SCOTTISH NATURAL HERITAGE

COMMISSIONED REPORT

Commissioned Report No. 077

Trial re-introduction of the European beaver to Knapdale: public health monitoring 2001–3

(ROAME No. F02AC327)

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Summary

Trial re-introduction of European beaver to Knapdale: public health monitoring 2001–3

Commissioned Report No. 077 (ROAME No. F02AC327)
Contractor: Argyll and Bute Council Public Protection Service

Background

Scottish Natural Heritage (SNH) has proposed to undertake a trial re-introduction of the European beaver *Castor fiber* to Knapdale, Argyll. Potential concerns which have been raised during the consultation process include the detrimental effect the beavers might have on the quality of drinking and surface water in the immediate locality, specifically contamination from *Giardia* and *Cryptosporidium* which are protozoan parasites that may be present in animals, soil and water-courses. The potential impact of these proposals to public health, and particularly the quality of surface and drinking water supplies, is considered. This work has been undertaken independently by Argyll and Bute Council's Public Protection Service to assess water quality prior to the trial re-introduction of the beaver, if approved. Results of pre-release monitoring for the period 2001–3 are presented.

Main findings

- The sampling work to date has established baseline data for the water quality within the Knapdale Forest area and identified the presence, on occasion, of microbiological organisms including *Giardia* (one sample) and *Cryptosporidium* (four samples). This indicates the presence of animal excretors in the area (eg deer, sheep).
- It has also demonstrated that the microbiological quality of private and surface water supplies varies considerably and is dependant upon climatic and environmental conditions. *Giardia* and *Cryptosporidium* were not identified in the private drinking water supplies.
- Should Scottish Executive give consent for the trial re-introduction of the beaver, this background sampling work will provide a basis for comparison. The subsequent sampling programme should continue once the beavers are released, in order to provide a means of assessing their impact on public health and water quality.
- It is concluded that, subject to the animals undergoing appropriate quarantine and screening, the release of a limited number of beavers, together with the provision of monitoring and controls, will not pose a significant additional public health risk. It is further concluded that the risk of increased human cases of Giardiasis is significantly low and that it should not be considered an obstacle to beaver re-introduction.

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1 INTRODUCTION

Evidence suggests the European beaver *Castor fiber* was resident in Scotland until as recently as the 16th century, when it was hunted to extinction by over-hunting. Since 1995, Scottish Natural Heritage (SNH) has been investigating the potential for reintroducing this species to the wild. The work SNH has undertaken during the 'European Beaver Project' is in line with obligations on the UK Government, under Article 22 of the European Council Directive 92/43/EEC on Conservation of Natural Habitats and of Wild Flora and Fauna ('the Habitats Directive'), to consider the desirability of re-introducing certain species listed in Annex IV, including the European beaver.

Following a national consultation, SNH proposed that a trial re-introduction of the European beaver should take place at Knapdale, mid-Argyll (Appendix 1). It was proposed that up to four beaver families should be introduced for a five-year period, in order to study the beaver in the Scottish environment. This would include assessing the effects of beaver activities on the environment and how they would affect existing land uses. At the end of the trial a decision will be made as to whether to proceed with a full-scale re-introduction.

The proposal by SNH to undertake a trial re-introduction of the European beaver to Knapdale has received both positive and negative responses. Potential concerns which have been raised include the detrimental impact the beavers might have on the quality of drinking and surface water in the immediate locality, specifically contamination from *Giardia* and *Cryptosporidium*. These are protozoan parasites that may be present in animals, soil and in water-courses and which can have an impact on public health.

The potential effect of these proposals on public health, and particularly the quality of surface and drinking water supplies, is considered in this report. The study considers these factors and focuses only on the water transmitted infections which may impact on human health. This work has been undertaken independently by Argyll and Bute Council's Public Protection Service to assess water quality prior to the trial re-introduction of the beaver. Results of pre-release monitoring for the period 2001–3 are presented.

2 BACKGROUND

The European beaver is entirely herbivorous and tends to forage for food within waterways or close to the water's edge (eg grasses, reeds, water horsetail, other herbaceous species). They do not eat fish. During autumn and winter, bark from deciduous tree species tends to become a larger component of their diet. If necessary, beavers will build dams to raise water levels above their burrow entrances. Studies from Lapland have indicated that they build dams in only 18.7% of the sites they use. The preferred diameter of tree stems taken for food is 1.5–3.5cm.

