea state: large wavelets, some white caps. New mussel fishery (Site name: Kallee Ness) not yet classified, owned by East Voe Shellfish. SE corner position. 3x double headed longlines, 8m droppers. Located NW Stream Sound fishery. Mussels on site.
2	04/09/2013 08:53	HU 39241 35241	439241	1135241			SW corner of the Kallee Ness fishery.
3	04/09/2013 08:54	HU 39393 35387	439393	1135387			NW corner of the Kallee Ness fishery.
4	04/09/2013 08:56	HU 39392 35358	439392	1135358			NE corner of the Kallee Ness fishery.
5	04/09/2013 09:04	HU 40263 36146	440263	1136146			SE corner of the Whal Wick fishery. 6x double headed longlines, 4m droppers on three inner eastern lines closest to the shore and 8m droppers on three outer western lines, mussels on site. Two gulls present on buoys at the fishery.
6	04/09/2013 09:13	HU 40197 36171	440197	1136171			SW corner of the Whal Wick fishery. Boat on site removing one of the mussel lines.
7	04/09/2013 09:13	HU 40212 36248	440212	1136248			NW corner of the Whal Wick fishery. 13 sheep noted on the eastern shore.
8	04/09/2013 09:15	HU 40269 36234	440269	1136234	Figure 5	CS-MUSS01 (Top), CS-MUSS02 (Bottom), CS-SW01	Whal Wick fishery - Salinity Profile 1 collected (ppt/°C): 10m 35.02/12.8, 5m 35.00/12.8, 3m 34.92/12.8, surface 34.84/12.8. Mussels collected from furthest east line, closest to the shore, just south of the NE corner buoy. Surface sample collected from the top of a mussel line, bottom sample collected from the bottom of a mussel line. Seawater sample collected.
9	04/09/2013 09:27	HU 40270 36245	440270	1136245			NE corner of the Whal Wick fishery.
10	04/09/2013 09:31	HU 40221 37623	440221	1137623			SE corner of the Booth fishery. 8x double headed longlines, 6m droppers on northern 1/3 of the lines, 8m droppers on southern 2/3 of the lines, mussels on site.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
11	04/09/2013 09:32	HU 40225 37795	440225	1137795			NE corner of the Booth fishery. No mussels at NE corner of the fishery.
12	04/09/2013 09:36	HU 40202 37795	440202	1137795		CS-MUSS03 (Top), CS-MUSS04 (Bottom), CS-SW02	Booth fishery - Salinity Profile 2 collected (ppt/°C): 10m 34.84/12.7, 5m 34.80/12.8, 3m 34.79/12.8, surface 34.78/12.9. Mussels collected from north end of the third line in from the east. Surface sample collected from the top of a mussel line, bottom sample collected from the bottom of a mussel line. Seawater sample collected. Bird faeces present on the buoys at the fishery.
13	04/09/2013 09:47	HU 40149 37793	440149	1137793			NW corner of the Booth fishery.
14	04/09/2013 09:48	HU 40141 37623	440141	1137623			SW corner of the Booth fishery.
15	04/09/2013 09:53	HU 40170 35628	440170	1135628			New mussel fishery not yet classified, operated by Shetland Mussels (Site name: Wester Quarff) located east of the Stream Sound fishery. 1x double headed longline, 8m droppers. Northern end of the line.
16	04/09/2013 09:55	HU 40174 35311	440174	1135311			Southern end of the line, Wester Quarff fishery.
17	04/09/2013 10:04	HU 38620 32157	438620	1132157			NW corner of the Clift Sound Houss fishery. 6x double headed longlines, 10-15m droppers, mussels on site. Three shags and two gulls present on buoys at the fishery.
18	04/09/2013 10:10	HU 38544 31945	438544	1131945	Figure 8		SW corner of the Clift Sound Houss fishery.
19	04/09/2013 10:14	HU 38574 32027	438574	1132027		CS-MUSS05 (Top), CS-MUSS06 (Bottom), CS-SW03	Clift Sound Houss fishery - Salinity Profile 3 collected (ppt/°C): 10m 35.31/12.2, 5m 35.30/12.2, 3m 35.30/12.2, surface 35.30/12.3. Mussels collected from midway along furthest west line. Surface sample collected from the top of a mussel line, bottom sample collected from the bottom of a mussel line. Seawater sample collected.
20	04/09/2013 10:23	HU 38677 31897	438677	1131897			SE corner of the Clift Sound Houss fishery.
21	04/09/2013 10:25	HU 38750 32111	438750	1132111			NE corner of the Clift Sound Houss fishery. One guillemot in the water, one artic tern and one gull in flight.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
22	04/09/2013 10:29	HU 39148 33381	439148	1133381			SW corner of the East Hogaland fishery. 8x double headed longlines, 10-15m droppers, mussels on site. Two shags present on buoys at the fishery.
23	04/09/2013 10:30	HU 39220 33583	439220	1133583			NW corner of the East Hogaland fishery.
24	04/09/2013 10:38	HU 39327 33541	439327	1133541			NE corner of the East Hogaland fishery.
25	04/09/2013 10:39	HU 39255 33334	439255	1133334			SE corner of the East Hogaland fishery.
