Scottish Sanitary Survey Report

Sanitary Survey Report
Meikle Craigs
SA-643
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Partner Organisations

The hydrographic assessment and the shoreline survey and its associated report were undertaken by SRSL, Oban.

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Appendices

I. Executive Summary

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

The purpose of the sanitary survey is to demonstrate compliance with the requirements stated in Annex II (Chapter II Paragraph 6) of Regulation (EC) 854/2004. The sanitary survey results in recommendations on the location of RMPs, the frequency of sampling for microbiological monitoring, and the boundaries of the production areas deemed to be represented by the RMPs. A sanitary survey was undertaken on the classified razor clam fishery at Meikle Craigs on the basis recommended in the European Union Reference Laboratory publication: "Microbiological Monitoring of Bivalve Mollusc Harvesting Area Guide to Good Practice: Technical Application" (http://www.cefas.defra.gov.uk/nrl/information-centre/eu-good-practice-guide.aspx). This area was selected for survey at this at it is a newly classified area.

Meikle Craigs lies within the Firth of Clyde on the Ayrshire coast, between the towns of Troon and Ayr. Razor clams are harvested by diving within an area adjacent to the coast between Meikle Craigs rocks and Bell Rock.

The principal sources of contamination to the fishery area

- Diffuse agricultural pollution, urban surface water drainage and human sewage carried to the sea via Pow Burn and the River Ayr
- Combined sewer overflows to sea along the eastern boundary of the production area and to Pow Burn and the River Ayr
- Faecal contamination from gulls and other seabirds, principally at Meikle Craigs rocks and around Pow Burn.

Contamination is largely carried via the two main watercourses in the area: Pow Burn and the River Ayr. Although tidal currents are predicted to be relatively slow, surface currents driven by prevailing southwest winds may increase transport toward the northeast for distances greater than the 2 km predicted for tidal transport alone.

There was insufficent monitoring history to permit geographical or seasonal assessment of results or of results against environmental variables.

No changes were recommended to the production area boundaries, however it was recommended that the representative monitoring zone (RMZ) be expanded to the area from the mouth of Pow Burn to the car park at the north end of Prestwick and extending approximately 250 m offshore.

II. Sampling Plan

Production Area	Meikle Craigs
Site Name	Meikle Craigs
SIN	SA-643-1316-16
Species	Razor clams
Type of Fishery	Wild
RMZ Boundary	The area bounded by lines drawn from NS 3354 2800 to NS 3327 2800 to NS 3376 2731 to NS 3405 2623 to NS 3428 2623 to NS 3428 2631 to NS 3401 2737 and back to NS 3354 2800
Tolerance (m)	Not applicable
Depth (m)	Not applicable
Method of Sampling	Dived
Frequency of Sampling	Monthly
Local Authority	South Ayrshire
Authorised Sampler(s)	Martin Scott
Production Area Boundaries	The area bounded by lines drawn from NS 3292 2883 to NS 3401 2737 to NS 3428 2631 to NS 3421 2499 to NS 3299 2500 to NS 3224 2828

III. Report

1. General Description

Meikle Craigs is a small rocky outcrop between Troon and Ayr, within the Firth of Clyde in Ayrshire. It lies within the South Ayrshire council area. The study area lies around this outcrop.

The coast around Meikle Craigs is densely populated, with the town of Prestwick lying directly adjacent and the towns of Troon and Ayr lying to the north and south respectively. Glasgow Prestwick Airport is located 1 km inland from the shore.

Ayr Bay faces westward and is approximately 12 km wide with a depth of less than 20 m throughout.

A sanitary survey was undertaken on the classified production area at Meikle Craigs on the basis recommended in the European Union Reference Laboratory publication: “Microbiological Monitoring of Bivalve Mollusc Harvesting Area Guide to Good Practice: Technical Application” (http://www.crlcefas.org/gpg.asp). This production area was selected for survey as it is a newly classified area.

Figure 1.1 Location of Meikle Craigs

2. Fishery

Meikle Craigs is a newly classified wild razor clam (*Ensis spp.*) fishery. The production area extends approximately 3.8 km along the shore at Prestwick, from Meikle Craigs rocks at the north end to the just north of Bell Rock at the south end. Production area details are given in Table 2.1.

Table 2.1 Production area details for Meikle Craigs

Production area	Site	SIN	Species	Provisional production area boundary
Meikle Craigs Annual	Meikle Craigs	SA-643-1316-16	Razor clam	The area bounded by lines drawn from NS 3292 2883 to NS 3401 2737 to NS 3428 2631 to NS 3421 2499 to NS 3299 2500 to NS 3224 2828.

The area has a provisional representative monitoring zone, which is given as the area encompassed by lines drawn between NS 3370 2776 to NS 3401 2737 to NS 3416 2679 to NS 3406 2677 to NS 3391 2733 to NS 3361 2771.

The area has previously received fast track classifications for three razor clam harvesting areas in 2013: Meikle Craigs Silver Sands, Meikle Craigs 2 and Meikle Craigs 3.

The fishery location described in the shoreline survey report is plotted in Figure 2.1.

As the fisheries exploit wild populations, the full extent of the shellfish beds is uncertain. No comprehensive stock assessments have been conducted. The extent plotted in Figure 2.1 has been estimated is based on the known preferred substrate type and depth range for the species, species location information from the national biodiversity network (http://data.nbn.org.uk/) and seabed substrate information from the SSMEI Clyde Pilot document entitled “The Process of Developing a Seabed Habitat Map for the Firth of Clyde” (Tresadern, 2008).

Figure 2.1 Meikle Craigs Fishery

3. Human Population

Information was obtained from the General Register Office for Scotland (GRO Scotland) on the population within the census output areas in the vicinity of Meikle Craigs. The last census was undertaken in 2011. The census output areas surrounding Meikle Craigs are shown thematically mapped by the 2011 population densities(people/km^2) in Figure 3.1.

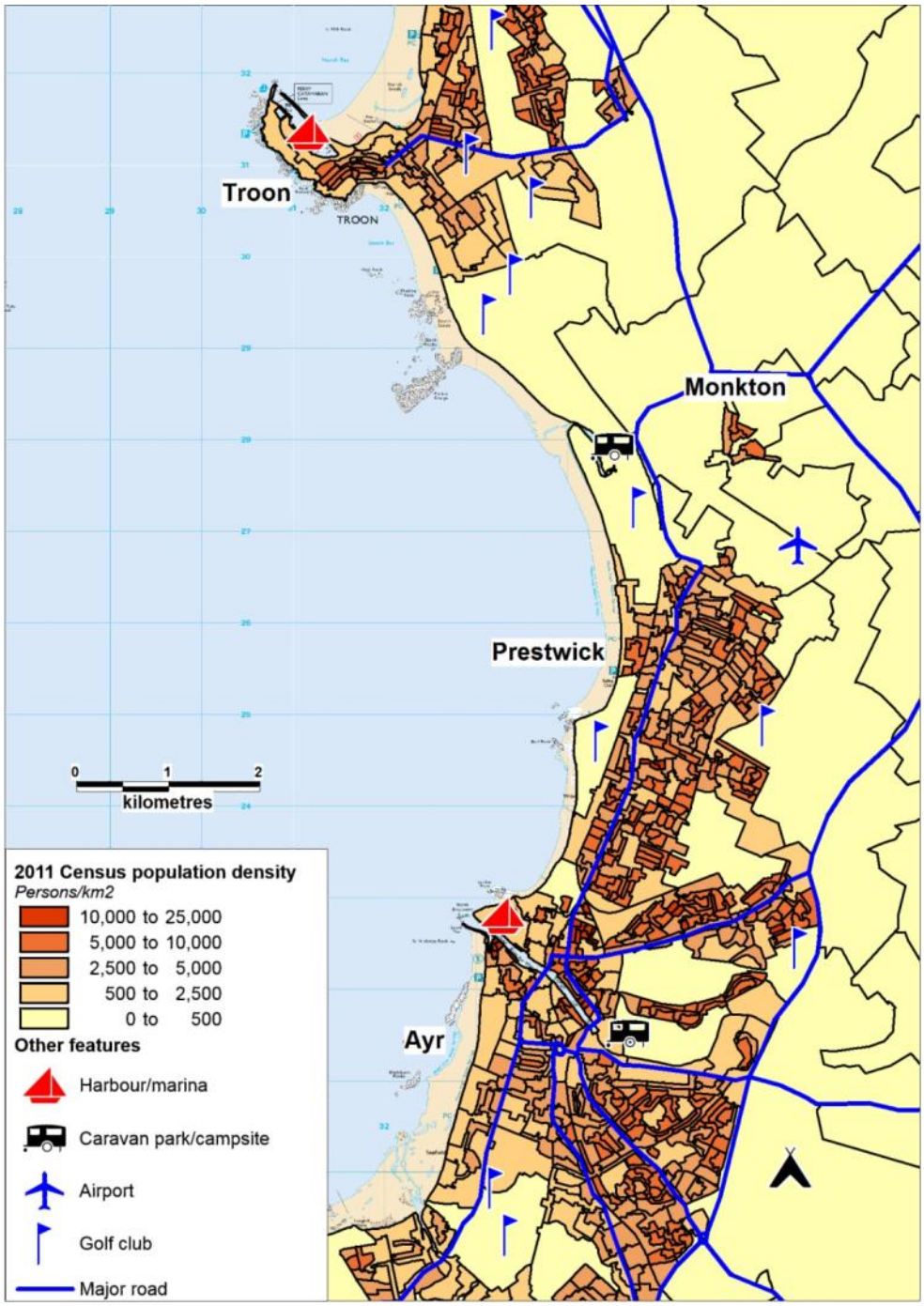

Figure 3.1 Population map for Meikle Craigs

Population density is high for the towns of Troon, Prestwick and Ayr and low for the surrounding census output areas.

The most recent data available are the mid-2012 estimates of population by locality, obtained from GRO Scotland Estimated population for the main towns adjacent to the Meikle Craigs fishery are given in Table 3.1.

Table 3.1 Mid-2012 population by locality

Locality	Estimated population
Troon	14680
Monkton	930
Prestwick	14750
Ayr	14680

The coastline adjacent to the fishery has numerous golf courses scattered in between settlements, several caravan parks and campsites and access to most of the coastline via a road and/or coastal paths that run parallel to the shoreline. The bathing beaches at Troon, Prestwick and Ayr are popular with families-and watersports enthusiasts, the latter of which are likely to use the area year round. Prestwick holiday park located on the near the shore west of Glasgow Airport has approximately 200 pitches (caravancampingsites.co.uk, 2014). The other two holiday parks in Prestwick and Ayr have a smaller number of pitches (90 and 120) and are located further inland (caravancampingsites.co.uk, 2014). There is likely to be additional holiday accommodation including hostels, hotels, self catering accommodation and bed and breakfasts in the area.

Transport infrastructure for the area includes Glasgow Prestwick International Airport, located north east of Prestwick, and a rail line with connections to Glasgow and Paisley. There is a ferry terminal at Troon which runs a twice daily return service to Larne in Northern Ireland. Troon Yacht Haven has 400 berths, full visitor facilities and space ashore for an additional 150 boats (Troon Yacht Haven, 2014). Ayr Harbour is a smaller commercial port with a resident fishing fleet and some mooring space for visiting pleasure boats. On the day of the shoreline survey eight boats were observed moored up in Ayr River and two large bulk carrier merchant ships were observed moored offshore in the bay.

Due to the developed urban areas and their close to the fishery, there is likely to be significant impact from contamination associated with human development, including discharge of sewage and surface water runoff from streets and hard standing. Due to the number of visitor berths and tourist accommodation and campsites in the area, it is expected that the population of the area will increase significantly during the summer holiday months. Impacts from human sources to the water quality of the shellfish bed are likely to be seasonal, peaking during the summer months when visitor numbers are higher.

4. Sewage Discharges

Information on sewage discharges within 7 km around grid reference NS 3373 2500 (on the southern production area boundary) was sought from Scottish Water and the Scottish Environment Protection Agency (SEPA). Data requested included the name, location, type, size (in either flow or population equivalent), level of treatment, sanitary or bacteriological data, spill frequency, discharge destination (to land, watercourse or sea), any available dispersion or dilution modelling studies, and whether improvements were in work or planned.

4.1 Community Discharges

The Meadowhead Sewage Network serves the majority of area. The Meadowhead Sewage Treatment Works is consented to discharge 85782 m^3/day (dry weather flow) of secondary treated sewage effluent via an outfall approximately 12 km northwest of the northern production area boundary for Meikle Craigs. Due to the distance from the fishery, this discharge is not included in Table 4.1. The network includes a large number of combined sewer overflows and emergency overflows, some of which discharge near or within the production area boundary.

Three smaller community systems are also located within the assessment area. All are located inland and discharge to nearby watercourses. The largest of these, Annbanks STW, also incorporates a CSO. Details of these are given in Table 4.1.

Table 4.1 Community sewage discharges near Meikle Craigs

No.	Licence number	Location	Discharge Name	Type	Treatment Level	PE	Discharges to
1	CAR/L/1000653	NS 36240 20255	Masonhill Crematorium	Continuous	Primary	50	Annfield Glenn Burn
2	CAR/R/1105533	NS 37358 24154	1-8 Kevoc Cottages + The Old Schoolhouse, Ayr	Continuous	Primary	45	U/T of Ladykirk burn
3	CAR/L/1003418	NS 40035 23374	Annbank STW	Continuous	Secondary	1200	River Ayr
4	CAR/L/1026135	NS 31849 31564	Pan Rocks PS EO	Intermittent	-	-	North Bay
5	CAR/L/1026135	NS 30650 31220	Harbour PS, CSO/EO	Intermittent	Not given	-	Firth of Clyde
6		NS 33804 27781	St Andrews Caravan Park PS CSO/EO	Intermittent	-	-	Firth of Clyde
7		NS 34541 27810	St Andrews Caravan Park EO	Intermittent	-	-	Rumbling Burn
8		NS 34191 26819	Prestwick Esplanade PS CSO	Intermittent	-	-	Firth of Clyde
9		NS 35188 26653	Pow Burn PS EO	Intermittent	-	-	Pow Burn
10		NS 33800 24000	Ayr PS, EO	Intermittent	-	-	Firth of Clyde

No.	Licence number	Location	Discharge Name	Type	Treatment Level	PE	Discharges to
11	CAR/L/1026135	NS 31808 23805	Shore Road CSO	Intermittent	-	-	Firth of Clyde
12		NS 33575 23356	Ayr PS EO @ station with CSO	Intermittent	-	-	Firth of Clyde
13		NS 33891 22154	George Street CSO	Intermittent	-	-	River Ayr
14		NS 34565 21276	Holmston Storm Tank CSO	Intermittent	-	-	River Ayr
15		NS 31513 19818	Shore Road Greenan PS EO	Intermittent	-	-	Firth of Clyde

U/T – unnamed tributary

Details of all intermittent discharges are given in Appendix 5.

4.2 Other Consented Discharges – SEPA

SEPA provided information regarding consented discharges within the request area identified. Consents related to activities such as water abstraction, engineering works, and businesses such as petrol stations are unlikely to contribute any faecal input to the area and were therefore excluded from the assessment.

SEPA provided information on 76 sewage discharges from dwellings and businesses. Details of these consents are given in Appendix 6.

One private septic tank (CAR/R/1051252) with a population equivalent (PE) of 5 discharges to sea approximately 700 m north of the northern end of the production area. There are several discharges to Pow Burn and its tributaries which flow into the firth directly adjacent to the production area.

Among the consents provided by SEPA were seven surface water outfalls for Prestwick Airport discharging to Pow Burn. SEPA also provided information of three consents for the release of wash water from meat production, including abattoirs and meat processing plants. Effluent from these all discharge to the community sewerage network and therefore the locations have not been plotted in Figure 4.1.

Discharge-related Shoreline Survey Observations

Observations of sewage infrastructure made during the shoreline survey are listed in Table 4.2 and shown in Figure 4.1.

Table 4.2 Discharge-associated observations made during the shoreline survey

No.	Date	NGR	Associated Photograph (Appendix 5)	*E. coli* (cfu/100ml)	Description
1	03/06/2014	NS 31639 30614	-	-	Seawater sample taken near square concrete installation with iron grill at terminus of outfall pipe. No flow observed.
2	03/06/2014	NS 32987 29016	-	-	Concrete pipe flowing.
3	03/06/2014	NS 33975 27668	-	-	Old outflow pipe missing a section, open onto beach. No flow.
4	03/06/2014	NS 34395 27870	-	-	Sewage pumping station
5	03/06/2014	NS 34520 27669	Fig. 17	<1000	Pipe and inspection box. Pipe is cracked and effluent coming from crack
6	03/06/2014	NS 34288 26807	-	6	Esplanade PS CSO
7	03/06/2014	NS 34486 26829	-	-	Public CSO.
8	03/06/2014	NS 34537 25416	-	20	Old iron outflow pipe, running from under wall to shore.
9	03/06/2014	NS 34061 23935	-	120	Outflow from iron pipe appears clean. Pipe downstream of square hole blocked with sand and appears out of use.
10	03/06/2014	NS 34058 23936	-	26	Deliberately cut break in iron outfall pipe near shore with water flowing.
11	03/06/2014	NS 34017 23749	-	-	Concrete pipe protruding from beneath road with water flowing.
12	03/06/2014	NS 33751 23167	Fig. 7	-	Outfall pipe with storm baffle, at Saltpans Road. No flow from pipe.

Many pipes were recorded along the shoreline surveyed, and several of these appear to be associated with combined sewer outfalls (CSOs) or emergency outfalls (EOs) (Nos. 3, 4, 5, 6, 7, 9, 10 and 12). Many of the pipes recorded were in a poor condition with some pipes leaking. These could result in unintended release of sewage effluent or poor dispersal and dilution.

Samples taken from pipe effluent or near their outfalls did not suggest any major sewage input, however as there was no heavy rain during or prior to the survey it is unlikely that any CSOs were active at the time.

Summary

The area around Meikle Craigs is served by a community sewage system, final effluent outfall of which is located over 12 km north of the production area. The only continuous discharges are small private discharges, and these in the most part are located inland. However as many consents discharge to watercourses these have the potential to affect the fishery. All consented discharges from the community sewage systems are either CSOs or EOs, which have the potential to cause significant pollution although this would be intermittent in nature.

List of Acronyms

NGR=	National Grid Reference	EO	Emergency Overflow
PE=	Population Equivalent	CSO=	Combined Sewer Overflow
WWTW=	Wastewater Treatment Work	U/T	Unnamed Tributary

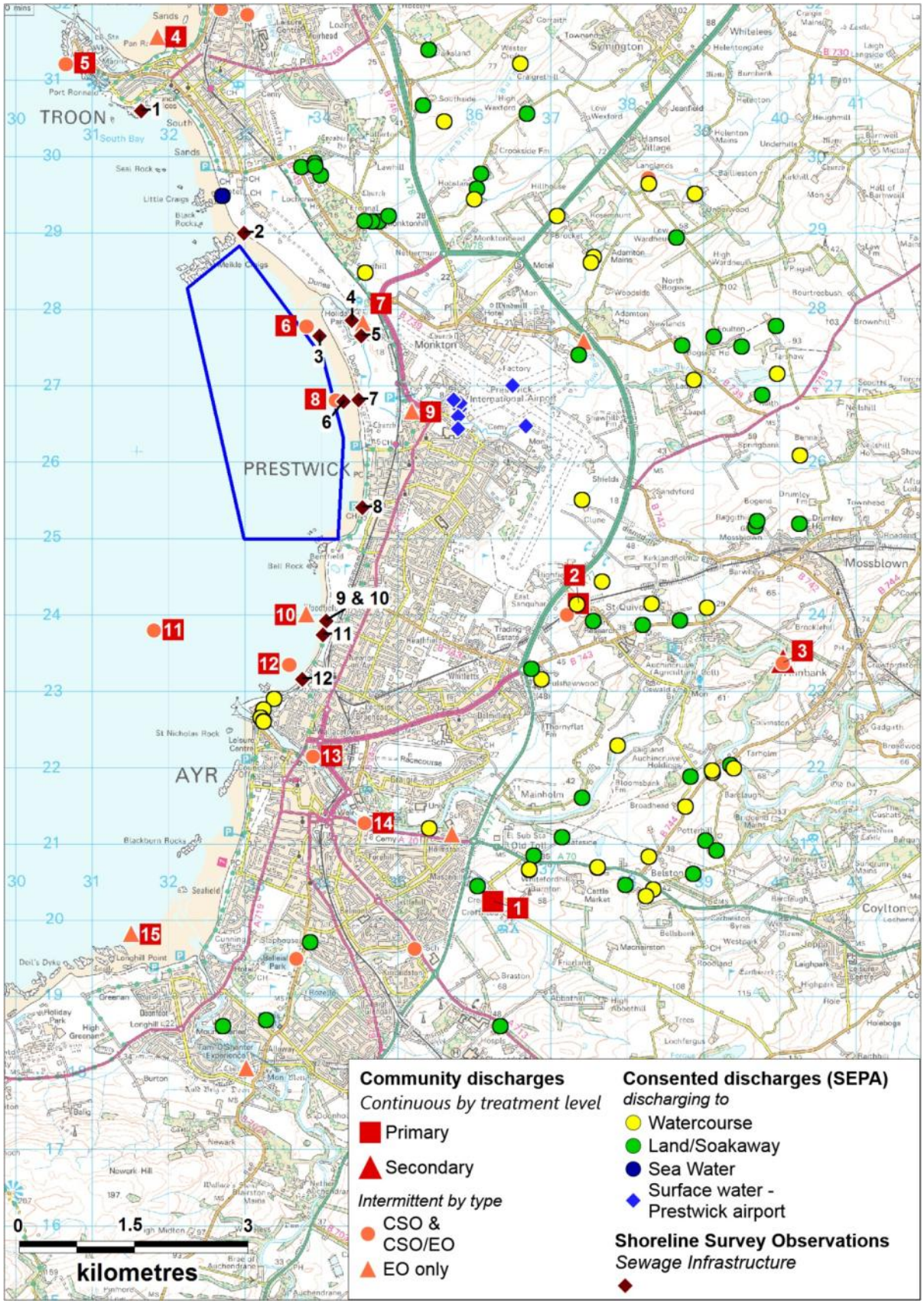

Figure 4.1 Map of discharges for Meikle Craigs

5. Agriculture

Information on the spatial distribution of animals on land adjacent to or near the fishery can provide an indication of the potential amount of organic pollution from livestock entering the shellfish farm areas. Agricultural census data to parish level was requested from the Scottish Government Rural Environment, Research and Analysis Directorate (RERAD) for the Dundonald, Symington, Monkton and Prestwick and Ayr parishes. Reported livestock populations for the parishes in 2013 are listed in Table 5.1. RERAD withheld data for reasons of confidentiality where the small number of holdings reporting would have made it possible to discern individual farm data. Any entries which relate to less than five holdings, or where two or fewer holdings account for 85% or more of the information, are replaced with an asterisk.