Giardia and *Cryptosporidium* are the two most commonly reported parasites of humans in the world. They are parasitic protozoa that may be present in the intestines of humans and other hosts. Infectious organisms present in contaminated potable water have the potential to infect large numbers of people. These parasites have been responsible for over 140 outbreaks of waterborne disease worldwide (Smith and Grimason 1998). The pathway for infection can be waterborne through drinking water contaminated by discharges of effluent and waste-water (New York State Department of Health web site). However, the parasites can also be transmitted person to person and studies have shown that the faecal-oral pathway is the major route of infection in humans (Smith and Grimason 1998).

Giardia and *Cryptosporidium* infection occurs when viable oocysts are excreted by infected hosts and reach the intestine of a suspect host. The presence of oocysts does not indicate a risk of infection in all cases as it is only the viable, or live, oocysts that can transmit the infection. The symptoms of both parasites are primarily mild to severe diarrhoea and fever over a prolonged period of about ten days.

Surveillance data of Giardiasis and *Cryptosporidium* for Scotland demonstrates they are prevalent in the community in humans and animals (Table 2.1). It should be noted that the majority of the human cases are attributable to infection during foreign travel.

Table 2.1 Surveillance data of Giardiasis and *Cryptosporidium* for Scotland, collated by the Scottish Centre for Infection and Environmental Health (SCIEH web site).

	No. of Cases			
	1999	**2000**	**2001**	**2002**
Cryptosporidium				
Zoonotic	581	495	287	356
Human	598	867	569	646
Giardiasis				
Zoonotic	2	2	0	0
Human	296	281	251	207

The parasites are present in domestic and wild animals and humans. An important measure is to control the transmission of the oocysts through the targeting of water and environmental sources.

Giardiasis has been referred to as 'Beaver Fever' by the media in North America. This followed a specific Canadian outbreak of Giardiasis from a water source. This was purported to be attributable to the North American beaver (*Castor canadensis*) as *Giardia* was identified during a post mortem of a beaver carcass. It should, however, be noted that no post mortems were done of other animal species (eg cattle) which are also known to be hosts for the protozoan.

There is very little epidemiological evidence of *Giardia* in Scotland, although there are wild animals in Scotland which are known to carry it.

3 METHODS

3.1 Sampling

Knapdale Forest, located to the west of Lochgilphead, is a large forested area, predominately rural, with only a small number of dwellings situated within it. The area is used for recreational purposes, including walking, cycling and fishing. A number of inland lochs provide water to the Crinan Canal.

Once released at Knapdale, beavers will excrete directly or indirectly into the aquatic habitat. Therefore the assessment of the potential impact to public health from the trial re-introduction of the European beaver will concentrate on one of the possible routes of transmission, specifically the consumption of contaminated water.

Within Knapdale Forest there are 10 private water supplies which extract their drinking water from surface water courses. This number has recently reduced from 13 following the connection of properties to a public mains extension to Achahoish.

The Council's strategy to assess the existing quality of these potentially 'at risk' supplies and the surface burns was to sample from all supplies and identify six representative surface burns spread across the Knapdale Forest area. The programme was agreed with Scottish Natural Heritage. The map in Appendix 1 indicates the sampling locations used in this study.

The sampling methodologies were agreed with Scottish Water (formerly known as West of Scotland Water). Scottish Water undertook the analysis of the water samples. Samples were taken either using a portable pump, in which water was passed through a filter which was then analysed by the laboratory, or with a grab sample, in which a 10 litre sample of water was taken.

Over the last 30 years many sampling methods have been developed to identify *Cryptosporidium* and *Giardia* in raw and treated waters. Both large and small volume (grab) sampling methods have been developed, the main difference being that the large volume method entails the collection of the sample over a period of several hours at defined volumes and flow rates, whereas the small volume method simply involves the relatively quick filling of sampling containers (Smith and Grimason 1998). For this study, the initial plan was to take small volume grab samples at the sites at a pre-determined frequency:

- Private supplies – twice annually
- Surface waters – six times annually

These samples were analysed for *Cryptosporidium*, *Giardiasis*, *Salmonella*, Faecal *Streptococcus* and general microbiological quality (see table in Appendix 2). Chemical analysis was not considered to be essential on a regular basis although it was carried out at the beginning of the project.

Actual sampling rates were less than originally planned. This was particularly the case for private supplies. Difficulties were experienced obtaining access to sample private water supplies due to concerns by the residents that the sampling method would impact on their supplies.

