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Scottish Environment Protection Agency

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SEPA's main aim is to provide an efficient and integrated environmental protection system for Scotland which will both improve the environment and contribute to the Scottish Ministers' goal of sustainable development.

Radiological Habits Survey,
Faslane, 2006

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SUMMARY

This report presents the results of a survey, conducted in 2006, into the habits and consumption patterns of people living and working in the vicinity of the Faslane Naval Base and the Royal Naval Armaments Depot at Coulport, which together make up Her Majesty's Naval Base Clyde. Faslane Naval Base discharges liquid wastes into Gare Loch and Royal Naval Armaments Depot at Coulport discharges tritium into the atmosphere. Faslane Naval Base also has sources of direct radiation. Potential exposure pathways for the site include consumption of locally sourced terrestrial and aquatic foods and occupancy of nearby properties and intertidal areas. The survey investigated all of these pathways and the data obtained for the consumption and occupancy rates of individuals are presented and discussed. Data were collected for 214 adults and 91 children.

Foods consumed from the survey areas included locally caught seafood, meat, milk, eggs, game, honey, wild/free foods and home-grown fruit and vegetables. Occupancy habits included those related to residences and workplaces within 1 km of the southern end of the Faslane site, recreation and work activities over intertidal areas and handling of intertidal sediment. In the aquatic survey area, the main activity observed was shore angling. In the terrestrial survey area, livestock production was predominantly beef and lamb.

1. BACKGROUND

1.1 Regulation of radioactive waste discharges

There are generally three main sources of radiation exposure to members of the public from nuclear sites in routine operations: discharges of radioactive waste to the aquatic environment, discharges to the atmosphere and direct radiation from the site. Radioactive waste storage and disposal at Faslane and Coulport are regulated by SEPA, who issues Letters of Agreement for the disposal of radioactive wastes under the pseudo-RSA93 arrangements.

1.2 The critical group concept

Radiological protection of the public is based on the concept of a critical group. The critical group is defined as the people who, because of where they live and their habits, receive the highest radiation dose from the site and its discharges. It is the assessed radiation dose to the critical group that is compared to relevant limits and constraints. If the dose to the critical group is acceptable, it follows that the lower doses received by other members of the public will be below any limits and constraints, and overall protection of the public from the effects of the radioactivity is provided. This survey provides information to assist SEPA in determining critical groups around Faslane and Coulport.

1.3 Dose limits and constraints

Assessed radiation doses to critical groups can be compared to nationally and internationally agreed dose limits, recommendations and constraints.

The Radioactive Substances (Basic Safety Standards) (Scotland) Regulations 2000 (Scottish Executive, 2000) directs SEPA to ensure that the sum of doses of ionising radiation to the public do not exceed the limits set out in Article 13 of Council directive 96/29/Euratom (CEC, 1996) and that doses should be as low as reasonably achievable (ALARA), economic and social factors being taken into account. In connection with the latter, SEPA is directed to have regard to the following maximum doses which may result from a defined source, for use at the planning stage in radiation protection:

a) 0.3 millisieverts per year from any source from which radioactive discharges are first made on, or after 13 May, 2000: or

b) 0.5 millisieverts per year from the discharges from any single site.

Additionally, the Government accepts that, in general it should be possible to operate existing facilities within the 0.3 mSv per year source constraint.

2. THE SURVEY

2.1 Survey aims

The Centre for Environment, Fisheries and Aquaculture Science (Cefas) undertook the survey in July and August 2006 on behalf of SEPA (Cefas contract C2448 and SEPA contract R40067/PUR). The aim of the survey was to review habits related to public radiation exposure via aquatic, terrestrial and direct radiation exposure pathways resulting from the routine activities undertaken at Faslane Naval Base and the Royal Naval Armaments Depot (RNAD) at Coulport.

The last full habits survey of the Faslane area conducted by Cefas was in 2000 (Sherlock, Caldwell and McMeekan, 2002). Data from this survey are currently being used for dose assessments in the Faslane area; this survey did not cover RNAD, Coulport.

Fieldwork was conducted in order to obtain site specific habits data. These data, in combination with monitoring data, can be used to determine local critical group(s) and identify critical exposure pathways to the local population. General habits survey information for the area was also obtained.

Investigations were carried out to ascertain the following:

- External exposure activities, including angling, bait digging, mollusc collection and general recreational activities along the intertidal shoreline.
- Internal exposure from the consumption of food sources from the aquatic and terrestrial environments.
- The production, use and destination of local produce.
- The types and extent of consumption of wild foods in the area.
- The extent of occupancy within 1 km of NGR NS 247 879 (a point at the southern end of the Faslane site where liquid effluent was stored awaiting treatment and discharge).

- The extent of any unusual practices.
- The use of any natural resources from the aquatic environment (e.g. sand extraction and the use of seaweed as a fertiliser).

The survey team also collected information that could be used in the assessment of other pathways such as the inhalation of re-suspended radioactivity in sea spray, the inadvertent ingestion of contaminated seawater and contact with, and/or inadvertent ingestion of, contaminated sediments.

2.2 Site activity

Her Majesty's Naval Base (HMNB) Clyde comprises two sites; Faslane Naval Base and the Royal Naval Armaments Depot (RNAD) at Coulport.

Faslane is an operational base situated on Gare Loch, approximately 25 miles north-west of Glasgow, and provides maintenance and support services for the UK's nuclear powered submarine fleet. The site deals with radioactive wastes arising from the operation at sea and the maintenance ashore of submarine nuclear propulsion systems. The radioactive wastes consist exclusively of solid LLW and VLLW and liquid LLW; the solid wastes are consigned for disposal to the LLW repository near Drigg and the liquid waste is discharged, after treatment, into the waters of Gare Loch. The site contains sources of direct radiation.

RNAD Coulport is situated on Loch Long and stores conventional armaments for Royal Navy vessels and also warheads for the Trident missile system. Coulport discharges gaseous radioactive waste (tritium) into the atmosphere and solid LLW is stored at Coulport pending its disposal, via Faslane, to the LLW repository near Drigg.

2.3 Survey areas

Following discussions with SEPA three survey areas were defined to cover the aquatic, terrestrial and direct radiation pathways as follows:

The aquatic survey area covered the whole of Gare Loch, from Garelochhead at the northern tip, to Rosneath Point at its western mouth and Helensburgh Pier at its eastern mouth (shown in Figure 1). It was chosen based on Admiralty tidal data and included all intertidal and aquatic areas.

The terrestrial survey area was designed to encompass the main areas of potential deposition of gaseous discharges from RNAD Coulport, taking into account the prevailing south-westerly winds. It included all land within a 5 km radius of the Faslane site centre (NGR NS 246 895) and extended to the west to include the whole of the Rosneath peninsular (shown in Figure 2). This differed from the 2000 survey area which extended 5 km from the Faslane site centre, but excluded terrain within the 5 km radius which was situated to the west of the ridge line running along the Rosneath peninsula.

The direct radiation survey normally aims to cover individuals residing and working within 1 km of a site centre. After discussion with the SEPA site inspector, the survey area (also shown in Figure 2) was defined as a circle of 1 km radius from a point at the southern end of the Faslane site (NS 247 879) where liquid effluent was stored awaiting treatment and discharge.

2.4 Conduct of the survey

The fieldwork component of the survey was carried out during the period 25th July to 3rd August 2006 by three members of staff from the Cefas laboratory at Lowestoft, according to techniques as described by Leonard *et al* (1982).

People with a local knowledge of the survey areas were contacted for information on any aspects relevant to the exposure pathways. These included the local council, fishing tackle shops, outdoor centres, farmers, yacht clubs, shop owners (butchers and fishmongers) and beekeepers.

Occupants of residences and businesses located within the direct radiation survey area were interviewed about their times at home and at their place of business, both indoors and outdoors; HMNB Clyde employees and contractors were excluded. Gamma dose rate measurements were taken inside and outside most of these properties. For comparison, background readings were taken outside the 1 km survey area.

Interviews were used to establish individuals' consumption rates and occupancy times relevant to all pathways and to obtain any general information of possible use to the survey. Using this information, a list of occupations and activities was built up to produce a picture of potential exposure pathways. Emphasis was placed on those individuals who were likely to be in the most exposed groups. These included anglers, bait diggers, farmers, and individuals living and/or working within the direct radiation survey area.

3. METHODS FOR DATA ANALYSIS

3.1 Data conversion

The data collected during the fieldwork were recorded in logbooks. Information on individuals' consumption and external exposure rates was entered into a database. Each individual for whom information was obtained was given a unique identifier (the Observation Number) to assist in maintaining data quality. Consumption data were converted to consumption rates in kilograms per year (wet weight) of locally produced food and litres per year for milk. Where interviewees were unable to provide consumption rates in weight per year, they were asked to estimate the number of units, e.g. the average number of eggs, consumed per week. In a limited number of cases, annual consumption was supplied in other quantities, for example

the number of plants or the length and number of rows in which the crop was grown. These data were converted to consumption rates, in kilograms per year, using published produce weights (e.g. Hessayon, 1997 and Good Housekeeping, 1994), edible fraction data researched by Cefas and information supplied by the Beef and Livestock Commission. For the purpose of data analysis, foodstuffs were aggregated into food groups; the typical food groups used in surveys are shown in Table 1.

All consumption and occupancy data in the text are rounded to two significant figures. In the tables and annexes, the data are usually presented to one decimal place; the exceptions are for values less than 0.05 which are presented to two decimal places in order to avoid them appearing as 0.0. External exposure times are quoted as integers.

3.2 Determination of critical groups

The critical group is determined by assessing doses that are representative of the most exposed individuals. The group will change according to the assessment being undertaken. Each assessment will have associated concentrations and/or dose rates distributed in space and time. This survey provides information that can be used to help define the critical group in an assessment but it does not constitute an assessment in itself. The terms critical groups and critical group consumption rates are only used here for ease of presentation. A critical group can only be established once a dose assessment using environmental monitoring data has been undertaken.

3.3 Data analysis

The habits data are structured into groups of food items or substrate types with similar attributes. For example, when considering terrestrial food consumption, all types of root vegetables are grouped together in a food group called ‘root vegetables’. Similarly, for aquatic food consumption, all mollusc species are grouped as ‘molluscs’. For external exposure over intertidal sediments, occupancy over a common substrate, (for example, mud)

is chosen. The choice of a group of activities is made when it is reasonable to assume that consistent concentrations or dose rates would apply within the group. In addition to grouping of activities, ingestion data are structured into age groups because different dose coefficients can apply to different ages. The age groups used were: from 0 to 1.0 y of age (called 3 months); more than 1.0 y to 2.0 y (called 1 year old); more than 2.0 y to 7.0 y (called 5 year old); more than 7.0 y to 12.0 y (called 10 year old); more than 12.0 y to 17.0 y (called 15 year old). Children over 17 are treated as adults. These age groupings are consistent with those used by ICRP (ICRP, 1996).

All consumption, occupancy, and handling rates for individual adults and children are presented in Annex 1 and Annex 2, respectively.

Ingestion pathways

Consumption rate data are presented for individuals and are further characterised in two ways to represent high rate consumers in each food and age group. Firstly, the 97.5 percentile rate is calculated from the observed data, for each of the food groups and for all age groups where consumption by more than one person occurred, using the Microsoft Excel mathematical function for calculating percentiles. Secondly, the 'cut-off' method described by Hunt *et al* (1982) is used for each age group's observations for each of the food groups where consumption occurred. In this case, the rate representing high rate consumers is calculated by taking the arithmetic mean of the maximum value and all consumption rates observed within a factor of three of the maximum value (termed the lower threshold value). It accords with the principle expressed by ICRP (ICRP, 1984) that the critical group should be small enough to be reasonably homogeneous with respect to age, diet and those aspects of behaviour that affect the doses received.

In exceptional cases, the 'cut-off' method can result in only one member in the high rate group. In this case, judgement is used as to whether to include other individuals within the group. If it is decided appropriate to include other individuals, the next highest suitable

observation is used to set the lower threshold but the top value is still included in the mean. Cefas have called the rate derived by the cut-off method the critical group rate for ease of presentation though the term is not strictly correct. This is because the critical group can only be established once a dose assessment using environmental monitoring data has been undertaken.

Consumption data for aquatic foodstuffs are presented for adults in Tables 2 to 4, and for children in Table 5. Consumption data for terrestrial foodstuffs are presented for adults in Tables 9 to 23, and for children in Table 24. Both the aquatic and terrestrial consumption data are summarised in Table 6 for adults and Tables 7 and 8 for children. For purposes of comparison, generic values for the 97.5 percentiles and mean consumption rates for aquatic and terrestrial foodstuffs based on national data are provided in the summary tables.

