
Scottish Sanitary Survey Project



Restricted Sanitary Survey Report Carradale Bay AB 511 February 2010



Report Distribution – Carradale Bay

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1. Area Overview

Carradale Bay is located on the Kintyre Peninsula on the southwest coast of Scotland. It lies on the west side of Kilbrannan Sound, across from the Isle of Arran (see Figure 1.1).

Carradale Bay is 1 km wide, with a 0.2 km stretch of beach down to the sea. Carradale Bay is sheltered by the Carradale Point headland which stretches 1.2 km south of the coastline. A restricted sanitary survey at Carradale Bay was initiated in response to receipt of an application to classify the area for commercial harvest of razor clams (*Ensis* spp.).

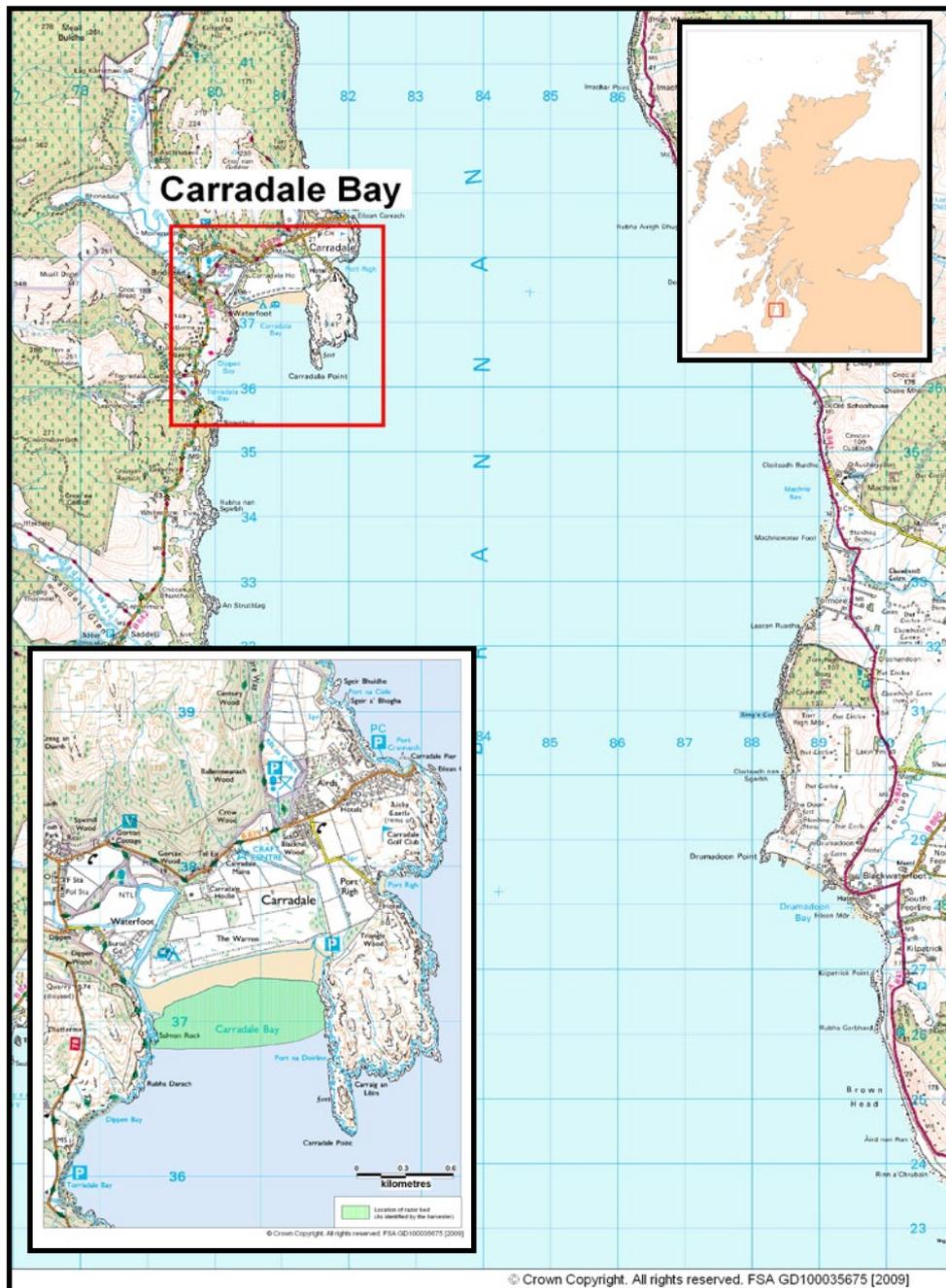


Figure 1.1 Location of Carradale Bay

1.1 Land Use

Land Cover 2000 data indicates that the land surrounding Carradale Bay is a mixture of neutral and acid grassland, open heath land, and improved grassland with large areas of coniferous woodland further inland (see Figure 1.2).

Faecal coliform contributions from improved grassland have been shown to be approximately 8.3×10^8 cfu km⁻² hr⁻¹ (Kay et al, 2008). The contributions to the contamination of shellfish from all land cover types would be expected to increase significantly after marked rainfall events. This increase would be highest, at more than 100-fold, for improved grassland. Areas of improved grassland surrounding Carradale Bay would be expected to contribute the most to contamination levels carried in surface runoff to this side of the razor clam bed – these areas are mainly located to the north of the bay.

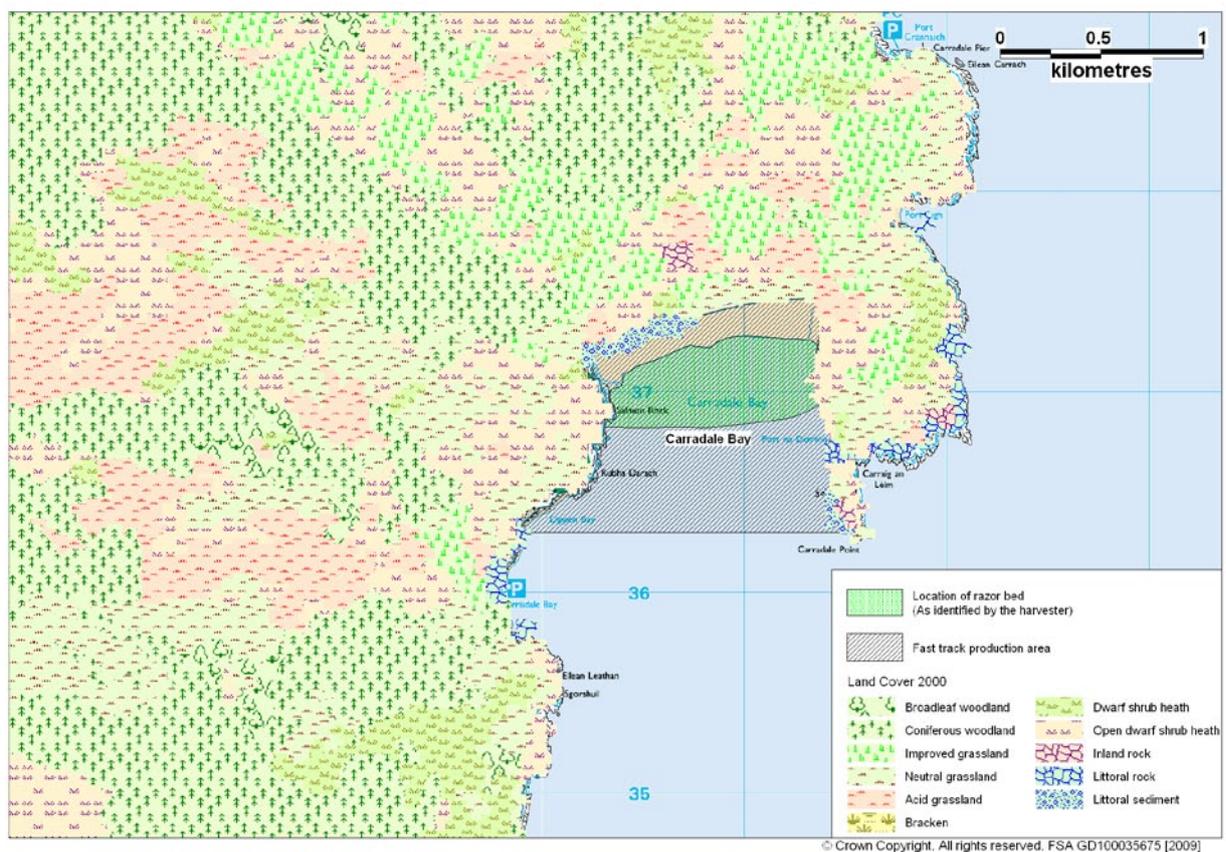


Figure 1.2 Land Cover 2000 data for Carradale Bay

1.2 Human Population

Figure 1.3 shows 2001 Census information obtained from the General Register Office for Scotland on the population within the census output areas in the vicinity of Carradale Bay. There are two census output areas with populations of 114 and 123 that are directly adjacent to Carradale Bay. The population surrounding Carradale Bay is mainly located in the village of Carradale, which is split into east and west sides by the Carradale Estate. There is a caravan park located at the western side of the beach that includes 4 pine lodges, static caravans and approximately 70 visitor pitches. The park operates from March to October, with

peak season during school holidays and from the end of June to September. Further hotel and self catering accomodation for tourists is avaiable within the area, indicating there may be a significant seasonal increase in human population associated with tourism.

The main sources of human faecal contamination will therefore be associated with the caravan park and other homes on the west side of the bay and the main village of Carradale, although those in the east Carradale area will tend to more directly influence water quality in Kilbrannan Sound, outside of the bay.