Table 5.1 Livestock numbers in the Dundonald, Symington, Monkton and Prestwick and Ayr agricultural parishes 2013

	Dundonald		**Symington**		**Monkton and Prestwick**		**Ayr**	
	50 km^2		15 km^2		15 km^2		49 km^2	
	Holdings	Numbers	Holdings	Numbers	Holdings	Numbers	Holdings	Numbers
Pigs	*	*	*	*	0	-	*	*
Poultry	12	406	*	*	0	-	*	*
Cattle	20	3107	11	3988	*	*	16	3658
Sheep	20	1771	*	*	*	*	15	5705
Other horses and ponies	18	100	5	15	*	*	26	165

* data withheld

The livestock census numbers for Dundonald, Symington, Monkton and Prestwick, and Ayr relate to relatively small parish areas. The Monkton and Prestwick agricultural parish borders the southern part of the fishery and is largely urban, includes Prestwick Airport, and has relatively little livestock. Dundonald agricultural parish occupies the remaining shoreline adjacent to the fishery and has moderate numbers of cattle and sheep in relation to parish size and also a small number of other horses and ponies. Ayr Parish lies south of the production area, and whilst urban on its western boundary is largely agricultural further inland. Farms within this parish similar numbers of cattle and horses to Dundonald parish but over three times as many sheep. The Symington agricultural parish, which is located inland, also has moderate numbers of cattle and a small number of other horses and ponies.

A source of spatially relevant information on livestock population in the area was the shoreline survey (see Appendix 5) which only relates to the time of the site visit on the 4th June 2014. Observations made during the survey are dependent upon the viewpoint of the observer some animals may have been obscured by the terrain. The spatial distribution of animals observed and noted during the shoreline survey is illustrated in Figure 5.1.

During the shoreline survey twelve dairy cattle were observed grazing in a field near the shoreline. These cattle were the only livestock observed during the shoreline survey.

A review of publicly available aerial images shows that improved pasture is the dominant land cover type surrounding the urban areas of Troon, Ayr and Prestwick (Bing Maps, accessed 31/07/2014). The Prestwick Bathing Waters Report (SEPA, 2013) identifies more than 40 farms within the Prestwick bathing water catchment, the majority of which are dairy farms with some sheep and beef farms in the upland areas. The report identified that that watercourses draining the catchment are likely to be affected by run-off from agricultural activities.

Numbers of sheep are expected to be approximately double during the spring and summer months when lambs are present. Outside of the urban areas, cattle farming is the main land use activity and any contributions of faecal contamination from livestock grazing in the area would potentially affect those shellfish grown in shallower water closest to the shore. Impacts from livestock would be expected to be high along the stretches of coastline consisting of improved pasture in-between the urban areas and near the outlets of watercourses draining agricultural areas.

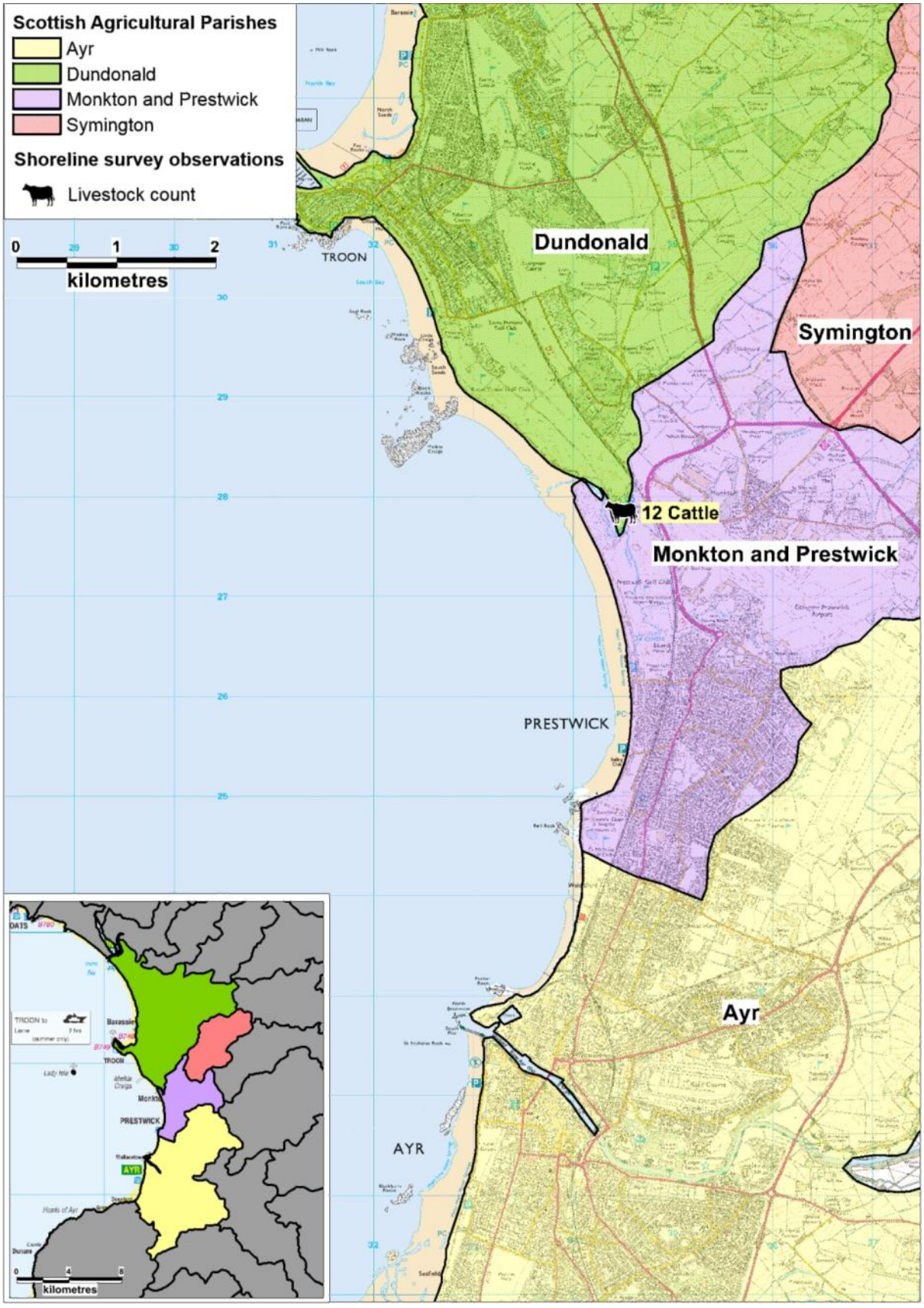

Figure 5.1 Livestock observations at Meikle Craigs

6. Wildlife

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

Only larger species that are potentially present at or near the fishery and to contribute significantly to faecal indicator levels there are considered within this assessment.

Pinnipeds

In the 2013 Special Committee on Seals Report (Special Committee on Seals, 2013), 20 grey seals (*Halichoerus grypus)* and no common seals (*Phoca vitulina*) were observed during August surveys around Meikle Craigs between years 2007 and 2011.

There is reportedly a seal colony on Lady Isle, approximately 4.7 km northwest of the Meikle Craigs rocks (http://www.ayrshire-birding.org.uk/2003/07/lady_isle/, Accessed 29/08/2014). This information was confirmed by reports from kayakers http://www.ukriversguidebook.co.uk/forum/viewtopic.php?f=4&t=77207, Accessed 29/08/2014), though no information on the numbers of animals was found. Troon harbour is also reportedly home to one or two seals (Ayrshire Coastal Path, 2014). No seals were observed during the shoreline survey.

Cetaceans

Since 2009 there have been a number of cetacean sightings reported off the Ayrshire coastline, which have included two Minke whales, a killer whale, a bottlenose dolphin and a harbour porpoise (Hebridean Whale and Dolphin Trust, 2014). Anecdotal accounts suggest harbour porpoises can be observed from the Ayrshire coastline (Contours Walking Holidays, 2014). One report was found of a Minke Whale sighted near Lady Isle, however no specific information was found on the presence of these animals further inshore near Meikle Craigs (http://www.ukriversguidebook.co.uk/forum/viewtopic.php?f=4&t=77207). It is likely that the shallow water depths found in and around the production area would restrict access to only the smaller species. No cetaceans were observed during the shoreline survey.

Birds

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

Table 6.1 Seabird 2000 counts within 5 km of Meikle Craigs

Common name	Species name	Count	Method	Estimated individuals*
European shag	*Phalacrocorax aristotelis*	178	Occupied nests	356
Great Cormorant	*Phalacrocorax carbo*	198	Occupied nests	396
Herring Gull	*Larus argentatus*	1644	Occupied nests, Occupied territory	3288
Great Black-Backed Gull	*Larus marinus*	200	Occupied nests	400
Lesser Black-Backed Gull	*Larus fuscus*	1311	Occupied nests, Occupied territory	2622
Black Guillemot	*Cepphus grylle*	72	Individuals on sea	72

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

The largest concentration of seabirds in the assessment area is found at Lady Isle, approximately 4.7 km northwest of Meikle Craigs rocks, where over 3000 birds were recorded during the Seabird 2000 survey. Relatively large nesting colonies of herring gulls and lesser black backed gulls are found on rooftops in Ayr town centre as well as further inland at Heathfield sawmills. These birds typically breed between April and June. Contamination impacts from these birds would be expected to be higher during the summer months when they are present on and near nests near the fishery and when any rainfall is likely to wash accumulated guano from around the nest sites into land runoff.

Meikle Craigs rocks are reported to host large numbers of breeding gulls, cormorants and shags, and also moulting eider ducks. In Scotland, Eider ducks moult during July and August and are flightless (and therefore less mobile) for approximately 3 weeks (Galbraith, 1992). Significant numbers of wading birds and wildfowl are reported to use the southern end of the Prestwick bathing beach (SEPA, 2013).

Significant numbers of gulls, cormorants, and shags nest on Lady Isle, a private island 4.8 km northwest of Meikle Craigs rocks (http://www.ayrshire-birding.org.uk/2003/06/ringing_on_lady_isle/, Accessed 28/8/2014). Large numbers of eider ducks are also reported to gather at the island to moult. Birds were the predominant wildlife observed during the shoreline survey. The most abundant were gulls, which were noted in exceptionally high numbers at the mouth of Pow Burn adjacent to the fishery and just to the south of that location. Other seabird species noted included a cormorant and a common gull. Swans and eider ducks with goslings were also noted, with small numbers of wagtails, rock pipits, rooks, carrion crows and starlings also present.

Otters

The Eurasian otter (*Lutra lutra*) is noted as being predominantly located on largely uninhabited areas of coastline. However the Ayrshire coast is anecdotally reported as being a good place to see otters (Contours Walking Holidays, 2014). During the shoreline survey, a potential otter sprat was noted along the River Ayr, though it was unclear whether it was from an otter or a dog.

Deer

Deer are likely to be present on open land adjacent to the fishery, particularly along the northern half of the production area, where there is a golf course. In 2013, a passenger aircraft was delayed landing at Prestwick airport due to a deer on the runway (http://news.stv.tv/west-central/221476-ryanair-plane-stopped-after-deer-seen-on-prestwick-airport-runway/). Although no information was found on deer populations in the area, given the amount of open space along the northern shore of the fishery and the reported sighting of deer on the airport, it is likely that deer are present at or near the shoreline as well as in the wider area. Deer faeces may be deposited directly on or adjacent to the shoreline, and is also likely to contribute to faecal indicator loadings carried in local watercourses.

Dogs

Dog walking is common along much of the shoreline and pedestrian esplanade. Dog litter signs reminding owners to pick up after their dog were present and bins were provided in carparks and along the esplanade. A total of 21 dogs were being walked along the shoreline at the time of the survey, with dog waste noted in the sand dunes during the survey.

Overall

Gulls are anticipated to be significant contamination sources to the Meikle Craigs fishery. The presence of large numbers of gulls on the shore near Pow Burn suggests they may use this area in particular to bathe. Gulls and eider ducks present around Meikle Craigs rocks are likely to pose a direct source to the northern end of

the production area. Dogs may also be a potential source of contamination, as the area is popular with dog walkers. Other species such as seals, cetaceans and otters may contribute to background levels of contamination, though the impact of these is largely unpredictable in terms of location and timing.

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Figure 6.1 Map of wildlife around Meikle Craigs

7. Land Cover

The predominant land cover types adjacent to Meikle Craigs are improved grassland, built up areas, and arable and horticultural land. There are also scattered small areas of woodland, dwarf shrub heath, neutral grassland and rough grassland. The areas identified as improved grassland correspond with the locations of the many golf courses and also the area upon which dairy cattle were observed grazing. The built up areas shown represent the towns of Troon and Prestwick and Ayr. The Land Cover Map 2007 data for the area is shown in Figure 7.1.

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

The highest potential contribution of contaminated run-off to the Meikle Craigs shellfish bed is from the suburban/urban areas of Troon and Prestwck and Ayr and the areas of improved grassland located along the shoreline. The potential contribution of contaminated run-off to the shellfish farm would be high along the entire stretch of the bay. Areas utilised for rough grazing would be expected to contribute significantly to faecal contaminant loading carried in watercourses and overland flow draining the area during rainfall.

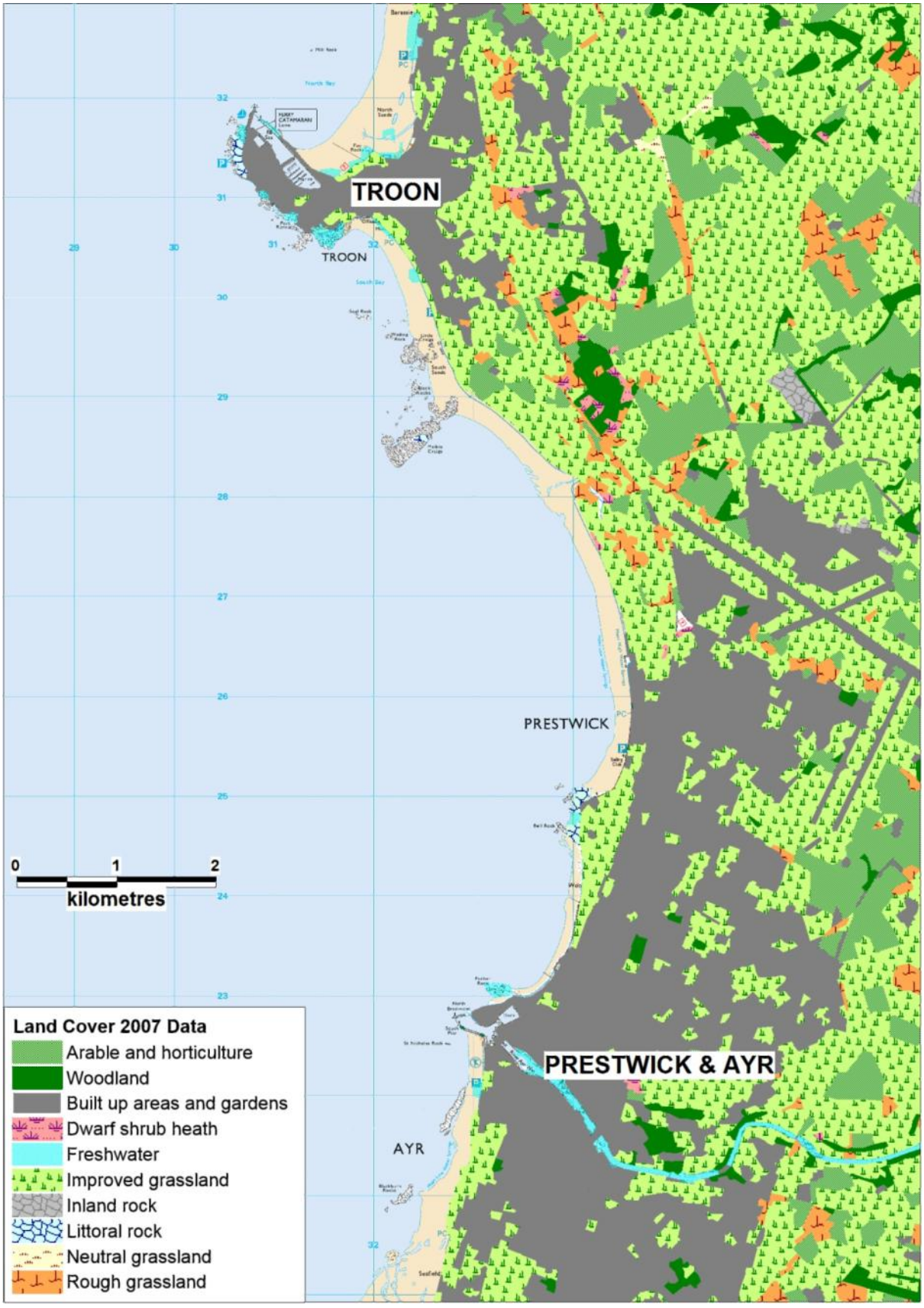
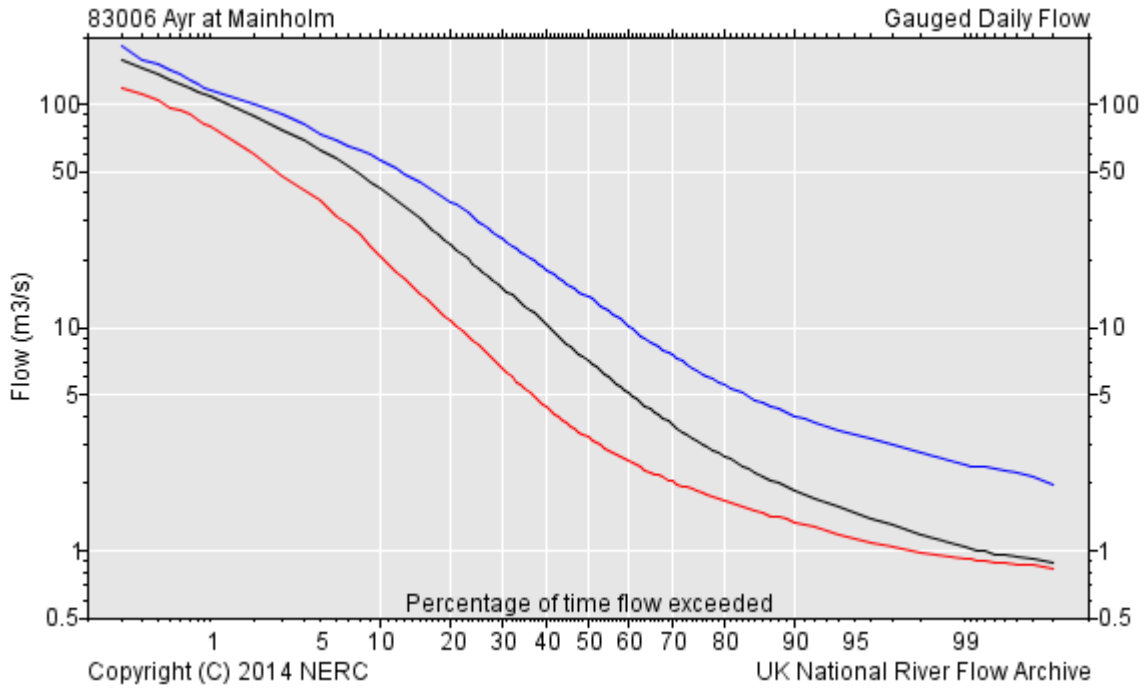


Figure 7.1 LCM2007 land cover data for the area around Meikle Craigs

8. Watercourses

The Ayr, Mainholm gauging station is located on the River Ayr approximately 4 km upstream from the mouth of the river. Flow data was provided for the period 1976-2014, with mean measured flow at 15.976 m^3/s and a base flow index of 0.3 m^3/s (NERC Centre for Ecology and Hydrology, 2014). The flow duration curve is displayed in Figure 8.1. The x-axis graph shows the percentage of time for which the flows on the left-hand y-axis are exceeded. The Q50 value, the flow which is exceeded for 50% of the time, on an annual basis, is given as 7.136 m^3/s (this corresponds to 616550.40 m^3/d). The flows are markedly higher in winter (blue line) than in summer (red line).



Key: **Black line - annual; blue line - December to March; red line - June to September.**

Figure 8.1 Flow duration curve for Ayr, Courtesy of UK NRFA, 2014

Spot measurements of flow and microbial content were obtained during the shoreline survey conducted on the 3rd and 4th June 2014. The weather was dry in the 48hrs prior to the survey with some light rain in the early hours of the 3rd and the 4th prior to the shoreline surveys. The watercourses listed in Table 8.1 are those recorded during the shoreline survey. Two watercourses and four flowing land drainage pipes were observed and locations and loadings are mapped in Figure 8.1. Loadings were estimated based on the spot measurements and microbiological test results. Whilst caution should be exercised in interpreting these results as they are only single samples and results would be expected to vary depending on conditions, these are the only such results that can be related to other conditions observed during the shoreline survey and are therefore useful in estimating the potential contribution from these watercourses.

Table 8.1 Watercourses recorded at Meikle Craigs

No.	Eastings	Northings	Description	Width (m)	Depth (m)	Flow (m^3/d)	Loading (*E. coli* per day)
1	234061	623935	Pipe – land drainage	0.5	0.08	971	1.2×10^9
2	234017	623750	Pipe – land drainage	0.25	0.02	938	9.4×10^{10}
3	233700	622182	Ayr River*	4.6	0.83**	41234**	1.9×10^{11}
4	232615	629816	Pipe – land drainage	0.56	0.6	4355	4.4×10^{11}
5	234475	627681	Pow Burn	11.4	0.14	21277	1.2×10^{11}
6	234518	627676	Pipe – land drainage	0.25	0.1	1791	1.8×10^{10}

*Measured at low tide **Average taken from two measurements

The River Ayr represents the largest watercourse discharging onto the shellfish bed. The National River Flow Archive Q50 value obtained from the hydrological data series is significantly higher than the measured estimated flow recorded during the shoreline survey, this is likely to be due to a number of factors, including the dry weather conditions, the state of tide and surveying restrictions on the day of the shoreline survey. If the flow was taken as the Q50 value, the estimated loading would be 2.9×10^{12} . SEPA have identified the River Ayr as being of moderate status and impacted by diffuse source pollution, sewage disposal, urban wastewater runoff, and livestock farming (SEPA, 2009).

Pow Burn was roughly half the size of the River Ayr in terms of flow as recorded during the shoreline survey, however it is likely to be many times smaller than that normally expected for the river. Pow Burn is reported by SEPA to be of poor status and impacted by diffuse source pollution from livestock farming, urban and airport surface water runoff, sewage disposal, mining and coal quarrying (SEPA, 2009). The burn discharges to the centre of the bay adjacent to the fishery.

Two of the land drainage pipes discharge adjacent to the shellfish bed north of the River Ayr and had moderate estimated loadings at the time of shoreline survey. Another drainage pipe discharges into Pow Burn, contributing to the high estimated loading of the burn, which flows into the centre of the bay. The fourth drainage pipe discharges onto the shoreline west of Troon and also had a high estimated loading.

Overall, freshwater inputs are expected to provide moderate to high levels of contamination to the Meikle Craigs shellfish bed, with the highest impact expected in the areas of fishery closest to the mouth of Pow Burn and also at the locations where the surface water drainage pipes discharge. Although the highest potential contribution will come from the River Ayr, it lies approximately 2km south of the southern production area boundary.

Figure 8.2 Map of watercourse loadings at Meikle Craigs

9. Meteorological Data

The nearest weather station for which a near complete rainfall data set was available is located at Prestwick; Gannet, situated approximately 4.5 km east of the production area. Rainfall data was available for January 2008 – December 2013 with data missing from 21/11/2008-24/11/2008 and 20/08/2012-22/08/2012. The nearest wind station is also situated Prestwick. Conditions may differ between this station and the fisheries due to the distances between them. However, this data is still shown as it can be useful in identifying seasonal variation in wind patterns.

