Scottish Sanitary Survey Programme

Sanitary Survey Review
Sandsound Voe
SI 261
November 2013

Report Title	Sandsound Voe Review
Project Name	Scottish Sanitary Survey
Client/Customer	Food Standards Agency Scotland
Cefas Project Reference	C5792F
Document Number	C5792F_2013_1
Revision	Final V1.0
Date	21/11/2013

Revision History

Revision number	Date	Pages revised	Reason for revision
0.1	17/11/2013	All	Draft
1.0	10/01/2014	5,6,8,10,11	Correction of typographic errors

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Partner Organisation

The shoreline survey and its associated report were undertaken by SQQC, Shetland.

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APPENDICES

Review Specification

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, the review comprises of a brief desktop search of publicly available information together with a shoreline survey. The review will determine significant changes in:

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

The output of the review will be in the form of a report identifying any new information that has been identified or whether major elements of the original sanitary survey can be regarded as essentially unchanged. The report should include 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 provide: A description of the revised boundaries and a revised sampling plan with the boundaries and RMP(s) locations stated.

1. Introduction

In 2007 a Sanitary Survey Report for Sandsound Voe 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 recommended sampling plan for the fishery. This is listed on the following page alongside the sampling plan recommended 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.

2. Sampling Plan – Sandsound Voe

	2007 recommendations	2013 review	Changes
PRODUCTION AREA	Sandsound Voe		Change in tolerance only
SITE NAME	Sandsound Voe		
SIN	SI-242-443-08		
SPECIES	Common mussels		
TYPE OF FISHERY	Long line aquaculture		
NGR OF RMP	HU 3515 4988		
EAST	435150		
NORTH	1149880		
TOLERANCE (M)	40		
DEPTH (M)	1		
METHOD OF SAMPLING	Hand		
FREQUENCY OF SAMPLING	Monthly		
LOCAL AUTHORITY	Shetland Island Council		
AUTHORISED SAMPLER(S)	Sean Williamson	Sean Williamson Marion Slater Agnes Smith Alan Harpin Vicki Smith	Change in staff
RECOMMENDED PRODUCTION AREA	HU 3466 5019 to HU 3505 5022 and HU 3464 4954 to HU 3554 4954 extending to MHWS.		No changes

3. Area and Fishery

The general location of Sandsound Voe is shown in Figure 3.1.

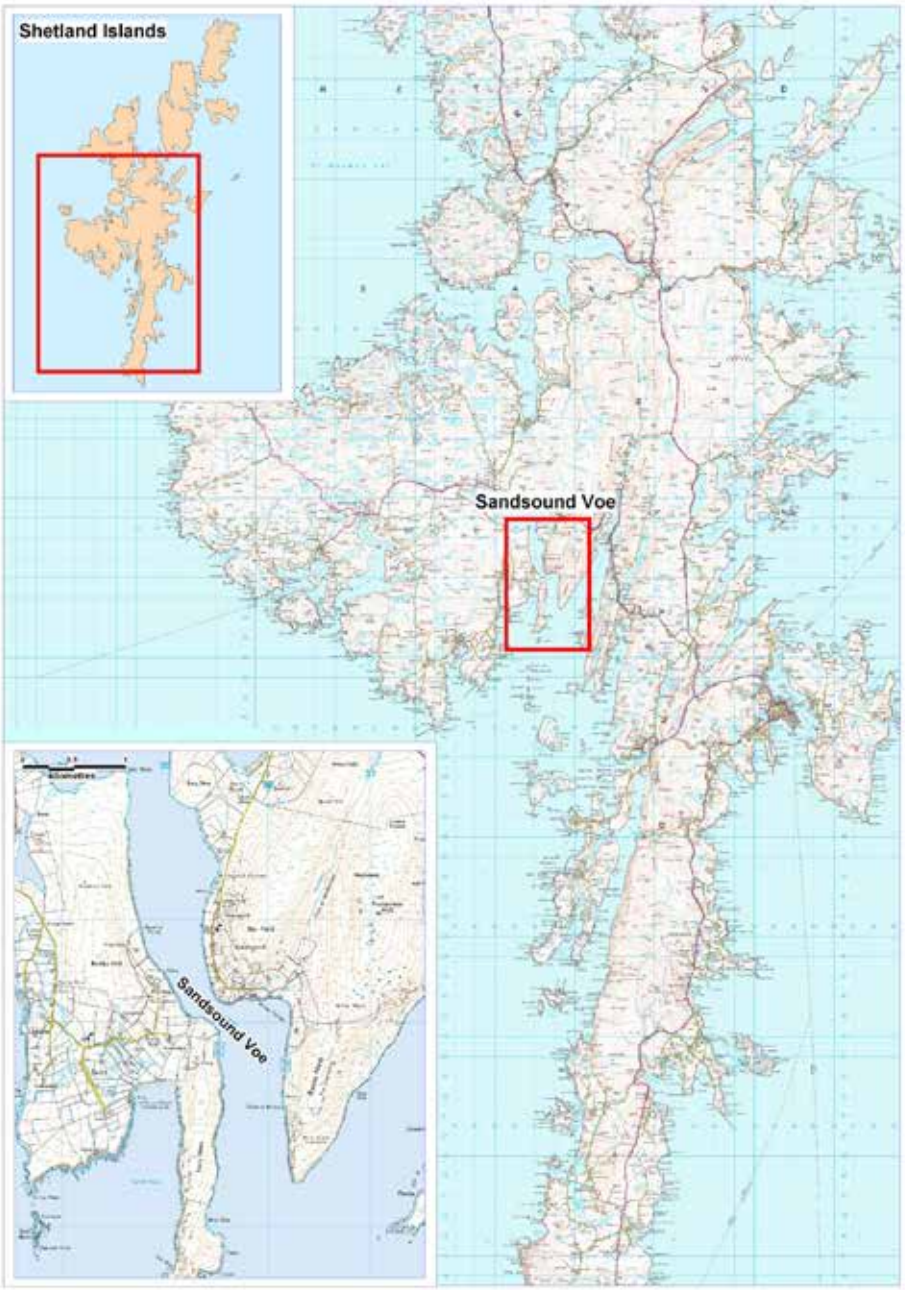

Figure 3.1 Location of Sandsound Voe

The shellfishery at Sandsound Voe is a long line mussel aquaculture farm. During the 2013 survey, the farm was noted to be comprised of nine double headed mussel lines with 8-9 m droppers, running parallel to shore. This was an increase over the five lines present in 2007 and therefore the extent covered by the lines was correspondingly greater than in 2007, as shown in Figure 3.2.

The expansion of the farm means that the RMP lies inward of the northwest end of the lines. The production area still covers the whole extent of the present farm.

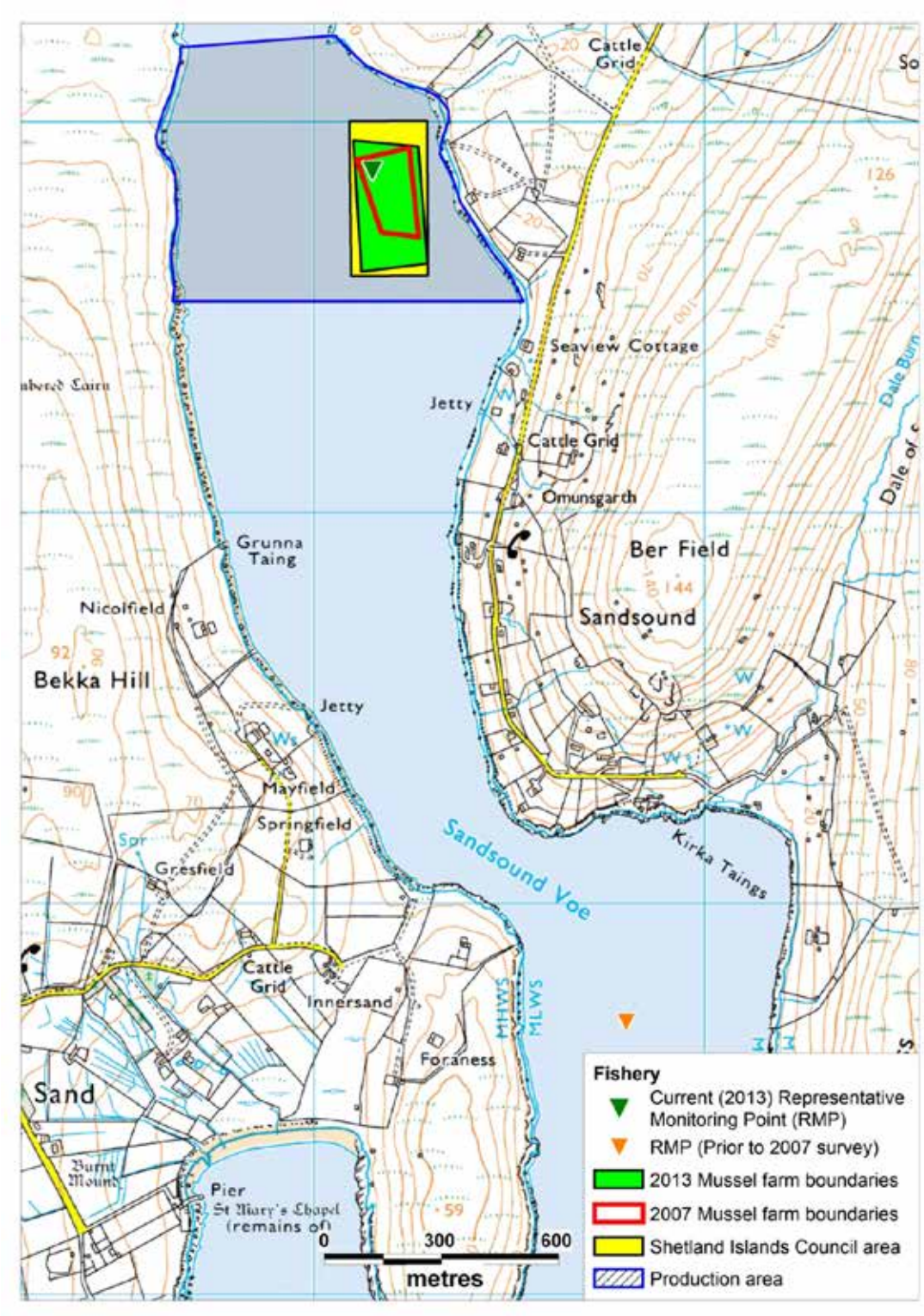

Figure 3.2 Current fishery production area, with current and historical farm boundaries at Sandsound Voe

4. Population and Human Sewage Impacts

Detailed data from the 2011 population census is listed alongside data from the 2001 census in Table 4.1.

Table 4.1 Population census data for areas around Sandsound Voe, from 2001 and 2011

Census Output Areas	Counts	
	2001	2011
60RD000033	131	132
60RD000136	55	66
60RD000032	153	209
60RD000026	91	158

The most notable population increase has been on the western side of Sandsound Voe.

Since the 2007 report, four planning applications were identified for the area >1 km northeast of Sandsound Voe in Tresta and Bixter. These applications were downloaded from the Shetland Island Council Planning portal (http://pa.shetland.gov.uk/online-applications/) in June 2013, with full details presented in Appendix 1.

Three of the four applications have been approved and were for new dwelling houses with associated septic tanks to soakaways: all three had provision for sustainable drainage systems (SDS), which will manage surface water drainage. The fourth application was for a change in a discharge condition, relating to an existing dwelling house. No further information on this application was available, and it is unclear from the description whether the change requested related to size, location or another condition of the sewage discharge. This application was pending consideration.

No significant change in boating activity was identified.

The 2007 sanitary survey report identified two community septic tanks to the north of Sandsound Voe, <2 km from the production area boundaries. These are presumed to still be extant. Details of these are listed below in Table 4.2 and displayed in Figure 4.1.

Table 4.2 Scottish Water discharges (2007)

NGR	Discharge Name	Discharge Type	Level of Treatment	Flow (m^3/d)	PE
HU 3300 5200	Bixter	Continuous	Septic Tank	3.6	20
HU 3570 5140	Tresta	Continuous	Septic Tank	-	10

-No data available

Significantly more observations related to sewage infrastructure were recorded in 2013 than in 2007: this may be due to observations of multiple dwelling houses with septic tanks being grouped in the initial 2007 shoreline survey. The majority of sewage discharge-related observations in both shoreline surveys were made along the eastern shoreline. One observation in 2013 related to a malfunctioning septic tank (observation 9), with faecal matter observed by the septic tank. Sewage-related observations from the 2013 shoreline survey are shown in Table 4.3.

Overall, sewage input to Sandsound Voe is mostly centred on the eastern shoreline, with many pipes and septic tanks from privately owned dwelling-houses observed along the shoreline. Input is not anticipated to have increased significantly since 2007, with only three new private septic tanks noted, and one change to an existing discharge condition. None of these new septic tanks were along the shoreline survey route covered in the 2013 shoreline survey.

Table 4.3 Sewage discharge-related observations around Sandsound Voe from the 2013 shoreline survey

No.	Year	NGR	Description of potential sewage discharge
1	2013	HU 3540 4979	Concrete septic tank of a house near the shore, adjacent to the Sandsound Voe mussel site.
2	2013	HU 3550 4967	Open plastic septic tank with two pipes extruding from the ground in a field next to a house located near the shore.
3	2013	HU 3554 4947	Plastic septic tank on grassy verge above the shore for B&B adjacent. Plastic pipe coming from the septic tank leading to the water, can't see the end of the pipe as it goes underground.
4	2013	HU 3550 4939	Old croft house on the shore, concrete septic tank located in the garden, possibly pipe leading to the shore underground as rocks built up on the beach extending into the water.
5	2013	HU 3547 4906	Concrete septic tank in field below the road for a house located above the road.
6	2013	HU 3538 4886	Plastic septic tank just above the shore for house located further up the field.
7	2013	HU 3544 4887	Concrete septic tank in the field below the road for the house located above the road.
8	2013	HU 3545 4873	Concrete septic tank next to a house just below the road. Tank overflowing discharging down the field to the shore. Toilet roll and human faecal matter extruding from the tank.
9	2013	HU 3547 4854	Concrete septic tank in use by house above the road.
10	2013	HU 3548 4849	Concrete septic tank located at the top of the field for house above the road.
11	2013	HU 3550 4841	Septic tank of a house above the shore.
12	2013	HU 3555 4831	Concrete septic tank of the house, looked very old, may not have been in use but couldn't find an alternative septic tank.
13	2013	HU 3573 4826	Plastic septic tank of house, black overflow pipe located further down the field.
14	2013	HU 3486 4847	Concrete septic tank of the second house.
15	2013	HU 3497 4833	Concrete septic tank, observed on the walk back from a road above the houses.

