Scottish Sanitary Survey Review

Weisdale Voe

Sanitary Survey Review

SI 468, 469 and 768

May 2014

Cefas

Food Standards Agency
food.gov.uk

Report Title	Weisdale Voe Review
Project Name	Scottish Sanitary Survey
Client/Customer	Food Standards Agency Scotland
Cefas Project Reference	C5792F
Document Number	C5792F_2013_3
Revision	V1.1
Date	30/05//2014

Revision History

Revision number	Date	Pages revised	Reason for revision
0.1	14/03/2014	All	Draft for external consultation
0.2	17/03/2014	35	Corrected recommended RMP to agree with sampling plan
1.0	28/05/2014	iv,v,9,26	Amended text in accordance with consultation responses
1.1	30/05/2014	4,5,10,12,16,19,27,36	Removed incorrect map layer from figures

	Name	Position	Date
Author	Liefy Hendrikz, Ron Lee	Scottish sanitary survey team	30/05/2014
Checked	Michelle Price-Hayward	Principal shellfish hygiene scientist	30/05/2014
Approved	Ron Lee	Principal shellfish hygiene scientist	30/05/2014

This report was produced by Cefas for its Customer, FSAS, for the specific purpose of providing a sanitary survey as per the Customer's requirements. Although every effort has been made to ensure the information contained herein is as complete as possible, there may be additional information that was either not available or not discovered during the survey. Cefas accepts no liability for any costs, liabilities or losses arising as a result of the use of or reliance upon the contents of this report by any person other than its Customer.

Report Distribution – Weisdale Voe

Name	Agency
Joyce Carr	Scottish Government
David Denoon	SEPA
Hazel MacLeod	SEPA
Fiona Garner	Scottish Water
Alex Adrian	Crown Estate
Dawn Manson	Shetland Islands Council
Sean Williamson	HMMH (Scotland) Ltd
Meriem Kayoueche-Reeve	SOTEAG
Michael Laurenson (Greena and Vedri Geo)	Harvester
Michael Tait (North Flotta)	Harvester

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.

In 2007 a Sanitary Survey Report for Weisdale 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 in 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.

Table of Contents

Scottish Sanitary Survey Review ..... *i*
Review Specification and Introduction ..... *i*
Sampling Plan – Weisdale Voe ..... *iv*
Sampling Plan – Weisdale Voe Upper ..... *v*

1. AREA DESCRIPTION AND FISHERY 1

2. POPULATION AND HUMAN SEWAGE IMPACTS 5

2.1 POPULATION 5
2.2 SEWAGE DISCHARGES 6

3. FARM ANIMAL POPULATION AND AGRICULTURAL IMPACTS 11

4. WILDLIFE 13

5. WATERCOURSES 17

6. METEOROLOGICAL DATA 20

7. HISTORICAL *E. COLI* DATA 24

7.1 SUMMARY OF MICROBIOLOGICAL RESULTS 24
8.3 TEMPORAL PATTERNS OF RESULTS 27

8. MOVEMENT OF CONTAMINANTS 31

9. OVERALL ASSESSMENT 32

10. RECOMMENDATIONS 35

11. REFERENCES 37

12. LIST OF FIGURES AND TABLES 38

APPENDICES

1. **PLANNING APPLICATIONS**
2. **SHORELINE SURVEY REPORT**

Sampling Plan – Weisdale Voe

	2007 recommendations	2014 review	Changes
PRODUCTION AREA	Weisdale Voe		No change
SITE NAME	North Flotta		
SIN	SI-297-469-08		
SPECIES	Common mussels		
TYPE OF FISHERY	Long-line		
NGR OF RMP	HU 3815 4653	HU 3810 4650	Amended
EAST	438150	438100	
NORTH	1146530	1146500	
TOLERANCE (M)	40 m		Amended
DEPTH (M)	1 m		No Change
METHOD OF SAMPLING	Hand		
FREQUENCY OF SAMPLING	Monthly		
LOCAL AUTHORITY	Shetland Islands Council		
AUTHORISED SAMPLER(S)	Sean Williamson, George Williamson, Kathryn Winter, Marion Slater	Sean Williamson, Marion Anderson, Agnes Smith, Alan Harpin, Vicki Smith	Changes in staff
RECOMMENDED PRODUCTION AREA	The area bounded by lines drawn between HU 3805 4607 and HU 3796 4607 and between HU 3764 4657 and HU 3672 4700 and between HU 3722 4780 and HU 3834 4720 extending to MHWS	The area bounded by lines drawn between HU 3805 4607 and HU 3796 4607 and between HU 3764 4657 and HU 3672 4700 and between HU 3722 4780 and HU 3834 4720 extending to MHWS	No Change

Sampling Plan – Weisdale Voe Upper

	2007 recommendations	2014 review	Changes
PRODUCTION AREA	Weisdale Voe Upper		No change
SITE NAME	Vedri Geo		
SIN	SI-378-768-08		
SPECIES	Common mussels		
TYPE OF FISHERY	Long-line		
NGR OF RMP	HU 37960 48710	HU 3796 4871	No change
EAST	437960	437960	
NORTH	1148710	1148710	
TOLERANCE (M)	40 m		Amended
DEPTH (M)	1 m		No change
METHOD OF SAMPLING	Hand		
FREQUENCY OF SAMPLING	Monthly		
LOCAL AUTHORITY	Shetland Islands Council		
AUTHORISED SAMPLER(S)	Sean Williamson, George Williamson, Kathryn Winter, Marion Slater	Sean Williamson, Marion Anderson, Agnes Smith, Alan Harpin, Vicki Smith	Changes in staff
RECOMMENDED PRODUCTION AREA	Area bounded by lines drawn between HU 3786 4882 and HU 3822 4853 and HU 3770 4755 and HU 3722 4780 extending to MHWS	The area bounded by lines drawn between HU 3796 4895 and HU 3864 4834 and between HU 3770 4755 and HU 3722 4780 extending to MHWS	Changed to include the new Olligarth site

1. Area Description and Fishery

The location of Weisdale Voe is shown in Figure 1.1.

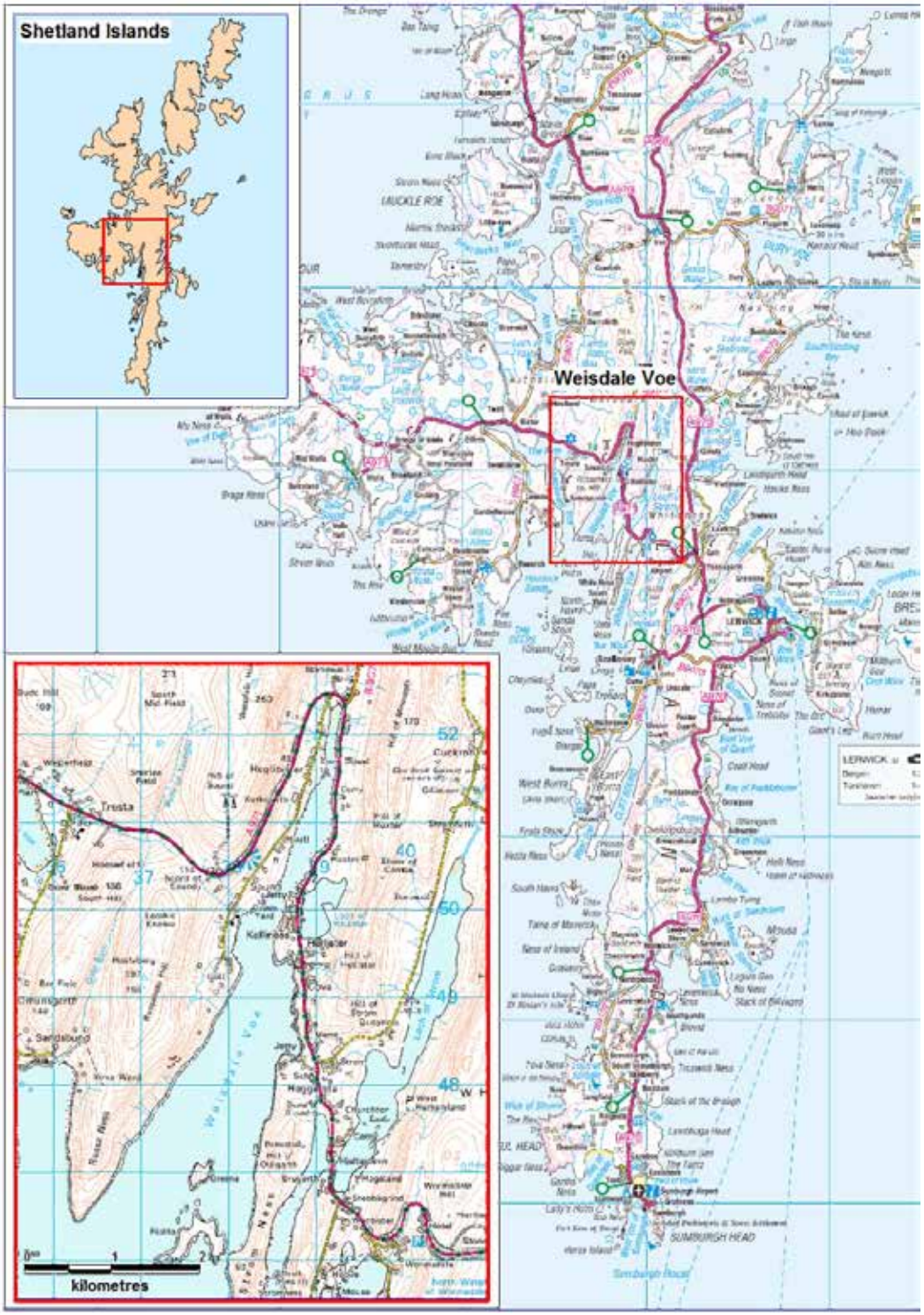

Figure 1.1 Location of Weisdale Voe

The three common mussel farms operating within Weisdale Voe at the time of the 2007 report remained classified and in operation in 2013. Details of these farms can be found in Table 1.1, with recorded locations from both the 2007 and 2013 shoreline surveys shown in Figure 1.2.

Table 1.1 Current classified fishery at Weisdale Voe

Production area	Site	SIN	Species	RMP
Weisdale Voe	Greena	SI-297-468-08	Common mussels	HU 3813 4644
	North Flotta	SI-297-469-08		
Weisdale Voe Upper	Vedri Geo	SI-378-768-08		HU 3793 4873

Current RMPs identified by FSAS differ slightly from those recommended in the 2007 report for both North Flotta and Vedri Geo fisheries. These differences are listed in Table 1.2.

Table 1.2 Comparison of differences in recommended and present RMP locations

Site	2007 recommended RMP	2013/14 FSAS RMP
North Flotta	HU 38150 46530	HU 3813 4644
Vedri Geo	HU 37960 48710	HU 3793 4873

Applications for two new common mussel fisheries in Weisdale Voe were received in December 2013. The details of these are listed in Table 1.3. First harvest was expected in December 2013 at both sites.

Table 1.3 Information and current status of new sites

Site Name	Production Area Name	SIN	Current fishery status
Kirkaward	Weisdale Voe Upper	SI-378-1523-08	1[x]330 m long-line
Olligarth	Weisdale Voe East	SI-700-1521-08	1[x]330 m long-line

The 2007 sanitary survey report stated that new lines were placed for spat settlement between May and early June, with mussels taking three years to reach market size. Harvesting was undertaken via rotation, with different lines set in different years to allow harvesting year round. Harvesting was conducted between September and May. No additional information on harvesting was noted during the 2013 survey and therefore it is assumed harvesting remains unchanged.

Observations of fisheries made during the 2013 shoreline surveys were as follows:

Greena: site consists of 9x lines with 10 m droppers on most, except for the SE corner where approximately 100 droppers were at 7-8 m depth on the innermost line. The site is licensed for 6x210 m quad-headline long-lines.

Vedri Geo: site consists of 6x lines with 10 m droppers. The site is licensed for 6x210 m quad-headline long-lines.

North Flotta: site consists of 7xlines with 10 m droppers. The site is licensed for 7x330 m twin-headline long-lines.

Both new sites (Olligarth and Kirkaward) were stocked with mussels at the time of the 2013 shoreline survey. Both sites consisted of 1x double-headed longline with 8 m droppers.

The presently classified sites have increased in capacity since 2007 and there are also the two new sites in the area. The total mussel production in the voe has therefore increased significantly.

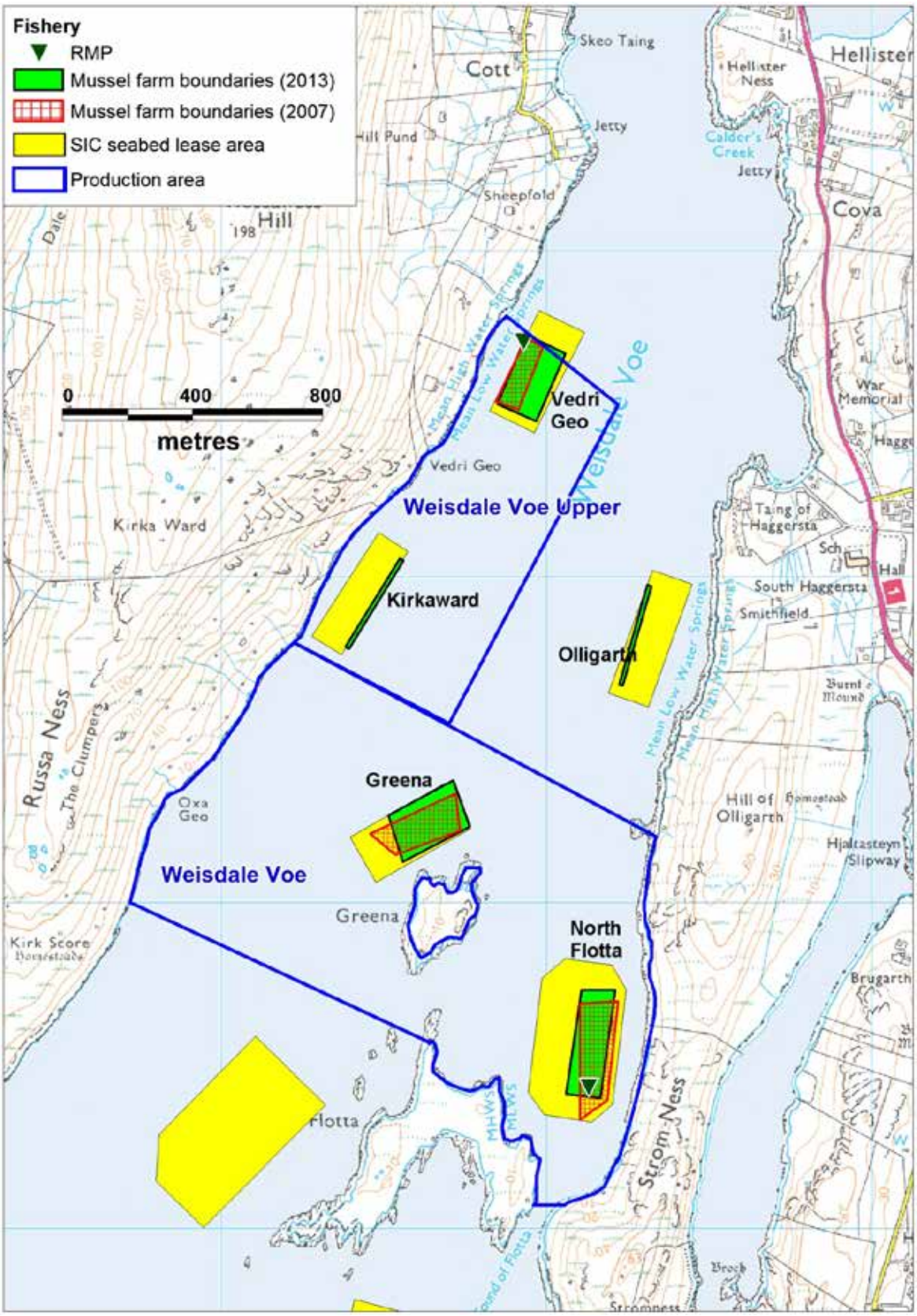

Figure 1.2 Current and historical fishery locations, Weisdale Voe

2. Population and Human Sewage Impacts

2.1 Population

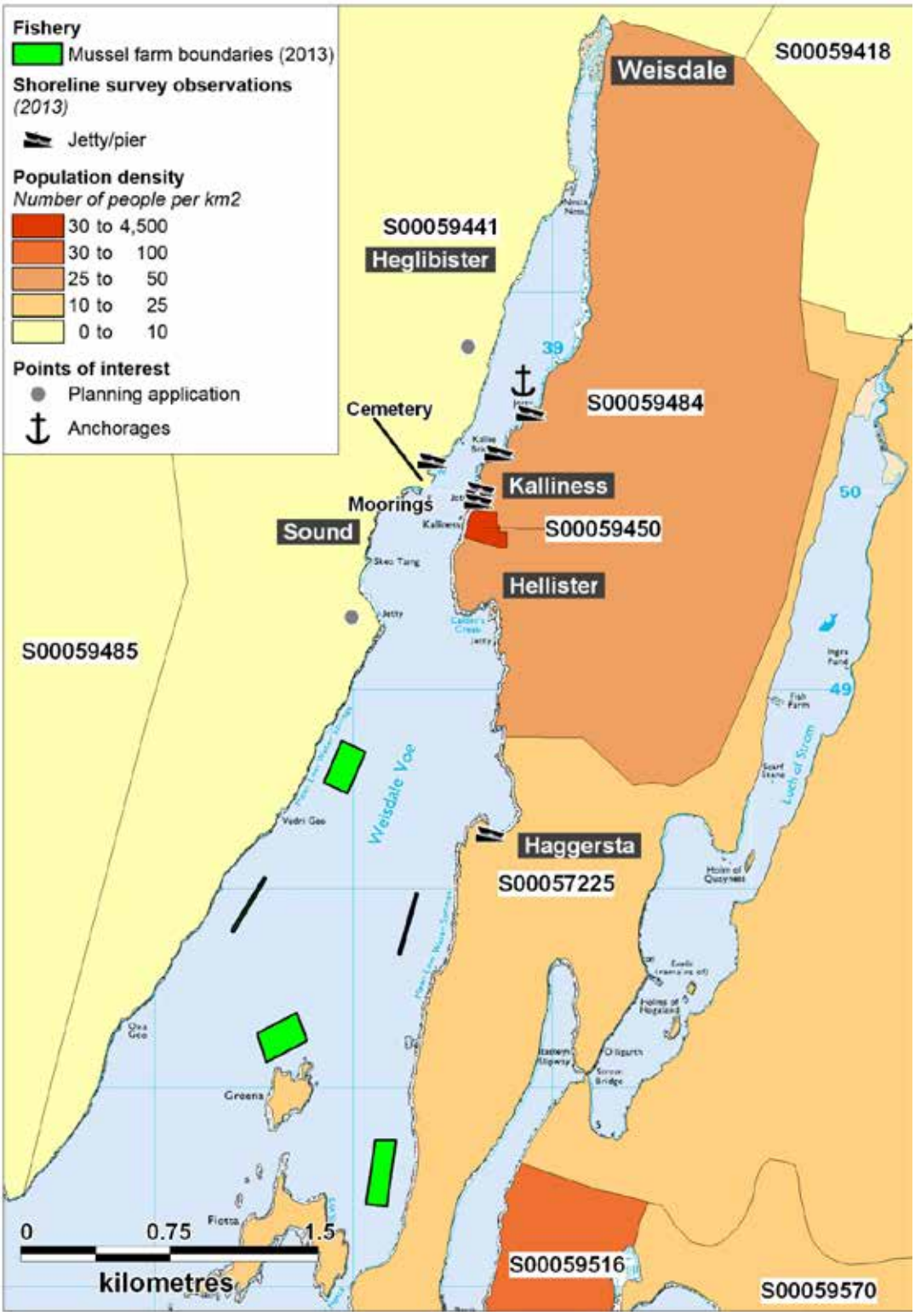

Figure 2.1 Distribution of human population around Weisdale Voe

Population data from the General Register Office for Scotland for both the 2001 and 2011 censuses for areas immediately around Weisdale Voe are shown in Table 2.1. Comparisons are complicated owing to changes in identifiers for many of the output areas.