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

9.1 Rainfall

High rainfall and storm events are commonly associated with increased faecal contamination of coastal waters through surface water run-off from land where livestock or other animals are present, and through sewer and waste water treatment plant overflows (Mallin, et al., 2001; Lee & Morgan, 2003). The box and whisker plots in Figures 9.1 and 9.2, present a summary of the distribution of individual daily rainfall values by year and by month. The grey box represents the middle 50% of the observations, with the median at the midline. The whiskers extend to the largest or smallest observations up to 1.5 times the box height above or below the box. Individual observations falling outside the box and whiskers are represented by the symbol *.

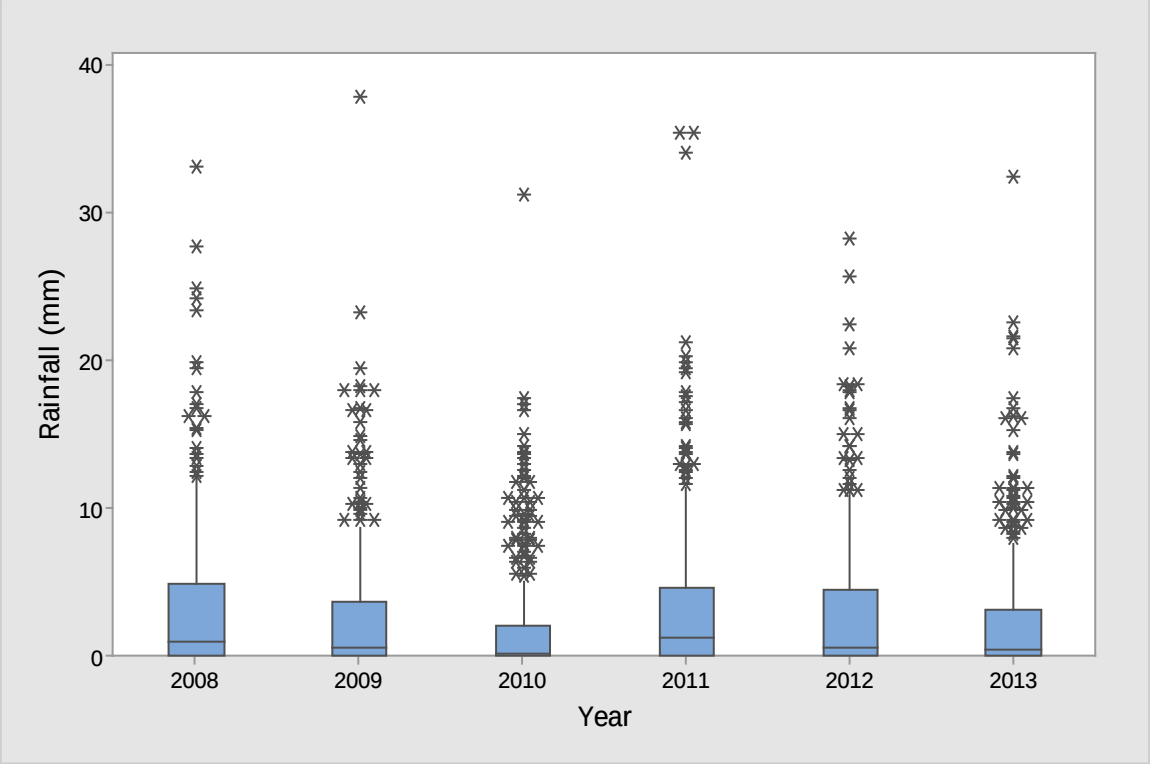


Figure 9.1 Box plot of daily rainfall values by year at Prestwick; Gannet (2008 – 2013)

Daily rainfall values varied from year to year, with 2010 being the driest year (739 mm). The wettest year was 2011 (1228 mm). Rainfall values over 30 mm/d occurred in most years.

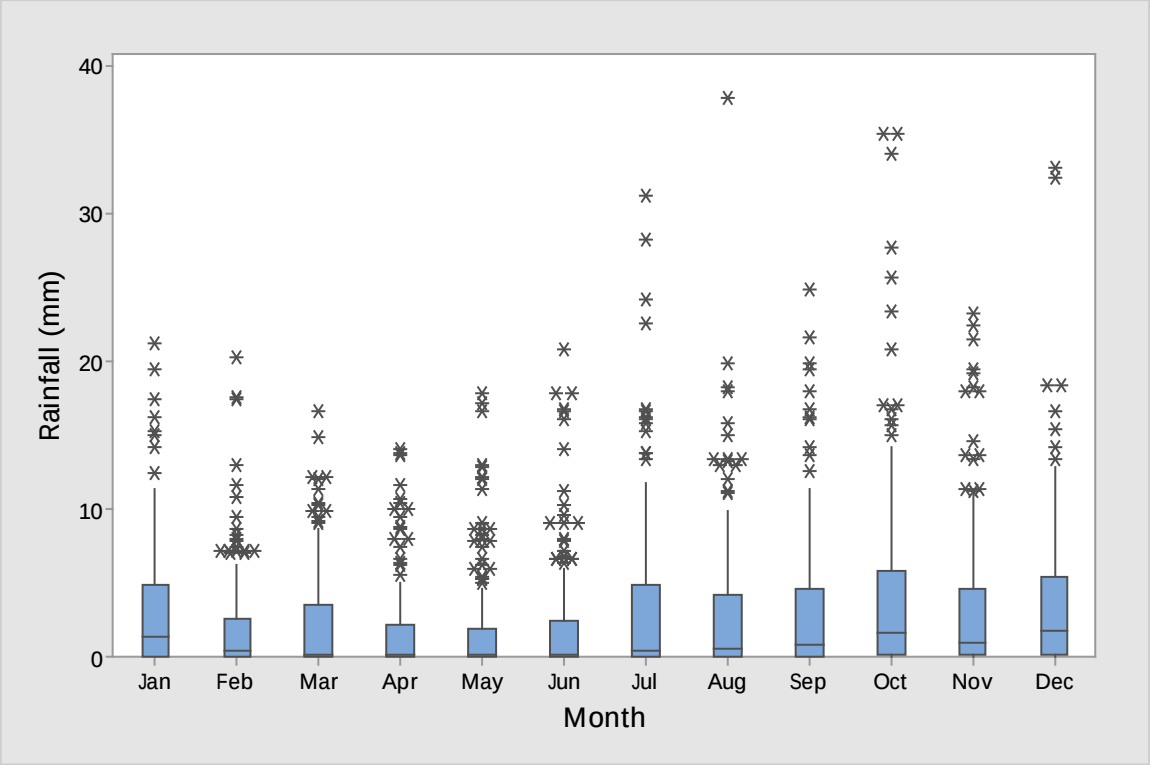


Figure 9.2 Box plot of daily rainfall values by month at Prestwick; Gannet (2008 – 2013)

Total monthly rainfall values were higher during the autumn and winter. Rainfall was highest in October (810 mm and lowest in April (304 mm). Rainfall values exceeding 30 mm/d were seen in July, August, October, and December.

For the period considered here (2008 – 2013) 55 % of days received daily rainfall of less than 1 mm and 7 % of days received daily rainfall of over 10 mm.

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

9.2 Wind

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

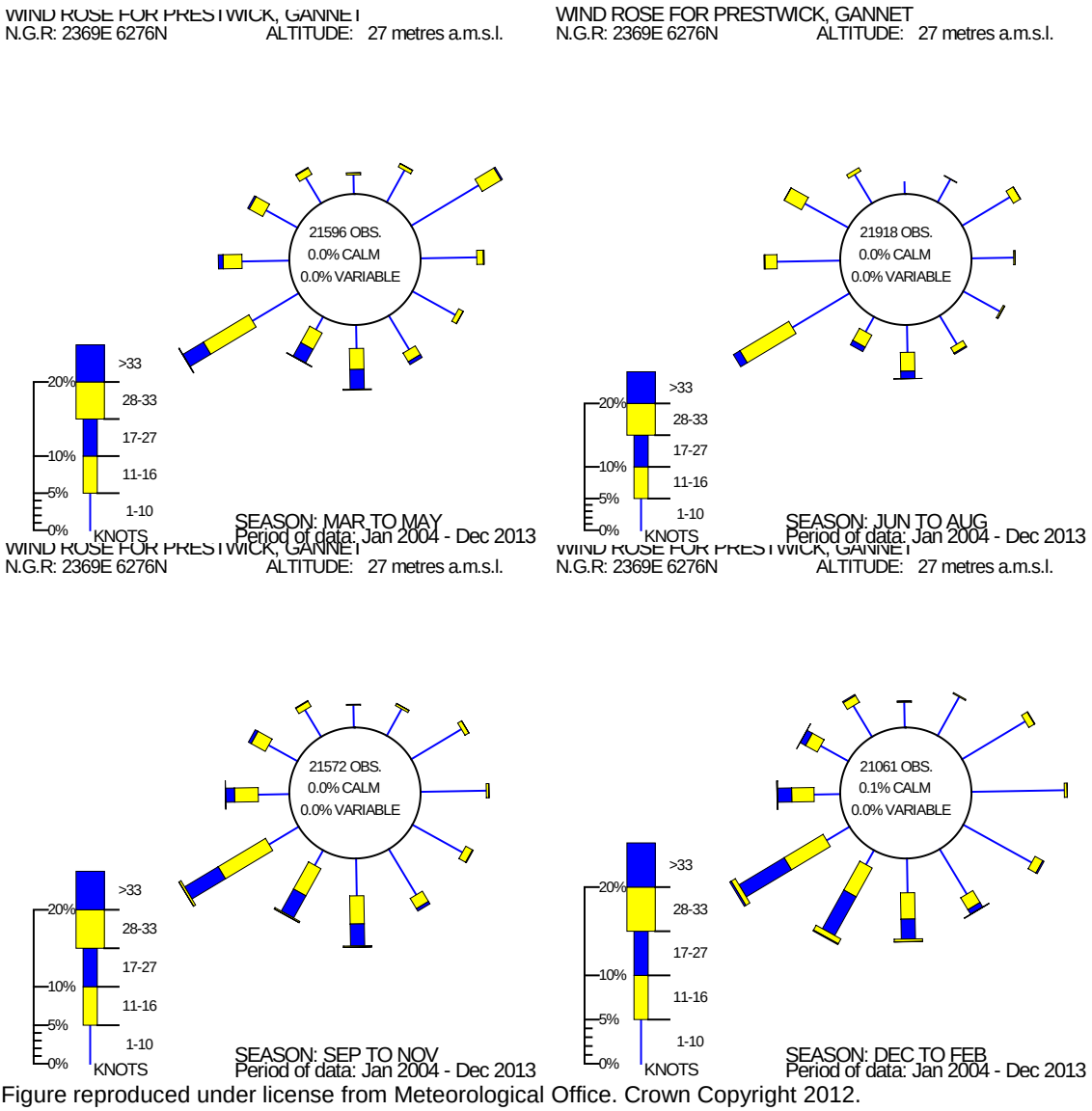


Figure 9.3 Seasonal wind roses for Prestwick; Gannet

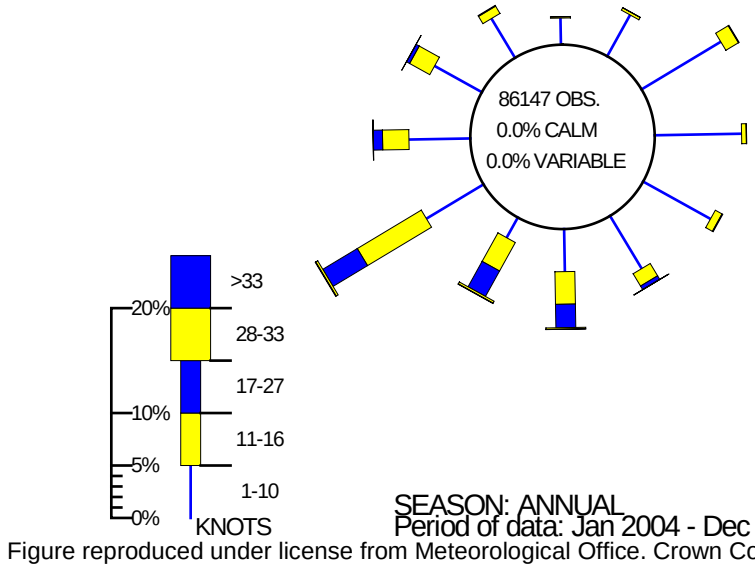


Figure 9.4 Annual wind rose for Prestwick; Gannet

Overall the winds predominantly came from west south west. The strongest winds also tended to come to from this direction. Seasonally, the strongest winds occurred during the winter.

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

10. Classification Information

Parts of the wider Meikle Craigs fishery have been classified under the FSAS fast track system between 2012 and 2014. These areas were:

Table 10.1 Fast track classifications at Meikle Craigs

SIN	Name	Location	Fast tracked in year
SA-626-1234-16	Silver Sands	North end of production area	2012-2013
SA-639-1291-16	Meikle Craigs 2	Centre part of production area	2013
SA-651-1374-16	Meikle Craigs 3	Southern end of production area	2013

Under the fast track system, areas are given a seasonal B classification for 4 months on the basis of a preliminary risk assessment and a set of four, weekly samples.

If any of the official control samples leading up to classification return a result >4600 *E. coli* MPN/100 g ('class C'), the area will be deemed unsuitable for fast track classification.

Meikle Craigs 3 was declassified upon receipt of a class C result from a sample collected on 29 July 2013.

An application for standard classification was submitted under the production area name Meikle Craigs Annual and the area has been awarded a B classification for the period August 2013 to March 2014.

11. Historical *E. coli* Data

11.1 Validation of historical data

Results for all samples assigned against Meikle Craigs, Meikle Craigs 2, Meikle Craigs 3 and Meikle Craigs Annual production areas for the period 01/01/2009 to the 19/06/2014 were extracted from the FSAS database and validated according to the criteria described in the standard protocol for validation of historical *E. coli* data. The data was extracted from the database on 19/06/2014. All *E. coli* results were reported as most probable number (MPN) per 100 g of shellfish flesh and intravalvular fluid.

All sample results reported as <18/<20 were reassigned a value of 10 *E. coli* MPN/100 g for the purposes of statistical evaluation and graphical representation.

All samples assigned to all four production areas were recorded as valid, were received within 48 hours of collection and had box temperatures of <8^{o}C. All five samples assigned to Meikle Craigs 3 and two samples assigned to Meikle Craigs 2 plotted >100 m outside the production area and have been omitted from further analysis in this report.

11.2 Summary of microbiological results

Sampling and results summaries of individual production areas are listed in Table 11.1, alongside a collated sampling and results summary for the Meikle Craigs fishery. Further sample analysis will consider sample results as a combined Meikle Craigs fishery.

Table 11.1 Summary of historical sampling and results

Sampling Summary				
Production area	Meikle Craigs	Meikle Craigs 2	Meikle Craigs Annual	Meikle Craigs Combined
Site	Silver Sands	Meikle Craigs 2	Meikle Craigs	Silver Sands, Meikle Craigs 2, Meikle Craigs
Species	Razor clams			
SIN	SA-626-1234-16	SA-639-1291-16	SA-643-1316-16	SA-626-1234-16, SA-639-1291-16 & SA-643-1316-16
Location	Unverified	Various	NS 3424 2638 and NS 3430 2637	Various
Total no of samples	9	5	11	25
No. 2012	7	0	0	7
No. 2013	2	5	5	12
No. 2014	0	0	6	6
Results Summary				
Minimum	<20	<20	<20	<20
Maximum	330	3500	230	3500
Median	<20	<20	<20	<20
Geometric mean	-	-	23	32
90 percentile	-	-	-	330
95 percentile	-	-	-	2550
No. exceeding 230/100g	2	1	0	3 (12%)
No. exceeding 1000/100g	0	1	0	1 (4%)
No. exceeding 4600/100g	0	0	0	0
No. exceeding 18000/100g	0	0	0	0

Sampling has been uneven across sites at Meikle Craigs, owing to the various fast track licences held for the area since 2012. The highest sample results were taken during fast track sampling at Silver Sands (2012) and at Meikle Craigs 2 (first half of 2013). It should also be noted that one result >4600 *E. coli* MPN/100g was obtained from fast track sampling at Meikle Craigs 3, at the southern end of the production area, however as the reported grid reference was over 100 m from the production area boundary it was excluded from analysis.

11.3 Overall geographical pattern of results

The geographical locations of all sample results assigned to Meikle Craigs are mapped thematically in Figure 11.1. Eleven samples had unverified NGRs and are therefore not included in the following geographical analysis. These include all nine of the Silver Sands samples and two samples from Meikle Craigs 2.

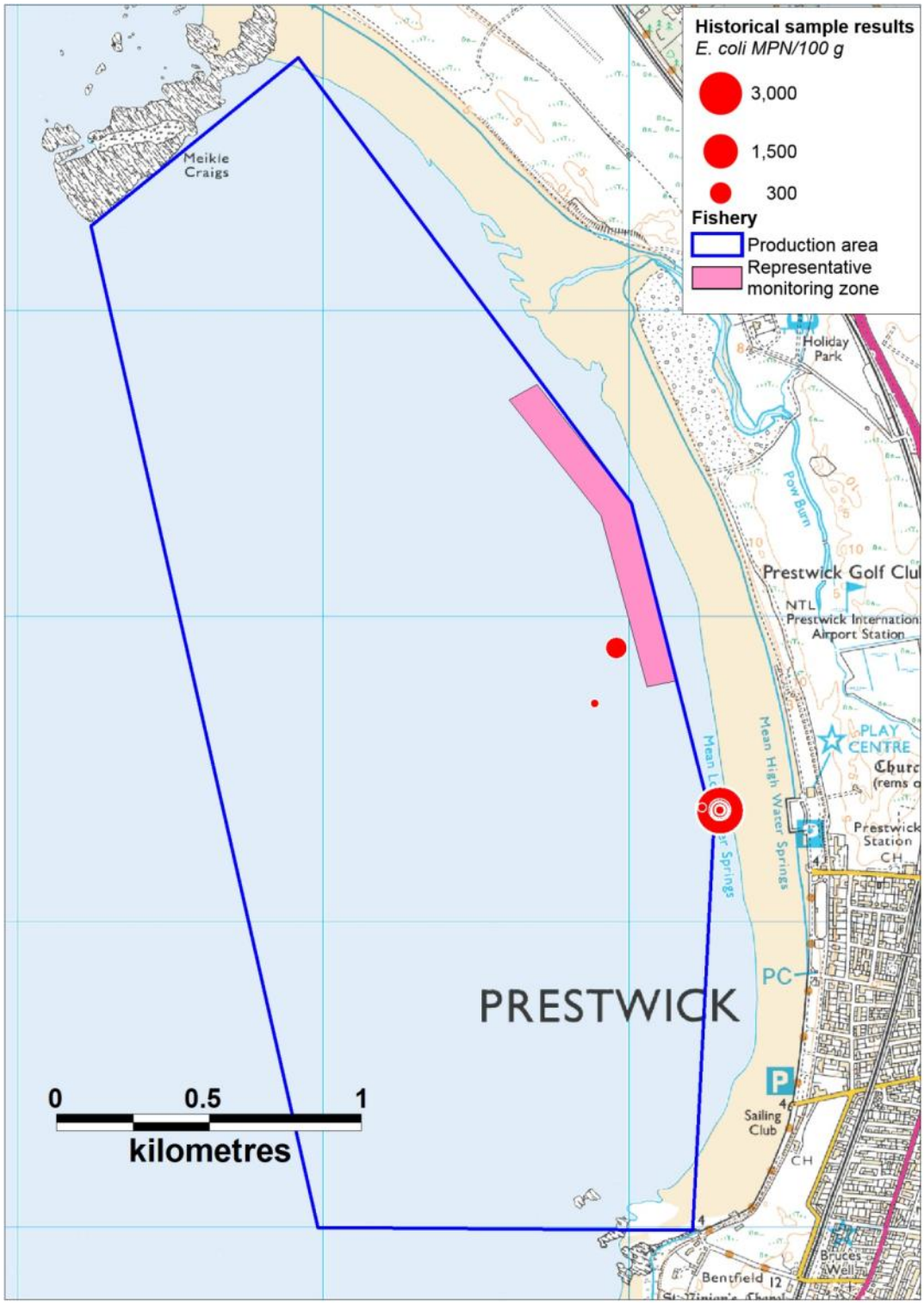


Figure 11.1 Map of reported sampling locations for razor clams at Meikle Craigs

The majority of samples (n=12) have been taken from a location approximately 400-450 m southeast of the RMZ, where the highest result was also taken. Two samples plotted west of the RMZ; one at 176 m southwest and the other 65 m west of the RMZ.

11.4 Overall temporal pattern of results

A scatterplot of *E. coli* results against date for the combined dataset for Meikle Craigs is presented in Figure 11.2. The dataset is fitted with a lowess trend line. 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.

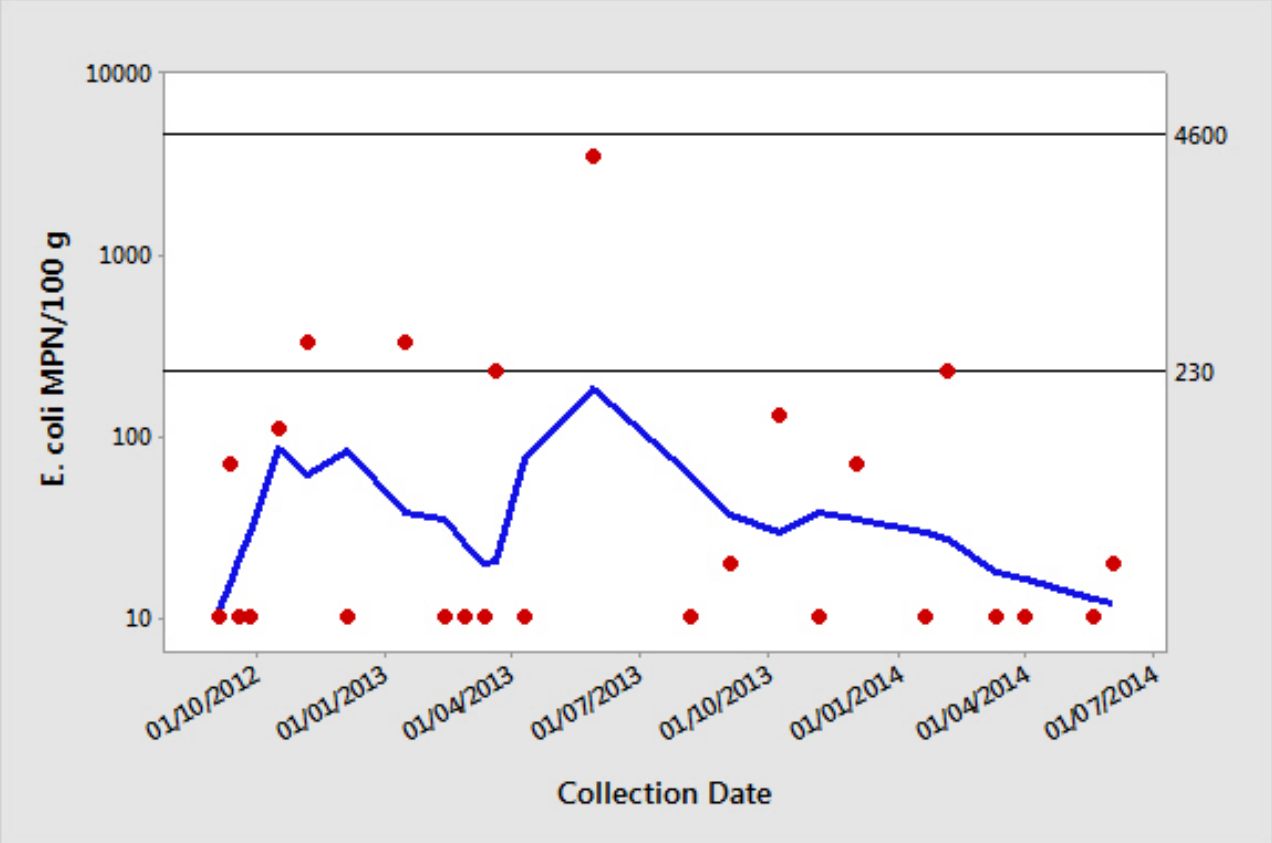


Figure 11.2 Scatterplot of *E. coli* results by collection date for Meikle Craigs combined dataset, fitted with a lowess line

There has been an absence of sample results >230 *E. coli* MPN/100 g since May 2013, following the highest reported sample result of 3500 *E. coli* MPN/100 g.