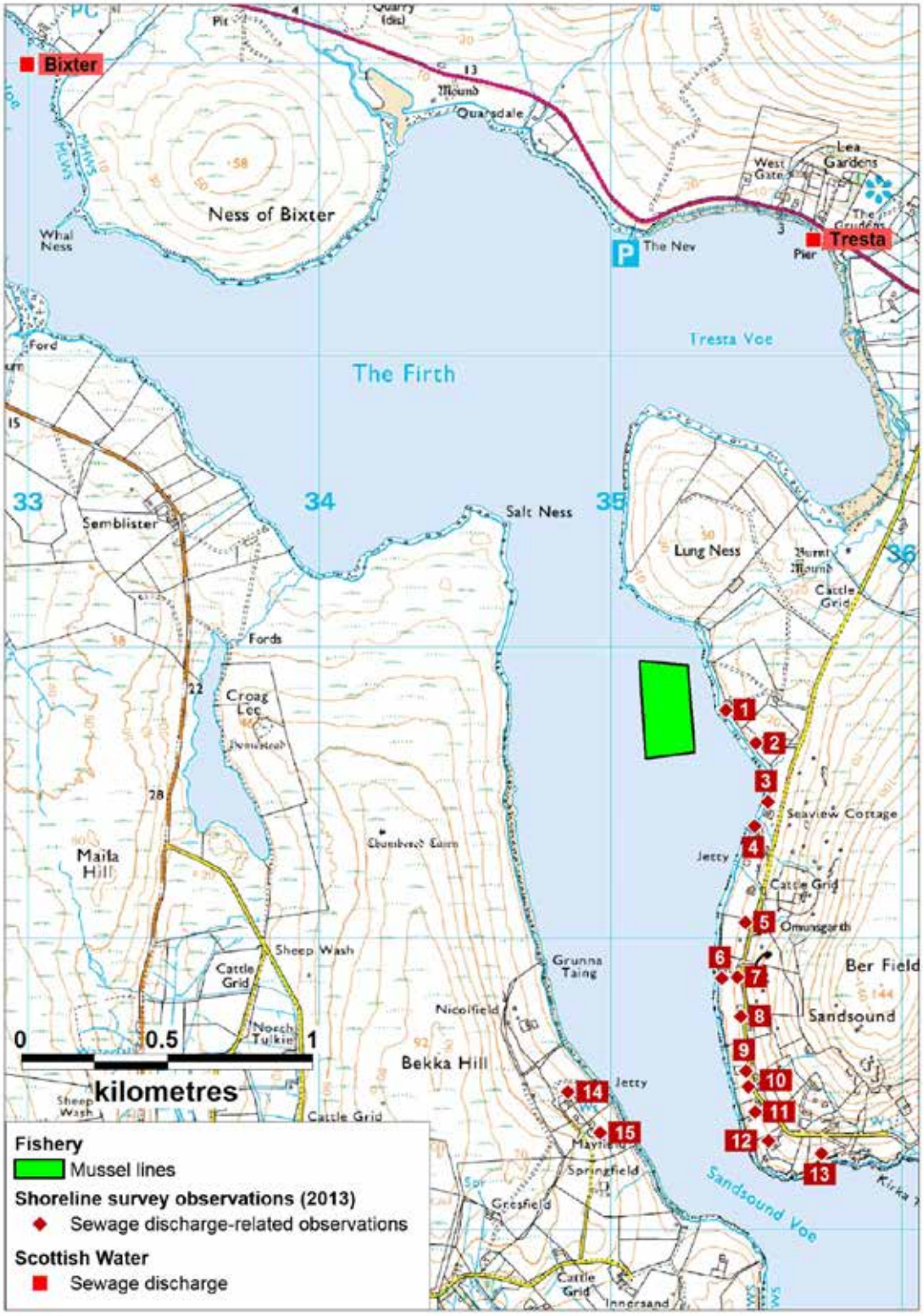

Figure 4.1 Sewage discharges and discharge-related 2013 shoreline survey observations in the vicinity of Sandsound Voe

5. Agricultural Impacts

The 2007 report included information on farm animal populations, including data from the Agricultural Census and shoreline survey. A recent desk-based search undertaken for this review returned no additional information on farming practices in the Sandsound Voe area. The following data presented for 2013 therefore only relates to the shoreline survey carried out on the 9th & 15th May 2013. Locations of animals observed during the 2013 survey are displayed in Figure 5.1.

The 2007 survey identified that sheep were common along most of the shoreline, with the largest flock observed on the hills south of the mussel farm. Sheep and stable bedding waste (a mixture of wood chippings and manure) were observed on the shoreline adjacent to the mussel farm.

In the 2013 survey, sheep remained common along much of the shoreline, with approximately 358 sheep observed in total. The largest concentrations of sheep were noted in Tresta, northeast of the mussel farm and near Sand, to the southwest of the mussel farm. Again, a number of sheep were recorded on the along the shore adjacent to the mussel farm. Sheep droppings were noted along both east and west shorelines. A sheep feeding area was also noted to the southwest shore.

Five agricultural sheds were observed in 2013, though none of them contained livestock at the time of the survey. Two sheds were observed on the east, some distance from shore and three were observed to the southwest, adjacent to houses and also set back from shore. No information on whether these sheds were used to store livestock or feedstock/machinery, and therefore it is uncertain whether these represent a concentrated source of faecal contamination.

Other livestock observed during the 2013 survey included two Shetland ponies fenced in a field below a house, southeast of the Voe.

A larger number of sheep were seen during the 2013 shoreline survey. However, it is not clear whether this is due to an increase in the population or to more animals being visible during the 2013 survey. The number of sheep is expected to continue to be highest between May-September (which includes the dates of both shoreline surveys). The purpose of the agricultural sheds remains unclear, though if livestock are kept in them over winter for shelter, they are likely to represent concentrated sources of faecal contamination, though all were noted to be >1 km south of the mussel farm.

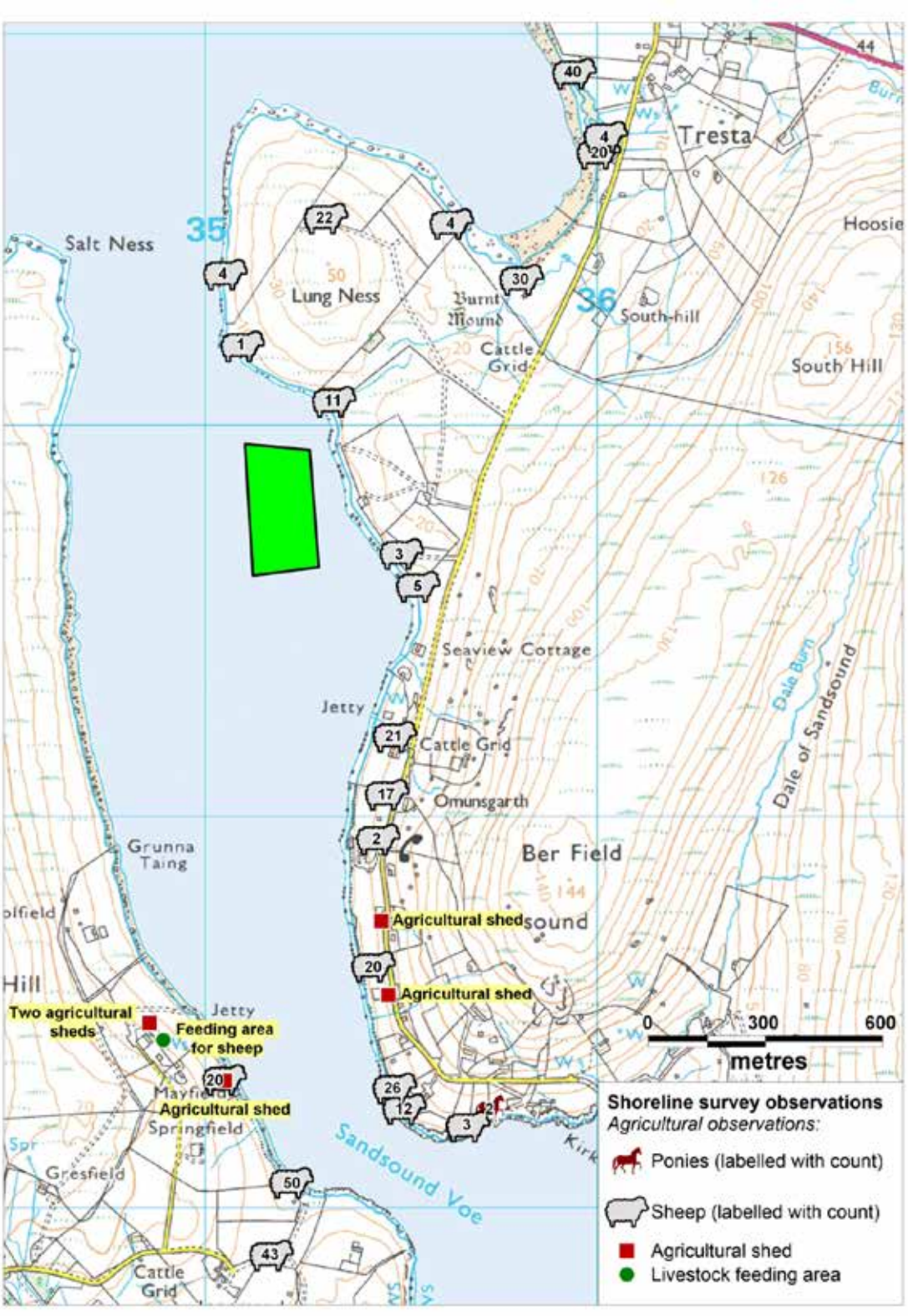

Figure 5.1 Farm animals and associated observations made during the 2013 shoreline survey

6. Wildlife

Information on pollution sources from wildlife has been obtained through surveys conducted in 2007 and 2013, and through a desk-based internet search undertaken for this review. Shoreline survey observation information only relates to the time of the surveys undertaken in May 2007 and on the 9th and 15th May 2013. Wildlife observations are displayed in Figure 6.1.

The main potential wildlife sources of faecal contamination identified in the 2007 sanitary survey were seals and seabirds.

During the 2007 survey, seals were observed in the water and hauled out on the shorelines at Effirth Voe and Bixter Voe, northwest of Sandsound Voe. The harvester stated that seals had been observed lying between mussel floats in the Sandsound Voe area (Mr Anderson pers. comm.).

Since the 2007 Sanitary Survey Report, a series of population counts for the common/harbour (*Phoca vitulina*) seal and the grey seal (*Halichoerus grypus*) have been carried out in Shetland. Reports indicate the area northwest of Sandsound Voe, close to Bixter Voe and Effirth Voe is considered an important haul out area for common seals (Duck *et al*., 2011; NAFC Marine Centre, 2012). The SCOS also identified this area as a popular haul out site in 2012, which is shown in Figure 6.1.

No seals were observed during the 2013 shoreline survey, which did not extend into Bixter/Effirth Voe. Changes in this seal population since the 2007 survey remain uncertain. It is expected that seals continue to pass through Sandsound Voe to move between the haul out site and open sea and thus there may be occasional contamination events from this source.

The Marine and Spatial Plan Shetland (NAFC Marine Centre, 2012) reports Sandsound Voe is an important area for harbour porpoise, whilst an area southwest of the Voe also represents an area important for white beaked dolphins. No whales or dolphins were observed during the 2007 or 2013 shoreline surveys. The impact from these animals within the voe, however, remains uncertain.

Small numbers of seabirds were seen in 2007, however Seabird 2000 was not queried in the original survey, although information from this source for Shetland in general was presented (Mitchell *et al*., 2004). Table 6.1 lists species found within a 5 km radius of Sandsound Voe. This data is presented geographically in Figure 6.1.

Bird data from the Marine and Spatial Plan have also been included in Figure 6.1, highlighting the widespread occurrence of available seabird habitat in areas around Sandsound Voe, as well as the prevalence of duck habitat and winter Eider duck habitat. This information closely matches detailed population data provided by Mitchell *et al*., (2004).

Table 6.1 Seabird 2000 census data for the 5 km area of Sandsound Voe

Common name	Species	Count	Method
Northern Fulmar	*Fulmarus glacialis*	264	Occupied nests
		1634	Occupied sites
European Shag	*Phalacrocorax aristotelis*	18	Occupied nests
Great Skua	*Stercorarius skua*	4	Occupied Territory
Arctic skua	*Stercorarius parasiticus*	2	Occupied Territory
Common Tern	*Sterna hirundo*	24	Individuals on land
Arctic Tern	*Sterna paradisaea*	273	Individuals on land
		72	Occupied nests
Black-legged Kittiwake	*Rissa tridactyla*	68	Occupied nests
Black Guillemot	*Cepphus grylle*	102	Individuals on land
Common Gull	*Larus canus*	122	Individuals on land
		30	Occupied nests
		64	Occupied Territory
Herring Gull	*Larus argentatus*	660	Individuals on land
		18	Occupied nests
		72	Occupied Territory
Lesser Black-backed Gull	*Larus fuscus*	12	Individuals on land
		24	Occupied Territory
Great Black-backed Gull	*Larus marinus*	56	Individuals on land
		4	Occupied nests
		31	Occupied Territory
Black-headed Gull	*Larus ridibundus*	14	Occupied Territory

*Occupied nests, Occupied Territory and Occupied Sites have been multiplied by two.

The largest collection of seabird nests, sites, and territory, as well as individual sightings was located on the northwest edge of Sandsound Voe, with a count of 827 seabirds. Due to the close proximity of these colonies (<500 m northwest) to the mussel farm, contamination from these birds is may have a significant impact on the bacteriological quality of water at the fishery. It is expected that contamination levels from these birds will be greatest over the spring and summer months, in particular April-June.

In the 2013 survey birds were the only wildlife observed, with species including; oystercatchers, gulls, a plover and geese. All sightings were of <10 individual birds at any one location, and feeding debris (e.g. shellfish shells) noted at three locations along the east shoreline suggested areas of potentially concentrated bird contamination. Goose faeces were also noted at two sites along the east shoreline.

Overall, the main species present in the vicinity of Sandsound Voe have not changed since the 2007 report. The spatial impact from seabirds has been re-assessed and is considered to be higher than assumed in the 2007 report, owing to the inclusion of count data specific to the Sandsound Voe area. Significant input of

faecal contamination from birds is likely to impact the mussel farm the most during the summer breeding season April-September, and is considered to be highest at the northwest corner of the fishery, due to the large colony located immediately to the northwest. Contamination from seals is likely to have remained the same, with a haul out site now officially recognised to the northwest of the Voe.