26	04/09/2013 10:41	HU 39150 33385	439150	1133385		CS-MUSS07 (Top), CS-MUSS08 (Bottom), CS-SW04	East Hogaland fishery - Salinity Profile 4 collected (ppt/°C): 10m 35.27/12.4, 5m 35.26/12.4, 3m 35.26/12.4, surface 35.26/12.4. Mussels collected from just north of the SW corner. Surface sample collected from the top of a mussel line, bottom sample collected from the bottom of a mussel line. Seawater sample collected. One gull observed in flight.
27	04/09/2013 10:56	HU 39479 34609	439479	1134609	Figure 6	CS-MUSS09 (Top), CS-MUSS010 (Bottom), CS-SW05	Stream Sound fishery 6x double headed longlines, 10-15m droppers, mussels on site. Salinity Profile 5 collected (ppt/°C): 10m 35.24/12.4, 5m 35.22/12.5, 3m 35.21/12.5, surface 35.21/12.6. Mussels collected from just north of the SE corner. Surface sample collected from the top of a mussel line, bottom sample collected from the bottom of a mussel line. Seawater sample collected. Seven shags and one gull observed on buoys at the fishery. One gull observed in flight.
28	04/09/2013 11:05	HU 39483 34601	439483	1134601			SE corner of the Stream Sound fishery. Eleven shags observed in flight.
29	04/09/2013 11:15	HU 39369 34788	439369	1134788			NE corner of the Stream Sound fishery. Nine shags and one gull observed on buoys at the fishery.
30	04/09/2013 11:15	HU 39277 34748	439277	1134748			NW corner of the Stream Sound fishery.
31	04/09/2013 11:17	HU 39394 34552	439394	1134552			SW corner of the Stream Sound fishery.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
32	04/09/2013 13:23	HU 40584 37658	440584	1137658			Shoreline walk Uradale, eastern shore. Field drain small water flow. Flow rate measured; width 20 cm, depth 4 cm, flow 0.023 m/s, st. dev. 0.007 m/s. Fifty sheep grazing on the hill no fences, access to the shore. Net present next to the drain.
33	04/09/2013 13:27	HU 40584 37676	440584	1137676			Rough grazing with thistles present. Sheep faeces present with scallop shells observed on the grassy verge above the shore possibly where birds have been feeding. Steeper escarpments lessening to lowland stony beach area.
34	04/09/2013 13:32	HU 40622 37775	440622	1137775		CS-FW01	Large watercourse leading to small stony beach. Freshwater sample obtained (on survey plan) and flow rate measured; width 120 cm, depth 10 cm, flow 0.239 m/s, st. dev. 0.011 m/s. One gull observed in flight and one dead rabbit present on the shore.
35	04/09/2013 13:39	HU 40600 37884	440600	1137884		CS-FW02	Large watercourse, freshwater sample obtained (on survey plan) and flow rate measured; width 50 cm, depth 15 cm, flow 0.541 m/s, st. dev. 0.026 m/s. Large pieces of soil present beside the watercourse, still present from a landslide that took place last year. Wild iris on the banks of the watercourse. Fifteen sheep present grazing at the edge of the watercourse upstream. Sheep faeces observed.
36	04/09/2013 13:47	HU 40638 38048	440638	1138048		CS-FW03	Escarpments steepening slightly before lowering to a small stony beach with seaweed. Wet boggy areas next to a field drain with a small water flow. A number of small drainage ditches joining in to field drain leading to the shore. Small shed, rowing boat, canoe and small motor boat present at the shore. Freshwater sample obtained (not on survey plan) and flow rate measured; width 30 cm, depth 9 cm, flow 0.05 m/s, st. dev. 0.024 m/s. Five houses observed up the hill from the shore.
37	04/09/2013 13:56	HU 40662 38120	440662	1138120			Fifty sheep present on the hill with access to the shore, sheep faeces observed. Wet boggy areas with wild iris present. Escarpments steepening with thistles present on the rough grazing land. One gull observed in the water and one gull in flight. Houses at the top of the hill near the road.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
38	04/09/2013 14:00	HU 40607 38319	440607	1138319			Curlew, artic tern, oystercatcher and gull observed in flight. One rabbit and eleven sheep observed. Sheep faeces present.
39	04/09/2013 14:02	HU 40617 38395	440617	1138395			Very wet boggy ground, long grass.
40	04/09/2013 14:04	HU 40597 38467	440597	1138467			Old septic tank disused at the edge of the escarpment.
41	04/09/2013 14:05	HU 40618 38509	440618	1138509			End of the Uradale shoreline walk.