11.5 Seasonal pattern of results

Season dictates not only weather patterns and water temperature, but livestock numbers and movements, presence of wild animals and patterns in human distribution. All of these can affect levels of microbial contamination, causing seasonal patterns in results. A scatterplot of *E. coli* results by month, overlaid by a lowess line to highlight trends for Meikle Craig results is displayed in Figure 11.3. Jittering was applied at 0.02 (x-axis) and 0.001 (y-axis) respectively.

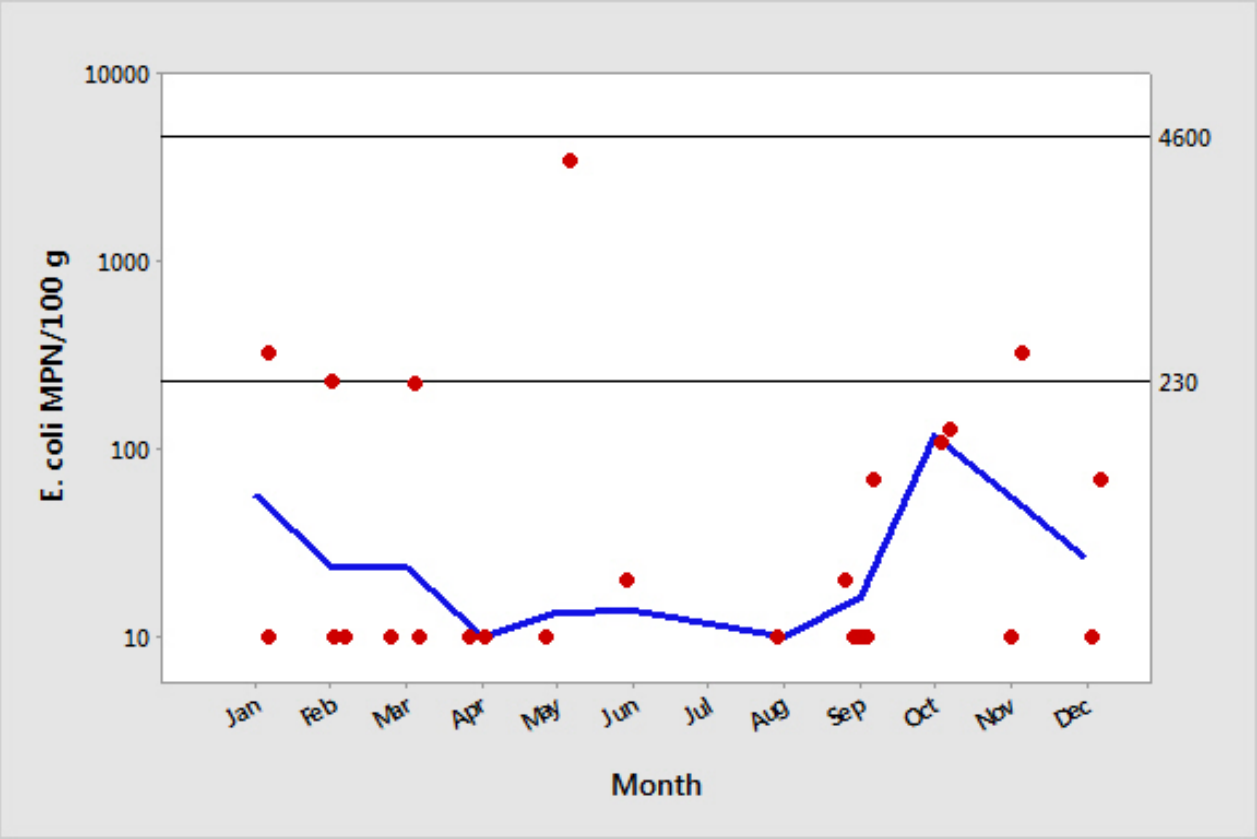


Figure 11.3 Scatterplot of *E. coli* results by month at Meikle Craigs, fitted with a lowess line

Uneven sampling between months has occurred with no samples taken in July and only one taken in June and August, compared to four samples taken in September. The lowess line peak in October is due to an absence of results <20 *E. coli* MPN/100g.

There were too few results to support further analysis by season.

11.6 Analysis of results against environmental factors

There were insufficient results to support further analysis against environmental factors.

11.7 Evaluation of results over 230 *E. coli* MPN/100 g

Three razor clam samples from Meikle Craigs had results >230 *E. coli* MPN/100 g and are listed below in Table 11.2.

Table 11.2 Meikle Craigs historic *E. coli* sampling results over 230 *E. coli* MPN/100g

Area	Collection Date	*E. coli* (MPN/100g)	Location
Silver Sands	06/11/2012	330	unverified
Silver Sands	14/01/2013	330	unverified
Meikle Craigs 2	28/05/2013	3500	NS 3430 2637

The three highest sample results were taken in November 2012, January and May 2013. The highest sample result of 3500 *E. coli* MPN/100 g was the only sample to have a verified sample location and was taken approximately 40 m outside the southern extent of the production area. The other two samples were reported against the fast track area at the northern end of the fishery, however without geographic reference data it is not possible to verify where the samples were taken.

11.8 Summary and conclusions

Uneven sampling frequency during several fast track applications makes it difficult to assess temporal trends in sampling results. Overall there has been an absence of elevated results (>230 *E. coli* MPN/100 g) since May 2013, when the highest sample result was reported at 3500 *E. coli* MPN/100 g. Highest results were from samples taken in January, May and November.

Geographical analysis was also restricted owing to a number of samples lacking verified sampling locations. The majority of samples for which geographic references had been provided were reported to have been taken from the shoreline at Prestwick, approximately 400-450 m southeast of the RMZ.

12. Designated Waters Data

Shellfish Growing Waters

The wild razor clam fishery at Meikle Craigs does not lie within a designated shellfish growing water.

Bathing Waters

There are 4 designated bathing waters in the area. Prestwick bathing water lies adjacent to the production area, with a monitoring point approximately mid-way along its length The Troon (South Beach) bathing water extends along the beach from Troon to Black Rocks, north of the production area, with a monitoring point at the northern end of the area.. Ayr (South Beach) bathing water lies south of Meikle Craigs production area and runs from the River Ayr south to the River Doon with a monitoring point at the northern end of the designated area. The Heads of Ayr bathing water is located southwest of Ayr (South Beach), approximately 8 km from the Meikle Craigs fishery. The compliance history since 2007 is shown in Table 12.1. Compliance in these years has been assessed against the stricter EU bathing waters directive (Directive 2006/7/EC).

Bathing waters boundaries and location of monitoring points are shown in Figure 12.1.

Troon (South Beach) bathing water report identified that there were no significant pollutions inputs to this designated area under normal conditions (SEPA, 2013). In 2009, SEPA used DNA tracing techniques to identify whether sources of faecal pollution to bathing waters were human or animal. Results indicated the ruminant (animal) sources in the River Ayr were likely to be contributing factor at times, in affecting the bathing water quality at Prestwick(SEPA, 2013). The Heads of Ayr and Ayr (South Beach) bathing water reports identified that the principle sources of short term pollution to the designated areas were considered to be surface water urban drainage, agricultural runoff and combined sewer overflows.

Table 12.1. Compliance history at Meikle Craigs designated bathing waters

Bathing Water	Year						
	2007	2008	2009	2010	2011	2012	2013
Troon (South Beach)	Pass-G	Pass-M	Pass-M	Pass-M	Pass-M	Pass-M	Pass-M
Prestwick	Fail	Pass-M	Pass-M	Pass-M	Pass-M	Pass-M	Pass-M
Ayr (South Beach)	Fail	Pass-M	Pass-M	Fail	Pass-M	Pass-M	Pass-M
Heads of Ayr	NA	Pass-M	Fail	Fail	Pass-M	Fail	Pass-M

Notes: Pass-G: Indicates sample meets EC Guideline Standards
Pass-M: Indicates sample meets the EC Mandatory Standards
Fail: Fail of Directive's Standards

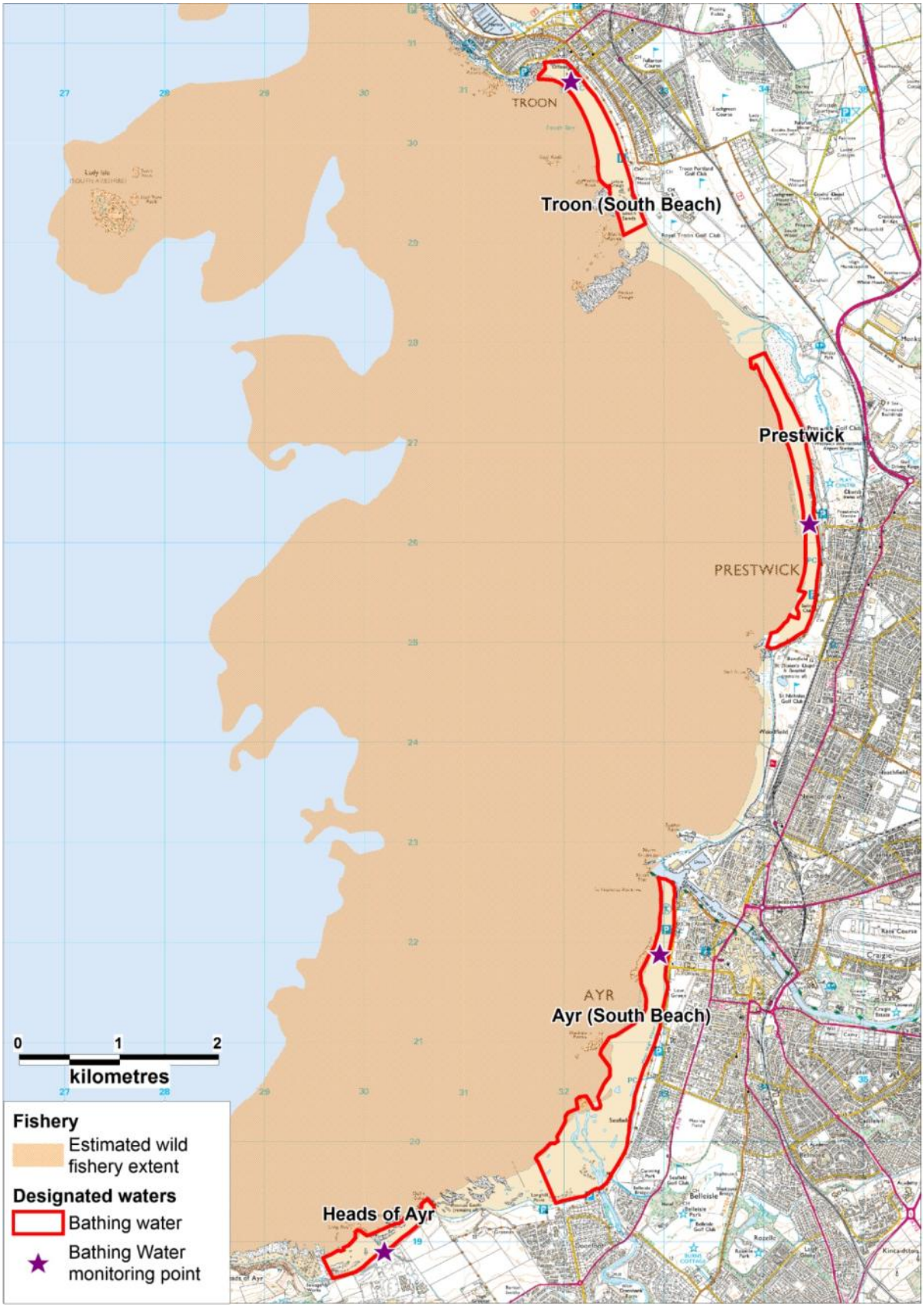


Figure 12.1 Designated waters – Meikle Craigs

13. Hydrographic Assessment

13.1 Introduction

13.1.1 The Study Area

The region under assessment is within an area defined as the Clyde Sea. The Clyde Sea is defined as the marine tidal inlet which encompasses the Firth of Clyde and the Clyde Estuary and the sea lochs to the north of the Firth and Loch Ryan to the south (Scottish Government, 2012). The Firth of Clyde is the body of water in the southern part of the Clyde Sea that forms the seaward boundary with the North Channel which is the deep water passage between Scotland and Northern Ireland. The Clyde Estuary refers to the area of water of the Clyde River particularly where it exits into the northern part of the Firth of Clyde.

The assessment area for Meikle Craigs comprises a substantial portion of the Firth of Clyde, stretching between Farland Head and Heads of Ayr on the eastern boundary, and between Sannox and Dippen Head on the Isle of Arran in the west. Meikle Craigs itself lies 2.5 kms south of Troon in Ayrshire.

The assessment area encompasses a large part of the Firth of Clyde, which is considered to be an extensive fjordic system (Edwards, et al., 1986). It is shown in Figure 13.1 with the assessment area demarcated by the red line. The eastern boundary comprises of a series of sandy bays. This is in sharp contrast to the mountainous terrain of the Isle of Arran.

Figure 13.1 Extent of the hydrographic study area

The Firth of Clyde Forum has developed a Marine Spatial Plan and a Strategic Environmental Assessment for the Firth of Clyde to guide management of the Firth of Clyde and to enable sustainable use of the marine environment (SSMEI, 2010). The coastline of the Isle of Arran between Brodick and the northern boundary of the assessment area has been designated as a National Scenic Area, and Sites of Special Scientific Interest are found along the coastline at Ardrossan and at South Sands adjacent to Meikle Craigs (Scottish Natural Heritage, n.d.).

Coordinates for Meikle Craigs:

55.52229°N 004.6565°W
OS NS 324286

13.2 Bathymetry and Hydrodynamics

13.2.1 Bathymetry

Figure 13.2 shows the bathymetry of Meikle Craigs and the wider assessment area of the Firth of Clyde. The Firth of Clyde is a wide and deep coastal embayment. Between the Isle of Arran and the Ayrshire coast, the Firth contains a large basin called the Arran Basin. The Firth has an area of 3680 km^2 (Muller, et al., 1995) and a volume of 1 x 10^{11} m^3 (Dooley, 1979). There are no sills within the assessment area. Bathymetry is deepest in the middle portion of the assessment reaching depths of over 100 m in a channel to the east of the Isle of Arran. Bathymetry slopes

downwards more steeply from the western side of the assessment area to the central deep channel than from the eastern side. The assessment area has a maximum charted depth of 172 m, in the vicinity of a disused explosives dumping ground. This area is also known as the 'Arran Deep' (Edwards, et al., 1986).

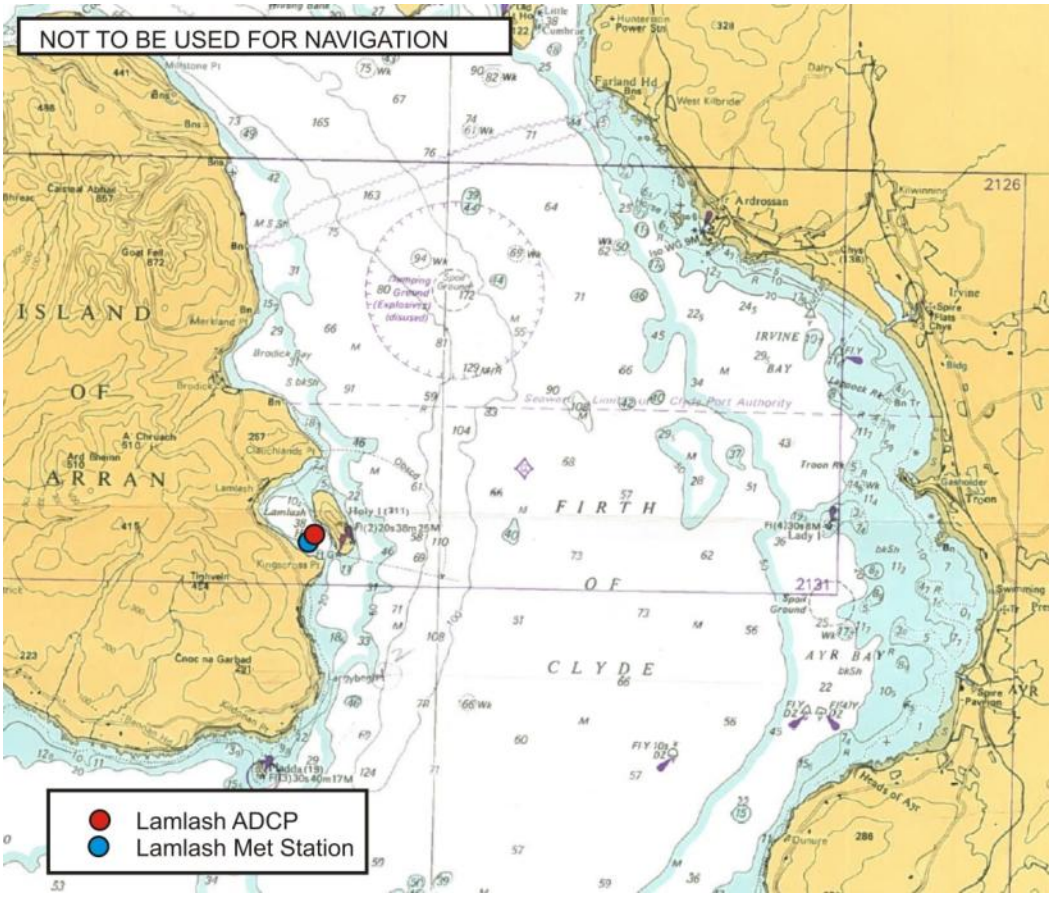


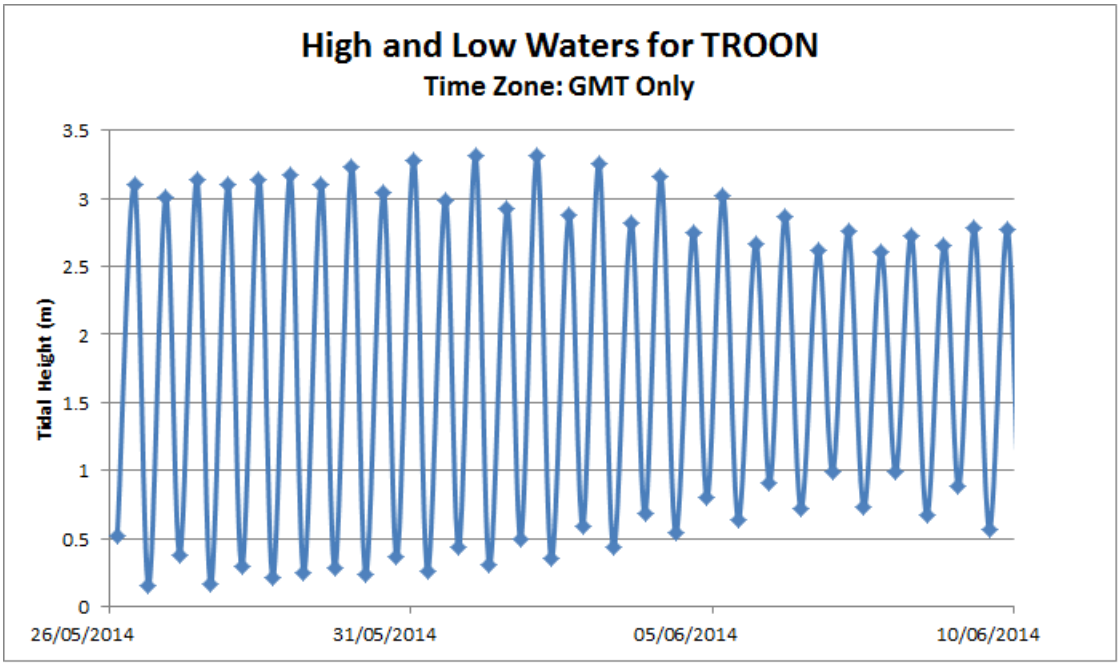
Figure 13.2 Admiralty chart (2724, Edition 3 year 1979) extract for the Firth of Clyde. Locations of ADCPs and weather stations within assessment area are shown.

There are extensive shallow intertidal and sandy beach areas along the eastern side of the assessment area including Irvine Bay and the beaches at Prestwick and Ayr.

13.2.2 Tides

Data on tidal information is provided based on tidal characteristics determined from the site. Standard tidal data for Troon, centred around the survey date of 2nd June 2014, are shown in Figure 13.3.

Tidal predictions for Troon indicate that in this region the tidal characteristics are semi-diurnal, with a well-developed spring-neap cycle.



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

Figure 13.3 Two week tidal curve for Troon.

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

Mean High Water Springs = 3.2 m
Mean Low Water Springs = 0.3 m
Mean High Water Neaps = 2.6 m
Mean Low Water Neaps = 1.0 m

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

Springs: 2.11×10^9 m^3
Neaps: 1.17×10^9 m^3

13.2.3 Tidal Streams and Currents

Tidal currents in the Firth of Clyde are typically weak in the deep water and are generally < 0.2 m/s in magnitude for most of the year (Edwards, et al., 1986; Lewis, 1986; Simpson & Rippeth, 1993). Tidal currents are weak due to the attenuation of the tide as it propagates from the North Channel and crosses the broad, shallow sill at the entrance to the Clyde Sea (Edwards, et al., 1986). Further, rotational effects due to Coriolis forces can be important in this relatively wide fjord.

There is one published tidal diamond within the assessment area in the centre of the Firth of Clyde, just east of Holy Island on the Isle of Arran. A further published tidal diamond is found just to the south of the assessment area between Pladda, a small island off the southern end of Arran, and Turnberry Point on the mainland. The following statements are derived from these data, though it must be remembered that data at tidal diamonds may only be relatively crude indications of flow characteristics derived from short current records (e.g. Bell and Carlin 1998).

East of Holy Island, the flow is aligned northeast-southwest, with flood tides generally oriented northeast, and ebb flows southwest. The maximum rates are 0.3 knots (0.15 m s^{-1}) at springs and 0.2 knots (0.10 m s^{-1}) at neaps. There will be variations to these values across the assessment area in the vicinity of bays and headlands.

The maximum cumulative transport that might be expected during each phase of the tide at the centre of the assessment area is around 2 km.

South of the assessment area, to the southeast of the Isle of Arran flow rates are stronger, with maximum speeds of 0.6 knots (0.31 m s^{-1}) at springs, and 0.4 knots (0.21 m s^{-1}) at neaps. These flows are oriented in a northerly direction on the flood tide, and in a south westerly direction on the ebb tide.

The maximum cumulative transport that might be expected during each phase of the tide south of the assessment area is 4.3 km.