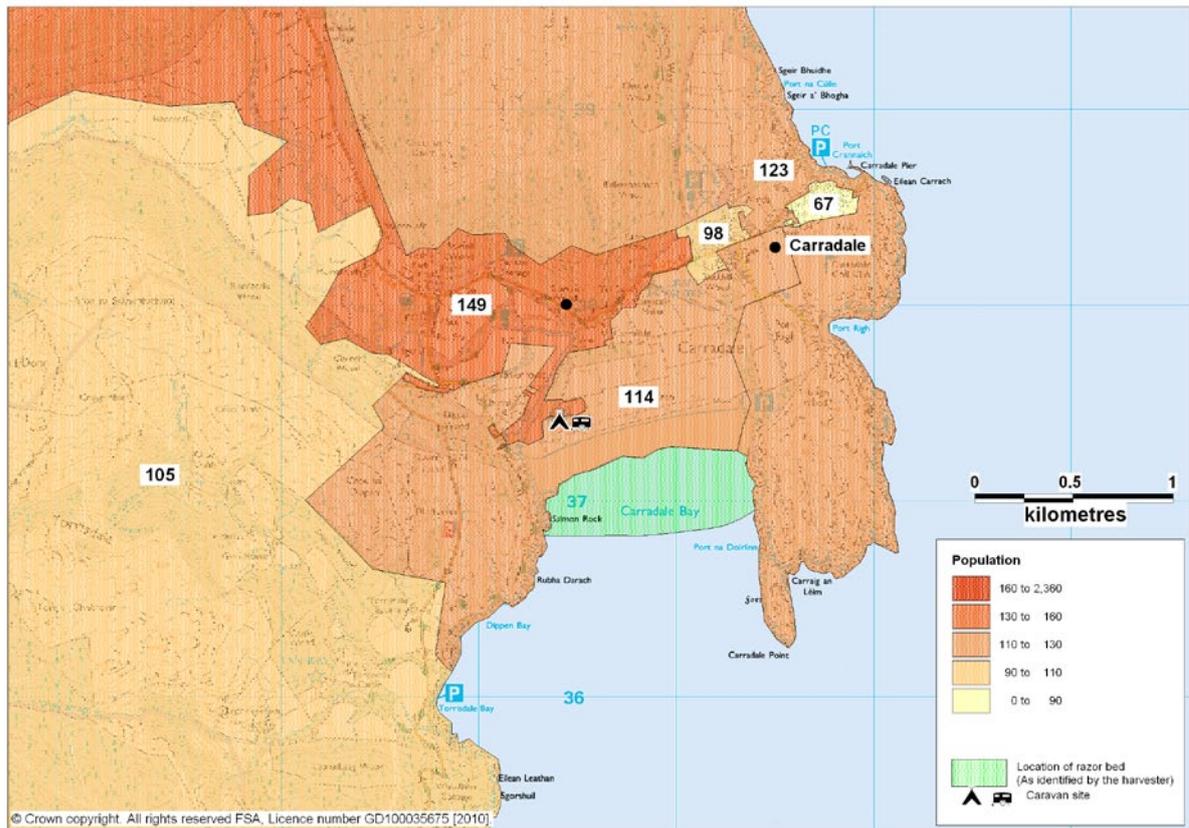


Figure 1.3 Human population surrounding Carradale Bay

2. Fishery

The fishery at Carradale Bay (AB 511 930 16) is comprised of a wild razor clam (*Ensis* spp.) bed.

The fast track classification production area boundaries as identified by the Food Standards Agency on 16th June 2009 are given as the area bounded by lines drawn between NR 7985 3630 to NR 8150 3630 extending to MHWS.

There is currently no representative monitoring point (RMP) assigned to this area. The razor bed at Carradale Bay does not lie within a designated shellfish growing water.

The harvester has outlined the boundaries of the actual razor bed which lies within the fast track production area (see Figure 2.1). The razors will be hand dived and harvesting is planned to take place throughout the year.

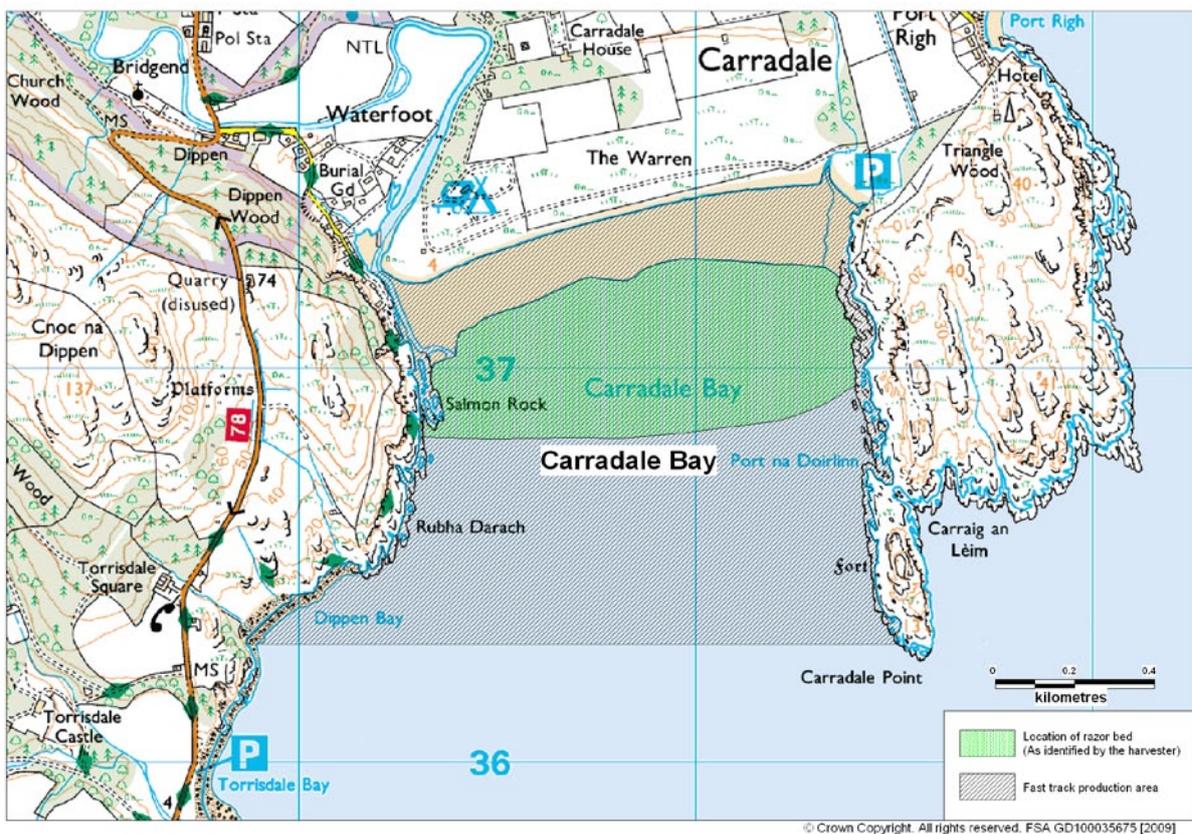


Figure 2.1 Carradale Bay fishery

3. Sewage Discharges

A number of discharge consents were provided by SEPA for the area adjacent to Carradale Bay. These are listed in Table 3.1 and mapped in Figure 3.1.

Table 3.1 SEPA discharge consents

Consent No.	NGR of discharge	Discharge type	Discharges to	PE	Discharge Vol m ³ per day
CAR/R/1033641	NR 7969 3785	Continuous	Carradale Water	15	-
CAR/R/1031750	NR 7969 3783	Continuous	Carradale Water	16	-
CAR/R/1017417	NR 8021 3751	Continuous	Land via soakaway	6	-
CAR/R/1015690	NR 8026 3742	Continuous	Carradale Water	15	-
CAR/R/1019679	NR 8041 3696	Continuous	Carradale Water	5	-
CAR/R/1018538	NR 8139 3803	Continuous	Land via soakaway	6	-
CAR/R/1000893	NR 8220 3790	Continuous	Kilbrannan Sound	440	114

One community septic tank and sewage discharge was identified by Scottish Water for the area adjacent to Carradale Bay. This is detailed in Table 3.2 and mapped in Figure 3.1. It corresponds to the last entry in Table 3.1.