42	05/09/2013 08:55	HU 40401 35201	440401	1135201			Start of shoreline walk West Voe of Quarff. Weather: Overcast, light rain and light breeze. Sea state: small ripples, no white caps. Sheep faeces present. One rabbit observed. Small boat shed near the shore, used for storage of nets and wood. Rough grassland, lowland area with a stony beach. Large group of eider ducks observed in the water near the shore.
43	05/09/2013 08:59	HU 40485 35112	440485	1135112			Equine faeces present. Heather present amongst the grassland. Escarpments steepening, small path along cliff edge. Curlew observed in flight.
44	05/09/2013 09:06	HU 40600 35045	440600	1135045		CS-FW04	Lowland area at the head of the voe, large watercourse which splits into a number of drains. Main drain surrounded by wild iris and sheep faeces present. Freshwater sample obtained (on survey plan) and flow rate measured; width 60 cm, depth 30 cm, flow 0.735 m/s, st. dev. 0.036 m/s. Forty sheep in fenced area. Eight cows in a field above the road, some distance from the shore. Houses present further east some distance from the shore.
45	05/09/2013 09:10	HU 40577 35015	440577	1135015			Smaller drain in watercourse mentioned above, south of the main drain. Flow rate measured; width 20 cm, depth 6 cm, flow 0.166 m/s, st. dev. 0.006 m/s. Leading to small stony beach, ferns present near the shore.
46	05/09/2013 09:13	HU 40552 34985	440552	1134985	Figure 9		Green plastic septic tank associated with a new house above the road.
47	05/09/2013 09:15	HU 40535 34981	440535	1134981			Cow and sheep faeces present. Escarpments steepening.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
48	05/09/2013 09:18	HU 40428 34952	440428	1134952			Small watercourse running through vegetation.
49	05/09/2013 09:19	HU 40407 34947	440407	1134947	Figure 10		Concrete septic tank associated with house above the road. Cow and sheep faeces present, broken fence down at the shore.
50	05/09/2013 09:23	HU 40358 34985	440358	1134985			Small watercourse coming under the road, sheep faeces present, animals would have had access to the shore.
51	05/09/2013 09:24	HU 40338 34996	440338	1134996			Three great skuas and three gulls observed in flight. Old disused boat, rowing boat and trailer on the shore. Four moorings in the water but no boats present at the time of the survey.
52	05/09/2013 09:34	HU 40312 34992	440312	1134992	Figure 18		Small pontoon. Small motor boat and three rowing boats on the shore, creels present. Four houses above the road with one motor boat and yacht outside.
53	05/09/2013 09:39	HU 40266 34998	440266	1134998			End of the shoreline walk.
54	05/09/2013 10:21	HU 38072 31435	438072	1131435			Shoreline walk Voe of North House. Two gulls observed in flight.
55	05/09/2013 10:22	HU 38024 31468	438024	1131468	Figure 17		Scottish Sea Farms Ltd. shore base with a large shed. Two large workboats and one small workboat berthed at the pier. Storage unit present on the pier.
56	05/09/2013 10:24	HU 38101 31560	438101	1131560			Small stony beach with seaweed and ferns. Two rowing boats on the shore, derelict house present above the road. Sheep faeces present on the beach.
57	05/09/2013 10:28	HU 38037 31638	438037	1131638		CS-FW05	Thirty sheep not fenced in next to a small watercourse leading to the beach coming under the road. Freshwater sample obtained (on survey plan) and flow rate measured; width 30 cm, depth 8 cm, flow 0.427 m/s, st. dev. 0.006 m/s.
58	05/09/2013 10:33	HU 37920 31640	437920	1131640			Escarpments steepening. Twenty sheep in fenced area. Snipe observed in flight. House present some distance from the shore with associated out buildings. Sheep faeces present out with the fenced area near the cliff edge. Rough grassland.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
59	05/09/2013 10:38	HU 37845 31549	437845	1131549		CS-FW06	Very small watercourse flowing through vegetation. Freshwater sample obtained (on survey plan) Flow rate measured; width 10 cm, depth 6 cm, flow 0.23 m/s, st. dev. 0.007 m/s. Two houses above the road. Hay bales present at the top of the field. Sheep faeces present.
60	05/09/2013 10:44	HU 37778 31411	437778	1131411			One sheep in a fenced area and one outside the fenced area. Sheep faeces present inside and outside fenced area. Three gulls observed, one in flight, one on a fence post and one in the water. Two plovers and one artic tern observed in flight. Six sheep in a fenced area with eight gulls.
61	05/09/2013 10:49	HU 37781 31299	437781	1131299			Hay field that had been cut. Eleven gulls in flight from the field. Two rabbits observed. Small stony beach at the bottom of a steeper escarpment.
