



# Scottish Environment Protection Agency

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,  
Chapelcross, 2005**

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2006

The work described in this report was carried  
out under contract to the Scottish Environment Protection Agency  
SEPA contract R40067/PUR  
Cefas contract C2448

Environment Report RL 04/06



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## **SUMMARY**

This report presents the results of a survey, conducted in 2005, into the habits and consumption patterns of people living and working in the vicinity of the Chapelcross site which discharges gaseous and aqueous emissions to the atmosphere and the Solway Firth respectively. The site also has sources of direct radiation. Potential exposure pathways for the site include consumption of locally sourced terrestrial and marine foods and occupancy of nearby dwellings, the liquid effluent pipeline and intertidal areas. The survey investigated all of these pathways and the data obtained on the consumption and occupancy rates of individuals are presented and discussed. Data was collected for 314 adults and 50 children.

Food sources included locally caught seafood, local meat, local game, wildfowl, wild/free foods and home-grown fruit and vegetables. Occupancy habits include those related to residences and workplaces within 1km of the site, recreation and work activities over intertidal areas, handling of fishing gear and intertidal sediment and occupancy along the liquid effluent pipeline. In the marine environment the main activity was the salmon fishery which employed three fishing methods: haaf netting, poke netting and stake netting. In the terrestrial survey area livestock production was predominantly beef, lamb and dairy. Egg production was noted though this was of a small scale. Most farmers produced hay and cereals for winter livestock feed.

## **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 normal circumstances: discharges of radioactive waste to the aquatic environment, discharges to the atmosphere and direct radiation from the site. Regulation of waste discharges is carried out under the Radioactive Substances Act 1993, (RSA93) (UK Parliament, 1993). Authorisations granted under RSA93 set limits on the quantities and types

of radioactivity that are permitted to be released from the site. For discharges in Scotland, the Scottish Environment Protection Agency (SEPA) is the primary regulatory authority under RSA93. Sources of direct radiation from sites are regulated by the Nuclear Installations Inspectorate (NII) of the Health and Safety Executive (HSE).

## **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 Chapelcross.

## **1.3 Dose limits and constraints**

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

The Radioactive Substances (Basic Safety Standards) (Scotland) Direction 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 2005 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 external exposure pathways resulting from routine radioactive emissions and direct radiation from the Chapelcross site. SEPA also requested that attention be paid specifically to occupancy along the liquid effluent pipeline.

The last full habits survey of the Chapelcross site was by Cefas in 2000 (Tipple, Sherlock and Taylor, 2002); Cefas also undertook a survey (habits and monitoring) solely along the liquid effluent pipeline in 2002 (Tipple, McTaggart and Sherlock, 2002). The data from these surveys are currently being used for dose assessments in the Chapelcross area.

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 salmon fishing and wildfowling 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 1km of the site and along the liquid effluent pipeline.
- The extent of any unusual practices.
- The use of any natural resources from the aquatic environment (e.g. sand extraction, 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 Survey areas**

Different survey areas were selected to cover the aquatic, terrestrial and direct radiation pathways.

The aquatic survey area was based on data regarding the local tidal excursion around the pipeline, as shown by admiralty tidal charts, which is 12km to the east (Gretna) and 13km to

the west (the mouth of Lochar Water). For this survey, the area was extended a further 10km west to Scar Point (shown in Figure 1).

The terrestrial survey area, shown in Figure 2, was defined as the full circle to a radius of 5km from the site centre; this area is considered to encompass the main areas of potential deposition.

For the direct radiation area, again shown in Figure 2, the survey aimed to cover individuals residing and working within 1km of the site centre. On SEPA's request this survey area was extended slightly to take in residences to the south of the main road running through Creca village. The survey also covered the whole length of the liquid effluent discharge pipeline.

### **2.3 Conduct of the survey**

The fieldwork component of the survey was carried out during the period 25<sup>th</sup> July to 07<sup>th</sup> August 2005 by three members of staff from the Cefas laboratory at Lowestoft, according to techniques as described by Leonard *et al* (1982).

On 27<sup>th</sup> July 2005 a meeting was held between representatives from Chapelcross, SEPA and Cefas; this served to provide details about site operations, including waste disposal, and information about potential pathways and activities in the area. Further information was sought about wildlife studies and pest control measures in and immediately around the site; these animals could act as vectors for transporting radioactive materials off-site and are also potential food items for some individuals.

People with a local knowledge of the survey area were contacted for information on any aspects relevant to the exposure pathways. These included the secretary of the Annan Fishermens' Association, individuals connected with the local salmon fishery (haaf, poke and stake netmen), individuals connected with local wildfowling clubs, marsh wardens, farmers, shop owners (butchers and fishmongers), beekeepers and allotment holders.

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 inside and outside. Gamma dose rate measurements were taken inside and outside most of these properties. For comparison, background readings were taken from outside the 5km 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 salmon fishermen, marsh wardens, allotment holders and farmers, and individuals living and/or working within the direct radiation survey area.

## **2.4 Site activity**

Chapelcross ceased electricity generation in June 2004. At the time of the survey, de-fuelling had not started but once this is completed the site's decommissioning phase will begin. The Chapelcross Processing Plant is still in operation. Since generation stopped, the levels of direct radiation have fallen to background; the previously elevated levels around the Uranium Oxide store have also fallen since the building has had extra cladding built around it. Low-level liquid radioactive wastes are discharged into the Solway Firth via the liquid effluent pipeline and gaseous waste discharges are made to the atmosphere.

## **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 assessed and entered into a database. Each individual for whom information was obtained was given a unique identifier (the Observation

Number) to assist in data sorting. 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 on which the yield was grown or the length and number of rows in which the crop was grown. These data were converted to approximate 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 2 significant figures. In the tables and annexes, the data are usually presented to 1 decimal place; the exceptions are for values less than 0.05 which are presented to 2 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. They can only be established once a dose assessment using environmental monitoring data has been undertaken.

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).

### **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 where consumption occurred, using the Microsoft Excel mathematical function for calculating percentiles. This 97.5 percentile rate is calculated for all age groups where consumption was noted. 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 3 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 when doses are determined taking into account all pathways.

Consumption data for aquatic foodstuffs are presented for adults in Tables 2 and 3, and for children in Tables 4 and 5 and they are summarised in Tables 6 to 10. For purpose of comparison, values for 97.5 percentile and mean consumption rates based on national data, referred to as 'generic' rates in this report, are shown for aquatic foodstuffs for adults, 15 and 10 year old children (no generic data were available for the 5 and 1 year old children). Consumption data for terrestrial foodstuffs are presented for adults in Tables 11 to 26, and for children in Tables 27 to 38 and they are summarised in Tables 6 to 10. Again, for purpose of comparison, values for 97.5 percentile consumption rates based on national data are shown for terrestrial foodstuffs for adults, 15 and 10 year old children (no generic data were available for the 5 and 1 year old children).

The critical group rate has been calculated from the survey data for children. However, because few child consumers were identified the method should be viewed with caution. For assessment purposes, a theoretical 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 46. The ratios have been calculated using generic 97.5 percentile consumption rates determined by MAFF and FSA (Byrom *et al* 1995, Smith and Jones, 2003 and FSA, 2002) for adults, 10 year olds and children aged 6–12 months.

### **External exposure in intertidal areas**

A similar approach to ingestion pathways is used for occupancy and handling rates in intertidal areas (Tables 40 and 41 respectively). 97.5 percentile rates and critical group rates are determined for groups of activities or substrates 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 as for consumption is used. The factor reflects variations in the doses likely to be received due to natural variations in the interaction of radiation with tissues caused by, for example, differences in anatomy.

