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# Scottish Sanitary Survey Project



Restricted Sanitary Survey Report  
Arran: Pirnmill  
NA 008 330 16  
January 2009



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## Report Distribution – Arran: Pirnmill

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\* Distribution of both draft and final reports to relevant agency personnel is undertaken by FSAS.

\*\* Distribution of draft and final reports to harvesters is undertaken by the relevant local authority.

## **Acknowledgements**

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## 1. Area Overview

The receipt of a standard application for the classification of the shellfish harvesting area Arran: Pirnmill for razor clams triggered a restricted sanitary survey. Arran: Pirnmill is located off the west coastline of Scotland, on the Isle of Arran. The production area is located in a stretch of water between the Isle of Arran and the Kintyre peninsula. The channel of water varies from 4.5 – 16 km wide and 32 km long. The depth of the water in the channel varies from 0 – 200 m.



Figure 1.1 Location of Arran: Pirnmill

## **1.1 Land Cover**

The land cover on the Isle of Arran is predominantly heath land with areas of coniferous woodland and improved and neutral grassland. Most of the coastline adjacent to the shellfish bed is composed of raised beaches. There are areas of improved grassland all along the coastline adjacent to the fishery at Lennimore, Rubha Ban, Pirnmill, Whitefarland Point, Imachar Point and on the northern banks of the Iorsa Water. This improved grassland would be expected to be associated with a greater level of contamination to the shellfishery than the raised beaches.

## **1.2 Human Population**

Figure 1.2 shows the census output areas that are directly adjacent to Arran: Pirnmill. There are three census output areas on the eastern coastline and seven on the western coastline. On the eastern coastline are the small settlements of Lennimore, Pirnmill and Auchencar and on the western coastline is the settlement of Carradale with a population of 279 (2001). Human faecal contamination would be expected to be mainly associated with these settlements. There is little seasonal population in the area with no campsites/caravan sites and only several B&Bs.

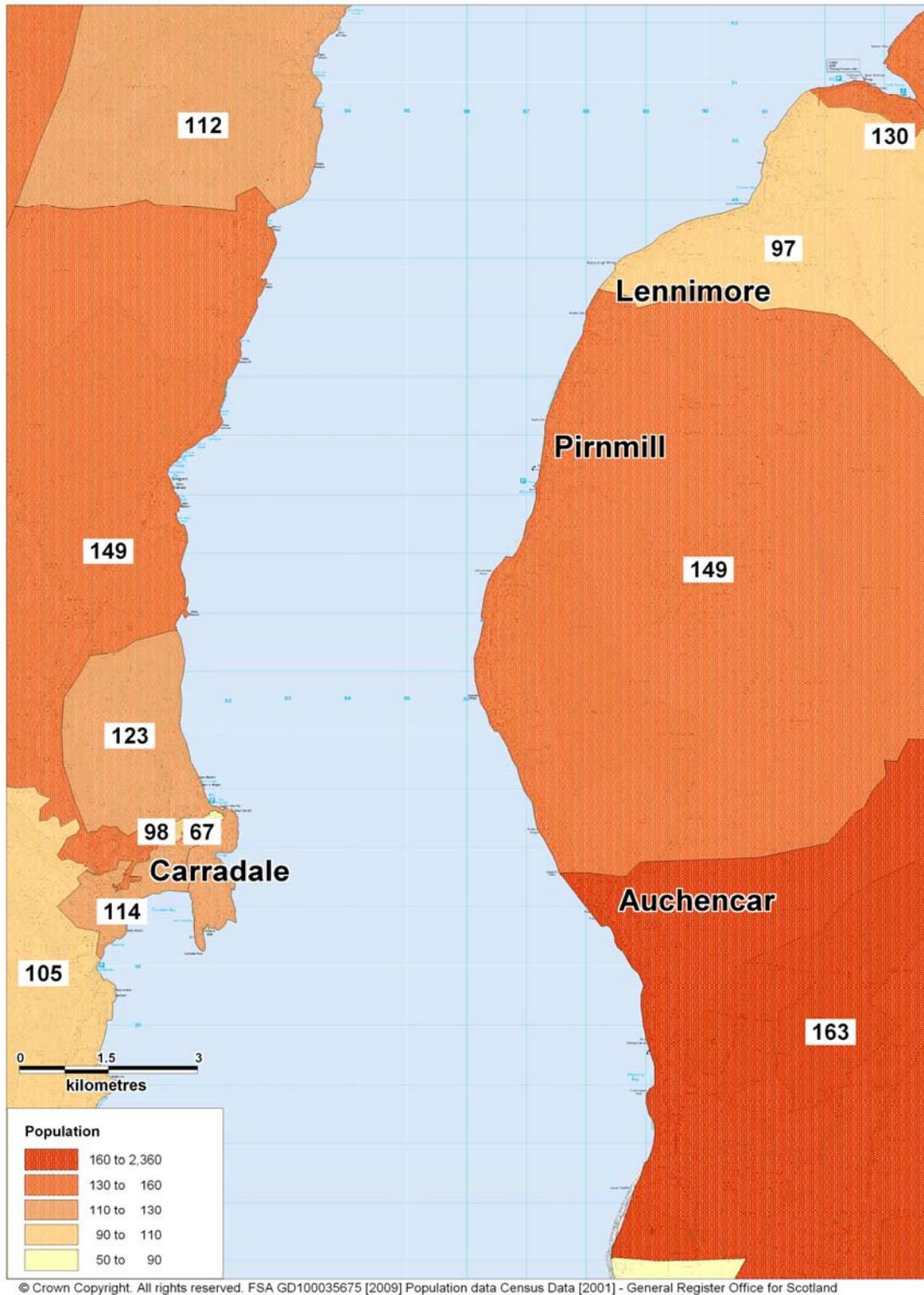


Figure 1.2 Human population of Pirrmill

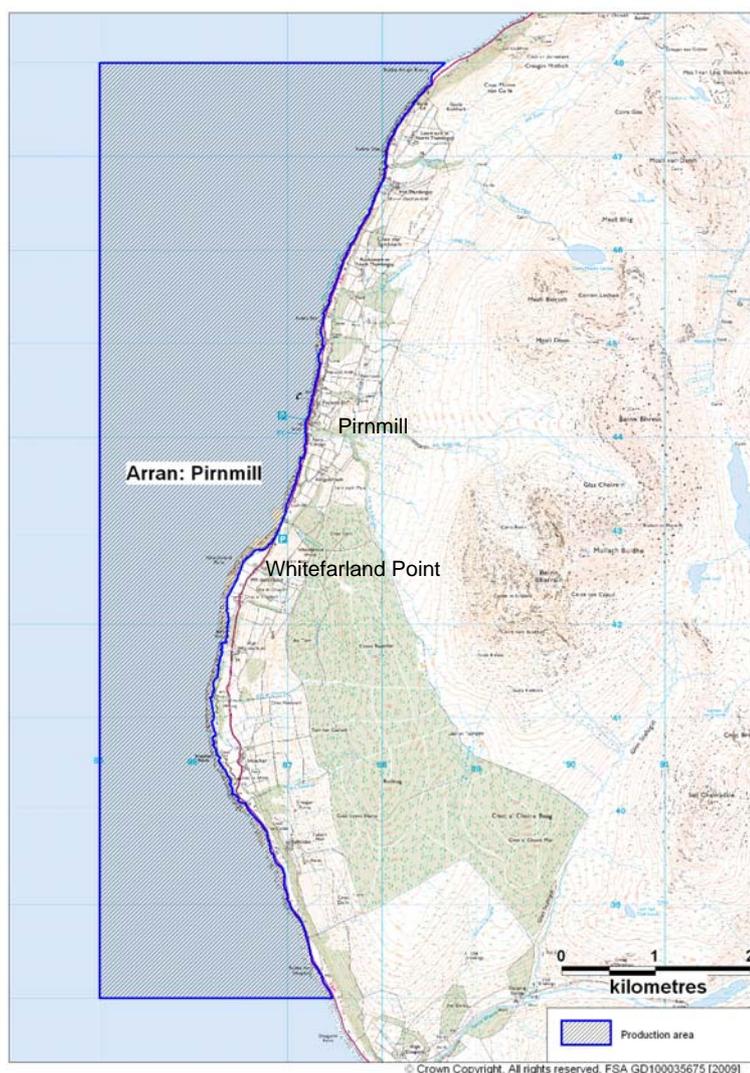
## 2. Fishery

The fishery at Arran: Pirmill is comprised of a wild Razor fish (*Ensis spp.*) bed within the Arran: Pirmill (SIN NA 008 330 16) production area, as illustrated in Figure 2.1.

The current production area boundaries are given as the area inshore of a line drawn between NR 8866 4800 and NR 8500 4800 and between NR 8500 4800 and NR 8500 3800 and between NR 8500 3800 and NR 8747 3800.

There is currently no RMP assigned to this area. The production area does not lie within a designated shellfish growing water and there are no bathing waters designated in this area.

The razor bed extends from NR 86136 40625 (south end) to NR 88256 47825 (north end) and occupies a narrow strip of seabed following the shore, going no deeper than 8 metres. The harvester intends to fish no further south than Whitefarland Point, just south of the town of Pirmill. The razor clams will be harvested all year round (weather permitting) by hand by divers.



### 3. Sewage Discharges

A number of discharge consents were issued by SEPA for the area of Arran: Pirnmill. These are listed in Table 3.1 and mapped in Figure 3.1.

Table 3.1 SEPA discharge consents

Ref No.	NGR of discharge	Discharge Type	PE	Discharge Vol m <sup>3</sup> per day
CAR/L/1011046	NR 8728 4474	Continuous	-	6.4
CAR/R/1031411	NR 87264 44505	Continuous	21	-
CAR/R/1009254	NR 8644 4229	Continuous	5	-
CD10758	NR 872 445	Continuous	-	Solids content of discharge should not exceed 100mg/litre
CD8842	NR 8719 4418	Continuous	-	

Scottish Water identified a single community septic tank and sewage discharge for the area surrounding Arran: Pirnmill. This is detailed in Table 3.2 and mapped in Figure 3.1.

Table 3.2 Discharge identified by Scottish Water

Discharge Name	Ref No.	NGR of discharge	Discharge Type	Level of Treatment	Consented flow m <sup>3</sup> /day	Consented/design pop
Pirnmill public septic tank	CD8842	NR 8718 4417	Continuous	Septic tank	4	20
WPC/W/13802	CD10758	NR 8730 4454	Continuous	Septic tank	-	*serves 4 houses

No sanitary or microbiological data were available for these discharges.

Table 3.3 Observations of potential sewage discharges during shoreline survey

No.	Date	NGR	Description of potential sewage discharge
1	04/02/2009	NR 86867 42920	23cm diameter outfall pipe
2	04/02/2009	NR 86882 42939	15cm diameter outfall pipe
3	04/02/2009	NR 86894 42968	23cm diameter outfall pipe
4	04/02/2009	NR 87229 44080	Pirnmill public toilets
5	04/02/2009	NR 872 441	SW septic tank, inspection covers and outfall pipe
6	04/02/2009	NR 87206 44172	SW broken outfall pipe and discharge point
7	04/02/2009	NR 87273 44380	Outfall pipe flowing into stream
8	04/02/2009	NR 87295 44517	SW septic tank
9	04/02/2009	NR 87288 44572	Septic tank and outfall pipe

As shown in Figure 3.1 all the observed and known sewage discharges are concentrated in the central section of coastline near the settlements of Pirnmill and Whitefarland. All of the noted sewage discharges are sufficiently close to the shellfish bed to adversely impact water quality of this section of the production area.



## 4. Animals

### 4.1 Livestock

The only significant source of information concerning livestock numbers in the Arran: Pirnmill area was available from the shoreline survey. The shoreline survey only relates to the time of the site visits on the 20<sup>th</sup> and 22<sup>nd</sup> January and the 18<sup>th</sup> February 2009.

During the shoreline survey, sheep were observed in fields close to the shoreline along the stretch of coastline south of Pirnmill (see Figure 4.1). Approximately 20 cattle were also observed in a field north of Pirnmill. In all cases due to the raised beaches, livestock did not have any obvious direct access to the shoreline. However, it is not known what access livestock may have to freshwater courses discharging to the production area. Based on stream contamination levels observed during the shoreline survey, it is likely that livestock have access to these watercourses.

### 4.2 Wildlife

While the Isle of Arran does host some colonies of breeding seabirds, the Arran: Pirnmill stretch of coastline does not host significant colonies. Seabirds such as gulls will always be present along the coastline but their distribution is likely to be even over time and as such would not materially affect placement of an RMP. During the shoreline survey 20 gulls, 5 oyster catchers & 1 gannet were observed on the shoreline just north of Whitefarland (see Figure 4.1).

Other marine wildlife associated with the Isle of Arran includes otter, porpoises and dolphins.

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*).

The Sea Mammal Research Unit has recorded a growing number harbour seals on the Isle of Arran and East Kintyre area over the past twenty years (Table 4.1). Grey seals have also been spotted but in much smaller numbers and only in the past eight years (Table 4.2). However, no spatial data is available regarding the distribution of seals in the area.

Table 4.1 Harbour Seals

Location		Aug 1989	Aug 1996	Aug 2000	Aug 2007
Arran	Pirnmill	0	0	0	0
	Arran & East Kintyre	70	123	148	293

Table 4.2 Grey Seals

Location		Aug 1989	Aug 1996	Aug 2000	Aug 2007
Arran	Pirnmill	0	0	0	0
	Arran & East Kintyre	0	0	2	13



Figure 4.1 Wildlife and livestock observed during the shoreline survey at Arran: Pirnmill

## 5. Rainfall

The nearest weather station is located at Arran Dougarie Lodge, approximately 1.2km south of the production area. Rainfall data was supplied for the period 01/01/03 to 31/12/07 (total daily rainfall in mm). For this period of 1826 days, total daily rainfall was not recorded for 143 days, including the entire month of October 2006. It is likely that the rainfall experienced at Arran Dougarie Lodge is very similar to that experienced at the production area due to their close proximity.

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 wastewater treatment plant overflows (e.g. Mallin et al, 2001; Lee & Morgan, 2003).

### 5.1 Rainfall at Arran Dougarie Lodge

Total annual rainfall and mean monthly rainfall were calculated, and are presented in Figures 5.1 and 5.2. As there were no records for October 2006, the annual rainfall for 2006 has been omitted. The monthly mean for October was calculated by dividing the total monthly rainfall by the number of years for which records were provided.