Critical group rates have been calculated from the survey data for children. However, because few child consumers were identified the results should be viewed with caution. For assessment purposes, a different approach may be taken where survey rate data for children's age groups are absent or limited. This involves taking the rates for adults, provided in Table 6, and scaling them by ratios shown in Table 31, which have been calculated using generic 97.5 percentile consumption rates.

External exposure in intertidal areas

A similar approach to that used for ingestion pathways is used for occupancy and handling rates in intertidal areas (Tables 26 and 27 respectively). Critical group rates and 97.5 percentile rates are determined for groups of substrates or activities with common attributes. In previous surveys a factor of 1.5, instead of 3, was used to define the cut-off value for intertidal occupancy and handling. However, it is now considered appropriate that the same factor of 3, as for consumption, is used.

Exposure in or on water

Activities taking place in or on the water can lead to ingestion of water and/or inhalation of spray. These pathways are generally considered to be minor in comparison with other exposure pathways such as the ingestion of foods produced in the vicinity of a nuclear site. However, in order to allow for their assessment, relevant data have been collected.

Occupancy rates for activities taking place in or on seawater around Faslane are shown in Table 29.

No further manipulation of the data (for example, calculating critical group mean rates) has been carried out.

Direct radiation exposure

Occupancy data for the direct radiation pathway are left in their detailed form for each individual at each location. Grouping of these data is not helpful at this stage in the assessment process when there is no definitive measurement or prediction of dose rate due to external radiation from the site. The occupancy data are presented in Table 30.

4. AQUATIC RADIATION PATHWAYS

4.1 Aquatic survey area

Overview of the survey area

The aquatic survey area is shown in Figure 1. The tidal excursion calculated from Admiralty charts was 5 km at the mouth of the loch, although opposite Faslane base at the discharge pipe the tidal excursion was much less. In general the intertidal area comprised a narrow shingle beach interspersed with areas of muddy sediment (especially towards the head of the loch) and rocky areas. There were access points onto the foreshore around most of Gare Loch apart from where the Faslane base perimeter fence prohibited entry. The loch had many moorings for pleasure craft along with marinas, yacht clubs, an RNLI station, a coastguard station and a watersports centre. No nets, long-lines or pots were allowed to be used in the loch either from the shore or from a boat. Angling was popular around the loch, especially at Rhu Spit, Rockville and from Helensburgh Pier. Parts of the shoreline were popular with walkers and dog-walkers and one area was used by commercial winkle *(Littorina littorea*) collectors.

Rosneath Point to Rosneath

The substrate along this stretch of shoreline was mainly stone and shingle. There were several moorings for pleasure craft in the loch along this stretch of shoreline and there was one marina. Rosneath Point was a rocky promontory at the southern end of the Rosneath Peninsula. It was accessible by a footpath through woods alongside Culwatty Bay. There was evidence that the point was used for barbeques and angling. Culwatty Bay was a stony beach, again with evidence of barbeques and angling having taken place. A large caravan park was situated on the shore of Rosneath Bay; this was very popular throughout the year. Guests at the caravan park used the Rosneath Bay for angling and watersports such as sailing, kayaking and windsurfing.

Rosneath to Clynder

The substrate was stones and there was easy access onto the shoreline all along this stretch of the loch. Several lay-bys by the shore offered parking and these were used by anglers fishing from the shore. There were approximately 20 moorings for pleasure craft in the loch along this stretch and there were several slipways from the road down onto the beach. At high tide the beach was completely covered by water.

Clynder to Garelochhead

Access to the shore was more difficult along some parts of this coastline, there being a thick line of trees and hedges before a steep drop down onto the shore itself. However, there were a few lay-bys where anglers could park and climb down to fish. Angling was especially popular on the rocky outcrop at Rockville. The substrate was stones.

Garelochhead to Faslane

The intertidal substrate was stones and mud mixed with mussel shells at the head of the loch and then became stones down the east side of the loch towards Faslane. There was easy access onto the shore at Garelochhead via a large slipway and the foreshore was occasionally used by bait-diggers. There were several offshore moorings for pleasure craft in the loch around Garelochhead, with smaller rowing boats moored at the shoreside for use in accessing the offshore moorings.

Faslane to Rhu Spit

The base itself occupied a two kilometre stretch of the shoreline, from Faslane Bay to Carnban Point, and there was no public access onto the shore here. There was also an exclusion zone in the loch around the base prohibiting boats from entering, which extended out to 170 metres from the shore.

The southern extremity of the base was at Carnban Point, where public access to the shore was possible again. At Carnban Point a muddy harbour was adjacent to the perimeter fence of the base and this was used by a boatyard for the maintenance of boats. The yard had a concrete slipway for launching boats into the loch and hauling boats into the boatyard for maintenance and repair.

Between Shandon and Rhu Spit the substrate was stones and shingle. There were several slipways down to the loch from the main road and there were many offshore moorings for pleasure craft in the loch. This stretch also contained an outdoor centre which took adults and children on sailing, canoeing and kayaking courses in the loch. Rhu Spit was a shingle bank popular with anglers and walkers, which extended into the loch and formed the Rhu Narrows. The Narrows formed the entrance to a deep water section of the loch and was occasionally closed to boat traffic to permit submarine movements.

Rhu Spit to Helensburgh

There was easy access onto the shoreline between Rhu Spit and Helensburgh. There was one marina, two sailing clubs, a coastguard station and an RNLI station. The shoreline opposite Kidston Park, between Rhu and Helensburgh, was popular with commercial winkle collectors. The winkles were exported to France and Spain. Helensburgh pier was very popular with anglers, usually spinning for mackerel. The substrate along this stretch of shoreline was stones and mud.

4.2 Commercial fisheries

No nets, long-lines or pots were permitted in the loch either from the shore or from boats. The survey team observed a group of three individuals using a small net in the loch but was unable to gain any information from them.

No commercial crustacean fishing took place within Gare Loch.

There was commercial winkle collection taking place on the shores of Gare Loch. The winkles were reportedly sold to merchants in Glasgow and then exported to France and Spain.

4.3 Angling

All fish caught in the survey area was by anglers. Angling took place throughout the loch and was particularly popular at Helensburgh, Rhu Spit, Rockville and Rosneath. All the anglers used rod and line, with either artificial lures or lugworm for bait. Fish species caught included codling, mackerel and sea trout. The main species consumed were mackerel and sea trout. Neither of these species reside permanently in the loch but migrate from the sea into Gare Loch for a few months during the summer. Mackerel spend the rest of the year at sea and sea trout pass through the loch, either on the way upriver to spawn, or downriver out to sea to their feeding grounds.

Bait digging in the area was not as popular as in the previous survey with the availability of worms reported as being poor.

4.4 Seafood wholesalers and retailers

Fish retailers in the area were interviewed to assess the distribution and consumption pathways of any local seafood. Fish, crustaceans and molluscs were landed from outside the survey area and imported for sale locally. No anglers sold their catch. The survey team did not identify any fish, crustaceans or molluscs from the survey area being sold by the retailers.

4.5 Wildfowling

No wildfowling was identified in the survey area.

4.6 Internal exposure

Adult consumption rates

Adults' consumption rate data for fish, crustaceans and molluscs are shown in Tables 2, 3 and 4 respectively and are summarised in Table 6. The main consumers of seafood from Gare Loch were anglers and their families.

The main species of fish consumed by adults were mackerel and sea trout. A critical group of seven individuals was identified with a maximum consumption rate of 25 kg/y and a mean of 19 kg/y. The observed 97.5 percentile rate based on 39 observations was 25 kg/y. This compares with the adult generic mean and 97.5 percentile consumption rates for fish of 15 kg/y and 40 kg/y respectively. Critical group fish consumption, based on the total amount consumed, consisted of a mix of approximately 52% sea trout, 35% mackerel, 10% cod, 1.5% dab and 1.5% flounder.

The only crustacean consumption identified during the survey was for two adults, both consuming lobster at a rate of 0.20 kg/y. This gives a critical group mean and 97.5 percentile consumption rate also of 0.20 kg/y. This compares with the adult generic mean and 97.5 percentile consumption rates for crustaceans of 3.5 kg/y and 10 kg/y respectively.

Despite commercial winkle collection taking place, the only mollusc consumption identified during the survey was one adult consuming mussels at a rate of 0.20 kg/y. This compares with the adult generic mean and 97.5 percentile consumption rates for molluscs of 3.5 kg/y and 10 kg/y respectively.

No consumption of wildfowl or marine plants by adults was observed during the survey.

Children's consumption rates

Children's consumption rate data for fish are shown in Table 5 and are summarised in Tables 7 and 8. No children in the 5 year old, 1 year old and 3 month old age groups were noted to be consuming locally caught fish. No children were identified who consumed crustaceans, molluscs, wildfowl or marine plants.

15 year old age group

For fish, a critical group of one individual was identified with a consumption rate of 5.9 kg/y. The observed 97.5 percentile rate based on 2 observations was 5.7 kg/y. This compares with the generic mean and 97.5 percentile consumption rates for fish of 6.5 kg/y and 20 kg/y respectively. The only species of fish consumed by children in this age group was mackerel.

10 year old age group

For fish, a critical group of one individual was identified with a consumption rate of 7.2 kg/y. The observed 97.5 percentile rate based on 4 observations was 6.7 kg/y. This compares with the generic mean and 97.5 percentile consumption rates for fish of 6.0 kg/y and 20 kg/y respectively. The only species of fish consumed by children in this age group was mackerel.

The use of seaweed as a fertiliser

The survey investigated the use of seaweed as a fertiliser and soil conditioner. Four individuals collected seaweed from Shandon, Mambeg and Rosneath Point for use on their fruit and vegetable gardens, and one resident collected seaweed from Cove which was just outside the aquatic survey area. One of these individuals also collected mussel shells from Shandon to use as a fertiliser. The seaweeds collected were bladderwrack (*Fucus vesiculosus*) and kelp *(Laminaria sp.*) in quantities of up to 200 kilograms per year.

4.7 External exposure

Intertidal occupancy

External exposure from artificial radiation to members of the public who frequent intertidal areas depends on the occupancy time and dose rate after subtraction of an appropriate value for natural background radiation. Dose rates over mud and salt marsh can be higher than those over coarser substrates due to fine grain size and consequent ability to adsorb more radioactivity. Consequently, occupancy times over these substrates are considered to be radiologically more important than similar times over other substrates. Estimates of natural backgrounds used by Cefas for assessing doses to individuals (EA, EHS, FSA and SEPA, 2005) are 0.05 micro Gy/h for sandy substrates, 0.07 micro Gy/h for mud and salt marsh and 0.06 micro Gy/h for all other substrates.

The predominant substrates identified in the intertidal areas were mud, rock, stone and shingle. Activities were identified over the following four substrates: mud; mud and stones; rock; and stones/shingle.

Intertidal activities observed during the survey included angling, bait digging, dog walking and mollusc collection.

Gamma dose rate measurements were taken at selected locations, shown in Table 28, to supplement those of SEPA's scheduled monitoring programme.

Table 26 lists the observed intertidal occupancy rates, grouped by the substrates mud, mud and stones, rock, and stones/shingle. For mud, the maximum rate was 30 h/y and a mean rate of 28 h/y was identified for 20 individuals, mainly coastguards. For mud and stones, the maximum rate was 96 h/y and a mean rate of 64 h/y was identified for seven individuals, mainly anglers, bait diggers and walkers. For rock, the maximum rate was 780 h/y and a mean rate of 480 h/y was identified for seven individuals, all shore anglers. For

stones/shingle, the maximum rate was 940 h/y and a mean rate of 570 h/y was identified for three individuals, all shore anglers.

Handling

Handling sediment while bait digging or mollusc collecting can give rise to skin exposure from beta radiation. This needs consideration even though the annual dose limit for skin is a factor of 50 times higher than that for effective dose. There is also a contribution to effective dose due to skin exposure (ICRP, 1991).

Table 27 shows the observations made during this survey for times spent handling sediment.

A mean critical group sediment handling rate of 33 h/y was identified for eight individuals, who were bait diggers or mollusc collectors, with a maximum rate of 72 h/y. No fishing gear handling was identified in the survey. Handling of angling equipment was not considered to be a significant pathway. Therefore, as in previous surveys, data for this pathway were not collected.

4.8 Water based activities

Activities taking place in or on the water can lead to ingestion of water and/or inhalation of spray. These pathways are generally considered to be minor in comparison with other exposure pathways such as the ingestion of foods produced in the vicinity of a nuclear site. However, in order to allow for their assessment, relevant data have been collected. Activities where there is a high potential of the individual's face going under the water have been classified as activities in water since they are likely to lead to ingestion of water. All other activities have been classified as activities on water.