### **Direct radiation exposure**

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. These data are presented in Table 44.

A summary of consumption, occupancy, and handling rates for adults and children are presented in Annex 1 and Annex 2 respectively.

## **4. AQUATIC RADIATION PATHWAYS**

### **4.1 Aquatic survey area**

The aquatic survey area is shown in Figure 1. The Solway Firth in the aquatic area had a large tidal excursion. The predominant sediment was a thin layer of soft mud that extended out approximately 5 metres from the shoreline and then became firm sand. The shoreline was mainly stone along the high-water mark, giving way to tide-washed grass crossed with rills up to the land in the eastern and central parts of the survey area, with large areas of salt marsh at the western end. Several rivers and burns (streams) flow into the Solway Firth in the survey area, the main ones being, from east to west; River Sark, Kirtle Water, River Annan, Pow Water, Lochar Water and the River Nith. Access to the foreshore was easy with several metalled roads leading down to the Solway, except at the western end.

The three types of salmon netting in the area were poke netting, stake netting and haaf netting. Both poke and stake nets are fixed gears; at Chapelcross the poke nets were fixed approximately 500 metres offshore and consisted of individual bag nets strung in a line perpendicular to the water flow. The poke nets were strung between metal poles approximately one metre apart with the headline of each net approximately 1.5 metres high. Stake nets are larger walls of nets, also set perpendicular to the water flow, which funnel the fish into pockets from which they can't escape; they were set much closer to the shoreline. Both poke and stake nets were checked twice a day at low tide. A haaf net consists of a five metre cross beam with a 1.5 metre pole in the middle, which the fisherman holds in the water, and side sticks at either end which form a frame to attach a rectangular net. The haaf netsmen stand facing the current, upto chest-high in the water, waiting for salmon to swim into their net; they fished both the ebb and flood tides, usually twice per day. For all the above forms of salmon netting the season was from the 25<sup>th</sup> of February until the 9<sup>th</sup> of September; no fishing was allowed over the weekends, from 1800 Friday until 0600 Monday (the haaf netsmen did not go out and the poke and stake nets were set so as not to catch any fish). In the close-season the poke and stake nets were dismantled; the nets were either discarded or stored at the fishermen's homes.

### **Gretna to Eastriggs**

This stretch of coastline is approximately 9km long; the England/Scotland border is formed by the channel of the River Esk and continues close to the coastline along its first two thirds. Haaf netters set off from this area but all fished on the English side; the haaf net licences along this stretch had all been brought by the North Atlantic Salmon Conservation Organisation. A wildfowling club was active along this stretch of the coastline and parts were used by farmers for grazing cattle. Other observations included birdwatchers and two shore anglers.

### **Eastriggs to Powfoot**

This stretch of coastline is approximately 11km long and includes the liquid discharge pipeline from Chapelcross. Most of the salmonid fishing activities occurred in this stretch. There were three stake nets and five sets of poke nets (each set having 15 nets), and these were the only stake and poke nets in the survey area. This was also where most of the haaf netters fished, usually walking out onto the sand from either Battlehill, Whinnyrig or Seafield. People were observed walking around the shore at Seafield and cattle were grazed on the tide-washed grass just to the west of the pipeline.

The main river in the survey area, the River Annan, flowed into the Solway halfway along this stretch of coastline. Several shrimp boats used to operate from the port of Annan but there were none in operation at the time of the survey. The River Annan was a popular angling water, with public fishing allowed up to the old bridge and permit fishing after that; the river is tidal up to Northfields House. Small areas of tide-washed grass were used for grazing cattle along the lower reaches and cattle were observed drinking from the river.

There was a large expanse of sand exposed at low tide opposite Powfoot and this was popular for walkers, horse riders and dog walkers. It was in this area that the last survey identified an old bathing pool, approximately 400 metres below the high water mark, which was used by a few mussel collectors; this was now completely covered with sand.

### **Powfoot to Scar Point**

From Powfoot, west to the mouth of the River Nith, the coastline was mainly salt marsh and the largest area was Caerlaverock National Nature Reserve which is managed by Scottish Natural Heritage; this area was popular with wildfowlers, bird watchers and walkers. Several farmers used the salt marsh for grazing their cattle.

## **4.2 Commercial fisheries**

### **The salmonid fishery**

The salmon and sea trout fishing season on the north Solway coast was from 25<sup>th</sup> February to 9<sup>th</sup> September, although most fishermen did not start until mid-May when the water became warmer. During 2005, there were two licensed fishermen using stake nets, 31 licensed fishermen using haaf nets and five licensed fishermen using poke nets. The majority of the fish caught were either sold locally or sent to Billingsgate Market, London, with small amounts being consumed by the fishermen and their families. Salmonids were also caught along the River Annan and Kirtle Water by anglers.

Other marine fish species were occasionally caught during salmonid fishing as a by-catch, the most common being bass, mullet and flounder; these were usually consumed by the fishermen and their families.

### **Crustaceans**

The only crustacean species found in commercial quantities in the survey area were common shrimps (*Crangon crangon*). During 2000, there were three registered fishing boats based at Annan, although these had all since stopped fishing. The only commercial shrimp fishing in the survey area was by a few boats from the English side of the Solway fishing from Silloth and Maryport, although this was reported as being rare.

No other crustacean species were noted as being caught and consumed from the survey area.

## **Molluscs**

No commercial collection of molluscs was noted in the survey area. The area identified in the 2000 survey as being used for mussel collection had been covered by sand. The cockle fishery in the Solway has been closed to vessels since 1992, tractor dredging since 1995 and all forms of cockling since 2002. However, the fishery may be re-opened in the near future, the proposal being to have 6 licensed cockle boats and 100 licensed handrakers, the boats being limited to 2 tonnes of cockles per day and the handrakers limited to 1 tonne per day. An enquiry due in September 2005 to decide whether to re-open the fishery had been postponed to a later date.

### **4.3 Angling**

Salmon and sea trout angling on the River Annan was very popular; most of the river was privately owned and was fished by syndicates or by anglers purchasing tickets. One individual was noted angling for flounder, from the shore at Browhouses. No angling charter vessels were working in the survey area.

### **4.4 Seafood wholesalers and retailers**

Wholesalers and retailers were sought in order to assess the distribution and consumption pathways of local seafood; only one seafood shop was identified that sold locally caught salmon (from haaf netters). Two individuals bought salmon from the haaf netsmen in the survey area which was sold on to Billingsgate Market, London.

## **4.5 Internal exposure**

### **Adult consumption rates**

Consumption rate data for adults of fish and wildfowl are shown in Tables 2 and 3 respectively and are summarised in Table 6.

The main consumers of fish from the Chapelcross survey area were the salmonid netmen together with their families. The main species of fish consumed by adults was salmon. A critical group of three individuals was identified with a maximum consumption rate of 48 kg/y and a mean of 31 kg/y. The observed 97.5 percentile rate based on 97 observations was 19 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 consisted of a mix of 78% salmon, 19% sea trout and 2.8% flounder.

Wildfowling was very popular in the Solway Firth and several local wildfowlers were interviewed. The main species of wildfowl consumed by adults were ducks and geese. A critical group of 14 individuals was identified with a maximum consumption rate of 23 kg/y and a mean of 19 kg/y. The observed 97.5 percentile rate based on 21 observations was 23 kg/y. There are no generic consumption rate data for wildfowl. Critical group wildfowl consumption consisted of a mix of 74% duck, 16% goose, 6.6% mallard, 2.3% teal and 1.1% widgeon.