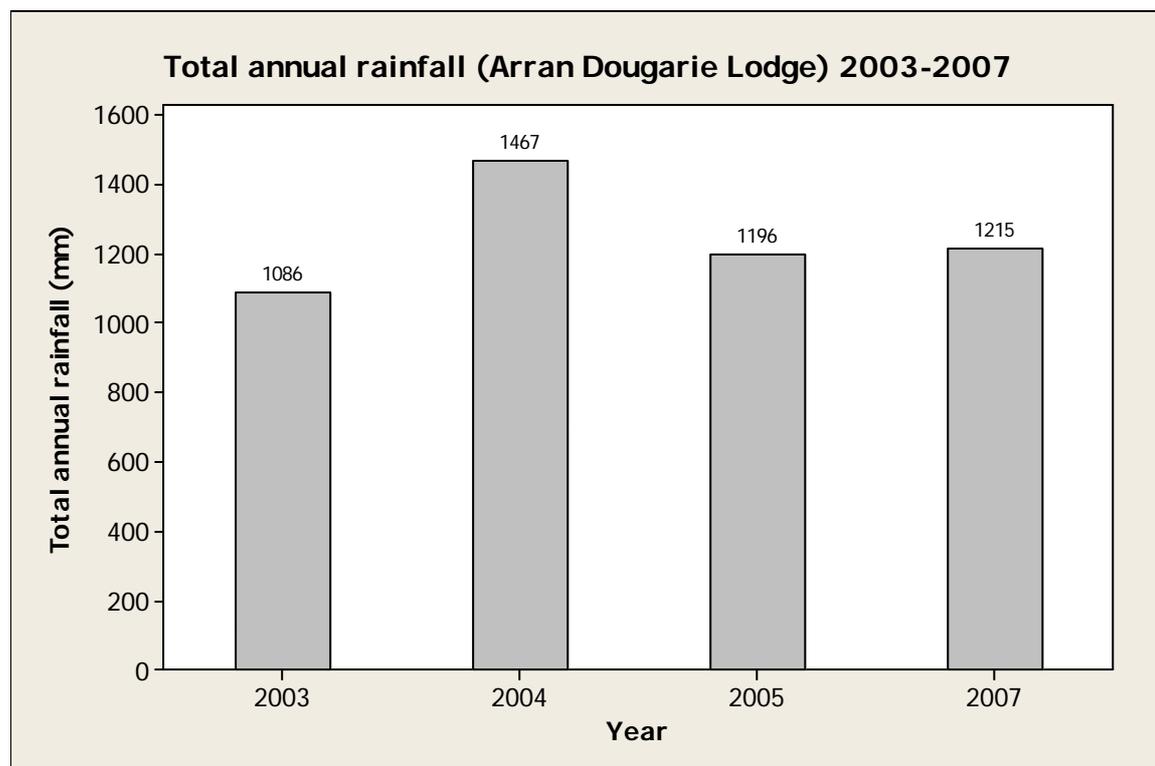


Figure 5.1 Total annual rainfall at Arran Dougarie Lodge 2003 – 2007 (no records for 143 days, including October 2006).

Total annual rainfall varied markedly, with 2004 much wetter than either 2003 or 2005.

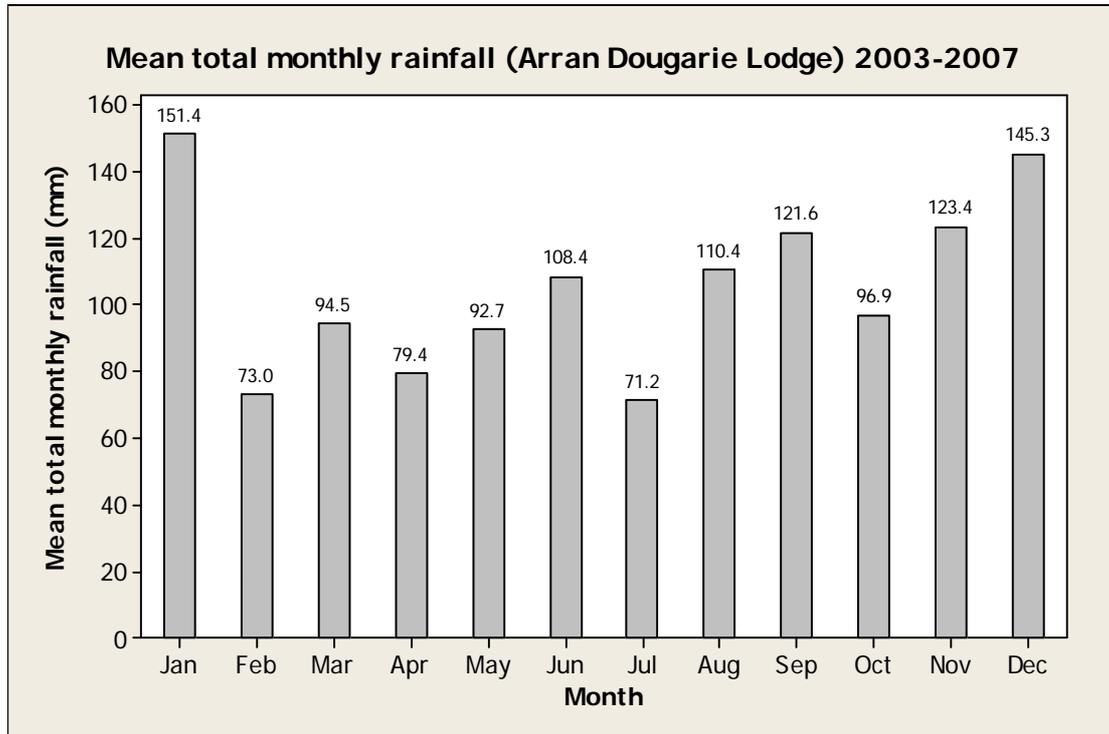


Figure 5.2 Mean total monthly rainfall at Arran Dougarie Lodge 2003 – 2007 (no records for 143 days, including October 2006.)

The wettest months were January, September, November and December. The largest increases in rainfall over the previous months occurred in August and November. For the period considered here (2003 – 2007), only 33 % of the days experienced no rainfall while 43 % of days experienced rainfall of 1mm or less. Average February rainfall amounted to less than half that received in January.

Periods of increased rainfall are generally associated with higher levels of contaminated surface water runoff, and episodes of high rainfall can occur during any month.

Faecal contaminants from other sources may be independent of rainfall and so episodes of contamination may occur outside identified periods of higher rainfall, for example when livestock are present on the shoreline.

It can therefore be expected that levels of rainfall-dependent faecal contamination entering the production area from these sources will be higher during the autumn and winter months. Faecal matter can build up on pastures during the drier summer months when livestock populations are at highest, leading to more significant faecal contamination of runoff at the onset of the wetter weather, though this episodic flush of bacteria can occur after a heavy rain at any time of the year.

## 6. River Flow

There is no river gauging station in the vicinity of Arran: Pirnmill. A large number of fresh water inputs to the production area were observed during the shoreline survey. Many of these streams were very small and therefore not measured or sampled. The larger streams and rivers were sampled and measured. These are listed in Table 6.1 and mapped in Figures 6.1 and 6.2.

Where the bacterial concentration is labelled, the scientific notation is written in digital format, as this is the only format recognised by the mapping software. So, where normal scientific notation for 1000 is  $1 \times 10^3$ , in this case it would be written as 1E+3.

Table 6.1 River/stream flows and loadings for Arran: Pirnmill

No	Grid Ref	Description	Width (m)	Depth (m)	Measured Flow (m/s)	Flow in m <sup>3</sup> /day	<i>E. coli</i> (cfu/100ml)	Loading ( <i>E. coli</i> per day)
1	NR 88336 36925	River Iorsa	^	^	^	^	<100	^
2	NR 87442 38106	Stream	0.52	0.04	0.334	525	<100	-
3	NR 87213 38651	Stream	0.90	0.06	0.294	1370	<100	-
4	NR 86854 39549	Stream	0.70	0.07	0.201	851	<100	-
5	NR 86798 39721	Stream	0.65	0.09	0.0309	156	<100	-
6	NR 86749 39833	Stream	0.33	0.03	0.647	553	100	5.5 x10 <sup>8</sup>
7	NR 86556 40090	Stream	1.00	0.09	0.291	2260	<100	-
8	NR 86417 40264	Large stream	0.90	0.07	0.765	4160	10000	4.2 x10 <sup>11</sup>
9	NR 86232 40840	Stream	1.10	0.15	0.985	14000	<100	-
10	NR 86210 40987	Stream	0.46	0.06	0.105	250	400	1 x10 <sup>9</sup>
11	NR 86217 41017	Stream	0.30	0.09	0.104	243	300	7.3 x10 <sup>8</sup>
12	NR 86200 41103	Stream	0.35	0.05	0.143	216	<100	-
13	NR 86201 41159	Stream	1.20	0.12	0.414	5150	100	5.2 x10 <sup>9</sup>
14	NR 86216 41218	Stream	0.45	0.10	0.065	253	<100	-
15	NR 86275 41547	Large stream	1.00	0.09	0.21	1630	100	1.6 x10 <sup>9</sup>
16	NR 86307 41670	Large stream	1.00	0.09	0.693	5390	<100	-
17	NR 86322 41780	Stream	0.09	0.05	0.263	102	<100	-
18	NR 86343 41805	Stream	0.10	0.02	0.372	64.3	<100	-
19	NR 86366 41849	Stream	0.17	0.04	0.467	274	<100	-
20	NR 86358 42151	Large stream	2.00	0.27	0.233	10900	100	1.1 x10 <sup>10</sup>
21	NR 86442 42421	Stream	0.15	0.01	0.404	52.4	<100	-
22	NR 86682 42779	Stream	0.65	0.10	0.206	1160	<100	-
23	NR 86809 42838	Stream	0.30	0.04	0.403	418	<100	-
24	NR 86945 43108	Large stream	1.00	0.03	0.466	1210	<100	-
25	NR 87032 43342	Stream	0.60	0.04	0.441	914	<100	-
26	NR 87148 43702	Stream	0.35	0.02	0.375	227	400	9.1 x10 <sup>8</sup>
27	NR 87191 43840	Stream	0.25	0.03	0.775	502	<100	-
28	NR 87201 43950	Stream	0.25	0.03	0.35	227	<100	-
29	NR 87203 44145	River Allt Gobhlach	3.00	0.35	0.615	55800	<100	-
30	NR 87250 44284	Stream	0.30	0.04	0.042	43.6	<100	-
31	NR 87273 44380	Stream	0.20	0.04	0.013	8.99	1700	1.5 x10 <sup>8</sup>
32	NR 87305 44525	Large stream	0.80	0.22	0.44	6690	<100	-
33	NR 87390 453031	Stream	0.20	0.03	0.746	387	<100	-
34	NR 87389 45264	Stream	0.40	0.05	0.329	569	2100	1.2 x10 <sup>10</sup>
35	NR 87490 45580	Large stream	0.70	0.16	0.37	3580	100	3.6 x10 <sup>9</sup>
36	NR 87653 45996	Stream	0.40	0.04	0.11	152.06	<100	-
37	NR 88021 46748	Stream	0.15	0.01	0.561	72.71	<100	-
38	NR 88039 46890	Large stream	2.70	0.20	0.282	13156.99	<100	-

^ River too large to measure safely

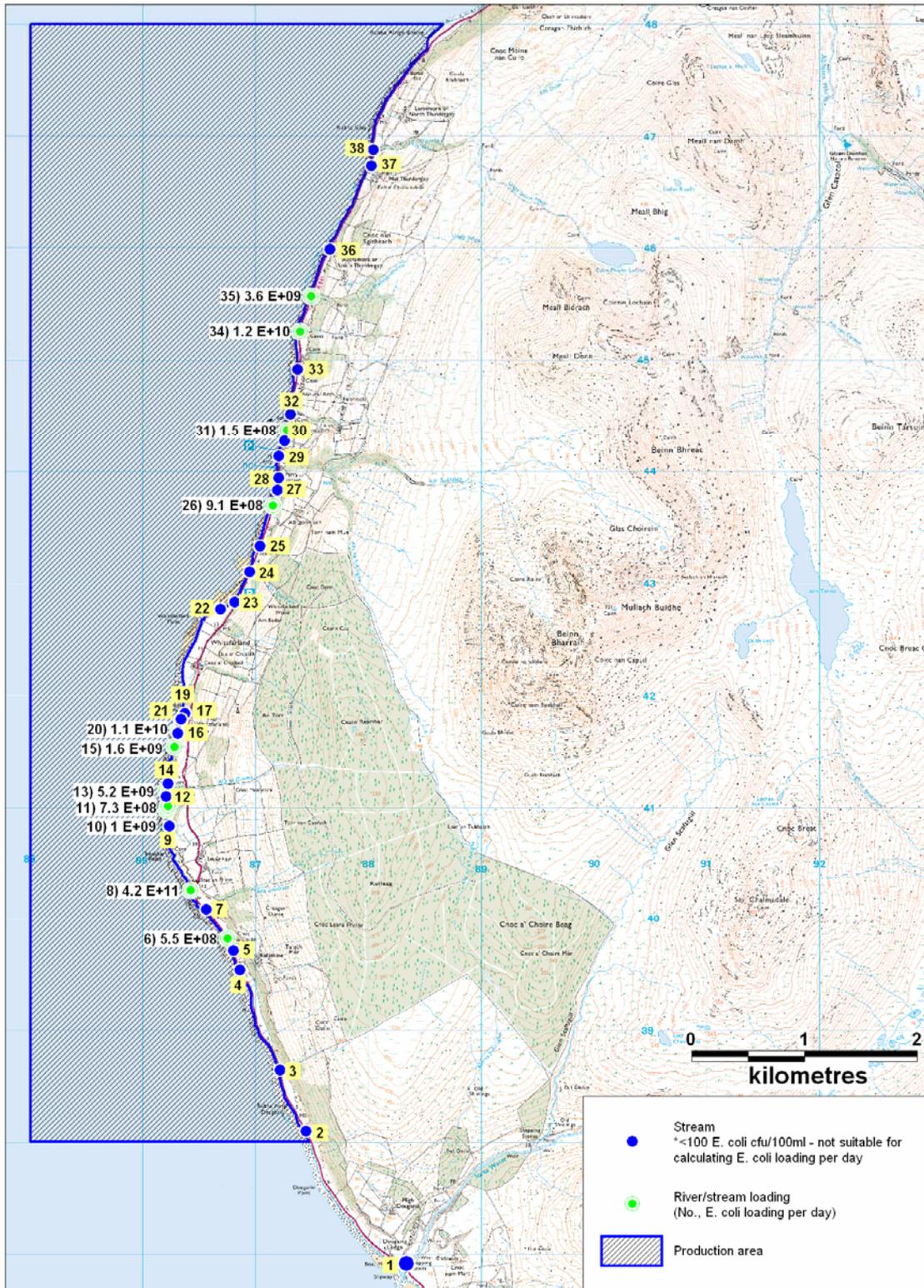


Figure 6.1. Location of stream/river flows and loadings at Arran: Pirmill

Of the streams/ivers sampled, 71% contained  $<100 E. coli$  (CFU/100 ml). Calculated loadings are based on the flows and dimensions observed during the shoreline survey only, and may not be representative of conditions year round. Most of the streams contributing significant  $E. coli$  loadings to the fishery were located in the southern half of the area.

## **7. Historical *E. coli* Monitoring Data**

### **7.1 Validation**

The *E. coli* results of all the shellfish samples taken from Arran: Pirnmill from the beginning of 2001 up to 2008 were extracted from the database and validated according to the criteria described in the standard protocol for validation of historical *E. coli* data.

No samples were rejected on the basis of major geographical or sampling date discrepancies.

Samples with a result of <20 were assigned a nominal value of 10 for statistical analysis.

All *E. coli* results are reported in most probable number per 100g of shellfish flesh and intravalvular fluid.

### **7.2 Summary of sampling and results by species/monitoring point**

A summary of the number of samples and the *E. coli* results is presented in Table 7.1.

Arran: Pirnmill was declassified in 2008 due to submission of insufficient samples.