Table 2.1 Scottish Government Census data for years 2001 and 2011

2001 Census data		2011 Census data	
60RD000026	91	S00059441	158
60RD000155	132	S00059484	119
60RD000156	131	S00059450	117
60RD000023	277	S00057225	164
Total	**631**	***Total***	**558**

Census data indicates the overall population for output areas around Weisdale Voe has decreased. Only two planning applications pertaining to the areas around Weisdale Voe were found to have been made to the since the 2007 report. These applications were downloaded from the Shetland Island Council Planning Portal in December 2013 (http://pa.shetland.gov.uk/online-applications/), with full details listed in Appendix 1. Locations of both planning applications are displayed in Figure 2.1.

One of the two applications was for a new dwelling house in the Heglibister area (northwest) and included plans for a new septic tank (ST) to soakaway. The other application was to convert an existing croft in the area south of Sound into a shed, with drainage going to an existing drain. In addition to these applications, a cemetery on north of Sound on the west shore was observed during the 2013 survey.

The 2007 shoreline survey reported that boat traffic was mostly associated with serving the mussel farms in Weisdale Voe. Small jetties were noted at Haggersta and Kalliness, with three moorings and a boat at Haggersta and two small boats north of Kalliness.

The 2013 shoreline survey reported that boat traffic continued to mostly be associated with the mussel farms. Five jetties and one pontoon were observed along the east shore, four within the Kalliness area and one at Haggersta. A sixth jetty was located in Sound on the west shore. Unoccupied moorings were noted at Kalliness and Sound.

2.2 Sewage Discharges

The 2007 sanitary survey report included information on three community STs discharging into Weisdale Voe. The locations of these discharges are displayed in Figure 2.2. The 2007 shoreline survey found a number of private septic tanks that were not connected to community STs, with the majority located within the Kalliness area. Three overflowing STs were observed in the 2007 survey; one associated with

a farmhouse north of Kalliness, one next to channel of the Loch of Hellister and one south in Hellister. There were also three possible ST overflows in Kalliness.

No information was found regarding any improvements to the community STs in an internet search conducted for this review. Discharge-related observations made during the 2013 shoreline survey are listed in Table 2.2 and locations are displayed in Figure 2.2.

Table 2.2 Sewage discharge-related observations around Weisdale Voe from the 2013 shoreline survey

No.	NGR	Description
1	HU 3803 4926	Septic tank associated with property
2	HU 3809 4942	Old septic tank on the shore directly above a pipe leading to the sea, although appeared not to be active. Missing section of pipe on the shore and an inspection hatch missing. Neither had signs of flow or waste. Property below the road with a septic tank to soakaway
3	HU 3802 4950	Overflow from the septic tank and watercourse running below
4	HU 3800 4951	Overflow of solid waste from the septic tank mentioned above. Some pooling in the grass beneath
5	HU 3796 4961	Septic tank in a poor condition for a small house above the road. Can hear the sound of flowing water
6	HU 3806 4979	Septic tank for a house below the road. Possible soakaway for the tank
7	HU 3811 4990	Three houses above the road. Pipe leading to the water, a mild smell of sewage.
8	HU 3926 5181	Swedish Houses community septic tank
9	HU 3923 5169	Swedish Houses community ST sample chamber hatch and large discharge pipe running north to outfall below MLWS
10	HU 3888 5038	Port-a-cabin with waste pipe to the sea beneath the rock armour.
11	HU 3877 5023	Septic tank
12	HU 3878 5024	Septic tank serving property above the foreshore. Outfall to the sea, below MLWS
13	HU 3876 5019	Discharge pipe to the sea, below MLWS. Unable to determine the origin
14	HU 3883 5012	Grey water discharge to the loch from the Shetland Jewellery building
15	HU 3882 5012	Septic tank associated with the Shetland Jewellery premises and visitors centre, adjacent to the Loch of Hellister
16	HU 3866 5002	Discharge pipe, unknown source or outfall. Suspected that the outfall is lost under recently reclaimed land associated with a property under construction
17	HU 3865 4996	Discharge pipe outfall, unknown source although clearly associated with the property under construction
18	HU 3859 4986	Manhole covers above the shore with no visible discharge pipe. In retrospect this was considered to be the location of the Kalliness West community septic tank as it looked visually similar to the Swedish Houses septic tank identified later
19	HU 3866 4945	Septic tank for the outfall mentioned in the previous observation
20	HU 3865 4944	Two pipes from a property adjacent to the shore discharging to the beach. One septic and the other clear, very low flow from both

No.	NGR	Description
21	HU 3876 4936	Several water board markers and an access hatch in an area of grass below a cluster of seven houses. Sewage smell noted
22	HU 3876 4935	Discharge pipe crossing watercourse from north to south. Perforated pipe, possibly land drainage from the house above joins the watercourse above the discharge
23	HU 3877 4934	Second smaller tank or access hatch in a poor condition with sewage overflow and standing water surrounding. This eventually flows into a ditch running towards the sea past the larger tank, meeting the shore just below the tank outfall. No apparent flow
24	HU 3876 4933	Large septic tank with outfall to the sea, below MLWS. Sludge apparent on top of the tank. With a pipe across the watercourse mentioned above and water board markers previously encountered this is likely to serve the cluster of properties above the shore
25	HU 3878 4927	Septic tank associated with final house in the cluster, no apparent outfall.
26	HU 3881 4926	Smaller disused septic tank associated with the same property
27	HU 3879 4829	Property adjacent to the shore, no septic tank identified. Pipe discharging onto the beach, possibly grey water or septic. This is associated with a gully alongside the track leading to the property
28	HU 3892 4824	Drainage ditch below the tank, with iron bacterial film. This drains to the watercourse
29	HU 3897 4822	Clach-na-Strom community septic tank, can hear the sound of flowing water. Outfall not determined. Watercourse located in a field to the north of the tank, approximately 10m away although there is no sign of an outfall to the watercourse.
30	HU 3883 4819	Septic tank from one of two properties above the shore, the other tank not identified

Observations of associated sewage related infrastructure were made in the close vicinity of the three community STs during the 2013 survey. However, the Clach-na-Strom ST was observed to be more than 200 m southeast and further inland than the original location stated in the 2007 sanitary survey report.

Overall a greater number of private STs and sewage related infrastructure were observed during the 2013 shoreline survey than in 2007, with more observations made in the Sound area of the west shore. Of the three overflowing STs observed in the 2007 shoreline survey, one appeared to be continuing to overflow in 2013. This overflowing ST was located in Hellister and in 2013 it was observed to be a large ST with sludge on the lid. In addition, the 2013 survey identified a second overflowing ST in standing water within 20 m of the aforementioned overflowing ST. Both these lie more than 800 m northeast of the closest fishery of Vedri Geo.

During the 2013 survey, a third overflowing ST was noted on the western shore south of Sound and nearby a fourth ST was also observed to be in poor condition. These STs lay approximately 550 m northwest of the closest fishery (Vedri Geo). Pipes were also noted to be associated with a smell of sewage on the west shore,

but returned a seawater sample of <1 *E. coli* MPN/100 g, which suggested little sewage contamination.

There is no information to suggest that contamination from sewage discharges will have changed significantly in the area since the 2007 sanitary survey report. However, some additional information is available regarding the local of private septic tanks, Identified inputs are still primarily located in the Kalliness/Hellister and Haggersta areas on the eastern shore, with a number of private discharges on the western shore at Sound. Due to the proximity of the new Olligarth site, it is expected that this farm will be impacted by continuous discharges from Clach-na-Strom ST and other private discharges from Haggersta, less than 500 m from the fishery.

Subsequent to consultation on the draft of this review report, SEPA operations identified that they intended to carry out an inspection of the septic tanks identified as overflowing to determine if they pose any risks.

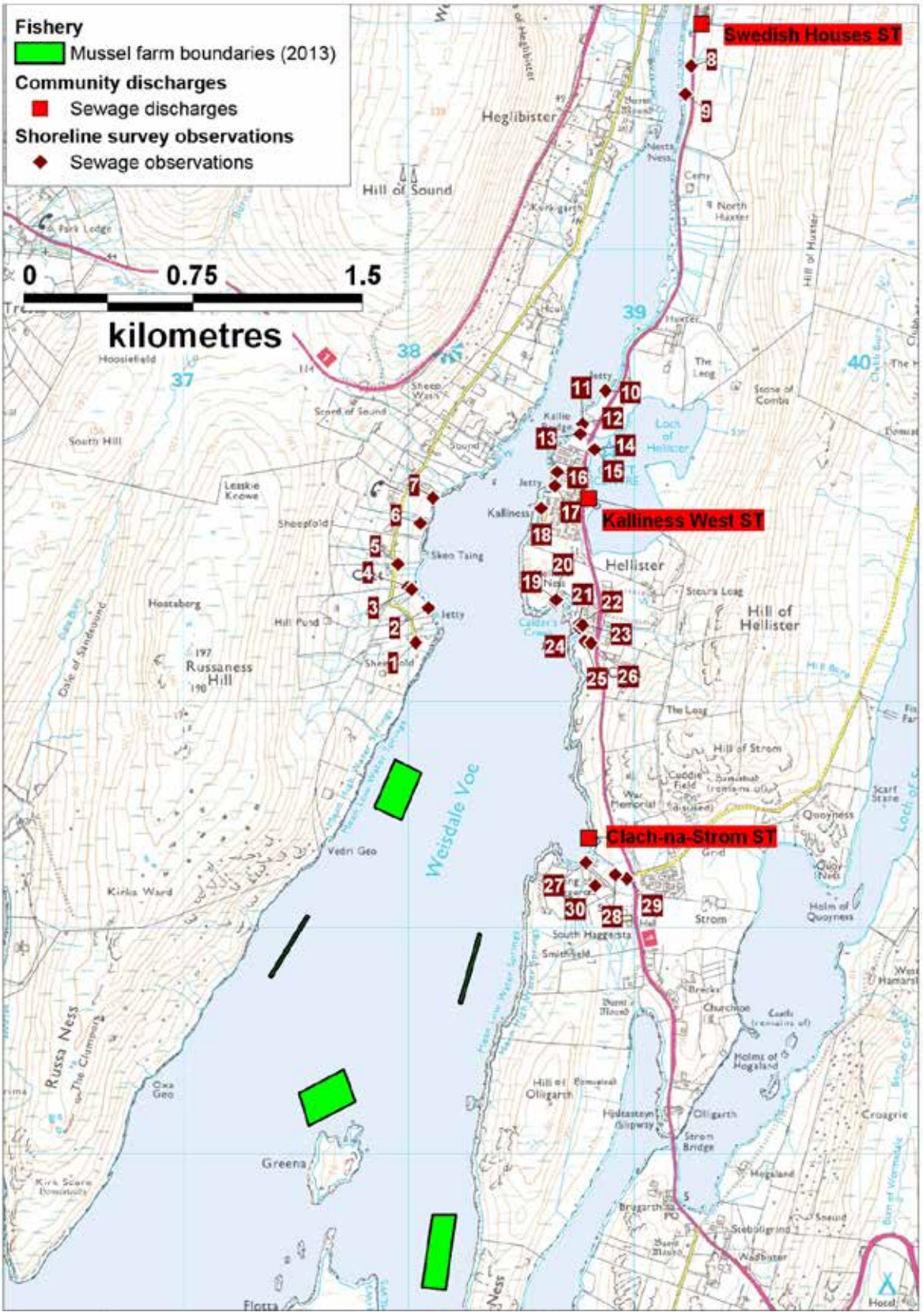

Figure 2.2 Map of public sewage discharges (from the 2007 sanitary survey report) and 2013 shoreline survey observations, in the vicinity of Weisdale Voe

3. Farm Animal Population and Agricultural Impacts

Information presented on farm animals in the 2007 sanitary survey report was based on a combination of farm census data and shoreline survey observations. It was concluded that represented a significant contamination source to Weisdale Voe fisheries, with sheep grazed around much of the surrounding land, with access to the shore along the northwest. Straw bedding waste and faeces were also observed tipped on the bank at Haggersta. There were also a number of crofts located to the northwestern shoreline and a farm located just north of Kalliness. Overall, agriculture was surmised to be impacting the water quality within Weisdale Voe.

Information on agricultural based contamination sources for this review has been obtained through th shoreline surveys conducted in 2013 and through a desk-based internet search. Shoreline survey observation information only relates to the time of the survey undertaken on the 29th and 30th October 2013. Figure 3.1 displays the locations of animals observed during that shoreline survey.

During the 2013 shoreline survey, sheep were also observed to be the main livestock reared on land surrounding Weisdale Voe, with the majority observed along the west side of the Voe. Sheep were found to still have shoreline access along the northwest shore of the voe though sheep were observed in fenced areas of improved grassland. Sheep faeces were also noted on the beach on the shores around Sound, less than 500 m north of the Vedri Geo fishery. Fewer sheep were seen on the eastern shore, though large numbers were noted at the head of the Voe, just north of Kalliness associated with a farm and south of Haggersta. Sheep south of Haggersta would have been prevented from accessing the shore due to the steepness of the cliffs.

Cow hoof prints and faeces were observed in fields along the mid-west shore, where shore access was also possible. Piles of manure were also noted at three locations along the eastern shoreline: at Haggersta, Kalliness and Calder's Creek. Horse manure was noted in a field near the shore at Hellister.

No further information could be found on agricultural practices around Weisdale Voe during the desk based study for this review. However, one planning application was found for a new storage shed conversion from an existing croft on the west shore, though no further details of its purpose were reported.

Overall, there is no evidence that impacts from farm animals will have changed significantly since the 2007 sanitary survey. Farm animal observations (principally sheep) were confined to the upper half of the voe. This will be partly due to the sheep there being fenced and partly to the steep sides of the southern voe, limiting access by sheep.