Occupancy rates for activities taking place in or on seawater in the survey area are shown in Table 29.

Activities in the water

Activities in the water in the survey area included commercial diving, kayaking and swimming.

Activities on the water

Activities on the water in the survey area included working on a boat, angling and water sports.

5. TERRESTRIAL RADIATION PATHWAYS

5.1 Terrestrial survey area and local produce

The terrestrial survey area is shown in Figure 2. There were eight farms in the survey area, predominately beef and lamb producers. There was one dairy farm, which also produced venison. Several of the farmers took small amounts of their produce for household consumption, a small amount was sold to a local butcher, and the rest was sold outside the survey area. Most of the beef and lambs were sold at Stirling market. The dairy farm sold its milk to First Milk and its venison was sold outside the survey area to other farms for finishing.

There were no allotment sites or smallholdings in the survey area, although there were gardens in which fruit and vegetables were grown.

Three beekeepers were interviewed during the survey with reports of another five who could not be contacted. One beekeeper had 10 hives and another had three; both produced around 60 kg of honey per hive per year which was consumed by friends and family. The third beekeeper had four hives which produced around 110 kg of honey per hive per year which was again consumed by friends and family.

Consumption of wild foods from within the survey area was limited, with mushrooms, blackberries, elderberries, raspberries, sloes and hazelnuts consumed on a small scale.

A small amount of locally caught rabbit, duck, pheasant and roe deer were consumed along with small amounts of local chicken eggs.

Three households were found to use spring, well or stream water for domestic consumption. Four farms in the area had land where livestock had access to spring or stream water.

No freshwater fish, molluscs or crustaceans were consumed.

Butchers, bakers and grocers in the survey area were visited and one butcher was found to sell local beef and lamb.

5.2 Novel radiation pathways

The survey team investigated unusual pathways, such as peat cutting and the consumption of unusual foods, but none were identified.

5.3 Land cover

Figure 3 shows the land cover in the survey area. The figure is reproduced from a land cover map produced by Macaulay Land Use Research Institute (Macaulay Institute, 1988), with their consent.

A large proportion of the area was heather moor and improved grassland. There were large areas of coniferous plantation on the west side of Gare Loch, with the main urban areas being at the northern tip and the east side of the loch. There were also areas of blanket bog, open canopy and broadleaved and mixed woodland.

5.4 Internal exposure

Adult consumption rates

Consumption rate data for adults are shown in Tables 9 to 23 and are summarised in Table 6. Consumption of terrestrial foods in the following 15 food groups was identified: green vegetables, other vegetables, root vegetables, potatoes, domestic fruit, milk, cattle meat, sheep meat, poultry, eggs, wild/free foods, rabbits/hares, honey, wild fungi and venison. The percentage contribution each food type makes to its terrestrial food group (where they have multiple species) for adults is shown in Table 25. No consumption was identified for pig meat, freshwater fish or locally produced cereals.

No critical group mean consumption rates exceeded the generic 97.5 percentile rates. Seven critical group mean consumption rates exceeded the generic means; these were for green vegetables, other vegetables, root vegetables, milk, cattle meat, sheep meat and eggs. Seven critical group mean consumption rates were less than the generic means; these were for potatoes, domestic fruit, poultry, wild/free foods, rabbits/hares, honey and wild fungi. The observed 97.5 percentile consumption rates for green vegetables, other vegetables and sheep meat exceeded the generic 97.5 percentile consumption rates. There are currently no generic consumption data available for venison.

Children's consumption rates

Consumption rate data for children are shown in Table 24 and are summarised in Table 8. Only one child was identified as consuming local terrestrial foods, this was in the 10 year old age group.

10 year old age group

The only consumption of terrestrial foods identified for this age group was one child consuming wild/free foods. No consumption was identified for the following food groups: green vegetables, other vegetables, root vegetables, potatoes, domestic fruit, milk, cattle meat, pig meat, sheep meat, poultry, eggs, rabbits/hares, honey, wild fungi, venison, freshwater fish and locally produced cereals. No 97.5 percentile rate can be calculated since there is only one observation. However, the observed consumption rate for wild/free foods was 1.8 kg/y, which is lower than both the generic mean and 97.5 percentile consumption rates of 3.0 kg/y and 11 kg/y respectively.

6. DIRECT RADIATION

The direct radiation survey sought information on the amount of time spent indoors and outdoors, in hours per year, by people living, working or pursuing leisure activities within 1 km of a point at the southern end of Faslane Naval Base (NGR NS 247 879) where liquid effluent was stored awaiting treatment and discharge (Figure 2). These data are presented in Table 30 along with associated gamma dose rates. Occupancy due to employment associated with operations at Faslane Naval Base was not considered.

Direct radiation survey area

The Faslane Naval Base is situated on the east bank of Gare Loch, some 25 miles north-west of Glasgow. The nearest settlements are the village of Garelochhead to the north and Shandon to the south, with the northern part of Shandon being inside the direct radiation survey area.

Occupancy within direct radiation survey area

Local residents and individuals were interviewed and their occupancy times within the direct radiation survey area were recorded (Table 30). Data obtained included occupancy rates for residents, employees at a boat maintenance yard, and the staff and children attending a nursery. Twenty adults had total occupancy rates over 7000 h/y. The maximum total occupancy rate was 7900 h/y for a local resident.

Gamma dose rate measurements

Gamma dose rate measurements were taken indoors and outdoors at most of the residences and businesses within the direct radiation area (Table 30). Outdoor measurements were taken approximately 5 to 10 metres from the nearest buildings. Neither the indoor or outdoor measurements have been adjusted for natural background dose rates.

Gamma dose rate measurements were also taken at locations outside the 1 km area to obtain background dose rates (Table 30).

All measurements were taken at a height of 1 metre above the substrate.

The maximum gamma dose rate measured indoors was 0.118 micro Gy/h and outdoors was 0.082 micro Gy/h; these were at different properties. The outdoor gamma dose rate measurements can be compared to the mean of the four background measurements which was 0.074 micro Gy/h.

7. COMBINED PATHWAYS

In determining habits data for the purposes of assessing radiological doses to the public, it may be necessary to consider a combination of pathways. Cefas have provided data for adults in Annexe 1 and for children in Annex 2 so that the full effect of combining pathways can be assessed for individual observations, given the concentrations and dose rates for a particular assessment. In some circumstances, it will be possible to make simplifying assumptions and define the consumption and external exposure rates appropriate to a series of potential critical groups. Such assumptions will depend on the assessment in question but can be made using the information in Annex 1 and Annex 2.

The most extensive combinations of pathways for adult dose assessment are shown in Annex 3. Each of the 19 combinations shown in this annex represents an actual individual (or individuals) from Annex 1 who has positive data (irrespective of the magnitude), for each pathway marked with an asterisk. It should be noted that combination numbers in Annex 3 do not correlate directly with observation numbers in Annex 1. Other individuals from Annex 1 have combinations that are not listed in Annex 3 because they have fewer pathways and a dose assessment for them would be adequately covered by one of the 19 listed combinations.

Combinations of pathways at critical group rates may be achieved by considering the data in Annexes 1 and 2. Although critical group rates are not given in the annexes, the rates for individuals making up the groups are shown emboldened. Possible combinations of pathways and their associated critical group rates are therefore apparent.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1 Survey findings

Exposure pathways were investigated for 305 individuals. The survey considered pathways relating to three potential sources of exposure:

- Discharges of liquid radioactive waste into Gare Loch from Faslane Naval Base
- Discharges of gaseous radioactive waste from RNAD Coulport to the atmosphere
- Direct radiation emitted directly from the Faslane Naval Base

The adult critical group mean consumption rates of aquatic foods were:

- 19 kg/y for fish
- 0.20 kg/y for crustaceans
- 0.20 kg/y for molluscs

The main aquatic species consumed were mackerel, sea trout, lobster and mussels.

No consumption of wildfowl or marine plants was found.

The critical group mean occupancy rates over intertidal areas were:

- 28 h/y for mud
- 64 h/y for mud and stones
- 480 h/y for rock
- 570 h/y for stones/shingle

The critical group mean handling rate for sediment was 33 h/y.

The adult critical group mean consumption rates of terrestrial foods were:

- 34 kg/y for green vegetables
- 31 kg/y for other vegetables
- 26 kg/y for root vegetables
- 16 kg/y for potatoes
- 18 kg/y for domestic fruit
- 210 l/y for milk
- 39 kg/y for cattle meat
- 23 kg/y for sheep meat
- 2.7 kg/y for poultry
- 11 kg/y for eggs
- 4.0 kg/y for wild/free foods
- 0.45 kg/y for rabbits and hares
- 0.90 kg/y for honey
- 2.3 kg/y for wild fungi
- 1.0 kg/y for venison

The main terrestrial foods consumed were all three vegetable groups, potatoes, domestic fruit, wild/free foods and honey. The percentage contribution each terrestrial food type made to its food group for adults is shown in Table 25.

The highest total occupancy rate (indoor plus outdoor) within 1 km of NGR NS 247 879 was 7900 h/y.

8.2 Comparisons with previous surveys

The results from this 2006 survey can be compared with results from the last survey undertaken at Faslane in 2000.

The adult critical group mean consumption rates for fish, crustaceans and molluscs had increased in 2006 when compared to the rates obtained from the 2000 survey. In 2000, these rates were 9.9 kg/y of fish and nil for crustaceans and molluscs, compared to this survey's consumption rates of 19 kg/y for fish, 0.20 kg/y for crustaceans and 0.20 kg/y for molluscs. In both the 2000 and 2006 surveys there was no consumption of wildfowl or marine plants.

For external pathways, it should be noted that the methodology for determining the critical group has changed since the 2000 survey (Section 3.2) so care is needed when comparing results.

The 2000 survey identified the following three substrates: mud; sand and mud; and rock. The 2006 survey identified the following four substrates: mud; mud and stones; stones/shingle; and rock. Occupancy rates over mud and over rock from 2000 and 2006 can therefore be compared. The 2000 survey identified a critical group mean intertidal occupancy rate over mud of 200 h/y for 15 individuals (still 200 h/y for 15 individuals using the current methodology) compared to 28 h/y over mud for 20 individuals in 2006. This decrease was because of a change in working practices at the boat yard since 2000. The 2000 survey identified a critical group mean intertidal occupancy rate over rock of 1000 h/y for five individuals (830 h/y for 12 individuals using the current methodology) compared to 480 h/y over rock for seven individuals in 2006.

The 2000 survey identified a critical group of one bait digger with a sediment handling rate of 1400 h/y, but this individual had since passed away. The 2006 critical group mean sediment handling rate for eight individuals was 33 h/y. It was reported by bait diggers that the availability of worms in the survey area had decreased since 2000.

Water based activities were not surveyed in 2000, therefore no comparison can be made with 2006.

The 2006 terrestrial survey area was extended from that used in 2000, in order to include areas potentially subject to gaseous deposition from RNAD Coulport. However, it is still useful to compare the results from the two surveys. For terrestrial food groups, the adult critical group consumption rates (kg/y or l/y) in the 2006 survey together with those of the 2000 survey are tabulated below, for ease of comparison:

	2000	**2006**
• Green vegetables	36	34
• Other vegetables	30	31
• Root vegetables	52	26
• Potatoes	55	16
• Domestic fruit	21	18
• Milk	180	210
• Cattle meat	38	39
• Pig meat	Nil	Nil
• Sheep meat	Nil	23
• Poultry	2.6	2.7
• Eggs	22	11
• Wild/free foods	2.0	4.0
• Rabbits/hares	Nil	0.45
• Honey	1.3	0.90
• Wild fungi	0.70	2.3
• Venison	Nil	1.0
• Freshwater fish	Nil	Nil

In 2006, consumption rates had increased in the following food groups: other vegetables, milk, cattle meat, sheep meat, poultry, wild/free foods, rabbits/hares, wild fungi and venison. Consumption rates had decreased in the following food groups: green vegetables, root vegetables, potatoes, domestic fruit, eggs and honey. Neither survey identified any consumption of pig meat or freshwater fish.

The only food group showing a significant increase in consumption rate since 2000 is sheep meat, which has increased from nil to 23 kg/y. The most significant decreases in consumption rates were for root vegetables, potatoes and eggs.

In common with the 2000 direct radiation survey, this survey identified several individuals living in the area who spent more than 7000 h/y within 1 km of the site.

8.3 Recommendations for environmental monitoring

The 2005 SEPA monitoring programme comprised sampling of fish, sediments, seawater and seaweed (EA, EHS, FSA and SEPA, 2006). Gamma dose rate measurements were taken at Garelochhead, Gulley Bridge Pier, Rhu, Helensburgh and Carnban boatyard. No terrestrial samples were monitored around Faslane or Coulport.