Table 7.1 Summary of historical results from Arran: Pirnmill

Sampling Summary								
Production area	Arran: Pirnmill							
Site	Pirnmill							
Species	Razors							
SIN	NA 008 330 16							
Location	All (7)	NR 8746645771	NR 8752945976	NR 8758946130	NR865430	NR870440	NR870444	NR870446
Total no of samples	31	1	1	1	10	16	1	1
N 2003	8	0	0	0	3	5	0	0
n 2004	7	0	0	0	7	0	0	0
n 2005	6	0	0	0	0	6	0	0
n 2006	5	0	0	0	0	4	1	0
n 2007	2	0	0	0	0	1	0	1
n 2008	3	1	1	1	0	0	0	0
Results Summary								
Minimum	19	500	70	70	<20	<20	<20	40
Maximum	3500	500	70	70	310	3500	<20	40
Median	19	500	70	70	<20	<20	<20	40
Geometric mean	41.2	500	70	70	46.6	32.2	<20	40
90 percentile	19	-	-	-	<20	<20	-	-
95 percentile	70	-	-	-	130	20	-	-
n exceeding 230/100g	3 (9.7%)	-	-	-	1 (10%)	1 (6.25%)	-	-
n exceeding 1000/100g	1 (3.2%)	-	-	-	0	1 (6.25%)	-	-
n exceeding 4600/100g	0 (0%)	-	-	-	0	0	-	-
n exceeding 18000/100g	0 (0%)	-	-	-	0	0	-	-

### 7.3 Temporal pattern of results

Figure 7.1 presents a scatterplot of the individual results against date for all razor clam samples taken from Arran: Pirnmill.

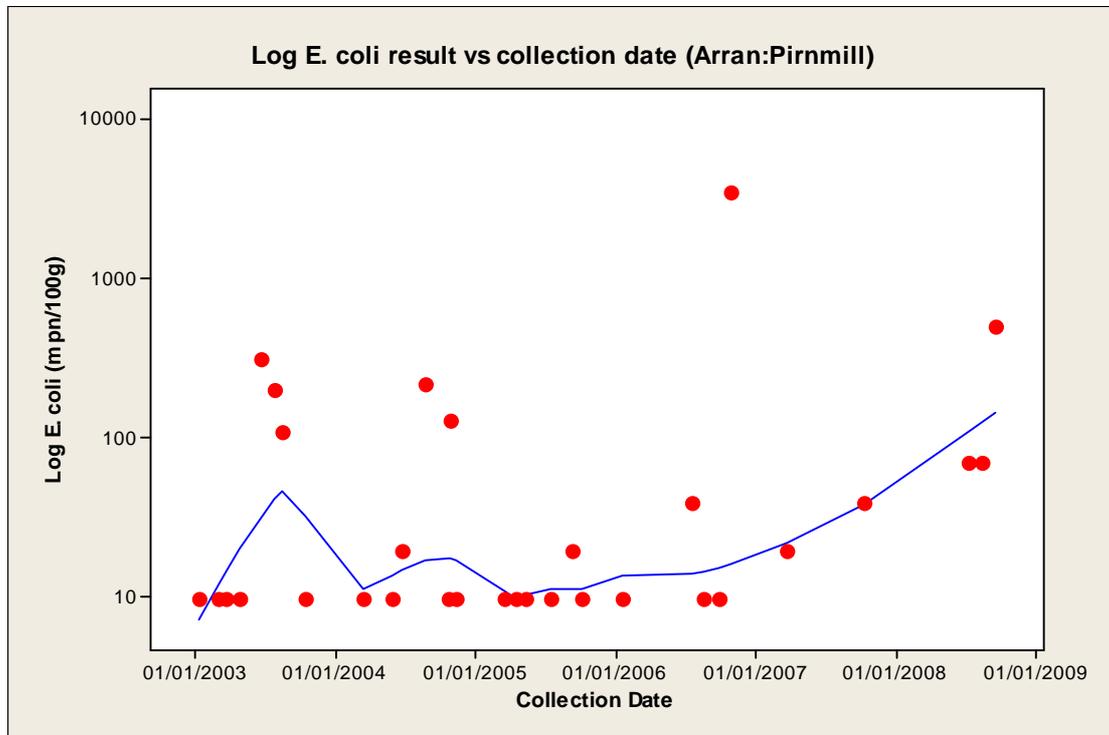


Figure 7.1 Scatterplot of *E. coli* result (MPN/100g) for razor clams vs collection date with rolling geometric mean.

In 2003 and 2004, results seem to peak in the summer months while the majority of results obtained at other times are very low. However, in recent years there have been no results of  $<20$  *E. coli* /100 g and peak results have been higher. It should be noted that fewer samples were submitted during this period, leading to declassification of the area in 2008.

### 7.4 Geographical pattern of results

Samples have only been recorded as having been taken in the northern half of the production area and usually quite close to the shore – as would be expected from the deeply shelving seabed. Most of the samples have been reported against two locations and the geographical analysis is difficult. However, it should be noted that the highest result (3500 *E. coli* MPN/100 g) was reported for a sample taken at NR 870 440. Figure 7.2 shows each sampling location labelled with the highest *E. coli* result for razor clams taken from that point over the 2003 - 2008 five year period.

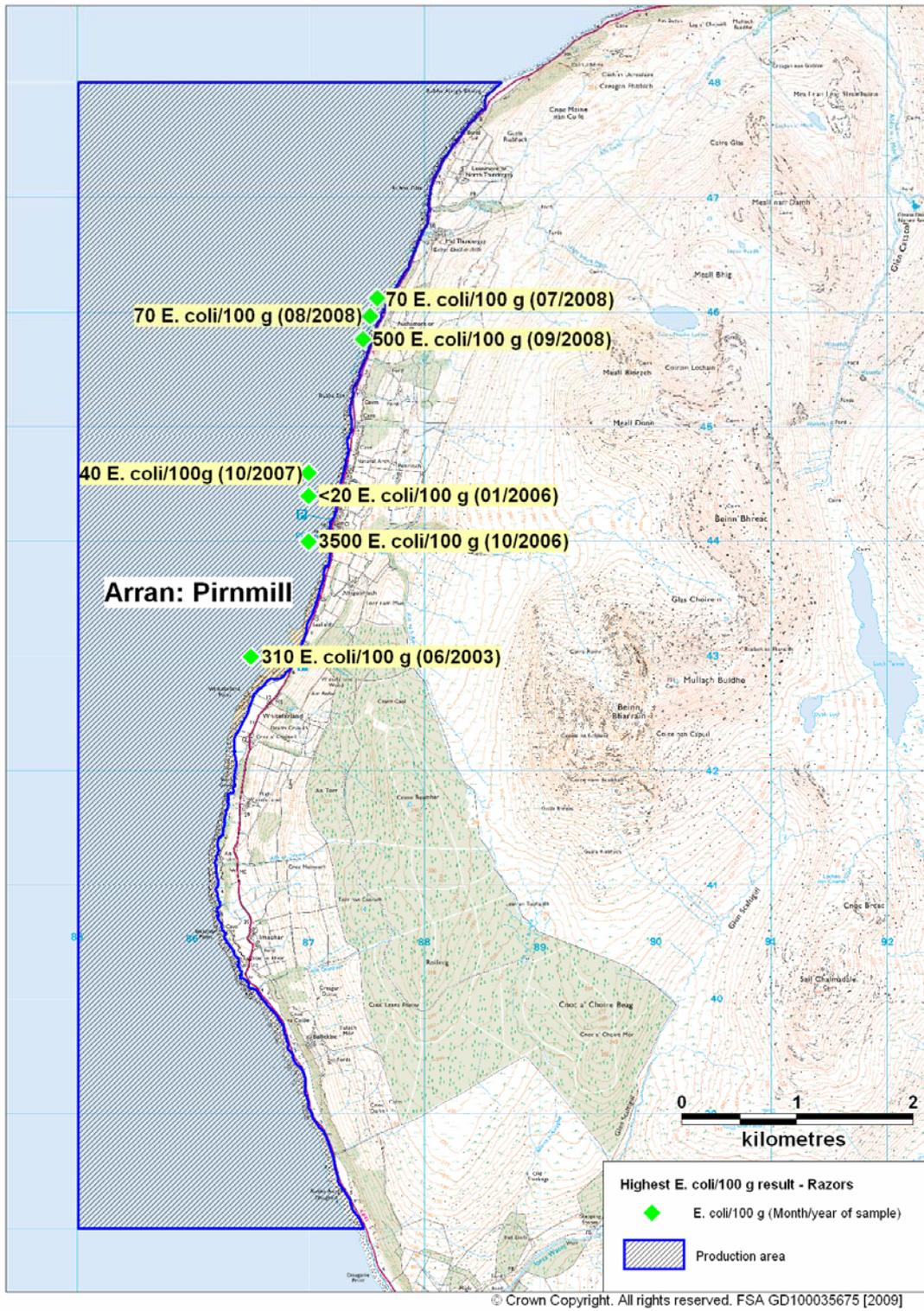


Figure 7.2 Highest *E. coli*/100 g result for each razor clam sampling location during 2003 – 2008 at Arran: Pirmill

## 8. Bathymetry and Hydrodynamics

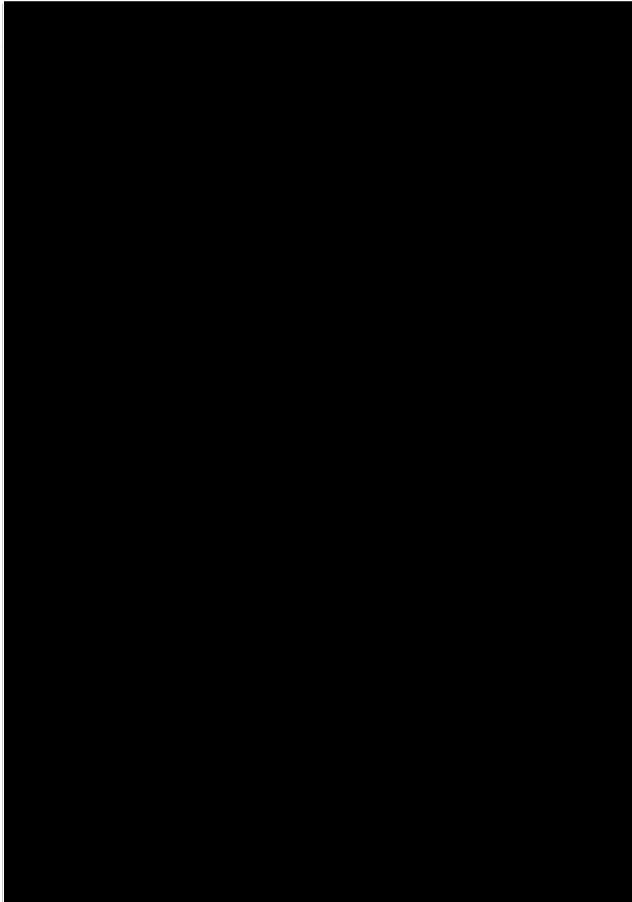


Figure 8.1 Arran: Pirnmill bathymetry



Figure 8.2 Arran: Pirnmill

The bathymetry chart above (Figure 8.1) shows that there is a drying area following along the stretch of the coastline. Beyond the drying area the depth rapidly increases from 0 – 20 metres, then gradually to 30 metres and 50 metres.

### 8.1 Tidal curve and description

The two tidal curves below are for the port of Carradale, the nearest secondary port– they have been output from UKHO TotalTide. The first is for seven days beginning 00.00 GMT on 20<sup>th</sup> January 2009. The second is for seven days beginning 00.00 GMT on 28<sup>th</sup> January 2009. Together they show the predicted tidal heights over high/low water for a full neap/spring tidal cycle.

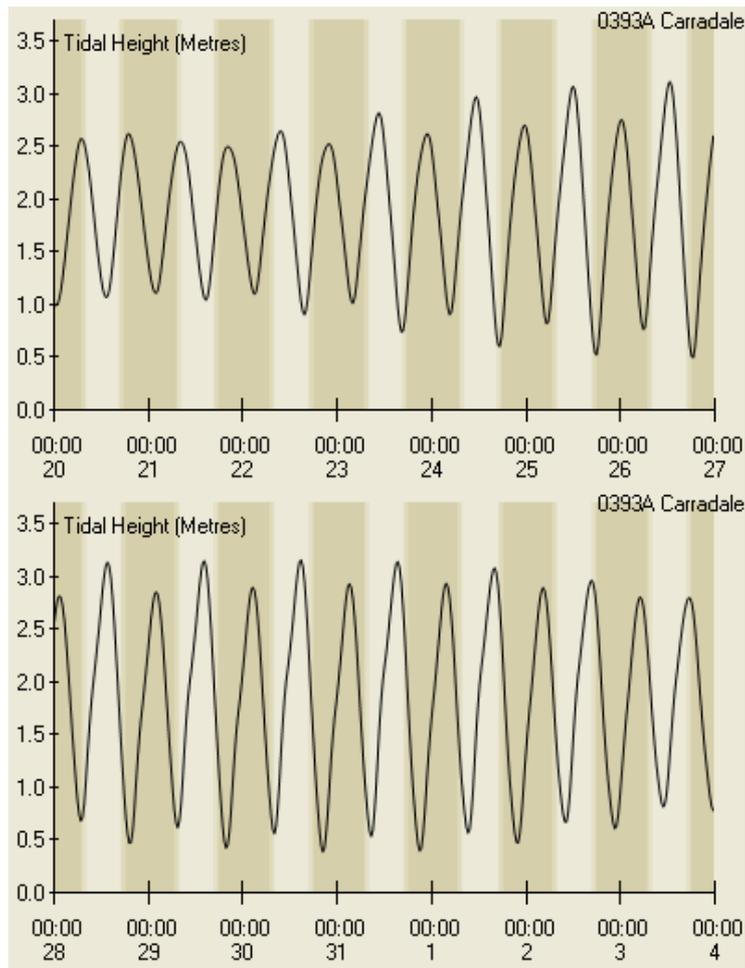


Figure 8.3 Tidal curves for Carradale

The following is the UKHO summary description for Carradale:  
The tide type is Semi-Diurnal.

MHWS	3.1 m
MHWN	2.6 m
MLWN	1.1 m
MLWS	0.4 m

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Predicted heights are in metres above chart datum. The tidal range at spring tide is therefore approximately 2.7 m and at neap tide 1.5 m.

## 8.2 Currents

The nearest tidal stream information comes from the tidal diamond SN040G, located at NR 84792 47706, 330m southwest of the north-western corner of the Arran: Pirnmill production area.

Table 8.1 Tidal diamond information for SN040G

Time	Direction	Spring rate	Neap Rate
-06h	040°	0.15 m/s	0.10 m/s
-05h	030°	0.15 m/s	0.10 m/s
-04h	017°	0.15 m/s	0.10 m/s
-03h	330°	0.15 m/s	0.10 m/s
-02h	297°	0.15 m/s	0.10 m/s
-01h	243°	0.15 m/s	0.10 m/s
HW	225°	0.21 m/s	0.15 m/s
+01h	215°	0.26 m/s	0.15 m/s
+02h	205°	0.21 m/s	0.15 m/s
+03h	194°	0.15 m/s	0.10 m/s
+04h	121°	0.05 m/s	0.05 m/s
+05h	062°	0.10 m/s	0.05 m/s
+06h	044°	0.15 m/s	0.10 m/s

Figures 8.4 and 8.5 present predicted maximum tidal flows and direction on the ebb and flood tide respectively on 20/01/2009.