Table 3.2 Discharge identified by Scottish Water

Consent No.	Discharge Name	NGR of discharge	Discharge Type	Level of Treatment	Consented/design PE	Consented flow m ³ /day
CAR/R/1000893	Carradale STW	NR 8220 3790	Continuous	Septic tank	440	114

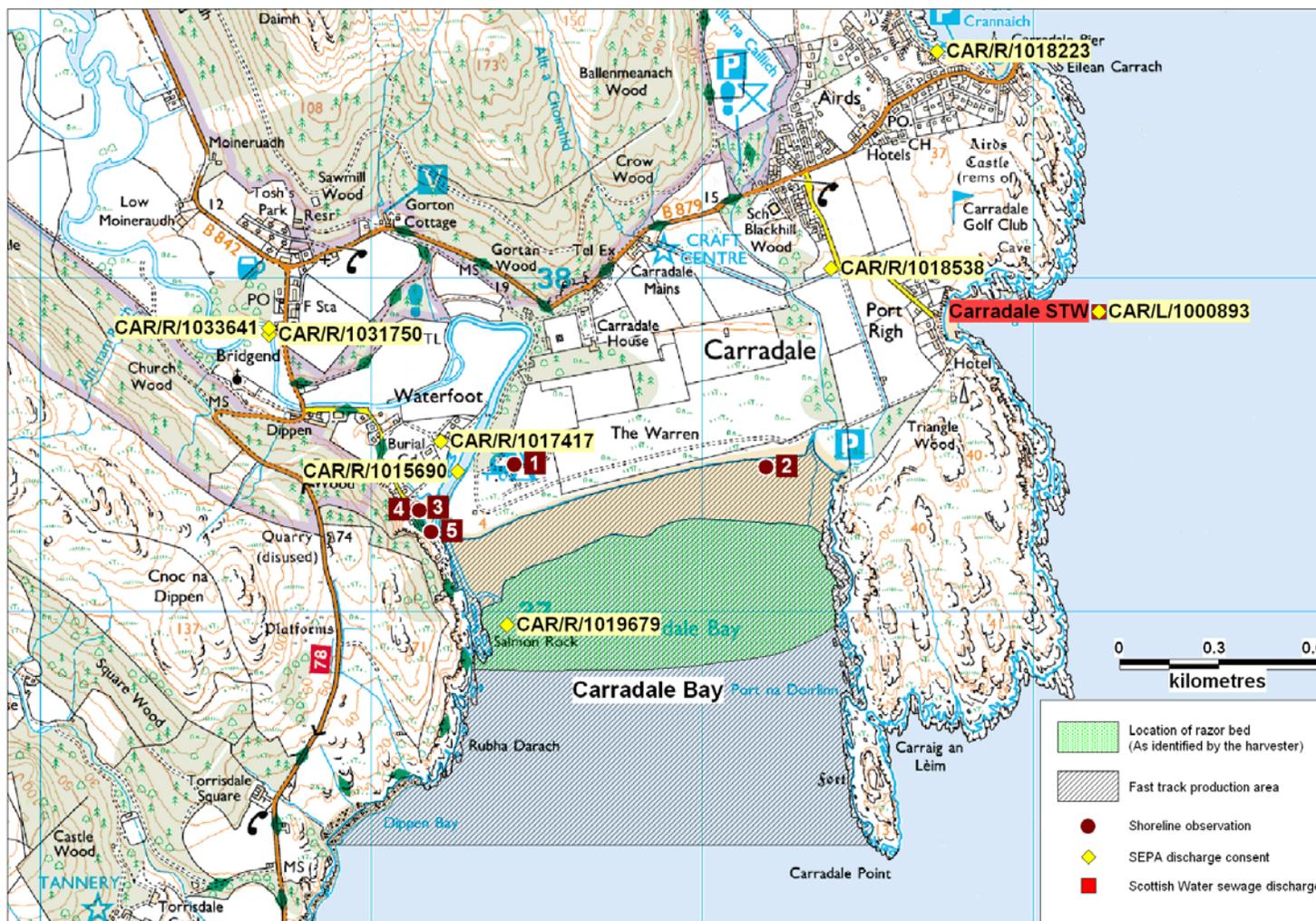
No sanitary or microbiological data were available for these discharges.

A caravan site toilet block, sanitary debris, outfall pipes and possible septic tanks were also observed during the shoreline survey and these are listed in Table 3.3. Their locations have been included in the mapped discharges in Figure 3.1. Further details can be found in the shoreline survey report in the appendix. The shoreline survey concentrated on the area around Carradale Bay and therefore neither the discharges higher up Carradale Water, nor the discharge to Kilbrannan Sound associated with Carradale STW, were confirmed visually.

Table 3.3 Observations of potential sewage discharges

No.	Date	NGR	Description of potential sewage discharge
1	14/10/2009	NR 80434 37443	Caravan site toilet and shower block
2	14/10/2009	NR 81196 37436	Evidence of sanitary ware in the high tide line
3	14/10/2009	NR 80141 37312	Pipe underneath house, not flowing
4	14/10/2009	NR 80146 37306	Pipe underneath house, not flowing
5	14/10/2009	NR 80182 37240	Possible septic tanks

Overall, the majority of the sewage discharges are located on the western side of the bay, where four of the SEPA consents discharge into Carradale Water which flows into Carradale Bay. Contamination inputs are therefore expected to be higher on the western side of the shellfish bed.



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Figure 3.1 Sewage discharges at Carradale Bay

4. Animals

4.1 Livestock

The most significant source of information concerning livestock numbers in the area surrounding Carradale Bay was available from the shoreline survey. The shoreline survey relates to the time of the site visits on the 14th October 2009.

During the shoreline survey approximately 25 cattle were observed on the shoreline on the north-east side of the bay (see Figure 4.1). On the south western coastline of the bay a further 8 sheep were observed adjacent to Dippen Bay and a further 28 sheep were observed just south of Dippen Bay.

Horse or pony rides are advertised by the caravan park on the bay as being available during the summer months for children at the park, therefore it is likely that there will be some increased impact to the bay from horse faeces during this time.

Livestock numbers in the area as a whole are likely to be at their highest during the summer months when calves and 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.

During the winter months, livestock, including dairy cattle are likely to be kept in barns with a likely increase in slurry production and a higher runoff from hard standing areas. Seasonal variation in the presence of livestock is therefore expected to lead to higher rates of deposition on the land at these times.

4.2 Wildlife

Information from the Carradale Estate website (www.carradale.org.uk/wildlife) indicates there is a colony of feral goats living on Carradale Point, however their numbers are not specified. The site also notes that roe deer, seals and otters are present in the area.

During the shoreline survey approximately 20 gulls and 10 cormorants were observed on the eastern side of Carradale Bay and a further 30 gulls were observed on the western side (see Figure 4.1). Seabirds such as gulls will always be present on and around Carradale Bay but their distribution is likely to be even over time and as such would not materially affect the assessment. Rabbits were spotted at scattered locations along each side of the shoreline. No other wildlife was observed at the time of the shoreline survey.

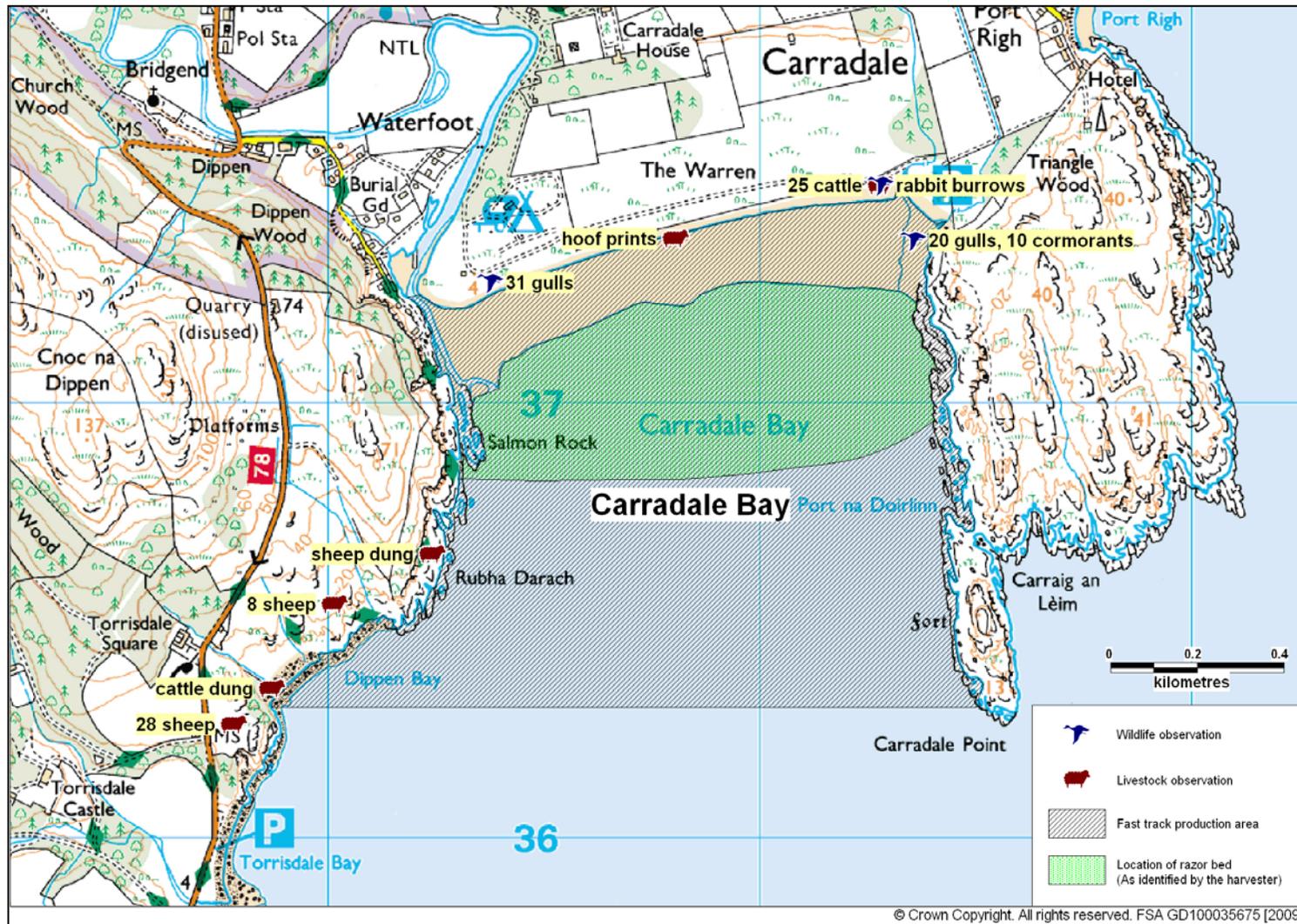


Figure 4.1 Livestock and wildlife present at Carradale Bay during the shoreline survey

5. Rainfall

The nearest weather station is located at Arran Dougarie Lodge, approximately 7 km east of Carradale Bay. Due to the close proximity of the weather station to Carradale Bay, rainfall recorded here is likely to be similar to that experienced in the bay and the surrounding land. Daily rainfall values were purchased from the Meteorological Office for the period 1/1/2003 to 31/12/2008 inclusive for the Arran Dougarie Lodge weather station. For this period of 2192 days, total daily rainfall was not recorded for 206 days, including the entire month of October 2006.