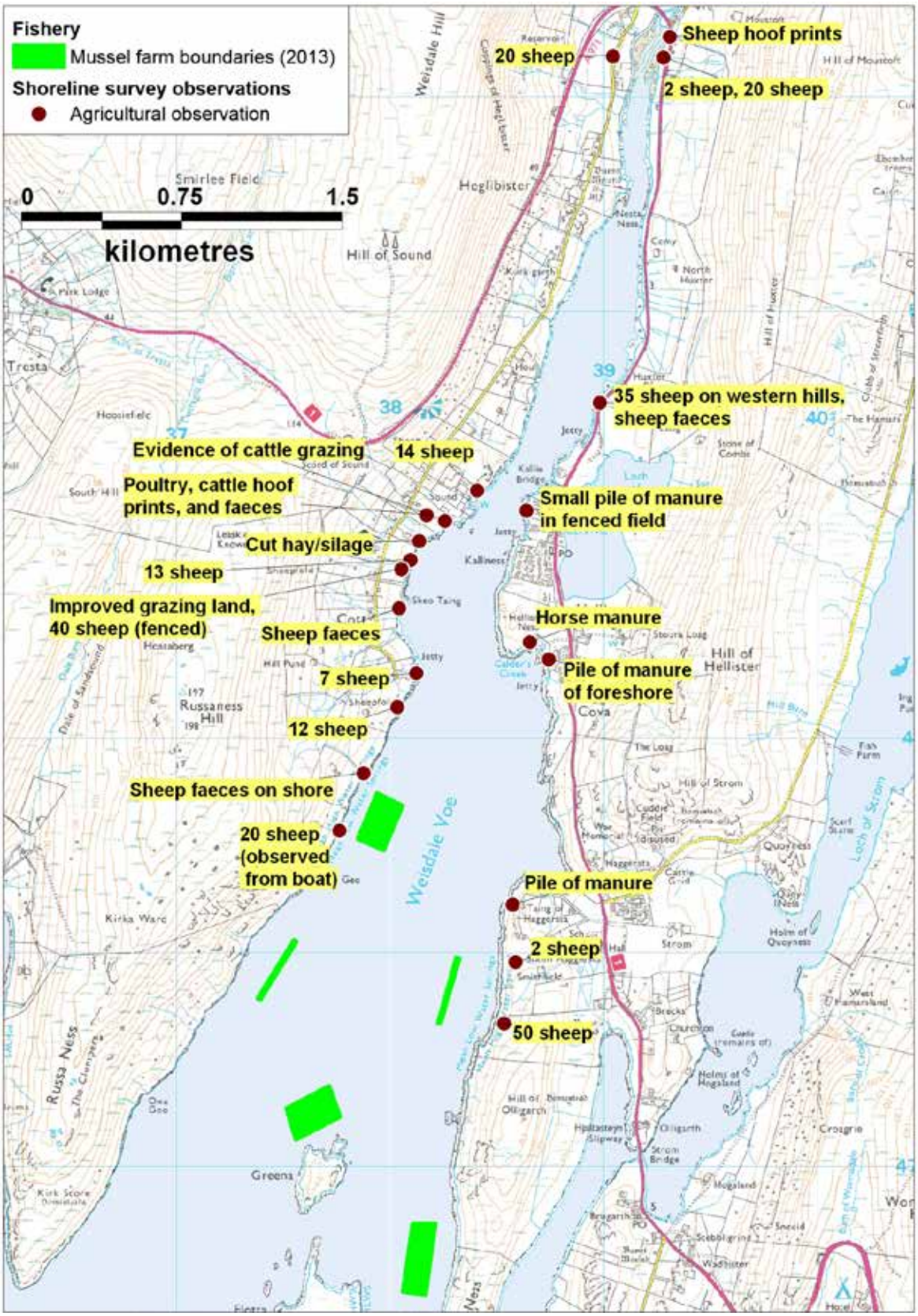

Figure 3.1 Map of farm animals and associated observations made during the 2013 shoreline survey

4. Wildlife

The 2007 sanitary survey concluded that wildlife contamination impacts were unpredictable. Impacts from birds were expected from northern fulmar colonies noted at the head of the Voe, as well as one Greena and Flotta islands at the entrance of the Voe. Other impacts from species such as cormorants, gulls and Arctic terns were also expected at all mussel fisheries.

For this review, information on wildlife has been obtained through a shoreline survey conducted in 2013, and through a desk-based internet search. Shoreline survey observation information only relates to the time of the survey undertaken on the 29th and 30th 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, 3,003 harbour seals were observed in Shetland, compared to 4,883 seals seen in 2001 (SCOS, 2012). However, grey seal populations are shown to be booming, with an estimated 3,300 grey seal pups alone born in 2010 (Shetland and mainland Scotland) taken from aerial surveys (SCOS, 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 (NAFC Marine Centre, 2012) identified that a common seal habitat area lies in nearby Whiteness Voe. During the 2013 shoreline survey, two dead seals were observed, with two live seals also observed in the water south of Hellister.

Cetaceans

There have been no new records of cetaceans in Weisdale Voe since the 2007 report. No cetaceans were seen during either shoreline surveys.

Seabirds

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

Table 4.1 Seabird 2000 census data for Weisdale Voe

Common name	Species	Count*	Type
European herring gull	*Larus argentatus*	672	Occupied nests, territory and Individuals on land
Common gull	*Larus canus*	211	Occupied territory and individuals on land
Lesser black-backed gull	*Larus fuscus*	30	Occupied nests, territory and Individuals on land
Black headed gull	*Larus ridibundus*	80	Occupied territory
Great black-backed gull	*Larus marinus*	65	Occupied nests, territory and Individuals on land
Northern fulmar	*Fulmarus glacialis*	666	Occupied sites
Black guillemot	*Cepphus grylle*	47	Individuals on land
Common tern	*Sterna hirundo*	15	Individuals on land
Arctic tern	*Sterna paradisaea*	130	Individuals on land
Parasitic jaeger	*Stercorarius parasiticus*	4	Occupied territory
Great skua	*Stercorarius skua*	4	Occupied territory

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

European herring gulls and Northern fulmars are the most common seabird reported around Weisdale Voe. Notable occupied sites for Northern Fulmar were located at the head of the Voe and south associated with the small islands of Greena and Flotta. European herring gulls were more widely distributed throughout the surrounding area, though the densest occupied territory was located on the islands of Greena and Flotta.

The Marine and Spatial Plan for the Shetland Islands (NAFC Marine Centre, 2012) further confirmed that significant amounts of eider duck, duck and seabird habitat are located around Weisdale Voe.

In the report by the Shetland Oil Terminal Environmental Advisory Group/Sullom Voe Association Ltd (SOTEAG, 2012), it was identified that over the past six years, eider duck were moulting in areas close to aquaculture (finfish and shellfish) sites rather than their traditional areas. In SOTEAG's 2012 survey, all observed eider ducks within Weisdale Voe (578 birds) were present at mussel lines around Flotta. At this moult time, the ducks remain in close proximity, only moving a maximum distance of 3 km away to feed. Other birds noted at the head of the Voe around Flotta and Greena included Great Northern divers and slavonian grebes.

Birds were the most common wildlife observed during the 2013 shoreline survey. Species included guillemots, shags, gulls, greater black-backed gulls, snipe and

ringer plovers, with gulls being the most common. The majority of birds were observed around the mid west and east shorelines, with some birds and birds faeces noted on the buoys at the mussel farms.

Rabbits

One rabbit was observed on the eastern shoreline near Haggersta. 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).

Conclusions

Overall, it is anticipated that birds continue to represent the most significant and continuous contamination impact from wildlife. New information indicates that contamination from birds is expected to be highest at the southern end of the voe, with moulting population of eider ducks a significant potential source of contamination to the Flotta fishery during the summer months.

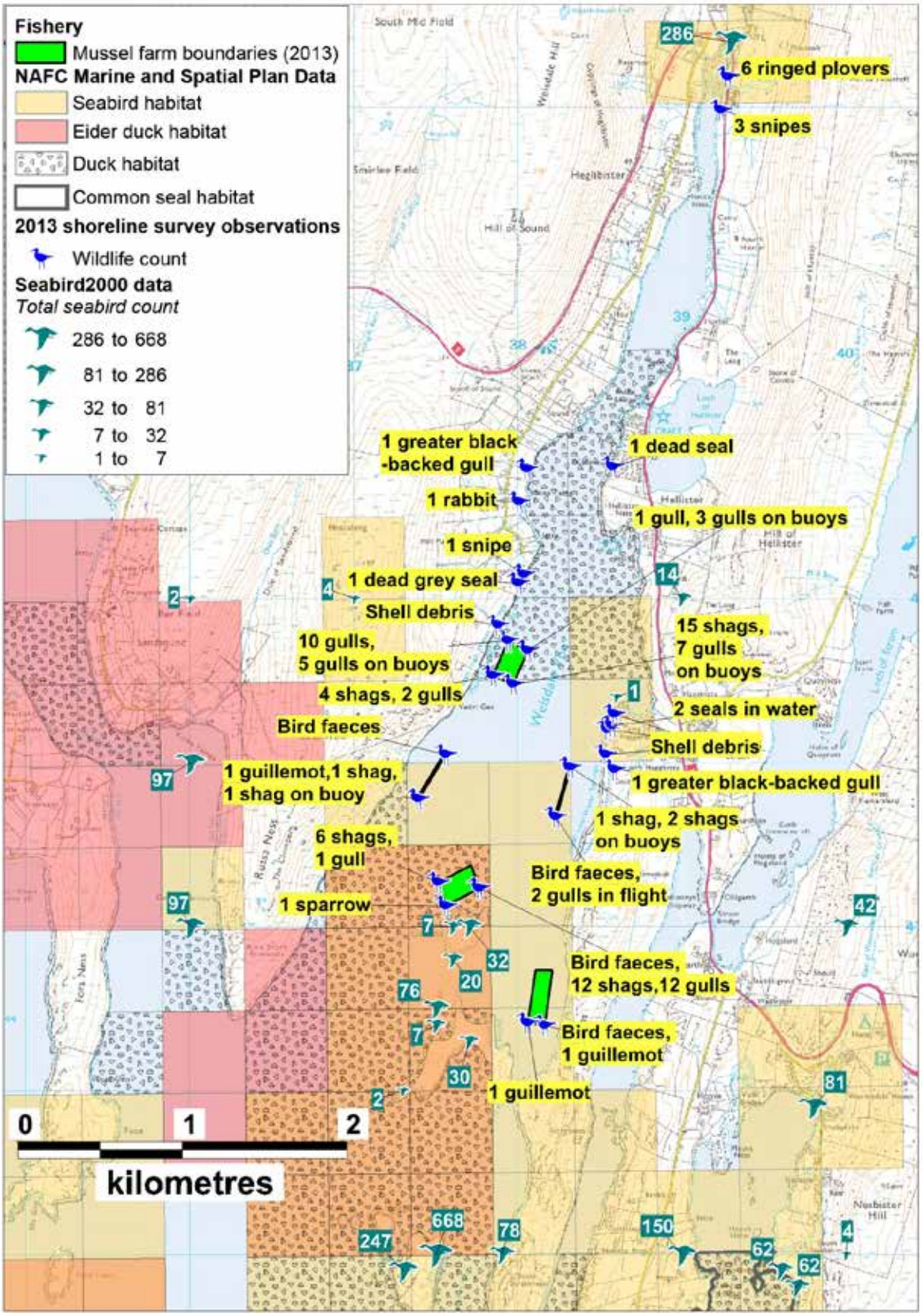

Figure 4.1 Map of wildlife around Weisdale Voe, including observations made during the 2013 shoreline survey

5. Watercourses

The only significant data on the extent of faecal contamination of watercourses in Weisdale Voe came from the two shoreline surveys undertaken in 2007 and 2013. The 2007 sanitary survey report also considered additional flow data for the Burn of Weisdale, for which there was a flow gauge. Rainfall conditions experienced during the shoreline surveys were as follows: 2007 intermittent showers; 2013 light rain fell on the first survey day and increased on the second.

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. Sample loadings calculated from the 2013 survey are displayed in Figure 5.1.

Only three watercourses were measured and sampled during the 2007 shoreline survey although other watercourses were recorded. Only one watercourse, the Burn of Wesidale, weas measured and sampled during both shoreline surveys. The loading estimated from the 2013 measurements was higher than that estimated from the 2007 measurements: this may have been due to the later survey having been undertaken under wetter conditions.

In addition, a large number of land drainage areas and a bog land area were also observed during the 2013 survey and are displayed in Figure 5.1. A full list of flow measurements and sample results from the 2013 survey can be found in Appendix 3.

The highest estimated loading from both surveys enter the head of Weisdale Voe from the Burn of Weisdale, more than 3 km north of the closest fishery at Vedri Geo. Most of the other potentially significant watercourses enter on the western shore of the middle of the voe, around Sound.

Contamination associated with watercourses will tend to have the greatest impact at the northern end of the production area, particularly at the Vedri Geo farm. However, after heavy rainfall, there is likely to be additional inputs around the voe, both in the form of temporary watercourses and direct run-off.

Table 5.1 Watercourses recorded during the 2007 and 2013 shoreline surveys

No.	Description	NGR	2007 Loading (*E. coli* / day)	2013 Loading (*E. coli* / day)
1	Channel from Loch of Hellister	HU 3838 5017	NR	ND
2	Watercourse	HU 3824 5000	NR	2.8x106
3	Watercourse	HU 3817 4994	NR	2.7x108
4	Watercourse	HU 3808 4980	NR	1.4x108
5	Watercourse	HU 3802 4951	NR	1.6x108
6	Watercourse	HU 3883 4831	NR	ND
7	Land drain with flow	HU 3876 4935	NR	ND
8	Burn of Weisdale	HU 3928 5238	1.2x1010	5.0x1010
9	Watercourse	HU 3924 5198	3.1x107	ND
10	Watercourse	HU 3923 5183	NR	ND
11	Watercourse	HU 3917 5227	3.6x108	NR

NR - Not recorded ND- Recorded and measured, but not sampled

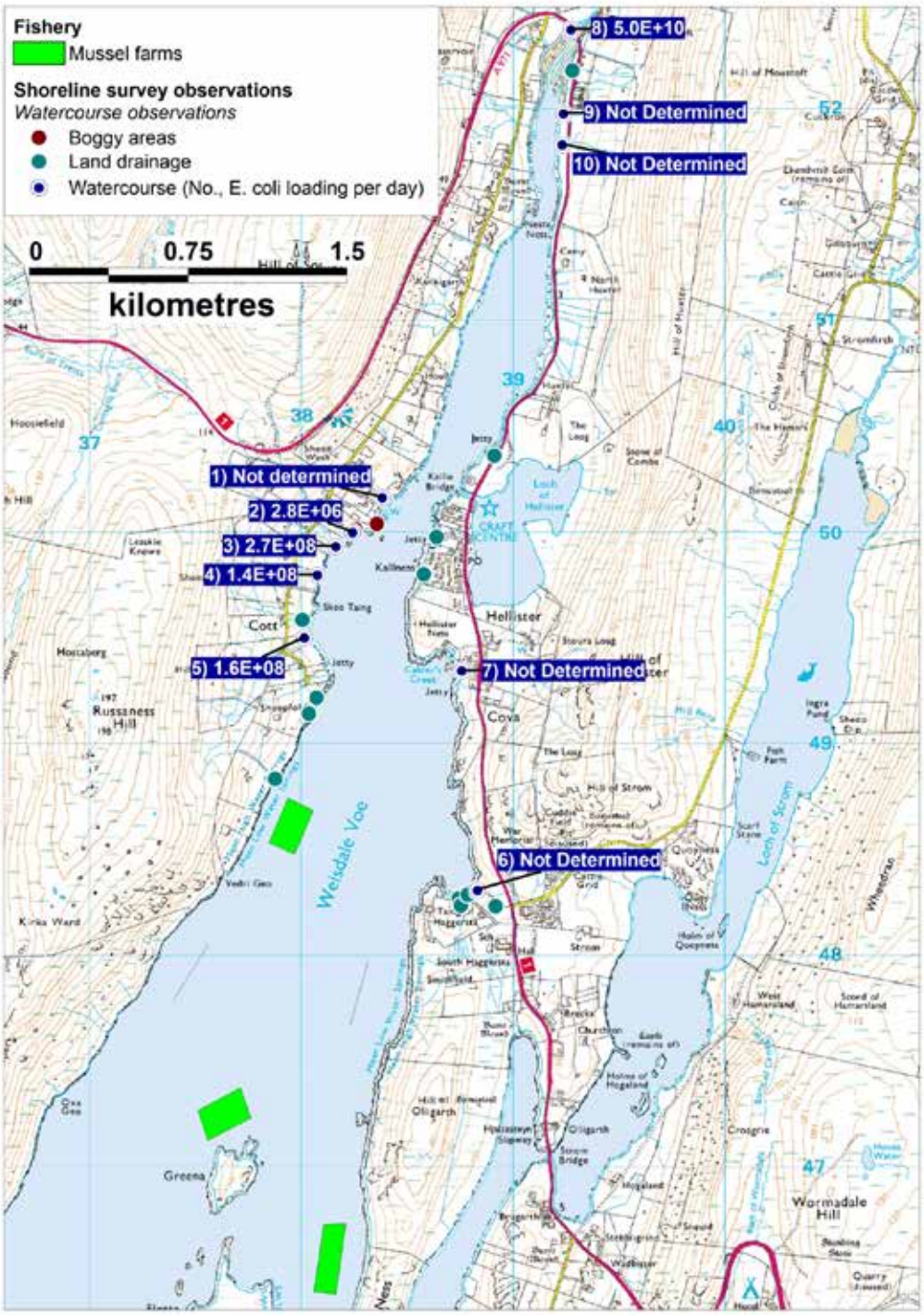

Figure 5.1 Watercourse loadings into Weisdale Voe from measurements taken during the 2013 shoreline survey

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.

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 Weisdale Voe Sanitary Survey Report: rainfall box-plots and wind roses for 2003-2006 period are presented in the 2007 report and have not been reproduced here. The data related to 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 and 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.

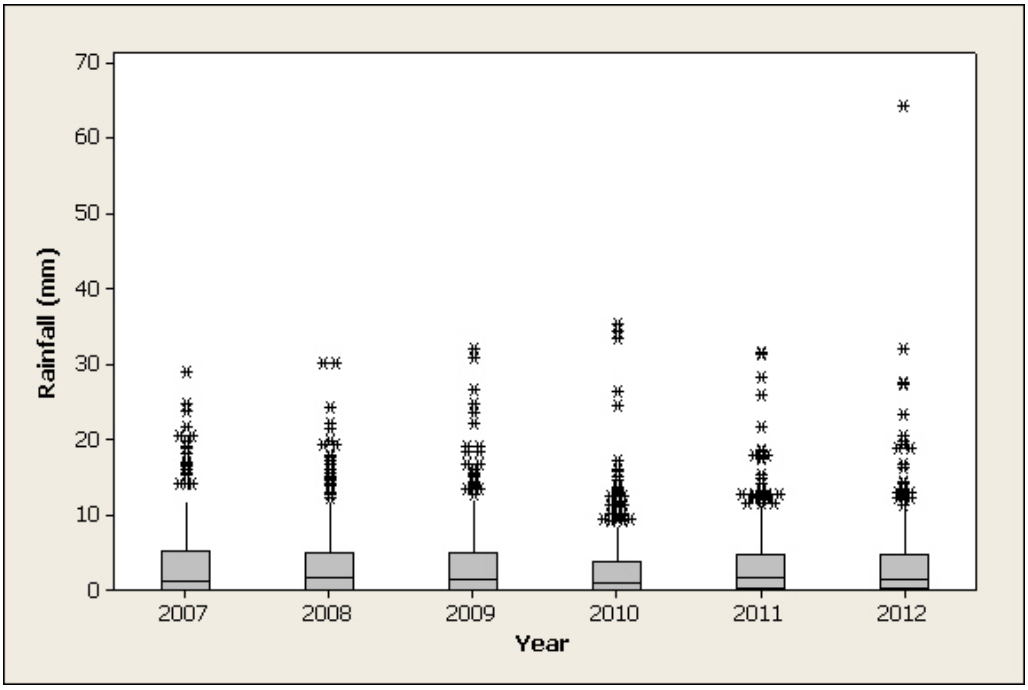

Figure 6.1 Boxplot of daily rainfall at Lerwick by year (2008-2012)

In both data sets, the bulk of the observations were below 10 mm rainfall/day. In the 2007-2012 period presented here, total rainfall values varied somewhat from year to year, with 2010 being the driest year (a total of 1085 mm) and 2009 the wettest (1284 mm) . 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. The number of rainfall events exceeding 30 mm/d occurred in all years except 2007, with an extreme rainfall event of nearly 70 mm/d in 2012.