In general, residual flows in the Firth of Clyde are related to distribution of freshwater over the area further enhanced by any large-scale wind forcing (Lewis, 1986). Due to the rather persistent stratification, there is typically a two layer flow with residuals in the upper layer being mainly southward with a magnitude of ~0.01 m/s (Midgley, et al., 2001).

A residual flow in the study area has been estimated using the tidal diamond data from the tidal diamond east of Holy Island. The tidal diamond provides a drift rate and direction for each hour of the tide. By summing the vectors for both spring flow and neap flow it is possible to calculate the residual flow, or net flow, over a tidal cycle. The residual speed was found to be 0.18 m s^{-1} oriented in a south easterly direction at 109°. However, this is probably not representative of the wider area.

A north-westerly residual flow is also reproduced in the area of Meikle Craigs using a 3D model covering the North Channel and Clyde Sea giving a depth mean flow speed of around 0.02 m/s (Davies & Hall, 2000). This flow pattern and rate is enhanced during SW winds such that a cyclonic gyre (anti-clockwise) is set up within the assessment area.

Further information on the circulation in the assessment area and the broader Firth of Clyde is given in the literature. The assessment area lies south of the inner, fjordic Clyde Estuary, but to the north of the Great Plateau which is found south of the Isle of Arran. Year-round stratification is common, punctuated by periods of wind-driven vertical mixing in the late autumn (Edwards, et al., 1986; Rippeth, et al., 1995; Matthews, et al., 1999). There is proposed to be a general residual circulation around the Isle of Arran in a clockwise direction, at speeds of 1-2 cm s^{-1}, while surface water currents are often reflective of weather conditions, and may be complemented by a subsurface counterflow. Matthews et al. (1999) suggest that a strong north-westerly signal in deep water flow in the Arran Deep could be part of a deep counter-circulation around Arran which is enhanced or induced by the wind. This counter-flow eased when wind stress decreased.

A further study by Lewis et al. (1986) focussed on Irvine Bay, found in the eastern part of the assessment area. Once again, currents were deemed to be highly susceptible to wind forcing, and longshore drift was estimated to be approximately 5 cm s^{-1} in a north westerly direction. Inshore waters in Irvine bay were determined to be influenced by brackish water outflow from the Irvine-Garnock Estuary. The authors were also able to estimate longitudinal and transverse dispersion coefficients for the bay, at 2.17 m^2 s^{-1} and 0.25 m^2 s^{-1}, respectively.

Current meter data were available from SEPA at one specified sites within the assessment area at Lamlash Bay, Arran, shown in Figure 13.4.

The survey spanned a period of fifteen days, focussing on a half-lunar period in order to capture a spring-neap cycle: 30th March 2006 to 14th April 2006 (Marine Harvest, 2006) collected at Lamlash, 55°31.062N, 5°05.872W, are summarised in Table 13.1. The average water depth recorded for the duration of the survey was 40.4 m.

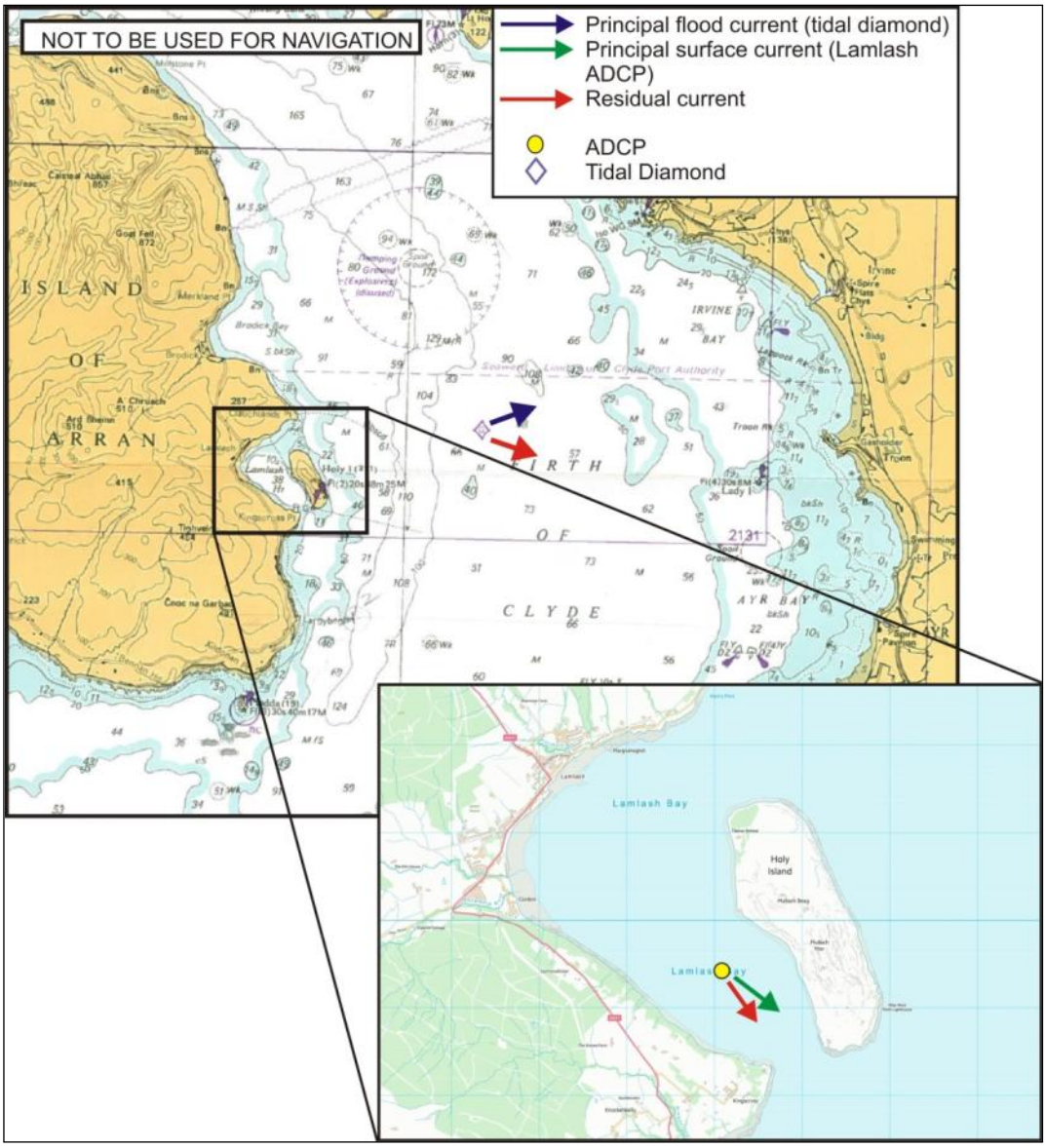


Figure 13.4 Map showing the Meikle Craigs assessment area and Lamlash ADCP sample sites (inset) within the assessment area.

The expected flood and residual current distances and directions are shown for the tidal diamond found within the assessment area. At the Lamlash ADCP site, using the surface principal current amplitude and residual current velocities and the assumption of a uniform sinusoidal tide, the cumulative transport distance and direction that might be expected during each phase of the tide is shown above.

Mean current speeds suggest that there is a slight gradient in flow between the sub-surface and the sea bed, with speed decreasing with increasing depth. The strongest currents at this site are most frequently characterised by flows along a south-easterly – north-westerly axis. Residual current directions fall within a similar range as principal current directions, while residual current speeds were greater at the surface than at the seabed. No distinct pattern was observed in tidal flows across the spring-neap cycle.

A weather station was also deployed during the Lamlash survey. Average wind speeds varied between approximately 0.77 m s^{-1} and 1.54 m s^{-1}, and reached a maximum of 2.98 m s^{-1}. Most frequently, winds came from an easterly to north easterly direction.

In general, the current meter data from Lamlash suggests that that particular site is moderately flushed. However, the assessment area is substantially larger and more open in nature than the Lamlash ADCP site, so it is not appropriate to translate results from Lamlash to the wider area.

Table 13.1 Lamlash current data measured in 2006

Average Depth	Near-bed (3.7 m above seabed)	Mid-water (25.7 m above seabed)	Sub-surface (33.7 m from seabed)
Mean Speed (ms^{-1})	0.068	0.069	0.077
Maximum Speed (ms^{-1})	0.251	0.249	0.334
Principal Axis Amp & Dir (ms^{-1}) & (^{o}M)	0.066 (145.0)	0.057 (124.8)	0.048 (127.4)
Residual speed (ms^{-1})	0.025	0.027	0.042
Residual direction (^{o}M)	120.3	167.04	144.48

Using the surface principal current and assuming a uniform sinusoidal tide, the cumulative transport that might be expected during each phase of the tide (approximately 6 hours) has been estimated for the Lamlash site as 0.66 km (based on a surface principal current amplitude of 0.048 m/s). No distinction is made here for springs and neaps.

Dispersion is an important property of a water body with respect to redistribution of contaminants over time. Dispersion coefficients have been estimated for Irvine Bay, north of Troon, and could provide insight into likely dispersion at Meikle Craigs. Lewis (1986) estimated the longitudinal dispersion coefficient for Irvine Bay to be 2.17 m^2 s^{-1} and the transverse dispersion coefficient to be 0.25 m^2 s^{-1}.

Dispersion of surface contaminants may be enhanced by wave energy in the assessment area, particularly given the open aspect at both northern and southern area boundaries. Sources of wave energy are from both short period waves generated within the assessment area itself and longer period swells originating from the waters to the south which are open to the Irish Sea.

13.2.4 River/Freshwater Inflow

Substantial freshwater inflow into the Firth of Clyde comes from a variety of sources, including several major lochs and rivers found to the north of the assessment area. Within the assessment area, major sources of freshwater inflow are found on the eastern shore, and include the Rivers Garnock, Lugton, and Ayr. Comparatively little

freshwater flows into the assessment area from catchments on the Isle of Arran (Poodle, 1986).

The Firth of Clyde is described as a ROFI (Region of Freshwater Influence) and has a mean annual salinity of between 32.5 and 32.8 (Edwards, et al., 1986)with the fresher areas being within the Inner Firth and the salinity gradually increasing towards the North Channel (S = 34).

The mean annual run off for the Clyde Sea is typically 300 m^3/s with a large seasonal variation of ± 200 m^3/s (Midgley, et al., 2001). Other estimates of annual run off for the region are 60 – 700 m^3 s^{-1} (Poodle, 1986).

The Clyde Estuary to the north is the source of two thirds of the freshwater input into the Firth (Edwards, et al., 1986). In the year August 1989 – July 1990 it provided 4390 x 10^6 m^3 of freshwater into the Firth and, combined with the freshwater input from the rivers Ayrshire, Arran and the sea loch system which amounted to 1880 x 10^6 m^3, this gives a total input of freshwater into the Firth of Clyde of 6270 x 10^6 m^3 (Muller, et al., 1995). In the same period, the total rainfall over the Firth of Clyde was approximately 5190 x 10^6 m^3. This was calculated from the average daily rainfall measurements collected from three gauging stations at Rothesay, Carskiey and Doonholm.

Freshwater inflow from the Ayrshire catchment area is estimated to represent 15% of the freshwater input into the Clyde Sea at 51.0 m^3 s^{-1}, while freshwater input from Arran represents 7% of inflow, at 23.0 m^3 s^{-1}. The River Clyde is the largest point discharge into the Clyde Sea, at 41.0 m^3 s^{-1} (Poodle, 1986).

In the surface layers of the Arran Basin, the water is of consistently low salinity with typical values at < 32.5. Higher salinity waters exist at depth near the Ayrshire coast (Dooley, 1979).

Overall, the Clyde Sea demonstrates fairly persistent stratification during the year by combination of thermal and freshwater inputs (Simpson & Rippeth, 1993). The strongest stratification occurs in the summer during periods of thermal warming and moderate freshwater discharge. The effect being to create a surface layer that can respond to wind forcing. During winter the stratification is dominated by the increase in freshwater discharge. However, there are periods where the water column can become fully mixed after periods of strong winds and intense surface cooling.

13.2.5 Meteorology

The nearest weather station for which a continuous rainfall dataset is available is located at Prestwick, Gannet. This station is situated approximately 4.5 km to the east of the assessment area. Rainfall records are available from January 2008 to December 2013.

The driest year was 2010 (1198mm) although data for this year is incomplete. The wettest year was 2008 (2353 mm). Rainfall events of > 30 mm d^{-1} were recorded in all years except 2012. Rainfall events greater than 20 mm d^{-1} occurred in all months except March, April and May. Rainfall events of greater than 30 mm d^{-1} were observed in July, August, October and December. A maximum value of approximately 37 mm d^{-1} was observed in August 2009. Daily rainfall varied seasonally, from lower values in January to June and higher values from July to December. Rainfall at Prestwick peaks in October (1348 mm) and the driest month is June (429 mm). For the duration of the dataset, daily rainfall of below 1 mm occurred on 47% of days, while daily rainfall above 10 mm occurred on 17% of days.

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

Wind data were also obtained from Prestwick, Gannet. Data collected between January 2004 and December 2013 indicate that the predominant wind direction is from the west south west. Seasonally the strongest winds occurred during the winter months and also came from this direction.

13.2.6 Model Assessment

Whilst there is a considerable amount of in situ data for this location, it is not appropriate to set up a box model run for the assessment area due to the unconstrained nature of the study area.

Some 3D modelling work has been undertaken in the past (Davies & Hall, 2000) and the key results from this have been reported in 13.2.3. Although a tidal surge model does exist (developed by SEPA), we are not aware of any high resolution circulation models.

Simple box modelling work has been done previously (Rippeth, et al., 1995) but this was only able to reproduce the seasonal changes in stratification in Clyde Sea deep water locations and gave rather little impression of circulation and dispersion in Irvine Bay.

13.3 Hydrographic Assessment

13.3.1 Surface Flow

Assessment of the literature for the Firth of Clyde indicates that freshwater inflow has an important bearing on the surface flow characteristics. This surface flow is further modified by large scale wind forcing with local winds influencing the waters very close to the coast, within water depths of < 10 m.

The water generally shows prolonged stratification which becomes weaker in the autumn/winter such that there is occasional full convective mixing. However, this is much less likely close to sources of freshwater which will sustain the stratified nature of the water.

Tidal flow in the Firth of Clyde is generally weak and not aligned along the axis of the Firth of Clyde. There is rather little information for tidal flow at the Ayrshire coast but it is presumed to broadly follow the coast northwards on the flood and south on the ebb. The maximum tidal excursion in the Firth of Clyde during a flood or ebb phase of the tide is typically 2 km.

Residual flows in the Firth of Clyde are reported to be typically slow at 0.01 m/s to the south. Over 12 hours this would result in a net transport of around 0.5 km. Residual flow closer to the Ayrshire coast is reported at around 0.02 m/s, perhaps higher, in the northwest direction. Over 12 hours this would result in a net transport of around 1 km.

The dominance of the south westerly winds is likely to sustain the residual flow and may even enhance them.

Dispersion measurements in nearby Irvine Bay have indicated that the dispersion rates are greater than those prescribed by SEPA management guidelines and will result in an alongshore and offshore transport. Again, dispersive behaviour will be enhanced with wind forcing.

13.3.2 Exchange Properties

Due to tidal currents being generally weak within the Firth of Clyde, the flushing of water is rather long compared to smaller, more tidally energetic sea lochs. Estimates of renewal time of water in the Clyde range from four weeks (Steele, et al., 1973) to two months (Edwards, et al., 1986) but exchange can be enhanced (i.e. reduced residence time) through wind forcing. However, in general we would expect the larger area of the Firth of Clyde to be weakly flushed.

In the area of Meikle Craigs there is potential for a rather persistent alongshore residual current and potentially relatively high dispersion rates; therefore, the waters may be flushed more effectively than in the adjacent Firth of Clyde. However, it is likely that there is a through flow of water at Meikle Craigs with water being advected through the site from further south.

Much of this assessment is based on a mature body of literature that is itself based on extensive measurement. The assessment site is relatively simple in terms of topography. However, there are no direct measurements at the site nor is there a high resolution circulation or exchange model available. Therefore the confidence level of this assessment is MEDIUM.

14. Shoreline Survey Overview

The shoreline survey at Meikle Craigs was conducted on the 3rd and 4th June 2014. No rainfall was reported in the 48 hours prior to the survey, though light rain fell in the morning of both survey days. Both days reported light winds, with a highest speed of 11 knots in a westerly direction noted on the first day. Sea state declined from 3 to 0 between survey days.

The fishery consists of a wild razor clam bed. Harvest is through diver collection. The maximum safe diver limit of 50 m limits the seaward extent of harvest. The sampling officer indicated harvest was year round, though at the time of the survey harvesting had stopped for 2-3 months to allow stocks to recover. No shellfish samples were taken during this survey.

The towns were noted to contain hotels and guest houses, with Marine Hotel located just south of Troon and St Andrews Caravan Park located close to Prestwick Airport. The caravan park was mainly used by residential vans, though several spaces were available to touring caravans and camping. The beaches adjacent to the towns and pedestrian esplanade are popular, with both noted to be in continuous use throughout the survey.

During the survey, a leaking pipe was noted near St Andrews SPS and a sample from the effluent returned a result of <1000 *E. coli* cfu/100 ml. Ayr PS and EO were also observed, with 1 m diameter pipes also noted either side of the River Ayr. A resident indicated that the latter were associated with three CSOs which discharged offshore and that the two pipes submerged under the river 300 m downstream of the Ayr Bridge. No private discharges were observed during the survey.

Troon marina located to the north of the survey area is large and contains the P&O ferry terminal. Ferries operate between Troon and Ireland, with the ferry observed leaving the marina during the survey. A sailing club is also located at Prestwick, with eight moored yachts noted in the Ayr River and two large bulk carrier merchant ships were observed moored offshore.

Agricultural land is largely absent from the area, though 12 dairy cows were observed in a field adjacent to St. Andrews Caravan Park.

The foreshore at Troon and Prestwick was noted to be mostly comprised of urban residential accommodation, compared to at Ayr where the North Harbour Industrial Estate flanks the shoreline. Several golf courses lay along the foreshore between the three main towns and sand dunes line the land behind the beaches. Sand dunes between Troon and Prestwick are particularly extensive, stabilised on the upper shore by gabions south of Troon. Small areas of woodland were also noted inland between Troon and Prestwick.

The two major watercourses in the area, Pow Burn and the River Ayr, returned freshwater sample results of 550 and 470 *E. coli* cfu/100 ml respectively. Ten drainage pipes were also noted emerging from beneath roads, the esplanade or from pipes emerging from the beach. Flows from eight of these were measured and sampled, with two suspected land drainage pipes noted at Troon and at Woodfields returning high freshwater sample results of 10000 *E. coli* cfu/100 ml.

Large aggregations of gulls were noted on the beach at the mouth of Pow Burn and just south of Pow Burn. The area was popular with dog walkers, with a total of 21 dogs observed. Possible otter/dog faeces were noted by a pipe running along Pow Burn.

Significant observations from the shoreline survey are identified on the map in Figure 14.1. The full shoreline survey report can be found in Appendix 4.

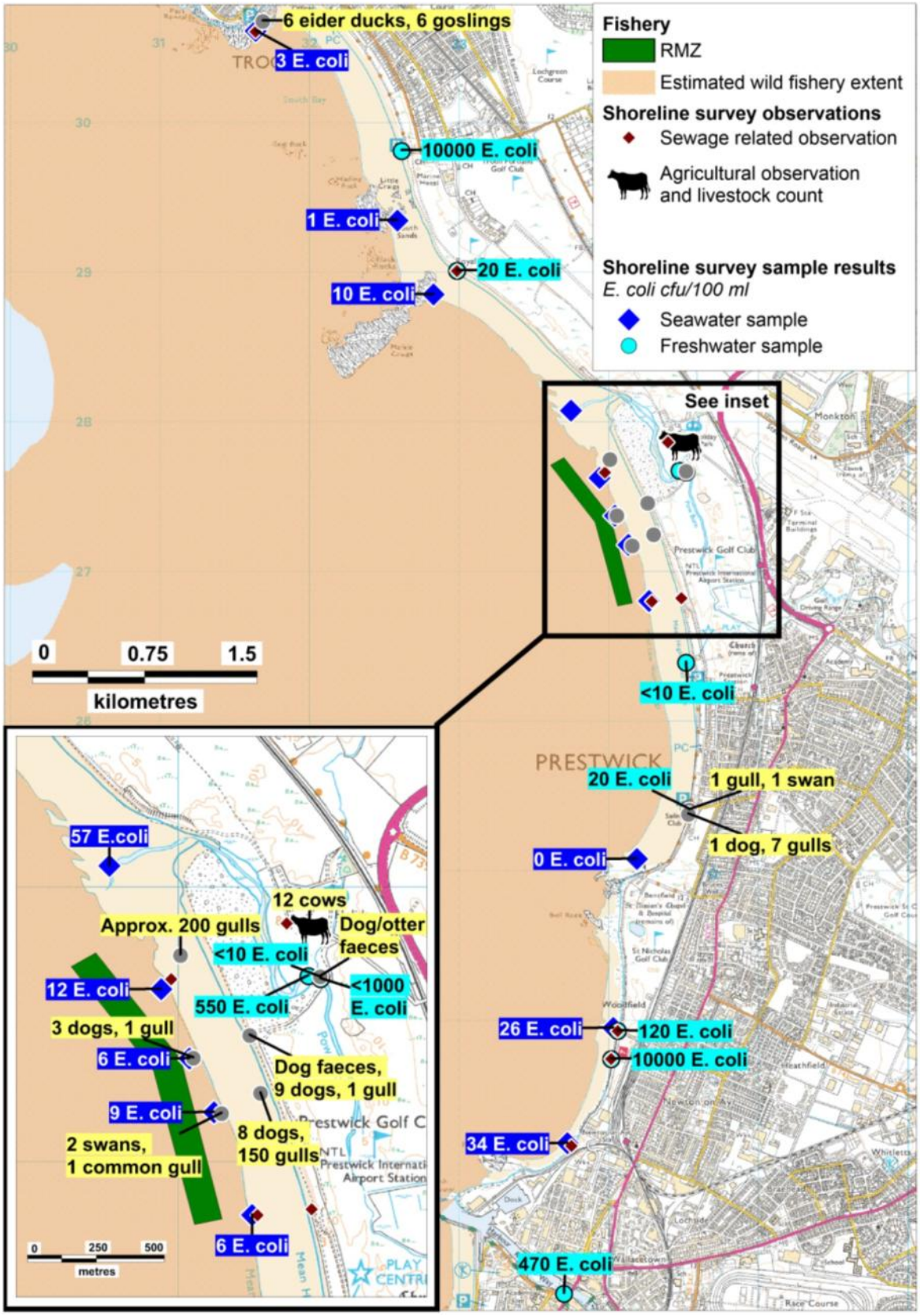


Figure 14.1 Map of shoreline survey observations at Meikle Craigs

15. Bacteriological Survey

No bacteriological survey was recommended for this area due to the nature of the fishery.

16. Overall Assessment

Human sewage impacts

Although the area is heavily built-up, the majority of the population is served by the Meadowhead sewerage network, which discharges secondary treated effluent approximately 12 km to the northwest of the Meikle Craigs classified razor clam area. Due to the distance from the fishery, this discharge is not expected to directly impact on water quality at the Meikle Craigs fishery, though it may contribute to background levels of contamination in the area. Three additional continuous public sewage discharges operate inland of the fishery, discharging to watercourses within the River Ayr and Pow Burn catchments. Of these, the largest has a PE of 1200 and discharges to the River Ayr and therefore will contribute to contamination levels contributed by the river.