Tidal flows at the diamond are generally bi-directional, with water moving in a north-easterly direction on the flood and south-westerly on the ebb.

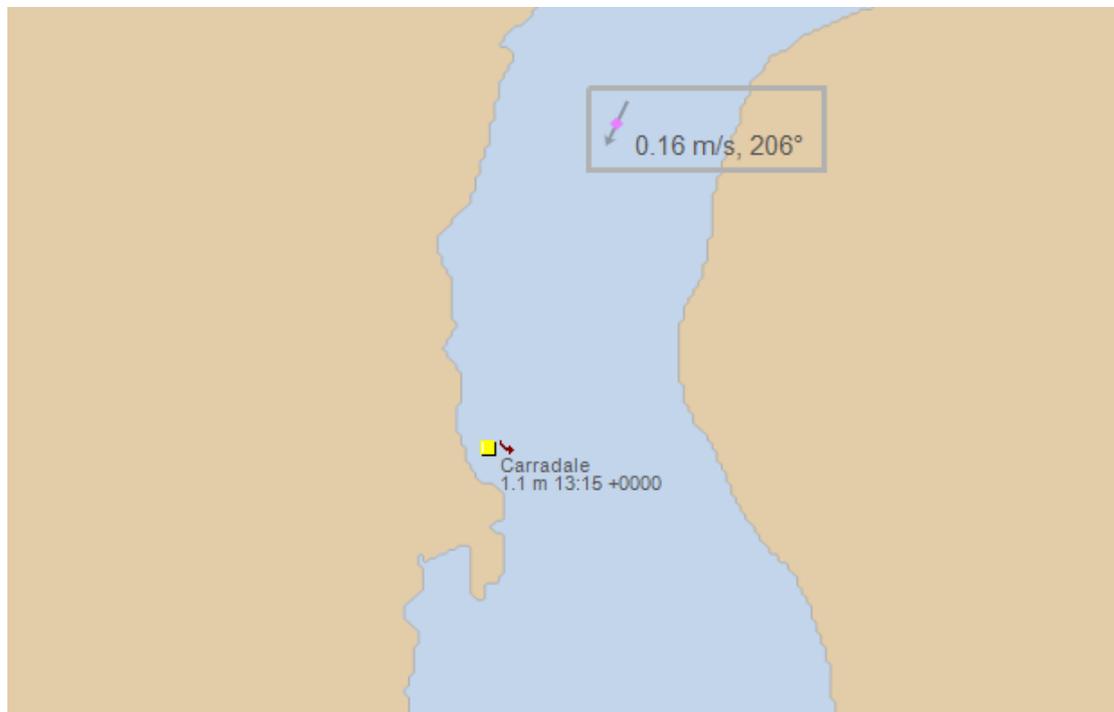


Figure 8.4 Maximum ebb tide flow and direction on a large spring tide at SN040G (from Admiralty TotalTide)



Figure 8.5 Maximum flood tide flow and direction on a large spring tide at SN040G (from Admiralty TotalTide)

### 8.3 Conclusions regarding effect on impacting sources

The relatively large currents in the area would tend to transport contamination from land-based sources (sewage discharges and agricultural sources) parallel to the coast and then along the fishery. However, given the rapidly shelving seabed and the relatively small size of the known pollution sources, it would be expected that significant dilution would occur within a relatively small distance and thus any effects on the microbiological quality of the shellfish would be extremely localised.

## 9. Shoreline Survey Overview

A restricted shoreline survey of the Arran: Pirnmill area was undertaken by staff from North Ayrshire Council on the 20<sup>th</sup> and 22<sup>nd</sup> January and the 4<sup>th</sup> February 2009. Staff from Argyll and Bute Council and the harvester collected shellfish samples on 18<sup>th</sup> February 2009.

Sea water samples were taken all along the coastline of the Arran: Pirnmill production area. Results were varied from 1 – 21 *E. coli* CFU/100 ml.

Fresh water samples were taken all along the coastline of the Arran: Pirnmill production area at streams and flowing outfall pipes. Results ranged from <100 to 10,000 *E. coli* (CFU/100 ml). There are only five samples above 300 *E. coli* (CFU/100 ml). Two samples with 300 and 400 *E. coli* (CFU/100 ml) were from two streams in very close vicinity to each other just north of Imachar. Two water samples had a result of 2100 *E. coli* (CFU/100 ml), one from a stream located at the north end of Pirnmill and the other located 1 km further north near Rubha Ban. The highest fresh water result of 10,000 *E. coli* (CFU/100 ml) was obtained from a stream just south of Imachar.

Sheep and cattle were present along the Arran: Pirnmill coastline. However, direct access to shoreline was on occasions restricted due to the topography of the coastline.

Razor samples were collected at eight points along the coastline of the Arran: Pirnmill production area during the shoreline survey. All shellfish samples contained fewer than 90 *E. coli* (MPN/100 g).

A map is provided in Figure 9.1 that shows the relative locations of the most significant findings of the shoreline survey. Where the bacterial concentration is labelled, the scientific notation is written in digital format, as this is the only format recognised by the mapping software. So, where normal scientific notation for 1000 is  $1 \times 10^3$ , in this case it would be written as 1E+3.

In summary, identified sources of potentially significant contamination are:

- Contaminated freshwater streams in the area
- Pirnmill septic tanks and outfall pipes

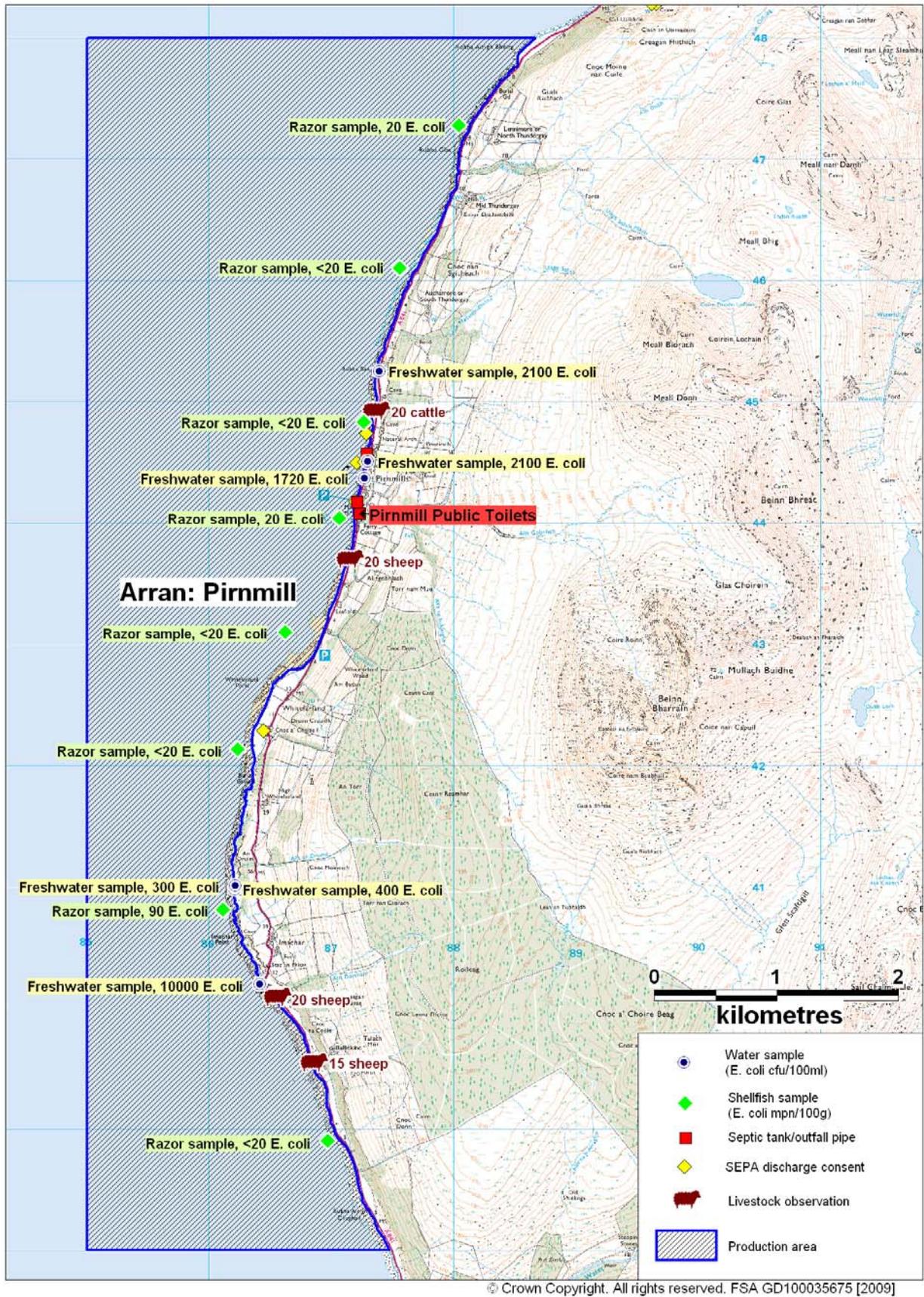


Figure 9.1 Summary of shoreline observations

## **10. Overall Assessment**

### **Fishery**

The razor bed at Arran: Pirnmill occupies a narrow strip of land following the entire coastline of the production area, going no deeper than 8 metres. However, all historical data indicates that samples have only been taken north of Whitefarland Point and this northern stretch is the area that the harvester is planning to harvest.

### **Land Use**

There are several areas of improved grassland all along the coastline adjacent to the fishery stretching from Lennimore down to Imachar Point and also on the northern banks of the Iorsa Water. The level of contamination for this land cover type would be expected to increase significantly after marked rainfall events, this being expected to be highest, at more than 100-fold, for the improved grassland.

### **Human sewage inputs**

The Isle of Arran has a human population of 5058 (2001 census). The largest settlements along the coastline of the Arran: Pirnmill fishery include; Pirnmill, Whitefarland and Imachar. In addition to the Pirnmill public toilets, three septic tanks and associated outfall pipes were identified in Pirnmill.

### **Agricultural inputs**

Approximately 115 sheep were observed grazing along the shoreline during the survey. However, sheep were usually located on the raised beaches away from the direct shoreline. The largest group of 60 sheep were observed roughly 1 km south of the production area.. A single group of 20 cattle was observed grazing in a field north of Pirnmill.

Overall, farm animals were observed in approximately equal numbers along the shoreline and so will be assumed to have an equal impact across the fishery.

### **Wildlife inputs**

During the shoreline survey 20 gulls, 5 oyster catchers & 1 gannet were observed on the shoreline just north of Whitefarland. While the Isle of Arran does host some colonies of breeding seabirds, the Arran: Pirnmill stretch of coastline does not host significant colonies. Seabirds such as gulls will always be present along the coastline but their distribution is likely to be even over time and as such would not materially affect placement of an RMP.

Wildlife such as dolphins, porpoises, water birds and otters may be present at times in the area, but not in large numbers.

### **Seasonal variation**

Seasonal variation was evident in the historical *E. coli* monitoring results. Apart from 2005, results seem to peak in the summer months, especially during 2003 and 2004. The majority of results obtained at other times are very low.

Seasonal rainfall is highest in winter; and the greatest change in rainfall occurs in August and November when it is much higher than in the preceding months.

Livestock numbers in the area as a whole are likely to be at their highest during the summer months when lambs are present. During the warmer months livestock may access streams to drink and cool off more frequently, leading to higher levels of faecal contamination in freshwater streams and the shellfish bed itself. With several B&Bs in Pirnmill, there is likely to be an increase in visitors to the area during the summer holidays.

### **Rivers and streams**

At the time of the shoreline survey there were a large number of fresh water streams flowing. All the larger ones were measured and sampled. Out of the 38 streams sampled 27 had *E. coli* results below <100 cfu/100 ml. *E. coli* loadings for these 27 streams were therefore not calculated. The remaining streams had loadings ranging from  $1.5 \times 10^8$  to  $4.2 \times 10^{11}$  *E. coli* / day. The highest *E. coli* loading ( $4.2 \times 10^{11}$  *E. coli* / day) was found in a stream that was sampled just south of Imachar. All of the streams recorded and measured were flowing directly onto the shellfish bed. Overall it is expected that the freshwater inputs into the Arran: Pirnmill production area could have the potential to contribute to the bacterial contamination of shellfish.

### **Rainfall**

Rainfall patterns at Arran Dougarie Lodge (the nearest rainfall station) show rainfall levels are higher between August and January than during the remainder of the year. An increase in rainfall, especially early in this period and after the dry summer months, may be expected to wash a flush of bacteria from the surrounding land into the production area. The impact of this is likely to be most acute nearest where the streams enter the sea.

### **Analysis of results**

Historic shellfish hygiene monitoring results for Razors were available from 2003 to present, with samples collected from the northern end of the production area between Whitefarland and South Thundergay. Results varied greatly, ranging from 19 to 3500 *E. coli* (MPN/100 g) with the most contaminated result occurring nearest the public conveniences at Pirnmill.

Seawater samples taken from sixteen points along the shoreline ranged from 1 to 17 *E. coli* CFU/100 ml. Overall, these results showed low levels of contamination.

Shellfish samples were taken from eight points along the stretch of the production area during the shoreline survey. All samples taken had relatively low levels of *E. coli* (<20 - 90 *E. coli* MPN/100 g).

These three data sets indicate that the greatest level of contamination is likely to be concentrated along the stretch of coastline from Pirnmill down to Imachar, nearer the southern end of the production area.

### **Movement of contaminants**

Any contamination arising from land based sources (including discharges and streams) would tend to be transported parallel to the coast by tidal currents. Any effects would be likely to be most pronounced near the shore given the shelving of the sea bed which would result in significant dilution of such contamination further from shore.

### **Overall conclusions**

Contamination from these sources will be greatest at the input points but will also affect the microbial quality in shallow water either side of these due to the effect of tidal currents. Any impacts will decrease rapidly away from the shore due to dilution in deeper water.

The highest historical result in the *E. coli* monitoring was obtained from a sample taken off Pirnmill itself. Apart from the time of the shoreline survey, no razor samples had been taken from the area south of Whitefarland Point.

## 11. Recommendations

Given that:

- The main impacting sources on the area to be fished in the near future are located in the vicinity of Pirnmill.
- The most razor samples submitted to date have been reported to have been taken at NR 870 440.
- The sample yielding the highest *E. coli* result to date was reported to have been taken at this location.

It is recommended that this becomes the RMP, defined as NR 8700 4400, to 10 m accuracy; with a tolerance of 150 m. Sampling frequency should be monthly until such time as the results can be assessed for stability.

The recommended RMP location was partly based on the fact that the harvester does not currently intend to harvest from south of Whitefarland Point and thus the local impact of pollution sources to the south of there were not taken into account. The limits of the production area need to take into account that potential sources of pollution in the Mull of Kintyre have not been assessed.

The recommended production area is therefore the area bound by lines drawn between NR 8870 4800 and NR 8600 4800 and between NR 8600 4800 and NR 8600 4260 and between NR 8600 4260 and NR 8650 4260, extending to MHWS.

If it is subsequently intended that harvesting take place south of Whitefarland Point, then a review of the location of the RMP should be undertaken based on this sanitary survey, supplemented by any significant information immediately available from the local authority, SEPA and Scottish Water, prior to extension of the production area.