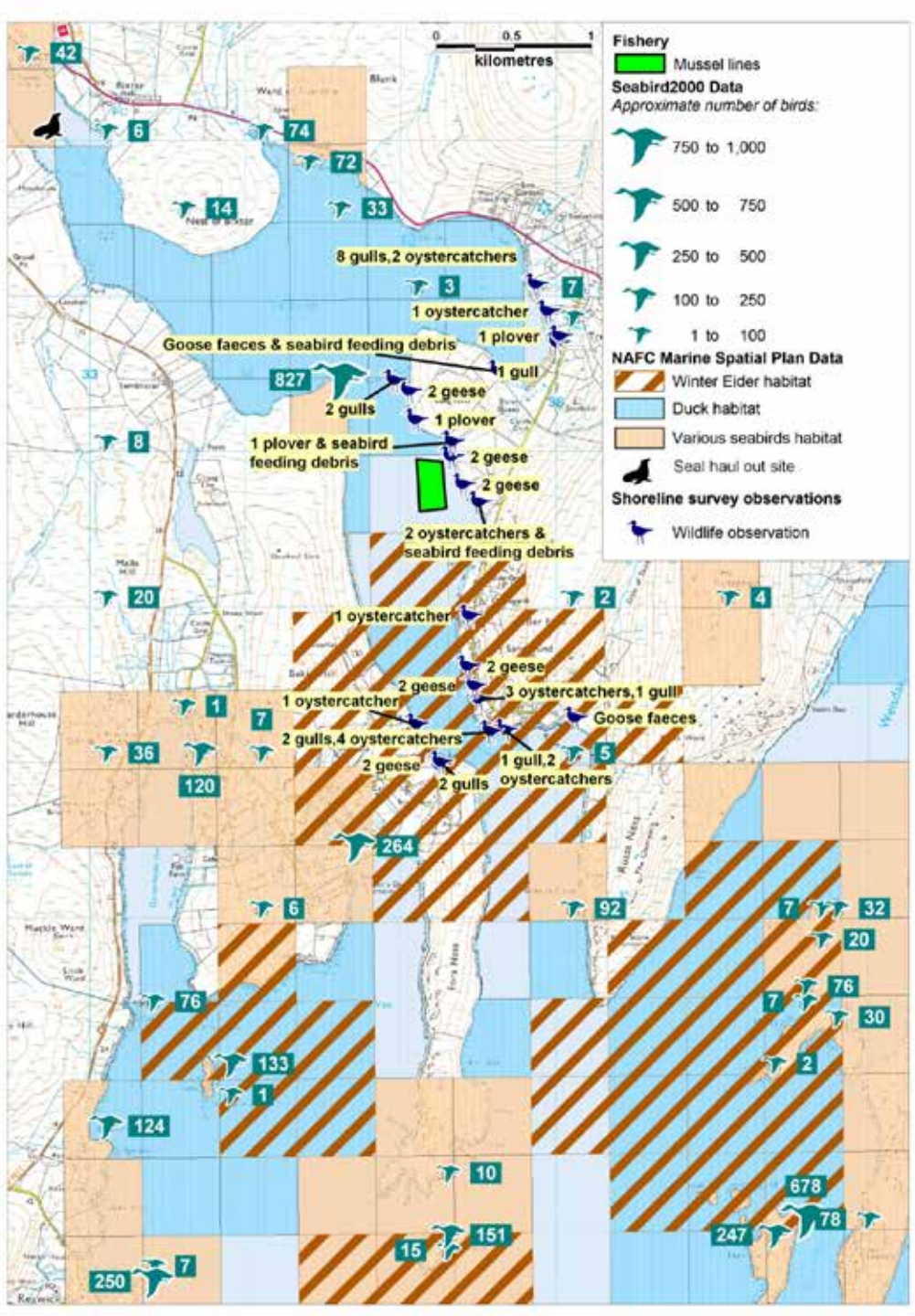

Figure 6.1 Map of wildlife around Sandsound Voe, including observations made during the 2013 shoreline survey

7. Watercourses

Prevailing weather conditions during the shoreline surveys were as follows: May 2007: dry, with rain reported in the 48 hrs prior to the survey, May 2013: light rain, mostly dry conditions over the 48 hrs prior to the survey.

A full list of recorded flow measurements and sample results from the 2013 shoreline survey can be found in Appendix 2.

Table 7.1 shows watercourse loadings estimated on the basis of the 2013 shoreline survey measurements and *E. coli* concentrations.

Table 7.1 Watercourse loadings to Sandsound Voe taken during the 2013 survey

No.	Description	NGR	Width (m)	Depth (m)	Flow (m^3/d)	*E. coli* (cfu/ 100 ml)	Loading (*E. coli* per day)
1	Dale Burn	HU 3612 4829	0.30	0.20	1100	44	$4.8x10^8$
2	Small watercourse	HU 3546 4850	0.10	0.04	66.0	600	$4.0x10^8$
3	Small watercourse	HU 3549 4920	0.10	0.06	21.0	<1	$<2.1x10^5$
4	Small watercourse	HU 3551 4940	0.15	0.15	41.0	<1	$<4.1x10^5$
5	Watercourse	HU 3555 4959	0.40	0.07	53.0	25	$1.3x10^7$
6	Large watercourse	HU 3581 5037	0.40	0.1	800	34	$2.7x10^7$
7	Small watercourse	HU 3599 5056	Not measured or sampled				Not Determined
8	Tresta Burn	HU 3587 5107	1.80	0.15	1800	20	$3.5x10^8$

To compare changes in freshwater contamination levels over time, freshwater sample data from the 2007 report is listed in Table 7.2. No flow data was recorded at the time of the 2007 survey, so sample *E. coli* concentrations are listed below. Locations of watercourses observed in 2007 are shown in Figure 7.1.

Table 7.2 Freshwater samples to Sandsound Voe taken during the 2007 survey

No.	NGR	Description	Width (m)	Depth (m)	*E. coli* (cfu/ 100 ml)
1	HU 3553 4958	Freshwater	0.50	0.02	11
2	HU 3552 4941	Freshwater	Not measured		>3000
3	HU 3598 5056	Freshwater	0.34	0.03	69
4	HU 3599 5067	Freshwater	1.10	0.02	11
5	HU 3551 4940	Freshwater	0.45	0.02	7
6	HU 3580 5038	Freshwater	1.44	0.29	>3000

E. coli levels in four of the freshwater samples taken during the 2007 survey were low at <70 *E. coli* cfu/ 100 ml. The levels in the other two samples, from watercourses 2 & 6, were high at >3000 *E. coli* cfu/ 100 ml. *E. coli* levels from samples taken in 2013 were predominantly low, except for watercourse 2 which had a moderate level of 600 *E. coli* CFU/ 100 ml.

Loadings calculated for watercourses sampled during the 2013 survey varied between $<4.1x10^5$ and $4.8x10^8$ *E. coli* per day, with the highest calculated for Dale Burn which enters in the northeast of Sandsound Voe. These loadings are towards the low end of the range encountered in Scottish watercourses during the sanitary survey programme. Watercourses 3-5 entered the voe to the eastsoutheast of the mussel farm, with that nearest to the farm (No. 5) having the highest loading of the three ($1.3x10^7$ *E. coli* per day).

Overall, the amount of contamination estimated to be entering into Sandsound Voe from freshwater sources is small. This may increase following heavy rainfall. The most significant source with respect to the mussel farm lies a short distance to the eastsoutheast.

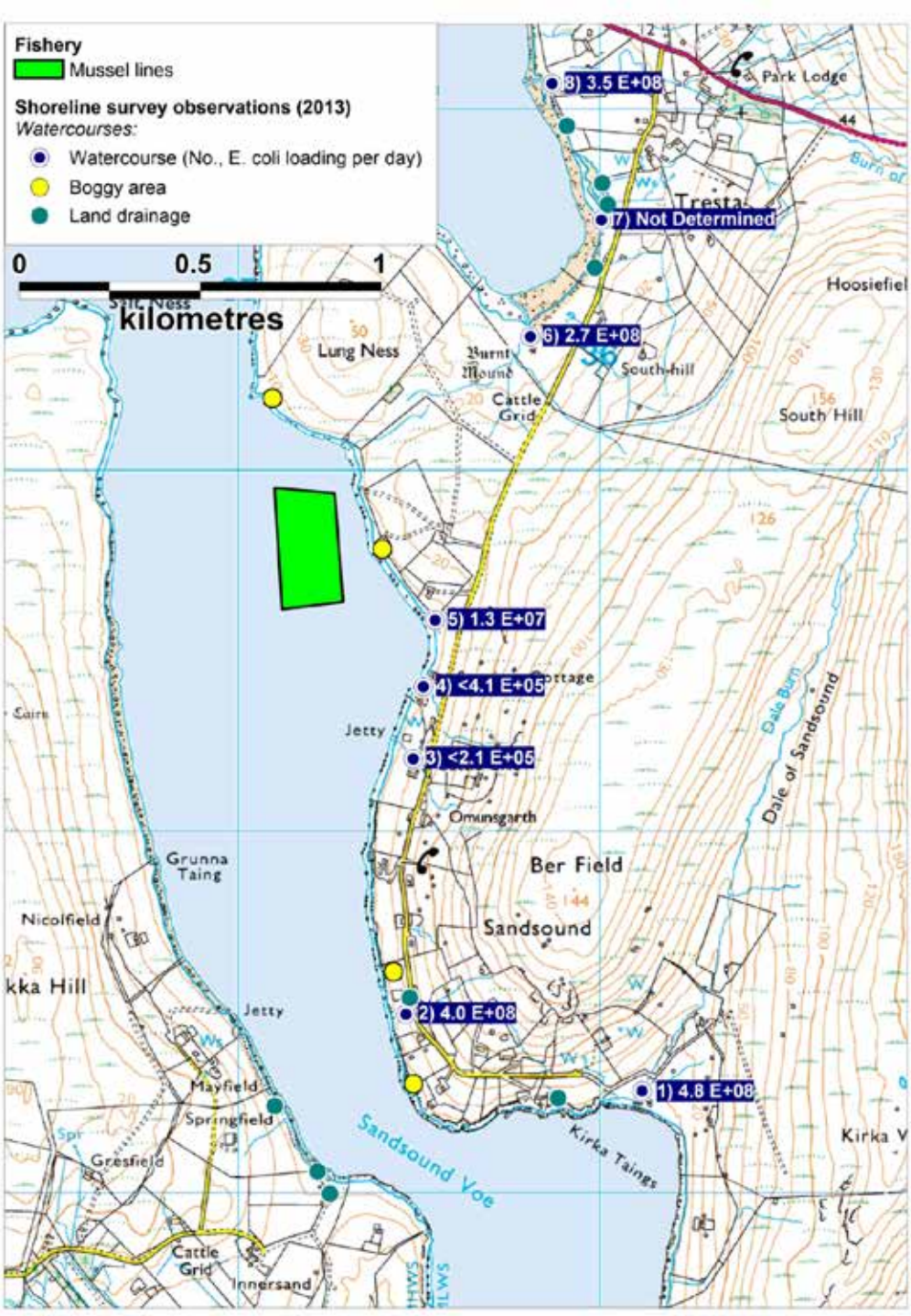

Figure 7.1 Watercourse loadings into Sandsound Voe, estimated from measurements made during the 2013 shoreline survey

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.

8. 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 Sandsound Voe Sanitary Survey Report: rainfall boxplots 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) and wind roses were taken from the Lerwick weather station, which lays approximately 12 km SE of the Sandsound Voe production area.

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 complete for the 2070 survey days.

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 and Morgan, 2003).

The Lerwick weather station rainfall dataset for 2007-2012 is presented by year in Figure 8.1 and by month in Figure 8.2.

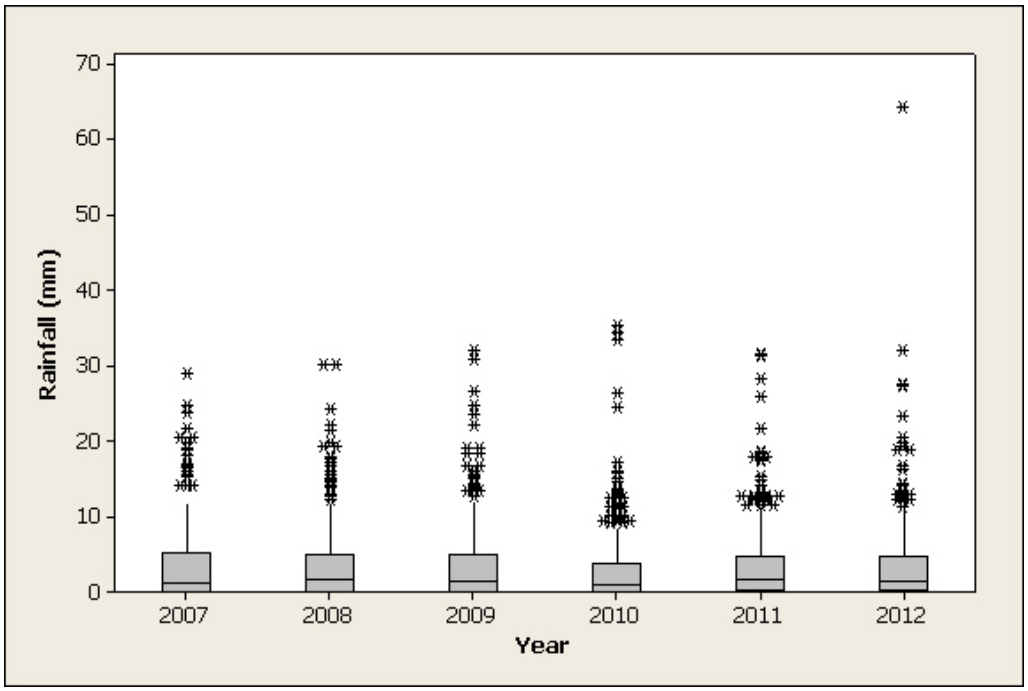

Figure 8.1 Boxplot of daily rainfall at Lerwick by year (2007-2012)

The bulk of the observations are below 10 mm rainfall/day. In the period 2007-2012 there were both wetter and drier years than occurred during the previous period 2003-2006: 2009 was generally wetter and 2010 was drier. The number of rainfall events exceeding 30 mm/day occurred in all years, with an extreme rainfall event of nearly 70 mm/d seen in 2012.