A total of 12 intermittent discharges are located within the vicinity of the fishery, including those that discharge to the lower reaches of the River Ayr and Pow Burn. Of these, two CSOs discharge directly adjacent to the production area. When operating, these would be expected to contribute significant faecal contamination to the eastern side of the fishery. Two further CSOs discharge between the southern production area boundary and the River Ayr. In light of the predicted movement of contaminants, these would be expected to impact the southern end of the production area when operating. The relative importance of these two CSOs in relation to the two that discharge adjacent to the production area will depend on actual spill frequency. Data on spill frequencies from these CSOs was not available for this assessment.

One private discharge with a PE of 5 was reported to discharge to sea north of Meikle Craigs rocks, approximately 1 km north of the production area. Given the small size of the discharge, it is expected to be significantly diluted prior to reaching the fishery although it may contribute to background levels of contamination, particularly at the northern boundary of the production area.

The majority of consented private discharge were located well inland and approximately half discharge to water, with the other half discharging to land or soakaway. These discharges are expected to contribute to faecal loadings carried by the main watercourses in the area.

Agricultural impacts

Although much of the shoreline is urban, particularly along the southern shore of the production area, there is significant agricultural activity inland of the towns, and this is considered to significantly contribute to faecal contaminant loadings carried in both Pow Burn and the River Ayr. Cattle were observed grazing on pasture near Pow

Burn during the shoreline survey. Greatest impact is likely to occur near mouth of Pow Burn, adjacent to the east side of the production area.

Wildlife impacts

Large numbers of gulls and other seabirds were noted to the north of the production area, at Meikle Craigs rocks and at Lady Isle, where there is also a seal colony. A large number of gulls was observed at the mouth of Pow Burn during the shoreline survey, where they are likely to be attracted by the fresh water. Gulls are likely to be present in the area year round, though the overall number of seabirds present in the area is expected to be highest during the summer months, when a number of species are known to nest in the area. The major nesting areas lie north of the production area and therefore impacts from these will be higher at the northern production area boundary. Contamination from gulls and any other birds congregating around the mouth of Pow Burn would be expected to affect water quality around the mouth of the burn, however their contribution may be small in comparison to agricultural and human sources coming from upstream. Impacts from wading birds may be higher at the southern end of the production area.

Seasonal variation

Seasonal variation in impacts from human and wildlife sources is anticipated. The area is popular with tourists and has several designated bathing beaches, suggesting increased input from human sources during the summer months. Seabirds are likely to be present in higher numbers during the summer. Rainfall data showed marked variation with higher rainfall occurring during the autumn and winter, however peak rainfall events (>30 mm/day) occurred in most months. River flow data for the River Ayr showed higher flows in winter than in summer.

Rivers and streams

The two main watercourse discharging to the area, Pow Burn and the River Ayr, were identified by SEPA as receiving impacts from human sewage and diffuse pollution from both urban and agricultural sources. E. coli loadings calculated from spot samples and measurements taken during the shoreline survey showed relatively high loadings of faecal bacteria entering the production area from these sources. It was not possible to identify sources, but the contamination is presumed to have come from a mix of human, agricultural and wildlife sources. Although the River Ayr was larger than Pow Burn, the loadings estimated form the shoreline survey observations were similar. However, assuming a greater flow for the River Ayr, as indicated by river gauging data, the expected loading from the River Ayr is much greater. Impacts from the River Ayr are more likely to affect the southern end of the production area, whilst impacts from Pow would be expected to have a more direct impact as it discharges near the middle of the production area.

Movement of contaminants

Contamination entering the production area from freshwater sources is likely to be contained within a stratified surface layer of fresher water and therefore the transport of contaminants from these sources to the shellfish at the seabed will depend on mixing. When the tide is out, and at spring tides, contaminants carried via Pow Burn may directly affect any shellfish living nearer mean low water springs, where freshwater from the burn will reach the seabed.

Predicted tidal excursion is approximately 2 km, with a residual flow to the northwest. However, wind-driven currents are predicted to be a significant factor in the movement of surface waters near the shore. Given the prevailing southwesterly wind direction, it is likely that contaminants arising to the south of the fishery will be driven northeastward and along the coast further than the predicted tidal excursion alone. There may be an effect some distance from either river mouth as particulate matter with associated contaminants gradually settles out to the seabed, and resuspension of sediments may add to the contaminant load when the seabed is disturbed, as in during heavy weather.

Temporal and geographical patterns of sampling results

No clear trends were apparent in the historical *E. coli* monitoring data, as there has been little more than one year of sampling history. There were no clear geographical patterns in the relatively few monitoring results available. The majority of results were reported against a location near shore at the north end of Prestwick town. No geographical references were provided for any of the samples reported against Meikle Craigs Silver Sands. It is not clear whether any samples have been taken to date from within the RMZ. Five samples taken from the Meikle Craigs 3 fast track area, at the southern end of the current production area, all plotted above or near MHWS and more than 100 metres from the production area boundary. Therefore, it was not possible to assess geographic variation in the results available.

Conclusions

The Meikle Craigs production area is subject to faecal contamination from human sewage, agricultural sources (mainly cattle) and wildlife. The two most significant sources of contamination are the River Ayr and Pow Burn. Both watercourses receive diffuse urban and agricultural source pollution, as well as combined sewer overflows from pumping stations on the Meadowhead network. River Ayr also receives secondary treated sewage effluent from a small treatment works, although this lies several km further upstream of the town of Ayr.

Pow Burn discharges directly to the production area, and will be a significant direct and continuous source of contamination to the eastern side of the fishery. Under

certain conditions, the River Ayr may be a significant source of contamination to the southern end of the production area.

Intermittent discharges from CSOs to the eastern side of the production area would result in significant contamination when they spill. The impact from these discharges are not necessarily captured within a year's monthly classification monitoring due to the intermittent nature of their operation. Therefore, there is a risk that after a significant spill, heavily contaminated shellfish could potentially be harvested under a better classification than merited . A reactive system alerting relevant parties to spill events in real time may therefore convey better public health protection. Further CSOs to the south of the production area would potentially impact the southern end of the fishery when spilling.

Contamination inputs from wildlife are likely to be relatively minor in comparison to contamination carried via watercourses. Gulls present around the mouth of Pow Burn are likely to contribute to the loading already carried in that watercourse, while gulls and other birds present at Meikle Craigs rocks will have a seasonal impact at the northern end of the fishery during the summer months.

17. Recommendations

Production area

No changes are recommended to the provisional production area boundary.

RMZ

It is not possible to achieve a monitoring zone that fully takes into account sources along the eastern side and southern end of the fishery. As the sources to the east of the production area are the most immediate and, in the case of Pow Burn, continuous, it is recommended that the RMP be retained at that side of the production area. However, it is recommended that the area be expanded to encompass an area from the mouth of Pow Burn to the car park at the north end of Prestwick and extending approximately 250 m offshore to allow broader scope for provision of samples. The recommended RMZ is therefore

> The area bounded by lines drawn from NS 3354 2800 to NS 3327 2800 to NS 3376 2731 to NS 3405 2623 to NS 3428 2623 to NS 3428 2631 to NS 3401 2737 and back to NS 3354 2800.

Frequency

As the area has relatively little monitoring history, monthly sampling is recommended.

Depth of sampling

Not applicable

Tolerance

Not applicable

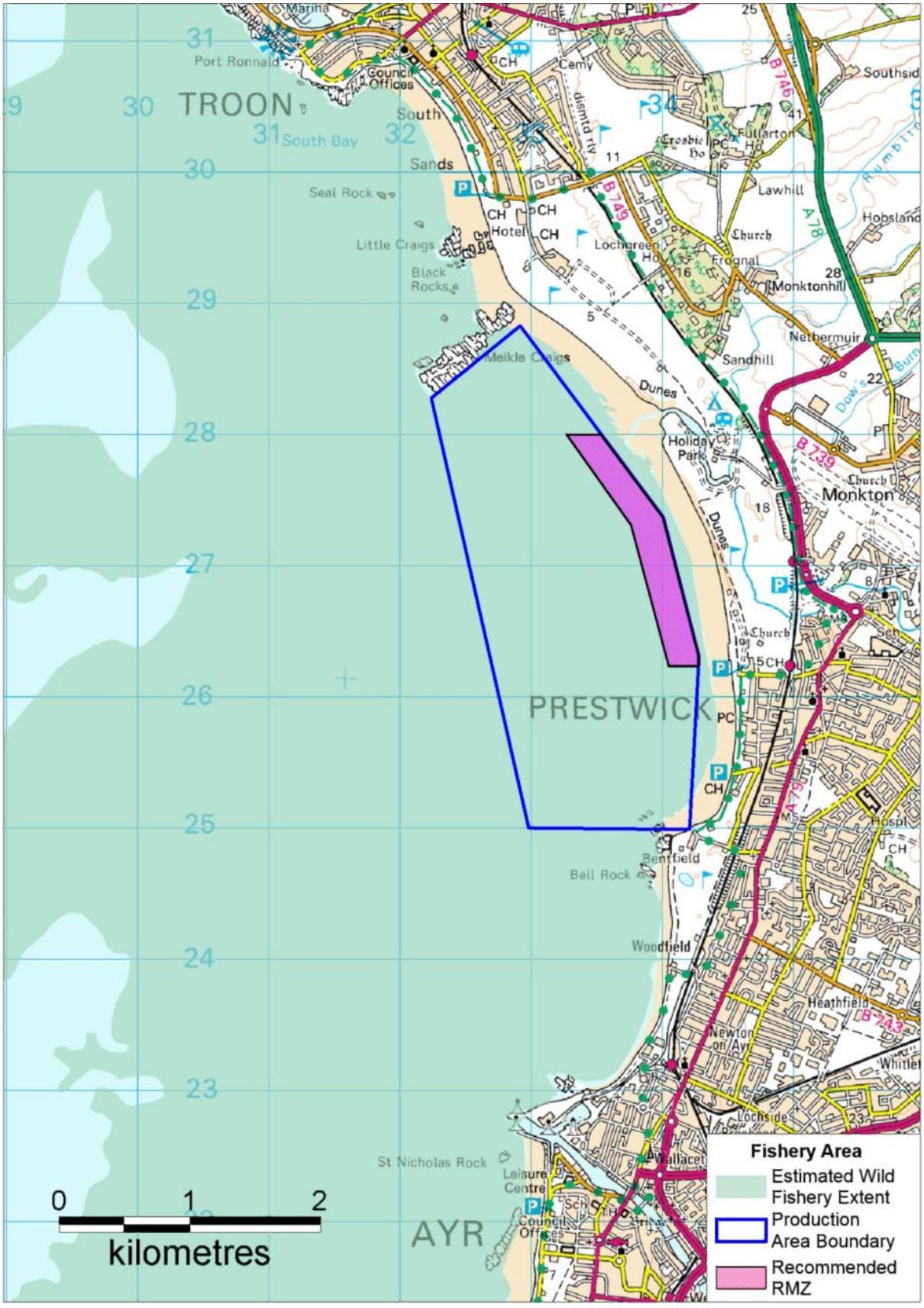


Figure 17.1 Map of recommendations at Meikle Craigs

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1. General Information on Wildlife Impacts

Pinnipeds

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

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

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

Adult Grey seals weigh 150-220 kg and adult common seals 50-170 kg. They are estimated to consume between 4 and 8% of their body weight per day in fish, squid, molluscs and crustaceans. No estimates of the volume of seal faeces passed per day were available, though it is reasonable to assume that what is ingested and not assimilated in the gut must also pass. Assuming 6% of a median body weight for harbour seals of 110kg, that would equate to 6.6kg consumed per day and probably very nearly that defecated.

The concentration of *E. coli* and other faecal indicator bacteria contained in seal faeces has been reported as being similar to that found in raw sewage, with counts showing up to 1.21×10^4 CFU (colony forming units) *E. coli* per gram dry weight of faeces (Lisle *et al* 2004).

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

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

Cetaceans

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

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

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

Birds

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

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

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

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

Deer

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

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

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

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

Other

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

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

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2. Tables of Typical Faecal Bacteria Concentrations

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

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

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

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

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

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

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

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

Source: (Gauthier & Bedard, 1986)

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3. Hydrographic Assessment Glossary

The following technical terms may appear in the hydrographic assessment.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4. Shoreline Survey Report

Shoreline Survey Report

Report Title	Meikle Craigs, Troon and Prestwick, Shoreline Survey Report
Project Name	Shellfish Sanitary Surveys
Client/Customer	Cefas
SRSL Project Reference	00561_B0067

Document Number	B0067_Shoreline 0032

Revision History

Revision	Changes	Date
A	Issue for internal review	12/06/2014
B	Second issue for internal review	18/06/2014
01	First formal issue to Cefas	03/07/2014
02	Revision following receipt of comments on v01	23/07/2014
03	Third formal issue incorporating comment from issue 02	25/07/2014
04	Fourth issue with corrections from issue 03	01/08/2014

	Name & Position	Date
Author	Peter Lamont, Colin Abernethy	06/06/2014
Checked	John Hausrath	23/07/2014
Approved	Andrea Veszelovszki	01/08/2014

This report was produced by SRSL for its Customer for the specific purpose of providing a shoreline survey report for Meikle Craigs, Ayrshire, as per the Customer's requirements. This report may not be used by any person other than SRSL's Customer without its express permission. In any event, SRSL 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.

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

Production area: Meikle Craigs
Site name: Meikle Craigs
SIN: SA-643-1316-16
Species: Razor clam, *Ensis ensis*
Harvester: Alan Forbes
Local Authority: Ayrshire
Status: Existing area
Date Surveyed: 3rd and 4th June 2014
Surveyed by: Peter Lamont, Colin Abernethy
Existing RMP: The RMZ (Routine Monitoring Zone) is bounded by lines drawn between NS3370 2776, NS3401 2737, NS3416 2679, NS3406 2677, NS3391 2733, NS3361

Area Surveyed: The coastline between Ayr, Saltpans Road (N Ayr) and S Troon, Titchfield Road, was surveyed in three sections.

Two sections were surveyed on Tuesday 3rd June: Saltpans Road to Woodfield, (N Ayr) and, Troon (Titchfield Road) to Meikle Craigs rocks (off Royal Troon Golf Course). The third, middle section was surveyed on Wednesday 4th from the mouth of the Pow Burn (off St.Andrews Holiday/Caravan Park) to Bell Rock (off St. Nicholas Golf Club, Maryborough Road, Ayr).

Weather

The preceding two days to the survey were dry in the area with some light rain in the early hours of Tuesday and Wednesday prior to the shore surveys.

Tuesday 3rd June started with full cloud cover clearing around 09:30 with full sunshine for the duration. Winds were light with wind speed recorded at 11 knots westerly with a sea state 3 (Slight).

Wednesday 4th again preceded with some light rain overnight but was dry during the day until the end of the survey with about 60% cloud cover at the start. Wind was absent with an almost flat, calm sea state 0. Low tide was in the morning with the tide coming in as the shore surveys were conducted.

Stakeholder engagement during the survey

The harvester Mr Alan Forbes was contacted before the survey and informed when the survey team would be in the area. Initially agreeing to meet the team, he was unfortunately unavailable during the visit.

The sampling officer, Martin Scott, met the team at the end of the second survey day, Wednesday 4th June. He informed the team that the harvester, as

a normal procedure, depurated the shellfish in a facility at Portencross (Farland Head, N Ayrshire).

Fishery

The fishery is for the razor clam *Ensis ensis* and these are collected by divers and rock salt is being used to encourage the animals from their burrows. Consequently the fishery area is limited to seaward by safe dive depth, in practice about 50 m water depth. The team were informed by the sampling officer that the harvester harvested all year round, there being no closed season. At the time of the survey the harvester had stopped operations for two or three months to permit recovery of the fishery. No razor clam shellfish samples were available from the harvester or live animal burrows observed by the team at low water although dead razor shells were occasionally seen and no suitable sized mussels or cockles were found during the shore survey for sampling, although many small mussels (<2 cm length) were seen.

Sewage Sources

The area is densely populated with the villages of Troon, Prestwick and Ayr bordering the survey shore. Almost half of the eight kilometres of shoreline is bordered by roadway or council maintained, pedestrian esplanade and the remainder by sand dunes backing onto golf courses.

The towns are served by municipal sewage schemes and no private discharges were observed. A private discharge was indicated on the survey plan opposite the Marine Hotel, Troon, but this could not be found by the team. Four other private discharges were indicated on the map south of the shore survey section in Ayr. These lie in a restricted dockside beyond the planned survey shore which the team could not access.

An exposed section of pipe was seen inland from the beach by Pow Burn and observed to be connected to the St. Andrews SPS (marked as "St. Andrews Caravan Park PS EO" on the survey map). It was found by the team to be leaking and was sampled separately (Fig. 17, waypoint 38). The emergency overflow (EO) appeared not to be running during the time of the team visit (no sound of flowing water through the steel pipe).

In Ayr, upstream and downstream on either side of New Bridge (carrying the A719 along New Bridge Street) the River Ayr is bounded by a one metre diameter metal sewer pipe (Fig. 8) covered in green algae. The gap between the pipe and the built bankside is formed by gabions in-filled with large, irregular rocks of uniform graded size. A resident informed the team that a municipal sewer pipe ran underneath the river about 300 m west (downstream) of the bridge.

The terminal ends of the three Combined Sewage Overflows (CSOs) indicated on the survey plan were submerged offshore during the survey. The Ayr PS EO (pumping station emergency overflow) was visited by the team but was not operational at the time of the visit (Fig. 7).

The southern shore survey section from Saltpans Road to Woodfield is backed by industrial premises while immediately to the south and inland of the dock lies the North Harbour Industrial Estate with a large number of active commercial premises (south of waypoint 13, Fig. 3). The north surveyed section has a residential part of the town above the waterfront of Troon South Sands Beach (east of waypoints 22, 23 and 24, Fig. 1) while about one fifth of the central shore section is backed by a residential area of Prestwick (east of waypoint 57, Fig. 2). Elsewhere on the shore survey sections the shore was backed by sand dunes and golf courses.

The popular public beaches of Troon, Prestwick and Ayr are regularly cleared by the local council using tractor towed surf rakes (Fig. 19). This equipment is capable of removing seaweed, flotsam, other litter and also dog faeces from large areas leaving the sand surface uniformly raked (Fig. 11). One Council operator informed the team that the debris accumulated in the collection hopper would be assessed for either recycling at the composting and recycling centre operated by South Ayrshire Council, or for burying in the dunes to aid regeneration of the dune vegetation. The decision to bury is left to the operator to assess and depends on the amount of inorganic content (chiefly plastic litter). One public notice stated that this, and other restoration methods to stabilise the dunes, were funded by the South Ayrshire Council, the Lottery, Fresh Futures and South Ayrshire Waste and Environment Trust (Fig. 12).

Seasonal Population

Local information was that the static vans at St. Andrews caravan Park by Prestwick Airport, (Fig 13), were mainly owner-occupied vans with some limited space for touring caravans and camping. The team observed that hotels and guest houses seem to predominate over bed and breakfast accommodation. During the survey the esplanades and beaches, especially near the towns, were in continuous use for leisure activities while the weather was dry, sunny and mainly warm.

Dog walkers were seen on the shores throughout the survey (Fig. 18). The team observed a professional dog walker’s vehicle at one car park and on another occasion five people in two groups were observed with 14 dogs altogether on the sand by the sea. Council maintained dog mess bins were situated at each of the car parks visited by the team and there were also notices to encourage dog owners to clear up after their animals (Figs. 14 and

20). The team observed only one set of dog faeces on the sand (in the dunes).

Boats/Shipping

Although there is a large marina in Troon immediately north of the surveyed shore, and eight moored yachts were observed in the Ayr River (Fig. 10), no leisure boats were observed on the water off the surveyed shore. A sailing club is present in Prestwick close to waypoint 58.

Two large, bulk carrier merchant ships were observed moored offshore but later in the survey period only one remained. The shore survey sections did not contain any piers or other suitable anchorage for smaller boats as the nearshore waters consist of shallow, shelving sands in between the gently shelving bedrock outcrops such as Meikle Craigs and Bell rock.

The P&O operated catamaran ferry was observed leaving Troon during the survey, heading for Ireland. The P&O terminal and Troon marina lie less than one kilometre north of the Troon survey section.

Farming and Livestock

Twelve grazing dairy cows were observed in a field adjacent to St. Andrews Caravan Park and these were the only livestock seen by the team (waypoint 33).

Land Use

The towns of Troon and Prestwick, where they are next to the shore, consist of urban residential accommodation while at Ayr the North Harbour Industrial Estate lies just inland from the shore and dock. This seemed to the team an actively busy area with many viable commercial premises.

Golf courses dominate the remaining land behind the beaches with a belt of sand dunes being more extensive west of St. Andrews Caravan Park between Troon and Prestwick. Only one field of twelve cows were observed beside the caravan park.

The dunes are actively managed and stabilised on the upper shore by gabions, notably along the top of the shore south of Troon bordering the Marine Hotel and Royal Troon Golf Course grounds. This management is by the South Ayrshire Waste and Environment Trust according to information notices on one esplanade.

Within half a kilometre of the shore all land was either built urban environment, sand dunes, golf course or industrial or derelict ex-industrial land.

Land Cover

The urban built environment of the towns of Troon, Prestwick and Ayr dominate the coastal hinterland with long-established golf courses bordering the beaches behind sand dunes. The dunes have typical specialised grasses such as marram (*Ammophila arenaria*) and are actively managed by planting and other methods to improve stabilisation (information from notices, e.g. Fig. 12, council worker and observation). Mature trees are absent near the shores and small areas of woodland are restricted mainly to the area inland between Troon and Prestwick.

Watercourses

There are only two flowing watercourses between Troon and Ayr, the Pow Burn flowing past St. Andrew's Caravan Park, Fig. 15, and Ayr River in the centre of the town, Fig. 9, where it is tidal. The Pow Burn is joined by the Rumbling Burn, a smaller stream with tributaries flowing from the villages of Symington, Frognal and Monkton.

At the time of the team visit in June, rainfall had been light and the flow in both burns was low. Elsewhere the team observed altogether ten drainage pipes emerging from beneath roads or the public esplanade or the beach with some flow in eight of these (assumed to be surface water).

Two old outfall pipes at the start of the south section Woodfield to Saltpans Road (Waypoint 6) and also just north of the Marine Hotel (Waypoint 25) had some flow appearing to be land runoff and were sampled and measured.

All other small watercourses, either open burns or issuing from pipes, had no apparent sediment loading, colour or smell.

Wildlife/Birds

Seabirds were observed in large numbers, other birds were observed in small numbers. On the south shore survey section one wagtail and a pair of rock pipits were seen feeding among the gravel on the upper shore. At Troon South Beach car park in Titchfield Road there were several rooks probing the grass or perched on the seawall. A pair of carrion crows was observed searching shore debris for food below the Prestwick Esplanade PS CSO. A small flock of less than 20 starlings was seen in managed vegetation (*Rosa rugosa*) on the seaward side of Troon South Beach esplanade as the team returned to their vehicle. Seabirds consisted of mainly common gull with a flock of over 200 seen at the south of the Pow Burn mouth on the second survey day (Fig. 21). This end of the beach is less frequented by dog walkers because it is bounded by the burn and remote from the nearest car park. The resting birds in were disturbed by the team approaching to take a seawater

sample. In the Ayr River near New Bridge the team observed one black guillemot, a cormorant and about six gulls. One pair of swans and then a single bird were seen by waypoints 49 and 6, off Prestwick Sands. A small number of swallows were observed but never more than a pair, e.g. at waypoint 57.