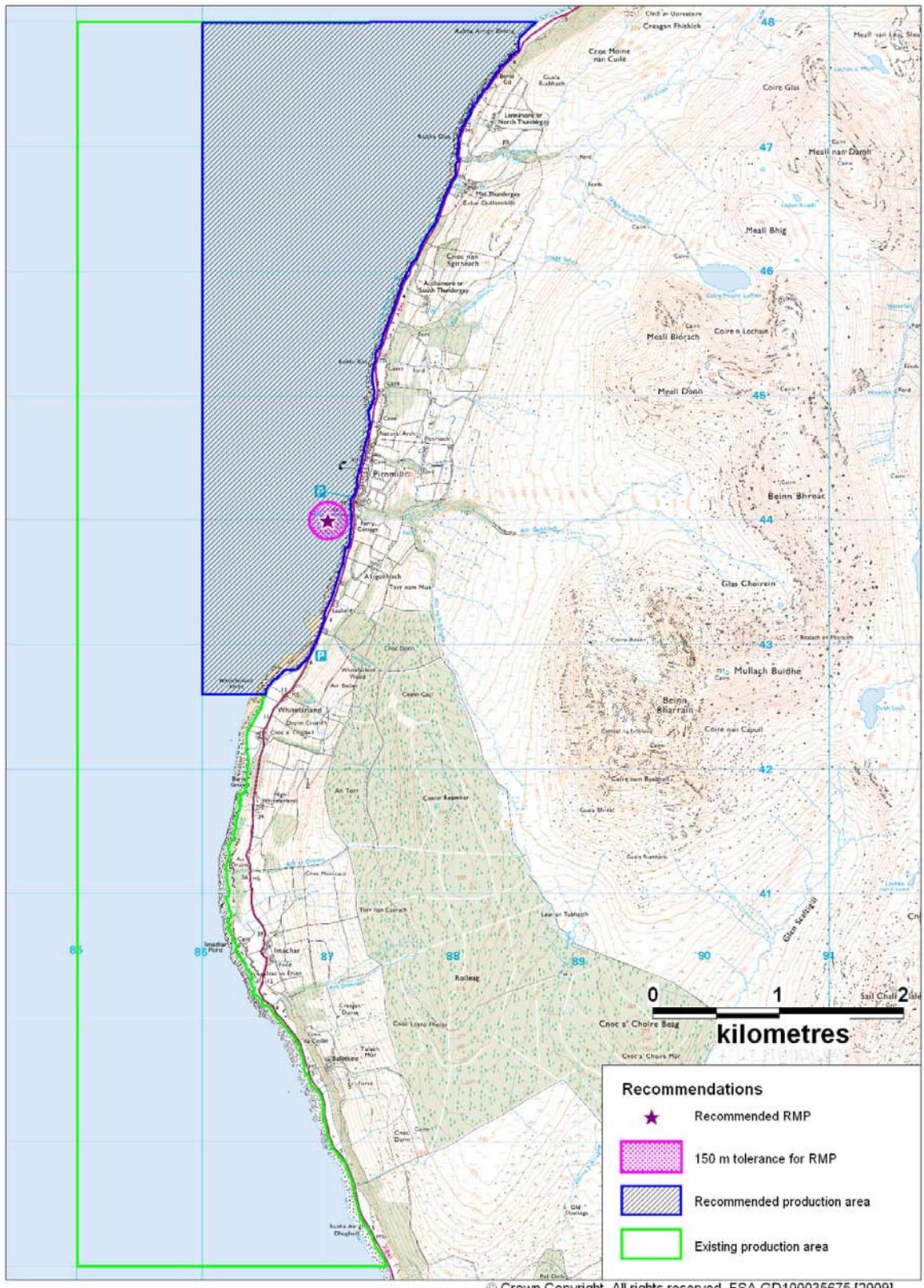


Figure 11.1 Recommendations for Arran: Pirmill

## References

Lee, R.J., Morgan, O.C. (2003). Environmental factors influencing the microbial contamination of commercially harvested shellfish. *Water Science and Technology* 47, 65-70.

Mallin, M.A., Ensign, S.H., McIver, M.R., Shank, G.C., Fowler, P.K. (2001). Demographic, landscape, and meteorological factors controlling the microbial pollution of coastal waters. *Hydrobiologia* 460, 185-193.

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# Appendices

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2. **Table of Proposed Boundaries and RMPs**
3. **Shoreline Survey Report**

### Sampling Plan for Arran: Pirnmill

PRODUCTION AREA	SITE NAME	SIN	SPECIES	TYPE OF FISHERY	NGR OF RMP	EAST	NORTH	TOLERANCE (M)	DEPTH (M)	METHOD OF SAMPLING	FREQ OF SAMPLING	LOCAL AUTHORITY	AUTHORISED SAMPLER(S)	LOCAL AUTHORITY LIAISON OFFICER
Arran: Pirnmill	Pirnmill	NA 008 330 16	Razor clams	Wild	NR 8700 4400	87000	944000	150	NA	Hand dived	Monthly	Argyll & Bute Council	Christine McLachlan William MacQuarrie Ewan McDougall Donald Campbell	Christine McLachlan

### Table of Proposed Boundaries and RMPs – Arran: Pirnmill

Production Area	Species	SIN	Existing Boundary	Existing RMP	New Boundary	New RMP	Comments
Arran: Pirnmill	Razor clams	NA 008 330 16	Area inshore of a line drawn between NR 8866 4800 and NR 8500 4800 and between NR 8500 4800 and NR 8500 3800 and between NR 8500 3800 and NR 8747 3800	NA	Area bounded by lines drawn between NR 8870 4800 and NR 8600 4800 and between NR 8600 4800 and NR 8600 4260 and between NR 8600 4260 and NR 8650 4260, extending to MHWS	NR 8700 4400	

# Shoreline Survey Report



## Arran: Pirnmill

NA 008 330 16

Scottish Sanitary Survey Project  **Cefas**

## Shoreline Survey Report

Production area: Arran: Pirnmill  
 Site name: Pirnmill  
 Species: Razors  
 Harvester: Mr Hector Stewart  
 Local Authority: Argyll & Bute Council and North Ayrshire Council  
 Status: New site

Date Surveyed: 20<sup>th</sup> & 22<sup>nd</sup> January, 4<sup>th</sup> & 18<sup>th</sup> February 2009  
 Surveyed by: Andrew Miller North Ayrshire Council  
 William Murray North Ayrshire Council  
 Cathy McGorran North Ayrshire Council  
 William MacQuarrie Argyll & Bute Council  
 Christine McLachlan Argyll & Bute Council

Existing RMP: N/A  
 Area Surveyed: See Figure 1.

### Weather observations

20<sup>th</sup> January: Overcast, SW winds, occasional light showers but mainly dry.  
 22<sup>nd</sup> January: Heavy rainfall previous night, dry during survey, strong SW winds.  
 4<sup>th</sup> February: Clear, dry, NE wind.  
 18<sup>th</sup> February: Dry, overcast, SW wind force 2.

### Site Observations

#### Fishery

The Arran Pirnmill site is harvested for Razors (*Ensis spp*). The razors are hand gathered by divers and will be harvested all year round. The razor bed extends from NR86136 40625 (south end) to NR88256 47825 (north end) and occupies a narrow strip of land following the shore, going no deeper than 8 metres.

#### Sewage/Faecal Sources

The area surveyed includes the settlements of Pirnmill, Imachar, Whitefarland, South Thundergay, Mid Thundergay and North Thundergay. There is one SW community septic tank serving the Pirnmill area. During the shoreline survey Pirnmill public toilets were located in addition to two other septic tanks and several outfall pipes.

#### Seasonal Population

There are no campsites/caravans in the area. Several B&Bs were observed in Pirnmill.

**Boats/Shipping**

No boats were seen on the 20<sup>th</sup> and 22<sup>nd</sup> January however, 1 large fishing boat, 1 small freighter and 1 large tugboat were observed off the coastline on the 4<sup>th</sup> February.

**Land Use**

Most of this part of the coastline of Arran was composed of raised beaches. Where slopes were found to be gentle, houses and farms had been built and the better land is used for pasture for animals. No arable land was noted.

**Wildlife/Birds**

Wildlife present in the area mostly consisted of birds, including seagulls, herons, swans, oystercatchers and gannets. Seals are known to be present in the area but none were seen during the survey. Deer are present on the hillside and are managed by the estate.

**Livestock**

The majority of the livestock were observed south of Whitefarland Point. Sheep were frequently seen in the hills above the shoreline from the area of coastline stretching from Balliekine to Cnoc a' Chaibeil. North of Whitefarland Point livestock was more sparse with only a few sheep and 20 cattle observed.

Observations can be found in Table 1 and mapped in Figures 1 and 2.