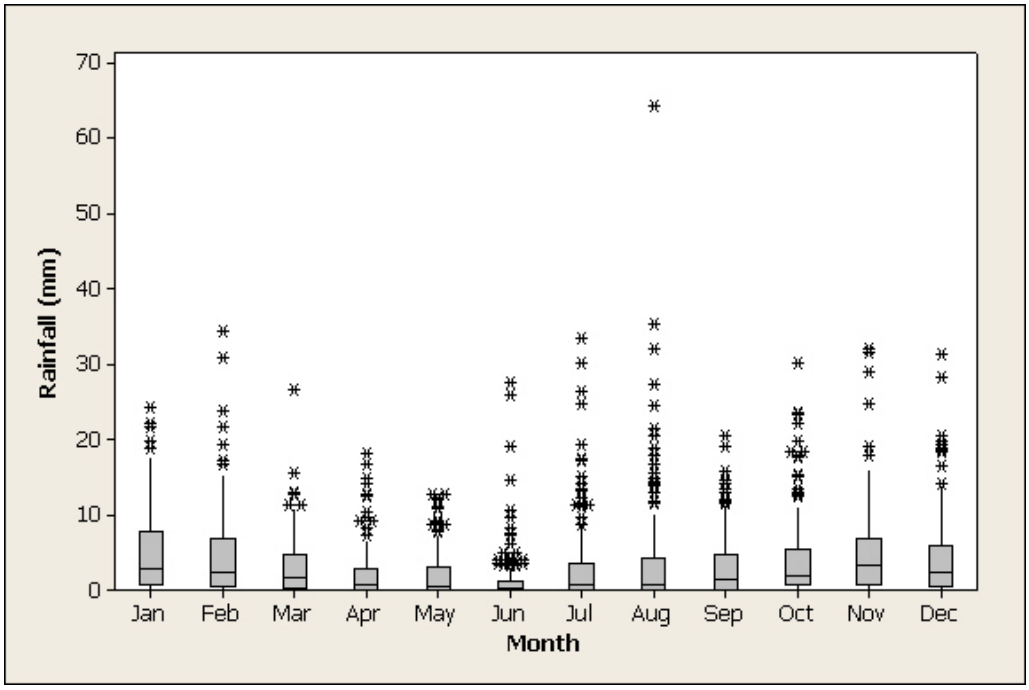

Figure 8.2 Boxplot of daily rainfall at Lerwick by month (2007-2012)

Figure 8.2 presents a boxplot of daily rainfall values by month for the 2007-2012 dataset. The period 2003-2006 had shown a marked difference in rainfall with season, with October to January the wettest months, and August and July the driest. A similar trend was seen in data from the period 2007-2012, with November to February representing the wettest months, and June the driest. There has been a shift in the pattern of rainfall events greater than 30 mm day; in 2003-2006 these were found in months February, August, October and November, compared to 2007-2012 when they also occurred in months July and December. A similar extreme rainfall event of greater than 60 mm rain in one day was seen in August, but no recurrence of the October 2006 >40 mm was found.

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 8.3 shows seasonal wind roses for Lerwick for the period 2002-2011 while Figure 8.4 shows the annual wind rose for the same period. The local topography at Sandsound Voe may result in differing wind patterns to those shown in the wind roses (Lerwick is on the east coast, Sandsound Voe is on the west coast).

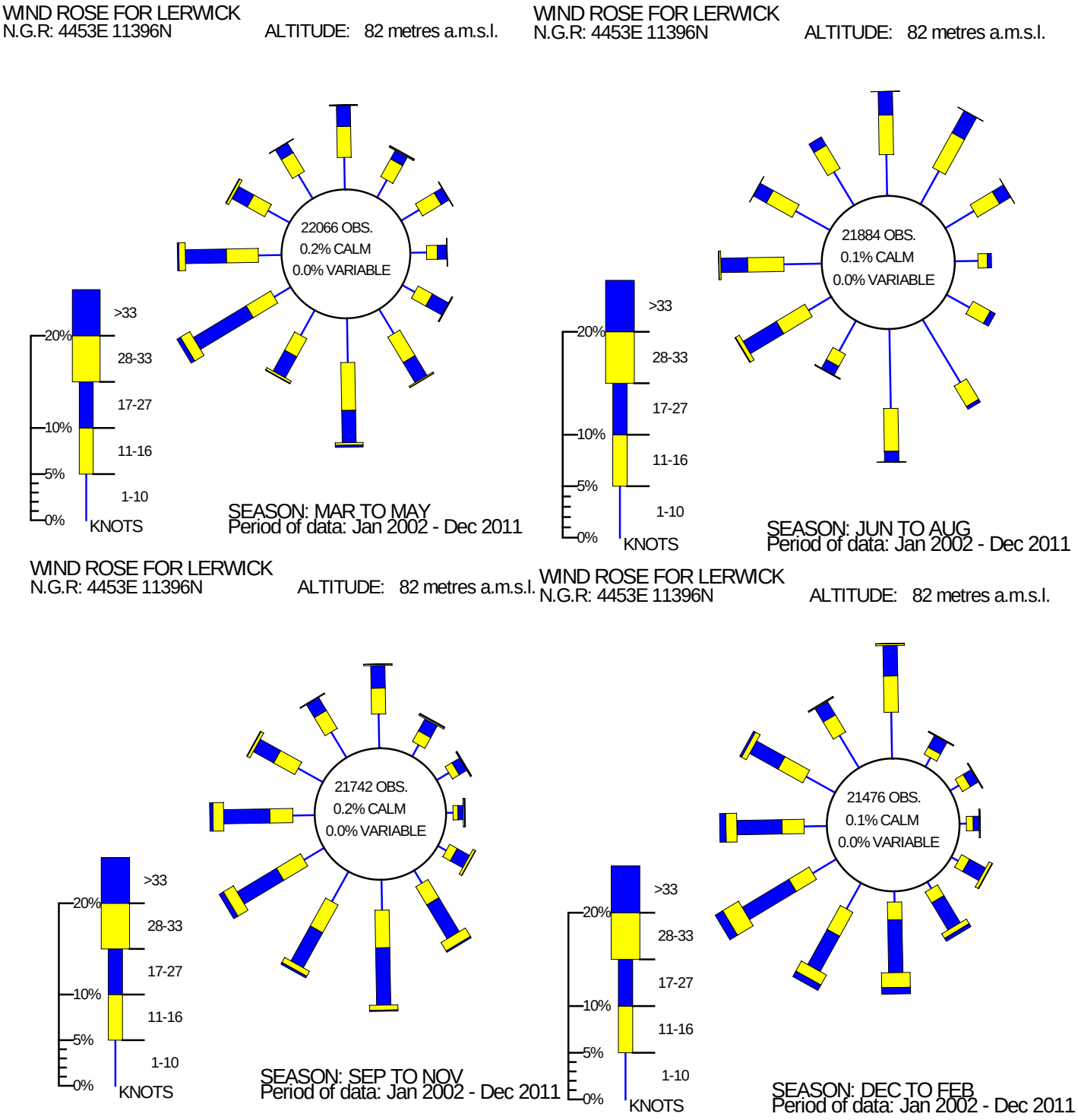

Figure 8.3 Seasonal wind roses for Lerwick (2002-2011)

Prevailing winds throughout all four seasons appears to be between south-south westerly particularly in autumn and winter when they are the highest winds. However, strong north easterly and north westerly winds also occur in summer, whilst spring winds were highest to the south-west. There are slight variations between years and seasons, but this trend was seen in both datasets.

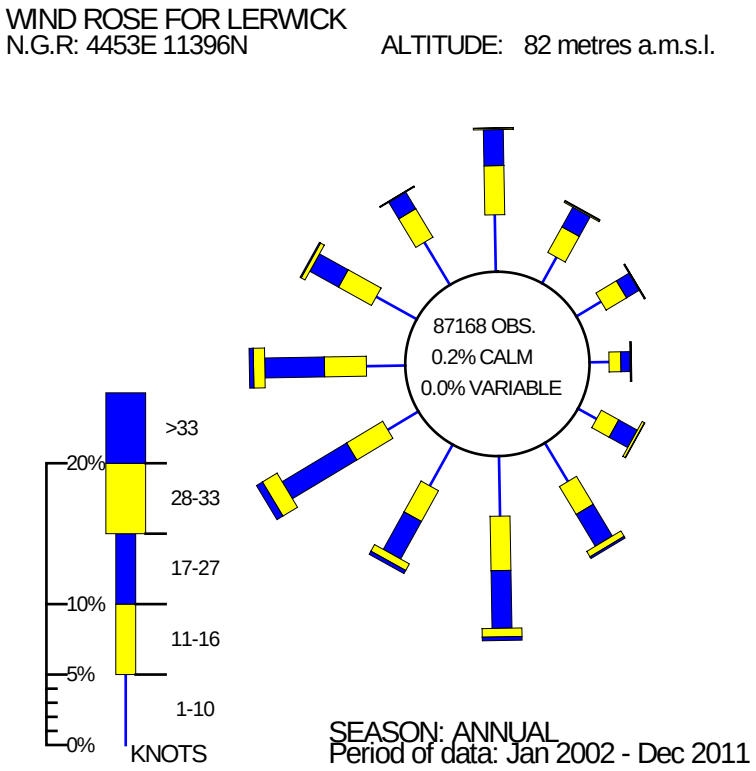

Figure 8.4 Annual wind rose at Lerwick (2002-2011)

The wind rose in Figure 8.4 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.

Sandsound Voe is narrow, south facing and surrounded by high ground. This is likely to result in a channelling effect on the prevailing wind. Strong winter southerly winds will increase the circulation of water and hence dilution of contamination from point sources within Sandsound Voe and will carry any contamination originating from the south (e.g. from settlements at Sand and Sandsound) up the Voe towards the production site. Comparatively in the summer when north-easterly winds prevail, contamination will be transported from the north (e.g. from the settlement at Tresta) towards the production site. Overall wind is expected to play a large role on contaminant transport, but it is likely that the narrowing at the entrance to Sandsound Voe will also cause tidal circulation to increase.

9. Historical *E.* coli Data

Results for the site assigned against Sandsound Voe between 01/01/2007 and 29/04/2013 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 April 2013. Historical *E. coli* data used in the 2007 report had already been extracted and validated. For the purposes of this report, samples pre-dating 2001 were deleted.

All *E. coli* results were reported as most probable number per 100 g of shellfish flesh and intravalvular fluid. *E. coli* results reported as <20 were reassigned a value of 10 *E. coli MPN*/100 g for the purposes of statistical evaluation and graphical representation.

Two samples [S02278-07-W and SSQC_2011_2311] were recorded on the database as 'rejected' and were deleted. One sample [SSQC_2010_1260] did not have a result assigned to it and was therefore deleted. All remaining samples were received at the laboratory within the 48 hr window. Seventeen samples reported results of <20 *E. coli MPN*/100 g.

Summary of microbiological results

The summary of sampling results between sampling periods 2001-2006 and 2007-2013 is given below in Table 9.1.

Table 9.1 Sampling summary results for Sandsound Voe common mussel fishery between 2001 and 2013

Sampling Summary				
Production area	Sandsound Voe			
Site	Sandsound Voe			
Species	Common mussels			
SIN	SI-242-443-08			
Location	Shetland Islands			
Years	2002-2006		2007-2013	
Total no. of samples	53		64	
	No. 2001	0	No. 2007	8
	No. 2002	6	No. 2008	9
	No. 2003	12	No. 2009	10
	No. 2004	12	No. 2010	11
	No. 2005	12	No. 2011	10
	No. 2006	11	No. 2012	12
			No. 2013	4
Results Summary				
Minimum	<20		<20	
Maximum	9100		790	
Median	50		30	
Geometric mean	69		41.3	
90 Percentile	500		270	
95 Percentile	1280		330	
No. exceeding 230/100g	6 (11%)		6 (9%)	
No. exceeding 1000/100g	2 (4%)		0 (0%)	
No. exceeding 4600/100g	1 (2%)		0 (0%)	
No. exceeding 18000/100g	0 (0%)		0 (0%)	

Sampling began in 2002, with between 10-12 samples taken during most years since 2003, except for years 2007 and 2008 when only 8 and 9 samples were taken respectively. The highest result (9100 *E. coli* MPN/ 100 g) was taken in the 2001-2006 sampling period.

Table 9.2 Classification status for Sandsound Voe common mussel fishery

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	B	B	B	B	B	A	A	A	A	A	B	B
2004	A	A	A	A	A	A	A	A	A	A	A	A
2005	A	A	A	A	A	A	A	A	A	A	A	A
2006	B	B	A	A	A	A	A	B	B	B	B	B
2007	B	B	A	A	A	A	A	B	B	B	A	A
2008	A	A	A	A	A	A	A	A	B	B	A	A
2009	A	A	A	A	A	A	A	A	B	B	A	A
2010	A	A	A	A	A	A	A	A	A	A	A	A
2011	A	A	A	A	A	A	A	A	A	A	A	A
2012	A	A	A	A	A	A	A	A	A	A	A	A
2013	A	A	A	A	A	A	A	A	A	A	A	A
2014	A	A	A									

Sandsound Voe mussel fishery has been classified since 2003. The area was class A in 2004 and 2005 and from 2010 on. The fishery had a seasonal A/B classification in 2004, 2006, 2008 and 2009 although the months classified as B varied.

Geographical patterns of results

The location of the historical and current RMPs and shellfish sampling locations for the sampling period 01/01/2007 – 29/04/2013 are displayed in Figure 8.1. Sampling locations and geometric means are listed in Table 8.3.

One sample [S00945-07-W] had an unverified NGR and has not been included in Figure 9.1.

Four samples taken in the first seven months of 2007 were recorded as being taken at the historical RMP at HU 358 477, which lay south of the Voe outside of the mussel farm. The remaining samples were taken within <150 m of the current RMP (HU 3515 4988). The highest E. coli results were associated with samples recorded as being taken from a location southeast of the RMP.