No consumption of crustacean, mollusc or marine plants by adults was observed during the survey.

### **Children's consumption rates**

Consumption rate data for children for fish and wildfowl are shown in Tables 4 and 5 respectively and are summarised in Tables 7 to 10. No children in the 1 year old and 3 month old age group were noted to be consuming locally-caught fish. No children in the 5 year old,

1 year old and 3 month old age groups were consuming wildfowl. No children were identified who consumed crustaceans, molluscs or marine plants.

### **15 year old age group**

For fish, a critical group of seven individuals was identified with a maximum consumption rate of 8.2 kg/y and a mean of 5.8 kg/y. The observed 97.5 percentile rate based on nine observations was 8.1 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. Critical group fish consumption consisted of 79% salmon, 15% sea trout, 3.1% bass and 2.9% brown trout.

For wildfowl, a critical group of three individuals was identified with a maximum consumption rate of 17.9 kg/y and a mean of 17.5 kg/y. The observed 97.5 percentile rate based on three observations was 17.9 kg/y. No generic consumption rates have been derived for this age group for wildfowl. Critical group wildfowl consumption consisted of 44% goose, 26% duck, 18% mallard, 6.5% teal and 5.5% wigeon.

### **10 year old age group**

For fish, a critical group of five individuals was identified with a maximum consumption rate of 8.2 kg/y and a mean of 5.6 kg/y. The observed 97.5 percentile rate based on seven observations was 8.2 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. Critical group fish consumption consisted of 76% salmon, 20% sea trout and 4.2% brown trout.

For wildfowl, a critical group of three individuals was identified with a maximum consumption rate of 17.9 kg/y and a mean of 16.4 kg/y. The observed 97.5 percentile rate based on three observations was 17.9 kg/y. No generic consumption rates have been derived for this age group for wildfowl. Critical group wildfowl consumption consisted of 55% duck, 34% goose, 5.9% wigeon, 4.3% mallard and 1.3% teal.

## **5 year old age group**

For fish, a critical group of one individual was identified with a consumption rate of 0.50 kg/y. No generic consumption rates have been derived for this age group. Critical group fish consumption consisted of 100% salmon.

## **The use of seaweed as a fertiliser**

The survey investigated the use of seaweed as a fertiliser and soil conditioner and none was found.

## **4.6 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 substrate materials in the intertidal areas of the survey area were sand, mud and salt marsh.

Intertidal activities observed during the survey included salmon fishing (including gear handling), wildfowling, marsh wardens, walking, tending livestock, birdwatching and angling.

Gamma dose rate measurements were taken at selected locations, shown in Table 42, to supplement those of SEPA's scheduled monitoring programme.

Table 40 lists the intertidal occupancy rates observed, grouped by substrate. Commercial salmon netmen using stake nets formed the critical group for occupancy over mud. A mean time of 950 h/y was identified for three individuals with a maximum rate of 1100 h/y for two of the stake netmen. Poke and haaf netmen formed the critical group for occupancy over sand, with a mean rate of 430 h/y for five individuals and a maximum rate of 510 h/y. Marsh wardens and wildfowlers formed the critical group for occupancy over salt marsh, with a mean rate of 450 h/y for 17 individuals and a maximum rate of 830 h/y.

## **Handling**

Handling sediment while bait digging, mollusc collecting or handling commercial fishing gear 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 41 shows the observations made during this survey for times spent handling sediment and commercial fishing gear.

A mean critical group sediment handling rate of 610 h/y was identified for nine individuals, who were stake netters or wildfowlers, with a maximum rate of 1100 h/y. A mean critical group fishing gear handling rate of 390 h/y was identified for 15 individuals, with a maximum rate of 620 h/y.

## **4.7 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.

These provide quantitative data that might be of use in the probabilistic assessment of dose and/or risk to individuals via radiological pathways. Pathways to consider include individuals who may inhale re-suspended radioactivity in sea spray, inadvertently ingest contaminated seawater and/or have contact with and/or inadvertently ingest contaminated sediments while undertaking coastal area activities such as walking, sailing and wildfowling.

Occupancy rates for activities taking place in or on seawater around Chapelcross are shown in Table 43.

#### **Activities in the water**

Activity in the water around Chapelcross was mainly by the haaf netsmen who stand up to chest-high in the water whilst fishing. No other activities such as swimming or scuba diving were observed in the survey area.

#### **Activities on the water**

Activity on the water was again mainly by a group of haaf netsmen who rowed across to the English side of the Solway to fish; we have conservatively considered all of their time as being on Scottish waters. There were no sailing or water sports clubs in the survey area and very little fishing (commercial or pleasure angling) activities which would have given rise to observations on the water.

## **5. TERRESTRIAL RADIATION PATHWAYS**

### **5.1 Terrestrial survey area and local produce**

The terrestrial survey area is shown in Figure 2. Farming in the area was predominantly beef, sheep and dairy with arable crops such as barley and grass grown for animal feed. Several of the farmers took small amounts of either beef or sheep meat for their own personal consumption and most dairy farmers and their families consumed milk from their cows. Most of the beef was sold to abattoirs in Stirlingshire, Aberdeen, Ayr, Perth, Dornock or Lockerbie. Most of the lamb was sold at Longtown or Dumfries markets. Milk was sold to Sorn or First Milk for national distribution. A small number of farms and smallholdings kept chickens and ducks for egg production and one chicken farm was noted.

There were two allotment sites in Annan, although one of these was almost completely unused. The main site grew a wide variety of fruit and vegetables which were consumed by the allotment holders' households, friends or families. A few smallholdings and gardens growing fruit and vegetables were found in the survey area.

Three beekeepers were identified within the survey area. One had 11 hives which produced between 4.5 and 20 kilograms of honey per hive per year which was consumed by friends and family, and another had 16 hives which produced around 18 kilograms of honey per hive per year which was sold to several local shops. The third beekeeper had six hives which produced around eight kilograms of honey per hive per year which was consumed by friends and family.

Consumption of wild foods from within the survey area by individuals was limited, with mushrooms and blackberries consumed on a small scale. Several households were found to be consuming game caught within the survey area including pheasant, partridge, pigeon, rabbit and roe deer.

No households were found to use spring or groundwater for domestic consumption. Several farms in the area had land where livestock had access to river or estuary (Solway Firth) water.

No freshwater fish, molluscs or crustaceans were consumed; the 2000 survey had identified a trout fishery (stocked with rainbow trout) but this was now a catch and release fishery only.

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 spent time investigating unusual pathways such as peat cutting and consumption of unusual food types. A large peat cutting works was within the survey area with the peat being used to make compost for sale all over the UK.

## **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.

The area consisted mainly of arable land and improved grassland. There were also pockets of coniferous (both plantation and semi-natural) and broadleaved and mixed woodland. There were a few small areas of blanket bog and other peatland vegetation, along with pits and quarries.

## **5.4 Internal exposure**

### **Adult consumption rates**

Consumption rate data for adults are shown in the food groups where consumption occurred in Tables 11 to 26 and are summarised in Table 6. Consumption of terrestrial foods in the following 16 food groups was identified: green vegetables, other vegetables, root vegetables, potatoes, domestic fruit, milk, cattle meat, pig meat, sheep meat, poultry, eggs, wild/free foods, honey, wild fungi, rabbits/hares 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 39. No consumption was identified for freshwater fish or local cereal crops.