3.2 Analysis

The analyses of the water samples were undertaken by Scottish Water at their UKAS-accredited (United Kingdom Accreditation Service) laboratory at Balmore Road, Glasgow. Scottish Water has accreditation for *Cryptosporidium* analysis using the Cuno Filter Method (MP11) and the Genera Filter (MP18). These methods are recognised as the United Kingdom industry standards.

The general detection method isolates and enumerates the *Cryptosporidium* and *Giardia* cysts in the ground, surface and finished waters using filtration, immunomagnetic separation and fluorescent antibody staining. The antibodies used are genus specific and therefore will not identify the species of *Cryptosporidium* or *Giardia* detected. The method detects the presence of cysts but not their viability.

The regulatory analysis involves concentrating the (oo)cysts initially by filtration and then by centrifugation. The sample is then treated with immuno-magnetic beads that extract the (oo)cysts from the sample and the laboratory are then able to stain the organisms and describe them microscopically.

As with any laboratory analysis there are limitations dependant on the sample type and the accuracy of equipment. The sensitivity can be affected by the presence of large numbers of algae in the sample, the water type (hard or soft), and the amount of water filtered.

4 RESULTS

The results of the sampling work are detailed in Appendix 2. To date they indicate the following:

- The private water supplies are satisfactory in respect of chemical parameters, although microbiologically they are predominantly unsatisfactory.
- Raw water quality is dependent upon many factors, including environmental ones (eg wet/dry weather, presence of sheep and wild animals, etc.). The sampling results to date have found variable levels of microbiological contamination consistent with the impact of these factors.
- The presence of *Cryptosporidium* oocysts in surface water burns (stream numbers 1, 2, 4 and 5, sampling date 31 July 2002) signifies the presence of wild and domestic animals (eg deer, foxes, sheep, etc.) in the immediate area of the lochs or burns. These burns are supplied from different catchment areas.
- *Giardia* oocysts were identified in a sample taken from stream number 6 on 11 July 2001.
- No *Giardia*, *Salmonella*, *Cryptosporidium* or Faecal *Streptococci* were isolated from drinking water supplies.
- The presence of *E.coli* and *Coliform* in drinking water supplies are indicative of faecal contamination of these supplies. This is not uncommon for raw, untreated water supplies.

5 DISCUSSION

The results to date have produced no clear trends other than to confirm that the microbiological quality of the private water supplies and surface burns is variable and dependent upon climatic and environmental factors. This is particularly evident when comparing all the results of 2002–3 with the data from 11 July 2001 and 17 January 2002.

Giardia and *Cryptosporidium* are present in the natural environment and within a number of surface water samples. The sources may be from a combination of animals or from surface run-off from the soil, since oocysts can live for up to 18 months in the soil under ideal solutions (Turkington 2002). The quality of the surface water burns may be affected by varying sources of pollution, including the impact of traffic on forestry roads, grazing sheep, deer and other wildlife, and surface water run-off.

6 FUTURE WORK AND CONCLUSIONS

There is not only a need to continue with the sampling regime but also to review the methodologies and practices that are currently used. The existing short term (grab) samples provide a sufficient indicator, but the methodology needs to be developed to include a combination of short and long term volume (filtered) sampling. In addition, no assessment has been made of the viability of any oocyst. Only live oocysts impact on public health. It is therefore proposed that arrangements be made to serotype any positive sample.

Consideration must be given to providing for additional control/protection of private supplies via the provision of filtration for the private water supplies.

The sampling work to date has established baseline data for the water quality within the Knapdale Forest area and identified the presence, on occasion, of microbiological organisms including *Giardia* (one occasion) and *Cryptosporidium*. This indicates the presence of animal excretors in the area (eg deer, sheep). It is likely that the beavers will add to this microbiological load, particularly that of *E. coli* and *Coliform*. However, this cannot be quantified at this stage.

It has also indicated that the microbiological quality of private and surface water supplies varies considerably depending on climatic and environmental conditions. Of note is that *Cryptosporidium* has been identified in four samples of surface water and *Giardia* in one sample. This indicates the presence of these protozoa in the existing environment in Knapdale. *Giardia* and *Cryptosporidium* were not identified in the private drinking water supplies.

Should Scottish Executive give consent for the trial re-introduction of the beaver, this background sampling work will provide a basis for comparison. The subsequent sampling programme should continue once the beavers are introduced, in order to provide a means of assessing their impact on public health and water quality.