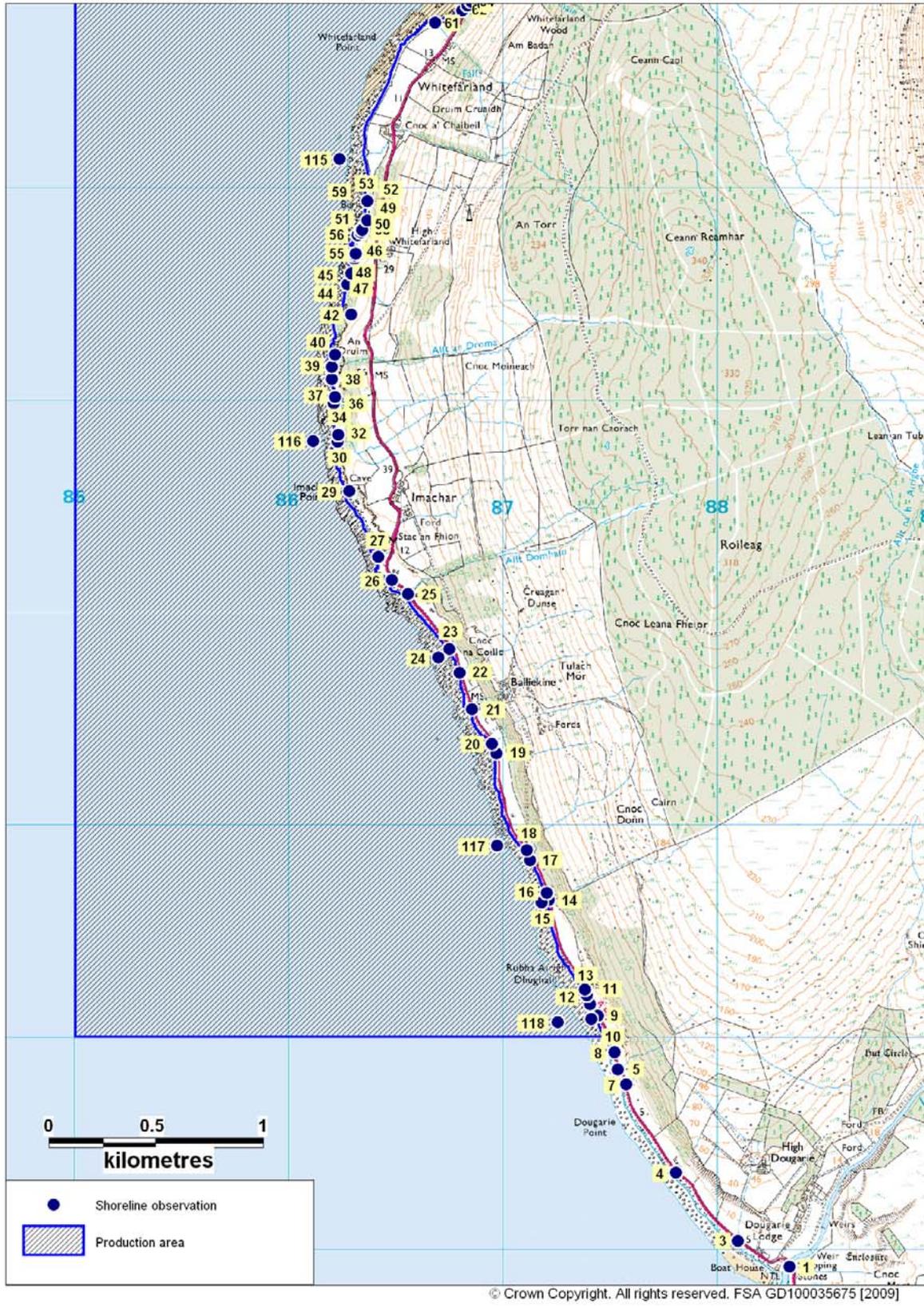


Figure 1. Shoreline observations – Southern end of Arran: Pirmill

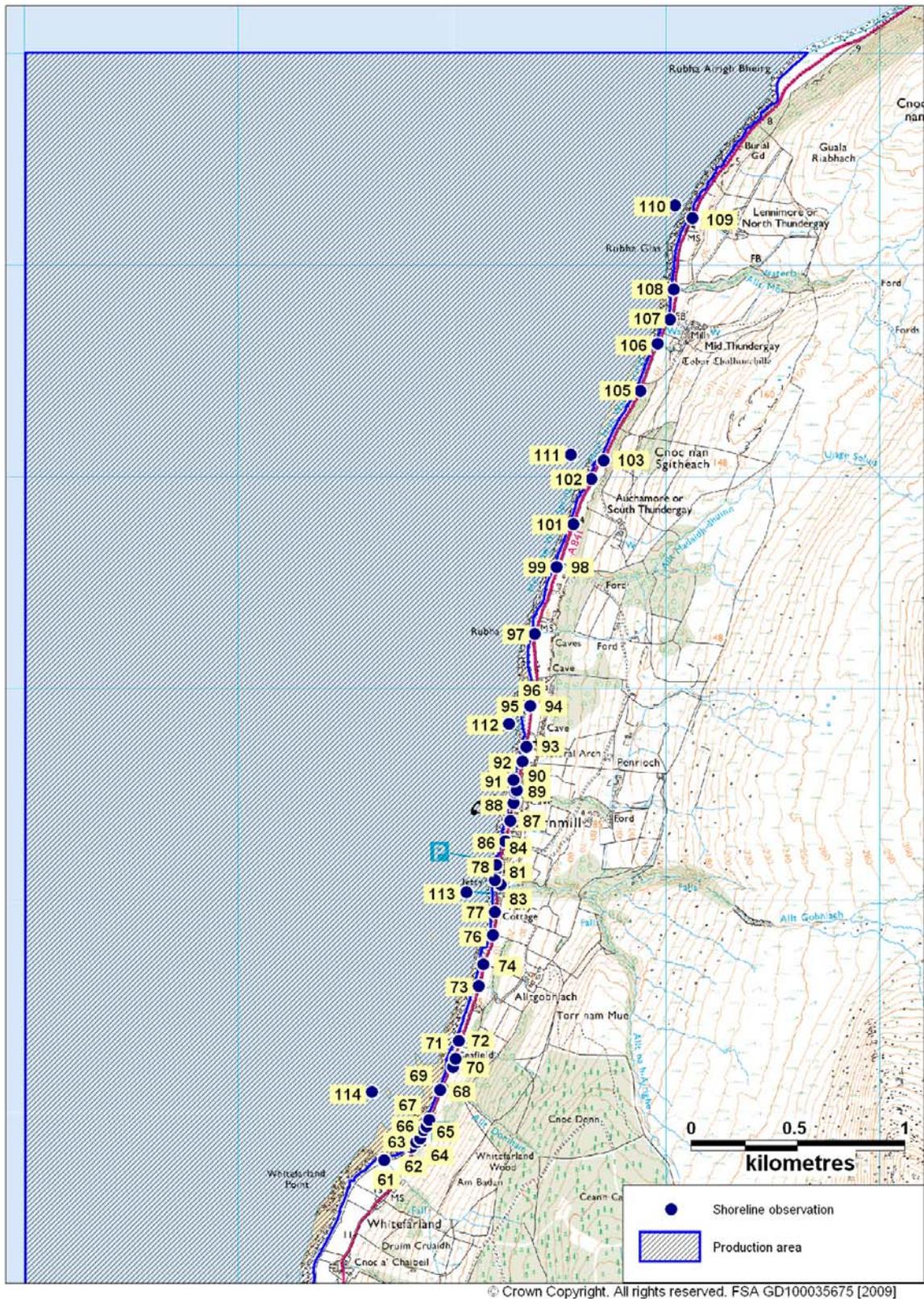


Figure 2. Shoreline observations – Northern end of Arran: Pirmill

Table 1. Shoreline observations

No.	Date	Time	NGR	East	North	Associated photograph	Description
1	20/01/2009	09:15	NR 88336 36925	188336	636925	Figure 6	River lorsa, approx 60 sheep in field to north, 4 houses next to river. Water sample 1, day 1 (fresh water).
2	20/01/2009	-	-	-	-	Figure 7 & 8	Photograph of shoreline looking south and north.
3	20/01/2009	09:42	NR 88095 37045	188095	637045	Figure 9	Stream running through field and under road, approx 60 sheep in field, 4 houses on hill next to stream, just north of River lorsa. Water sample 2, day 1 (freshwater).
4	20/01/2009	09:52	NR 87806 37368	187806	637368		Stream running through field and under road, little flow, no sample.
5	20/01/2009	09:57	NR 87534 37854	187534	637854		Small stream running through field and under road, little flow, no sample.
6	20/01/2009	-	NS 87576 37785	287576	637785	Figure 10	Photograph of shoreline looking north.
7	20/01/2009	-	NR 875341 37852	187576	637785		Stream running off hill, water sample 4, day 1 (freshwater).
8	20/01/2009	-	NR 87520 37934	187520	637934		Drain for road, dry at time of survey.
9	20/01/2009	10:30	NR 87442 38106	187442	638106	Figure 11	Small stream running under road from field and hill behind. W 0.52, D 0.035, Flow 0.334 m/s. Water sample 5, day 1 (freshwater).
10	20/01/2009	10:30	NR 87413 38090	187413	638090		Water sample 6, day 1 (seawater).
11	20/01/2009	-	NR 87405 38160	187405	638160		Water sample 7, day 1 (freshwater).
12	20/01/2009	-	NR 87392 38202	187392	638202	Figure 12	Stream. Unknown manhole cover.
13	20/01/2009	-	NR 87383 38229	187383	638229		Stream running under road, no sample.
14	20/01/2009	12:05	NR 87213 38651	187213	638651		Stream running under road. W 0.90, D 0.06, Flow 0.294 m/s. Water sample 8, day 1 (freshwater).
15	20/01/2009	12:05	NR 87179 38638	187179	638638		Water sample 9, day 1 (seawater).
16	20/01/2009	12:20	NR 87204 38684	187204	638684		Stream, metal basket with stones 10 yards up from location of water sample 8, day 1.
17	20/01/2009	-	NR 87125 38837	187125	638837	Figure 13	Concrete pipe like structure probably electricity cables.
18	20/01/2009	-	NR 87112 38885	187112	638885		Stream, small flow, water sample 11, day 1 (freshwater).
19	20/01/2009	12:56	NR 86968 39340	186968	639340		Stream running under road, no sample.
20	20/01/2009	13:00	NR 86949 39385	186949	639385	Figure 14	Pipe lower than beach creating pond, small flow. Water sample 12, day 1 (freshwater).
21	20/01/2009	13:10	NR 86854 39549	186854	639549		15 Sheep in field with stream running through. W 0.70, D 0.07, Flow 0.201 m/s. Water sample 13, day 1 (freshwater). 2 houses at Balliekin to the east.
22	20/01/2009	13:20	NR 86798 39721	186798	639721		Stream. W 0.65, D 0.09, Flow 0.0309 m/s. Water sample 13B, day 1 (freshwater).
23	20/01/2009	13:45	NR 86749 39833	186749	639833		Stream running under road. W 0.33, D 0.03, Flow 0.647 m/s. Water sample 14, day 1 (freshwater).
24	20/01/2009	13:45	NR 86697 39793	186697	639793		Water sample 15, day 1 (seawater).
25	20/01/2009	13:58	NR 86556 40090	186556	640090		Stream. W 1.00, D 0.09, Flow 0.291 m/s. No animals in field next to beach but approx. 20 sheep on high hills behind. Water sample 16, day 1 (freshwater).
26	20/01/2009	14:10	NR 86480 40157	186480	640157		Small stream running under road. Water sample 17, day 1 (freshwater).
27	22/01/2009	14:30	NR 86417 40264	186417	640264		Large stream. W 0.90, D 0.07, Flow 0.765 m/s. Water sample 18, day 1 (freshwater).
28	20/01/2009	-	-	-	-	Figure 15	Photograph of shoreline looking North at Imachar (est. 8 houses).
29	20/01/2009	-	NR 86283 40575	186283	640575		Small flow of water off cliff rocks.
30	20/01/2009	-	NR 86229 40807	186229	640807		Small stream, little flow, running to sea.

No.	Date	Time	NGR	East	North	Associated photograph	Description
31	20/01/2009	-	-	-	-	Figure 16	Photograph of stream noted and sampled below.
32	22/01/2009	09:24	NR 86232 40840	186232	640840		Sheep in fields above cliffs but cannot see them. Stream. W 1.10, D 0.15, 0.985 m/s. Water sample 1, day 2 (freshwater).
33	22/01/2009	-	-	-	-	Figure 17	Photograph of waterfall off cliff flowing into stream in (water sample 1, day 2).
34	22/01/2009	09:24	NR 86232 40840	186232	640840	Figure 18	Water sample 2, day 2 (seawater).
35	22/01/2009	-	-	-	-		Photograph of shoreline looking North.
36	22/01/2009	09:50	NR 86210 40987	186210	640987	Figure 19	Natural stream, probably only runs in heavy rain. W 0.46, D 0.06, Flow 0.105. Water sample 2B, day 2 (freshwater).
37	22/01/2009	09:55	NR 86217 41017	186217	641017		Small stream, running through grass. W 0.30, D 0.09, Flow 0.104 m/s. Water sample 3, day 2 (freshwater).
38	22/01/2009	10:10	NR 86200 41103	186200	641103		Small natural stream flowing down to sea. W 0.35, D 0.05, Flow 0.143 m/s. Water sample 4, day 2 (freshwater).
39	22/01/2009	10:19	NR 86201 41159	186201	641159		Flow from waterfall off cliff. W 1.20, D 0.12, Flow 0.414 m/s. Water sample 5, day 2 (freshwater).
40	22/01/2009	10:34	NR 86216 41218	186216	641218		Small stream. W 0.45, D 0.10, Flow 0.065 m/s. Water sample 6, day 2 (freshwater).
41	22/01/2009	-	-	-	-	Figure 20	Photograph of shoreline looking north.
42	22/01/2009	11:00	NR 86293 41406	186293	641406		Flow off cliff. Water sample 7, day 2 (freshwater). 2 Ducks in the sea.
43	22/01/2009	-	-	-	-	Figure 21	Photograph of the sea
44	22/01/2009	11:09	NR 86275 41547	186275	641547		Large stream. W 1.00, D 0.09, Flow 0.21 m/s. Water sample 8, day 2 (freshwater).
45	22/01/2009	11:25	NR 86292 41599	186292	641599		Small flow, no sample.
46	22/01/2009	11:28	NR 86307 41670	186307	641670	Figure 22	Large stream. W 1.00, D 0.09, Flow 0.693 m/s. Water sample 9, day 2 (freshwater).
47	22/01/2009	-	NR 86307 41684	186307	641684		Small natural stream, no sample.
48	22/01/2009	11:40	NR86313 41693	186313	641693		Small stream, no sample.
49	22/01/2009	11:45	NR 86322 41780	186322	641780		Small stream. W 0.09, D 0.05, Flow 0.263 m/s. Water sample 10, day 2 (freshwater).
50	22/01/2009	11:54	NR 86336 41793	186336	641793		Small stream, small flow, no sample.
51	22/01/2009	11:55	NR 86343 41805	186343	641805		Flow between rocks. W 0.10, D 0.02, Flow 0.372 m/s. Water sample 11, day 2 (freshwater).
52	22/01/2009	12:05	NR 86366 41849	186366	641849		Natural stream. W 0.17, D 0.04, Flow 0.467 m/s. No animals or wildlife on raised beach next to cliffs, approx. 20 sheep in fields on top of cliffs. Water sample 12, day 2 (freshwater).
53	22/01/2009	12:14	NR 86366 41939	186366	641939		Flow between rocks. Water sample missing.
54	22/01/2009	-	-	-	-	Figure 23 & 24	Photograph of shoreline looking north and south.
55	22/01/2009	12:14	NR 86358 42151	186313	641693	Figure 25	Large stream runs beside 6 houses, probable that septic tanks run into stream. W 2.00, D 0.27, Flow 0.233 m/s. Water sample 14, day 2 (freshwater). Evidence of sheep droppings in field next to stream.
56	22/01/2009	-	NR 86325 42138	186322	641780		Water sample 15, day 2 (seawater).
57	04/02/2009	09:02	NR 86442 42421	186336	641793		Small stream. W 0.15, D 0.01, Flow 0.404 m/s. Water sample 1, day 3 (freshwater).
58	04/02/2009	09:11	NR 86494 42555	186343	641805		20cm clay pipe, field drain, houses at other side of field (see photograph 114). Water sample 2, day 3 (freshwater).
59	04/02/2009	09:24	NR 86557 42682	186366	641849		Water flowing down through gravel for 10m.
60	04/02/2009	-	-	-	-	Figure 26	Photograph of houses at other side of field with stream running down the side.
61	04/02/2009	09:30	NR 86682 42779	186682	642779		Stream with pond, stream runs beside two houses and through pasture field, 20 seagulls, 5 oyster catchers, 1 gannet. W 0.65, D 0.10, Flow 0.206 m/s. Water sample 3, day 3 (freshwater).
62	04/02/2009	09:42	NR 86809 42838	186809	642838		Small stream. W 0.30, D 0.04, Flow 0.403 m/s. Water sample 4, day 3 (freshwater).

No.	Date	Time	NGR	East	North	Associated photograph	Description
63	04/02/2009	09:50	NR 86834 42863	186834	642863		15cm pipe, next to swing park, drain from road? Water sample 5, day 3 (freshwater).
64	04/02/2009	09:56	NR 86851 42881	186851	642881		Pipe under road. Road drain, small flow, no sample.
65	04/02/2009	10:00	NR 86867 42920	186867	642920		23cm pipe, water sample 6, day 3 (freshwater).
66	04/02/2009	10:09	NR 86882 42939	186882	642939		15cm pipe small flow, no sample.
67	04/02/2009	10:11	NR 86894 42968	186894	642968		23cm pipe, water sample 7, day 3 (freshwater).
68	04/02/2009	10:26	NR 86945 43108	186945	643108	Figure 27	Large stream running through culvert in road and down seawall runs beside house (Learig). W 1.00, D 0.03, Flow 0.466 m/s. Water sample 8, day 3 (freshwater).
69	04/02/2009	10:26	NR 86945 43108	186945	643108		Water sample 9, day 3 (seawater).
70	04/02/2009	10:55	NR 87005 43218	187005	643218		Flow through rocks in breakwater. On other side of road is a small stream, water sample 10, day 3 (freshwater).
71	04/02/2009	11:08	NR 87018 43257	187018	643257		Stream 10m north of the above water sample.
72	04/02/2009	11:14	NR 87032 43342	187032	643342	Figure 28	Stream runs between two houses. W 0.60, D 0.045, Flow 0.441 m/s. Water sample 11, day 3 (freshwater).
73	04/02/2009	11:30	NR 87126 43599	187126	643599		27cm pipe running under road. Water sample 12, day 3 (freshwater).
74	04/02/2009	11:43	NR 87148 43702	187148	643702		Stream that probably runs through Allt Gobhlach Farm, some sheep on high hill directly behind farm. W 0.35, D 0.02, Flow 0.375 m/s. Water sample 13, day 3 (freshwater).
75	04/02/2009	-	-	-	-	Figure 29	Photograph of snow on hills.
76	04/02/2009	11:52	NR 87191 43840	187191	643840		Small stream running under road. W 0.25, D 0.03, Flow 0.775 m/s. Water sample 14, day 3 (freshwater).
77	04/02/2009	12:00	NR 87201 43950	187201	643950		Stream running at side of Ferry cottage, stream runs through pastureland. W 0.25, D 0.03, Flow 0.35 m/s. Water sample 15, day 3 (freshwater).
78	04/02/2009	-	NR 87229 44080	187229	644080	Figure 30	Public toilets Pirnmill with probable septic tank but no sign of pipe into river Allt Gobhlach.
79	04/02/2009	-	-	-	-	Figure 31	River Allt Gobhlach with probable septic tank pipe, no flow.
80	04/02/2009	-	-	-	-	Figure 32	River Allt Gobhlach with clay pipe running along side it, no flow.
81	04/02/2009	12:20	NR 87203 44145	187203	644145	Figure 33	River Allt Gobhlach. W 3.00, D 0.35, Flow 0.615 m/s. Water sample 16, day 3 (freshwater).
82	04/02/2009	-	-	-	-		Photograph of shoreline looking north from Pirnmill. To left is SW septic tank and outfall.
83	04/02/2009	-	NR 872 441	187200	644100		Scottish Water Septic tank and manhole covers.
84	04/02/2009	12:46	NR 87206 44172	187206	644172		Scottish Water Discharge point. Pipe discharge from septic tank appears broken; flow comes from rocks in bushes. Water sample 17, day 3 (freshwater).
85	04/02/2009	-	-	-	-	Figure 34	Photograph of shoreline looking north through Pirnmill.
86	04/02/2009	12:53	NR 87250 44284	187250	644284		Church hall directly behind and approx 8 houses. Small stream. W 0.30, D 0.04, Flow 0.042 m/s. Water sample 18, day 3 (freshwater).
87	04/02/2009	13:01	NR 87273 44380	187273	644380	Figure 35	Stream between 2 houses and under road with probable septic tank pipe flowing into stream. W 0.20, D 0.04, Flow 0.013 m/s. Water sample 19, day 3 (freshwater).
88	04/02/2009	13:11	NR 87287 44464	187287	644464	Figure 36	Black pipe from under road, no flow.
89	04/02/2009	13:16	NR 87295 44517	187295	644517	Figure 37	Scottish Water Septic Tank "SEP TK 2 NR 873/446". Water sample 20, day 3 (septic tank outflow).
90	04/02/2009	13:20	NR 87305 44525	187305	644525	Figure 38 & 39	Large stream flowing under road just north of primary school. W 0.80, D 0.22, Flow 0.44 m/s. Water sample 21, day 3 (freshwater).
91	04/02/2009	13:33	NR 87288 44572	187288	644572	Figure 40	Septic tank and outfall pipe. Water sample 22, day 3 (septic tank outflow).
92	04/02/2009	13:40	NR 87331 44660	187331	644660		Pipe running under road from stream running between two houses. Water sample 23, day 3 (freshwater).