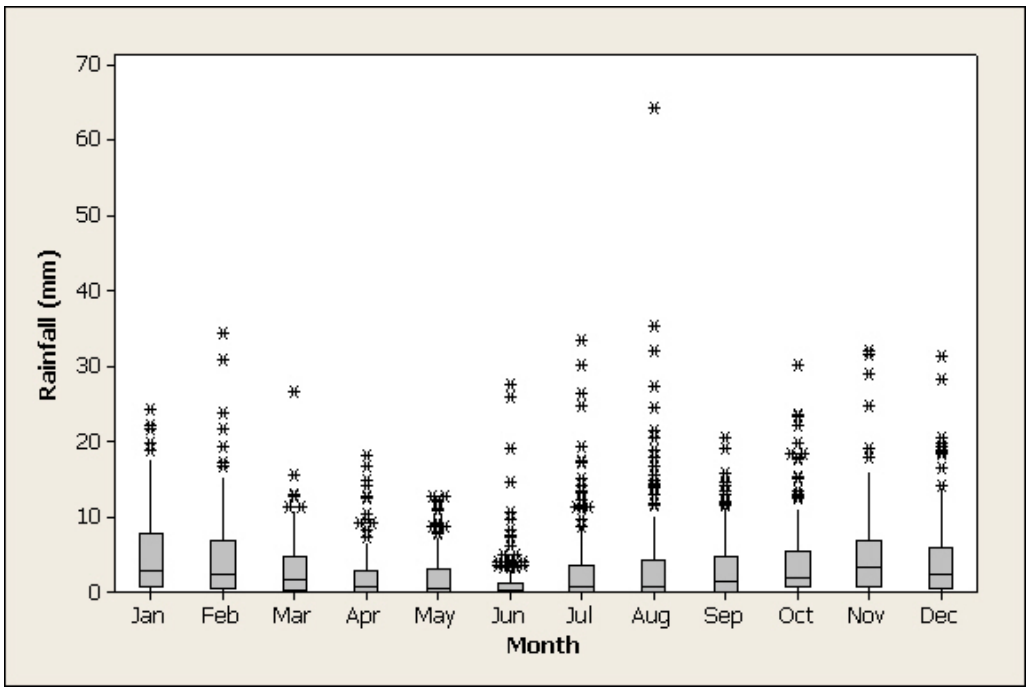

Figure 6.2 Boxplot of daily rainfall at Lerwick by month (2008-2012)

The 2003-2006 period showed a marked difference in rainfall with season, with October to January the wettest months, with August 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.

7.2 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 Weisdale Voe 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 Weisdale Voe is on the west coast).

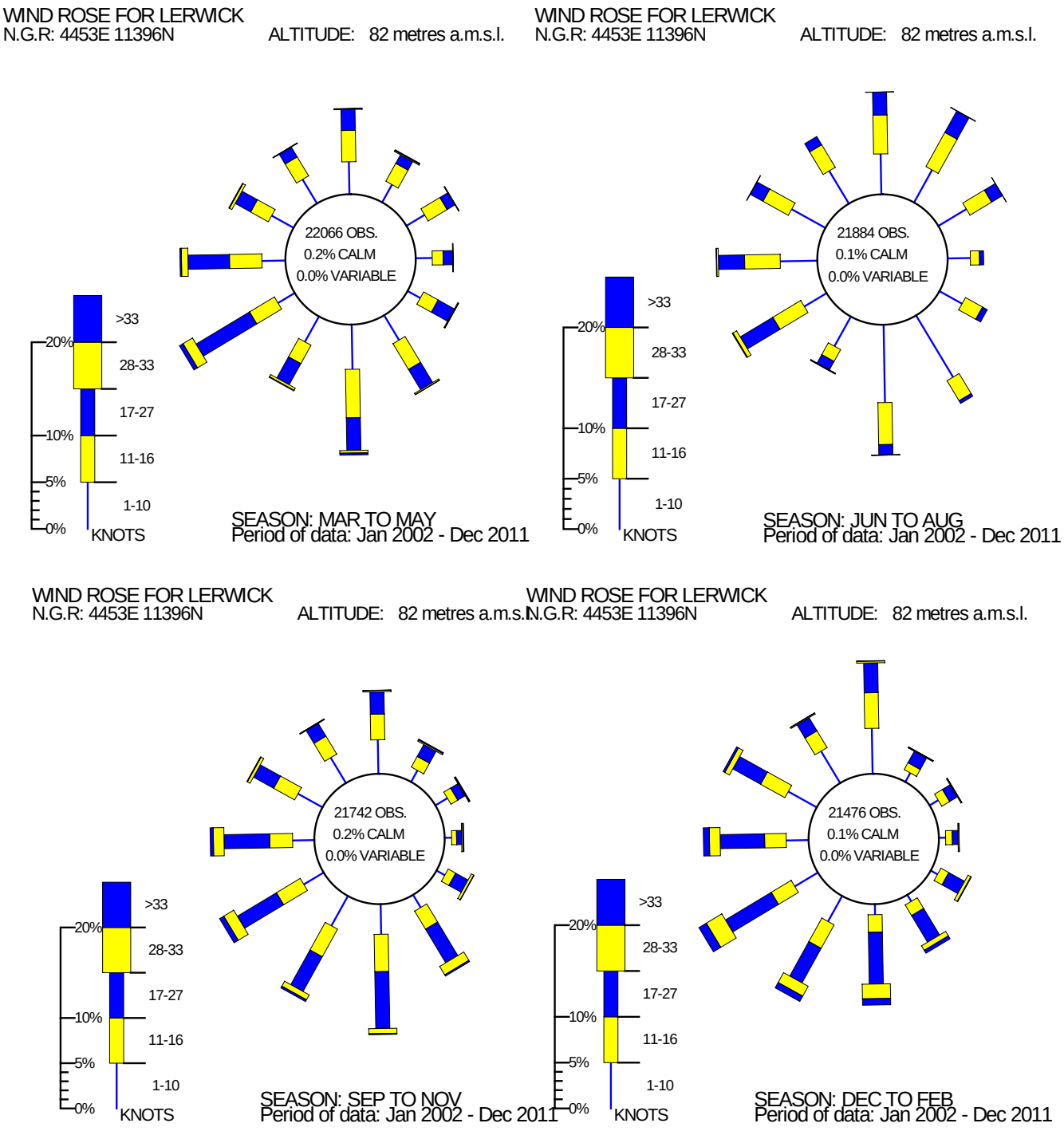

Figure 6.3 Seasonal wind roses for Lerwick (2002-2011)

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

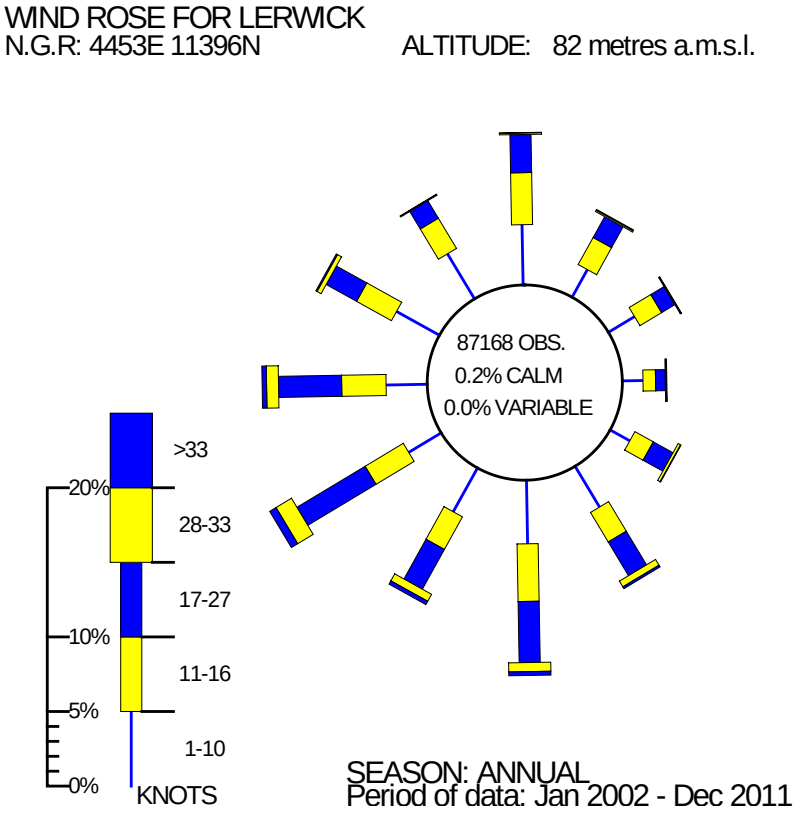

Figure 6.4 Annual wind rose for Lerwick (2002-2011)

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. Weisdale Voe 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 the period 01/01/2007 to 11/12/2013 were extracted from the FSAS database for the Weisdale Voe and Weisdale Voe Upper production areas, 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 December 2013. Historical *E. coli* data used in the 2007 report had already been extracted and validated. All *E. coli* results were reported as most probable number per 100 g of shellfish flesh and intravalvular fluid.

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

North Flotta

Two samples were recorded as rejected in the database and were excluded from further analysis. Two samples were excluded from further analysis as the reported sampling locations plotted outside of the Weisdale Voe production area: one sample lay 400 m south and the other lay >10 km west. The remaining 70 samples were all received within 48 hr of collection. One sample did not have a box temperature recorded. Over 50% of samples had results of 19/<20 *E. coli* MPN /100 g.

Vedri Geo

Two samples were recorded as rejected in the database and were excluded from further analysis. The remaining 64 samples were all taken within <100 m of the production area, were received within 48 hrs of collection and had box temperatures of <8^{o}C.

7.1 Summary of microbiological results

Summary results for sites North Flotta and Vedri Geo are displayed in Tables 7.1 and 7.2.

Table 7.1 Sampling summary results for North Flotta fishery 2004-2013

Sampling Summary				
Production area	Weisdale Voe			
Site	North Flotta			
Species	Common mussels			
SIN	SI - 297-469-08			
Location	Various			
Years	2004-2006		2007-2013	
Total no. of samples	26		70	
			2007	8
			2008	10
			2009	10
			2010	10
	2004	4	2011	9
	2005	12	2012	11
	2006	10	2013	12
Minimum	<20		<20	
Maximum	1300		16000	
Median	<20		<20	
Geometric mean	25		22	
90 Percentile	247		80	
95 Percentile	954		176	
No. Exceeding 230/100g	2 (8%)		2 (3%)	
No. Exceeding 1000/100g	1 (4%)		1 (1%)	
No. Exceeding 4600/100g	0		1 (1%)	
No. Exceeding 18000/100g	0		0	

Table 7.2 Sampling summary results for Vedri Geo fishery 2008-2013

Sampling Summary	
Production area	Weisdale Voe Upper
Site	Vedri Geo
Species	Common mussels
SIN	SI-378-768-08
Location	Various
Total no. of samples	64
2008	9
2009	10
2010	11
2011	10
2012	12
2013	12
Minimum	<20
Maximum	3500
Median	50
Geometric mean	46
90 Percentile	515
95 Percentile	1473
No. Exceeding 230/100g	9 (14%)
No. Exceeding 1000/100g	3 (5%)
No. Exceeding 4600/100g	0
No. Exceeding 18000/100g	0

The highest result was seen at North Flotta in the 2007-2013 sampling period. However, a greater proportion of results >230 *E. coli* MPN / 100 g was seen at Vedri Geo.

7.2 Geographical patterns of results

The sampling locations of all samples assigned to both Vedri Geo and North Flotta are displayed in Figure 7.1.

A t-test was calculated to determine whether there was a statistically significant difference in sample results between Vedri Geo and North Flotta sites between 2008 and 2013. A significant difference was found between log transformed *E. coli* results at North Flotta and Vedri Geo sites (Two sample t-test, t = -2.92, DF = 119, p = 0.004), where sample results were higher at Vedri Geo than at North Flotta.

As most samples at both sites have been taken relatively close to the identified RMPs, it is not possible to analyse the results for spatial variation within each site.

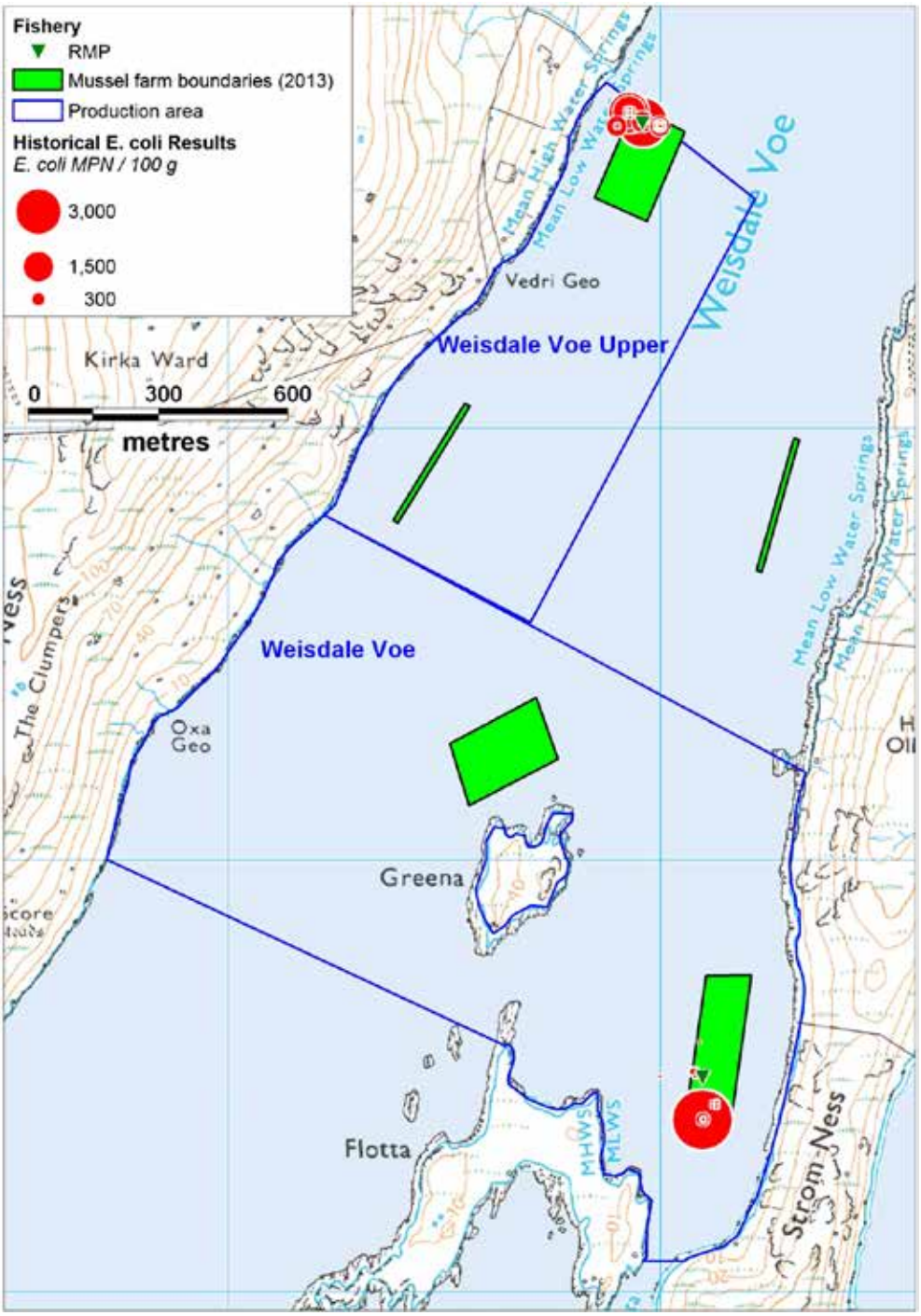

Figure 7.1 Sample results and locations from Vedri Geo and North Flotta common mussel fisheries

8.3 Temporal patterns of results

Temporal trends for North Flotta and Vedri Geo are displayed in Figures 7.3 and 7.4. The datasets are fitted with lowess trend lines. Lowess trendlines 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.

Statistical analyses were carried out for the data from North Flotta using the statistical software package Minitab. A two sample t-test (using $\log_{10}$ transformed *E. coli* data) was used to determine whether there was a statistically significant difference between mean *E. coli* results between the two sampling periods. A Fisher's Exact Test was used to test for a significant difference in the observed and expected *E. coli* results above the 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.