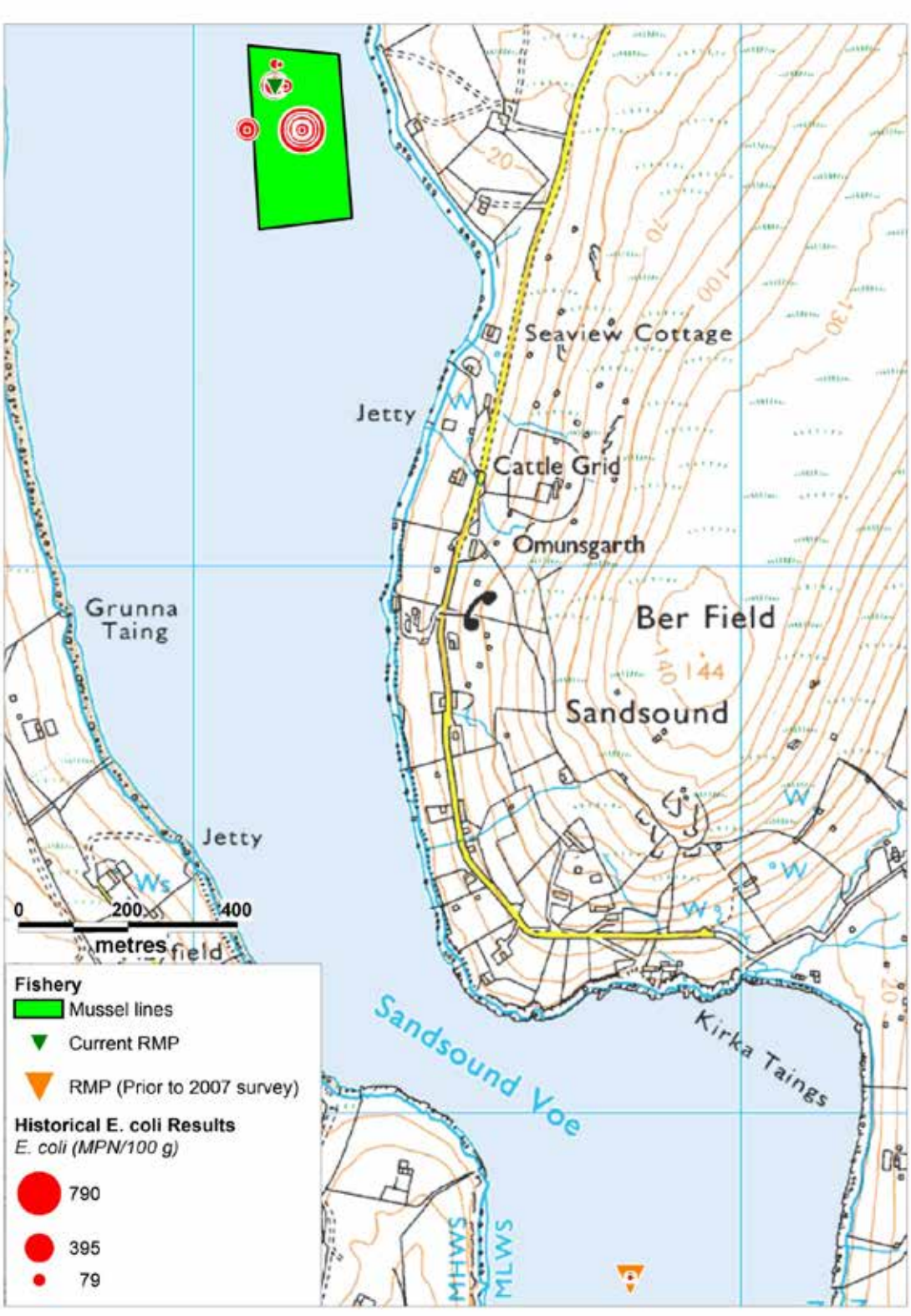

Figure 9.1 Sample results and locations of Sandsound Voe common mussel fishery

Temporal patterns of results

The trends of *E. coli* results for Sandsound Voe have been analysed for the years between the previous sampling period (2002-2006) and the current sampling period (2007-2013).

To test for significant differences between results from samples taken at Sandsound Voe over the two periods, the following statistical analyses were carried out:

- 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 Chi squared test was used to test for significant difference in observed and expected *E. coli* results above the level of 230 *E. coli* MPN/ 100 g from both sampling periods.
- A Fisher's Exact Test was used to test for significant difference in the observed and expected *E. coli* results above 1000 *E. coli* MPN/ 100 g from both sampling periods. This was due to two cells having expected counts at less than five, preventing the Chi-squared approach being a valid statistical analytical method.

Temporal trends are displayed below in Figure 9.2, followed by results from the statistical analyses in Table 9.3..

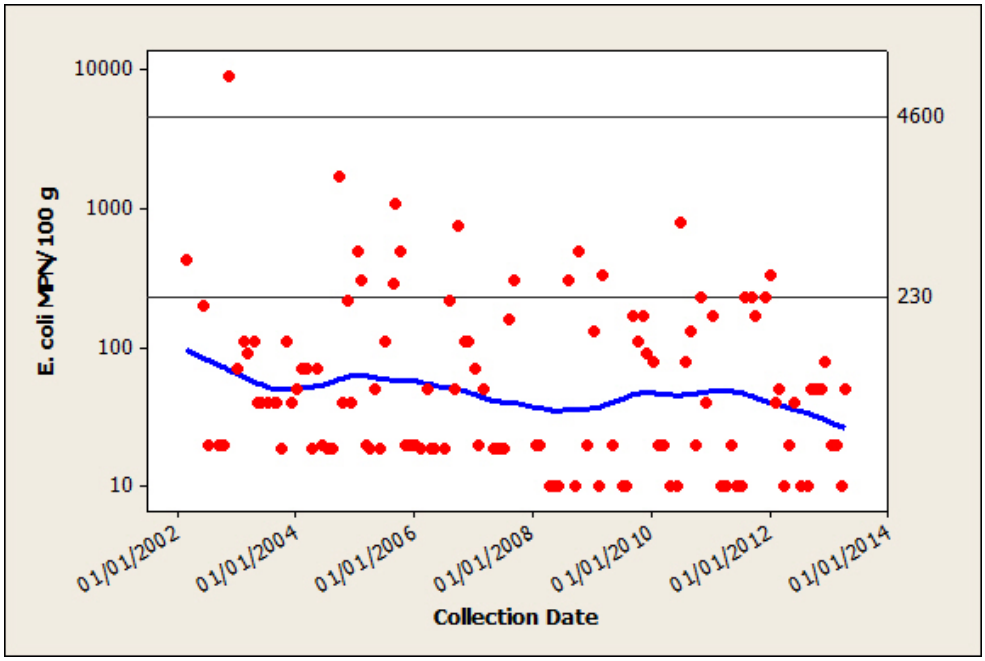

Figure 9.2 Scatterplot of Sandsound Voe common mussel *E. coli* results by date (2001-2013), with a lowess line

Figure 9.2 shows that both the peak levels of *E. coli*, and the general level of contamination, have declined since 2002. Fewer results since 2007 have been

>230 *E. coli MPN*/100 g. The difference between the two periods was not statistically significant, (Two sample t-test, t = 1.71, df = 125, p = 0.089).

Table 9.3 Chi-squared test and Fisher's Exact test results above and below 230 and 1000 *E. coli MPN*/100 g for Sandsound Voe common mussel *E. coli* results

		***E. coli* MPN/100g**			***E. coli* MPN/100g**		
		≤230	>230	**Total**	≤1000	>1000	**Total**
2001-2006	Observed	44	9	53	50	3	53
2007-2013	Observed	58	6	64	64	0	64
	Total	105	12	117	114	3	117

No statistically significant difference was found between the proportion of results ≤230 *E. coli* MPN/100 g and >230 *E. coli* MPN/100 g occurring during the two sampling periods (Chi-square test, $X^2 = 1.501$, df = 1, p = 0.221).

No statistically significant difference was found between sampling results ≤1000 *E. coli* MPN/100 g and >1000 *E. coli* MPN/100 g between sampling periods (Fisher's Exact Test, p = 0.09).

10. Movement of contaminants

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

- Weak tidal currents will continue to allow for localised contamination inputs to remain in Sandsound Voe for long periods at a time, due to the slow flushing time of eight days.
- Wind is expected to drive the majority of water movement, aided by the narrow constrictions in the middle and north extents of the Voe.
- The prevailing wind direction southwest will mean that net water movement will be north.

There have been no recent assessments of the hydrography or topography at Sandsound Voe that could be used to assess changes in the movement of contaminants. Satellite imagery courtesy of Bing maps (accessed 15/07/2013 at 17.09pm) and hydrographic chart data maps indicate that there have been no changes since the 2007 report. It is therefore anticipated that movement remains unchanged since the 2007 assessment.

11. 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

The 2011 population census data shows that, of the two census areas immediately adjacent to Sandsound Voe, the one to the west has shown a significant increse in population. Planning applications for three new dwelling houses and septic tanks, as well as a change in condition of an existing discharge were consented for the Tresta area, >1 km northeast of the production area: these are unlikely to have a significant effect at the fishery over and above the other sources identified in the area. The number of visitors to Sandsound Voe is likely to have remained the same, with only one B&B noted in Sandsound Voe.

During the 2013 shoreline survey, two septic tanks were noted directly adjacent to the mussel fishery, including one from a B&B. Two malfunctioning septic tanks were observed in the recent survey >1 km south of the fishery. At the time, one was continuing to overflow, whilst the other had stopped, though faecal matter remained present below the end of the pipe.

Agricultural impacts

Sheep continue to be the main livestock species reared along both sides of Sandsound Voe. They continue also to have free access to much of the shoreline. Sheep droppings were ubiquitous along both sides of the Voe during the recent survey, though no droppings were noted along the shore. Livestock numbers observed in both surveys are expected to represent the spring-summer lambing season, and populations are therefore expected to be lower during the winter. Overall, the observed numbers of sheep were higher in the 2013 shoreline survey and therefore the risk of contamination from this source may be greater although the spatial effects are expected to remain the same.

Wildlife Impacts

The Bixter/Effirth Voe area north of Sandsound Voe is now identified as a haul out site for seals and thus seals may use Sandsound Voe regularly when travelling between the haul out site and open sea. Any contamination effects from this source are expected to be relatively random across the mussel fishery.

A large seabird breeding colony is now known to be present to the northwest of Sandsound Voe, consisting of Northern Fulmar and European Shags which will breed over the summer months from as early as February/May. Contamination from this colony and other smaller colonies noted along the east and west sides of the Voe are likely to add to contamination entering across the fishery. Although

more birds were observed during the 2013 shoreline survey than in 2007, this may reflect short-term variations and not long-term population changes.

Seasonal Variation

Variations in the number of seabirds and sheep will occur across the year. However, the 2007 report did not find any significant seasonal variation in shellfish *E. coli* concentrations: the time series plot for more recent data does not indicate any clear seasonal trend.

Watercourses

Watercourse loadings were low. One watercourse was noted to discharge adjacent to the fishery and was anticipated to have the greatest potential impact on the fishery, particularly at the southeastern corner. This would be expected to be greater after rainfall.

Movement of contaminants

No information was obtained to suggest that the bathymetry and hydrodynamics have significantly changed since the 2007 sanitary survey report, therefore indicating movements of contaminants would be largely unchanged since the 2007 report.

Analysis of Results

Historical *E. coli* results

Mussel samples have predominantly been taken within 150 m of the current RMP (HU 3515 4988). This excludes four samples taken in 2007, which were located at the site of the historical RMP (HU 358 477). The highest results were associated with a sampling location to the southeast of the present RMP. No results >1000 E. coli MPN/100 g occurred during the period January 2007 to April 2013 inclusive.

Shoreline survey samples

- Mussel samples from the recent shoreline survey showed contamination levels were slightly lower from samples taken at the top of the mussel lines (20 and <20 *E. coli* MPN/ 100 g) than samples taken at the bottom (40 and 50 *E. coli* MPN/ 100 g), at both the northern and southern extents of the mussel lines. There was no marked difference between samples taken at the northern and southern extents of the lines.

- All seawater samples gave very low *E. coli* results between <1 and 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 Sandsound Voe:

- Human population with two community discharges in The Firth to the north of Sandsound Voe.
- Large numbers of sheep on both sides of the Voe, most with access to the shoreline.
- Diffuse contamination via watercourses

An increase in sheep in the area has been noted between the two shoreline surveys, as well as a small increase in the number of private septic tanks in the area. The historical *E. coli* monitoring results indicate that these have not had a significant effect on the level of contamination of the mussels.

The previous sanitary survey report did not consider contamination from seabirds to be significant: the more detailed data presented in this review indicates that these will be a potential source of contamination of the fishery to the northwest edge of the fishery.

The 2007 sanitary survey report had recommended restricting the southern boundary of the production area to exclude identified sources to the south and the location of the RMP at the northwestern edge of the mussel farm. The northern edge of the production area excluded the sources identified to the north of the fishery, including the seabird sites and the community septic tanks. It is therefore concluded that the recommendations of the 2007 sanitary survey report are still valid.

12. Recommendations

The production area and sampling plan recommendations are given below. The only difference from those given in the 2007 sanitary survey report is for tolerance of sampling. This has been changed from a 20 m radius to a 40 m radius from the RMP in order to allow for greater movement of the mussel lines.

Production area

The area bounded by lines drawn between HU 3466 5016 to HU 3505 5022 and HU 3464 4954 to HU 3554 4954, extending to MHWS.

RMP

HU 3515 4988

Tolerance

40 meters

Depth

1 meter

Frequency

Monthly

13. References

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14. List of Figures and Tables

Appendices

1. List of planning applications
2. Shoreline Survey Report

Appendix 1. List of planning Applications

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

Table 1 List of planning applications to the Shetland Island Council, to land surrounding Sandsound Voe

Date	Reference number	Planning Application
Jun-12	2012/215/DCON	Change of discharge condition No 2, Sevilla Cottage Tresta Bixter Shetland ZE2 9LT
Sep-10	2010/337/PCD	Erect new dwelling house with septic tank to soakaway using a SDS, Tresta Bixter ZE2 9LT
Sep-09	2009/264/PCD	Erect detached dwelling house with septic tank and soakaway, by Moorens, Tresta Bixter ZE2 9LT
Aug-08	2008/289/PCD	To erect dwellinghouse with septic tanks and SUDs, New dwelling Tresta Bixter ZE2 9LT
May-08	2008/187/ADV	To erect 2 information boards and life saving equipment, Tresta Beach Fetlar ZE2 9DJ

Shoreline Survey Report

Production Area:	Sandsound Voe
Site Name:	Sandsound Voe
SIN:	SI-242-443-08
Species:	Common Mussel
Harvesters:	Sandsound Mussels – Stephen Anderson
Local Authority:	Shetland Islands Council
Status:	Existing area
Dates surveyed:	9th & 15th May 2013
Surveyed By:	Sean Williamson (Hall Mark Meat Hygiene Ltd.) Vicki Smith (SSQC Ltd.) We are grateful to Stephen Anderson for providing assistance during the marine survey work.
Existing RMP:	HU 3515 4988
Area Surveyed:	See Figure 1

Specific observations made on site are mapped in Figure 1 and listed in Table 1. Water and shellfish samples were collected at the locations marked on Figures 2 and 3. Bacteriology results are given in Tables 2 and 3. Salinity profiles are presented in Table 4 with profile locations marked on Figure 2. Photographs are presented in Figures 4-14.