Three critical group mean consumption rates exceeded the generic 97.5 percentile rates; these were for root vegetables, milk and honey. A further eight critical group mean consumption rates exceeded the generic means; these were for green vegetables, potatoes, domestic fruit, cattle meat, pig meat, sheep meat, poultry and eggs. Four critical group mean consumption rates were less than the generic means; these were for other vegetables, wild/free foods, rabbits/hares and wild fungi. The observed 97.5 percentile consumption rates for root vegetables, potatoes, milk, cattle meat, eggs and honey 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 Tables 27 to 38 and are summarised in Tables 7 to 10. No children in the 3 month old age group were identified as consuming local terrestrial foods.

### **15 year old age group**

Consumption of terrestrial foods was identified in the following 12 food groups: green vegetables, other vegetables, root vegetables, potatoes, domestic fruit, milk, cattle meat, sheep meat, poultry, eggs, rabbits/hares and wild fungi. No consumption was identified for the following food groups: pig meat, wild/free foods, honey, venison and freshwater fish. Two critical group mean consumption rates exceeded the generic 97.5 percentile rates; these were for milk and poultry. A further three critical group mean consumption rates exceeded the generic means; these were for green vegetables, cattle meat and eggs. Six critical group mean consumption rates were less than the generic means; these were for other vegetables, root vegetables, potatoes, domestic fruit, sheep meat and wild fungi. Only the observed 97.5 percentile consumption rates for milk and eggs exceeded the generic 97.5 percentile consumption rates.

### **10 year old age group**

Consumption of terrestrial foods was identified in the following 10 food groups: green vegetables, other vegetables, root vegetables, potatoes, domestic fruit, milk, cattle meat, sheep meat, eggs and wild fungi. No consumption was identified for the following food groups: pig meat, poultry, wild/free foods, rabbits/hares, honey, venison and freshwater fish. The critical group mean consumption rate for milk exceeded the generic 97.5 percentile consumption rate. Three critical group mean consumption rates exceeded the generic means; these were for root vegetables, eggs and wild fungi. Six critical group mean consumption rates were less than the generic means; these were for green vegetables, other vegetables, potatoes, domestic fruit, cattle meat and sheep meat. Only the observed 97.5 percentile consumption rate for milk exceeded the generic 97.5 percentile consumption rate.

### **5 year old age group**

Consumption of terrestrial foods was identified for milk and eggs. No consumption was identified for the following food groups: green vegetables, other vegetables, root vegetables, potatoes, domestic fruit, cattle meat, pig meat, sheep meat, poultry, wild/free foods, rabbits/hares, honey, wild fungi, venison and freshwater fish. No generic consumption rates have been determined for this age group.

### **1 year old age group**

Consumption of terrestrial foods was identified for milk and eggs. No consumption was identified for the following food groups: green vegetables, other vegetables, root vegetables, potatoes, domestic fruit, cattle meat, pig meat, sheep meat, poultry, wild/free foods, rabbits/hares, honey, wild fungi, venison and freshwater fish. No generic consumption rates have been determined for this age group.

## **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 and/or working and/or pursuing leisure activities within approximately 1km of the site centre (Figure 2). These data are presented in Table 44 along with associated gamma dose rates. Occupancy due to employment associated with operations at Chapelcross was not considered. The survey also paid consideration to occupancy along the Chapelcross liquid effluent discharge pipeline and these data are presented in Table 45.

### **Direct radiation survey area**

Chapelcross Power Station is situated 3km north east of the town of Annan, on a disused RAF airfield site at the head of small valley encompassing Gullielands Burn, an offshoot of the

Annan Valley. The nearest settlement is the village of Creca which is approximately 1km from the site centre. The area surrounding the site is mainly farmland with a number of dwellings, farms and businesses located within the direct radiation survey area. Commercial activities noted to take place within the direct radiation area included farming, a sawmill and a scrapyards. No leisure activities were observed within the area.

### **The Pipeline survey area**

The discharge pipeline is approximately 5km long and carries liquid effluent from the Chapelcross site to Seafield, along the path of a dismantled railway, where it's discharged into the Solway Firth; Figure 4 shows a diagrammatic layout of the pipeline's path. Parts of the pipeline are above ground. For the purposes of the survey, the pipeline area was divided into 5 sections and these are also shown in Figure 4.

### **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 44). Data obtained included occupancy rates for the following activities: residential occupancy, farming and businesses. Two individuals had occupancy rates over 8000 h/y, one a farmer living and working in the survey area and the other a resident; seven other individuals had occupancy rates over 7000 h/y, three of whom were children.

### **Occupancy within pipeline survey area**

The survey team divided the pipeline area into sections and walked these seeking members of the public to interview. The interviews consisted of questions to ascertain the number of hours per year that individuals spent in close proximity to the pipe, along which sections of the pipeline their activities took place and their approximate distance from the pipe when engaged in these activities. Twenty-nine observations were made (Table 45) with occupancy rates

ranging from 670 to 17 h/y. The activities observed included walking, dog walking and grounds maintenance, with most of the activities taking place along the stretch of pipeline from Annan to Seafield. It was noted that children gained access to the pipeline adjacent to the sports centre in Annan despite this stretch being fenced off.

### **Gamma dose rate measurements**

Gamma dose rate measurements were taken at most of the residences and businesses both inside and outside the properties, and also at locations remote from the site to obtain background dose rates (Table 44). The measurements were generally low and indistinguishable from background. The maximum gamma dose rate measured in the direct radiation survey area was 0.11 micro Gy/h inside and also 0.11 micro Gy/h outside; these were at different locations. Gamma dose rate measurements were also taken along the pipeline (Table 45). The maximum gamma dose rate measured along the pipeline was 0.24 micro Gy/h.

The dose rate measurements compare to the mean of the four background measurements taken over terrestrial substrates of 0.073 micro Gy/h, and to the mean of the three background measurements taken over intertidal substrates of 0.080 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 in Annexes 1 and 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 on the basis of the

information in Annex 1, the most extensive combinations of pathways for adult dose assessment are shown in Annex 3.

## **8. CONCLUSIONS AND RECOMMENDATIONS**

### **8.1 Survey findings**

Exposure pathways were investigated for 364 individuals. The survey considered pathways relating to four potential sources of exposure:

- Discharges of liquid radioactive waste to the Solway Firth
- Discharges of gaseous radioactive waste to the atmosphere
- External radiation emitted directly from the site
- External radiation emitted from the liquid effluent pipeline

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

- 31 kg/y for fish
- 19 kg/y for wildfowl

The main aquatic fish species consumed was salmon and sea trout, and the main wildfowl species were duck and goose.

No consumption of crustaceans, molluscs or marine plants was found.

The critical group mean occupancy times over intertidal areas were:

- 950 h/y for mud
- 450 h/y for salt marsh
- 430 h/y for sand

Both fishing gear and sediment handling times were recorded; the critical group mean rates were 390 h/y and 610 h/y respectively.

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

- 20 kg/y for green vegetables
- 11 kg/y for other vegetables
- 54 kg/y for root vegetables
- 110 kg/y for potatoes
- 27 kg/y for domestic fruit
- 270 l/y for milk
- 40 kg/y for cattle meat
- 34 kg/y for pig meat
- 8.9 kg/y for sheep meat
- 19 kg/y for poultry
- 19 kg/y for eggs
- 1.5 kg/y for wild/free foods
- 5.9 kg/y for rabbits and hares
- 10 kg/y for honey
- 1.4 kg/y for wild fungi
- 7.0 kg/y for venison

The main terrestrial foods consumed were all three vegetable groups, potatoes, domestic fruit, milk, cattle meat, sheep meat and eggs. The percentage contribution each terrestrial food type made to its food group for adults is shown in Table 39.