It is considered that SEPA's current monitoring programme provides adequate coverage. Based on the findings of this habits survey, it is recommended that samples currently monitored remain unchanged. The following sample could be considered as an addition to the programme:

- A winkle (*Littorina littorea*) sample from the shore in front of the Helensburgh Sailing Club (NGR NS 271 835) could be taken, in light of the commercial collection taking place around Gare Loch.

9. ACKNOWLEDGEMENTS

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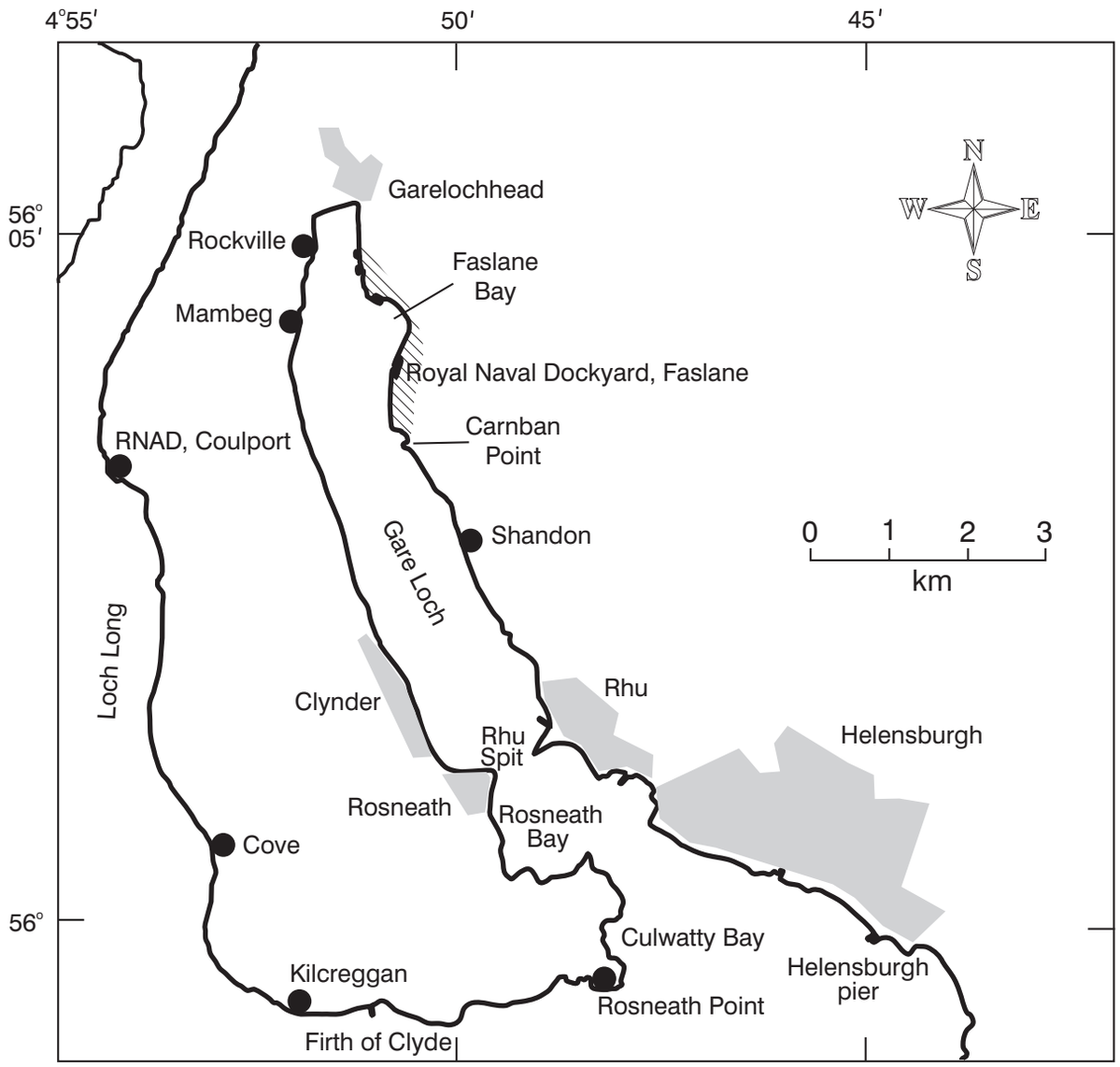

Figure 1. The Faslane aquatic survey area.

Figure 2. The Faslane terrestrial and direct radiation survey areas.

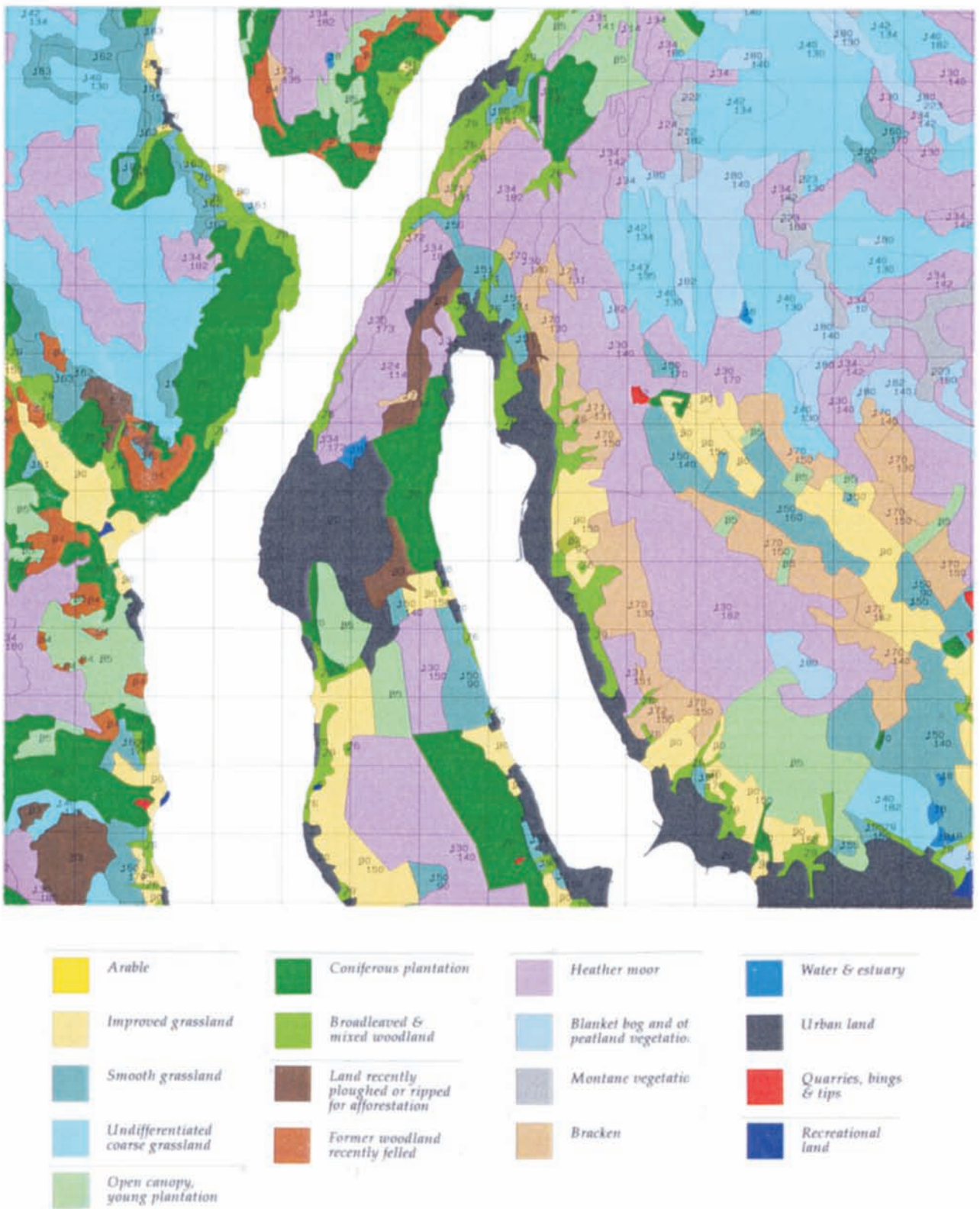

Figure 3. Land cover around HM Naval Base Clyde, Faslane.

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Base scale is 1:50000

Table 1. Typical food groups used in habits surveys

Green vegetables	Globe artichoke, asparagus, broccoli, brussel sprout, cabbage, calabrese, cauliflower, chard, courgettes, cucumber, gherkin, herbs, kale, leaf beet, lettuce, marrow, spinach
Other vegetables	Aubergine, broad bean, chilli pepper, french bean, mangetout, pea, pepper, runner bean, sweetcorn, tomato
Root vegetables	Jerusalem artichoke, beetroot, carrot, celeriac, celery, chicory, fennel, garlic, kohl rabi, leek, onion, parsnip, radish, shallot, spring onion, swede, turnip
Potato	
Domestic fruit	Apple, apricot, blackberry, blackcurrant, boysenberry, cherry, damson, fig, gooseberry, grapes, greengages, huckleberry, loganberry, melon, nectarines, peach, pear, plum, pumpkin, raspberry, redcurrants, rhubarb, rowanberry, strawberry, tayberry, whitecurrant
Milk	Milk, butter, cream, cheese, yoghurt, goats milk
Cattle meat †	
Pig meat †	
Sheep meat †	
Poultry	Chicken, duck, goose, grouse, guinea fowl, partridge, pheasant, pigeon, snipe, turkey, woodcock
Eggs	Chicken egg, duck egg, goose egg
Wild/free foods	Blackberry, blackcurrant, chestnut, crab apple, damson, dandelion root, elderberry, nettle, raspberry, rowanberry, samphire, sloe, strawberry, watercress, wild apple
Honey	
Wild Fungi	Mushrooms
Rabbits/Hare	Hare, rabbit
Venison †	
Fish (sea)	Bass, brill, cod, common ling, dab, Dover sole, flounder, gurnard, haddock, hake, herring, lemon sole, mackerel, monkfish, mullet, plaice, pollack, witch saithe, salmon, sea trout, squid*, cuttlefish*, rays, turbot, whitebait, whiting
Freshwater fish	Brown trout, rainbow trout, perch, pike, salmon (river), eels
Crustaceans	Brown crab, spider crab, crawfish, lobster, *Nephrops* , squat lobster, prawn, shrimp
Molluscs	Cockles, limpets, mussels, oysters, queen scallop, razor shell, whelks, winkles

Notes:
* Although squid and cuttlefish are molluscs, radiologically they are more akin to fish
† Including offal

Table 2. Adults' consumption rates of fish in the Faslane area (kg/y)

Observation number	Cod	Dab	Flounder	Lesser spotted dogfish	Mackerel	Sea trout	Total
113-115	**3.4**	**0.6**	**0.5**		**5.2**	**15.6**	**25.3**
112	**3.4**	**0.6**	**0.5**		**5.2**	**15.6**	**25.3**
278					**7.2**	**5.6**	**12.8**
286					**9.2**		**9.2**
270					**8.8**		**8.8**
285						7.8	7.8
280					7.2		7.2
269					3.3	3.8	7.1
196					5.9		5.9
116					5.5		5.5
287					5.5		5.5
261						3.8	3.8
203-204					3.7		3.7
235					3.7		3.7
236-237				0.7		2.7	3.3
201-202					3.3		3.3
207					2.9		2.9
296-297					1.8		1.8
192-193					0.2	0.6	0.8
228-231					0.6		0.6
208-209					0.5		0.5
253-254					0.5		0.5
281-283					0.3		0.3
290-291					0.2		0.2

Notes

Emboldened observations are the critical group consumers

The critical group consumption rate of fish based on the 7 highest adult consumers is 18.8 kg/y

The observed 97.5 percentile rate based on 39 observations is 25.3 kg/y

Table 3. Adults' consumption rates of crustaceans in the Faslane area (kg/y)

Observation number	Lobster
236-237	**0.2**

Notes
Emboldened observations are the critical group consumers
The critical group consumption rate of crustaceans based on the 2 highest adult consumers is 0.2 kg/y
The observed 97.5 percentile rate based on 2 observations is 0.2 kg/y

Table 4. Adults' consumption rates of molluscs in the Faslane area (kg/y)

Observation number	Mussel
297	**0.2**

Notes
Emboldened observations are the critical group consumers
The critical group consumption rate of molluscs based on the only adult consumer is 0.2 kg/y
The observed 97.5 percentile is not applicable for 1 observation

Table 5. Children's consumption rates of fish in the Faslane area (kg/y)