No mammals were observed however a resident of Ayr informed the team that he had seen an otter downstream of New Bridge prior to the survey, though no specific date was mentioned. The team did observe a possible otter spraint or fox dropping by a concrete pipe (Fig. 16) issuing into the Pow Burn at its confluence with Rumbling Burn.

Specific observations made during the survey are mapped in Figures 1, 2 and 3 and listed in Table 1. Water samples were collected at the locations marked on Figures 4, 5 and 6. Bacteriology results are given in Table 2. No shellfish samples were possible and therefore no results are presented.

Figure 1. Meikle Craigs waypoints, northern section

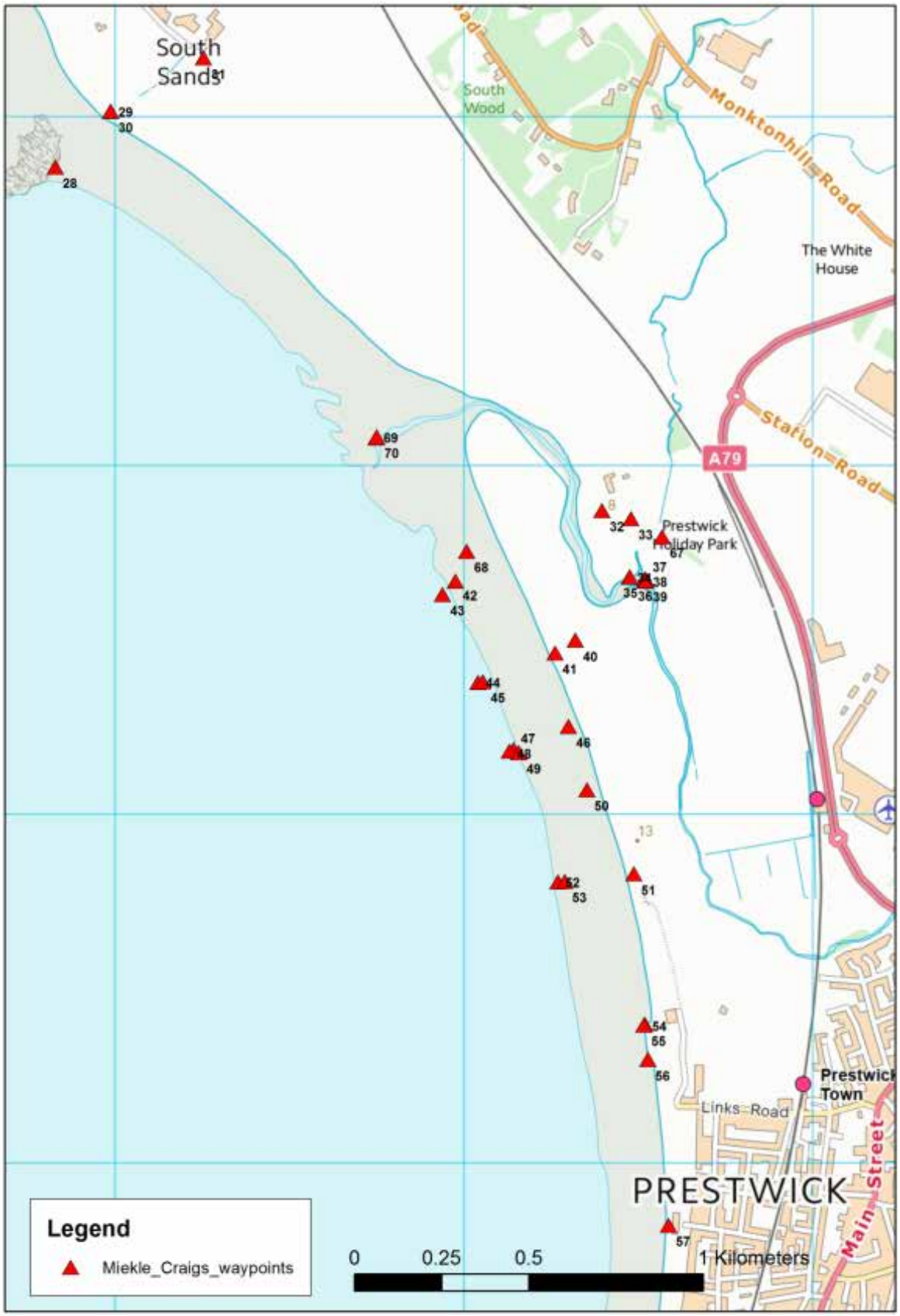

Figure 2. Meikle Craigs waypoints, mid-section

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Figure 3. Meikle Craigs waypoints, southern section

Figure 4. Meikle Craigs samples, northern section

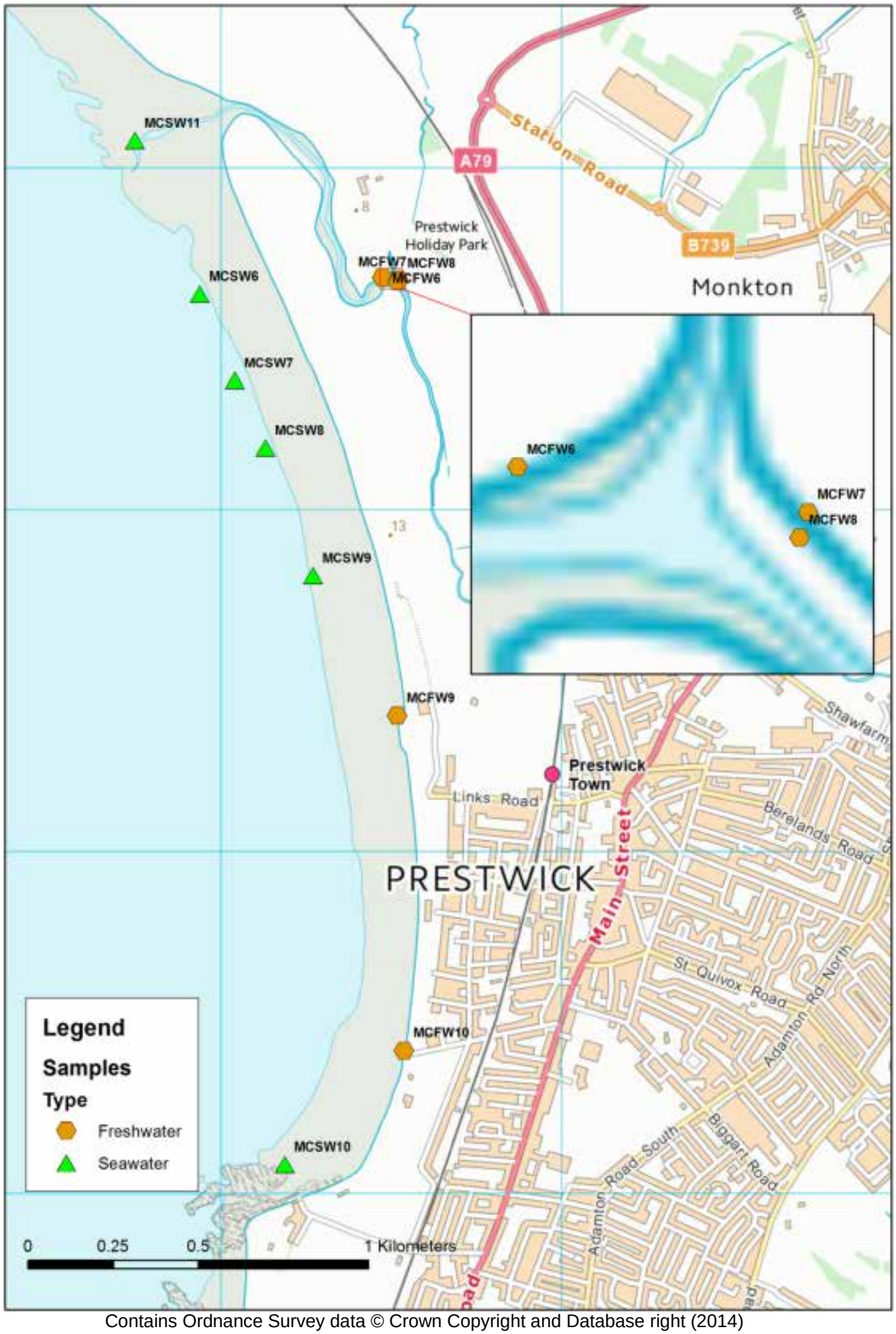

Figure 5. Meikle Craigs samples, mid-section

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Figure 6. Meikle Craigs samples, southern section.

No.	Date	Time	NGR Position	East	North	Associated photograph	Associated sample	Description
1	03/06/2014	8:10	NS 34070 23943	234071	623944			Start of shore survey south section at Saltpans Road, Ayr.
2	03/06/2014	8:19	NS 34029 23954	234029	623955		MCSW1	Planned seawater sample near old iron outfall pipe.
3	03/06/2014	8:21	NS 34023 23954	234023	623955			Seawater sample taken beside old outfall pipe – it ends underwater.
4	03/06/2014	8:27	NS 34058 23936	234058	623936			Deliberately cut break in old iron outfall pipe near shore with water flowing.
5	03/06/2014	8:30	NS 34060 23935	234061	623935		MCFW1	Unplanned freshwater sample from flowing top section of old outfall pipe. Sample associated with waypoint 6.
6	03/06/2014	8:31	NS 34061 23935	234061	623935			Outflow from old iron pipe appears clean. Pipe downstream of square hole blocked with sand and appears out of use. Flow: width 0.5 m, depth 8 cm, flow rate 0.281 m/s SD 0.012.
7	03/06/2014	8:41	NS 34017 23748	234018	623749		MCFW2	Unplanned freshwater sample. Sample associated with waypoint 8.
8	03/06/2014	8:41	NS 34017 23749	234017	623750			Concrete pipe protruding from beneath road with water flowing. Diameter 60 cm, water width 25 cm, depth in middle 2 cm, flow rate 2.171 m/s SD 0.298. SD high because of very shallow flow. Photographed on return walk.
9	03/06/2014	9:04	NS 33846 23331	233846	623332			Wildlife - 1 wagtail and two rock pipits feeding.
10	03/06/2014	9:06	NS 33812 23276	233812	623277			Winkles numerous on rocks. Clumps of small mussels but too small for a sample.
11	03/06/2014	9:16	NS 33722 23184	233722	623185		MCSW2	Planned seawater sample two.
12	03/06/2014	9:19	NS 33751 23167	233751	623168	Fig. 7		Outfall pipe terminus at Saltpans Road. Large rubber end cap measuring 2.8 m in height designed to open with flow pressure. Pipe diameter 2 m. No flow from pipe.
13	03/06/2014	9:24	NS 33751 23191	233752	623192			End of shore survey Saltpans Road, Ayr, Meikle Craigs south section.
14	03/06/2014	10:06	NS 33700 22179	233700	622179	Fig. 8	MCFW3	Planned freshwater sample from River Ayr. Sample associated with waypoint 15.

No.	Date	Time	NGR Position	East	North	Associated photograph	Associated sample	Description
15	03/06/2014	10:08	NS 33700 22181	233700	622182	Fig. 9		Ayr River observations. Bridge with five arches and four supporting piers each of 2 m width. Arch span total measured across bridge roadway = 71 m minus four pier combined widths = 62 m maximum possible width of river flow. Flow at low tide only under two arches on survey day measured by floating stick at 10 m/min for the second south arch and 5 m/min for the adjacent third arch (no flow under the first, fourth and fifth arches). Depth measured by weighted line. All measurements and estimates for Tuesday morning 3/06/2014 at around 10:00 with low tide leaving only freshwater river flow.
15								Second arch from south end depth = 0.93 m, flow rate 10 m/min, estimated width 4.6 m. Third arch from south end depth = 0.73 m, flow rate 5 m/min, estimated width 4.6 m. Wildlife: 1 black guillemot, 1 cormorant, 6 gulls.
16	03/06/2014	10:11	NS 33701 22186	233701	622186	Fig. 10		Leisure craft, 8 sailing yachts, moored 300 m downstream of the New Bridge, Ayr.
17	03/06/2014	11:27	NS 31563 30671	231564	630672			Start of northern shore survey section Troon, Titchfield Road to Royal Troon Golf Course. Wind 6 knots with 20% cloud cover, sunny and dry. About six rooks in the car park or on the seawall.
18	03/06/2014	11:30	NS 31639 30616	231639	630616		MCSW3	Planned seawater sample three.
19	03/06/2014	11:31	NS 31639 30614	231639	630614			Seawater sample taken near square concrete installation with iron grill at terminus of outfall pipe. No flow observed from pipe on survey day
20	03/06/2014	11:42	NS 31688 30682	231688	630683			Eider duck flock consisting of one drake, five ducks and about six goslings in seawater edge amongst flat rock outcropping.
21	03/06/2014	11:45	NS 31753 30759	231754	630759			Five starlings observed feeding on the shore.

No.	Date	Time	NGR Position	East	North	Associated photograph	Associated sample	Description
22	03/06/2014	11:50	NS 32063 30756	232063	630757	Fig. 11		Extensive swept area of Troon South Sands Beach below promenade extending about 150 m to seaward from the top of the beach. Machine swept with fine lines leaving no seaweed or other fragments of debris or flotsam on the swept area.
23	03/06/2014	11:57	NS 32338 30413	232338	630414	Fig. 12		People at leisure on the beach including four dogs. Two moored tankers or ore carriers (unladen) about two or three miles offshore. Troon Sands information notice, Fig. 12, information notice above beach on esplanade, east of waypoint 23.
24	03/06/2014	12:08	NS 32615 29816	232616	629817		MCFW4	Unplanned freshwater sample from beach pipe. Sample associated with waypoint 25.
25	03/06/2014	12:09	NS 32615 29816	232615	629816			Old iron pipe emerging from beach sand appearing to be land runoff. Diameter 60 cm, water width 56 cm, water depth 15 cm, flow rate 0.317 m/s, SD 0.023.
26	03/06/2014	12:27	NS 32712 29521	232713	629522			Marked private discharge point searched for but not found except for 3 m diameter uncut nettle patch inside and against the Marine Hotel fence.
27	03/06/2014	12:33	NS 32587 29349	232588	629350		MCSW4	Unplanned seawater sample at Little Craigs rock.
28	03/06/2014	12:49	NS 32828 28856	232828	628856		MCSW5	Planned seawater sample at Meikle Craigs rock.
29	03/06/2014	13:00	NS 32987 29015	232987	629015		MCFW5	Planned freshwater sample. Sample associated with waypoint 30.
30	03/06/2014	13:01	NS 32987 29016	232987	629016			Concrete pipe diameter 46 cm, water width 42 cm with uniform depth of 11 cm due to sand infilling, flow rate 0.392 m/s, SD 0.022.
31	03/06/2014	13:17	NS 33253 29168	233254	629169			End of shore survey north section, Troon South Sands at Royal Troon Golf Course buildings road end.
32	04/06/2014	8:42	NS 34395 27870	234396	627871			Start of survey route mid-section at Prestwick sands north. Sewage pumping station. Local information states that caravan park is owner occupied in the majority.

No.	Date	Time	NGR Position	East	North	Associated photograph	Associated sample	Description
33	04/06/2014	8:46	NS 34478 27847	234479	627848	Fig. 13 Fig. 14		Fig. 13, photograph of caravan park entrance (well-maintained park) approximately 150 vans. Fig. 14, notice and facilities for dog owners near to waypoint 33. Twelve cows were observed in a field adjacent to the caravan park.
34	04/06/2014	8:55	NS 34474 27679	234474	627680		MCFW6	Planned freshwater sample number 6 Pow burn.
35	04/06/2014	8:56	NS 34475 27681	234475	627681	Fig. 15		Observations: Width 11m 40cm Depth 1: 12cm Flow 1: 0.266m/s SD 0.008 Depth 2: 12cm Flow 2: 0.191m/s SD 0.006 Depth 3: 17cm Flow 3: 0.298m/s SD0.009
36	04/06/2014	9:11	NS 34521 27672	234521	627672		MCFW7	Unplanned freshwater sample number 7 from concrete pipe.
37	04/06/2014	9:13	NS 34518 27675	234518	627676	Fig. 16		Observations: Run off directly from pipe measured. Evidence of iron deposit. Dog or otter faeces lying beside pipe. Pipe width 30cm Flow width 25cm depth 10cm Flow 0.829m/s SD 0.006
38	04/06/2014	9:22	NS 34519 27668	234520	627668		MCFW8	Unplanned fresh water, contaminated sample. Sample associated with waypoint 39.
39	04/06/2014	9:23	NS 34520 27669	234520	627670	Fig. 17		Observations: Crack in pipe just prior to junction box. Leaking from bottom of pipe. Flow measured using jug and measuring time. Flow 570 millilitres in 10 sec = 3.4 L/min.
40	04/06/2014	9:36	NS 34319 27498	234319	627499			Storage container. Unknown use.
41	04/06/2014	9:39	NS 34260 27462	234261	627462			Dog faeces on path towards beach. 9 dogs visible on beach. 1 gull.
42	04/06/2014	9:48	NS 33975 27668	233975	627668			Old outflow pipe missing a section, open onto beach. Remainder of pipe intact towards sea approximately 5 metres further down shore and visible at low tide. Water is stagnant at the break point, so no sample taken.
43	04/06/2014	9:54	NS 33938 27630	233938	627631		MCSW6	Unplanned seawater sample number 6 taken near an old outfall pipe west of St. Andrews Caravan Park at north end of fishery RMZ.
44	04/06/2014	10:16	NS 34040 27377	234041	627378		MCSW7	Planned seawater number 7 at mid-point of fishery RMZ

No.	Date	Time	NGR Position	East	North	Associated photograph	Associated sample	Description
45	04/06/2014	10:17	NS 34054 27380	234055	627380			Three dogs on shore. 1 gull. No shellfish evident on shore.
46	04/06/2014	10:25	NS 34299 27252	234300	627252			Eight dogs on beach. 150 gulls just north of holiday park. 17 people on shore within survey area.
47	04/06/2014	10:32	NS 34141 27185	234142	627186			WP taken in error.
48	04/06/2014	10:34	NS 34130 27181	234130	627181		MCSW8	Unplanned seawater sample number 8.
49	04/06/2014	10:39	NS 34157 27177	234157	627177			Two swans flying, 1 common gull.
50	04/06/2014	10:46	NS 34352 27070	234352	627070	Fig. 18		Fourteen dogs on beach with 5 people.
51	04/06/2014	10:52	NS 34486 26829	234487	626829			Public CSO.
52	04/06/2014	11:08	NS 34269 26806	234269	626807		MCSW9	Planned seawater sample number 9 at south end of fishery RMZ opposite Prestwick Esplanade PS CSO.
53	04/06/2014	11:10	NS 34288 26807	234289	626808			Southern end of RMZ as on map at Prestwick Esplanade PS CSO at south end of fishery RMZ.
54	04/06/2014	11:22	NS 34517 26397	234518	626398		MCFW9	Unplanned freshwater sample number 9.
55	04/06/2014	11:22	NS 34515 26395	234516	626396			Observations for WP54. Run off from pipe running through wall at shore below public leisure facility. Flow measured by jug. Pipe width 30cm, flow width 12cm, depth 1cm, flow 250 millilitres per sec.
56	04/06/2014	11:31	NS 34526 26296	234527	626297			Disused overflow pipe.
57	04/06/2014	11:40	NS 34586 25821	234586	625822			Wildlife: 2 swallows.
58	04/06/2014	11:49	NS 34537 25417	234538	625418		MCFW10	Unplanned freshwater sample number 10. Sample associated with waypoint 59.
59	04/06/2014	11:49	NS 34537 25416	234537	625416			Observations: Pipe width 25cm, flow width 8cm, depth 1cm, flow measured by time/distance travelled 0.06m/s. Old iron outflow pipe, running from under wall to shore. One starling on shore.
60	04/06/2014	11:59	NS 34537 25410	234538	625411	Fig.19		Plastic field drain at bottom of sea wall. Fig. 19, South Ayr Council, Barber Surf Rake trailer, parked on roadside above waypoint 60.
61	04/06/2014	11:59	NS 34537 25411	234538	625412			One gull, 1 swan flying.

No.	Date	Time	NGR Position	East	North	Associated photograph	Associated sample	Description
62	04/06/2014	12:04	NS 34532 25383	234532	625383	Fig. 20		A dog and owner on beach, 7 seagulls. Fig. 20, sign on Prestwick Esplanade for dog owners south of waypoint 62.
63	04/06/2014	12:20	NS 34354 25074	234355	625074			Numerous dead cockle shells. No sign of mussels.
64	04/06/2014	12:32	NS 34187 25084	234187	625085		MCSW10	Planned seawater sample number 10 off Bentfield, Maryborough Road, Ayr.
65	04/06/2014	12:43	NS 34112 24913	234112	624913			Evidence of fires on beach, litter around it.
66	04/06/2014	12:46	NS 34077 24793	234077	624794			End of shore survey middle section, Prestwick Sands south end, Maryborough Road, Ayr.
67	04/06/2014	13:14	NS 34568 27796	234568	627796			Return to start of survey, middle section, Prestwick Sands north end.
68	04/06/2014	13:25	NS 34007 27754	234008	627754			Approximately 200 gulls on beach(around mouth of Pow Burn where next sea water sample will be taken)
69	04/06/2014	13:35	NS 33748 28079	233748	628079	Fig. 21	MCSW11	Planned seawater sample 11 from Pow Burn mouth. Fig. 21 resting birds by sample position.
70	04/06/2014	13:36	NS 33749 28082	233750	628082			End of Meikle Craigs survey.

Photographs referenced in the table can be found attached as Figures 7 to 21.

Sampling

Samples were collected as specified in the survey plan. Unplanned samples were collected where it was thought appropriate. Samples were labelled, bagged in zip lock bags and placed in a flexible insulated cool bag until the end of the shore survey for each of the two survey days. At the end of the survey each day the samples were then transferred to a Biotherm 30 box with ice packs and posted to Glasgow Scientific Services (GSS) for *E.coli.* analysis. No shellfish samples were obtained as the fishery lies below low water springs and the team were not present at a suitable low tide. No harvesting was being conducted by the harvester during the survey period as the fishery was being left fallow. Shellfish observed by the team on the shore were all too small to be acceptable for analysis.

Altogether 11 seawater and 10 freshwater samples were taken. Of these, 2 seawater and 6 freshwater samples were additional. One of the additional seawater samples was taken by an old iron outfall pipe off the St. Andrews Caravan Park (corresponding to the north end of the fishery RMZ) and the second at the Little Craigs rock, Troon South Sands, just north of the limits of the fishery. The six additional freshwater samples were taken at various pipes encountered with sufficient water flow.

The temperature of the Tuesday samples was recorded as 1.8 degrees and the Wednesday samples as 2.5 degrees on arrival at the testing laboratory on the day following collection.