62	05/09/2013 10:55	HU 37710 31106	437710	1131106	Figure 11		Concrete septic tank associated with two houses on the hill. Lid and side of tank cracked. Sheep faeces present, animals would have had access to the shore but escarpments quite steep, with a stony beach near the shore. South end of shoreline walk.
63	05/09/2013 11:03	HU 38072 31458	438072	1131458	Figure 12		Back to the start of the Voe of North House walk, septic tank for SSF shore base (Obsv 55). Man hole cover visible above the ground.
64	05/09/2013 11:21	HU 39091 33576	439091	1133576			Start of East Hogaland shoreline walk. Weather: wind increasing. Sheep faeces inside and outside a fenced area. Eight shags and six gulls on buoys at the East Hogaland fishery. Seven sheep present further up the hill. Crab carcasses present on the shore, possible feeding area for birds.
65	05/09/2013 11:23	HU 39053 33509	439053	1133509			Field where potatoes were being grown. Large number of rabbit holes present on the hill. Two rabbits observed on the hill.
66	05/09/2013 11:26	HU 38951 33411	438951	1133411	Figure 13		Septic tank present, three houses in the area, one derelict. Sheep in fenced area, sheep faeces present inside and outside the fenced area. Hay bales present in the field.
67	05/09/2013 11:29	HU 38949 33309	438949	1133309			50 sheep in a fenced area, sheep faeces present inside and outside the fenced area. Ten rabbits observed near the shore.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
68	05/09/2013 11:31	HU 38881 33267	438881	1133267	Figure 7		Nine sheep up the hill in a fenced area, sheep faeces on the shore outside the fenced area. Three rabbits observed. One gull in flight.
69	05/09/2013 11:40	HU 38791 33180	438791	1133180		CS-FW07	Large watercourse. Freshwater sample obtained (on survey plan) and flow rate measured; width 30 cm, depth 25 cm, flow 0.287 m/s, st. dev. 0.03 m/s. Old concrete structure not in use with a pipe leading to the shore. May have been associated with the Mill Pond reservoir. End of shoreline walk.
70	05/09/2013 12:37	HU 39861 37521	439861	1137521	Figure 4		Start of shoreline walk Glendale. Rough grassland with heather present. Two houses at the top of the hill. Fenced area, sheep faeces noted outside the fenced area. Steep escarpment at the shore.
71	05/09/2013 12:40	HU 39827 37409	439827	1137409			Wet boggy area at the cliff edge, escarpments decreasing in height. Gull and crow observed in flight and one gull observed in the water. 28 sheep present in a field above the shore not fenced, sheep faeces present. Large derelict boat on the shore on a stony beach. Two houses noted some distance up the hill. One rabbit observed and large numbers of rabbit holes noted. Crab carcass present possibly an area where birds have been feeding.
72	05/09/2013 12:50	HU 39777 37218	439777	1137218		CS-FW08	Small watercourse with rusty brown coloured algae present. Wild iris present around the watercourse nearer the shore, water flowing through the vegetation. Freshwater sample obtained (on survey plan) and flow rate measured; width 20 cm, depth 15 cm, flow 0.392 m/s, st. dev. 0.01 m/s. Sheep present in the field with the watercourse, sheep faeces present.
73	05/09/2013 12:54	HU 39802 37199	439802	1137199			Black plastic septic tank with a concrete lid. Vent pipe extruding from the ground beside the tank. Pipe observed at the shore leading to the beach, does not look to be in use as there is a break in the pipe and no discharge. Most likely not associated with the septic tank. Sheep faeces present.
74	05/09/2013 12:58	HU 39772 37104	439772	1137104	Figure 14		Large concrete septic tank associated with a house on the hill, small crack down the side of the tank and some leakage. Salmon farm present in the Sound. End of shoreline walk.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
75	05/09/2013 13:08	HU 39843 36664	439843	1136664			Start of shoreline walk Hogaland. Rough grassland. Three sheep in a fenced area up the hill. Sheep faeces near the shore. Escarpment height lessening to a lowland stony beach area. Goose faeces present. Five plovers taking flight from the beach. One rabbit observed.
76	05/09/2013 13:10	HU 39859 36546	439859	1136546	Figure 21		Four sheep in a fenced area. Twenty five domestic geese entering the water. Sheep and goose faeces on the stony beach. Two plovers and one gull in flight and one gull in the water. Two rabbits observed.