15 year old age group

Observation number	Age	Mackerel
198	**13**	**5.9**
210	14	0.5

Notes
Emboldened observations are the critical group consumers
The critical group consumption rate of fish based on the single highest 15 year old age group consumer is 5.9 kg/y
The observed 97.5 percentile based on 2 observations is 5.7 kg/y

10 year old age group

Observation number	Age	Mackerel
279	**9**	**7.2**
211	10	0.5
212	9	0.5
284	8	0.3

Notes
Emboldened observations are the critical group consumers
The critical group consumption rate of fish based on the single highest 10 year old age group consumer is 7.2 kg/y
The observed 97.5 percentile based on 4 observations is 6.7 kg/y

Table 6. Summary of adults' consumption rates in the Faslane area (kg/y or l/y)

Food group	Number of observations	No. higher rate consumers	Observed maximum critical group consumption rate	Observed minimum critical group consumption rate	Observed critical group mean consumption rate	Observed 97.5 %ile consumption rate	Generic mean consumption rate	Generic 97.5 %ile consumption rate
Fish	39	7	25.3	8.8	18.8	25.3	15.0	40.0
Crustaceans	2	2	0.2	0.2	0.2	0.2	3.5	10.0
Molluscs	1	1	0.2	0.2	0.2	NA	3.5	10.0
Marine plants and algae	NC	NC	NC	NC	NC	NC	ND	ND
Wildfowl	NC	NC	NC	NC	NC	NC	ND	ND
Green vegetables	26	7	47.9	17.8	33.7	47.9	15.0	45.0
Other vegetables	28	14	51.3	18.1	30.8	51.3	20.0	50.0
Root vegetables	20	13	39.4	15.9	25.6	36.8	10.0	40.0
Potato	26	11	24.6	10.2	16.2	24.6	50.0	120.0
Domestic fruit	20	12	25.0	8.8	18.1	25.0	20.0	75.0
Milk	4	4	207.4	207.4	207.4	207.4	95.0	240.0
Cattle meat	2	2	39.0	39.0	39.0	39.0	15.0	45.0
Pig meat	NC	NC	NC	NC	NC	NC	15.0	40.0
Sheep meat	6	6	39.0	15.4	23.3	39.0	8.0	25.0
Poultry	6	2	2.7	2.7	2.7	2.7	10.0	30.0
Eggs	8	6	14.4	8.2	10.8	14.4	8.5	25.0
Wild/free foods	17	11	18.1	1.8	4.0	12.7	7.0	25.0
Rabbits/hares	1	1	0.5	0.5	0.5	NA	6.0	15.0
Honey	12	12	1.4	0.6	0.9	1.4	2.5	9.5
Wild fungi	2	2	2.3	2.3	2.3	2.3	3.0	10.0
Venison	2	2	1.0	1.0	1.0	1.0	ND	ND
Freshwater fish	NC	NC	NC	NC	NC	NC	15.0	40.0

ND = not determined
NC = not consumed
NA = not applicable

Table 7. Summary of 15 year old children's consumption rates in the Faslane area (kg/y)

Food group	Number of observations	No. higher rate consumers	Observed maximum critical group consumption rate	Observed minimum critical group consumption rate	Observed critical group mean consumption rate	Observed 97.5 %ile consumption rate	Generic mean consumption rate	Generic 97.5 %ile consumption rate
Fish	2	1	5.9	5.9	5.9	5.7	6.5	20.0
Crustaceans	NC	NC	NC	NC	NC	NC	2.5	6.0
Molluscs	NC	NC	NC	NC	NC	NC	2.5	6.0
Marine plants and algae	NC	NC	NC	NC	NC	NC	ND	ND
Wildfowl	NC	NC	NC	NC	NC	NC	ND	ND
Green vegetables	NC	NC	NC	NC	NC	NC	6.0	20.0
Other vegetables	NC	NC	NC	NC	NC	NC	8.0	25.0
Root vegetables	NC	NC	NC	NC	NC	NC	6.0	20.0
Potato	NC	NC	NC	NC	NC	NC	45.0	85.0
Domestic fruit	NC	NC	NC	NC	NC	NC	15.0	50.0
Milk	NC	NC	NC	NC	NC	NC	110.0	240.0
Cattle meat	NC	NC	NC	NC	NC	NC	15.0	30.0
Pig meat	NC	NC	NC	NC	NC	NC	8.5	25.0
Sheep meat	NC	NC	NC	NC	NC	NC	4.0	10.0
Poultry	NC	NC	NC	NC	NC	NC	5.5	15.0
Eggs	NC	NC	NC	NC	NC	NC	6.5	20.0
Wild/free foods	NC	NC	NC	NC	NC	NC	3.0	11.0
Rabbits/hares	NC	NC	NC	NC	NC	NC	ND	ND
Honey	NC	NC	NC	NC	NC	NC	2.0	7.5
Wild fungi	NC	NC	NC	NC	NC	NC	1.5	4.5
Venison	NC	NC	NC	NC	NC	NC	ND	ND
Freshwater fish	NC	NC	NC	NC	NC	NC	6.0	20.0

ND = not determined
NC = not consumed

Table 8. Summary of 10 year old children's consumption rates in the Faslane area (kg/y)

Food group	Number of observations	No. higher rate consumers	Observed maximum critical group consumption rate	Observed minimum critical group consumption rate	Observed critical group mean consumption rate	Observed 97.5 %ile consumption rate	Generic mean consumption rate	Generic 97.5 %ile consumption rate
Fish	4	1	7.2	7.2	7.2	6.7	6.0	20.0
Crustaceans	NC	NC	NC	NC	NC	NC	2.5	7.0
Molluscs	NC	NC	NC	NC	NC	NC	2.5	7.0
Marine plants and algae	NC	NC	NC	NC	NC	NC	ND	ND
Wildfowl	NC	NC	NC	NC	NC	NC	ND	ND
Green vegetables	NC	NC	NC	NC	NC	NC	6.0	20.0
Other vegetables	NC	NC	NC	NC	NC	NC	8.0	25.0
Root vegetables	NC	NC	NC	NC	NC	NC	6.0	20.0
Potato	NC	NC	NC	NC	NC	NC	45.0	85.0
Domestic fruit	NC	NC	NC	NC	NC	NC	15.0	50.0
Milk	NC	NC	NC	NC	NC	NC	110.0	240.0
Cattle meat	NC	NC	NC	NC	NC	NC	15.0	30.0
Pig meat	NC	NC	NC	NC	NC	NC	8.5	25.0
Sheep meat	NC	NC	NC	NC	NC	NC	4.0	10.0
Poultry	NC	NC	NC	NC	NC	NC	5.5	15.0
Eggs	NC	NC	NC	NC	NC	NC	6.5	20.0
Wild/free foods	1	1	1.8	1.8	1.8	NA	3.0	11.0
Rabbits/hares	NC	NC	NC	NC	NC	NC	ND	ND
Honey	NC	NC	NC	NC	NC	NC	2.0	7.5
Wild fungi	NC	NC	NC	NC	NC	NC	1.5	4.5
Venison	NC	NC	NC	NC	NC	NC	ND	ND
Freshwater fish	NC	NC	NC	NC	NC	NC	6.0	20.0

ND = not determined
NC = not consumed
NA = not applicable

Table 9. Adults' consumption rates of green vegetables in the Faslane area (kg/y)

Observation number	Broccoli	Brussel sprout	Cabbage	Calabrese	Cauliflower	Courgettes	Cucumber	Herbs	Kale	Lettuce	Marrow	Pak choi	Rocket	Spinach	Total
238-239	**8.4**	**5.1**	**13.7**		**4.2**	**2.8**			**7.2**		**2.7**			**3.8**	**47.9**
253-254		**7.3**	**9.7**			**5.9**	**6.8**			**4.8**			**4.8**		**39.3**
288		**5.5**	**6.8**	**5.4**	**4.1**	**3.7**									**25.5**
192-193		**3.0**	**2.0**		**0.9**	**3.6**	**2.8**			**3.0**		**2.5**			**17.8**
292-293						5.5		0.7		9.0					15.2
110-111						11.0	3.4								14.4
307-308	2.2	2.9	2.7		2.2	1.5			1.8				0.5		13.8
295-300		1.2	4.3		1.7	3.1	1.4			1.3					13.0
289	8.2		2.7											1.4	12.2
108-109						3.7				1.8					5.5
240-241						1.7				3.2					4.9
290-291								0.5							0.5

Notes

Emboldened observations are the critical group consumers

The critical group consumption rate of green vegetables based on the 7 highest adult consumers is 33.7 kg/y

The observed 97.5 percentile rate based on 26 observations is 47.9 kg/y

Table 10. Adults' consumption rates of other vegetables in the Faslane area (kg/y)

Observation number	Broad bean	Chilli pepper	French bean	Mangetout	Pea	Pepper	Runner bean	Squash	Tomato	Total
110-111	**4.2**					**6.9**	**13.3**		**27.0**	**51.3**
288					**6.3**		**15.3**		**21.0**	**42.6**
253-254			**5.8**	**7.3**			**10.9**		**11.5**	**35.4**
307-308	**6.7**			**1.2**	**5.0**	**1.0**	**8.2**		**9.1**	**31.2**
238-239	**5.1**				**5.1**		**15.3**			**25.5**
108-109					**2.7**		**16.3**		**3.6**	**22.6**
292-293	**4.6**		**0.9**				**6.8**		**7.3**	**19.5**
296	**3.4**	**0.5**	**0.2**	**1.4**	**1.4**		**4.8**		**6.4**	**18.1**
289	4.5						2.7		9.1	16.3
297	3.4	0.5	0.2				4.8		6.4	15.2
192-193	4.5						3.4		7.1	15.0
295		0.5	0.2				4.8		6.4	11.8
298-300		0.5	0.2				4.8		6.4	11.8
240-241							7.3	0.3		7.7
290-291	0.5				1.4		2.3		2.3	6.4
247-248									5.4	5.4

Notes

Emboldened observations are the critical group consumers

The critical group consumption rate of other vegetables based on the 14 highest adult consumers is 30.8 kg/y

The observed 97.5 percentile rate based on 28 observations is 51.3 kg/y

Table 11. Adults' consumption rates of root vegetables in the Faslane area (kg/y)

Observation number	Artichoke	Beetroot	Carrot	Carrot	Celery	Garlic	Leek	Onion	Parsnip	Radish	Shallot	Spring onion	Swede	Turnip	Total
288				**17.3**	**2.1**		**10.0**	**8.2**			**1.8**				**39.4**
307-308			**1.4**			**0.5**	**1.8**	**27.2**			**3.0**				**33.9**
253-254							**7.2**	**5.8**			**5.1**	**3.2**	**10.9**		**32.2**
110-111			**8.5**				**5.0**	**11.0**							**24.5**
238-239	**4.1**		**5.1**					**4.1**	**4.1**		**4.8**				**22.0**
108-109		**4.9**	**2.7**				**5.4**	**1.8**						**3.2**	**18.0**
192-193		**2.7**	**3.7**			**0.2**	**3.0**	**2.4**	**1.2**	**0.9**	**1.1**			**0.9**	**15.9**
289							12.0								12.0
295-300		0.2	0.3					3.7	0.5		0.5		2.3		7.3

Notes

Emboldened observations are the critical group consumers

The critical group consumption rate of root vegetables based on the 13 highest adult consumers is 25.6 kg/y

The observed 97.5 percentile rate based on 20 observations is 36.8 kg/y

Table 12. Adults' consumption rates of potato in the Faslane area (kg/y)

Observation number	Potato
240-241	**24.6**
192-193	**18.0**
292-293	**15.0**
253-254	**14.6**
288	**13.6**
238-239	**10.2**
295-300	7.1
108-109	5.5
289-291	5.4
307-308	3.3
110-111	3.0

Notes

Emboldened observations are the critical group consumers

The critical group consumption rate of potato based on the 11 highest adult consumers is 16.2 kg/y

The observed 97.5 percentile rate based on 26 observations is 24.6 kg/y

Table 13. Adults' consumption rates of domestic fruit in the Faslane area (kg/y)