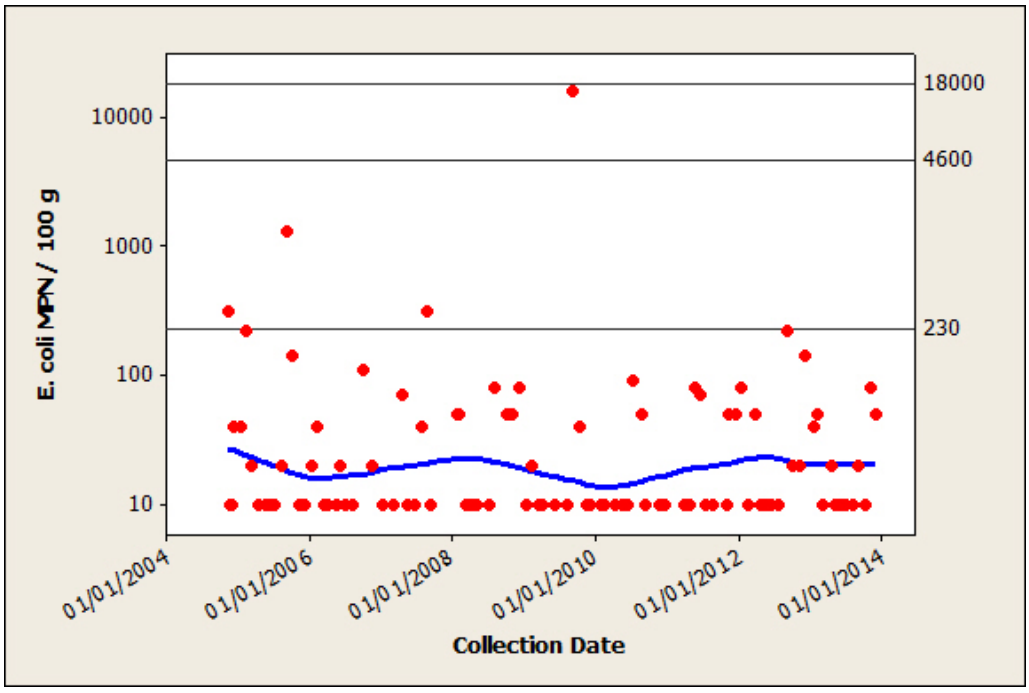

Figure 7.2Scatterplot of North Flotta *E. coli* results by date (2004-2013), with a lowess line

Contamination levels have predominantly been low over the sampling period, with three slight increases visible in 2005, at the start of 2008 and again from mid 2012 to present. These increases are caused by lower numbers of results at <20 *E. coli* MPN /100 g. The highest result was taken at the end of 2009.

No significant difference was found between the means of the $\log_{10}$-transformed *E. coli* results from the two survey periods (Two sample t-test, t = 0.38, DF = 42, p = 0.703).

Table 7.3 Results above and below 230 and 1000 *E. coli* MPN/100 g for North Flotta

		E. coli MPN/100g		Total	*E. coli* MPN/100g		Total
		≤230	>230		≤1000	>1000	
2001-2007	Observed	24	2	26	25	1	26
2008-2013	Observed	68	2	70	69	1	70
	Total	92	4	96	94	2	96

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 = 0.295).

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 = 0.470).

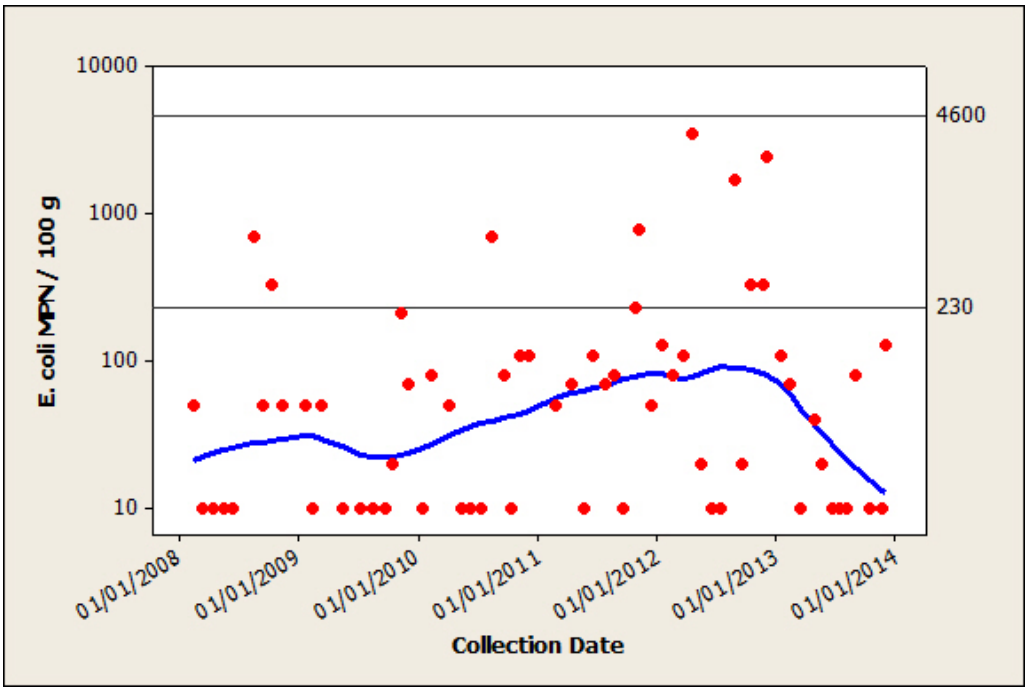

Figure 7.3Scatterplot of Vedri Geo *E. coli* results by date (2008-2013), with a lowess line

Contamination levels are shown to have increased up to late 2012 before decreasing sharply over 2013.

Conclusions

Although the highest result has been seen at North Flotta, on average the results are significantly higher at Vedtri Geo. There has been little change in the extent of contamination at North Flotta over time. Although there is a limited dat set avaialbe for Vedri Geo, this does show a change over the sampling period, with results peaking in 2012.

Overall, contamination levels are shown to have remained largely the same at North Flotta, with contamination levels at Vedri Geo showing an increase over the 2008-2013 sampling period. Sample results were statistically higher at Vedri Geo fishery than North Flotta between 2008 and 2013.

8. Movement of contaminants

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

- Wind driven water movements would have a more significant effect than tides on the movement of contaminations around the Voe
- Mixing is likely to be wind driven
- Freshwater input from the Burn of Weisdale at the head of the Voe may ride over the denser salt layer in certain conditions
- As bacterial contamination is likely to occur with freshwater runoff, higher contamination levels are expected to be seen in shallower water

Summary current data provided by SEPA for a site near the mouth of Weisdale Voe showed that the mean subsurface current speed was 0.035 m/s. Over a single ebb or flood tide, this would correspond to a transport distance of approximately 0.8 km. The direction and degree of anisotropy (whether the current was essentially bidirectional or not) was not given. The vector averaged residual current was very small at 0.002 m/s and the area was determined to be weakly flushed or even highly quiescent. This does not take any account of the effect of wind: wind-driven currents will be significant in areas where tidal currents are weak, as at Weisdale Voe. Strong winds for the prevailing direction of south to southwest would tend to increase currents on the fllod and decrease those on the ebb. The opposite effect would occur during periods of strong northerly winds.

Salinity profiles taken at three sites during the 2013 shoreline survey showed near-surface salinities ranging between 30.65 ppt (North of Flotta) and 34.94 ppt (Vedri Geo). There was a difference between near-surface and depth of more than 4 ppt at the surface at one site (North of Flotta) and of just over 1 ppt at another (Greena), wqhile the third (Vedri Geo), showed a difference of only 0.25 ppt, less than the variability inherent in the instrument. The results imply that, at the time of the shoreline survey, there was a greater impact from freshwater towards the southern end of the production area.

Data for 27 CTD/STD casts undertaken by FRS Marine Laboratory between 2004 and 2006 were obtained from the British Oceanographic Data Centre. The recordings related to positions located approximately along the centre line of the voe from the mouth to Kalliness. Near surface salinities ranged from 34.94 to 35.29 psu with the slightly higher values tending to occur nearer to the mouth. Differences between near surface and at depth salinities were all less than 0.2 psu. This larger data set indicates a minor freshwater influence near the surface within the voe which tends to increase towards the head.

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

The general level of contamination from sewage discharges is not expected to have changed markedly since 2007 although there has been some decrease in the population of most areas around the voe. Impacts inputs are still expected to be greatest from the community discharges located at the Kalliness and Clach-na-Strom on the eastern shore. There will also be effects from the large number of private discharges located around Kalliness/Hellister and Clach-na-Strom, as well as around Sound on the western shore. The principal effects on the microbiological quality at the fisheries will be at the northern ends of the Vedri Geo and Olligarth sites.

Agricultural impacts

Sheep continue to be the main livestock reared on land around Weisdale Voe. From the shoreline survey observations, impacts are expected to be greatest along the western side of Vedri Geo and the eastern side of Olligarth fisheries.

Wildlife Impacts

Birds continue to represent the greatest wildlife contamination source. More detailed information acquired since the 2007 report indicate that the greatest impact from this source is likely to be on the sites located at the southern end of the production areas (Greena and North of Flotta).

Seasonal Variation

Variations in rainfall were noted, with highest levels experienced in November to February. Variations in birds numbers are anticipated, with highest numbers of birds present at nesting sites of European herring gull, lesser black-backed gull and Great-black backed gull on islands of Flotta and Greena at the southern end of the Voe. The seasonality of gull populations is complex, due to a combination of breeding periods, inland movement of resident populations in winter in some areas, and arrival of migrants in winter. However, overall numbers are likely to be highest in the area in summer. Eider duck are expected to impact the North Flotta and to some extent the Greena site during the summer moulting season.

Watercourses

The greatest extent of contamination to the voe from a watercourse source is from from Burn of Weisdale at the head of the Voe. However, this is more than 3 km

north of the closest fishery. Other watercourses in the vicinity of Sound would impact the northern end of the Vedri Geo site. Other, minor impacts may also have an effect at the northern end of the Olligarth site. Direct run-off may impact along the steep shores of the voe during heavy rainfall.

Information from salinity profiles taken during the shoreline survey indicates significant freshwater impact towards the southern end of the voe. However, comprehensive data from FRS Marine Laboratory surveys showed only a small effect that tended to be greater towards the head of the voe.

Movement of contaminants

The average transport distance for contaminants over a flood or ebb tide has been estimated to be in the order of 0.8 km.

Analysis of Results

Historical *E. coli* results

The average *E. coli* levels in mussels from Vedri Geo are statistically higher than those taken from North Flotta. No significant change in the extent of the contamination at the North Flotta site has been seen over the period from 2004 to 2013.

Shoreline Survey results

The shellfish samples taken during the 2013 survey returned results ranging from <20 to 80 *E. coli* MPN/100 g. Two of the three sampling locations reported higher contamination levels in the shellfish sample taken at the top 1 m, than at the bottom, with Greena reporting higher contamination levels in shellfish sample taken at the bottom of the line. Highest contamination levels were taken at Vedri Geo (80 *E. coli* MPN/100 g) and lowest results were taken at Greena (5 *E. coli* MPN/100 g).

The highest seawater *E. coli* result (280 *E. coli* cfu/100 ml) was associated with a sample taken north of Kalliness. Results from samples taken around the middle of the voe (e..g around Vedri Geo) were lowest while those taken towards the southern end were slightly higher (e.g. 18 *E. coli* cfu/100 ml at North Flotta).

Conclusions

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

- Private STs that are in an unknown condition. A particularly high input risk is associated with Kalliness, where the majority of ST were observed and soil is freely draining

- Livestock and farming practices; sheep grazed over much of the land and with shore access to the northwest, tipping of bedding waste and faeces along the shoreline would all represent loadings during heavy rainfall

- Northern fulmar colonies at the head of the Voe and on islands of Flotta and Greena

- Freshwater runoff from land and watercourses, which will significantly impact shallower waters

- Winds in a westerly and south-westerly direction

The conclusions from the present review are as follows:

- Impact from the following sources will impact at the northern end of the present group of fisheries:
    - Sewage discharges, both public and private
    - Farm animals
    - Watercourses

- Impact from wildlife is likely to predominate at the southern end of the group of fisheries.

- Significantly higher *E. coli* levels in mussels have been seen at Vedri Geo than at North Flotta. This would support the assumption that the combined impact to the north of the fisheries was somewhat greater than the source(s) to the south.

- In general, ignoring any effects of wind-driven currents, transport distances within the voe are expected to be less than 1 km over a flood or ebb tide.

10. Recommendations

Weisdale Voe

Production Area

It is recommended that this remains as presently defined, i.e. “The area bounded by lines drawn between HU 3805 4607 and HU 3796 4607 and between HU 3764 4657 and HU 3672 4700 and between HU 3722 4780 and HU 3834 4720 extending to MHWS”.

RMP

As the predominant local sources of contamination will be associated with the wild bird populations, it is recommended that the RMP be amended to HU 3810 4650.

Tolerance

It is recommended that a tolerance of 40 m be applied to allow for drift of the mussel lines.

Depth

As there is a slight freshwater influence in the voe, it is recommended that the sampling depth be 1 m.

Frequency

Monthly

Weisdale Voe Upper

Production Area

It is recommended that the production area be expanded to include the new Olligarth mussel site and to ensure that it encompasses the whole lease area for Vedri Geo. This would then become: The area bounded by lines drawn between HU 3796 4895 and HU 3864 4834 and between HU 3770 4755 and HU 3722 4780 extending to MHWS.

RMP

It is recommended that this be maintained as recommended previously in the sanitary survey as this point lies well within the recorded mussel farm area and will reflect the identified sources of contamination to the north of the production area. This is HU 3796 4871.

Tolerance

It is recommended that a tolerance of 40 m be applied to allow for drift of the mussel lines.

Depth

As there is a slight freshwater influence in the voe, it is recommended that the sampling depth be 1 m.

Frequency

Monthly

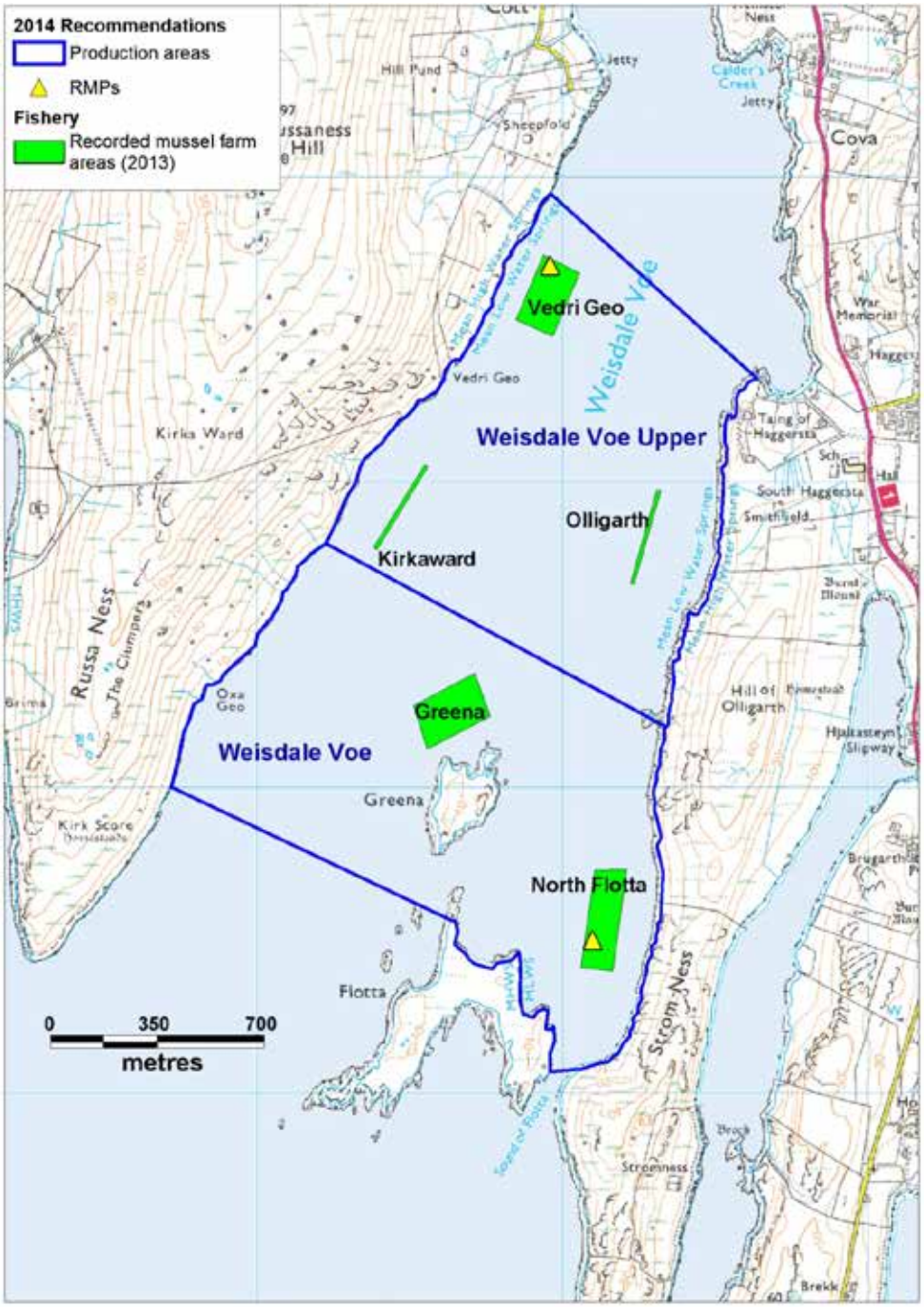

Figure 10.1 Map of recommendations for production areas and RMPs for the Weisdale Voe and Weisdale Voe Upper production areas

11. References

Brown, J., 1991. The final Voyage of Rapaiti: A measure of surface drift velocity in relation to the surface wind. *Marine Pollution Bulletin,* 22(1), pp. 37-40.

Group, S. O. T. E. A., 2012. *Ornithological Monitoring Programme in Shetland,* Aberdeen: Aberdeen Institute for Coastal Science and Management.

Lee, R. J. & Morgan, O. C., 2003. Envrionmental factors influencing the microbial contamination of commercially harvested shellfish.. *Water Science and Technology,* Issue 47, pp. 65-70.