77	05/09/2013 13:17	HU 39843 36493	439843	1136493	Figure 16	CS-FW09	Small watercourse flowing down from a house and associated out buildings through vegetation. Pipe discharging to the shore. Freshwater sample obtained (on survey plan) from the end of the pipe and flow rate measured using a 1 Litre jug. Time taken to fill the jug: 28/27/26 seconds. Goose faeces present. One gull in flight and 15 hens and ducks observed in the back garden of the house.
78	05/09/2013 13:23	HU 39843 36419	439843	1136419			Plastic pipe leading to the shore. No discharge from the pipe, may not be in use. Sheep and goose faeces noted.
79	05/09/2013 13:26	HU 39848 36333	439848	1136333			Five geese in a fenced area above the shore and four sheep outside the fenced area on the shore.
80	05/09/2013 13:30	HU 39823 36219	439823	1136219			End of a plastic pipe present at the shore, no discharge and ditch present in the field above the pipe was dry, no water flowing.
81	05/09/2013 13:32	HU 39823 36202	439823	1136202			Thirty sheep in a fenced area, sheep faeces present. Septic tank noted in the field further up the hill.
82	05/09/2013 13:35	HU 39815 36142	439815	1136142	Figure 15	CS-FW10	Small drain through vegetation. No water flowing. Freshwater sample obtained (on survey plan) from a stagnant pool of water in the drain. Three houses present up the hill. One rabbit observed. Goose and sheep faeces noted.
83	05/09/2013 13:41	HU 39810 36130	439810	1136130			Open plastic structure which water can be seen flowing. Vertical pipe extruding from the ground near the shore, not sure if the two are associated. One sheep observed and sheep faeces present.
84	05/09/2013 13:43	HU 39791 36042	439791	1136042			One house present. Nine sheep observed in a fenced area.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
85	05/09/2013 13:46	HU 39696 36119	439696	1136119			Walking up hill away from the shore. An old possibly disused concrete septic tank.
86	05/09/2013 13:48	HU 39688 36129	439688	1136129			Old septic tank possibly disused, concrete with wooden lid. No running water heard.
87	05/09/2013 13:49	HU 39722 36159	439722	1136159			New plastic septic tank possibly associated with structure mentioned in Obsv 83 as a similar structure present next to the septic tank.
88	05/09/2013 13:51	HU 39740 36184	439740	1136184			Large concrete septic tank. End of shoreline walk.
89	05/09/2013 14:08	HU 39896 37779	439896	1137779			Start of shoreline walk North Trondra. Rough grassland, high escarpments with stony beaches below. One gull observed in the water and one gull in flight.
90	05/09/2013 14:18	HU 39856 37846	439856	1137846		CS-FW11	Small watercourse coming under the road discharging to the shore. Small water flow through vegetation and over rocks. Freshwater sample obtained (on survey plan) and flow rate measured; width 35 cm, depth 7 cm, flow 0.076 m/s, st. dev. 0.013 m/s. Sheep faeces noted. Six houses present above the road. Two plovers observed in flight. One rabbit noted.
91	05/09/2013 14:24	HU 39947 38107	439947	1138107			130 sheep present in a fenced area above the road. Two gulls observed in the water.
92	05/09/2013 14:27	HU 40036 38146	440036	1138146		CS-FW12	Large stagnant pool of water dark brown in colour, pipe just visible on the stony beach, small discharge. Freshwater sample obtained (not on survey plan). Sheep faeces present on the beach.
93	05/09/2013 14:30	HU 40079 38148	440079	1138148	Figure 20		Five Shetland ponies in a fenced area.
94	05/09/2013 14:35	HU 40190 38164	440190	1138164			Concrete septic tank in a field next to a house just up from the shore. Eight sheep present in the field. Old disused septic tank noted, stones built up leading to the shore.
95	05/09/2013 14:39	HU 40283 38224	440283	1138224			New house just up from the shore unable to locate the septic tank. Lowland stony beach area along the shore. Two sheep in a fenced area next to the house.
96	05/09/2013 14:42	HU 40336 38265	440336	1138265	Figure 19		Concrete septic tank in a field next to a house located near the shore. Thirteen sheep present in the field.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
97	05/09/2013 14:47	HU 40390 38301	440390	1138301		CS-SW06	House near the shore with a private pier, one large motor boat and one small motor boat berthed at the pier. Two gulls in flight. Seawater sample obtained from the end of the pier.
98	05/09/2013 14:51	HU 40370 38349	440370	1138349			Septic tank for house mentioned above.
99	05/09/2013 14:56	HU 40438 38466	440438	1138466			Seven sheep observed in fenced area, sheep faeces present. Two houses noted above the road. End of shoreline walk.