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 (Mallin et al. 2001, Lee and Morgan 2003).

The influence of rainfall on microbiological quality will depend on factors such as local geology, topography, land use and sewerage infrastructure.

5.1 Rainfall at Arran Dougarie Lodge

Due to the missing data it is not appropriate to present total rainfall at Arran Dougarie Lodge by year or month. Instead, Figures 5.1 and 5.2 summarise the pattern of rainfall recorded at Arran Dougarie Lodge. The box and whisker plots present the distribution of individual daily rainfall values (observations) by year (Figure 5.1) or by month (Figure 5.2). 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 *.

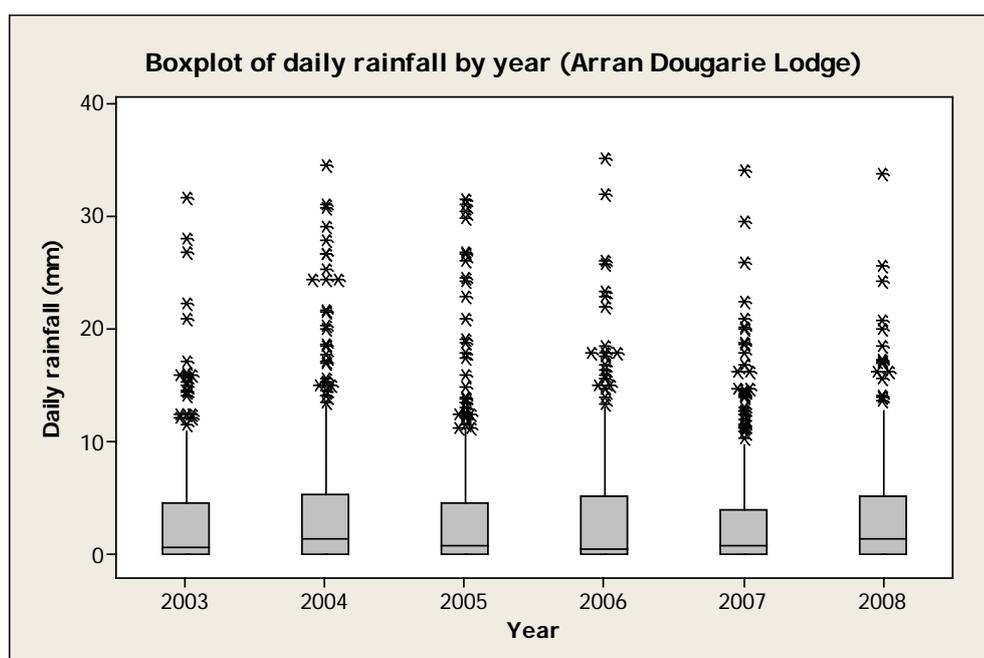


Figure 5.1 Boxplot of daily rainfall at Arran Dougarie Lodge by year

Figure 5.1 shows that there was relatively little variation between years observed.

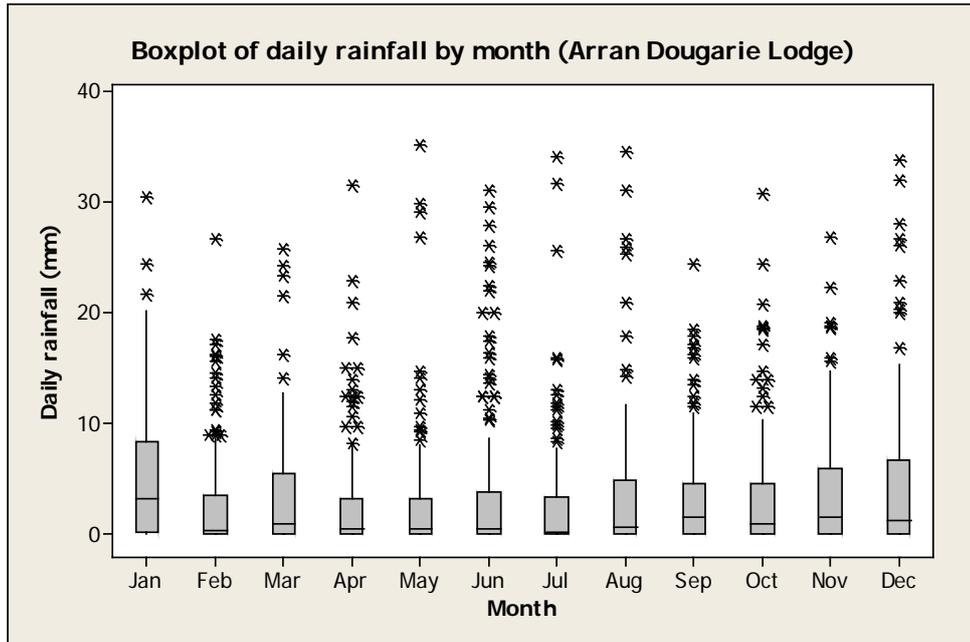


Figure 5.2 Boxplot of daily rainfall values at Arran Dougarie Lodge by month

The wettest months were December and January. For the period considered here (2003 – 2008), 35% of days for which records were available experienced no rainfall while 52% of days experienced rainfall of 1mm or less. The mean rainfall was less than 10 cm per day. Maximum recorded daily rainfall was greater than 30 cm. High rainfall events (>20 mm per day) were recorded during all months. The highest daily rainfall recorded here fell in May, generally one of the driest months.

Periods of increased rainfall are generally associated with higher levels of contaminated surface water runoff. Marked changes in the level of rainfall may also cause significant washoff of accumulated material.

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.

6. River Flow

There is no river gauging station in the vicinity of Carradale Bay. A total of eight fresh water inputs were observed discharging into the sound. Only three of these streams were of a measurable size and had a measurable flow. These streams represented the largest freshwater inputs to the area and are listed in Table 6.1 and mapped in Figure 6.1.

Table 6.1 Stream/river flow and loadings – Carradale Bay

No.	Grid Ref	Description	Width (m)	Depth (m)	Measured Flow (m/s)	Flow in m ³ /day	<i>E. coli</i> (CFU/100 ml)	Loading (<i>E. coli</i> per day)
1	NR81311 37491	Stream	1.51	0.15	0.571	11174.2	200	2.2 x 10 ¹⁰
2	NR 80206 37246	Carradale Water	*	*	*	*	700	NA
3	NR 80368 37582	Carradale Water	*	*	*	*	300	NA
4	NR 79868 37617	Carradale Water	*	*	*	*	200	NA
5	NR80300 37506	Carradale Water	14.40	0.34	0.363	153554.2	900	3.1 x 10 ¹¹
6	NR 79946 36414	Stream	*	*	*	*	<100	NA
7	NR 79866 36341	Stream	*	*	*	*	5700	NA
8	NR 79715 35837	Torrisdale Burn	4.94	0.20	0.893	79229.3	5400	4.1 x 10 ¹²

* Freshwater input dimensions and flow were not measured

Calculated loadings are based on the flows and dimensions recorded during the shoreline survey and do not necessarily reflect those that would apply under different conditions.