Occupancy times of members of the public within approximately 1km of the site were recorded. The highest occupancy time (indoor plus outdoor) was 8500 h/y.

## 8.2 Comparisons with previous surveys

The rate for fish has increased and the rates for crustaceans and molluscs have decreased, when compared to the adult critical group mean consumption rates obtained from the 2000 survey. In 2000, these were 20 kg/y of fish, 12 kg/y of crustaceans and 3.0 kg/y of molluscs, compared to this survey's consumption rates of 31 kg/y for fish and nil for crustaceans and molluscs. The adult critical group mean consumption rate for wildfowl in 2000 was 11 kg/y compared with 19 kg/y for 2005; in the 2000 report wildfowl was reported under the poultry food group.

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 a critical group mean intertidal occupancy over sand and mud of 1000 h/y (790 h/y using the current methodology). In this report the two substrates have been considered separately and occupancy rates of 950 and 430 h/y were identified for mud and sand respectively. The 2000 survey identified a critical group mean over salt marsh of 500 h/y (283 h/y using the current methodology) compared to 450 h/y in 2005.

The 2000 survey critical group mean fishing gear handling time was 1100 h/y (920 h/y using the current methodology), compared to this survey's rate of 390 h/y and the 2000 survey critical group mean sediment handling time was 11 h/y (8 h/y using the current methodology), compared to this survey's rate of 610 h/y. In 2000, the critical group for gear handling consisted of a shrimp fisherman and three stake netsmen; the shrimp fisherman is no longer working; also, in 2000, it was assumed that all the stake netsmen's time spent checking their nets would give rise to net handling, however, by observation, this isn't the case and therefore in 2005 the net handling rates have reduced. This report has given the stake netsmen sediment handling time for the entire time they're checking their nets, which wasn't the case in 2000, therefore these rates have increased for 2005.

For terrestrial food groups, the adult critical group consumption rates (kg/y) in the 2005 survey are tabulated below, together with those of the 2000 survey for ease of comparison:

	2000	2005
• Green vegetables	51	20
• Other vegetables	68	11
• Root vegetables	55	54
• Potatoes	110	110
• Domestic fruit	20	30
• Milk	251	270
• Cattle meat	62	40
• Pig meat	76	34
• Sheep meat	66	8.9
• Poultry/Wildfowl*	42/11	23/19
• Eggs	40	19
• Wild/free foods	3.8	1.5
• Rabbits/hares	8.3	5.9
• Honey	9.4	10
• Wild fungi	3.0	1.4
• Venison	11	7.0
• Freshwater fish	30	Nil

\* In the 2000 survey wildfowl was included in the poultry (E.g. pheasant, pigeon etc.) group. Wildfowl now has its own separate group. The adult critical group mean consumption rate for wildfowl in 2000 was 11 kg/y compared with 19 kg/y for 2005 and was 42 kg/y for poultry in 2000 compared with 23 kg/y in 2005.

Consumption rates had increased in the following food groups: domestic fruit, milk and honey. Consumption rates had decreased in the following food groups: green vegetables, other

vegetables, root vegetables, cattle meat, pig meat, sheep meat, poultry, eggs, wild/free foods, rabbits/hares, wild fungi, venison and freshwater fish.

No food groups showed significant increases in consumption rates since 2000. The most significant decreases in consumption rates were noted for green vegetables, other vegetables, pig meat, sheep meat, poultry, eggs and freshwater fish.

In common with the 2000 direct radiation survey, this survey identified several individuals living in the Chapelcross area who spent significant times within approximately 1km of the site and several individuals that spent time in close proximity to the Chapelcross pipeline.

### **8.3 Recommendations for environmental monitoring**

One important objective of habits surveys is to recommend any changes needed to the environmental monitoring programme.

The 2005 aquatic monitoring programme as carried out on behalf of SEPA (EA, EHS, FSA and SEPA, 2006) comprised sampling of sediments, seawater, seaweed and various seafoods (flounder, lemon sole, plaice, salmon, sea trout, shrimps, cockles, mussels and winkles).

Milk, grass, soil and various local produce and wild foods were sampled for terrestrial pathways.

Gamma dose rate measurements were taken at Southernness, Glencaple Harbour, Priestsie Bank, Powfoot Merse, pipeline, Redkirk, Battlehill, Dornockbrow and Browhouses.

Beta dose rate measurements were taken over the saltmarsh at Powfoot, over the stake nets near the pipeline's outfall and also 500 metres north, south, east and west of the pipeline.

Air sampling was performed at Eastriggs, Kirtlebridge and Brydekirk.

SEPA's current monitoring programme provides adequate coverage for the aquatic and terrestrial environment. However, in view of the report's findings it is recommended that the following could be considered for adding to the programme:

- An annual wildfowl sample (Mallard duck) should be included. This could be obtained from one of the many Solway wildfowling associations.

## **9. ACKNOWLEDGEMENTS**

Gratitude is expressed to representatives of local authorities and associations and members of the public who offered helpful advice and information during the survey. This survey was undertaken on behalf of the Scottish Environment Protection Agency.

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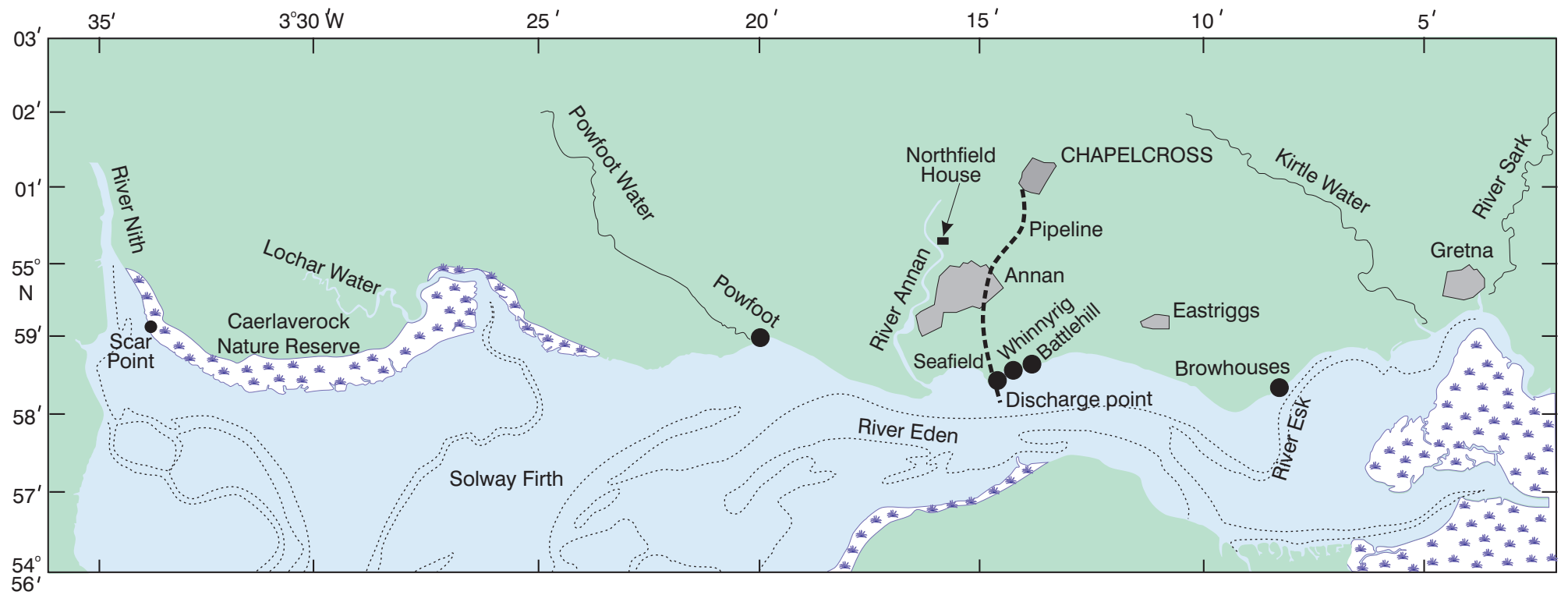


Figure 1. The Chapelcross aquatic survey area and locations.