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

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

Table 2. Water Sample Results

No.	Date	Sample	Grid Ref	Type	*E. coli* (cfu/100ml)	Salinity (ppt)
1	03/06/2014	MCFW1	NS 34060 23935	Freshwater	120	
2	03/06/2014	MCFW2	NS 34017 23748	Freshwater	10000	
3	03/06/2014	MCFW3	NS 33700 22179	Freshwater	470	
4	03/06/2014	MCFW4	NS 32615 29816	Freshwater	10000	
5	03/06/2014	MCFW5	NS 32987 29015	Freshwater	20	
6	04/06/2014	MCFW6	NS 34474 27679	Freshwater	550	
7	04/06/2014	MCFW7	NS 34521 27672	Freshwater	<10	
8	04/06/2014	MCFW8	NS 34519 27668	Freshwater	<1000	
9	04/06/2014	MCFW9	NS 34517 26397	Freshwater	<10	
10	04/06/2014	MCFW10	NS 34537 25417	Freshwater	20	
11	03/06/2014	MCSW1	NS 34029 23954	Seawater	26	31.8
12	03/06/2014	MCSW2	NS 33722 23184	Seawater	34	32.34
13	03/06/2014	MCSW3	NS 31639 30616	Seawater	3	31.43
14	03/06/2014	MCSW4	NS 32587 29349	Seawater	1	31.07
15	03/06/2014	MCSW5	NS 32828 28856	Seawater	10	30.89
16	04/06/2014	MCSW6	NS 33938 27630	Seawater	12	30.17
17	04/06/2014	MCSW7	NS 34040 27377	Seawater	6	29.99
18	04/06/2014	MCSW8	NS 34130 27181	Seawater	9	29.63
19	04/06/2014	MCSW9	NS 34269 26806	Seawater	6	30.89
20	04/06/2014	MCSW10	NS 34187 25084	Seawater	0	31.62
21	04/06/2014	MCSW11	NS 33748 28079	Seawater	57	24.21

Salinity Profiles

No boat work was required and therefore no CTD salinity profiles were taken in the water over the fishery by the team.

Photographs

Figure 7. Ayr PS EO terminus south of Saltpans Road. Waypoint 12.

Figure 8 New Bridge Ayr from south bank. Site of planned freshwater sample MCFW3, with elevated main sewer pipe (covered in green algae) bordering both banks, Waypoint 14.

Figure 9 New Bridge Ayr at low water Tuesday 3rd June 2014 from the north bank. Associated with Waypoint 15.

Figure 10 Leisure craft moored in the River Ayr downstream (west) of New Bridge. Taken from Waypoint 16.

Figure 11 Troon South Beach sands freshly raked by South Ayr Council. Associated with Waypoint 22.

Figure 12 Troon South Sands beach esplanade information notice.
East of Waypoint 23.

Figure 13 St. Andrews Caravan Park entrance and reception office. Waypoint 33.

Figure 14 Typical provision for dog walkers at the entrance to Prestwick Golf Club at the approach to the north end of Prestwick sands. Near to Waypoint 33.

Figure 15 Pow Burn below confluence with Rumbling Burn. Site of freshwater sample MCFW6. Waypoint 35.

Figure 16 Concrete pipe with runoff just upstream of Pow and Rumbling Burns' confluence. Faeces left of pipe mouth. Site of unplanned freshwater sample MCFW7, Waypoint 36.

Figure 17 Inspection junction in pipe (leaking) connecting with St. Andrews Caravan Park PS EO. Location of unplanned freshwater sample MCFW8, Waypoint 39.

Figure 18 Dogs and walkers on Prestwick sands. Waypoint 50.

Figure 19 Tractor towed Barber Surf Rake operated by South Ayr Council beside Prestwick Sailing Club. Near to Waypoint 57.

Figure 20 South Prestwick sands esplanade pavement sign. South of Waypoint 62.

Figure 21 Pow Burn mouth at Prestwick Sands north with resting gull flock. Associated with planned seawater sample MCSW11. Waypoint 69.

5. Intermittent Sewage Discharges

Licence number	Location	Discharge Name	Discharge Type	Discharging to
CAR/L/1003418	NS 40035 23374	Annbank STW CSO	Sewage (Public) Combined Sewer Overflow (CSO)	River Ayr
CAR/L/1003350	NS 33579 23368	Ayr PS	Sewage (Public) Combined Sewer Overflow (CSO)	Firth of Clyde
CAR/L/1000629	NS 33664 19461	Belleisle Golf Club CSO	Sewage (Public) Combined Sewer Overflow (CSO)	Slaphouse Burn
CAR/L/1000628	NS 33891 22154	George street CSO,	Sewage (Public) Combined Sewer Overflow (CSO)	Rumbling Burn
CAR/L/1003397	NS 34565 21276	Holmston Storm Tank CSO	Sewage (Public) Combined Sewer Overflow (CSO)	River Ayr
CAR/L/1010995	NS 38200 29900	Private Storm Sewage Overflow	Sewage (Private) Combined Sewer Overflow (CSO)	Pow Burn
CAR/L/1026135	NS 3268 3194	Mapel Grove PS Troon CSO	Sewage (Public) Combined Sewer Overflow (CSO)	Firth of Clyde
CAR/L/1033972	NS 33030 31866	Marr Screening Chamber CSO	Sewage (Public) Combined Sewer Overflow (CSO)	Darley Burn
CAR/L/1026135	NS 30650 31220	Harbour PS, CSO	Sewage (Public) Combined Sewer Overflow (CSO)	Firth of Clyde
CAR/L/1026135	NS 31808 23805	Shore Road CSO	Sewage (Public) Combined Sewer Overflow (CSO)	Firth of Clyde
CAR/L/1026135	NS 33030 31866	Marr Screening Chamber CSO	Sewage (Public) Combined Sewer Overflow (CSO)	Darley Burn
CAR/L/1026135	NS 33664 19461	Belleisle Golf Club CSO	Sewage (Public) Combined Sewer Overflow (CSO)	Slaphouse Burn
CAR/L/1026135	NS 33804 27781	St Andrews Caravan Park PS CSO	Sewage (Public) Combined Sewer Overflow (CSO)	Firth of Clyde
CAR/L/1026135	NS 33891 22154	George street CSO	Sewage (Public) Combined Sewer Overflow (CSO)	Rumbling Burn
CAR/L/1026135	NS 34191 26819	Prestwick Esplanade PS CSO	Sewage (Public) Combined Sewer Overflow (CSO)	Firth of Clyde
CAR/L/1026135	NS 34565 21276	Holmston Storm Tank CSO	Sewage (Public) Combined Sewer Overflow (CSO)	River Ayr
CAR/L/1026135	NS 35188 26653	Kirk Street storm tank SSO	Sewage (Public) Combined Sewer Overflow (CSO)	Pow Burn
CAR/L/1026135	NS 35188 26653	Kirk Street CSO	Sewage (Public) Combined Sewer Overflow (CSO)	Pow Burn
CAR/L/1026135	NS 35224 19637	Dalmellington Road CSO	Sewage (Public) Combined Sewer Overflow (CSO)	Annfield Burn
CAR/L/1026135	NS 37215 24005	St Quivox CSO	Sewage (Public) Combined Sewer Overflow (CSO)	U/N W/C
CAR/L/1026135	NS 37402 25514	Ladykirk Burn CSO	Sewage (Public) Combined Sewer Overflow (CSO)	Ladykirk Burn
CAR/L/1003419	NS 34191 26819	Prestwick Esplanade PS	Sewage (Public) Combined Sewer Overflow (CSO)	Firth of Clyde
CAR/L/1000673	NS 35188 26653	Kirk Street CSO	Sewage (Public) Combined Sewer Overflow (CSO)	Pow Burn
CAR/L/1003350	NS 31513 19818	Shore Road Greenan PS	Sewage (Public) Emergency Overflow (EO)	Firth of Clyde
CAR/L/1003350	NS 33575 23356	Ayr PS, EO	Sewage (Public) Emergency Overflow (EO)	Firth of Clyde
CAR/L/1003350	NS 33700 23200	Ayr PS, EO	Sewage (Public) Emergency Overflow (EO)	Firth of Clyde
CAR/L/1003350	NS 33800 24000	Ayr PS, EO	Sewage (Public) Emergency Overflow (EO)	Firth of Clyde

Licence number	Location	Discharge Name	Discharge Type	Discharging to
CAR/L/1000672	NS 35188 26653	Pow Burn PS EO	Sewage (Public) Emergency Overflow (EO)	Pow Burn
CAR/L/1010995	NS 38276 29726	Hansel Village EO	Sewage (Private) Emergency Overflow (EO)	Pow Burn
CAR/L/1010995	NS 38300 29700	Private Emergency Overfow	Sewage (Private) Emergency Overflow (EO)	Pow Burn
CAR/L/1026135	NS 3268 3194	Mapel Grove PS Troon EO	Sewage (Public) Emergency Overflow (EO)EO	Firth of Clyde
CAR/L/1026135	NS 30650 31220	Harbour PS, EO	Sewage (Public) Emergency Overflow (EO)	Firth of Clyde
CAR/L/1026135	NS 31513 19818	Shore Road Greenan PS, EO	Sewage (Public) Emergency Overflow (EO)	Firth of Clyde
CAR/L/1026135	NS 31849 31564	Pan Rocks PS, EO	Sewage (Public) Emergency Overflow (EO)	North Bay
CAR/L/1026135	NS 32150 31380	Pan Rocks PS, EO	Sewage (Public) Emergency Overflow (EO)	Firth of Clyde
CAR/L/1026135	NS 32180 31420	Pan Rocks PS, EO	Sewage (Public) Emergency Overflow (EO)	North Bay
CAR/L/1026135	NS 33015 18054	Cambusdoon PS, EO	Sewage (Public) Emergency Overflow (EO)	River Ayr
CAR/L/1026135	NS 33575 23356	Ayr PS, EO	Sewage (Public) Emergency Overflow (EO)	Firth of Clyde
CAR/L/1026135	NS 33700 23200	Ayr PS, EO	Sewage (Public) Emergency Overflow (EO)	Firth of Clyde
CAR/L/1026135	NS 33800 24000	Ayr PS, EO	Sewage (Public) Emergency Overflow (EO)	Firth of Clyde
CAR/L/1026135	NS 33804 27781	St. Andrews PS, EO	Sewage (Public) Emergency Overflow (EO)	Rumbling Burn
CAR/L/1026135	NS 34460 26819	Prestwick Esplanade PS, EO	Sewage (Public) Emergency Overflow (EO)	Firth of Clyde
CAR/L/1026135	NS 34541 27810	St Andrews Caravan Park PS, EO	Sewage (Public) Emergency Overflow (EO)	Rumbling Burn
CAR/L/1026135	NS 35188 26653	Pow Burn PS, EO	Sewage (Public) Emergency Overflow (EO)	Pow Burn
CAR/L/1026135	NS 35539 21288	Holmston PS, EO	Sewage (Public) Emergency Overflow (EO)	River Ayr
CAR/L/1026135	NS 35707 21121	Holmston PS No 1, EO	Sewage (Public) Emergency Overflow (EO)	U/T of River Ayr
CAR/L/1026135	NS 37434 27572	Brieryside PS, EO	Sewage (Public) Emergency Overflow (EO)	Pow Burn
CAR/L/1003420	NS 34460 26819	Prestwick Esplanade PS, EO	Sewage (Public) Emergency Overflow (EO)	Firth of Clyde

6. Other consented discharges

Licence No.	NGR	Site Name	Treatment type	Discharges to	MDF m3/d	DMF m3/d	PE
CAR/R/1009282	NS 38891 29520	Dwelling	Sewage (Private) Primary	Underwood Burn			7
CAR/R/1013493	NS 39113 21969	Dwelling, Auchincruive	Sewage (Private) Primary	U/T of River Ayr			5
CAR/R/1013586	NS 37370 27410	Dwelling, Monkton	Sewage (Private) Primary	soakaway			5
CAR/R/1015698	NS 39401 21999	Dwelling, Auchincruive	Sewage (Private) Primary	River Ayr			5
CAR/R/1016080	NS 38320 24150	Dwelling, Auchincruive	Sewage (Private) Primary	U/N W/C			5
CAR/R/1016398	NS 36604 31223	Dwelling, Corraith	Sewage (Private) Primary	Rumbling Burn			7
CAR/R/1016508	NS 33279 18704	4 Dwellings, Alloway	Sewage (Private) Primary	soakaway			20
CAR/R/1016545	NS 35406 31407	2 Dwellings, Loans	Sewage (Private) Primary	soakaway			14
CAR/R/1017666	NS 35997 29449	Dwelling, Prestwick	Sewage (Private) Primary	U/T of Rumbling Burn			5
CAR/R/1018107	NS 36040 20460	Dwelling	Sewage (Private) Primary	soakaway			6
CAR/R/1018856	NS 35330 30680	Dwelling, Troon	Sewage (Private) Primary	soakaway			5
CAR/R/1019286	NS 35606 30471	2 Dwellings, Loans	Sewage (Private) Primary	U/T of Rumbling Burn			10
CAR/R/1019614	NS 38282 20839	Dwelling, Belston	Sewage (Private) Primary	U/T of River Ayr			5
CAR/R/1019782	NS 39134 27651	Dwelling,Monkton	Sewage (Private) Primary	soakaway			6
CAR/R/1020012	NS 38720 27540	Dwelling, Monkton	Sewage (Private) Primary	soakaway			11
CAR/R/1020424	NS 39500 27520	Dwelling, Monkton	Sewage (Private) Primary	soakaway			6
CAR/R/1020427	NS 39770 26890	Dwelling, Monkton	Sewage (Private) Primary	soakaway			5
CAR/R/1021251	NS 38870 20620	Dwelling, Potterhill	Sewage (Private) Primary	soakaway			5
CAR/R/1023471	NS 38208 23873	Dwelling, Auchincruive	Sewage (Private) Primary	soakaway			5
CAR/R/1024038	NS 36036 29592	Dwelling, Monkton	Sewage (Private) Primary	soakaway			5
CAR/R/1024898	NS 32714 18622	5 Dwellings	Sewage (Private) Primary	soakaway			17
CAR/R/1028998	NS 38340 20410	Dwelling	Sewage (Private) Secondary	Field Drain			6
CAR/R/1031406	NS 38650 28950	Dwelling, Monkton	Sewage (Private) Primary	soakaway			5
CAR/R/1035607	NS 37412 25513	Dwelling Sandyford	Sewage (Private) Primary	Ladykirk Burn			16
CAR/R/1040471	NS 33380 22910	Business	Sewage (Private) Primary	River Ayr			25
CAR/R/1040480	NS 33240 22770	Business	Sewage (Private) Primary	River Ayr			5

Licence No.	NGR	Site Name	Treatment type	Discharges to	MDF m3/d	DMF m3/d	PE
CAR/R/1040495	NS 33205 22659	Business	Sewage (Private) Primary	River Ayr			5
CAR/R/1040496	NS 33240 22620	Business	Sewage (Private) Primary	River Ayr			10
CAR/R/1040497	NS 33245 22609	Business	Sewage (Private) Primary	River Ayr			5
CAR/R/1040825	NS 38828 21892	Dwelling, Auchincruive	Sewage (Private) Primary	soakaway			10
CAR/R/1048864	NS 39030 21050	Dwelling, Potterhill	Sewage (Private) Primary	soakaway			6
CAR/R/1049506	NS 33850 19720	Dwelling, Ayr	Sewage (Private) Primary	Land			5
CAR/R/1050518	NS 35410 21214	Dwelling, Ayr	Sewage (Private) Primary	River Ayr			5
CAR/R/1050827	NS 36883 23160	Dwelling, Ayr	Sewage (Private) Primary	U/N W/C			5
CAR/R/1051252	NS 32705 29492	Dwelling	Sewage (Private) Primary	South Bay			5
CAR/R/1052612	NS 39963 27163	Dwelling, Tarbolton	Sewage (Private) Primary	Raith Burn			5
CAR/R/1061226	NS 37560 23930	Dwelling, St. Quivox	Sewage (Private) Primary	soakaway			7
CAR/R/1063155	NS 33737 29872	Dwelling, Troon	Sewage (Private) Primary	soakaway			6
CAR/R/1063166	NS 38692 23934	Dwelling, Auchincruive	Sewage (Private) Primary	soakaway			5
CAR/R/1063202	NS 39051 24099	Dwelling, Auchincruive	Sewage (Private) Primary	U/T of River Ayr			5
CAR/R/1068064	NS 33914 29922	Dwelling, Troon	Sewage (Private) Primary	soakaway			8
CAR/R/1070885	NS 36782 20857	Dwelling, Ayr	Sewage (Private) Primary	soakaway			6
CAR/R/1070895	NS 37150 21100	Dwelling, Ayr	Sewage (Private) Primary	soakaway			7
CAR/R/1071059	NS 37615 20698	Dwelling, Ayr	Sewage (Private) Primary	U/T of River Ayr			5
CAR/R/1071073	NS 37561 28697	Dwelling, Monkton	Sewage (Private) Primary	Pow Burn			5
CAR/R/1050483	NS 39953 27788	Farm, Mauchline	Sewage (Private) Primary	Soakaway			10
CAR/R/1071132	NS 37529 28619	Dwelling, Monkton	Sewage (Private) Primary	Pow Burn			5
CAR/R/1071782	NS 39679 25165	Dwelling, Mossblown	Sewage (Private) Primary	soakaway			5
CAR/R/1071825	NS 39701 25234	Dwelling, Mossblown	Other Effluent	soakaway	5		30
CAR/R/1072267	NS 38767 21497	Dwelling, Auchincruive	Sewage (Private) Primary	U/T of River Ayr			6
CAR/R/1072873	NS 37676 24444	Dwelling, Prestwick	Sewage (Private) Primary	U/N W/C			6
CAR/R/1072996	NS 34750 29160	Dwelling, Monktonhill	Sewage (Private) Primary	soakaway			7
CAR/R/1073026	NS 34876 29231	2 Dwellings, Monktonhill	Sewage (Private) Primary	soakaway			10
CAR/R/1073122	NS 34658 29159	Dwelling, Monktonhill	Sewage (Private) Primary	soakaway			5

Licence No.	NGR	Site Name	Treatment type	Discharges to	MDF m3/d	DMF m3/d	PE
CAR/R/1073129	NS 34567 29169	2 Dwellings, Monktonhill	Sewage (Private) Primary	soakaway			10
CAR/R/1073456	NS 37614 20703	Dwelling, Ayr	Sewage (Private) Primary	U/T of River Ayr			5
CAR/R/1080675	NS 36718 20670	Dwelling, Ayr	Sewage (Private) Primary	U/T of River Ayr			6
CAR/R/1082163	NS 34574 28492	Dwelling, Southwood	Sewage (Private) Primary	Rumbling Burn			5
CAR/R/1085788	NS 36343 18623	Dwelling, Ayr	Sewage (Private) Primary	soakaway			5
CAR/R/1092569	NS 36690 30570	Dwelling, Symington	Sewage (Private) Primary	soakaway			10
CAR/R/1092646	NS 33990 29760	2 Dwellings, Troon	Sewage (Private) Primary	soakaway			10
CAR/R/1095023	NS 37980 20470	Dwelling, Ayr	Sewage (Private) Primary	soakaway			5
CAR/R/1101066	NS 39123 21942	Dwelling, Auchincruive	Sewage (Private) Primary	U/T of River Ayr			5
CAR/R/1106832	NS 37084 29235	2 Dwellings, Monkton	Sewage (Private) Primary	Dow's Burn			10
CAR/R/1108333	NS 37410 21610	Dwelling, Mainholm	Sewage (Private) Primary	soakaway			5
CAR/R/1108390	NS 39170 20920	Dwelling, Potterhill	Sewage (Private) Primary	soakaway			5
CAR/R/1108711	NS 38871 27088	Dwelling, Prestwick	Sewage (Private) Primary	Raith Burn			5
CAR/R/1108801	NS 33918 29883	Dwelling, Troon	Sewage (Private) Primary	soakaway			7
CAR/R/1110249	NS 36717 20676	2 Dwellings, Ayr	Sewage (Private) Primary	U/N W/C			10
CAR/R/1111597	NS 37877 22294	Dwelling, Mainholm	Sewage (Private) Primary	River Ayr			6
CAR/R/1114384	NS 37347 24149	Buisiness, Ayr	Sewage (Private) Primary	U/T of Ladykirk Burn			7
CAR/R/1114794	NS 36088 29786	Dwelling, Prestwick	Sewage (Private) Untreated	soakaway			5
CAR/R/1117052	NS 38249 20322	Dwelling, Ayr	Sewage (Private) Primary	U/N W/C			10
CAR/S/1020794	NS 39351 22040	Dwelling, Auchincruive	Sewage (Private) Primary	Land	5.8	5.8	29
CAR/S/1026489	NS 40260 25200	Dwelling, Mossblown	Sewage (Private) Primary	soakaway			45
CAR/S/1033474	NS 40263 26093	3 Dwellings, Annbank	Sewage (Private) Secondary	Ladykirk Burn	3.2	3.2	16
CAR/R/1014068	NS 32435 18588	Mount Charles Weir, Alloway	Fish Farm Freshwater Tank or Hatchery	River Doon			
RSA/A/1032298	NS 38100 23400	Avanticell Science, Auchincruive	Radioactive Substance Authorisation				
CAR/L/1000690	NS 35811 26716	Prestwick Airport Outfall 3	Surface Water (Other) Commercial, Ind & Other	Pow Burn			
CAR/L/1000759	NS 35818 26789	Prestwick Airport Outfall 1	Surface Water (Other) Commercial, Ind & Other				

Licence No.	NGR	Site Name	Treatment type	Discharges to	MDF m3/d	DMF m3/d	PE
CAR/L/1000760	NS 35792 26609	Prestwick Airport Outfall 4	Surface Water (Other) Commercial, Ind & Other				
CAR/L/1000761	NS 36675 26489	Prestwick Airport Outfall 2	Surface Water (Other) Commercial, Ind & Other				
CAR/L/1000762	NS 35731 26830	Prestwick Airport Outfall 5	Surface Water (Other) Commercial, Ind & Other				
CAR/L/1000778	NS 35790 26450	Glasgow-Prestwick International Airport	Surface Water (Other) Commercial, Ind & Other				
CAR/S/1034397	NS 36500 27020	Airport Car Park, Tarbolton Road, Monkton	Surface Water (Other) Commercial, Ind & Other	Pow Burn			
CAR/R/1008330	NS 37080 22580	Farm, Auchincruive	Sheep Dip onto Land				
CAR/R/1008365	NS 37800 21500	Farm, Old Toll, By Ayr	Sheep Dip onto Land				
CAR/S/1015568	NS 37800 21500	Farm, Old Toll, By Ayr	Sheep Dip onto Land	Land			
CAR/S/1015568	NS 38000 21600	Farm, Old Toll, By Ayr	Sheep Dip onto Land	Land			
CAR/S/1015568	NS 38200 21700	Farm, Old Toll, By Ayr	Sheep Dip onto Land	Land			
CAR/S/1083695	NS 37040 22560	Farm, Auchincruive (SAC)	Sheep Dip onto Land	Land			
CAR/S/1083695	NS 37130 22560	Farm, Auchincruive (SAC)	Sheep Dip onto Land	Land			
CAR/S/1083695	NS 37330 22690	Farm, Auchincruive (SAC)	Sheep Dip onto Land	Land			
CAR/S/1083695	NS 37310 22610	Farm, Auchincruive (SAC)	Sheep Dip onto Land	Land			
CAR/S/1083695	NS 39580 23880	Farm, Auchincruive (SAC)	Sheep Dip onto Land	Land			
CAR/S/1083695	NS 39790 23770	Farm, Auchincruive (SAC)	Sheep Dip onto Land	Land			
PPC/W/0020050	NS 35792 23399	Abattoir, Old Farm Rd, Ayr	Meat/Food Production				
PPC/W/0020056	NS 38680 24941	Meat Production, Sandyford Toll, Prestwick	Meat/Food Production				
PPC/W/0020060	NS 36327 25880	Food Production, Glenburn Rd, Prestwick,Ayr	Meat/Food Production				