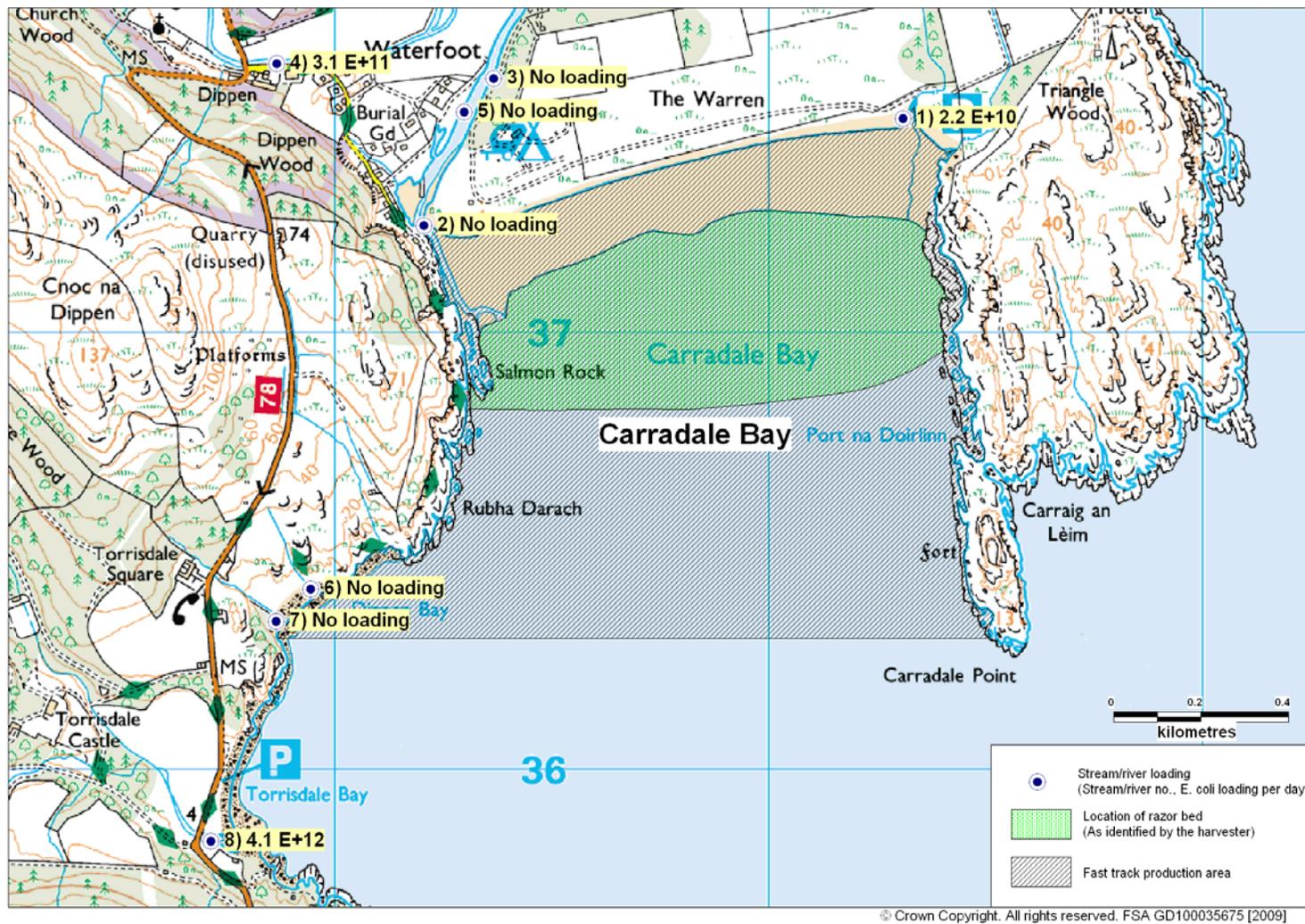


Figure 6.1. Location of stream/river flows and loadings at Carradale Bay

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

7. Historical *E. coli* Monitoring Data

7.1 Validation of historical data

The *E. coli* results for all shellfish samples taken from Carradale Bay from the middle of 2009 up to September 2009 were extracted from the FSAS database. The output was validated according to the criteria described in the standard protocol for validation of historical *E. coli* data.

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

7.2 Summary of microbiological results

Individual sample details are presented in Table 7.1. All samples were collected in 2009, following the receipt of the application to classify the area. They were taken over a period of less than 2 months.

Table 7.1 Individual sample results from Carradale Bay

Collection date	Production area	Site	SIN	Species	Grid reference	<i>E. coli</i> (MPN/100g)
01/07/2009	Carradale Bay	Carradale Bay Razors	AB 511 930 16	Razor clams	NR 80650 37078	<20
08/07/2009	Carradale Bay	Carradale Bay Razors	AB 511 930 16	Razor clams	NR 80472 36982	<20
15/07/2009	Carradale Bay	Carradale Bay Razors	AB 511 930 16	Razor clams	NR 80519 36908	700
22/07/2009	Carradale Bay	Carradale Bay Razors	AB 511 930 16	Razor clams	NR80498 36922	790
09/09/2009	Carradale Bay	Carradale Bay Razors	AB 511 930 16	Razor clams	NR 80471 36718	80

7.3 Overall geographical pattern of results

Figure 7.1 shows the location of the historical *E. coli* monitoring results. There are not enough results to assess the geographical pattern of results statistically. However, it can be seen that the two highest results were obtained from almost the same location, although sampled a week apart.



Figure 7.1 Geographical location of Carradale Bay historical *E. coli* monitoring results

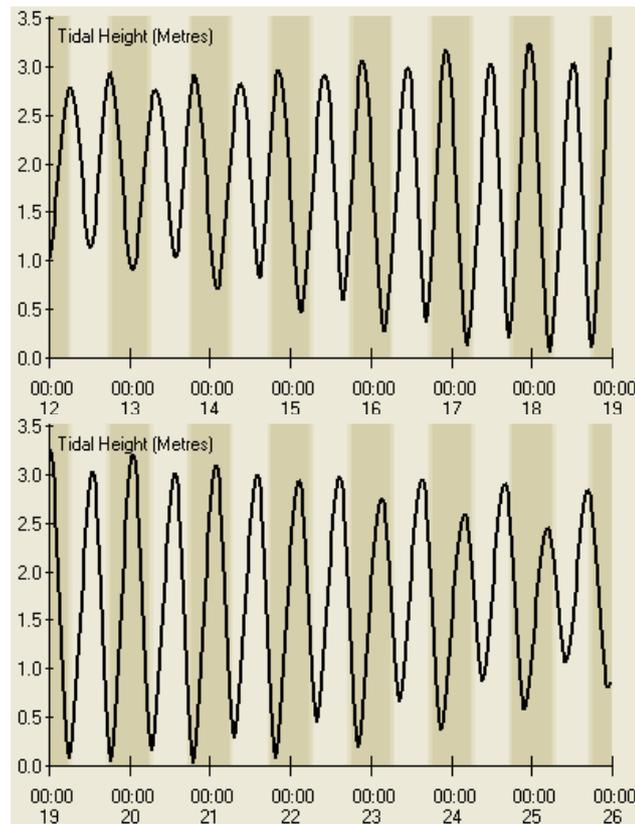
7.4 Further analysis of results (seasonality, effects of environmental variables)

There are insufficient data to conduct an analysis of the effects of season and environmental variables on *E. coli* levels in shellfish at Carradale Bay.

Sound. The area of the identified razor bed lies predominantly within the 10m depth curve.

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 12th October 2009. The second is for seven days beginning 00.00 GMT on 19th October 2009. Together they show the predicted tidal heights over high/low water for a full neap/spring tidal cycle.



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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

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 Admiralty Tidal Stream Atlas for Firth of Clyde and Approaches (UKHO 1992) indicates that the peak tidal stream within Kilbrannan Sound is approximately 0.2 (neap) to 0.3 knots (spring) in a northerly direction on the rising tide and 0.3 (neap) to 0.4 knots (spring) in a southerly direction on a falling tide. The relationship between knots and metres per second is that the latter is approximately half the former (i.e. 0.2 knots is about 0.1 m/s).

As in many areas, the change from rising to falling and vice versa does not exactly coincide in time with change in direction of the tidal streams. No information was found regarding currents within Carradale Bay itself.

8.3 Conclusions

Contamination arising from sources within Carradale Bay will be taken across the fishery on the falling tide. This will include contamination that has accumulated within Carradale Water on the flooding tide, once the tide has risen to the river mouth, and continuing into slack high water. On the flooding tide, contamination from sources outside the bay may be taken over the fishery, including that which has originated in Kilbrannan Sound north of Carradale Point (e.g. from the Carradale STW outfall). However, the high degree of dilution resulting from the depth of the area would be likely to markedly limit the effect from such sources.

9. Shoreline Survey Overview

A restricted shoreline survey of the Carradale Bay shoreline was undertaken by staff from Argyll and Bute Council on the 14th October 2009.

Sub surface sea water samples were taken from several points along the Carradale Bay coastline and also from within the shellfish bed area. Results ranged from 0 to 3500 *E. coli* cfu/100 ml. Four out of the seven results were above 100 *E. coli* cfu/100 ml, the highest result of 3500 *E. coli* cfu/100 ml was taken at the centre of the bay close to the shoreline.

Fresh water samples were taken all along the eastern coastline of Carradale Bay at any streams or burns flowing at the time of the shoreline survey. Results ranged from <100 to 5700 *E. coli* cfu/100 ml. The Torrisdale Burn located 1 km south of Carradale Bay had the highest *E. coli* loading of 4.1×10^{12} per day.

Approximately 25 cattle were observed on the shoreline on the east side of the bay. On the south western coastline of the bay a further 26 sheep were observed close to Dippen Bay.

Razor clam samples were collected from two points within the bay. Both samples returned results of less than <230 *E. coli* cfu/100 ml.

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 1×10^3 , 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
- Sewage outfall pipes discharging into the area
- Livestock grazing on the shoreline