Weather

Thursday 9 May 2013

Initial overcast, misty conditions at the start of the shoreline survey rapidly cleared, with sunshine and scattered clouds present for the majority of the shoreline walk. Gentle to moderate (F3/F4) winds persisted throughout the day moving from an easterly, present early morning to a southerly throughout the survey and into the afternoon.

Preceding the eastern shoreline walk, Tuesday 7th May was a calm day to start, with wind building to a F6 south easterly early evening. Cloudy throughout the day with only light rain present for a short period in the evening. Wednesday 8th May was another cloudy day with occasional breaks of sunshine. South easterly F2/F3 winds in the morning built to a strong F6 around midday before dying out to a F2/F3 easterly going into the evening. A brief spell of light rain occurred in the evening.

Wednesday 15 May 2013

Cloudy, overcast conditions persisted throughout the boat work and the western shoreline walk. A south easterly wind built from a moderate (F4) to a strong (F6) breeze during the survey with a light rain shower occurring towards the end of the boat work. The boat work was carried out during the early part of the flood tide. High water at Scalloway, the nearest secondary port to Sandsound Voe, was predicted at 12:19 (UT).

Preceding the boat work and the western shoreline walk, Monday 13th May was a cloudy day with wind building throughout the day increasing from a gentle south

westerly F3 in the morning to a strong south easterly F6 into the evening. Heavy rain persisted throughout late evening and into the early hours of the next day. Tuesday 14th May saw light rain showers persist through the morning with a southerly wind increasing from a F3 to a F6 throughout the day before dying away into the evening.

Fishery

The location of the Sandsound Voe mussel lines are mapped in Figure 1. The fishery did have stocked mussel lines on site at the time of the survey. Harvesting is occurring presently on a regular basis at the fishery.

The fishery consisted of nine mussel lines running parallel to the shoreline (Figure 4). All lines were double headed long lines with 8-9 metre droppers. Two mussel samples were collected from the north west corner of the site from the line furthest from the eastern shore, taken from the top and bottom of a mussel line. Two mussel samples were also collected from the south east corner of the site from the line nearest the eastern shore, taken from the top and bottom of a mussel line.

Sewage/Faecal Sources

Human – On the eastern shoreline there were two main dwelling areas, Sandsound to the south and east of the Sandsound Voe fishery and Tresta to the north of the fishery. Dwellings were noted frequently along the shoreline until reaching the Sandsound Mussels shorebase. Eight houses were observed in the Sandsound area above the road some distance from the shore however four septic tanks associated with these properties were identified in the fields below the road, above the shore. Fourteen houses were observed below the road in Sandsound with nine septic tanks identified. One of the properties had a septic tank which was overflowing and discharging faecal matter and associated waste to the field below (Figure 5). No dwellings were present in the Lung Ness area, with dwellings present again at the head of Tresta Voe before beginning to concentrate towards the end of the shoreline walk. Three properties were noted at the head of Tresta Voe, one below the road and two above but these were some distance from the shore. Fifteen houses were noted in the Tresta area, five below the road and ten above the road. Three of the houses below the road were near the shore but were found to be north of Tresta Burn, which defined the end location of the shoreline walk. No septic tanks were identified in Tresta. On the western shoreline at Innersand, dwellings were less frequent. Three dwelling houses were noted at the start of the survey some distance from the shore with another two properties, with associated agricultural buildings, observed towards the end of the shoreline walk with septic tanks identified for these two dwellings. No other dwellings are located on the western shore of Sandsound Voe.

A number of pipes were identified along the eastern shoreline associated with land drainage and septic tanks. A bed and breakfast, located directly on the shore just south of the Sandsound Voe fishery had a pipe discharging to the sea from the septic tank, however the end of the pipe could not be seen as it went underground just before the water edge (Figure 6). A built up area on the beach below a dwelling adjacent to the bed and breakfast looked to be covering what could be a discharge

pipe from the septic tank. Again the end of the pipe could not be seen as the built up area extended into the water (Figure 7). Three pipes associated with land drainage were observed coming under the road and discharging to the field below. One of these pipes created a small watercourse which lead to the shore which returned a high *E.coli* count but this was most likely due to faecal matter being present in the watercourse (Figure 8). A small overflow pipe entered the watercourse which was assumed to be associated with the septic tank adjacent but no discharge was coming from the pipe. A small drainage pipe discharging clear water to the shore was present below a house, assumed to be land drainage. At the beginning of the shoreline walk an overflow pipe was noted below a septic tank however no discharge was present from the pipe. An open septic tank was present in the field next to a property to the east of the Sandsound Voe fishery which had two pipes extruding vertically from the ground most likely used for venting.

Sample analysis

Seven freshwater samples were obtained from watercourses on the shoreline survey, six of which were outlined on the sampling plan and one additional sample not outlined in the plan. The additional sample was taken from a small watercourse originating from above the road on the eastern shoreline near the south end of Sandsound Voe. A decision was made to sample the watercourse as it contained what was assumed to be faecal matter and also a discharge pipe which joined the watercourse which may have been from a septic tank adjacent to the watercourse (Figure 9). The faecal matter did not look to be of human or sheep origin, and there were no animals grazing in the field at the time of the survey. There was no evidence of grazing of horses, ponies or cows through the presence of hoof marks. It was therefore suspected that the faecal matter had being discarded in the watercourse. Of the seven watercourses sampled, six were found to have *E.coli* levels of 44 cfu/100ml or below. The sample which was found to have an elevated *E.coli* count (600 cfu/100ml) was from the additional watercourse not outlined in the survey plan.

Three seawater samples were obtained on the shoreline walk, all of which were outlined on the survey plan. All three samples were found to have *E.coli* counts of 3cfu/100ml or below.

E.coli levels in the seawater samples taken from the north and south ends of the Sandsound Voe fishery were <1 cfu/100ml and 1 cfu/100ml respectively.

Four mussel samples were obtained from the Sandsound Voe fishery, two from the north west corner of the site and two from the south east corner of the site. The two samples collected from the north west corner were obtained from the top and bottom of a mussel line. The sample from the top of the mussel line returned a count of 20 *E.coli* MPN/100g with the bottom sample returning levels of 40 *E.coli* MPN/100g. The two samples collected from the south east corner again were collected from the top and bottom of a mussel line. The top sample returning a count of <20 *E.coli* MPN/100g and the bottom sample returning levels of 50 *E.coli* MPN/100g.

E.coli levels in the mussel tissue were found to be greater in samples obtained from the bottom of mussel lines compared with those obtained from the top of mussel lines. *E.coli* levels were quite similar at the two locations with the south east corner

having a slightly lower count in the sample obtained from the surface compared to the north west corner surface sample but the south east corner sample taken from depth had a slightly higher *E.coli* level than the sample obtained from depth at the north west corner.

Salinity profiles were collected from the north and south end of the Sandsound Voe fishery and the north and south ends of Sandsound Voe production area. All profiles obtained showed <0.18 ppt change in salinity from 10 metres to the surface which is within the accuracy of the probe used (± 0.35 ppt). All profiles showed a trend of a slight increase in salinity with decreasing depth although the range of these readings were within the accuracy level reported by the probe.

Temperature profiles showed little change from 10m depth to the surface with one profile showing no change and the other three profiles showing a slight decrease in temperature (0.1-0.4°C) from 10m to the surface.

Salinities of the seawater samples analysed at the laboratory showed salinities ranging from 34.57-35.06 PSU.

The seawater sample collected on the western shoreline walk at Innersand had the lowest salinity (34.57 PSU) with the sample collected from the Omunsgarth jetty on the eastern shoreline walk having the highest salinity (35.06 PSU) of the seawater samples.

Seasonal population

There is one known self-catering property and one known bed and breakfast situated on the eastern shoreline of Sandsound Voe. The self-catering property (The Lodge) is located near the south end of Sandsound Voe in a group of houses above the road some distance from the shore. The property is available to rent all year round and can house four people. The bed and breakfast which was noted during the shoreline survey is located just up from the shore, south of the Sandsound Voe fishery. The septic tank for this property was identified and the discharge pipe leading the sea was also noted. All other houses identified on the shoreline survey route were assumed to be dwelling houses.

Boats/Shipping

Most boat traffic in the Sandsound Voe area is associated with mussel farming. Sandsound Mussels who own the Sandsound Voe fishery have a shorebase located to the east of the fishery used to service the site (Figure 10). There are two production areas north of Sandsound Voe production area in The Firth. Three mussel fisheries are sited here which are owned by companies who do not have shorebases in the area so can only be accessed by travelling through Sandsound Voe. Sandsound Mussels had one large workboat and one small workboat moored at the shorebase at the time of the survey. Another mussel farming company have been given permission to use this shorebase to carry out weekly sampling for biotoxins and monthly sampling for *E.coli* at sites located out with Sandsound Voe in the surrounding area. However on the day of the shoreline survey the small workboat used for the sampling was not moored at the shorebase. There does seem to be some leisure boating activity in Sandsound Voe with a number of small boats moored on beaches on both the east and west shore. On the eastern shore two

small boats used for leisure purposes were observed on a small stony beach at the south end of the production area. Also at the Omunsgarth jetty there were another four boats ashore next to the house, again most likely used for leisure purposes (Figure 11). On the western shore at the start of the shoreline walk at Innersand, three small boats used for leisure purposes were ashore at the top of a small stony beach.

Farming and Livestock

The land on the shoreline survey was largely rough grazing with only one area of improved grazing land present on the eastern shoreline on the east side of Lung Ness. Sheep were frequently observed grazing on both the eastern and western shoreline. On the eastern shoreline sheep were observed on twenty occasions, 325 animals in total with approximately half these animals having access to the shore (Figure 12). On the western shoreline sheep were noted on three occasions but these were large groups of animals, 113 in total, with the majority of these animals having access to the shore, however access may have been difficult in some cases due to the steep escarpments at the shoreline. Sheep faeces were noted is most areas animals were grazing however there were two occasions where sheep faeces were noted but no animals were present.

Two Shetland ponies were observed in a field below a house (Figure 13) near the start of the eastern shoreline walk, at the south end of Sandsound Voe. The animals did not have access to the shore.

Two agricultural sheds were noted on the eastern shoreline however both were located above the road, some distance from the shore. On the western shoreline three agricultural sheds were observed adjacent to houses near the end of the shoreline walk in the Mayfield area. Also a feeding area for sheep was noted between the two houses in this area (Figure 14).

Land Use and Land Cover

Rough grassland dominated both eastern and western shorelines of the production area. Improved grazing land was observed on one occasion on the east side of Lung Ness.

Both shorelines were characterised by undulating landscape alternating between steep cliffs and escarpments with no access to the foreshore, to lowland beach areas where access to the foreshore was possible. Grazing varied between open and fenced areas, however in some areas where the animals were not fenced in the steep escarpments may have prevented the animals from accessing the shore.

There was little rainfall in the days preceding the eastern shoreline walk however wet boggy areas were noted on six occasions. Preceding the western shoreline walk there had been prolonged periods of rainfall, with one area of boggy ground noted.

Watercourses

Seven watercourses were sampled on the eastern shoreline, six of which were on the sample plan. The additional sample was collected from a small watercourse at the south end of Sandsound Voe originating from above the road with a number of dwelling houses in the surrounding area.

Flow rate was recorded at another four watercourses, one on the eastern shoreline and three on the western shoreline, where water samples were not obtained due to these areas not being considered as major sources of pollution.

Wildlife/Birds

On the eastern and western shoreline gulls, oystercatchers and geese were observed often taking flight from the shore or feeding on the shore. Goose droppings were also noted on two occasions on the eastern shoreline when there were no geese present. Individual plovers were observed on three occasions on the eastern shoreline and a cormorant was observed on a mussel float at the Sandsound Voe fishery during the boat work. Mussel shells were observed on grassy verges up from the east shore on a three occasions where birds may have been feeding, two of these locations being close to the Sandsound Voe fishery. Rabbits were observed on four occasions in fields above the shore, mainly on the eastern shoreline.

General observations

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

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

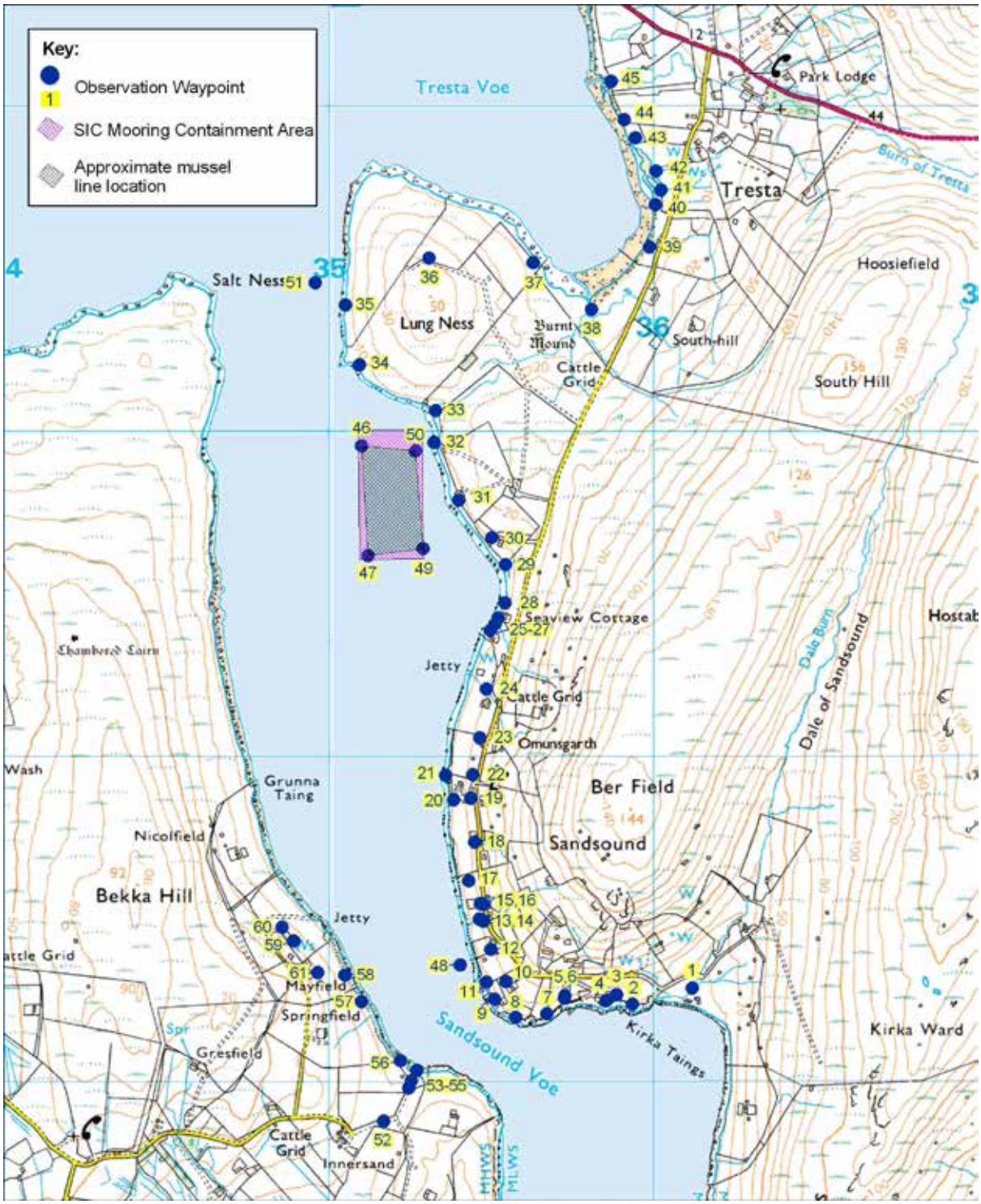

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Figure 1 Map of shoreline observations