Sampling

Water and shellfish samples were collected at the locations indicated in Figures 2.1, 2.2, 3.1 and 3.2. As well as those defined in the survey plan two additional freshwater samples were collected from small watercourses on the eastern and western shores, north of the Booth fishery. All samples were transported initially by a cool backpack and then in a cool box to SSQC Ltd. for analysis within 24 hours of sample collection.

Bacteriology results are present in Tables 2 and 3 and mapped in Figures 2.1, 2.2, 3.1 and 3.2.

Seawater samples were also tested for salinity at SSQC Ltd. In the field salinity profiles were collected using a YSI Professional Plus handheld meter and CT probe which had an accuracy of (± 0.35 ppt). Results are presented in Table 4 and locations of the profiles are mapped in Figures 2.1 and 2.2.

Table 2 Water sample *E.coli* results

No.	Sample Ref.	Date/Time (UT)	Position	Type	*E.coli* (cfu/100ml)	Salinity*
1	CS-SW01	04/09/2013 09:15	HU 40269 36234	Sea Water	2	34.03
2	CS-SW02	04/09/2013 09:36	HU 40202 37795	Sea Water	2	33.82
3	CS-SW03	04/09/2013 10:14	HU 38574 32027	Sea Water	<1	34.18
4	CS-SW04	04/09/2013 10:41	HU 39150 33385	Sea Water	<1	34.17
5	CS-SW05	04/09/2013 10:56	HU 39479 34609	Sea Water	3	33.96
6	CS-FW01	04/09/2013 13:32	HU 40622 37775	Fresh Water	100	-
7	CS-FW02	04/09/2013 13:39	HU 40600 37884	Fresh Water	400	-
8	CS-FW03	04/09/2013 13:47	HU 40638 38048	Fresh Water	$2.0x10^3$	-
9	CS-FW04	05/09/2013 09:06	HU 40600 35045	Fresh Water	900	-
10	CS-FW05	05/09/2013 10:28	HU 38037 31638	Fresh Water	800	-
11	CS-FW06	05/09/2013 10:38	HU 37845 31549	Fresh Water	$2.9x10^3$	-
12	CS-FW07	05/09/2013 11:40	HU 38791 33180	Fresh Water	80	-
13	CS-FW08	05/09/2013 12:50	HU 39777 37218	Fresh Water	160	-
14	CS-FW09	05/09/2013 13:17	HU 39843 36493	Fresh Water	$5.2x10^3$	-
15	CS-FW10	05/09/2013 13:35	HU 39815 36142	Fresh Water	$4.6x10^3$	-
16	CS-FW11	05/09/2013 14:18	HU 39856 37846	Fresh Water	$2.8x10^3$	-

No.	Sample Ref.	Date/Time (UT)	Position	Type	*E.coli* (cfu/100ml)	Salinity*
17	CS-FW12	05/09/2013 14:27	HU 40036 38146	Fresh Water	$3.2x10^3$	-
18	CS-SW06	05/09/2013 14:47	HU 40390 38301	Sea Water	3	33.83

*Practical Salinity Scale 1978 (PSS-78)

Table 3 Shellfish sample *E.coli* results

No.	Sample Ref.	Date/Time (UT)	Position	Type	Depth	*E.coli* (MPN/100g)
1	CS-MUSS01	04/09/2013 09:15	HU 40269 36234	Common Mussel	Top	790
2	CS-MUSS02	04/09/2013 09:15	HU 40269 36234	Common Mussel	Bottom	230
3	CS-MUSS03	04/09/2013 09:36	HU 40202 37795	Common Mussel	Top	230
4	CS-MUSS04	04/09/2013 09:36	HU 40202 37795	Common Mussel	Bottom	700
5	CS-MUSS05	04/09/2013 10:14	HU 38574 32027	Common Mussel	Top	20
6	CS-MUSS06	04/09/2013 10:14	HU 38574 32027	Common Mussel	Bottom	80
7	CS-MUSS07	04/09/2013 10:41	HU 39150 33385	Common Mussel	Top	20
8	CS-MUSS08	04/09/2013 10:41	HU 39150 33385	Common Mussel	Bottom	130
9	CS-MUSS09	04/09/2013 10:56	HU 39479 34609	Common Mussel	Top	50
10	CS-MUSS10	04/09/2013 10:56	HU 39479 34609	Common Mussel	Bottom	130

Table 4 Salinity profiles

Profile	Date/Time (UT)	Position	Depth (m)	Salinity (ppt) (± 0.35 ppt)	Temperature (°C)
1	04/09/2013 09:15	HU 40269 36234	surface	34.84	12.8
			3	34.92	12.8
			5	35.00	12.8
			10	35.02	12.8
2	04/09/2013 09:36	HU 40202 37795	surface	34.78	12.9
			3	34.79	12.8
			5	34.80	12.8
			10	34.84	12.7
3	04/09/2013 10:14	HU 38574 32027	surface	35.30	12.3
			3	35.30	12.2
			5	35.30	12.2
			10	35.31	12.2
4	04/09/2013 10:41	HU 39150 33385	surface	35.26	12.4
			3	35.26	12.4
			5	35.26	12.4
			10	35.27	12.4
5	04/09/2013 10:56	HU 39479 34609	surface	35.21	12.6
			3	35.21	12.5
			5	35.22	12.5
			10	35.24	12.4