Figure 2. The Chapelcross terrestrial (outer ring) and direct radiation (inner ring) survey areas.

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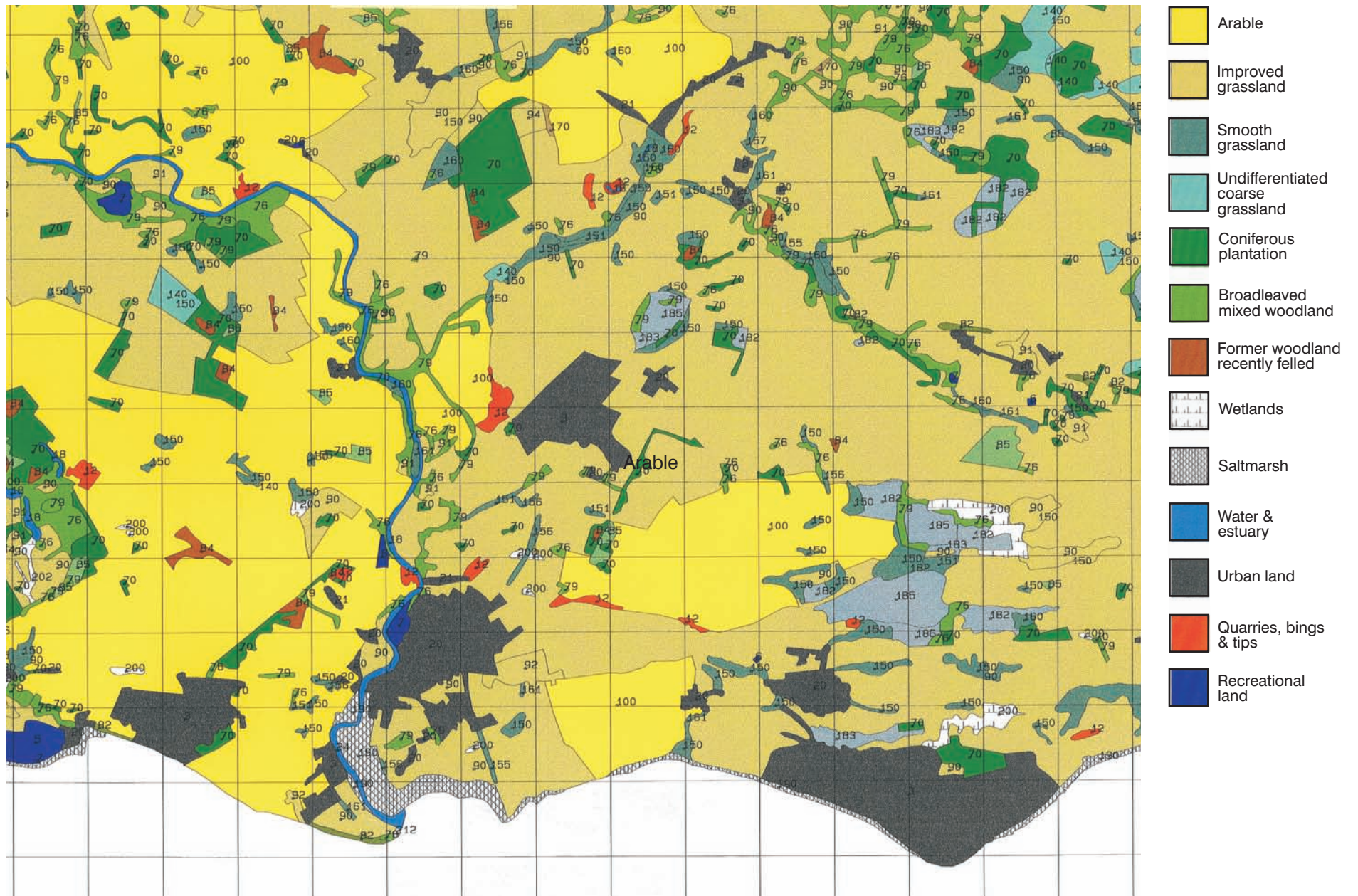


Figure 3. Land cover around Chapelcross.  
 Reproduced with the permission of The Macaulay Institute for Soil Research, Aberdeen.

Base scale is 1:500000.