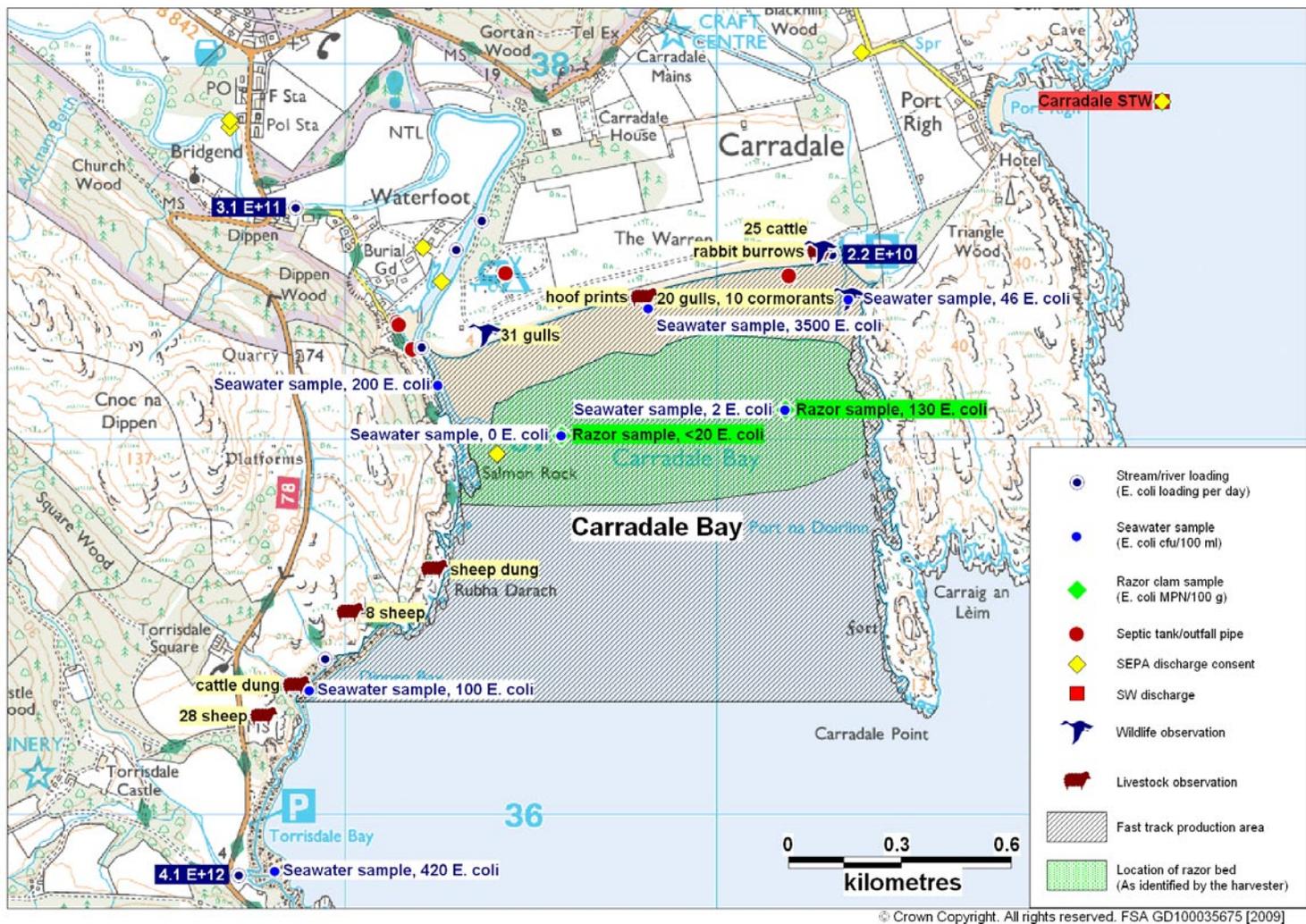


Figure 9.1 Summary of shoreline observations

10. Overall Assessment

Fishery

The shellfish bed is located within Carradale Bay. The harvester identified the boundaries of the bed to lie within the bay (see Figure 2.1), however historical *E. coli* monitoring results indicate that razor clams are present slightly further south of the area identified. The razors will be hand dived and harvesting is planned to take place throughout the year.

Human sewage inputs

There are two small settlements (Carradale and Waterfoot) close to Carradale Bay. Within the catchment area of Carradale Bay there are seven SEPA discharge consents, one Scottish Water discharge (which corresponds to one of the consents) and also several outfall pipes and a possible septic tank that were observed during the shoreline survey. None of the outfall pipes had sufficient flow to sample at the time of the shoreline survey.

The majority of the sewage discharges are concentrated at the north-western side of the bay and four of them discharge into Carradale Water which flows into the bay. Therefore contamination of the shellfish bed from sewage discharges is likely to be greatest on the north-western side.

Agricultural inputs

During the shoreline survey approximately 25 cattle were observed on the shoreline on the east side of the bay (see Figure 4.1). On the south western coastline of the bay a further 8 sheep were observed adjacent to Dippen Bay and a further 28 sheep were observed just south of Dippen Bay. All livestock was observed close to the shoreline. Due to the proximity of the livestock to the shellfish bed, agricultural sources are considered to be a significant source of contamination in the area. The north eastern and south western parts of the shellfish bed are likely to experience the largest amount of contamination from livestock on the basis of the limited information available.

Wildlife inputs

During the shoreline survey, in total approximately 50 gulls and 10 cormorants were observed in Carradale Bay. Several rabbits were spotted at scattered locations along each side of the shoreline. Seabirds including gulls will always be present along the coastline but, in the absence of specific roosting or nesting sites, their distribution and contamination effects is likely to be random over time.

Rivers and streams

A total of four streams were discharging into Carradale Bay shellfish bed area at the time of the shoreline survey. One stream was located at the north east corner of the bay, whilst the remainder were located on the western side of the bay. The Torrisdale Burn discharging into the south western end of the coastline had the

largest *E. coli* loading of 4.1×10^{12} . The two other streams sampled also had high *E. coli* loadings of 3.1×10^{11} (Carradale Water) to 2.2×10^{10} (unnamed stream). Overall it is expected that the freshwater inputs into Carradale Bay will have an intermediate effect on the bacterial contamination of shellfish, especially on the western side of the bay where the two streams (Carradale Water and Torrisdale Burn) had the higher *E. coli* loadings.

Rainfall

Rainfall patterns at Arran Dougarie Lodge (the nearest rainfall station) show that seasonal variation in rainfall levels occurs and the wettest months were December and January, however the highest recorded daily rainfall occurred in May, one of the drier months. Therefore, increased bacterial levels in the bay resulting from rainfall runoff could occur at any time of the year. The impact of rainfall events is likely to be most acute nearest where the streams enter the bay.

Analysis of results

Historical monitoring results were only available for two months in 2009. There are insufficient historical monitoring results available to establish a pattern of seasonal variation in microbiological quality of the shellfish. The highest result of 790 *E. coli* MPN/100 g was obtained from the western side of the fishery.

During the shoreline survey, razor clam samples were collected from two points within the bay. The sample taken from the eastern side of the shellfish bed had a higher result of 130 *E. coli* MPN/100 g compared to the sample taken from the western side of the bay that had a result of <20 *E. coli* MPN/100 g.

Seawater samples were taken along the coastline and throughout the bay returned high results in some areas. Results ranged 0 to 3500 *E. coli* cfu/100 ml. Four out of the seven results were above 100 *E. coli* cfu/100 ml; the highest result of 3500 *E. coli* cfu/100 ml was taken at the centre of the bay close to the shoreline.

Movement of contaminants

Contamination from sources discharging into Carradale Water will impact on the western side of the shellfish bed during the falling tide. Contamination from outside the bay may impact on the shellfish bed during the rising tide. Any effect from Torrisdale Burn will tend to be constrained to the western side of the bed. There is a very low possibility of contamination from north of Carradale Point being taken into the bay on the rising tide after having been taken south past this point on the falling tide.

Overall conclusions

The western edge of the shellfish bed is expected to receive the greatest contamination from both human and animal sources, through contamination from Carradale Water, local animal inputs, and possibly Torrisdale Burn. This is reflected in the location of the two highest shellfish *E. coli* results in the limited data set available.

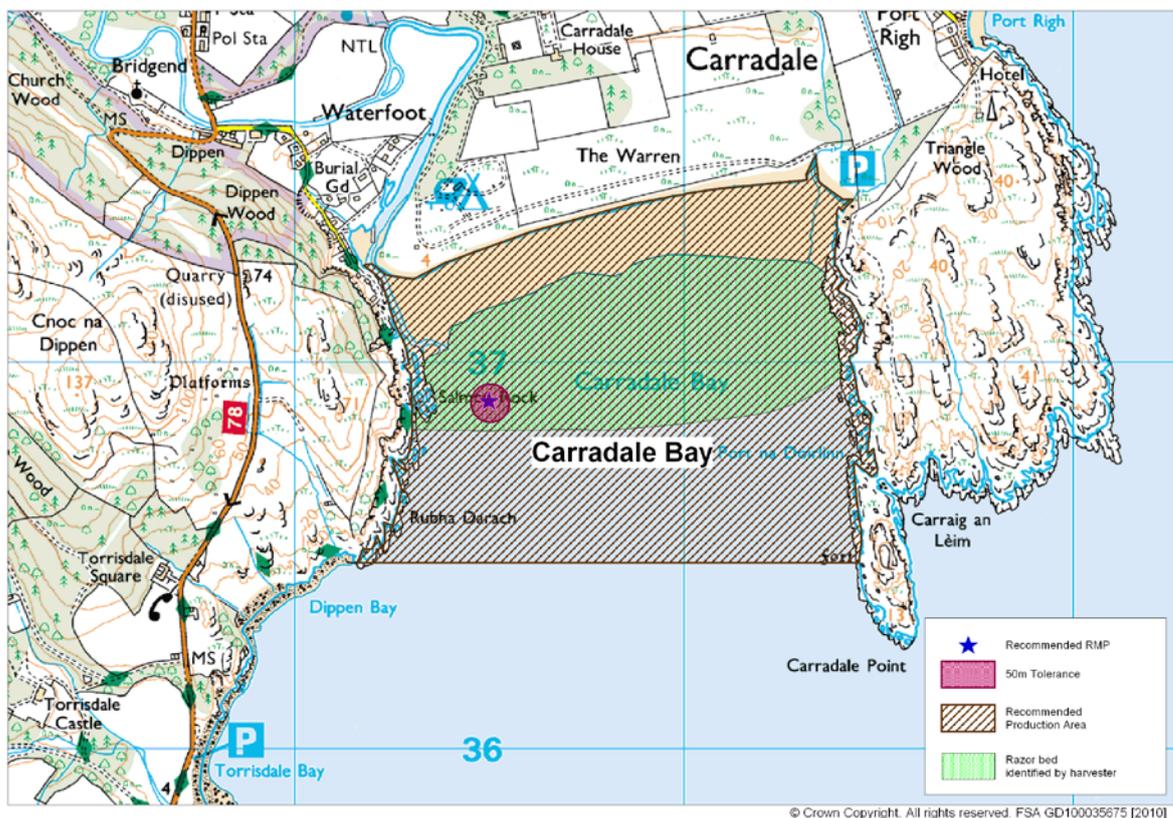
11. Recommendations

It is recommended that the RMP be located at NR 8050 3690 in the western side of the shellfish bed likely to be subject to the greatest contamination. The recommended tolerance is 50 m – this recognises the potential difficulty of gathering sufficient razors close to the identified point while constraining the sampling to that area identified as of higher risk.