No.	Date	Time	NGR	East	North	Associated photograph	Description
93	04/02/2009	13:47	NR 87350 44731	187350	644731	Figure 41	Mystery concrete block with manhole, no outlet pipes.
94	04/02/2009	13:52	NR 87366 44923	187366	644923		Small flow, no sample, heron on beach.
95	04/02/2009	13:55	NR 87390 453031	187366	644923		Stream runs between 4 houses, woodland to the rear. W 0.20, D 0.03, Flow 0.746 m/s. Water sample 24, day 3 (freshwater).
96	04/02/2009	13:55	NR 87390 453031	187366	644923	Figure 42	Approx 20 cattle in field just north of water sample 24, day 3.
97	04/02/2009	14:05	NR 87389 45264	187389	645264		Stream running through field. W 0.40, D 0.05, Flow 0.329 m/s. Water sample 25, day 3 (freshwater).
98	04/02/2009	14:15	NR 87490 45580	187490	645580	Figure 43	Large stream running under road, house to left of stream, 2 houses at South Thunderguy. W 0.70, D 0.16, Flow 0.37 m/s. Drains may run into this stream, rough pastureland around stream. Water sample 26, day 3 (freshwater).
99	04/02/2009	14:15	NR 87490 45580	187490	645580		2 swans in the sea. Water sample 27, day 3 (seawater).
100	04/02/2009	-	-	-	-	Figure 44	Photograph of shoreline looking north.
101	04/02/2009	14:28	NR 87568 45781	187568	645781		Stream running from road, small flow, no sample.
102	04/02/2009	14:32	NR 87653 45996	187653	645996		Stream running from hill and under road. W 0.040, D 0.04, Flow 0.11 m/s. Water sample 28, day 3 (freshwater).
103	04/02/2009	14:38	NR 87711 46083	187711	646083		Small stream from road, small flow, no sample. 2 houses close by.
104	04/02/2009	-	-	-	-		Photograph of shoreline looking north.
105	04/02/2009	14:44	NR 87881 46409	187881	646409		Pipe running under road, small flow, no sample.
106	04/02/2009	14:49	NR 87962 46632	187962	646632		Pipe running under road. Water sample 29, day 3 (freshwater).
107	04/02/2009	14:58	NR 88021 46748	188021	646748		Stream running down under road from Mid Thunderguy (up to 7 houses in Thunderguy). W 0.15, D 0.01, Flow 0.561 m/s. Water sample 30, day 3 (freshwater).
108	04/02/2009	15:04	NR 88039 46890	188039	646890	Figure 45	Large stream, 3 houses at Lennimore close by. W 2.70, D 0.20, Flow 0.282 m/s. Some rough grazing land. Water sample 31, day 3 (freshwater).
109	04/02/2009	15:20	NR 88125 47226	188125	647226		Small flow under road, no sample.
110	18/02/2009	08:25	NR88044 47286	188044	647286		Seawater sample 1 and Razor sample 1
111	18/02/2009	08:50	NR87558 46109	187558	646109		Seawater sample 2 and Razor sample 2
112	18/02/2009	09:05	NR87266 44837	187266	644837		Seawater sample 3 and Razor sample 3
113	18/02/2009	09:15	NR87068 44042	187068	644042		Seawater sample 4 and Razor sample 4
114	18/02/2009	09:30	NR86625 43101	186625	643101		Seawater sample 5 and Razor sample 5
115	18/02/2009	09:40	NR86238 42138	186238	642138		Seawater sample 5 and Razor sample 6
116	18/02/2009	09:55	NR86144 40810	186114	640810		Seawater sample 6 and Razor sample 7
117	18/02/2009	10:05	NR86971 38907	186971	638907		Seawater sample 7 and Razor sample 8
118	18/02/2009	10:30	NR87254 38077	187254	638077		Seawater sample 8, no razor sample from here as no razors found – too rocky

Photos referenced in the table can be found attached as Figures 6 - 45.

## Sampling

Water and shellfish samples were collected at sites marked on the map (Figures 3 and 4). Bacteriology results follow in Tables 2 and 3.

Water samples were collected over three days and sent to Glasgow Scientific Services for analysis. Bacteriology results follow in Table 2. Shellfish samples were collected on the closest possible date to the shoreline survey; results are shown in Table 3 and mapped in Figure 5.

Seawater samples were tested for salinity by the laboratory using a salinity meter under controlled conditions. These results are shown in Table 2, given in units of grams salt per litre of water. This is equivalent to ppt.

Table 2. Water sample results

No.	Date	Sample ref.	Grid Ref	Type	<i>E. coli</i> (cfu/100ml)	Salinity (g/L)
1	20/01/2009	Fresh 1	NR 87442 38106	Fresh water	<100	-
2	20/01/2009	Fresh 2	NR 88095 37045	Fresh water	400	-
3	20/01/2009	Fresh 4	NR 87534137852	Fresh water	<100	-
4	20/01/2009	Fresh 5	NR 87442 38106	Fresh water	<100	-
5	20/01/2009	Seawater 6	NR 87413 38090	Sea water	1	25
6	20/01/2009	Fresh 7	NR 87405 38160	Fresh water	<100	-
7	20/01/2009	Fresh 8	NR 87213 38651	Fresh water	<100	-
8	20/01/2009	Seawater 9	NR 87179 38638	Sea water	1	24.2
9	20/01/2009	Fresh 10	NR 87204 38684	Fresh water	<100	-
10	20/01/2009	Fresh 11	NR 87112 38885	Fresh water	<100	-
11	20/01/2009	Fresh 12	NR 86949 39385	Fresh water	<100	-
12	20/01/2009	Fresh 13	NR 86854 39549	Fresh water	<100	-
13	20/01/2009	Fresh 13B	NR 86798 39721	Fresh water	<100	-
14	20/01/2009	Fresh 14	NR 86749 39833	Fresh water	100	-
15	20/01/2009	Seawater 15	NR 86697 39793	Sea water	21	26
16	20/01/2009	Fresh 16	NR 86556 40090	Fresh water	<100	-
17	20/01/2009	Fresh 17	NR 86480 40157	Fresh water	<100	-
18	20/01/2009	Fresh 18	NR 86417 40204	Fresh water	10000	-
19	22/01/2009	Fresh 1 (Day 2)	NR 86232 40840	Fresh water	<100	-
20	22/01/2009	Seawater 2 (Day 2)	NR 86232 40840	Sea water	15	12.5
21	22/01/2009	Fresh 2B (Day 2)	NR 86210 40987	Fresh water	400	-
22	22/01/2009	Fresh 3 (Day 2)	NR 86217 41017	Fresh water	300	-
23	22/01/2009	Fresh 4 (Day 2)	NR 86200 41103	Fresh water	<100	-
24	22/01/2009	Fresh 5 (Day 2)	NR 86201 41159	Fresh water	100	-
25	22/01/2009	Fresh 6 (Day 2)	NR 86232 40840	Fresh water	<100	-
26	22/01/2009	Fresh 7 (Day 2)	NR 86293 14106	Fresh water	100	-
27	22/01/2009	Fresh 8 (Day 2)	NR 86275 41547	Fresh water	100	-
28	22/01/2009	Fresh 9 (Day 2)	NR 86307 41670	Fresh water	<100	-
29	22/01/2009	Fresh 10 (Day 2)	NR 86322 41780	Fresh water	<100	-
30	22/01/2009	Fresh 11 (Day 2)	NR 86343 41805	Fresh water	<100	-
31	22/01/2009	Fresh 12 (Day 2)	NR 86366 41849	Fresh water	<100	-
32	22/01/2009	Fresh 14 (Day 2)	NR 86358 42151	Fresh water	100	-
33	22/01/2009	Seawater 15 (Day 2)	NR 86325 42138	Sea water	16	28.3

No.	Date	Sample ref.	Grid Ref	Type	<i>E. coli</i> (cfu/100ml)	Salinity (g/L)
34	05/02/2009	Fresh 1 (Day 3)	NR 86442 42421	Fresh water	<100	-
35	05/02/2009	Fresh 2 (Day 3)	NR 86494 42555	Fresh water	<100	-
36	05/02/2009	Fresh 3 (Day 3)	NR 86682 42779	Fresh water	<100	-
37	05/02/2009	Fresh 4 (Day 3)	NR 86809 42838	Fresh water	<100	-
38	05/02/2009	Fresh 5 (Day 3)	NR 86834 42863	Fresh water	<100	-
39	05/02/2009	Fresh 6 (Day 3)	NR 86867 42920	Fresh water	<100	-
40	05/02/2009	Fresh 7 (Day 3)	NR 86894 42968	Fresh water	<100	-
41	05/02/2009	Fresh 8 (Day 3)	NR 86945 43108	Fresh water	<100	-
42	05/02/2009	Seawater 9 (Day 3)	NR 86442 42421	Sea water	17	27.4
43	05/02/2009	Fresh 10 (Day 3)	NR 87005 43218	Fresh water	<100	-
44	05/02/2009	Fresh 11 (Day 3)	NR 87032 43342	Fresh water	<100	-
45	05/02/2009	Fresh 12 (Day 3)	NR 87126 43599	Fresh water	<100	-
46	05/02/2009	Fresh 13 (Day 3)	NR 87148 43702	Fresh water	400	-
47	05/02/2009	Fresh 14 (Day 3)	NR 87191 43840	Fresh water	<100	-
48	05/02/2009	Fresh 15 (Day 3)	NR 87201 43950	Fresh water	<100	-
49	05/02/2009	Fresh 16 (Day 3)	NR 87203 44145	Fresh water	<100	-
50	05/02/2009	Fresh 17 (Day 3)	NR 87206 44172	Fresh water	<100	-
51	05/02/2009	Fresh 18 (Day 3)	NR 87250 44284	Fresh water	<100	-
52	05/02/2009	Fresh 19 (Day 3)	NR 87273 44380	Fresh water	1700	-
53	05/02/2009	Fresh 20 (Day 3)	NR 87295 44517	Septic tank outflow	2100	-
54	05/02/2009	Fresh 21 (Day 3)	NR 87305 44525	Fresh water	<100	-
55	05/02/2009	Fresh 22 (Day 3)	NR 87288 44572	Septic tank outflow	<100	-
56	05/02/2009	Fresh 23 (Day 3)	NR 87331 44660	Fresh water	<100	-
57	05/02/2009	Fresh 24 (Day 3)	NR 87390 45031	Fresh water	<100	-
58	05/02/2009	Fresh 25 (Day 3)	NR 87389 45264	Fresh water	2100	-
59	05/02/2009	Fresh 26 (Day 3)	NR 87490 45580	Fresh water	100	-
60	05/02/2009	Seawater 27 (Day 3)	NR 87490 45580	Sea water	2	20.9
61	05/02/2009	Fresh 28 (Day 3)	NR 87653 45996	Fresh water	<100	-
62	05/02/2009	Fresh 29 (Day 3)	NR 87962 46632	Fresh water	<100	-
63	05/02/2009	Fresh 30 (Day 3)	NR 88021 46748	Fresh water	<100	-
64	05/02/2009	Fresh 31 (Day 3)	NR 88039 46890	Fresh water	<100	-
65	05/02/2009	Seawater (Day 3)	NR 88039 46890	Sea water	2	25
66	18/02/2009	P/MILL W1	NR88044 47286	Sea water	0	31.5
67	18/02/2009	P/MILL W2	NR87558 46109	Sea water	0	31.5
68	18/02/2009	P/MILL W3	NR87266 44837	Sea water	0	31.5
69	18/02/2009	P/MILL W4	NR87068 44042	Sea water	1	31.6
70	18/02/2009	P/MILL W5	NR86625 43101	Sea water	0	30.8
71	18/02/2009	P/MILL W6	NR86238 42138	Sea water	0	31.6
72	18/02/2009	P/MILL W7	NR86144 40810	Sea water	0	31.6
73	18/02/2009	P/MILL W8	NR86971 38907	Sea water	0	30.8

Table 3. Shellfish sample results

No.	Date	Sample ref.	Grid Ref	Type	E. coli (cfu/100g)
1	18/02/2009	Pirnmill R1	NR88044 47286	Razors	20
2	18/02/2009	Pirnmill R2	NR87558 46109	Razors	<20
3	18/02/2009	Pirnmill R3	NR87266 44837	Razors	<20
4	18/02/2009	Pirnmill R4	NR87068 44042	Razors	20
5	18/02/2009	Pirnmill R5	NR86625 43101	Razors	<20
6	18/02/2009	Pirnmill R6	NR86238 42138	Razors	<20
7	18/02/2009	Pirnmill R7	NR86144 40810	Razors	90
8	18/02/2009	Pirnmill R8	NR86971 38907	Razors	<20