Mallin, M. A. et al., 2001. Demographics, landscape and meterological factors controlling the microbial pollution of coastal waters. *Hydrobiologica,* Issue 460, pp. 185-193.

Mitchell, I. P., Newton, S. F., Ratcliffe, N. & Dunn, T. E., 2004. *Seabird populations of Britain and Ireland: results of the Seabird 2000 census (1998-2002),* London: T & A D Poyser.

NAFC Marine Centre, 2012. *Shetland Marine Spatial Plan.* [Online] Available at: http://www.nafc.ac.uk/ssmei.aspx [Accessed 10 10 2012].

Peeters, J. E., Pohl, ,. P., Okerman, L. & Devriese, L. A., 1984. Pathogenic properties of Escherichia coli strains isolated from diarrheic commercial rabbits.. *J. Clin. Microbiol.,* 20(1), pp. 34-39.

Shetland Islands Council, 2014. *Planning: Simple Search.* [Online] Available at: http://pa.shetland.gov.uk/online-applications/ [Accessed 10 12 2013].

Special Committee on Seals, 2012. *Scientific Advice on Matters Related to the Management of Seal Populations 2012,* St Andrews: St Andrews University; Sea Mammal Research Unit.

UN World Health Organisation, 1998. *The Impact of Cemeteries on the Environment and Public Health an Introductory Briefing,* Denmark: UN WHO.

12. List of Figures and Tables

Table 1.1 Current classified fishery at Weisdale Voe 2

Table 1.2 Comparison of differences in recommended and present RMP locations . 2

Table 1.3 Information and current status of new sites 2

Table 2.1 Scottish Government Census data for years 2001 and 2011 6

Table 2.2 Sewage discharge-related observations around Weisdale Voe from the 2013 shoreline survey 7

Table 4.1 Seabird 2000 census data for Weisdale Voe..... 14

Table 5.1 Watercourses recorded during the 2007 and 2013 shoreline surveys..... 18

Table 7.1 Sampling summary results for North Flotta fishery 2004-2013..... 25

Table 7.2 Sampling summary results for Vedri Geo fishery 2008-2013 25

Table 7.3 Results above and below 230 and 1000 *E. coli* MPN/100 g for North Flotta 29

Figure 1.1 Location of Weisdale Voe..... 1

Figure 1.2 Current and historical fishery locations, Weisdale Voe 4

Figure 2.1 Distribution of human population around Weisdale Voe..... 5

Figure 2.2 Map of public sewage discharges (from the 2007 sanitary survey report) and 2013 shoreline survey observations, in the vicinity of Weisdale Voe..... 10

Figure 3.1 Map of farm animals and associated observations made during the 2013 shoreline survey 12

Figure 4.1 Map of wildlife around Weisdale Voe, including observations made during the 2013 shoreline survey 16

Figure 5.1 Watercourse loadings into Weisdale Voe from measurements taken during the 2013 shoreline survey 19

Figure 6.1 Boxplot of daily rainfall at Lerwick by year (2008-2012) 20

Figure 6.2 Boxplot of daily rainfall at Lerwick by month (2008-2012) 21

Figure 6.3 Seasonal wind roses for Lerwick (2002-2011) 22

Figure 6.4 Annual wind rose for Lerwick (2002-2011)..... 23

Figure 7.1 Sample results and locations from Vedri Geo and North Flotta common mussel fisheries 27

Figure 7.2Scatterplot of North Flotta *E. coli* results by date (2004-2013), with a lowess line..... 28

Figure 7.3Scatterplot of Vedri Geo *E. coli* results by date (2008-2013), with a lowess line..... 29

Figure 10.1 Map of recommendations for production areas and RMPs for the Weisdale Voe and Weisdale Voe Upper production areas..... 36

Appendices

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

Appendix 1

Planning applications to Weisdale Voe

Date	Code	Description	NGR	Sewage plans
Feb-13	2013/031/APN	Demolish existing croft house and erect storage shed	HU 3799 4937	Connect into existing drain
Nov-12	2012/382/PPP	To erect dwellinghouse (permission in principle)	HU 3858 5073	New ST to soakaway

Appendix 2

Shoreline Survey Report

Production Areas:	Weisdale Voe and Weisdale Voe Upper	
Site Names:	Weisdale Voe:	Greena
		North Flotta
	Weisdale Voe Upper:	Vedri Geo
SIN:	Greena:	SI-297-468-08
	North Flotta:	SI-297-469-08
	Vedri Geo:	SI-378-768-08
Harvesters:	**Blueshell Mussels**: Michael Laurenson - Greena and Vedri Geo	
	Shetland Mussels Ltd.: Michael Tait - North Flotta	
Local Authority:	Shetland Islands Council	
Status:	Existing area	
Date surveyed:	29 & 30 October 2013	
Surveyed by:	Sean Williamson (Hall Mark Meat Hygiene Ltd.)	
	Vicki Smith (SSQC Ltd.)	
	Alan Harpin (SSQC Ltd.)	
	Michelle Price-Hayward (Cefas)	
	Kasia Kazimierczak (Food Standards Agency)	
	We are grateful to Blueshell Mussels for providing assistance during the marine survey work.	
Existing RMPs:	North Flotta:	HU 3813 4644 (Biotoxin & *E.coli*)
	Vedri Geo:	HU 3793 4873 *(E.coli)*
Area Surveyed:	See Figure 1.1, 1.2 & 1.3	

Specific observations made on site are mapped in Figure 1.2 & 1.3 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 4-22.

Weather

Tuesday 29 October 2013

Cloudy conditions with some light rain present in the afternoon during the shoreline walk. F2-F3 winds persisted for the majority of the day, increasing to a F4 moderate breeze in the early evening before easing in the late evening and overnight. The day began with a westerly wind moving south westerly until midday before changing to a north easterly for the remainder of the day

Wednesday 30 October 2013

Calm conditions to start the day with very little wind. Rain showers more frequent with the wind building to a F3-F4 south easterly during the shoreline survey. The wind continued to strengthen over the remainder of the day peaking at a near gale F7 south westerly in the evening before weakening a little to a F5 overnight.

Preceding the shoreline survey, Sunday 27 October was a cloudy day with light rain showers frequent in the afternoon. A F3-F4 south westerly breeze remained throughout the morning before moving easterly in the afternoon. The wind dropped away to a light southerly F1-F2 breeze in the evening and overnight. Monday 28 October again was a cloudy day however rain was less frequent with only a brief period of light rain present in the evening. The wind built from a F1 to a gentle F3 south westerly which persisted throughout the day and into the evening.

Fishery

The location of the mussel lines for all three fisheries are mapped in Figure 1.1. 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 with harvesting not occurring at any of the fisheries at this time.

The Greena and Vedri Geo fisheries are operated by Blueshell Mussels on behalf of SI Seafarms Ltd.

The Greena fishery consisted of nine mussel lines running parallel to the western shoreline of the island of Greena (Figure 4). All lines were double headed longlines with 10 metre droppers on the majority of the lines, however due to the depth of the water at the south east corner approximately 100 droppers are present at a depth of 7-8 metres on the innermost line nearest the island of Greena. Two mussel samples were collected from the north west corner of the site. The site is licenced for six 210 metre quad-headline longlines.

The North Flotta fishery consisted of seven mussel lines running parallel to the eastern shoreline (Figure 5). All lines were double headed longlines with 10 metre droppers. Two mussel samples were collected at the north end of the site. The site is licenced for seven 330 metre twin-headline longlines.

The Vedri Geo fishery consisted of six mussel lines running parallel to the western shoreline (Figure 6). All lines were double headed longlines with 10 metre droppers. Two mussel samples were collected from the north west corner of the site. The site is licenced for six 210 metre quad-headline longlines.

Sewage/Faecal Sources

On the western shore of Weisdale Voe houses were evenly spaced from the Cott area just north of the Vedri Geo fishery to the head of the voe. The area on the western shore which was surveyed, from Sound to Cott, ten properties were observed with six septic tanks identified. A recently built property in the Cott area had a septic tank that was overflowing with the discharge pooling in the field, with a watercourse present below the septic tank discharge (Figure 7). There were another 22 houses located north of the area surveyed towards the head of the voe on the western shore. The largest dwelling area on the eastern shore was Kalliness with approximately 77 properties present in the area however not all these could be seen from the shore. Also in the Kalliness area there was a local shop and a jewellery making business (Shetland Jewellery) which had a workshop and a visitor's centre above the road adjacent to the tidal Loch of Hellister. Two septic tanks were identified at the north end of the Kalliness walk, one servicing a property north of the Loch of Hellister which had an outfall pipe leading to the sea (Figure 8) and the other tank (Figure 9) located above the road was associated with the Shetland Jewellery business, which also had a grey water discharge observed leading to the loch. The Kalliness area became more densely populated moving south out of Weisdale Voe. No other septic tanks were identified in the area however manhole covers above the shore near the south end of the walk were assumed to be the Kalliness West community septic tank however no discharge pipe could be identified. A number of discharge pipes were noted along the shore at Kalliness but the sources of these discharges were unknown. A smaller dwelling area was present at Calder's Creek with nine properties noted below the road and another ten properties present above the road. Four septic tanks were identified in the area with a large and small septic tank noted in a field below a cluster of seven houses with the small tank overflowing (Figure 10) and the discharge flowing down the field to a ditch running towards the sea. The furthest south dwelling area of Haggersta had five houses present with one septic tank identified at the north end of the walk servicing one of two properties a short distance from the shore. The Clach-na-Strom community septic tank (Figure 11) was identified further east near the road. The furthest north dwelling at the head of Weisdale Voe had nine properties which were located above the road. The Swedish House community septic tank was identified with a large discharge pipe observed leading to the sea (Figure 12).

Sample analysis

Six freshwater samples were obtained from watercourses around Weisdale Voe, four on the western shore, one from the head of the voe and one from the eastern shore. Four of the six samples obtained were outlined in the sampling plan, with two additional samples being obtained one from the west shore and one from the eastern

shore. A freshwater sample which was planned in Kalliness was exchanged for a seawater sample due to multiple discharges noted in the area. The six watercourses sampled were found to have *E.coli* levels between 2-60 cfu/100ml. The sample with the highest *E.coli* count (60 cfu/100ml) was obtained from the Burn of Weisdale at the head of Weisdale Voe (Figure 13).

Seawater samples were obtained from the north end of each of the three fisheries. The seawater samples obtained had *E.coli* levels between <1-18 cfu/100ml. Another seven seawater samples were obtained on the shoreline walks, two on the western shore and five on the eastern shore. Only one of the seawater samples, obtained from a jetty at Haggersta, was outlined in the survey plan the other samples were unplanned. One of the samples, obtained from a jetty north of Kalliness, was originally planned as a freshwater sample however this was exchanged for a seawater sample as there were a number of small discharges entering the small embayment where the jetty was located (Figure 14). Also a seawater sample planned at the end of the Kalliness walk was not obtained due to the height of the escarpment at the sampling location preventing access to the shore to obtain the sample. Six of the seven seawater samples obtained had *E.coli* levels between <1-14 cfu/100ml. The seawater sample with the highest *E.coli* count (280 cfu/100ml) was obtained near a discharge pipe (Figure 8) entering the water north of the channel where the Loch of Hellister joined Weisdale Voe. Another discharge pipe was also noted in the area just south of the channel.

Two mussel samples were obtained from the three fisheries. Samples were obtained from the north end of the Greena fishery, from the north west corner of the site. Mussels were obtained from sample bags located at depths of 1 metre and 10 metres from the surface. The sample obtained from the surface was found to have a count of 50 *E.coli* MPN/100g with the bottom sample returning levels of 20 *E.coli* MPN/100g. The samples from the North Flotta fishery were taken from sample bags at depths of 1 metre and 9 metres from the surface at the north end of the site, four lines in from the west. The sample obtained from the top recorded a count of 50 *E.coli* MPN/100g with the bottom sample returning levels of 20 *E.coli* MPN/100g. The samples from the Vedri Geo fishery were obtained from a sample bag located at depth of 1 metre and from the *E.co*li RMP sampling basket located 10 metres from the surface. The samples were obtained from the north end of the site, at the north west corner. The sample from the surface recorded a count of 80 *E.coli* MPN/100g with the bottom sample returning levels of <20 *E.coli* MPN/100g.

A salinity profile was obtained from the north end of each of the three fisheries. All profiles showed decreases in salinity from 10 metres to the surface. One of the three profiles showed a 0.25 ppt decrease in salinity, which is within the accuracy of the probe used (± 0.35 ppt) which was the profile obtained from the Vedri Geo fishery.

The other two profiles were out with the accuracy of the probe, with a 1.34 ppt decrease at the Greena fishery and a 4.4 ppt decrease in salinity at the North Flotta fishery. Surface salinity ranged from 30.65 ppt at the North Flotta fishery to 34.94 ppt at the Vedri Geo fishery.

A temperature profile was also obtained from the north end of the three fisheries. All profiles showed a decrease in temperature from 10 metres to the surface (0.4-1.9°C difference). Temperature ranged from 8.7°C to 10.7°C.

Salinities of the seawater samples analysed at the laboratory showed salinities ranging from 29.66 PSU present at the North Flotta fishery to 34.18 PSU present at the Vedri Geo fishery, slightly below full strength sea water.

Seasonal population

There is one known self-catering property in the Weisdale Voe area. Kinlea is located within the Kalliness area a short distance from the shore adjacent to the main road. The property is available to rent all year round and can accommodate up to four people.

Boats/Shipping

Boat traffic in the Weisdale Voe production areas are largely associated with mussel farming and leisure boats. Neither of the mussel faming companies that operate fisheries in Weisdale Voe have shorebases or piers in the production area so all traffic related to mussel farming comes from outwith Weisdale Voe. There is a pier in Stromness Voe where Blueshell Mussels berth a small workboat which is used to carry out monthly *E.coli* sampling at Vedri Geo and other sites out with the Weisdale Voe production area. Shetland Mussels has its main shorebase in Walls but berths a small workboat at a pier in Sandsound Voe which is used for weekly biotoxin and monthly *E.coli* sampling at the North Flotta fishery. Shetland Mussels had a large workboat with a small workboat tied up alongside on site at the North Flotta fishery during the boat survey. A creel boat (Figure 15) and small motor boat were also observed steaming south out of Weisdale Voe during the boat work. Rowing boats were observed on two occasions on the western shore. A small workboat was also berthed at a jetty at the north end of Kalliness (Figure 16). Moorings for boats were observed from the western shore and near Haggersta on the eastern shore but no boats were present. Six jetties or small piers were observed on the shoreline survey, one on the west shore near Sound and five on the east shore, one at Haggersta and four in the Kalliness area.

Farming and Livestock

The majority of the land observed during the Weisdale Voe shoreline survey was rough grazing. 161 sheep were observed on the western shore of Weisdale Voe. The animals were observed as far south as the Vedri Geo fishery, observed during the boat work, and as far north as the head of the voe, observed during the shoreline walk.108 of these animals had access to the shore with the other animals located in fenced areas. The fenced areas where the sheep were grazing was improved grazing land. Sheep faeces were noted on two occasions on the western shore where animals were not present, however animals in these areas would have been able to access the shore. On the eastern shore 144 sheep were observed on open grazing land, with access to the shore, at the head of the voe, Haggersta and Olligarth, north of the North Flotta fishery. The 72 sheep observed at Haggersta however may have been restricted from accessing the shore due to the steep escarpments. Sheep faeces were noted at Kalliness and sheep hoof prints were noted at the head of the voe but no animals were present however animals at these two locations would have been able to access the shore.

Near the start of the shoreline walk on the western shore there were two occasions where there was evidence that cattle had been grazing. Cow hoof prints and faeces were noted in fields adjacent to a house, these animals would have been able to access the shore.

Equine faeces were noted in a field near the shore in the Calder's Creek area, however animals would have had limited access to the shore in this area due to the steep banks.

Piles of manure were noted on three occasions on the eastern shore, at Haggersta (Figure 17), Kalliness and Calder's Creek.

Land Use and Land Cover

Rough grassland dominated the shorelines around the Weisdale Voe production areas. The eastern shoreline was characterised by undulating landscape alternating between steep escarpments and lowland areas. The shore was easily accessed at the head of the voe with steeper banks potentially limiting access to the shore at the south ends of the Haggersta and Kalliness areas (Figure 18) and the north end of the Calder's Creek area. The western shore was easily accessed throughout the shoreline walk with flat lowland areas and stony beaches present (Figure 19) at the bottom of steep hills covered with heather and stony outcrops. Wet boggy areas were noted on three occasions on the western shore with wild iris present around two watercourses on the west shore.

On the western shore there was one field that had been cut for silage or hay and one area where sheep were grazing that was improved grazing land.

There was rainfall in the days preceding the shoreline survey and during the shoreline survey however wet boggy areas were not common with no areas noted on the eastern shore and only three present on the western shore.

Watercourses

Six watercourses were sampled during the shoreline survey, four of which were outlined on the sample plan. The additional samples not outlined in the plan were obtained from a small watercourse on the west shore near Sound (Figure 20) and from the end of a pipe adjacent to a property at Haggersta on the eastern shore (Figure 21). The sampling plan detailed a freshwater sampling location in Kalliness however on approaching the location no significant freshwater water discharges could be observed but a seawater sample was obtained due to a number of pipes noted in the area discharging low volumes of water to the sea. Flow rate was recorded at all of the six watercourses sampled. Flow rate was also recorded at six additional locations, two small watercourses on the western shore at Sound and Cott and four watercourses on the eastern shore, two at Haggersta, one at Hellister and one near the head of the voe.