Table 1 Shoreline Observations

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
1	09/05/2013 08:56	HU 36118 48285	436118	1148285		SV-FW01	Shoreline survey walk Sandsound (east coast). Weather - misty, fresh breeze. Rough grassland with boggy lowland area near the mouth of the burn. Approximately eighty sheep on the hill, animals able to access the shore. Dale Burn, large watercourse running down from the top of the hill. Freshwater sample taken and flow rate measured; width 30 cm, depth 20 cm, flow 0.211 m/s, st. dev. 0.012 m/s. Sheep and goose faeces observed on the banks of the burn. Five derelict crofts present either side of the burn further up the hill. Stony beach at the mouth of the burn where it meets the shore.
2	09/05/2013 09:04	HU 35934 48236	435934	1148236			Cliffs steepening, two rabbits observed in the field above the shore.
3	09/05/2013 09:05	HU 35886 48264	435886	1148264			Water drainage area with small water flow below two derelict houses, discharging down steep cliff edge. Sheep faeces present.
4	09/05/2013 09:07	HU 35853 48247	435853	1148247			Old concrete septic tank in garden below an abandoned house. Garden overgrown with long grass, trees, daffodils and rhubarb.
5	09/05/2013 09:16	HU 35726 48254	435726	1148254	Figure 13		Two Shetland ponies in a fenced area below a house, not able to access the shore.
6	09/05/2013 09:18	HU 35727 48262	435727	1148262			Plastic septic tank of house mentioned above, black overflow pipe located further down the field. Another three houses observed above the road.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
7	09/05/2013 09:22	HU 35672 48207	435672	1148207			Three sheep in fenced area below a house, sheep faeces present inside and outside of the fenced area but steep escarpment at the shore. One gull and two oystercatchers taking flight from grassy verge at the shore.
8	09/05/2013 09:27	HU 35576 48196	435576	1148196			Two gulls and four oystercatchers in the field above the shore. Sheep faeces present but no animals grazing.
9	09/05/2013 09:29	HU 35510 48251	435510	1148251	Figure 12		Twelve sheep grazing in a fenced area below a house, one rabbit observed in the field.
10	09/05/2013 09:32	HU 35546 48305	435546	1148305			Concrete septic tank of the house mentioned above, looked very old, may not have been in use but couldn't find an alternative septic tank.
11	09/05/2013 09:34	HU 35485 48304	435485	1148304			Six sheep observed in a field next to the shore, animals have access to the shore. Lowland area, small stony beach with two small leisure boats on the shore at the top of the beach. Another twenty sheep including lambs were observed in the field above the road. Boggy area present at the northern end of the field.
12	09/05/2013 09:39	HU 35499 48405	435499	1148405			Septic tank of house above the shore. Three oystercatchers and one gull observed in the field.
13	09/05/2013 09:43	HU 35475 48491	435475	1148491			Concrete septic tank located at the top of the field for house above the road. Two geese taking flight from the shore.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
14	09/05/2013 09:53	HU 35464 48497	435464	1148497	Figure 8 & Figure 9	SV-FW02	Large grey drainage pipe coming under the road discharging to the field creating a small watercourse leading to the shore. Small water discharge, brown algae present at the end of the pipe. Suspected discarded faecal matter present in the watercourse. Small grey pipe joins the watercourse half way down possibly from septic tank mentioned above which was located next to the watercourse. No discharge from this pipe. Freshwater sample taken (not on survey plan) and flow rate measured; width 10 cm, depth 4 cm, flow 0.191 m/s, st. dev. 0.006 m/s.
15	09/05/2013 09:59	HU 35476 48543	435476	1148543			Pipe coming under road into the field above the shore most likely used for land drainage. Small discharge pooling at the top of the field, ground wet but no water flowing down to the shore.
16	09/05/2013 09:59	HU 35467 48544	435467	1148544			Concrete septic tank in use by house above the road. An agricultural shed was located adjacent to the house. Sheep faeces present in the field but no animals grazing. Animals would have access to the shore.
17	09/05/2013 10:03	HU 35430 48615	435430	1148615			Twenty sheep including lambs present in the field above the shore, steep cliffs at the shoreline so animals would have difficulty accessing the shore. Boggy land present. House present above the road. Two geese taking flight from the field.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
18	09/05/2013 10:07	HU 35450 48734	435450	1148734	Figure 5		Concrete septic tank next to a house just below the road. Tank overflowing discharging down the field to the shore. Toilet roll and human faecal matter extruding from the tank. Agricultural shed noted above the road.
19	09/05/2013 10:14	HU 35438 48868	435438	1148868			Concrete septic tank in the field below the road for the house located above the road.
20	09/05/2013 10:17	HU 35384 48864	435384	1148864			Plastic septic tank just above the shore for house located further up the field.
21	09/05/2013 10:22	HU 35360 48940	435360	1148940	Figure 11	SV-SW01	Seawater sample obtained from a small jetty associated with a house and large shed on the shore front at Omunsgarth. Four small leisure boats stored next to the house. Weather - mist has cleared, sun breaking through, partly cloudy.
22	09/05/2013 10:33	HU 35443 48941	435443	1148941			Two sheep noted in the field behind a house and garage up from the shore. One oystercatcher observed in flight.
23	09/05/2013 10:37	HU 35465 49055	435465	1149055			Concrete septic tank in field below the road for a house located above the road. Seventeen sheep including lambs observed, area not fenced but would have difficulty accessing the shore due to steep cliffs. Sheep faeces present.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
24	09/05/2013 10:48	HU 35485 49204	435485	1149204		SV-FW03	Small watercourse from above the road running through vegetation and rocks to the shore. Freshwater sample taken and flow rate measured; width 10 cm, depth 6 cm, flow 0.04 m/s, st. dev. 0.021 m/s. Abandoned house adjacent to the watercourse with old septic tank. Old disused house some distance up the hill above the road. Twenty one sheep including lambs observed.
25	09/05/2013 10:56	HU 35498 49386	435498	1149386	Figure 7		Old croft house on the shore, concrete septic tank located in the garden, possibly pipe leading to the shore underground as rocks built up on the beach extending into the water. High water so unable to see the end of the pipe.
26	09/05/2013 11:00	HU 35512 49404	435512	1149404		SV-FW04	Small watercourse flowing through rocks to the beach, located between two houses. Freshwater sample taken and flow rate measured; width 15 cm, depth 15 cm, flow 0.021 m/s, st. dev. 0.007 m/s.
27	09/05/2013 11:06	HU 35521 49423	435521	1149423			Black water drainage pipe below a house, small clear water discharge to the stony beach.
28	09/05/2013 11:09	HU 35543 49469	435543	1149469	Figure 6		Plastic septic tank on grassy verge above the shore for B&B adjacent. Plastic pipe coming from the septic tank leading to the water can't see the end of the pipe as it goes underground.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
29	09/05/2013 11:17	HU 35545 49588	435545	1149588		SV-FW05	Watercourse discharging to the shore at the south end of the Sandsound Voe mussel site. Freshwater sample taken and flow rate measured; width 40 cm, depth 7 cm, flow 0.022 m/s, st. dev. 0.006 m/s. Five sheep observed in the field beside the watercourse with access to the shore and sheep faeces present on the shore. Boggy ground present above the stony beach.
30	09/05/2013 11:24	HU 35502 49671	435502	1149671			Open plastic septic tank with two pipes extruding from the ground in a field next to a house located near the shore. Three sheep present in this field, fenced area with no access to the shore, sheep faeces observed. Another property located behind this house some distance from the shore. Mussel shells observed on the shore where birds may have been feeding. Two oystercatchers seen in flight.
31	09/05/2013 11:30	HU 35399 49785	435399	1149785			Concrete septic tank of a house near the shore, adjacent to the Sandsound Voe mussel site. Ground boggy and sheep faeces present on the shore. Two geese observed in flight.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
32	09/05/2013 11:34	HU 35323 49964	435323	1149964	Figure 4 & Figure 10		Sandsound Mussels shorebase, pier and pontoon to the north end of the Sandsound Voe mussel site. One large and one small workboat moored there at the time of the survey, but pontoon also used by another mussel farming company to moor a small workboat used for biotoxin and *E.coli* sampling. Equipment associated with mussel farming stored here such as mussel floats, pegs, ropes and anchors. Two geese observed in the water next to the shorebase.
33	09/05/2013 11:57	HU 35330 50061	435330	1150061			Eleven sheep present in a fenced area above the shore, however sheep faeces noted on the shoreline outside the fence. Mussel shells present on the grassy verge where birds may have been feeding. One plover taking flight from the shore.
34	09/05/2013 12:03	HU 35095 50202	435095	1150202			Rough grassland with occasional boggy areas. One sheep observed on the hill, sheep faeces noted near the shore. One plover in flight. Landscape changes dramatically from steep escarpment to accessible lowland area with a stony beach.
35	09/05/2013 12:08	HU 35052 50386	435052	1150386		SV-SW02	Seawater sample obtained from the shoreline at Lung Ness. Two geese taking flight and three sheep and one lamb observed on the hill.
36	09/05/2013 12:19	HU 35309 50530	435309	1150530			Twenty two sheep including lambs observed in fields at the north side of the Lung Ness hill.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
37	09/05/2013 12:24	HU 35630 50515	435630	1150515			Improved grazing land with two sheep and two lambs present. Goose and sheep faeces present. At the bottom of the field was a small sandy beach and small wooden pier. Mussel shells observed on the grassy verge up from the shore possibly where birds have been feeding.
38	09/05/2013 12:31	HU 35808 50373	435808	1150373		SV-FW06	Large watercourse at the head of Tresta Voe. Splitting off into a number of channels before reaching the shore. House observed below the road some distance from the shore. Freshwater sample taken and flow rate measured; width 40 cm, depth 10 cm, flow 0.23 m/s, st. dev. 0.007 m/s. House also present above the road with thirty sheep observed in a field beside the house.
39	09/05/2013 12:40	HU 35987 50564	435987	1150564			Small discharge from a pipe coming under the road most likely land drainage. Small house located above the road.
40	09/05/2013 12:45	HU 36006 50695	436006	1150695			Large areas of pooling water near the shore, most likely seawater left behind after the tide goes out. Flow rate was measured in channel leading to the sea. Width 120 cm, depth 5 cm, flow 0.516 m/s, st. dev. 0.014 m/s. Not thought to be a large source of pollution therefore no water sample taken. Gull taking flight from the shore. Weather - sun disappearing and more cloud cover moving in. Twenty sheep observed in the field above the road.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
41	09/05/2013 12:47	HU 36023 50739	436023	1150739			Field drain coming down from the hill under the road. Small discharge but little water flowing. Joins in with one of the pools at the shore. One plover feeding in the pool. Four sheep observed in the field next to the drain, with access to the shore. Sheep faeces present on the grassy verges.
42	09/05/2013 12:49	HU 36008 50798	436008	1150798			Field drain with a small discharge but little water flowing. Joins in with one of the pools at the shore. Two rabbits observed in the field above the shore.
43	09/05/2013 12:53	HU 35944 50900	435944	1150900			Forty sheep observed in a fenced area down from a house below the road. Thirteen geese noted in the field adjacent. Twelve houses present in this area, two below the road and ten above the road the majority some distance from the shore. One oystercatcher observed.
44	09/05/2013 12:55	HU 35910 50956	435910	1150956			Field drain through vegetation to the shore, very small water flow.
45	09/05/2013 13:00	HU 35869 51073	435869	1151073		SV-FW07	Tresta Burn, large watercourse leading to a sandy/stony beach on the shore. Freshwater sample taken and flow rate measured; width 180 cm, depth 15 cm, flow 0.075 m/s, st. dev. 0.011 m/s. Eight gulls and two oystercatchers observed in the ebb. Three houses noted closer to the shore just north of the burn.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
46	15/05/2013 07:23	HU 35101 49952	435101	1149952		SV-MUSS01 (Top), SV-MUSS02 (Bottom) & SV-SW03	NW corner of Sandsound Voe site. 9x double header long lines. Droppers 8-9m. Salinity Profile 1 collected (ppt/°C): 10m 35.01/8.5, 5m 34.89/8.9, 3m 34.87/8.9, surface 34.84/8.9. Mussels collected from furthest west line at the NW 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. Harvesting occurring at the moment on a regular basis. Weather: fresh breeze, numerous white caps on the water. Mostly cloudy with dark clouds approaching from the north. Brief breaks of sun.
47	15/05/2013 07:40	HU 35121 49616	435121	1149616			SW corner of Sandsound Voe site.
48	15/05/2013 07:48	HU 35405 48356	435405	1148356			Salinity profile collected form the south end of Sandsound Voe production area where channel narrows, further east in the channel. Salinity Profile 2 (ppt/°C): 10m 35.10/8.3, 5m 35.09/8.3, 3m 35.07/8.3, surface 35.05/8.3.
49	15/05/2013 08:00	HU 35290 49637	435290	1149637		SV-MUSS03 (Top), SV-MUSS04 (Bottom) & SV-SW04	SE corner of Sandsound Voe site. Salinity Profile 3 collected (ppt/°C): 10m 35.05/8.5, 5m 34.99/8.6, 3m 34.97/8.7, surface 34.95/8.7. Mussels collected from furthest east line at the SE 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.
50	15/05/2013 08:13	HU 35267 49937	435267	1149937			NE corner of Sandsound Voe site. One cormorant observed on a mussel float at the site.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
51	15/05/2013 08:17	HU 34959 50454	434959	1150454			Salinity profile collected from the north end of Sandsound Voe production area where the channel narrows near Lung Ness, further east in the channel. Salinity Profile 4 (ppt/°C): 10m 34.94/8.8, 5m 34.92/8.8, 3m 34.90/8.8, surface 34.86/8.9. Weather - overcast and light rain. Two gulls on the pontoon at the pier.
52	15/05/2013 09:05	HU 35169 47877	435169	1147877			Shoreline survey walk Innersand (west coast). Forty three sheep including lambs were observed in the fields up from the shore, thirty animals in a fenced area with the remaining animals not in fenced areas with access to the shore. Three houses in the area all some distance from the shore.
53	15/05/2013 09:07	HU 35247 47978	435247	1147978			Two geese observed in flight.
54	15/05/2013 09:09	HU 35255 48000	435255	1148000			Field drain to the shore, small flow of water. Flow rate measured; width 20 cm, depth 4 cm, flow 0.117 m/s, st. dev. 0.01 m/s. Two gulls taking flight from a field up from the shore.
55	15/05/2013 09:12	HU 35272 48033	435272	1148033		SV-SW05	Small stony/shelly beach at the shore, seaweed also present. Three small boats up on the beach used for leisure purposes. Seawater sample taken from the shore.