Observation number	Apple	Blackcurrant	Gooseberry	Grapes	Pear	Plum	Pumpkin	Raspberry	Redcurrants	Rhubarb	Strawberry	Tayberry	Worcesterberry	Total
238-239	**5.0**	**5.0**	**5.0**		**1.5**			**2.5**	**2.5**		**1.0**	**2.5**		**25.0**
289	**6.8**	**0.5**	**4.5**					**9.1**	**1.4**	**2.3**				**24.5**
292-293	**6.8**	**2.5**	**1.1**			**6.8**		**0.5**	**0.9**	**3.6**				**22.2**
192-193	**15.0**					**4.5**	**0.6**				**1.1**			**21.2**
288	**1.8**	**6.4**			**0.9**						**5.4**			**14.5**
307-308	**0.7**	**0.2**	**3.6**	**0.7**	**0.7**			**1.8**		**3.6**	**0.2**		**0.2**	**11.7**
290-291	**4.5**			**1.1**	**1.1**			**0.9**		**0.9**	**0.2**			**8.8**
295-300	1.2	0.4	0.2		0.2			0.2		0.8	0.2	0.2		3.4
108-109									1.1					1.1

Notes

Emboldened observations are the critical group consumers

The critical group consumption rate of domestic fruit based on the 12 highest adult consumers is 18.1 kg/y

The observed 97.5 percentile rate based on 20 observations is 25.0 kg/y

Table 14. Adults' consumption rates of milk in the Faslane area (l/y)

Observation number	Milk
186-189	**207.4**

Notes

Emboldened observations are the critical group consumers

The critical group consumption rate of milk based on the 4 highest adult consumers is 207.4 l/y

The observed 97.5 percentile rate based on 4 observations is 207.4 l/y

Table 15. Adults' consumption rates of cattle meat in the Faslane area (kg/y)

Observation number	Beef
190-191	**39.0**

Notes
Emboldened observations are the critical group consumers
The critical group consumption rate of cattle meat based on the 2 highest adult consumers is 39.0 kg/y
The observed 97.5 percentile rate based on 2 observations is 39.0 kg/y

Table 16. Adults' consumption rates of sheep meat in the Faslane area (kg/y)

Observation number	Lamb
190-191	**39.0**
249-252	**15.4**

Notes
Emboldened observations are the critical group consumers
The critical group consumption rate of sheep meat based on the 6 highest adult consumers is 23.3 kg/y
The observed 97.5 percentile rate based on 6 observations is 39.0 kg/y

Table 17. Adults' consumption rates of poultry in the Faslane area (kg/y)

Observation number	Duck	Pheasant	Total
261-262		**2.7**	**2.7**
186-189	0.1	0.5	0.6

Notes
Emboldened observations are the critical group consumers
The critical group consumption rate of poultry based on the 2 highest adult consumers is 2.7 kg/y
The observed 97.5 percentile rate based on 6 observations is 2.7 kg/y

Table 18. Adults' consumption rates of eggs in the Faslane area (kg/y)

Observation number	Chicken egg	Goose egg	Total
238-239	**14.4**		**14.4**
290-291	**8.9**	**0.9**	**9.7**
253-254	**8.2**		**8.2**
242-243	2.7		2.7

Notes
Emboldened observations are the critical group consumers
The critical group consumption rate of eggs based on the 6 highest adult consumers is 10.8 kg/y
The observed 97.5 percentile rate based on 8 observations is 14.4 kg/y

Table 19. Adults' consumption rates of wild/free foods in the Faslane area (kg/y)

Observation number	Blackberry	Elderberry	Hazel nuts	Raspberry	Sloe	Total
261	**9.1**	**9.1**				**18.1**
301	**2.3**			**2.3**		**4.5**
302	**2.3**			**2.3**		**4.5**
238	**2.5**					**2.5**
239	**2.5**					**2.5**
290	**0.7**				**1.4**	**2.0**
291	**0.7**				**1.4**	**2.0**
255	**1.8**					**1.8**
256	**1.8**					**1.8**
307	**1.8**					**1.8**
308	**1.8**					**1.8**
295	0.5		0.1			0.5
296	0.5		0.1			0.5
297	0.5		0.1			0.5
298	0.5		0.1			0.5
299	0.5		0.1			0.5
300	0.5		0.1			0.5

Notes
Emboldened observations are the critical group consumers
The critical group consumption rate of wild/free foods based on the 11 highest adult consumers is 4.0 kg/y
The observed 97.5 percentile rate based on 17 observations is 12.7 kg/y

Table 20. Adults' consumption rates of rabbits/hares in the Faslane area (kg/y)

Observation number	Rabbit
192	**0.5**

Notes
Emboldened observations are the critical group consumers
The critical group consumption rate of rabbits/hares based on the only adult consumer is 0.5 kg/y
The observed 97.5 percentile rate is not applicable for 1 observation

Table 21. Adults' consumption rates of honey in the Faslane area (kg/y)

Observation number	Honey
242-243	**1.4**
307-308	**1.4**
253-254	**1.1**
295-300	**0.6**

Notes
Emboldened observations are the critical group consumers
The critical group consumption rate of honey based on the 12 highest adult consumers is 0.9 kg/y
The observed 97.5 percentile rate based on 12 observations is 1.4 kg/y

Table 22. Adults' consumption rates of wild fungi in the Faslane area (kg/y)

Observation number	Mushrooms
301-302	**2.3**

Notes
Emboldened observations are the critical group consumers
The critical group consumption rate of wild fungi based on the 2 highest adult consumers is 2.3 kg/y
The observed 97.5 percentile rate based on 2 observations is 2.3 kg/y

Table 23. Adults' consumption rates of venison in the Faslane area (kg/y)

Observation number	Venison
192-193	**1.0**

Notes
Emboldened observations are the critical group consumers
The critical group consumption rate of venison based on the 2 highest adult consumers is 1.0 kg/y
The observed 97.5 percentile rate based on 2 observations is 1.0 kg/y

Table 24. Children's consumption rates of wild/free foods in the Faslane area (kg/y)

10 year old age group

Observation number	Age	Blackberry
259	**9**	**1.8**

Notes
Emboldened observations are the critical group consumers
The critical group consumption rate of wild/free foods based on the only 10 year old age group consumer is 1.8 kg/y
The observed 97.5 percentile rate is not applicable for 1 observation

Table 25. Percentage contribution each food type makes to its terrestrial food group for adults

Domestic fruit	
Apple	33.3 %
Gooseberry	10.6 %
Blackcurrant	10.2 %
Rhubarb	9.6 %
Plum	9.4 %
Raspberry	9.1 %
Strawberry	4.8 %
Redcurrants	4.4 %
Pear	3.7 %
Tayberry	2.7 %
Grapes	1.5 %
Pumpkin	0.5 %
Worcester berry	0.2 %
Green vegetables	
Courgettes	21.5 %
Cabbage	21.0 %
Lettuce	11.9 %
Brussel sprout	11.4 %
Cucumber	7.9 %
Broccoli	6.8 %
Cauliflower	6.7 %
Kale	4.2 %
Rocket	2.4 %
Spinach	2.1 %
Calabrese	1.3 %
Marrow	1.2 %
Pak choi	1.1 %
Herbs	0.5 %

Wild fungi	
Mushrooms	100.0 %
Sheep meat	
Lamb meat	72.1 %
Mutton	27.9 %
Other vegetables	
Tomato	37.1 %
Runner bean	36.9 %
Broad bean	10.8 %
Pea	6.2 %
Mangetout	3.2 %
Pepper	2.7 %
French bean	2.5 %
Chilli pepper	0.5 %
Squash	0.1 %
Wild/free foods	
Blackberry	64.1 %
Elderberry	19.4 %
Raspberry	9.7 %
Sloe	5.8 %
Hazel nuts	1.0 %

Root vegetables	
Onion	34.6 %
Leek	17.2 %
Carrot	15.9 %
Swede	9.1 %
Shallot	8.4 %
Beetroot	4.2 %
Parsnip	3.4 %
Turnip	2.1 %
Artichoke	2.1 %
Spring onion	1.6 %
Celery	0.5 %
Radish	0.5 %
Garlic	0.3 %
Eggs	
Chicken egg	97.6 %
Goose egg	2.4 %
Poultry	
Pheasant	94.1 %
Duck	5.9 %

Notes

No terrestrial foods were monitored by SEPA in 2005 (EA, EHS, FSA and SEPA, 2006)

Percentages are based on the consumption of all adults in the survey consuming that particular food group

Table 26. Intertidal occupancy rates in the Faslane area (h/y)

Observation number	Location*	Activity*	Mud	Mud and stones	Rock	Stones/ shingle
218-219	**Garelochhead/**Gare Loch coastline	**Bait digging/**Angling	**30**		30	
153-170	**Gare Loch coastline**	**Coastguard duties**	**28**			28
206	**South of Rockville**	**Angling**		**96**		
192	**South of Rockville**	**Angling**		**84**		
112	**Gare Loch coastline**	**Bait digging**		**72**		
244	**Gare Loch coastline**	**Walking**		**64**		
247-248	**Gare Loch coastline**	**Walking**		**50**		
294	**Gare Loch coastline**	**Bait digging**		**34**		
96-101	Opposite Helensburgh Sailing Club	Shellfish collecting		25		
236	Rhu**/Gare Loch coastline**	Bait digging**/Angling**		20	**780**	
102-107	Opposite Helensburgh Sailing Club	Shellfish collecting		10		
144-145	Blairvadach outdoor centre	Beach cleaning		10		
281-282	Helensburgh and Rhu/Rhu Spit	Bait digging/Angling		9		36
270	Rhu/Rhu Spit	Bait digging/Angling		8		143
196-197	**South of Rockville**	**Angling**			**576**	
201	**South of Rockville**	**Angling**			**430**	
202	**South of Rockville**	**Angling**			**430**	
226-227	**South of Rockville**	**Angling**			**270**	
223-225	Rockville to Rosneath Bay	Angling			240	
285	Rhu Spit	Angling			208	
198	South of Rockville	Angling			190	
207	South of Rockville	Angling			130	
232-234	South of Rockville	Angling			120	
220-222	Clynder and Rosneath Bay	Angling			96	
194-195	South of Rockville	Angling			64	
203	South of Rockville	Angling			64	
208-212	South of Rockville	Angling			30	
269	**Rhu Spit**	**Angling**				**936**
278-279	**Rhu Spit**	**Angling**				**390**
287	Rhu Spit, Rhu	Angling, bird watching				160
301	Gare Loch	Walking				156
302	Gare Loch coastline	Walking				150

Table 26. Intertidal occupancy rates in the Faslane area (h/y)

Observation number	Location*	Activity*	Mud	Mud and stones	Rock	Stones/ shingle
271-272	Rhu Spit	Angling				143
297	Mambeg	Walking				122
275-277	Rhu Spit	Dog walking				120
273-274	Gare Loch coastline	Angling				104
295-296	Mambeg	Walking				52
267	Rhu Spit	Angling				50
268	Rhu Spit	Walking				50
283	Rhu Spit	Walking				36
284	Rhu Spit	Angling				36
265-266	Rhu Spit	Angling				30
116-117	Rhu Spit	Angling				12
290-291	Gare Loch coastline	Walking				4

Notes

Emboldened observations are the critical group members

The critical group intertidal occupancy rate over mud based on 20 observations is 28 h/y

The observed 97.5 percentile rate based on 20 observations for mud is 30 h/y

The critical group intertidal occupancy rate over mud and stones based on 7 observations is 64 h/y

The observed 97.5 percentile rate based on 25 observations for mud and stones is 89 h/y

The critical group intertidal occupancy rate over rock based on 7 observations is 476 h/y

The observed 97.5 percentile rate based on 29 observations for rock is 637 h/y

The critical group intertidal occupancy rate over stones/shingle based on 3 observations is 572 h/y

The observed 97.5 percentile rate based on 47 observations for stones/shingle is 390 h/y

*The forward slash (/), separates the locations of, and activities taking place on, the separate substrates for that individual

Table 27. Handling rates of sediment in the Faslane area (h/y)

Observation number	Location	Activity	Sediment
112	**Gare Loch coastline**	**Bait digging**	**72**
294	**Gare Loch coastline**	**Bait digging**	**34**
218-219	**Garelochhead**	**Bait digging**	**30**
96-99	**Opposite Helensburgh Sailing Club**	**Shellfish collecting**	**25**
236	Rhu	Bait digging	20
102-105	Opposite Helensburgh Sailing Club	Shellfish collecting	10
281-282	Helensburgh and Rhu	Bait digging	9
270	Rhu	Bait digging	8

Notes

Emboldened observations are the critical group members

The critical group sediment handling rate based on 8 observations is 33 h/y

The observed 97.5 percentile rate based on 16 observations for sediment is 58 h/y

Table 28. Gamma dose measurements over intertidal substrates in the Faslane area (µGy/h)

NGR	Location and substrate	µGy/h
NS 262 836	Rhu Spit - Shingle	0.058
NS 238 909	Garelochhead - Mud and stone	0.064
NS 293 823	Helensburgh beach, 200m north of the pier - Stones	0.065
NS 278 832	Helensburgh beach - Stones	0.069
NS 262 851	Outdoor centre - Stones	0.064
NS 233 900	Rockville - Stones and sand	0.072
NS 234 901	South of Rockville - Rock	0.094
NS 244 850	Clynder - Stones	0.068