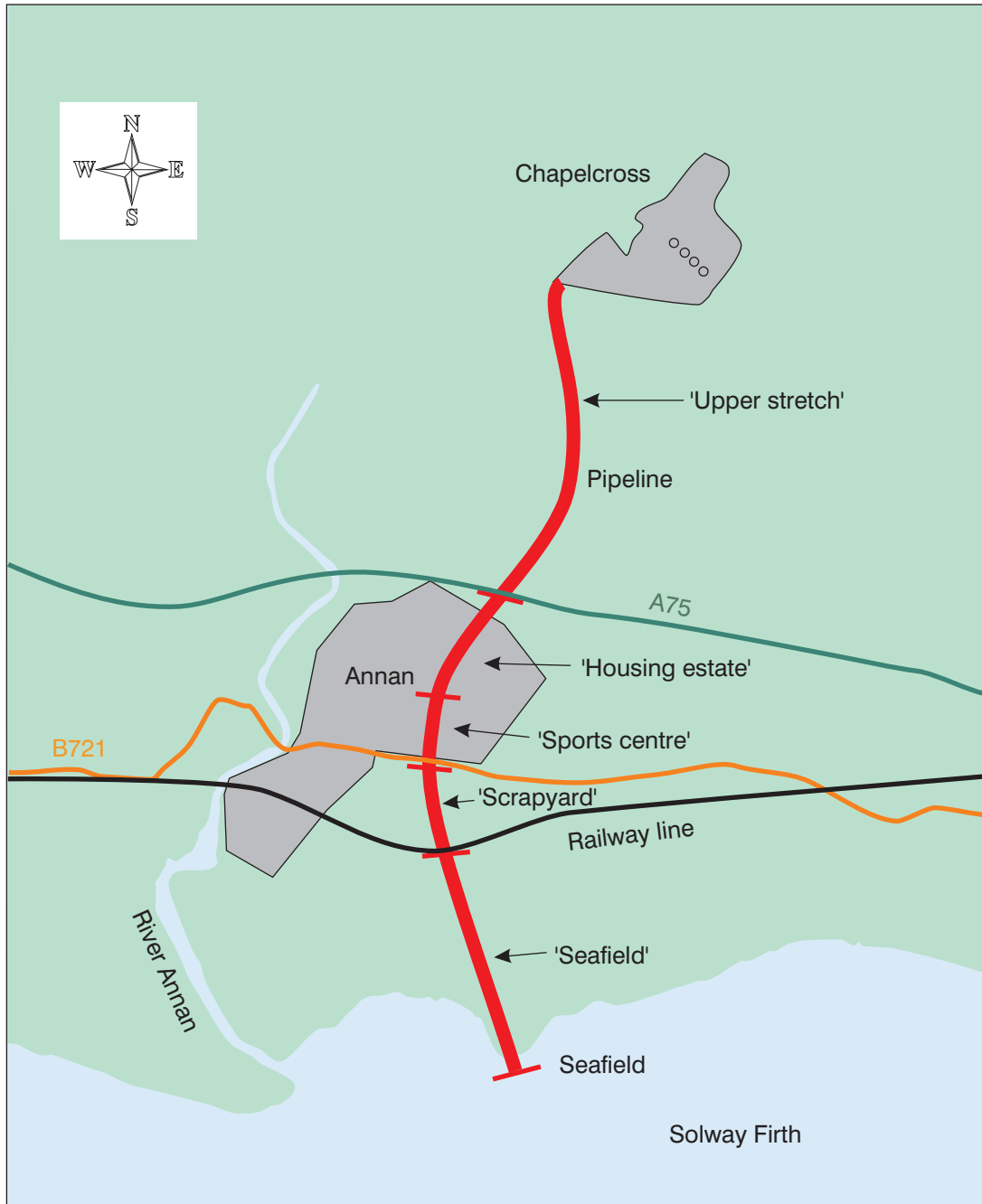


Figure 4. The Chapelcross pipeline survey areas.

**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, kohlrabi, 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, <i>Nephrops</i> , 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. Adult consumption rates of fish in the Chapelcross area (kg/y)**

Observation number	Bass	Brown trout	Flounder	Salmon	Sea trout	Total
<b>36</b>			<b>2.6</b>	<b>29.3</b>	<b>16.0</b>	<b>47.9</b>
<b>49</b>				<b>21.6</b>	<b>1.4</b>	<b>23.0</b>
<b>50</b>				<b>21.6</b>		<b>21.6</b>
139				7.4	6.9	14.3
277-279				13.1		13.1
41			0.7	7.3	4.0	12.0
51-52				9.3	0.5	9.8
242-243			1.8	4.6	2.3	8.8
171-172				8.3		8.3
190-191				8.2		8.2
13-14	1.3			6.5		7.8
44				7.3		7.3
345-346				7.0		7.0
64-65				6.9		6.9
348-351				6.5		6.5
270-271				6.5		6.5
3-4				4.9	0.9	5.8
267-269				5.2		5.2
55-56				4.6	0.5	5.0
213-216				4.9		4.9
353-354		1.2		1.3	2.3	4.8
140-142				4.2		4.2
183				4.2		4.2
18	1.1			2.9		3.9
256-260				3.1	0.8	3.9
42				2.3	1.3	3.5
1-2				3.3		3.3
57					3.1	3.1
17				2.9		2.9
19				2.9		2.9
20				2.9		2.9
34-35				1.6	0.9	2.6
262-266				1.7	0.8	2.6
228-231				1.5	0.9	2.4
45				1.5	0.8	2.4
47-48				1.5	0.8	2.4
53				2.3		2.3
60-61				2.3		2.3
143-144				2.2		2.2
21-24				2.0		2.0
232-233				1.6		1.6
152-153				0.9		0.9
209-212				0.8		0.8
352			0.7			0.7
291-292				0.7		0.7
148-151					0.5	0.5

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of fish based on the 3 highest adult consumers is 30.8 kg/y

The observed 97.5 percentile rate based on 97 observations is 18.7 kg/y

**Table 3. Adult consumption rates of wildfowl in the Chapelcross area (kg/y)**

Observation number	Duck	Goose	Mallard	Teal	Wigeon	Total
<b>184-189</b>	<b>22.5</b>					<b>22.5</b>
<b>353</b>		<b>15.4</b>	<b>2.1</b>	<b>0.6</b>	<b>2.9</b>	<b>21.1</b>
<b>190-191</b>	<b>13.5</b>	<b>4.4</b>				<b>17.9</b>
<b>326-327</b>		<b>7.3</b>	<b>7.5</b>	<b>2.7</b>		<b>17.5</b>
<b>183</b>	<b>17.0</b>					<b>17.0</b>
<b>203-204</b>	<b>6.8</b>	<b>1.1</b>				<b>7.9</b>
340-342		6.6				6.6
220	2.7	3.3				6.0
227	2.7	3.3				6.0
291-292			1.6	0.2	0.2	1.9

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of wildfowl based on the 14 highest adult consumers is 18.5 kg/y

The observed 97.5 percentile rate based on 21 observations is 22.5 kg/y

**Table 4. Children's consumption rates of fish in the Chapelcross area (kg/y)**

**15 year old age group**

Observation number	Age	Bass	Brown trout	Salmon	Sea trout	Total
<b>192</b>	<b>12</b>			<b>8.2</b>		<b>8.2</b>
<b>15</b>	<b>15</b>	<b>1.3</b>		<b>6.5</b>		<b>7.8</b>
<b>272</b>	<b>16</b>			<b>6.5</b>		<b>6.5</b>
<b>273</b>	<b>14</b>			<b>6.5</b>		<b>6.5</b>
<b>355</b>	<b>14</b>		<b>1.2</b>	<b>1.3</b>	<b>2.3</b>	<b>4.8</b>
<b>261</b>	<b>15</b>			<b>3.1</b>	<b>0.8</b>	<b>3.9</b>
<b>58</b>	<b>14</b>				<b>3.1</b>	<b>3.1</b>
145	16			2.2		2.2
146	12			2.2		2.2

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of fish based on the 7 highest 15 year old consumers is 5.8 kg/y

The observed 97.5 percentile rate based on 9 observations is 8.1 kg/y

**10 year old age group**

Observation number	Age	Bass	Brown trout	Salmon	Sea trout	Total
<b>193-194</b>	<b>10</b>			<b>8.2</b>		<b>8.2</b>
<b>356</b>	<b>11</b>		<b>1.2</b>	<b>1.3</b>	<b>2.3</b>	<b>4.8</b>
<b>347</b>	<b>10</b>			<b>3.5</b>		<b>3.5</b>
<b>59</b>	<b>9</b>				<b>3.1</b>	<b>3.1</b>
147	7			2.2		2.2
154	10			0.9		0.9

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of fish based on the 5 highest 10 year old consumers is 5.6 kg/y

The observed 97.5 percentile rate based on 7 observations is 8.2 kg/y

**5 year old age group**

Observation number	Age	Bass	Brown trout	Salmon	Sea trout	Total
<b>155</b>	<b>6</b>			<b>0.5</b>		<b>0.5</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of fish based on the only 5 year old consumer is 0.5 kg/y

The observed 97.5 percentile rate is not applicable for 1 observation

**Table 5. Children's consumption rates of wildfowl in the Chapelcross area (kg/y)**

**15 year old age group**

Observation number	Age	Duck	Goose	Mallard	Teal	Wigeon	Total
<b>192</b>	<b>12</b>	<b>13.5</b>	<b>4.4</b>				<b>17.9</b>
<b>328</b>	<b>15</b>		<b>7.3</b>	<b>7.5</b>	<b>2.7</b>		<b>17.5</b>
<b>355</b>	<b>14</b>		<b>11.6</b>	<b>2.1</b>	<b>0.6</b>	<b>2.9</b>	<b>17.2</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of wildfowl based on the 3 highest 15 year old consumers is 17.5 kg/y

The observed 97.5 percentile rate based on 3 observations is 17.9 kg/y

**10 year old age group**

Observation number	Age	Duck	Goose	Mallard	Teal	Wigeon	Total
<b>193-194</b>	<b>10</b>	<b>13.5</b>	<b>4.4</b>				<b>17.9</b>
<b>356</b>	<b>11</b>		<b>7.7</b>	<b>2.1</b>	<b>0.6</b>	<b>2.9</b>	<b>13.4</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of wildfowl based on the 3 highest 10 year old consumers is 16.4 kg/y