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
56	15/05/2013 09:19	HU 35221 48062	435221	1148062			Landscape: Rough grassland with some wet boggy areas. Increasing height of escarpments as you move along the shore. Sheep faeces present along the western coast on grassy verges at the edge of the cliffs. Small field drain leading to the shore, small flow of water at the cliff edge over the rocks. Slight flow through vegetation in the field with pooling areas of stagnant water. Flow rate measured; width 10 cm, depth 6 cm, flow 0.24 m/s, st. dev. 0.007 m/s. Fifty sheep in the field above the shore not fenced in but would have difficulty accessing the shore.
57	15/05/2013 09:26	HU 35101 48243	435101	1148243			Fast flowing field drain through vegetation. Flow rate measured; width 10 cm, depth 7 cm, flow 0.079 m/s, st. dev. 0.006 m/s. One oystercatcher taking flight from the shore.
58	15/05/2013 09:29	HU 35050 48325	435050	1148325			Twenty sheep in a field above the shore, no fences, next to a house with an agricultural shed. One rabbit observed in the field.
59	15/05/2013 09:36	HU 34892 48431	434892	1148431	Figure 14		Feeding area for sheep located between two houses.
60	15/05/2013 09:38	HU 34857 48473	434857	1148473			Concrete septic tank of the second house mentioned above. Two agricultural sheds behind the house.
61	15/05/2013 09:52	HU 34967 48332	434967	1148332			Concrete septic tank of first house mentioned in WP058, observed on the walk back, from a road above the houses.

Sampling

Water and shellfish samples were collected at the locations indicated in Figures 2 and 3. As well as those defined in the survey plan one additional freshwater sample was collected from a small watercourse discharging to the shore which had faecal matter present in the watercourse. All samples were transported initially by a cool backpack and then in a cool box to SSQC Ltd. for analysis on the same day.

Bacteriology results are present in Table 2 and 3 and mapped in Figures 2 and 3.

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 Figure 2.

Table 2 Water sample *E.coli* results

No.	Sample Ref.	Date/Time (UT)	Position	Type	*E.coli* (cfu/100ml)	Salinity*
1	SV-FW01	09/05/2013 08:56	HU 36118 48285	Fresh Water	44	-
2	SV-FW02	09/05/2013 09:53	HU 35464 48497	Fresh Water	600	-
3	SV-SW01	09/05/2013 10:22	HU 35360 48940	Sea Water	<1	35.06
4	SV-FW03	09/05/2013 10:48	HU 35485 49204	Fresh Water	<1	-
5	SV-FW04	09/05/2013 11:00	HU 35512 49404	Fresh Water	<1	-
6	SV-FW05	09/05/2013 11:17	HU 35545 49588	Fresh Water	25	-
7	SV-SW02	09/05/2013 12:08	HU 35052 50386	Sea Water	1	34.85
8	SV-FW06	09/05/2013 12:31	HU 35808 50373	Fresh Water	34	-
9	SV-FW07	09/05/2013 13:00	HU 35869 51073	Fresh Water	20	-
10	SV-SW03	15/05/2013 07:23	HU 35101 49952	Sea Water	3	34.66
11	SV-SW04	15/05/2013 08:00	HU 35290 49637	Sea Water	1	34.95
12	SV-SW05	15/05/2013 09:12	HU 35272 48033	Sea Water	1	34.57

*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	SV-MUSS01	15/05/2013 07:23	HU 35101 49952	Common Mussel	Top	20
2	SV-MUSS02	15/05/2013 07:23	HU 35101 49952	Common Mussel	Bottom	40
3	SV-MUSS03	15/05/2013 08:00	HU 35290 49637	Common Mussel	Top	<20
4	SV-MUSS04	15/05/2013 08:00	HU 35290 49637	Common Mussel	Bottom	50

Table 4 Salinity profiles

Profile	Date/Time (UT)	Position	Depth (m)	Salinity (ppt) (± 0.35 ppt)	Temperature (°C)
1	15/05/2013 07:23	HU 35101 49952	surface	35.01	8.5
			3	34.89	8.9
			5	34.87	8.9
			10	34.84	8.9
2	15/05/2013 07:48	HU 35405 48356	surface	35.10	8.3
			3	35.09	8.3
			5	35.07	8.3
			10	35.05	8.3
3	15/05/2013 08:00	HU 35290 49637	surface	35.05	8.5
			3	34.99	8.6
			5	34.97	8.7
			10	34.95	8.7
4	15/05/2013 08:17	HU 34959 50454	surface	34.94	8.8
			3	34.92	8.8
			5	34.90	8.8
			10	34.86	8.9

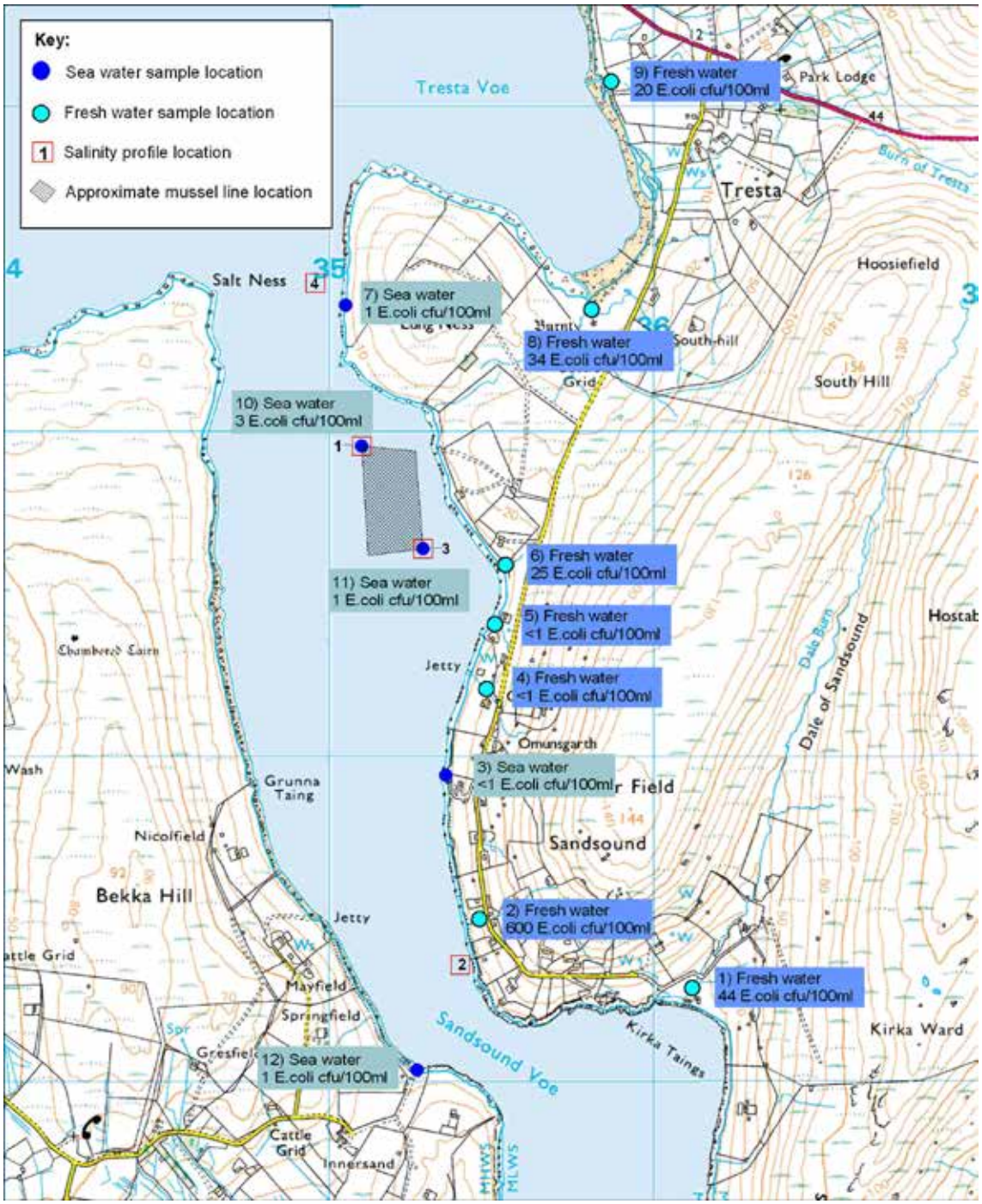

Figure 2 Map of water sample results and salinity profile locations

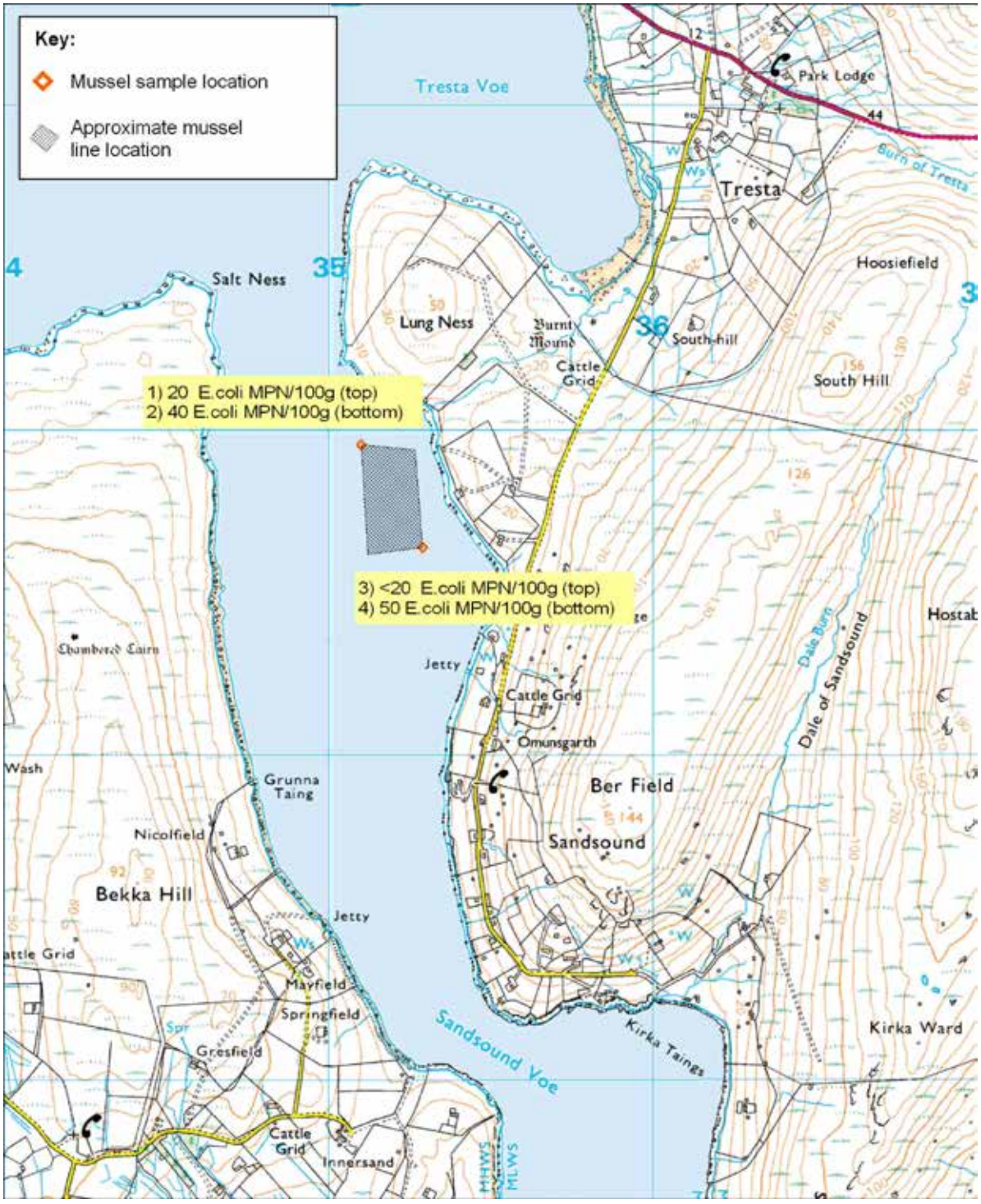

Figure 3 Map of shellfish sample results

Photographs

Figure 4 – Mussel lines at the Sandsound Voe fishery looking west.

Figure 5 – Overflowing septic tank at the south end of Sandsound Voe.

Figure 6 – Bed and Breakfast property pipe from the septic tank entering the water south of the Sandsound Voe fishery.

Figure 7 – Built up area which may be covering a pipe coming from a septic tank, south of the Sandsound Voe fishery.

Figure 8 – Suspected discarded faecal matter in a small watercourse at the south end of Sandsound Voe.

Figure 9 – Pipe assumed to be associated with a septic tank entering a small watercourse leading to the shore at the south end of Sandsound Voe.

Figure 10 – Sandsound Mussels shorebase.

Figure 11 – Leisure boats stored at Omunsgarth jetty.

Figure 12 – Sheep grazing below a house on the eastern shore.

Figure 13 – Shetland ponies below a house on the eastern shore.

Figure 14 – Feeding area for sheep located between two dwellings on the western shore.

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