There have been concerns raised that beavers will introduce *Giardia* to the Knapdale area and give rise to an outbreak of 'Beaver Fever'. This concern arises from a reported outbreak from a recreational water body in Canada. Investigations focused on a post mortem of a beaver from which *Giardia* was isolated. It should, however, be noted in this case that, as far as can be established, no post mortems were undertaken on cattle or other animals which are also recognised as potential carriers of the oocysts.

In public health terms, *Giardia*, *Cryptosporidium* and other microbiological parameters are naturally occurring in the environment and within animal and human populations. The general advice to reduce the risk to public health is to ensure hands are properly washed and water boiled before consumption.

This study has only established baseline levels of water quality in surface water and private water supplies in the Knapdale area. The full impact of the beaver project cannot be fully quantified by this work and there is no ability to "model" the impact that the beavers will have.

It is acknowledged that there is a potential for any infected animal to contaminate water when faecal material enters the water-course in run-off from land. It is expected that the beavers will increase current bacterial loads in the area, particularly that of *E.coli*.

The views of Professor G Morris, Scottish Centre for Infection and Environmental Health (SCIEH), were sought. He indicated that, subject to the beavers undergoing appropriate quarantine and screening, the introduction of a limited number of animals and the provision of monitoring and controls, the project will not pose a significant additional public health risk. He further indicates that the risk of increased human cases of Giardiasis is significantly low that it should not be considered an obstacle to beaver re-introduction.

The work to date has established the water quality within the Knapdale area and provides a baseline for comparison purposes should the project receive Scottish Executive consent. Having considered the information to date, Argyll and Bute Council Public Protection Service are of the opinion that subject to controls, the re-introduction of the beaver will not pose a significant risk to public health. However, monitoring of public health issues will become a key priority at the time of introduction and effective screening, tracking and other controls and monitoring systems will be necessary to objectively assess the impact on public health.

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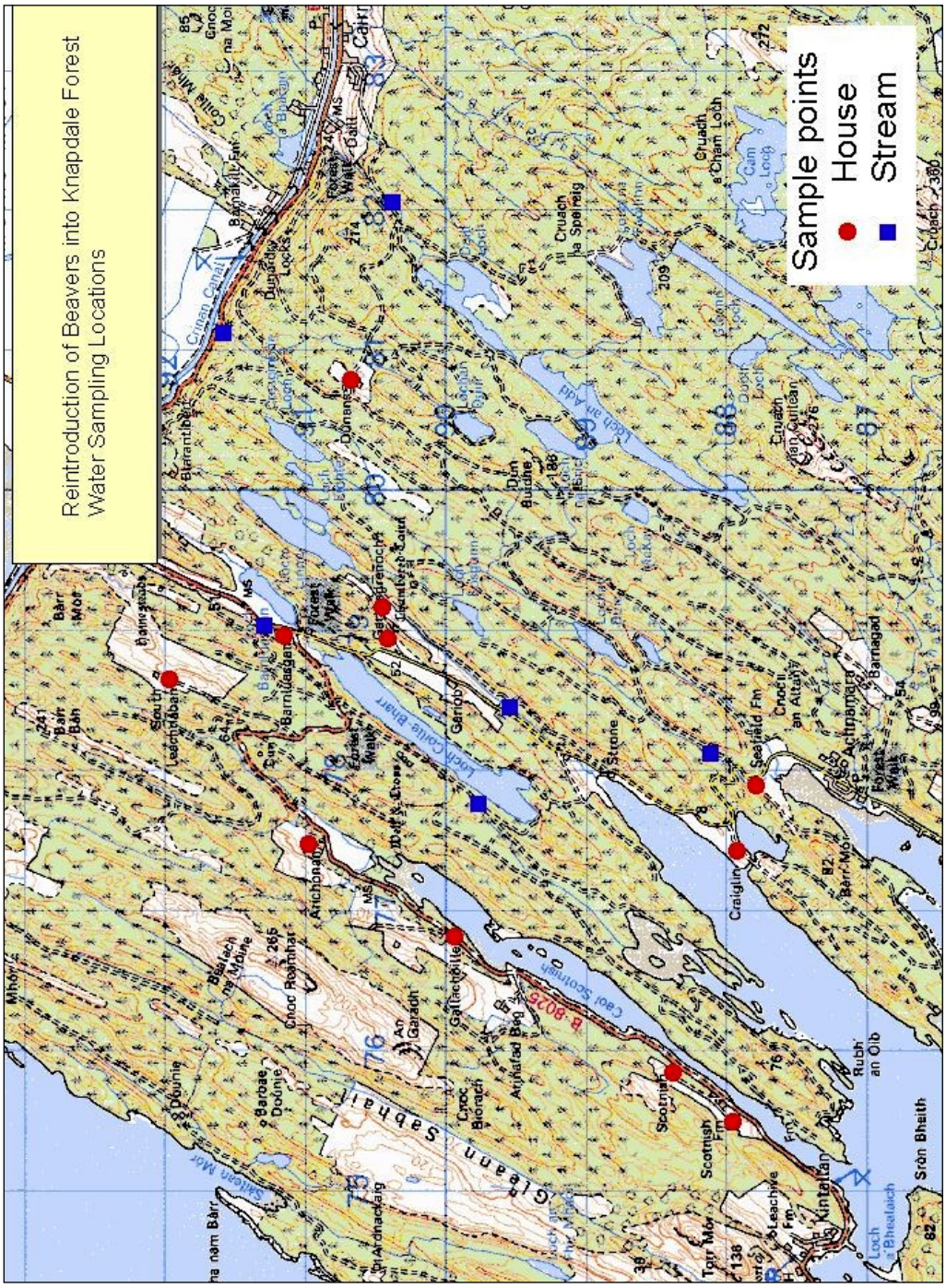
APPENDIX 1 – Trial re-introduction of Beavers into Knapdale Forest: Water Sampling Locations