Figure 2.1 Map of water sample results and salinity profile locations Clift Sound (north)

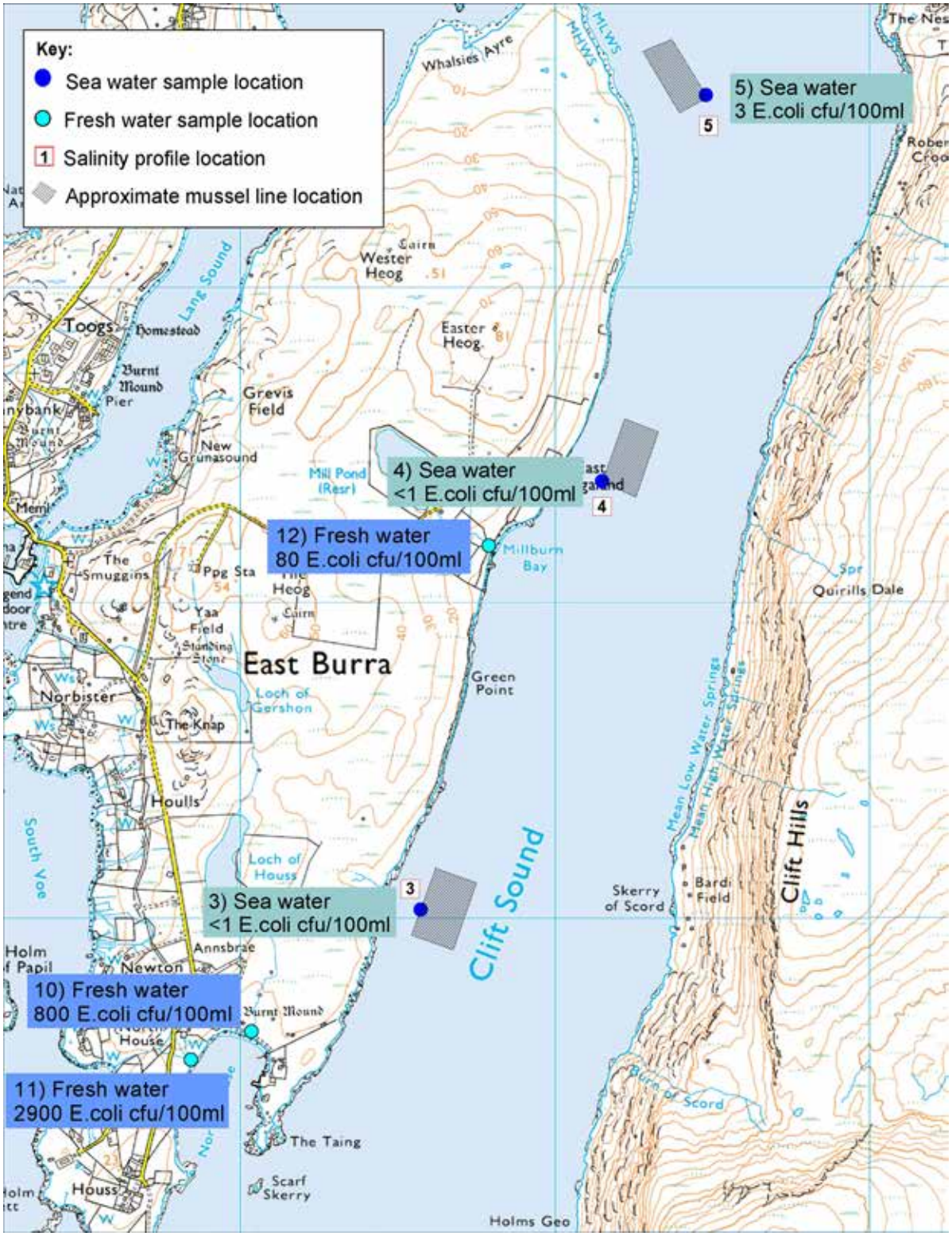

Figure 2.2 Map of water sample results and salinity profile locations

Clift Sound (south)

Figure 3.1 Map of shellfish sample results Clift Sound (north)