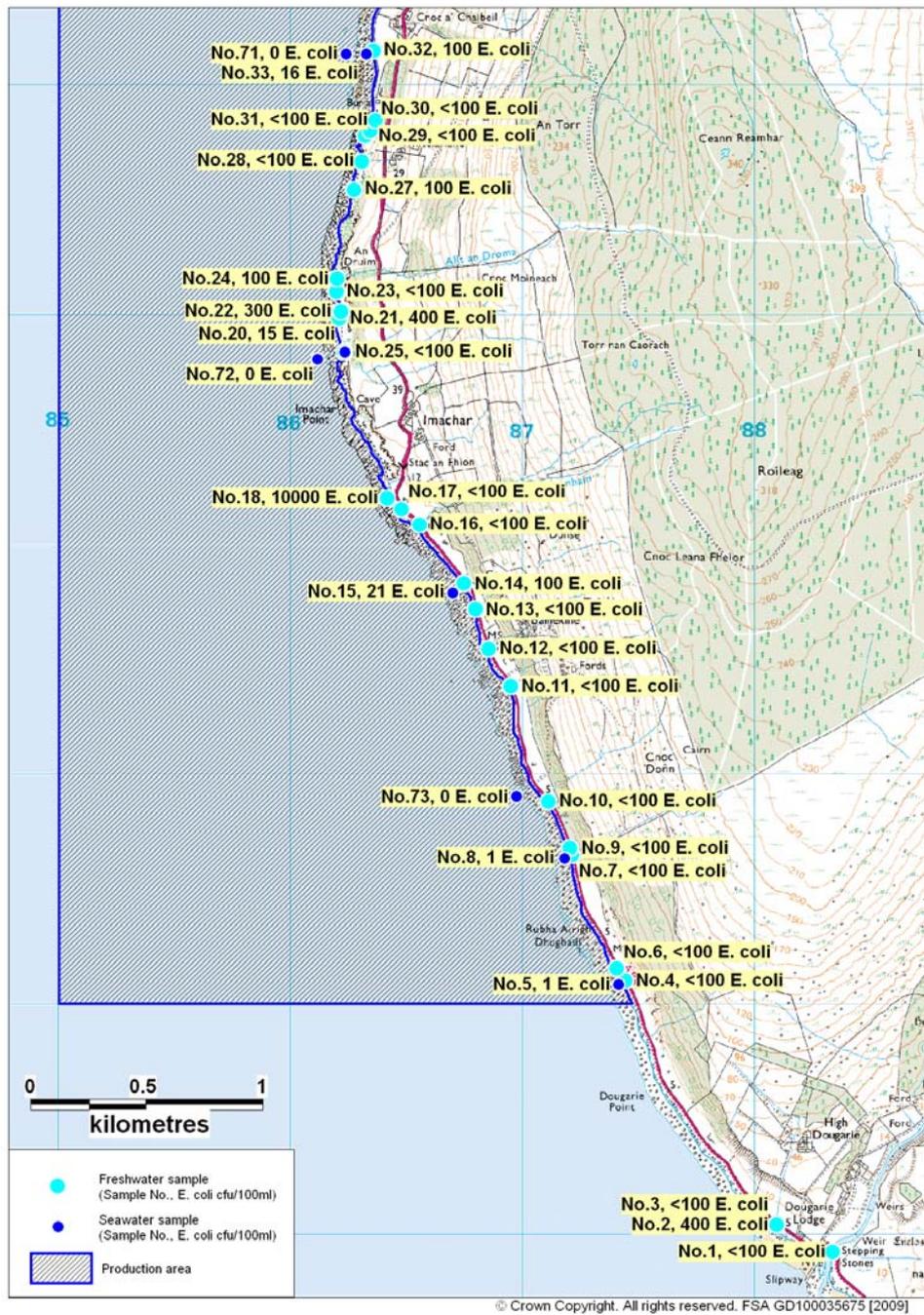


Figure 3. Water sample results – Southern end of Arran: Pirnmill

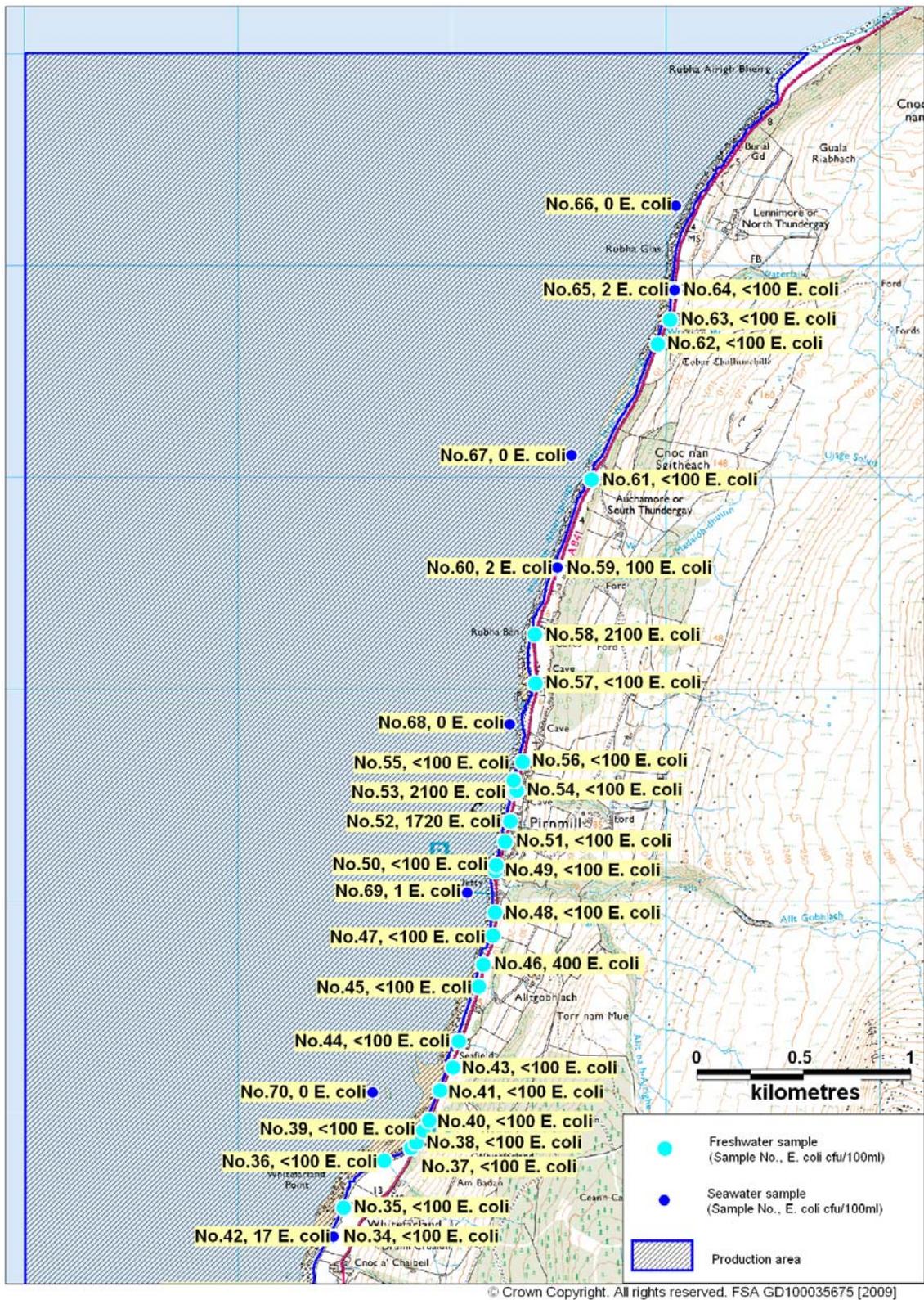


Figure 4. Water sample results – Northern end of Arran: Pirmill

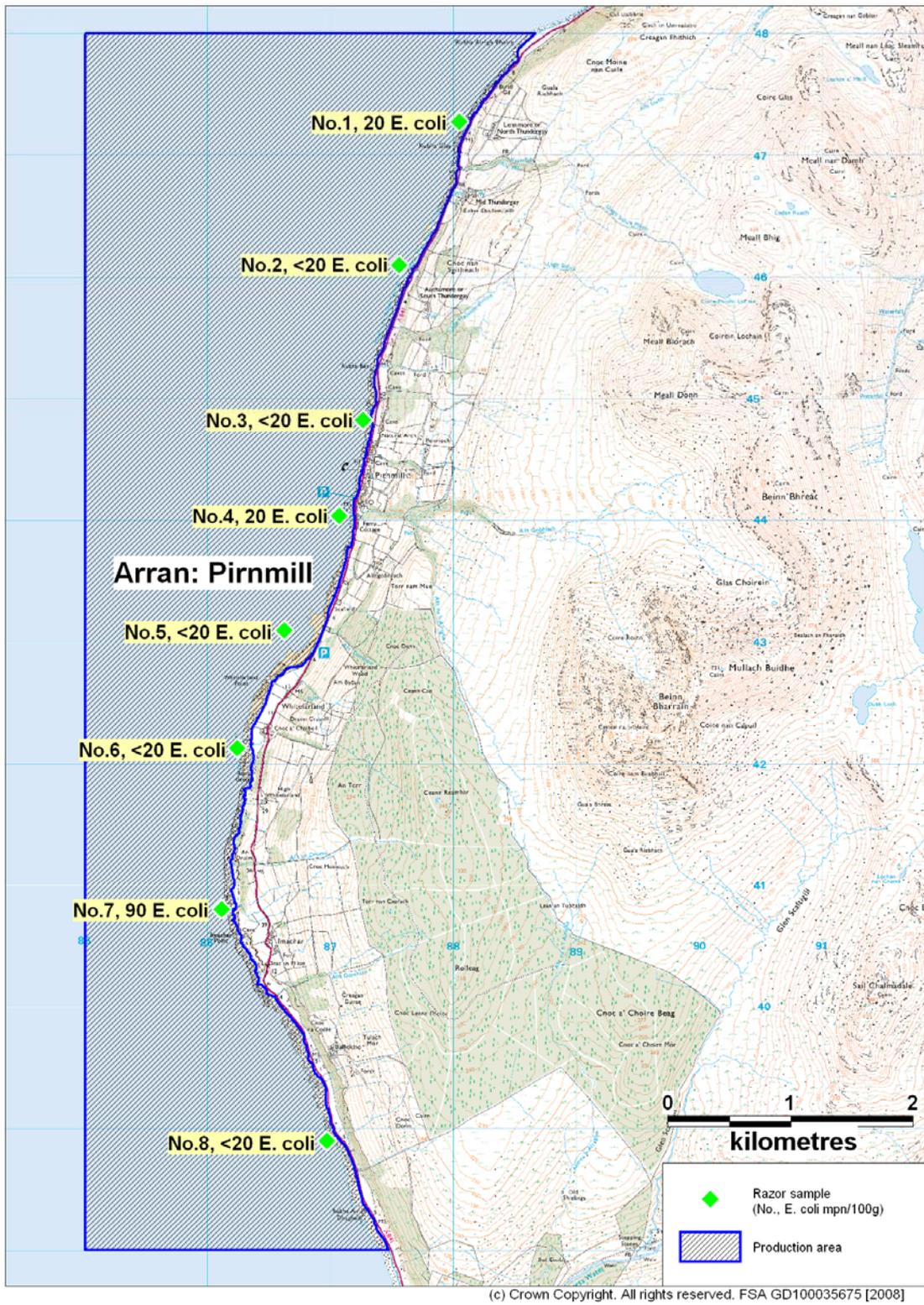


Figure 5. Shellfish sample results

## Photographs



Figure 6. River Iorsa



Figure 7. Shoreline looking south



Figure 8. Shoreline looking north



Figure 9. Sheep in field opposite shoreline



Figure 10. Shoreline looking north



Figure 11. Small stream running under road. Water sample 5, day 1.



Figure 12. Unknown manhole cover.



Figure 13. Concrete pipe structure, possibly for electricity cables.



Figure 14. Location of water sample 12, day 1



Figure 15. Shoreline looking north at Imachar



Figure 16. Location of water sample 1, day 2



Figure 17. Waterfall flowing off cliff into stream that water sample 1, day 2 was taken from



Figure 18. Location of water sample 2, day 2



Figure 19. Location of water sample 2b, day 2



Figure 20. Shoreline looking north



Figure 21. View of sea, day 2



Figure 22. Large stream, water sample 9, day 2



Figure 23. Shoreline looking north



Figure 24. Shoreline looking south



Figure 25. Large stream running beside 6 houses. Water sample 14, day 2.



Figure 26. Houses on other side of field with stream running down the side



Figure 27. Large stream running through culvert in road and beside house, water sample 8, day 3

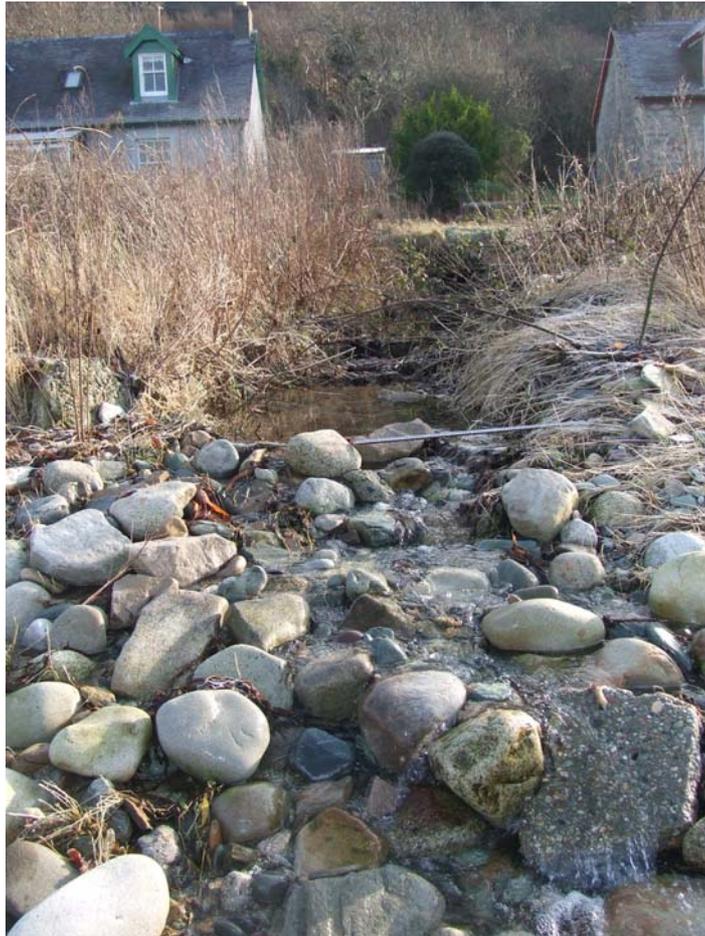


Figure 28. Stream running between two houses, water sample 11, day 3



Figure 29. Snow on hills



Figure 30. Pirnmill public toilets with inspection covers and suspected septic tank

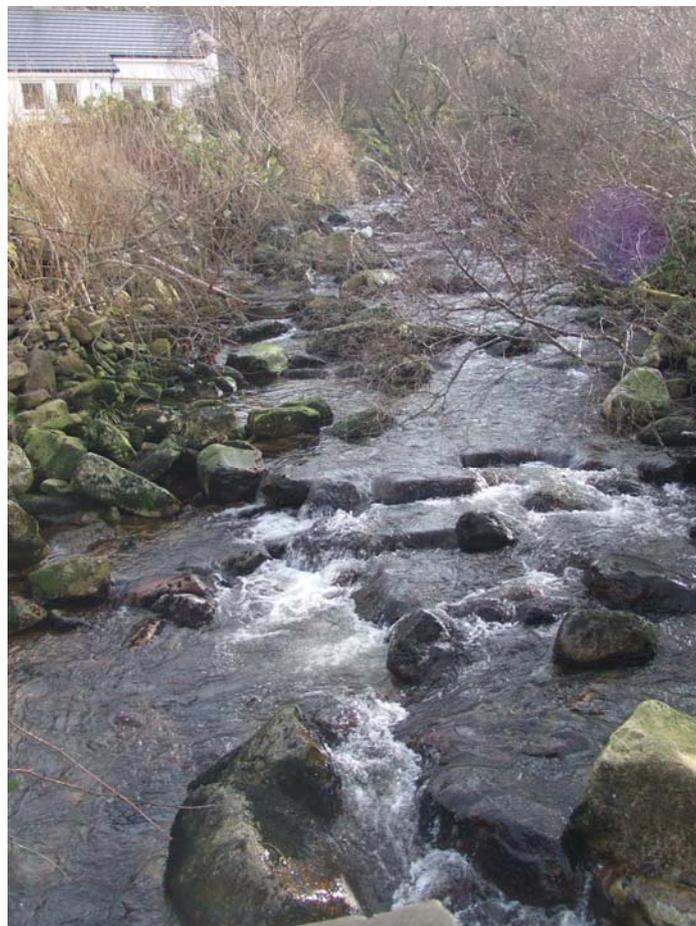


Figure 31. River Allt Gobhlach



Figure 32. Clay pipe running alongside River Allt Gobhlach



Figure 33. River Allt Gobhlach, water sample 16, day 3



Figure 34. Shoreline looking north through Pirnmill



Figure 35. Stream between 2 houses and under road



Figure 36. Black pipe under road, no flow



Figure 37. SW septic tank



Figure 38. SW Pirnmill Arran septic tank



Figure 39. Large stream flowing under road, just north of the primary school



Figure 40. Septic tank and outfall pipe, water sample 22, day 3



Figure 41. Concrete block with inspection cover, no visible outfall pipe



Figure 42. Approx. 20 cattle in field just north of sampling point for water sample 24, day 3



Figure 43. Large stream, house to left, water sample 26, day 3



Figure 44. Shoreline looking north



Figure 45. Large stream, water sample 31, day 3