Wildlife/Birds

Most of the birds observed were noted during the boat work. Most commonly observed were gulls (43 in total) and shags (42 in total) which were seen at the majority of the fisheries visited. The birds were observed on buoys, in the water or in flight around the fisheries. Three guillemots were observed in the water around the North Flotta and Kirkaward fisheries and a sparrow was observed landing on a buoy before taking flight again at the Greena fishery. Bird faeces were observed on buoys at most of the fisheries visited. During the shoreline walks greater black backed gulls were observed at Haggersta and north of Cott on the west shore. Four snipes were observed in flight, one on the west shore and three at the head of the voe. Six ringed plovers were observed in flight at the head of Weisdale Voe and a wren was observed in flight at Haggersta. Domestic poultry were present in a field next to a property in the Sound area. Shell debris and crab and urchin carcasses were observed near the shore on four occasions, once on the western shore adjacent to the Vedri Geo fishery and on three occasions at Haggersta which could indicate areas where birds may have been feeding.

One rabbit was observed in the Cott area on the western shore and two seals were noted in the water in the Haggersta area. Two dead seals were observed near the

shore, one at the southern end of the western shoreline walk (Figure 22) and one at the southern end of the Kalliness walk.

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.

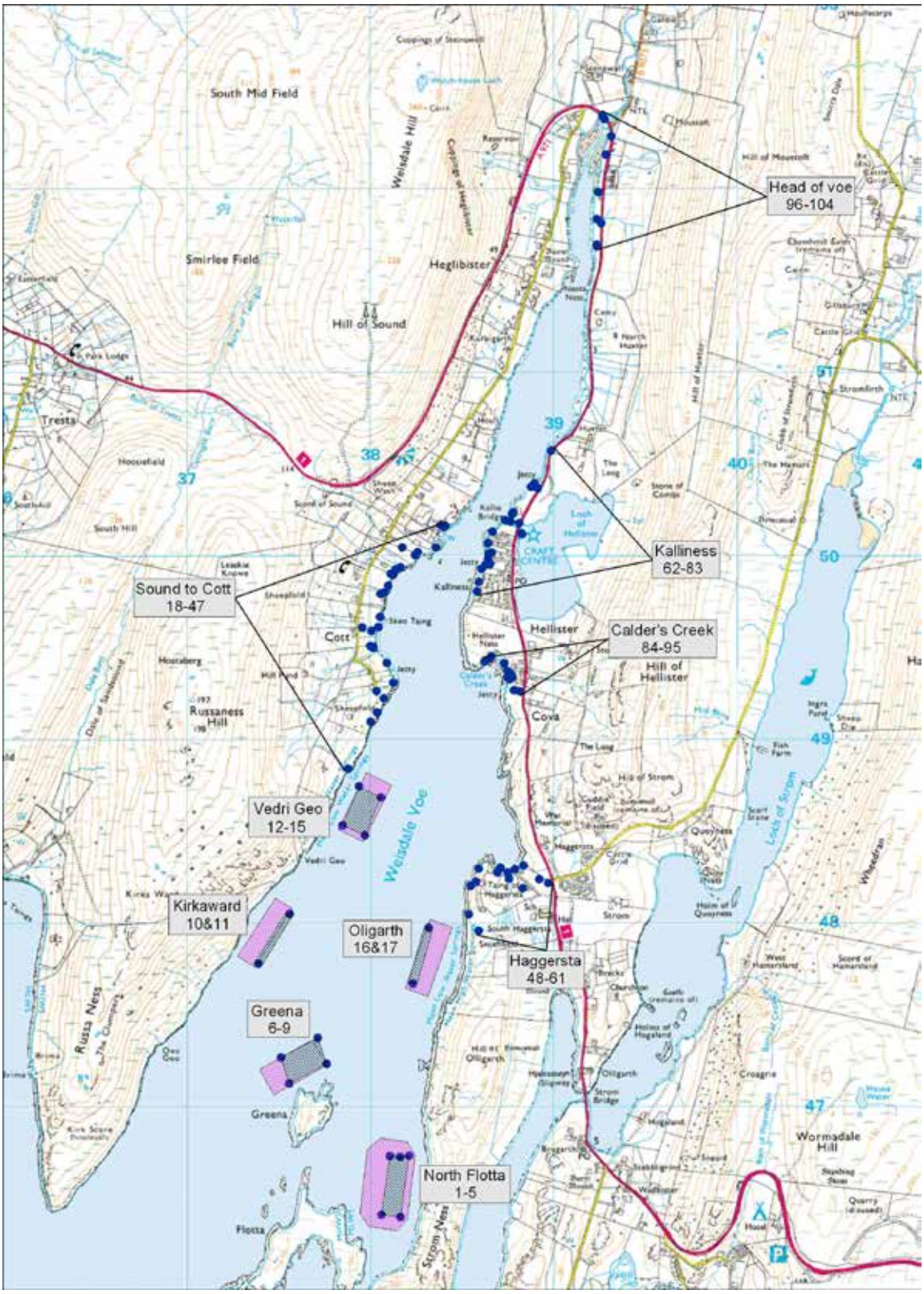

Figure 1.1 Overview map of shoreline observations Weisdale Voe. Numbers denote observation numbers recorded in each area

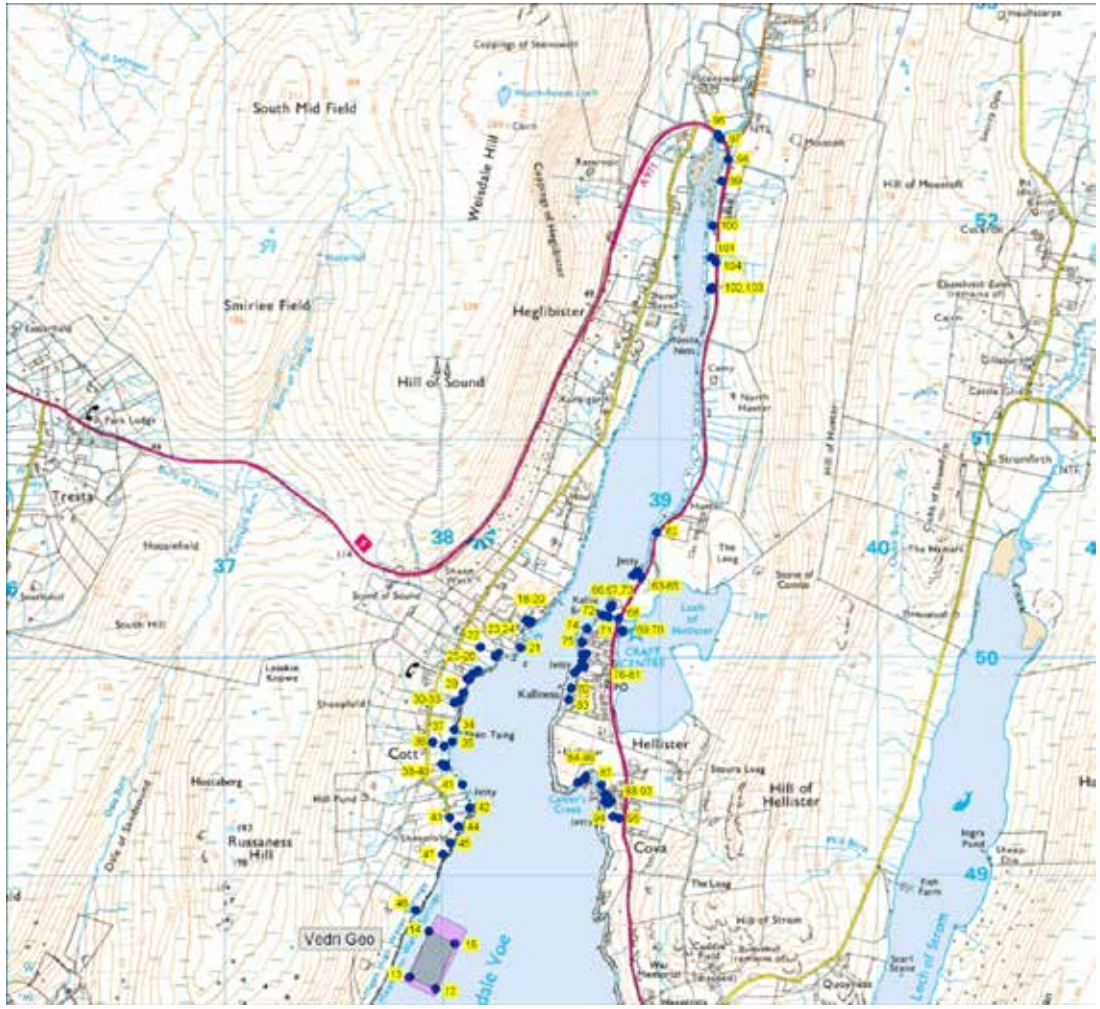

Figure 1.2 Map of shoreline observations Weisdale Voe (North)

Figure 1.3 Map of shoreline observations Weisdale Voe (South).

Table 1 Shoreline Observations

No.	Date/Time (UT)	NGR	Easting	Northing	Associated Photograph	Associated Sample	Description
1	29/10/2013 10:12	HU 38165 46399	438165	1146399			Weisdale Voe shoreline survey - boat work. Weather: Sunny, partly cloudy, light breeze. Sea state: small wavelets, no white caps. SE corner of the North Flotta fishery. 7x double headed longlines 10m droppers. Large workboat on site with small workboat tied up alongside. Some bird faeces present on the buoys. One guillemot observed in the water.
2	29/10/2013 10:13	HU 38060 46412	438060	1146412			SW corner of the North Flotta fishery. One guillemot observed in the water.
3	29/10/2013 10:16	HU 38107 46731	438107	1146731			NW corner of the North Flotta fishery.
4	29/10/2013 10:17	HU 38161 46728	438161	1146728	Figure 5	WDV-MUSS01 (Top), WDV-MUSS02 (Bottom) & WDV-SW01	North Flotta fishery - Salinity Profile 1 collected (ppt/°C): 10m 35.05/10.6, 5m 35.02/10.6, 3m 35.00/10.6, surface 30.65/8.7. Mussels collected from the north end of the site from the central mussel line, four lines in from the furthest west line, nearest the shore. Surface sample collected from a sample bag at 1m depth, bottom sample collected from a sample bag at a depth of 9m. Seawater sample collected.
5	29/10/2013 10:32	HU 38211 46733	438211	1146733			NE corner of the North Flotta fishery.
6	29/10/2013 10:37	HU 37764 47233	437764	1147233			NE corner of the Greena fishery. 9x double headed longlines 10m droppers. Bird faeces present on the buoys. Twelve shags and seven gulls observed on buoys at the site. Five gulls observed in the water.
7	29/10/2013 10:40	HU 37558 47126	437558	1147126			SE corner of the Greena fishery. One sparrow observed landing on a buoy before taking flight.

8	29/10/2013 10:42	HU 37514 47269	437514	1147269			SW corner of the Greena fishery. Six shags and one gull observed in flight.
9	29/10/2013 10:44	HU 37713 47375	437713	1147375	Figure 4 & Figure 15	WDV-MUSS03 (Top), WDV-MUSS04 (Bottom) & WDV-SW02	NW corner of the Greena fishery - Salinity Profile 2 collected (ppt/°C): 10m 35.24/10.7, 5m 35.11/10.6, 3m 35.01/10.6, surface 33.90/9.5. Mussels collected from the NW corner buoy. Surface sample collected from a sample bag at 1m depth, bottom sample collected from a sample bag at a depth of 10m. Seawater sample collected. Creel boat and small motor boat travelling south out of Weisdale Voe.
10	29/10/2013 10:57	HU 37391 47780	437391	1147780			Weather: very brief light rain shower. New mussel fishery (Site name: Kirkaward) not yet classified, owned by Shetland Mussels Ltd. 1x double headed longline, 8m droppers. Southern end of the line. Located south of the Vedri Geo fishery. Mussels on site. One guillemot and one shag observed in the water and one shag noted on a buoy at the north end of the line.
11	29/10/2013 10:59	HU 37560 48051	437560	1148051			Northern end of the line, Kirkaward fishery. Some bird faeces noted on the buoys.
12	29/10/2013 11:02	HU 37969 48478	437969	1148478			SE corner of the Vedri Geo fishery. 6x double headed longlines 10m droppers. Fifteen shags and seven gulls observed on buoys at the site.
13	29/10/2013 11:03	HU 37849 48532	437849	1148532			SW corner of the Vedri Geo fishery. Four shags and two gulls observed in flight. Shoreline to the west of the fishery - steep hill, rough grassland and heather with stony outcrops. Twenty sheep grazing on the hill with access to the shore.
14	29/10/2013 11:05	HU 37939 48744	437939	1148744	Figure 6	WDV-MUSS05 (Top), WDV-MUSS06	NW corner of the Vedri Geo fishery - Salinity Profile 3 collected (ppt/°C): 10m 35.19/10.7, 5m 35.14/10.7, 3m 35.09/10.7, surface 34.94/10.3.

						(Bottom) & WDV-SW03	Mussels collected from the NW corner buoy. Surface sample collected from a sample bag at 1m depth, bottom sample collected from the RMP *E-coli* sample basket at a depth of 10m. Seawater sample collected. Ten gulls observed in flight and five gulls observed on buoys at the site.
15	29/10/2013 11:24	HU 38058 48686	438058	1148686			NE corner of the Vedri Geo fishery. One gull in flight and three gulls observed on buoys at the site. Weather: overcast conditions to the north of Weisdale Voe, wind changed to easterly.
16	29/10/2013 11:28	HU 38317 47973	438317	1147973			New mussel fishery (Site name: Oligarth) not yet classified, owned by Shetland Mussels Ltd. 1x double headed longline, 8m droppers. Northern end of the line. Located north of North Flotta fishery. Mussels on site. One shag in flight and two shags on buoys at the site.
17	29/10/2013 11:30	HU 38231 47669	438231	1147669			Southern end of the line, Oligarth fishery. Some bird faeces noted on the buoys. Two gulls observed in flight. Fifty sheep observed on the eastern shore with access to the shore between the Oligarth and North Flotta fisheries. Undulating landscape on the eastern shore with rough grassland, heather and stony outcrops.
18	29/10/2013 13:03	HU 38409 50162	438409	1150162			Start of the shoreline walk; Western shore from north to south between Sound and Cott. Cloudy with light wind. Fourteen sheep in a field with access to the shore. Rough grazing.
19	29/10/2013 13:05	HU 38398 50157	438398	1150157			Drainage channel through a field which had a walled area, ruined buildings and jetty above a small stony beach with a rowing boat.
20	29/10/2013 13:06	HU 38384 50167	438384	1150167			Flow rate of channel measured; width 18 cm, depth 5 cm, flow 0.24 m/s, st. dev. 0.023 m/s.

21	29/10/2013 13:15	HU 38358 50045	438358	1150045	Figure 19		Cemetery. Photos looking north and south along the shore to illustrate land use. Boggy area fringing the adjacent field, draining to the beach.
22	29/10/2013 13:20	HU 38174 50047	438174	1150047			House approximately 100m above the shore. Septic tank not identified. Poultry present. Cow hoof prints and faeces (rough grazing) present in an adjacent field. Animals would have had access to the shore.
23	29/10/2013 13:24	HU 38258 50019	438258	1150019			Boggy area with wild iris present and evidence of cattle grazing previously.
24	29/10/2013 13:27	HU 38243 50003	438243	1150003	Figure 20	WDV-FW01	Small watercourse. Freshwater sample obtained (not on survey plan) and flow rate measured; width 15 cm, depth 6 cm, flow 0.181 m/s, st. dev. 0.003 m/s. Long grass present. Mooring for small boat noted.
25	29/10/2013 13:36	HU 38165 49937	438165	1149937		WDV-FW02	Larger watercourse. Freshwater sample obtained (on survey plan) and flow rate measured; width 25 cm, depth 13 cm, flow 0.644 m/s, st. dev. 0.056 m/s. General purpose shed located above the watercourse.
26	29/10/2013 13:48	HU 38139 49926	438139	1149926			Field which has been cut for silage or hay.
27	29/10/2013 13:51	HU 38112 49902	438112	1149902			Three houses above the road. Pipe leading to the water, a mild smell of sewage. Pipe fabricated of small welded sections.
28	29/10/2013 13:59	HU 38122 49895	438122	1149895		WDV-SW04	Seawater sample (not on survey plan) obtained in area where pipe (mentioned above) enters the sea.
29	29/10/2013 14:04	HU 38097 49836	438097	1149836			Thirteen sheep in a rough grazing field, fenced off at the shore.
30	29/10/2013 14:06	HU 38077 49801	438077	1149801			Watercourse. Flow rate measured; width 15 cm,

							depth 7 cm, flow 0.56m/s, st. dev. 0.031 m/s.
31	29/10/2013 14:09	HU 38074 49800	438074	1149800		WDV-FW03	Freshwater sample obtained (on survey plan) from watercourse mentioned above.
32	29/10/2013 14:12	HU 38055 49792	438055	1149792			Septic tank for a house below the road. Possible soak away for the tank. Greater black-backed gull observed in flight.
33	29/10/2013 14:12	HU 38055 49793	438055	1149793			Septic tank for a house below the road. Improved grazing land with approximately forty sheep, fenced off at the shore.
34	29/10/2013 14:22	HU 38053 49668	438053	1149668			Gate to the shore, rowing boat noted above the beach.
35	29/10/2013 14:24	HU 38045 49612	438045	1149612			Rough grazing with shore access. Sheep faeces present.
36	29/10/2013 14:26	HU 37955 49610	437955	1149610			Septic tank in a poor condition for a small house above the road Can hear the sound of flowing water.
37	29/10/2013 14:29	HU 38007 49591	438007	1149591			Watercourse, land drainage. Too choked with wild iris to measure the flow. One rabbit observed.
38	29/10/2013 14:36	HU 38015 49505	438015	1149505		WDV-FW04	Watercourse running below a malfunctioning septic tank associated with a recently built house below the road. Freshwater sample obtained (on survey plan) and flow rate measured; width 40 cm, depth 19 cm, flow 0.203m/s, st. dev. 0.021 m/s.
39	29/10/2013 14:38	HU 37999 49509	437999	1149509	Figure 7		Overflow of solid waste from the septic tank mentioned above. Some pooling in the grass beneath.
40	29/10/2013 14:40	HU 38016 49498	438016	1149498			Overflow from the septic tank and the watercourse running below.