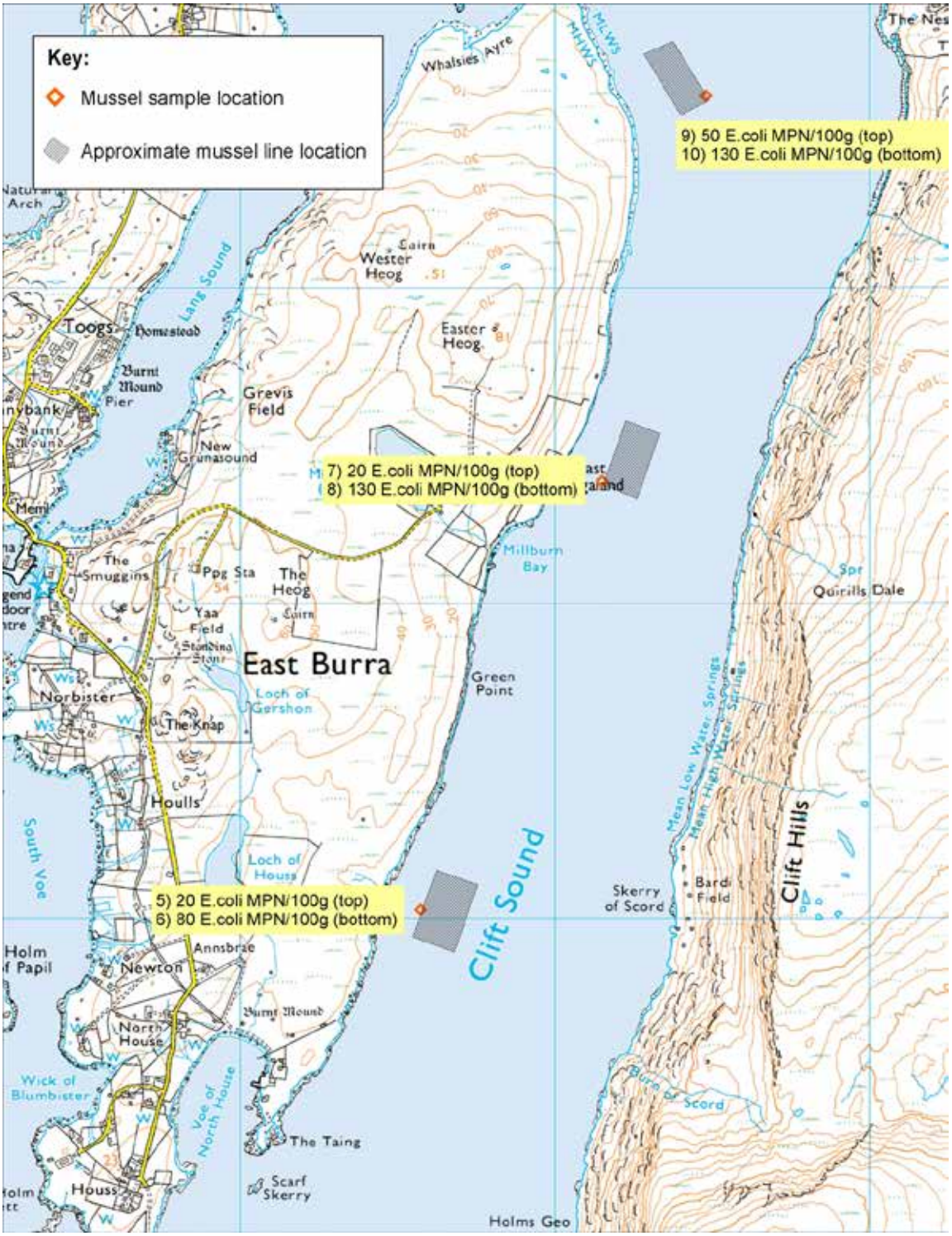

Figure 3.2 Map of shellfish sample results Clift Sound (south)

Photographs

Figure 4 – Mussel lines at the Booth fishery looking east.

Figure 5 – Mussel lines at the Whal Wick fishery looking south.

Figure 6 – Mussel lines at the Stream Sound fishery looking west.

Figure 7 – Mussel lines at the East Hogaland fishery looking north.

Figure 8 – Mussel lines at the Clift Sound Houss fishery looking north.

Figure 9 – Plastic septic tank servicing a house in the Wester Quarff area.

Figure 10 – Concrete septic tank servicing houses in the Wester Quarff area.

Figure 11 – Septic tank associated with two houses at the south end of the Voe of North House.

Figure 12 – Man hole cover associated with a septic tank servicing the Scottish Sea Farms Ltd. shore base at the Voe of North House.

Figure 13 – Septic tank servicing two houses in the East Hogaland area.

Figure 14 – Septic tank associated with a house in the Glendale area.

Figure 15 – Field drain below houses in the Hogaland area.

Figure 16 – Field drain below a house and associated sheds in the Hogaland area.

Figure 17 – Workboats berthed at the Scottish Sea Farms Ltd. shore base at the Voe of North House.

Figure 18 – Leisure boats on the shore at Wester Quarff.

Figure 19 – Sheep grazing in a fenced area next to a house at the north of Trondra.

Figure 20 – Five Shetland ponies grazing in a field next to a house at the north of Trondra.

Figure 21 – Domestic geese taking to the water at Hogaland.

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