It is recommended that the production area be defined as:

The area bounded by lines drawn between NR 8016 3648 to NR 8145 3648 extending to MHWS.

This area covers both the shellfish bed as identified by the harvester and the location of all of the shellfish samples taken to date, while moving the south-western boundary further away from the potential contamination source at Torrisdale Burn.



12. References

Kay, D, Crowther, J., Stapleton, C.M., Wyer, M.D., Fewtrell, L., Anthony, S.G., Bradford, M., Edwards, A., Francis, C.A., Hopkins, M. Kay, C., McDonald, A.T., Watkins, J., Wilkinson, J. (2008). Faecal indicator organism concentrations and catchment export coefficients in the UK. *Water Research* 42, 2649-2661.

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

UKHO 1992. Admiralty Tidal Stream Atlas: Firth of Clyde and Approaches. 1st Edition. Taunton:UKHO.

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Appendices

1. **Summary Sampling Plan**
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Sampling Plan for Carradale Bay

PRODUCTION AREA	SITE NAME	SIN	SPECIES	TYPE OF FISH-ERY	NGR OF RMP	EAST	NORTH	TOLE R-ANCE (M)	DEPTH (M)	METHOD OF SAMPLING	FREQ OF SAMPLING	LOCAL AUTHORITY	AUTHORISED SAMPLER(S)	LOCAL AUTHORITY LIAISON OFFICER
Carradale Bay	Carradale Bay Razors	AB 511	Razors	Wild harvest	NR 8050 3690	180500	636900	50	NA	-	Monthly	Argyll and Bute Council	Christine McLachlan William MacQuarrie Ewan McDougall Donald Campbell	Christine McLachlan

Comparative Table of Boundaries and RMPs – Carradale Bay

Production Area	Species	SIN	Existing Boundary	Existing RMP	New Boundary	New RMP	Comments
Carradale Bay	Carradale Bay Razors	AB 511 930 16	The area bounded by lines drawn between NR 7985 3630 to NR 8150 3630 extending to MHWS	Not applicable	The area bounded by lines drawn between NR 8016 3648 to NR 8145 3648 extending to MHWS	NR 8050 3690	No RMP has been defined previously. The southern boundary of the production area has been moved northwards.

Shoreline Survey Report



Carradale Bay AB 511

Restricted Scottish Sanitary Survey Project



Shoreline Survey Report

Production area: Carradale Bay
Site name: Carradale Bay Razors
Species: Razors (*Ensis* spp.)
Harvester: Andrew Charlwood
Local Authority: Argyll & Bute Council
Status: New site

Date Surveyed: Wednesday 14th October 2009
Surveyed by: Christine McLachlan and William MacQuarrie
Existing RMP: NA
Area Surveyed: See Figure 1.

Weather observations

Wednesday 14th October: Light Drizzle, Misty, Wind Southerly, Force 1.

Site Observations

Fishery

The Carradale Bay site is harvested for Razor clams (*Ensis* spp.). The razor clams are hand dived within the area identified by the harvester in Figure 1. The harvesters plan to harvest the razors all year round.

Sewage/Faecal Sources

The area surveyed has several scattered dwellings around the bay. There is also a small village called Waterfoot located on the western corner of the bay. There is a large campsite with a shower and toilet block just next to the village. Two pipes under houses were observed in the village of Waterfoot, although there was no flow at the time of the shoreline survey. Possible septic tanks close to the village were also spotted. Sewage related debris was spotted at high tide mark on the eastern side of the bay.

Seasonal Population

Carradale Bay Caravan Park is located at the western corner of the bay. The caravan park has onsite facilities for 40 motor homes, 20 tents, 60 hook-ups, 3 static caravans and 4 log cabins. Two separate static caravans were also observed on the north western shoreline of the Bay near The Warren. A third static caravan was observed on the western shoreline of the bay close to Salmon Rock. No hotels or B&BS were observed during the shoreline survey.

Boats/Shipping

At the time of the shoreline survey three boats were moored in Carradale Bay.

Land Use

The land surrounding Carradale Bay is a mixture of neutral and acid grassland, open heath land and improved grassland with large areas of coniferous woodland further inland.

Livestock

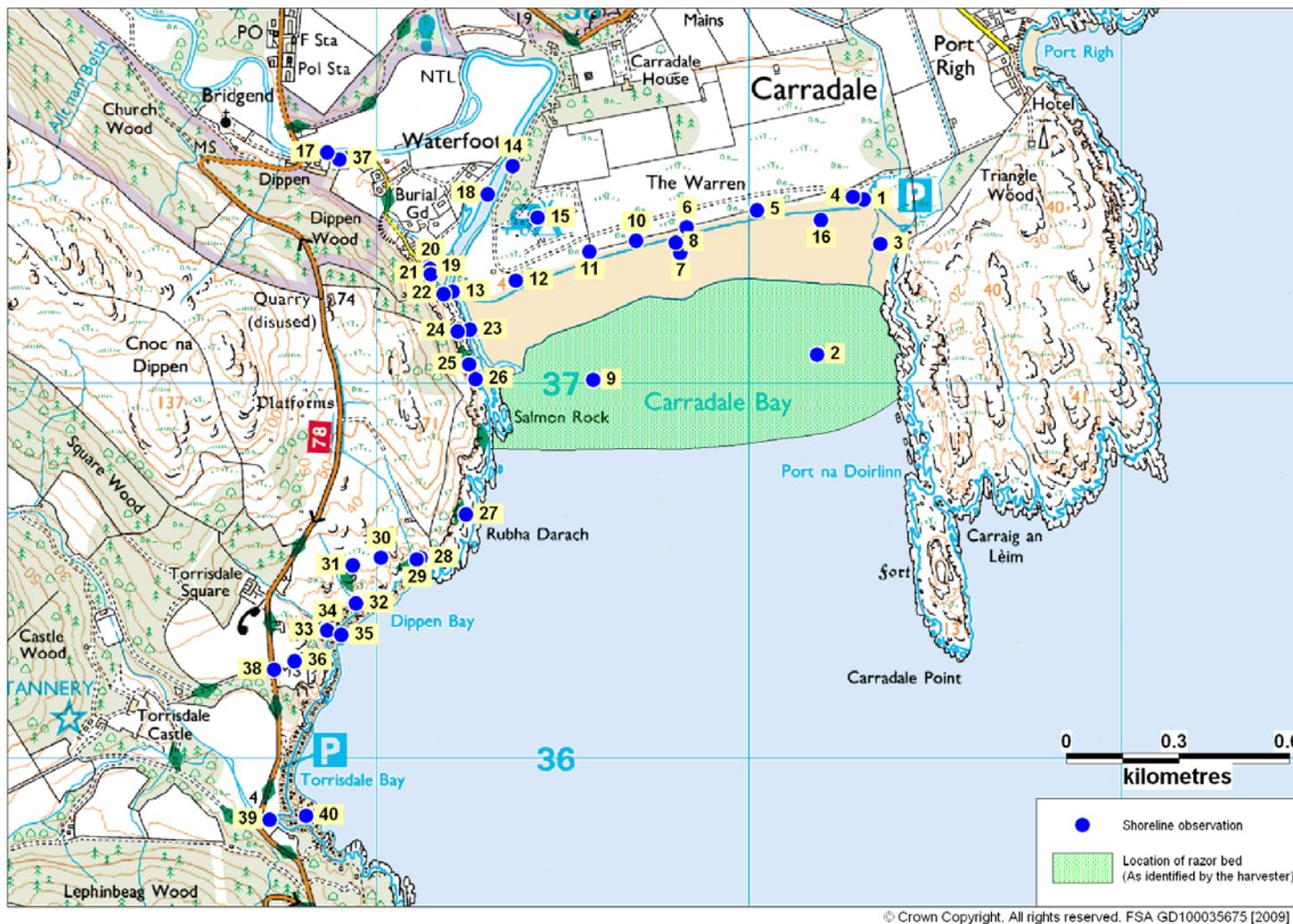
During the shoreline survey approximately 25 cattle were observed on the shoreline on the east side of the bay. On the south western coastline of the bay a further 8 sheep were observed adjacent to Dippen Bay and a further 28 sheep were observed just south of Dippen Bay.

Wildlife/Birds

During the shoreline survey approximately 20 gulls and 10 cormorants were observed on the eastern side of Carradale Bay and a further 30 gulls were observed on the western side.

Observations can be found in Table 1.