41	29/10/2013 14:44	HU 38091 49416	438091	1149416			Old septic tank on the shore directly above a pipe leading to the sea, although appeared not to be active. Missing section of pipe on the shore and an inspection hatch missing. Neither had signs of flow or waste. Property below the road with a septic tank and soak away, possibly draining to the other side of the hill.
42	29/10/2013 14:54	HU 38124 49309	438124	1149309			Raining steadily. Seven sheep in a field with access to the shore. Property below the road.
43	29/10/2013 14:58	HU 38034 49264	438034	1149264			Septic tank associated with the property identified above. Adjacent to a drainage channel.
44	29/10/2013 15:02	HU 38073 49224	438073	1149224			Flow rate of channel measured; width 20 cm, depth 5 cm, flow 0.621 m/s, st. dev. 0.02 m/s.
45	29/10/2013 15:07	HU 38037 49148	438037	1149148			Rough grazing with rushes and boggy areas. Twelve sheep with access to the shore. Snipe observed in flight.
46	29/10/2013 15:16	HU 37878 48840	437878	1148840		WDV-SW05	Watercourse. Poorly defined channel with water pouring over the peat bank to the beach below. Freshwater sample on the survey plan exchanged for a seawater sample, obtained from where the watercourse enters the sea. Lots of debris and sheep faeces present on the beach. Vedri Geo fishery to the east. Accumulation of shell debris on the banks indicates an area where birds may have been feeding.
47	29/10/2013 15:30	HU 38002 49096	438002	1149096	Figure 22		Dead grey seal on the shore.
48	30/10/2013 09:20	HU 38590 47957	438590	1147957			Start of the shoreline walk; Haggersta. Sunny with light wind, partially cloudy. Approximately seventy two sheep in a field above the shore. Access to the shore may be limited due to 5m banks, above a shore of boulders and exposed bedrock. Greater black-backed gull observed in flight.

							Property observed on the hill, no septic tank identified.
49	30/10/2013 09:26	HU 38535 48049	438535	1148049			Scattered urchin and shell debris, may indicate an area where birds have been feeding.
50	30/10/2013 09:30	HU 38545 48202	438545	1148202			Scattered urchin, crab and shell debris, may indicate an area where birds have been feeding. Property above the shore with associated outbuildings.
51	30/10/2013 09:34	HU 38576 48225	438576	1148225	Figure 17		Pile of manure noted above the shore. Two seals observed in the water.
52	30/10/2013 09:38	HU 38589 48297	438589	1148297			Scattered urchin and shell debris, may indicate an area where birds have been feeding. Wren observed in flight. Southerly breeze developing, increasing cloud cover.
53	30/10/2013 09:43	HU 38691 48277	438691	1148277			Jetty and slipway with two empty moorings.
54	30/10/2013 09:44	HU 38708 48301	438708	1148301		WDV-SW06	Seawater sample obtained from the end of the jetty (on survey plan).
55	30/10/2013 09:49	HU 38746 48276	438746	1148276			Large pipe outfall coming under a track leading to the beach, from two drains in the adjacent field.
56	30/10/2013 09:51	HU 38755 48242	438755	1148242			Flow rate measured of the larger land drain; width 15 cm, depth 5 cm, flow 0.271 m/s, st. dev. 0.007 m/s.
57	30/10/2013 09:56	HU 38787 48292	438787	1148292	Figure 21	WDV-FW05	Property adjacent to the shore, no septic tank identified. Pipe discharging onto the beach, possibly grey water or septic. This is associated with a gully alongside the track leading to the property. Freshwater sample obtained (not on survey plan) and flow rate measured using the one litre jug. Time to fill the jug: 5.5/5.9/6.4 seconds. Rain shower.

58	30/10/2013 10:07	HU 38834 48313	438834	1148313			Natural watercourse. Flow rate measured; width 30 cm, depth 15 cm, flow 0.591 m/s, st. dev. 0.01 m/s.
59	30/10/2013 10:12	HU 38828 48190	438828	1148190			Septic tank from one of two properties above the shore, the other tank not identified.
60	30/10/2013 10:16	HU 38968 48219	438968	1148219	Figure 11		Clach-na-Strom community septic tank, can hear the sound of flowing water. Outfall not determined. Watercourse (Obsv 58) located in a field to the north of the tank, approximately 10m away although there is no sign of an outfall to the watercourse. Possible soak away to the field below the tank.
61	30/10/2013 10:25	HU 38919 48238	438919	1148238			Drainage ditch below the tank, with iron bacterial film. This drains to the watercourse mentioned above. End of shoreline walk.
62	30/10/2013 10:56	HU 38983 50573	438983	1150573			Start of shoreline walk; Kalliness. Steady rain and southerly breeze. Thirty five sheep observed on the hills of the western shore of the voe. Shoreline below the main road, narrow strip of grass above rock armouring, foreshore of bedrock and stones. Long grass and sheep faeces present.
63	30/10/2013 11:01	HU 38912 50367	438912	1150367			Culvert under the main road, appears to be land drainage.
64	30/10/2013 11:03	HU 38894 50394	438894	1150394	Figure 16		Jetty with one small motor boat present.
65	30/10/2013 11:04	HU 38875 50376	438875	1150376			Portacabin with waste pipe to the sea beneath the rock armour. Can't see the end of the pipe.
66	30/10/2013 11:09	HU 38777 50236	438777	1150236	Figure 8		Septic tank serving property above the foreshore. Outfall to the sea, below MLWS.
67	30/10/2013 11:10	HU 38774 50228	438774	1150228			Location of septic tank mentioned above.
68	30/10/2013 11:13	HU 38809 50178	438809	1150178		WDV-SW07	Channel connecting Weisdale Voe with the (tidal)

							Loch of Hellister. Tide ebbing from the loch. Seawater sample obtained (not on survey plan). Salinity measured with refractometer; reading just over 3g sodium chloride per 100g.
69	30/10/2013 11:24	HU 38823 50123	438823	1150123	Figure 9		Septic tank associated with the Shetland Jewellery premises and visitors centre, adjacent to the Loch of Hellister.
70	30/10/2013 11:26	HU 38827 50117	438827	1150117			Grey water discharge to the loch from the Shetland Jewellery building.
71	30/10/2013 11:30	HU 38763 50185	438763	1150185			Discharge pipe to the sea, below MLWS. Unable to determine the origin.
72	30/10/2013 11:31	HU 38733 50195	438733	1150195			Small pier and pontoon. Not in use at the time of the survey.
73	30/10/2013 11:38	HU 38770 50229	438770	1150229		WDV-SW08	Backtracked to what was considered the best location for a sample to represent the discharge from both outfalls (Obsv 67 & 71) to the small embayment for the present weather conditions. Seawater sample obtained (not on survey plan).
74	30/10/2013 11:47	HU 38665 50131	438665	1150131			Looking along the shore to the north. Two properties near the shore in a cluster of six with the other four properties further inland.
75	30/10/2013 11:49	HU 38641 50068	438641	1150068			Small pile of manure at the bottom of a field, fenced off from the shore. Two properties inshore nearer the road.
76	30/10/2013 11:53	HU 38642 50010	438642	1150010			Small renovated jetty, no vessels present.
77	30/10/2013 11:54	HU 38661 50017	438661	1150017			Discharge pipe, unknown source or outfall. Suspected that the outfall is lost under recently reclaimed land associated with a property under construction.

78	30/10/2013 11:57	HU 38640 49982	438640	1149982			Drain in the rock armouring below the property under construction.
79	30/10/2013 12:03	HU 38651 49956	438651	1149956			Discharge pipe outfall, unknown source although clearly associated with the property under construction.
80	30/10/2013 12:09	HU 38629 49953	438629	1149953		WDV-SW09	Seawater sample obtained from the end of a jetty. Originally planned to collect a freshwater sample from here but opted to exchange for a seawater sample as there were multiple discharges observed to this small embayment.
81	30/10/2013 12:11	HU 38606 49930	438606	1149930	Figure 14 & Figure 18		Looking north and south along the shore.
82	30/10/2013 12:15	HU 38590 49858	438590	1149858			Manhole covers above the shore with no visible discharge pipe. In retrospect this was considered to be the location of the Kalliness West community septic tank as it looked visually similar to the Swedish Houses septic tank identified later. Nothing was found at the position given for the Kalliness West septic tank. Several houses observed above the shore in the Kalliness estate.
83	30/10/2013 12:18	HU 38580 49806	438580	1149806			Dead seal on the foreshore. Land drainage outfall nearby. The Kalliness section of the walk was ended here as the banks increased in height. Seawater sample (on survey plan) at the true end of the walk not collected due to the terrain.
84	30/10/2013 12:26	HU 38622 49425	438622	1149425			Start of shoreline walk; Calder's Creek. Weather bright with some cloud and a moderate southerly breeze. Sea state; some white caps.
85	30/10/2013 12:29	HU 38650 49442	438650	1149442			Two pipes from a property adjacent to the shore discharging to the beach. One septic and the other clear, very low flow from both.

86	30/10/2013 12:31	HU 38657 49453	438657	1149453			Septic tank for the outfall mentioned in the previous observation. Surrounding field has equine faeces but limited access to the shore due to the steep banks.
87	30/10/2013 12:38	HU 38729 49414	438729	1149414			Garage and outbuildings associated with property noted in Obsv 85.
88	30/10/2013 12:40	HU 38745 49373	438745	1149373			Pile of manure on the foreshore
89	30/10/2013 12:43	HU 38761 49359	438761	1149359			Several water board markers and an access hatch in an area of grass below a cluster of seven houses. Sewage smell noted.
90	30/10/2013 12:44	HU 38760 49349	438760	1149349			Watercourse. Flow rate measured; width 30 cm, depth 9 cm, flow 0.417 m/s, st. dev. 0.005 m/s. Discharge pipe crossing watercourse from north to south. Perforated pipe, possibly land drainage from the house above joins the watercourse above the discharge pipe.
91	30/10/2013 12:48	HU 38759 49329	438759	1149329			Large septic tank with outfall to the sea, below MLWS. Sludge apparent on top of the tank. With a pipe across the watercourse mentioned above and water board markers previously encountered this is likely to serve the cluster of properties above the shore.
92	30/10/2013 12:51	HU 38773 49340	438773	1149340	Figure 10		Second smaller tank or access hatch in a poor condition with sewage overflow and standing water surrounding. This eventually flows into a ditch running towards the sea past the larger tank, meeting the shore just below the tank outfall. No apparent flow in the ditch.
93	30/10/2013 13:00	HU 38745 49337	438745	1149337		WDV-SW10	Seawater sample obtained (not on survey plan), slightly north of the outfall from the pipe and near where the watercourse mentioned in Obsv 90

							enters the sea.
94	30/10/2013 13:04	HU 38782 49269	438782	1149269			Septic tank associated with final house in the cluster, no apparent outfall.
95	30/10/2013 13:05	HU 38812 49262	438812	1149262			Smaller disused septic tank associated with the same property. MPH opted to end this section of the walk early; no further properties along the shore below the main road.
96	30/10/2013 13:34	HU 39264 52398	439264	1152398			Start of the shoreline walk; head of Weisdale Voe. Cloudy with a moderate southerly breeze.
97	30/10/2013 13:37	HU 39275 52378	439275	1152378		WDV-FW06	The Burn of Weisdale flows beneath the road through a large concrete channel with two 3m sections either side of a central pier. Depth 12 cm and no indication that it varied across the concrete apron where the channel meets the foreshore. Uniform flow aside from in the lee of the pier. Flow rate measured, flow 0.848 m/s, st. dev. 0.025 m/s. Freshwater sample collected (on survey plan).
98	30/10/2013 13:45	HU 39312 52284	439312	1152284	Figure 13		Burn of Weisdale entering Weisdale Voe. Sheep hoof prints present, animals would have been able to access the foreshore.
99	30/10/2013 13:48	HU 39282 52185	439282	1152185			Culvert under the main road leading to a drainage ditch to the sea. Six ringed plovers observed in flight, two sheep grazing on rough grassland above the shore. Approximately twenty sheep on each hillside either side of the voe.
100	30/10/2013 13:53	HU 39239 51981	439239	1151981			Watercourse. Flow rate measured; width 20 cm, depth 11 cm, flow 0.156 m/s, st. dev. 0.017 m/s. Three snipes observed in flight.
101	30/10/2013 13:59	HU 39233 51834	439233	1151834			Watercourse - no significant flow.
102	30/10/2013 14:02	HU 39230 51688	439230	1151688	Figure 12		Large discharge pipe running north to outfall below MLWS. Associated with Swedish Houses

							community septic tank.
103	30/10/2013 14:04	HU 39234 51694	439234	1151694			Swedish Houses community septic tank sample chamber hatch.
104	30/10/2013 14:07	HU 39255 51812	439255	1151812			Swedish Houses community septic tank. End of shoreline walk.

Sampling

Water and shellfish samples were collected at the locations indicated in Figures 2 and 3. Four of the five freshwater samples detailed in the survey plan were obtained from watercourses, as well as two additional freshwater samples which were collected from a small watercourse on the western shore at Sound and a discharge pipe in the Haggersta area. 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 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	WDV-SW01	29/10/2013 10:17	HU 38161 46728	Sea Water	18	29.66
2	WDV-SW02	29/10/2013 10:44	HU 37713 47375	Sea Water	6	33.37
3	WDV-SW03	29/10/2013 11:05	HU 37939 48744	Sea Water	<1	34.18
4	WDV-FW01	29/10/2013 13:27	HU 38243 50003	Fresh Water	2	-
5	WDV-FW02	29/10/2013 13:36	HU 38165 49937	Fresh Water	15	-
6	WDV-SW04	29/10/2013 13:59	HU 38122 49895	Sea Water	<1	35.23
7	WDV-FW03	29/10/2013 14:09	HU 38074 49800	Fresh Water	27	-
8	WDV-FW04	29/10/2013 14:36	HU 38015 49505	Fresh Water	12	-
9	WDV-SW05	29/10/2013 15:16	HU 37878 48840	Sea Water	3	31.90
10	WDV-SW06	30/10/2013 09:44	HU 38708 48301	Sea Water	1	34.79
11	WDV-FW05	30/10/2013 09:56	HU 38787 48292	Fresh Water	10	-
12	WDV-SW07	30/10/2013 11:13	HU 38809 50178	Sea Water	11	20.54
13	WDV-SW08	30/10/2013 11:38	HU 38770 50229	Sea	280	31.59

				Water		
14	WDV-SW09	30/10/2013 12:09	HU 38629 49953	Sea Water	14	33.83
15	WDV-SW10	30/10/2013 13:00	HU 38745 49337	Sea Water	3	23.86
16	WDV-FW06	30/10/2013 13:37	HU 39275 52378	Fresh Water	60	-

*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	WDV-MUSS01	29/10/2013 10:17	HU 38161 46728	Common Mussel	Top	50
2	WDV-MUSS02	29/10/2013 10:17	HU 38161 46728	Common Mussel	Bottom	20
3	WDV-MUSS03	29/10/2013 10:44	HU 37713 47375	Common Mussel	Top	5
4	WDV-MUSS04	29/10/2013 10:44	HU 37713 47375	Common Mussel	Bottom	20
5	WDV-MUSS05	29/10/2013 11:05	HU 37939 48744	Common Mussel	Top	80
6	WDV-MUSS06	29/10/2013 11:05	HU 37939 48744	Common Mussel	Bottom	<20

Table 4 Salinity profiles

Profile	Date/Time (UT)	Position	Depth (m)	Salinity (ppt) (± 0.35 ppt)	Temperature (°C)
1	29/10/2013 10:17	HU 38161 46728	surface	30.65	8.7
			3	35.00	10.6
			5	35.02	10.6
			10	35.05	10.6
2	29/10/2013 10:44	HU 37713 47375	surface	33.90	9.5
			3	35.01	10.6
			5	35.11	10.6
			10	35.24	10.7
3	29/10/2013 11:05	HU 37939 48744	surface	34.94	10.3
			3	35.09	10.7
			5	35.14	10.7
			10	35.19	10.7

Figure 2 Map of water sample results and salinity profile locations Weisdale Voe

Figure 3 Map of shellfish sample results Weisdale Voe

Photographs

Figure 4 – Mussel lines at the Greena fishery looking south.

Figure 5 – Mussel lines at the North Flotta fishery looking south.

Figure 6 – Mussel lines at the Vedri Geo fishery looking south.

Figure 7 – Overflow from a septic tank for a property in the Cott area.

Figure 8 – Septic tank and discharge pipe at the north end of Kalliness where a seawater sample was obtained.

Figure 9 – Septic tank servicing the Shetland Jewellery workshop and visitors centre adjacent to the Loch of Hellister.

Figure 10 – Overflowing septic tank at Calder's Creek.

Figure 11 – Clach-na-Strom community septic tank.

Figure 12 – Discharge pipe associated with the Swedish Houses community septic tank.

Figure 13 – Head of Weisdale Voe where the Burn of Weisdale joins the voe.

Figure 14 – Seawater sample obtained from a jetty in a small embayment at Kalliness where multiple discharge pipes were observed.

Figure 15 – Creel boat steaming south out of Weisdale Voe.

Figure 16 – Small workboat berthed at a jetty at the north end of Kalliness.

Figure 17 – Pile of manure at the south end of Haggersta.

Figure 18 – Looking south down Weisdale Voe, steep escarpments at the south end of Kalliness preventing access to the shore.

Figure 19 – Lowland area with a stony beach at Sound, looking south.

Figure 20 – Additional freshwater sample obtained from a small watercourse near Sound.

Figure 21 – Additional freshwater sample obtained from a discharge pipe next to a property in the Haggersta area.

Figure 22 – Dead seal carcass on the shore located south of Cott.

Report prepared by:

Vicki Smith
Marine Surveyor
Marine Farm Services
SSQC Ltd.
Port Arthur
Scalloway
Shetland
ZE1 0UN

t: 01595 772403
e: vicki@ssqc.co.uk