Table 29. Occupancy rates in and on water in the Faslane area (h/y)

Observation number	Location*	Activity*	In water	On water
302	Gare Loch	Swimming and kayaking	242	
147-150	Gare Loch	Diving/Working on a boat	220	770
301	Gare Loch	Kayaking	156	
244	Gare Loch	Kayaking	50	
224-225	Rosneath Bay	Kayaking and swimming/Angling	34	190
291	Gare Loch	Swimming/Sailing	5	37
270	Rhu Spit/Gare Loch	Angling		287
223	Gare Loch	Angling		190
247	Gare Loch	Angling		160
271-272	Gare Loch	Angling		144
139-146	Gare Loch	Water sports		120
253-254	Gare Loch	Angling and canoeing		100
214-217	Rosneath Bay	Water sports		90
290	Gare Loch	Sailing		89
213	Gare Loch	Sailing		56
255-256	Gare Loch	Sailing		50
171-185	Gare Loch	Working on a boat		48
261	Garelochhead	Angling		32
130-131	Gare Loch	Working on a boat		15

*The forward slash (/), separates the locations and activities for that individual

Table 30. Occupancy rates (h/y) and gamma dose rates (µGy/h) in the Faslane direct radiation survey area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Indoor occupancy (h/y)	Outdoor occupancy (h/y)	Total occupancy (h/y)	Gamma dose rate in the property (µGy/h)	Gamma dose rate outside the property (µGy/h)
Adult observations							
109	F	68	6812	1120	7932	0.079	0.076
7	M	67	6660	1092	7752	NM	0.076
108	M	67	6044	1680	7724	0.079	0.076
260	M	54	4548	3120	7668	0.104	0.076
5	M	64	6152	1274	7426	0.091	0.074
263	M	61	7065	343	7408	0.095	0.082
264	F	62	7065	343	7408	"	"
111	F	62	7197	207	7404	0.118	0.078
151	M	75	6927	460	7387	NM	NM
152	F	75	6927	460	7387	"	"
301	M	30	2974	4382	7356	NM	0.066
136	F	44	6339	1008	7347	0.070	0.082
292	M	73	6088	1248	7336	0.095	NM
2	F	62	7198	88	7286	0.089	0.072
303	F	49	7120	104	7224	0.108	NM
289	F	87	6140	1040	7180	0.091	0.078
8	F	65	6998	182	7180	NM	0.076
3	M	82	6963	208	7171	0.104	0.076
1	M	71	7101	55	7156	0.089	0.072
4	F	81	6952	104	7056	0.104	0.076
6	F	63	5658	1274	6932	0.091	0.074
244	M	25	6018	870	6888	NM	0.066
248	F	77	6264	500	6764	0.099	0.082
247	M	77	6248	500	6748	"	"
293	F	68	4944	1560	6504	0.095	NM
256	F	40	6051	230	6281	0.103	0.076
110	M	61	5128	920	6048	0.118	0.078
306	F	17	5379	52	5431	0.108	NM
246	F	37	4904	130	5034	NM	NM
302	M	25	1718	3080	4798	NM	0.066
304	M	51	3835	365	4200	0.108	NM
255	M	41	2532	180	2712	0.103	0.076
118-135	M	U	2115	235	2350	0.067	0.078
9-23	F	U	1316	564	1880	0.065	0.062
24-25	F	U	1069	458	1528	"	"
22-23	F	U	987	423	1410	"	"
26	M	U	823	353	1175	"	"
27	F	U	823	353	1175	"	"
28	F	U	720		720	"	"
305	M	20	642	30	672	0.108	NM
261	M	60		520	520	0.104	0.076
262	M	U		520	520	"	"

Table 30. Occupancy rates (h/y) and gamma dose rates (µGy/h) in the Faslane direct radiation survey area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Indoor occupancy (h/y)	Outdoor occupancy (h/y)	Total occupancy (h/y)	Gamma dose rate in the property (µGy/h)	Gamma dose rate outside the property (µGy/h)
Child observations							
137	F	4	5969	1008	6977	0.070	0.082
138	F	4	5969	1008	6977	"	"
259	F	9	5729	552	6281	0.103	0.076
245	F	15	4943	300	5243	NM	NM
258	F	14	2672	16	2688	0.103	0.076
40	F	1	2277	253	2530	0.065	0.062
41	M	1	2277	253	2530	"	"
42	M	1	2277	253	2530	"	"
43	M	1	2277	253	2530	"	"
52	M	2	1771	759	2530	"	"
62	M	2	1771	759	2530	"	"
63	M	3	1771	759	2530	"	"
64	M	3	1771	759	2530	"	"
65	M	2	1771	759	2530	"	"
66	M	4	1771	759	2530	"	"
67	F	3	1771	759	2530	"	"
68	F	3	1771	759	2530	"	"
257	F	16	2324	52	2376	0.103	0.076
53	M	2	1417	607	2024	0.065	0.062
93	M	3	1417	607	2024	"	"
45	M	1	1366	152	1518	"	"
46	M	1	1366	152	1518	"	"
47	M	1	1366	152	1518	"	"
51	M	1	1366	152	1518	"	"
59	F	2	1063	455	1518	"	"
77	M	4	1063	455	1518	"	"
78	F	3	1063	455	1518	"	"
79	F	3	1063	455	1518	"	"
80	M	3	1063	455	1518	"	"
90	M	4	1063	455	1518	"	"
73	F	2	934	400	1334	"	"
74	F	2	934	400	1334	"	"
75	M	4	934	400	1334	"	"
32	M	1	708	304	1012	"	"
33	M	1	708	304	1012	"	"
34	M	1	708	304	1012	"	"
35	F	1	708	304	1012	"	"
44	F	1	911	101	1012	"	"
61	M	2	708	304	1012	"	"
76	M	3	708	304	1012	"	"
87	M	3	708	304	1012	"	"
88	M	3	708	304	1012	"	"
94	F	4	708	304	1012	"	"
95	M	4	708	304	1012	"	"
37	M	0.7	745	83	828	"	"
55	F	2	580	248	828	"	"
29	M	1	547	235	782	"	"
30	M	1	547	235	782	"	"
31	F	1	547	235	782	"	"

Table 30. Occupancy rates (h/y) and gamma dose rates (µGy/h) in the Faslane direct radiation survey area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Indoor occupancy (h/y)	Outdoor occupancy (h/y)	Total occupancy (h/y)	Gamma dose rate in the property (µGy/h)	Gamma dose rate outside the property (µGy/h)
56	M	2	547	235	782	"	"
71	M	3	515	221	736	"	"
81	M	2	515	221	736	"	"
82	F	4	515	221	736	"	"
83	M	3	515	221	736	"	"
84	M	3	515	221	736	"	"
85	F	3	515	221	736	"	"
86	F	2	515	221	736	"	"
49	M	2	483	207	690	"	"
58	M	2	386	166	552	"	"
69	M	2	386	166	552	"	"
70	F	4	386	166	552	"	"
38	M	0.9	455	51	506	"	"
50	M	1	455	51	506	"	"
54	M	2	354	152	506	"	"
60	M	2	354	152	506	"	"
72	F	2	354	152	506	"	"
91	M	4	354	152	506	"	"
92	F	4	354	152	506	"	"
36	F	1	414	46	460	"	"
39	F	1	414	46	460	"	"
48	M	1	414	46	460	"	"
57	M	1	414	46	460	"	"
89	M	2	322	138	460	"	"

NM - Not measured

Background Gamma dose rates

NGR	Location and substrate	µGy/h
NS 301 820	Helensburgh - Grass	0.072
NS 258 896	Glen Fruin - Grass	0.067
NS 251 811	Portkil House - Grass	0.078
NN 294 048	Arrochar - Grass	0.077

Table 31. Ratios for determining consumption rates for children

Food group	Ratio child/adult[1]	
	1 yr old	10 yr old
Fish[2]	0.050	0.200
Crustaceans[2]	0.050	0.250
Molluscs[2]	0.050	0.250
Green vegetables	0.222	0.444
Other vegetables	0.200	0.500
Root vegetables	0.375	0.500
Potatoes	0.292	0.708
Domestic fruit	0.467	0.667
Milk	1.333	1.000
Cattle meat	0.222	0.667
Pig meat	0.138	0.625
Sheep meat	0.120	0.400
Poultry	0.183	0.500
Eggs	0.600	0.800
Wild/free foods[3]	0.110	0.490
Game[4]	0.140	0.500
Honey	0.789	0.789
Wild fungi	0.150	0.450
Freshwater fish[2]	0.050	0.250
Direct radiation	1.000	1.000
External exposure	0.030	0.500
Plume	1.000	1.000

Notes

[1] The age groups suggested for assessment in this table are those relating to dose coefficients representing 1 to 2 yr olds (labelled 1 yr old) and 7 to 12 yr olds (labelled 10 yr old). Excepting notes 2 and 3, ratios were derived from Byrom et al., (1995) for 1yr old (6 - 12 months) and 10 yr old children (10 - 11 yrs).

[2] Ratios were derived from Smith and Jones, (2003) which presented data for infants and children.

[3] Ratios were derived from FSA, (2002) data for wild fruit and nuts for infants and 10 yr old children.

[4] Game includes rabbits/hares and venison.

Annex 1. Adults' consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Fish	Crustaceans	Molluscs	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
1	M	71																										7101	55
2	F	62																										7198	88
3	M	82																										6963	208
4	F	81																										6952	104
5	M	64																										6152	1274
6	F	63																										5658	1274
7	M	67																										6660	1092
8	F	65																										6998	182
9	F	U																										1316	564
10	F	U																										1316	564
11	F	U																										1316	564
12	F	U																										1316	564
13	F	U																										1316	564
14	F	U																										1316	564
15	F	U																										1316	564
16	F	U																										1316	564
17	F	U																										1316	564
18	F	U																										1316	564
19	F	U																										1316	564

Annex 1. Adults' consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Fish	Crustaceans	Molluscs	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
20	F	U																										1316	564
21	F	U																										1316	564
22	F	U																										987	423
23	F	U																										987	423
24	F	U																										1069	458
25	F	U																										1069	458
26	M	U																										823	353
27	F	U																										823	353
28	F	U																										720	
96	M	24																				25			**25**				
97	F	23																				25			**25**				
102	M	33																				10			10				
103	F	24																				10			10				
104	M	19																				10			10				
105	F	17																				10			10				
108	M	67				5.5	**22.6**	**18.0**	5.5	1.1																		6044	1680
109	F	68				5.5	**22.6**	**18.0**	5.5	1.1																		6812	1120
110	M	61				14.4	**51.3**	**24.5**	3.0																			5128	920
111	F	62				14.4	**51.3**	**24.5**	3.0																			7197	207

Annex 1. Adults' consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Fish	Crustaceans	Molluscs	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
112	M	43	**25.3**																			**72**			**72**				
113	F	45	**25.3**																										
114	M	20	**25.3**																										
115	M	18	**25.3**																										
116	M	35	5.5																					12					
117	F	42																						12					
118	M	U																										2115	235
119	M	U																										2115	235
120	M	U																										2115	235
121	M	U																										2115	235
122	M	U																										2115	235
123	M	U																										2115	235
124	M	U																										2115	235
125	M	U																										2115	235
126	M	U																										2115	235
127	M	U																										2115	235
128	M	U																										2115	235
129	M	U																										2115	235
130	M	U																									15	2115	235

Annex 1. Adults' consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Fish	Crustaceans	Molluscs	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
131	M	U																									15	2115	235
132	F	U																										2115	235
133	F	U																										2115	235
134	F	U																										2115	235
135	F	U																										2115	235
136	F	44																										6339	1008
139	M	U																									120		
140	M	U																									120		
141	M	U																									120		
142	M	U																									120		
143	M	U																									120		
144	M	U																				10					120		
145	M	U																				10					120		
146	F	U																									120		
147	M	50																								220	770		
148	M	27																								220	770		
149	M	35																								220	770		
150	M	45																								220	770		
151	M	75																										6927	460

Annex 1. Adults' consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Fish	Crustaceans	Molluscs	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
152	F	75																										6927	460
153	M	U																			**28**			28					
154	M	U																			**28**			28					
155	M	U																			**28**			28					
156	M	U																			**28**			28					
157	M	U																			**28**			28					
158	M	U																			**28**			28					
159	M	U																			**28**			28					
160	M	U																			**28**			28					
161	M	U																			**28**			28					
162	M	U																			**28**			28					
163	F	U																			**28**			28					
164	F	U																			**28**			28					
165	M	U																			**28**			28					
166	M	U																			**28**			28					
167	M	U																			**28**			28					
168	M	U																			**28**			28					
169	M	U																			**28**			28					
170	M	U																			**28**			28					