Figure 1. Shoreline Observations



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Table 1. Shoreline Observations

No.	Date	Time	NGR	East	North	Associated photograph	Description
1	14/10/2009	08:58	NR81311 37491	181311	637491	4	Stream east side of bay W 1.51, D 0.15, F 0.571. Carradale fresh water sample (CFW) 1
2	14/10/2009	09:00	NR 81186 37078	181186	637078	-	Razor sample (CBR) 1, Seawater sample (CBSW) A, Sal - 35 ppt, water temp 14C
3	14/10/2009	09:09	NR81356 37373	181356	637373	-	Carradale seawater sample (CSW) 1, Sal - 20 ppt. 20 seagulls on shore, 10 cormorants/shags on rock to point
4	14/10/2009	09:14	NR81281 37499	181281	637499	-	Cattle dung on sand, 25 cattle in field behind shore. Farm buildings, rabbit burrows.
5	14/10/2009	09:19	NR81023 37463	181023	637463	-	Static caravan in field behind shore
6	14/10/2009	09:23	NR 80835 37418	180835	637418	-	Static caravan in field behind shore
7	14/10/2009	09:25	NR 80818 37349	180818	637349	-	Carradale seawater sample (CSW) 2, Sal - 19 ppt
8	14/10/2009	09:28	NR 80805 37377	180805	637377	-	Horse hoof prints in sand
9	14/10/2009	09:30	NR 80583 37010	180583	637010	5	Razor sample (CBR) 2, Seawater sample (CBSW) B, Sal - 35 ppt, water temp 14C
10	14/10/2009	09:31	NR 80699 37382	180699	637382	-	Bungalow in distance
11	14/10/2009	09:33	NR 80574 37352	180574	637352	-	Start of caravan site boundary
12	14/10/2009	09:37	NR 80376 37276	180376	637276	-	Approx. 30 seagulls on shoreline, rabbit burrows
13	14/10/2009	09:42	NR 80206 37246	180206	637246	-	Carradale fresh water sample (CFW) 2, Sal - 3 ppt, dog swimming in sea, 3 small boats moored, 22 houses visible on Waterfoot side of river, river too deep to measure at this point
14	14/10/2009	09:53	NR 80368 37582	180368	637582	-	Carradale fresh water sample (CFW) 3, no sign of sewage discharge, river too deep to measure at this point
15	14/10/2009	10:00	NR 80434 37443	180434	637443	-	Caravan site shower and toilet block
16	14/10/2009	10:13	NR 81196 37436	181196	637436	6	Evidence of sewage related debris at the high tide line
17	14/10/2009	10:57	NR 79868 37617	179868	637617	-	Carradale fresh water sample (CFW) 4, river accessible and measurable at this point W 14.40, D 0.34, F 0.363
18	14/10/2009	11:13	NR80300 37506	180300	637506	7	Carradale fresh water sample (CFW) 5, no sewage discharge visible
19	14/10/2009	11:22	NR 80141 37312	180141	637312	8	Pipe underneath house, not flowing
20	14/10/2009	11:23	NR 80146 37306	180146	637306	-	Similar pipe underneath house, not flowing

No.	Date	Time	NGR	East	North	Associated photograph	Description
21	14/10/2009	11:24	NR 80147 37293	180147	637293		Very small stream, not measurable
22	14/10/2009	11:26	NR 80182 37240	180182	637240	9	Possible septic tanks, Carradale FW 6,
23	14/10/2009	11:31	NR80252 37144	180252	637144	-	Carradale sea water sample (CSW) 3, sal = 14 ppt
24	14/10/2009	11:33	NR 80219 37140	180219	637140	-	Last house in Waterfoot
25	14/10/2009	11:35	NR 80250 37051	180250	637051	-	Very small stream, not measurable
26	14/10/2009	11:36	NR 80267 37013	180267	637013	-	Static caravan
27	14/10/2009	11:44	NR 80241 36651	180241	636651	-	Sheep dung
28	14/10/2009	11:50	NR 80120 36536	180120	636536	-	House above shoreline (fairly new build)
29	14/10/2009	11:51	NR 80109 36531	180109	636531	-	Small stream, not measurable
30	14/10/2009	11:54	NR 80014 36536	180014	636536	-	8 sheep
31	14/10/2009	11:56	NR 79938 36515	179938	636515	-	2 houses
32	14/10/2009	11:58	NR 79946 36414	179946	636414	-	Small stream, not measurable, Carradale fresh water sample (CFW) 7
33	14/10/2009	12:02	NR 79866 36341	179866	636341	-	Small stream, Carradale fresh water sample (CFW) 8
34	14/10/2009	12:04	NR 79869 36342	179869	636342	-	Cattle dung
35	14/10/2009	12:05	NR 79906 36330	179906	636330	10	Carradale sea water sample (CSW) 4, sal = 16 ppt
36	14/10/2009	12:11	NR 79781 36260	179781	636260	-	28 sheep
37	14/10/2009	12:23	NR 79902 37599	179902	637599	-	Dippen Farm
38	14/10/2009	12:25	NR 79727 36237	179727	636237	-	House
39	14/10/2009	12:30	NR 79715 35837	179715	635837	-	Torrisdale Burn, Carradale fresh water sample (CFW) 9, 494cm x 20 cm x 0.893
40	14/10/2009	12:36	NR79812 35848	179812	635848	-	Carradale sea water sample (CSW) 5, sal = 25 ppt

Photos referenced in the table can be found attached as Figures 4 – 10.

Sampling

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

Seawater samples were tested for salinity using a hand held refractometer. These readings are recorded in Table 1 as salinity in parts per thousand (ppt).

Samples were also tested for salinity by the laboratory using a salinity meter under more controlled conditions. These results are shown in Table 2, given in units of grams salt per litre of water. This is the same as ppt.

Table 2. Water sample results

No.	Date	Sample	Grid Ref	Type	<i>E. coli</i> (cfu/100 ml)	Salinity (g/L)
1	14/10/2009	CFW1	NR 81311 37491	Fresh water	200	-
2	14/10/2009	CFW2	NR 80206 37246	Fresh water	700	-
3	14/10/2009	CFW3	NR 80368 37582	Fresh water	300	-
4	14/10/2009	CFW4	NR 79868 37617	Fresh water	200	-
5	14/10/2009	CFW5	NR 80300 37506	Fresh water	900	-
6	14/10/2009	CFW6	NR 80182 37240	Fresh water	56000	-
7	14/10/2009	CFW7	NR 79946 36414	Fresh water	<100	-
8	14/10/2009	CFW8	NR 79866 36341	Fresh water	5700	-
9	14/10/2009	CFW9	NR 79715 35837	Fresh water	5400	-
10	14/10/2009	CSW1	NR 81356 37373	Sea water	46	22.3
11	14/10/2009	CSW2	NR 80818 37349	Sea water	3500	17.0
12	14/10/2009	CSW3	NR 80252 37144	Sea water	200	21.1
13	14/10/2009	CSW4	NR 79906 36330	Sea water	100	14.9
14	14/10/2009	CSW5	NR 79812 35848	Sea water	420	24.2
15	14/10/2009	CBSWA	NR 81186 37078	Sea water	2	33.2
16	14/10/2009	CBSWB	NR 80583 37010	Sea water	0	28.0

Table 3. Shellfish sample results

No.	Date	Sample	Grid Ref	Type	<i>E. coli</i> (MPN/100 g)
1	14/10/2009	CBR1	NR 81186 37078	Razor clams	130
2	14/10/2009	CBR2	NR 80583 37010	Razor clams	<20

Figure 2. Water sample results



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Figure 3. Shellfish sample results



Photographs

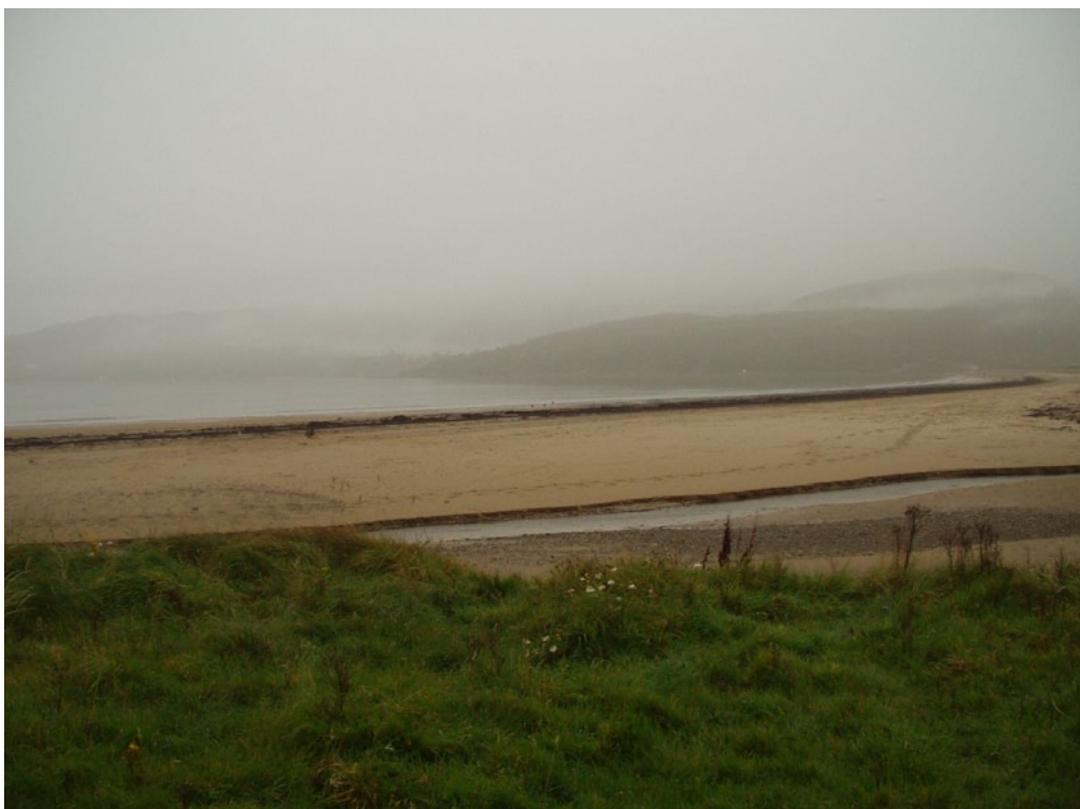


Figure 4. Stream on east side of the bay, location of fresh water sample 1 (CFW1)



Figure 5. Location of sea water sample 16 (CSWB)



Figure 6. Sewage related debris at high tide mark



Figure 7. Location of fresh water sample 5 (CFW5)



Figure 8. Pipe underneath house, no flow at time of shoreline survey



Figure 9. Possible septic tanks



Figure 10. Location of sea water sample 13 (CSW4)