APPENDIX 2 – Sampling and analytical results

Sampling point (name)	Sampling point (number)	Sample date	Colour Mg/l Pt/Co	Iron ug Fe /l	Manga-nese ug Mn /l	Coliform /100ml	Ecoli /100ml	Faecal Strepto-cocci /100ml	Crypto-sporidium oocysts/ 10l	Giardia oocysts/ 10l	Comments
Surface water burns											
Dunans	Stream 1	020501	21	106	17	16	0	0	0	0	
		110701	–	–	–	1700	1400	29	0	0	
		120901	–	–	–	950	130	2	0	0	*Salmonella* Present
		061101	–	–	–	74	6	1	0	0	
		170102	–	–	–	220	110	144	0	0	
		200302	–	–	–	82	4	1	0	0	
		310702	–	–	–	44	44	24	0.5	0	
		301002	–	–	–	14	10	0	0	0	
		111202	–	–	–	5	5	0	0	0	
		230403	–	–	–	10	0	2	0	0	
n/a	Stream 2	020501	69	329	20	21	0	0	0	0	
		110701	–	–	–	2800	2700	140	0	0	
		120901	–	–	–	61	18	2	0	0	
		061101	–	–	–	55	8	2	0	0	
		170102	–	–	–	270	40	370	0	0	
		200302	–	–	–	27	1	1	0	0	
		310702	–	–	–	17	17	10	1.5	0	
		301002	–	–	–	3	3	0	0	0	
		111002	–	–	–	4	1	0	0	0	
		230403	–	–	–	4	1	0	0	0	
		090703	–	–	–	6	5	0	0	0	
Barnluasgan	Stream 3	020501	26	151	80	4	2	0	0	0	
		110701	–	–	–	58	58	37	0	0	
		120901	–	–	–	1440	40	48	0	0	
		061101	–	–	–	110	10	14	0	0	
		170102	–	–	–	230	40	300	0	0	
		200302	–	–	–	37	1	0	0	0	
		310702	–	–	–	54	54	9	0	0	
		301002	–	–	–	9	8	1	0	0	
		111202	–	–	–	9	9	0	0	0	
		230403	–	–	–	5	0	0	0	0	