Annex 1. Adults' consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Fish	Crustaceans	Molluscs	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
171	U	U																									48		
172	U	U																									48		
173	U	U																									48		
174	U	U																									48		
175	U	U																									48		
176	U	U																									48		
177	U	U																									48		
178	U	U																									48		
179	U	U																									48		
180	U	U																									48		
181	U	U																									48		
182	U	U																									48		
183	U	U																									48		
184	U	U																									48		
185	U	U																									48		
186	M	U									**207.4**			0.6															
187	M	U									**207.4**			0.6															
188	F	U									**207.4**			0.6															
189	U	U									**207.4**			0.6															

Annex 1. Adults' consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Fish	Crustaceans	Molluscs	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
190	M	62										**39.0**	**39.0**																
191	F	69										**39.0**	**39.0**																
192	M	62	0.8			**17.8**	15.0	**15.9**	**18.0**	**21.2**							**0.5**			**1.0**		**84**							
193	F	62	0.8			**17.8**	15.0	**15.9**	**18.0**	**21.2**										**1.0**									
194	M	U																					64						
195	M	U																					64						
196	M	48	5.9																				**576**						
197	M	45																					**576**						
201	M	U	3.3																				**430**						
202	M	U	3.3																				**430**						
203	M	33	3.7																				64						
204	F	U	3.7																										
206	M	48																				**96**							
207	M	45	2.9																				130						
208	M	U	0.5																				30						
209	M	19	0.5																				30						
213	M	66																									56		
214	M	U																									90		
215	M	U																									90		

Annex 1. Adults' consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Fish	Crustaceans	Molluscs	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
216	M	U																									90		
217	M	U																									90		
218	M	U																			**30**		30		**30**				
220	M	40																					96						
223	M	42																					240				190		
226	M	47																					**270**						
227	M	43																					**270**						
228	M	U	0.6																										
229	F	U	0.6																										
230	F	U	0.6																										
231	F	U	0.6																										
232	F	25																					120						
233	M	28																					120						
234	M	30																					120						
235	F	U	3.7																										
236	M	39	3.3	**0.2**																		20	**780**		20				
237	F	39	3.3	**0.2**																									
238	M	U				**47.9**	**25.5**	**22.0**	**10.2**	**25.0**					**14.4**	**2.5**													
239	F	U				**47.9**	**25.5**	**22.0**	**10.2**	**25.0**					**14.4**	**2.5**													

Annex 1. Adults' consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Fish	Crustaceans	Molluscs	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
240	M	U				4.9	7.7		**24.6**																				
241	F	U				4.9	7.7		**24.6**																				
242	M	U													2.7			**1.4**											
243	F	U													2.7			**1.4**											
244	M	25																				**64**				50		6018	870
246	F	37																										4904	130
247	M	77					5.4															**50**					160	6248	500
248	F	77					5.4															**50**						6264	500
249	M	U											**15.4**																
250	M	U											**15.4**																
251	M	U											**15.4**																
252	M	U											**15.4**																
253	M	52	0.5			**39.3**	**35.4**	**32.2**	**14.6**						**8.2**			**1.1**									100		
254	F	46	0.5			**39.3**	**35.4**	**32.2**	**14.6**						**8.2**			**1.1**									100		
255	M	41														**1.8**											50	2532	180
256	F	40														**1.8**											50	6051	230
260	M	54																										4548	3120
261	M	60	3.8											**2.7**		**18.1**											32		520
262	M	U												**2.7**															520

Annex 1. Adults' consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Fish	Crustaceans	Molluscs	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
263	M	61																										7065	343
264	F	62																										7065	343
265	M	53																						30					
266	M	40																						30					
267	M	26																						50					
268	F	24																						50					
269	M	42	7.1																					**936**					
270	M	57	**8.8**																			8		143	8		287		
271	F	57																						143			144		
272	F	28																						143			144		
273	M	46																						104					
274	M	42																						104					
275	M	49																						120					
276	F	41																						120					
278	M	34	**12.8**																					**390**					
280	M	72	7.2																										
281	M	44	0.3																			9		36	9				
282	M	52	0.3																			9		36	9				
283	F	44	0.3																					36					

Annex 1. Adults' consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Fish	Crustaceans	Molluscs	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
285	M	30	7.8																				208						
286	M	59	**9.2**																										
287	M	57	5.5																					160					
288	M	U				**25.5**	**42.6**	**39.4**	**13.6**	**14.5**																			
289	F	87				12.2	16.3	12.0	5.4	**24.5**																		6140	1040
290	M	U	0.2			0.5	6.4		5.0	**8.8**					**9.7**	**2.0**								4			89		
291	F	U	0.2			0.5	6.4		5.0	**8.8**					**9.7**	**2.0**								4		5	37		
292	M	73				15.2	**19.5**		**15.0**	**22.2**																		6088	1248
293	F	68				15.2	**19.5**		**15.0**	**22.2**																		4944	1560
294	M	67																				**34**			**34**				
295	F	48				13.0	11.8	7.3	7.1	3.4						0.5		**0.6**						52					
296	M	50	1.8			13.0	**18.1**	7.3	7.1	3.4						0.5		**0.6**						52					
297	M	75	1.8		**0.2**	13.0	15.2	7.3	7.1	3.4						0.5		**0.6**						122					
298	F	30				13.0	11.8	7.3	7.1	3.4						0.5		**0.6**											
299	F	23				13.0	11.8	7.3	7.1	3.4						0.5		**0.6**											
300	M	19				13.0	11.8	7.3	7.1	3.4						0.5		**0.6**											
301	M	30														**4.5**			**2.3**					156		156		2974	4382
302	M	25														**4.5**			**2.3**					150		242		1718	3080
303	F	49																										7120	104

Annex 1. Adults' consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Fish	Crustaceans	Molluscs	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
304	M	51																										3835	365
305	M	20																										642	30
306	F	17																										5379	52
307	F	72				13.8	**31.2**	**33.9**	3.3	**11.7**						**1.8**		**1.4**											
308	M	74				13.8	**31.2**	**33.9**	3.3	**11.7**						**1.8**		**1.4**											

Annex 2. Children's consumption rates (kg/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years	Fish	Wild/free foods	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
15 year old age group													
257	F	16										2324	52
245	F	15										4943	300
210	M	14	0.5				30						
258	F	14										2672	16
198	M	13	**5.9**				190						
10 year old age group													
211	M	10	0.5				30						
212	M	9	0.5				30						
259	F	9		**1.8**								5729	552
279	M	9	**7.2**					**390**					
219	M	8			**30**		30		**30**				
222	M	8					96						
224	M	8					240			34	190		
284	M	8	0.3					36					
98	F	7				25			**25**				
225	M	7					240			34	190		
5 year old age group													
99	M	6				25			**25**				
221	M	5					96						
277	M	5						120					
66	M	4										1771	759
70	F	4										386	166
75	M	4										934	400
77	M	4										1063	455
82	F	4										515	221
90	M	4										1063	455
91	M	4										354	152
92	F	4										354	152
94	F	4										708	304
95	M	4										708	304
137	F	4										5969	1008
138	F	4										5969	1008
63	M	3										1771	759
64	M	3										1771	759
67	F	3										1771	759
68	F	3										1771	759
71	M	3										515	221
76	M	3										708	304

Annex 2. Children's consumption rates (kg/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years	Fish	Wild/free foods	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
78	F	3										1063	455
79	F	3										1063	455
80	M	3										1063	455
83	M	3										515	221
84	M	3										515	221
85	F	3										515	221
87	M	3										708	304
88	M	3										708	304
93	M	3										1417	607
49	M	2										483	207
52	M	2										1771	759
53	M	2										1417	607
54	M	2										354	152
55	F	2										580	248
56	M	2										547	235
58	M	2										386	166
59	F	2										1063	455
60	M	2										354	152
61	M	2										708	304
62	M	2										1771	759
65	M	2										1771	759
69	M	2										386	166
72	F	2										354	152
73	F	2										934	400
74	F	2										934	400
81	M	2										515	221
86	F	2										515	221
89	M	2										322	138
1 year old age group													
29	M	1										547	235
30	M	1										547	235
31	F	1										547	235
32	M	1										708	304
33	M	1										708	304
34	M	1										708	304
35	F	1										708	304
36	F	1										414	46
39	F	1										414	46
40	F	1										2277	253
41	M	1										2277	253
42	M	1										2277	253
43	M	1										2277	253

Annex 2. Children's consumption rates (kg/y) and occupancy rates (h/y) in the Faslane area

Observation number	Sex (U if unknown)	Age in years	Fish	Wild/free foods	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
44	F	1										911	101
45	M	1										1366	152
46	M	1										1366	152
47	M	1										1366	152
48	M	1										414	46
50	M	1										455	51
51	M	1										1366	152
57	M	1										414	46
100	F	1				25							
3 month old age group													
38	M	0.9										455	51
106	F	0.8				10							
37	M	0.7										745	83
107	F	0.3				10							
101	M	0.1				25							

Annex 3. Combinations of adult groups for consideration in dose assessments in the Faslane area

Combination number	Fish	Crustaceans	Molluscs	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over mud and stones	Intertidal occupancy over rock	Intertidal occupancy over stones/shingle	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy
1				*	*	*	*	*																		*	*
2	*																			*			*			*	*
3	*																			*		*	*		*		
4					*															*					*	*	*
5	*			*	*		*	*					*	*								*		*	*		
6																			*			*					
7									*			*															
8										*	*																
9	*			*	*	*	*	*							*			*		*							
10	*	*																		*	*		*				
11																			*		*		*				
12																					*				*		
13				*	*	*	*	*					*	*													
14	*			*	*	*	*						*			*									*		
15																				*				*		*	*
16														*											*	*	*
17	*											*		*											*		*
18	*		*	*	*	*	*	*						*		*						*					
19														*			*							*		*	*

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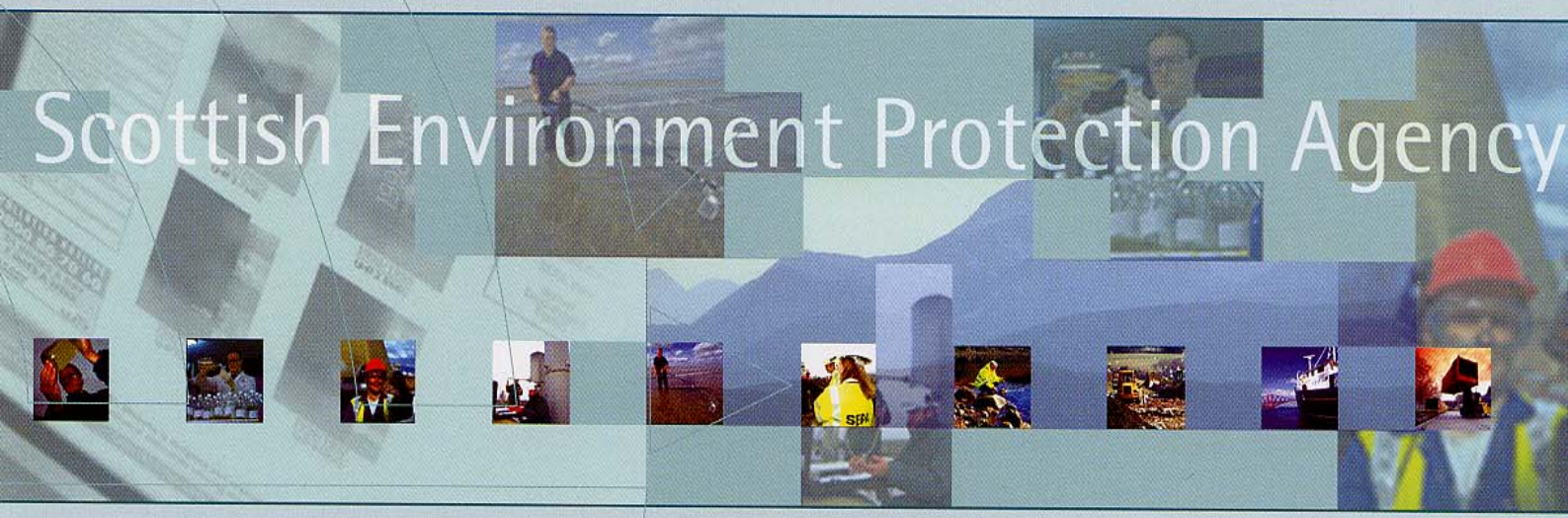

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