Appendix 2 *(continued)*

Sampling point (name)	Sampling point (number)	Sample date	Colour Mg/l Pt/Co	Iron ug Fe /l	Manga-nese ug Mn /l	Coliform /100ml	Ecoli /100ml	Faecal Strepto-cocci /100ml	Crypto-sporidium oocysts/ 10l	Giardia oocysts/ 10l	Comments
Gariob	Stream 4	020501	30	233	18	4	2	11	0	0	
		110701	–	–	–	1900	600	23	0	0	
		120901	–	–	–	1500	1400	7	0	0	*Salmonella* Present
		061101	–	–	–	130	10	4	0	0	*Salmonella* Present
		170102	–	–	–	82	35	48	0	0	
		200302	–	–	–	120	10	1	0	0	
		310702	–	–	–	74	74	7	1.5	0	
		301002	–	–	–	14	14	1	0	0	
		111202	–	–	–	5	4	4	0	0	
		230403	–	–	–	5	0	0	0	0	
Seafield	Stream 5	020501	46	366	19	24	4	1	0	0	
		110701	–	–	–	1300	400	24	0	0	
		120901	–	–	–	620	40	0	0	0	
		061101	–	–	–	170	20	1	0	0	
		170102	–	–	–	73	38	12	0	0	
		200302	–	–	–	190	0	1	0	0	
		310702	–	–	–	91	26	3	3	0	*Salmonella* Present
		301002	–	–	–	28	14	0	0	0	
		111202	–	–	–	10	8	1	0	0	
		230403	–	–	–	7	4	0	0	0	
Roger's corner	Stream 6	020501	32	47	<5	22	1	0	0	0	
		110701	–	–	–	39	11	2	0	1.3 ooyst S/101	*Giardia* present
		120901	–	–	–	13	1	18	0	0	
		061101	–	–	–	16	0	0	0	0	
		170102	–	–	–	2	1	0	0	0	
		200302	–	–	–	53	0	0	0	0	
		310702	–	–	–	9	8	1	0	0	
		301002	–	–	–	6	5	1	0	0	
		111202	–	–	–	1	1	0	0	0	
		230403	–	–	–	5	1	0	0	0	

Appendix 2 *(continued)*

Sampling point (name)	Sampling point (number)	Sample date	Colour Mg/l Pt/Co	Iron ug Fe /l	Manganese ug Mn /l	Coliform /100ml	Ecoli /100ml	Faecal Streptococci /100ml	Cryptosporidium oocysts/ 10l	Giardia oocysts/ 10l	Comments
Private Water Supplies											
Oakbank Farm	PW1	170401	10	36	8	10	0	0	0	0	
		061101	–	–	–	43	1	0	0	0	
Scotnish Farm	PW2	170401	<2	71	<5	7	0	0	0	0	
Scotnish Lodge	PW3	170401	5	25	<5	20	0	0	0	0	
Dunans	PW4	170401	27	90	<5	0	0	0	0	0	
		061101	–	–	–	160	0	0	0	0	
Leac na Ban	PW5	020401	<2	<10	<5	18	0	0	0	0	
		090703	–	–	–	0	0	0	0	0	
Seafield Farm	PW6	020401	<2	10	5	0	0	0	0	0	
		200302	–	–	–	1	0	0	0	0	
Gallachoile	PW7	170401	<2	<10	<5	14	0	0	0	0	
		061101	–	–	–	49	25	41	0	0	
Barnluasgan	PW8	270301	<2	<10	<5	0	0	0	0	0	
Craglin	PW9	270301	<2	<10	<5	1	0	0	0	0	
		200302	–	–	–	0	0	0	0	0	
Gartnagrenach	PW10	270301	<2	<10	<5	6	0	0	0	0	
		090703	–	–	–	3	2	0	0	0	
Tigh-na-grian	PW11	270301	3	22	5	0	0	0	0	0	

Notes

1. Seafield Farm (PW6) is no longer a sampling point as it has now been connected to a water mains extension
2. Maximum Values

The Maximum Admissible Concentration (MAC) values for each parameter are as follows:–

Parameter	Unit of measure	Maximum Admissible Concentrations
Colour	Hazen units (mg/l Pt/Co)	20
Iron	ug Fe/l	200
Manganese	ug Mn/l	50
Coliforms	count/100ml	0
E. Coli	count/100ml	0
Faecal *Streptococci*	count/100ml	0
Cryptosporidium	ooysts/10l	0
Giardia	ooysts/10l	0
Salmonella	count/100ml	Absent

3. Description of parameters

Colour	This parameter is affected by the level of suspended solids in the water and also the nature of the catchment area and ground from which it emanates (eg peaty ground produces brown water). At values in excess of 20 Hazen units, it can render UV disinfection inadequate
Iron and Manganese	These are naturally occurring parameters which have the effect of discolouring the water. They are of little public health significance although they affect the aesthetic properties of the drinking water through unpleasant taste and colour at excessive concentrations. At levels in excess of 1000mg/l they can discolour white washing
Salmonella,* Faecal *Streptococci	Microorganisms which can lead to gastro-enteritis in humans. They can enter the water supply through faecal contamination by animals, humans or slurry
E.coli* and *Coliform	Indicator organisms for faecal contamination
Giardia* and *Cryptosporidium	Oocysts can enter the water directly by animals (eg cattle, sheep etc.) or through surface water run-off from ground. They can lead to gastro-enteritis in humans