The observed 97.5 percentile rate based on 3 observations is 17.9 kg/y

**Table 6. Summary of adult consumption rates in the Chapelcross area (kg/y or l/y)**

Food group	Number of observations	No. higher rate consumers	Observed maximum critical consumption rate	Observed minimum critical 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	97	3	47.9	21.6	30.8	18.7	15.0	40.0
Crustaceans	NC	NC	NC	NC	NC	NC	3.5	10.0
Molluscs	NC	NC	NC	NC	NC	NC	3.5	10.0
Wildfowl	21	14	22.5	7.9	18.5	22.5	ND	ND
Green vegetables	29	21	27.3	10.0	19.9	27.3	15.0	45.0
Other vegetables	31	15	18.1	6.2	11.4	18.1	20.0	50.0
Root vegetables	28	3	78.8	40.8	53.5	53.2	10.0	40.0
Potato	40	13	160.0	54.4	107.9	160.0	50.0	120.0
Domestic fruit	30	5	38.5	17.6	27.1	38.5	20.0	75.0
Milk	34	29	365.0	136.9	272.1	365.0	95.0	240.0
Cattle meat	23	13	63.1	23.7	40.4	63.1	15.0	45.0
Pig meat	3	3	33.7	33.7	33.7	33.7	15.0	40.0
Sheep meat	22	18	13.5	5.7	8.9	13.5	8.0	25.0
Poultry	8	3	23.0	11.7	19.2	23.0	10.0	30.0
Eggs	36	21	35.6	11.9	19.0	29.4	8.5	25.0
Wild/free foods	4	2	1.5	1.5	1.5	1.5	7.0	25.0
Rabbits/hares	3	3	7.5	2.7	5.9	7.5	6.0	15.0
Honey	9	5	11.8	5.4	10.2	11.8	2.5	9.5
Wild fungi	7	5	1.7	1.0	1.4	1.7	3.0	10.0
Venison	1	1	7.0	7.0	7.0	NA	ND	ND

ND = not determined

NC = not consumed

NA = not applicable

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

Food group	Number of observations	No. higher rate consumers	Observed maximum critical consumption rate	Observed minimum critical 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	9	7	8.2	3.1	5.8	8.1	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
Wildfowl	3	3	17.9	17.2	17.5	17.9	ND	ND
Green vegetables	1	1	14.9	14.9	14.9	NA	9.0	25.0
Other vegetables	1	1	0.9	0.9	0.9	NA	10.0	30.0
Root vegetables	2	2	2.5	1.8	2.1	2.5	7.5	20.0
Potato	3	2	25.0	25.0	25.0	25.0	60.0	130.0
Domestic fruit	3	2	5.4	5.4	5.4	5.4	15.0	50.0
Milk	4	4	365.0	219.0	292.0	365.0	110.0	260.0
Cattle meat	6	6	23.7	15.8	19.2	23.7	15.0	35.0
Pig meat	NC	NC	NC	NC	NC	NC	10.0	30.0
Sheep meat	6	3	7.5	2.8	4.4	6.9	5.5	15.0
Poultry	1	1	23.0	23.0	23.0	NA	6.5	20.0
Eggs	10	6	28.5	10.9	16.4	25.7	7.0	25.0
Wild/free foods	NC	NC	NC	NC	NC	NC	3.0	13.0
Rabbits/hares	1	1	7.5	7.5	7.5	NA	ND	ND
Honey	NC	NC	NC	NC	NC	NC	2.0	5.0
Wild fungi	1	1	1.7	1.7	1.7	NA	2.0	5.5
Venison	NC	NC	NC	NC	NC	NC	ND	ND

ND = not determined

NC = not consumed

NA = not applicable

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

Food group	Number of observations	No. higher rate consumers	Observed maximum critical consumption rate	Observed minimum critical 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	7	5	8.2	3.1	5.6	8.2	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
Wildfowl	3	3	17.9	13.4	16.4	17.9	ND	ND
Green vegetables	2	2	4.7	4.7	4.7	4.7	6.0	20.0
Other vegetables	2	2	2.3	2.3	2.3	2.3	8.0	25.0
Root vegetables	3	2	12.7	12.7	12.7	12.7	6.0	20.0
Potato	2	2	20.5	20.5	20.5	20.5	45.0	85.0
Domestic fruit	3	3	8.4	5.4	7.4	8.4	15.0	50.0
Milk	3	3	365.0	219.0	285.9	360.4	110.0	240.0
Cattle meat	1	1	7.9	7.9	7.9	NA	15.0	30.0
Pig meat	NC	NC	NC	NC	NC	NC	8.5	25.0
Sheep meat	1	1	1.9	1.9	1.9	NA	4.0	10.0
Poultry	NC	NC	NC	NC	NC	NC	5.5	15.0
Eggs	4	3	15.7	10.9	13.6	15.6	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	2	2	1.7	1.6	1.6	1.7	1.5	4.5
Venison	NC	NC	NC	NC	NC	NC	ND	ND

ND = not determined

NC = not consumed

NA = not applicable

**Table 9. Summary of 5 year old children's consumption rates in the Chapelcross area (kg/y or l/y)**

Food group	Number of observations	No. higher rate consumers	Observed maximum critical consumption rate	Observed minimum critical 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	1	1	0.5	0.5	0.5	NA	ND	ND
Crustaceans	NC	NC	NC	NC	NC	NC	ND	ND
Molluscs	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	ND	ND
Other vegetables	NC	NC	NC	NC	NC	NC	ND	ND
Root vegetables	NC	NC	NC	NC	NC	NC	ND	ND
Potato	NC	NC	NC	NC	NC	NC	ND	ND
Domestic fruit	NC	NC	NC	NC	NC	NC	ND	ND
Milk	2	2	273.8	91.3	182.5	269.2	ND	ND
Cattle meat	NC	NC	NC	NC	NC	NC	ND	ND
Pig meat	NC	NC	NC	NC	NC	NC	ND	ND
Sheep meat	NC	NC	NC	NC	NC	NC	ND	ND
Poultry	NC	NC	NC	NC	NC	NC	ND	ND
Eggs	2	2	14.2	14.2	14.2	14.2	ND	ND
Wild/free foods	NC	NC	NC	NC	NC	NC	ND	ND
Rabbits/hares	NC	NC	NC	NC	NC	NC	ND	ND
Honey	NC	NC	NC	NC	NC	NC	ND	ND
Wild fungi	NC	NC	NC	NC	NC	NC	ND	ND
Venison	NC	NC	NC	NC	NC	NC	ND	ND

ND = not determined

NC = not consumed

NA = not applicable

**Table 10. Summary of 1 year old children's consumption rates in the Chapelcross area (kg/y or l/y)**

Food group	Number of observations	No. higher rate consumers	Observed maximum critical consumption rate	Observed minimum critical 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	NC	NC	NC	NC	NC	NC	ND	ND
Crustaceans	NC	NC	NC	NC	NC	NC	ND	ND
Molluscs	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	ND	ND
Other vegetables	NC	NC	NC	NC	NC	NC	ND	ND
Root vegetables	NC	NC	NC	NC	NC	NC	ND	ND
Potato	NC	NC	NC	NC	NC	NC	ND	ND
Domestic fruit	NC	NC	NC	NC	NC	NC	ND	ND
Milk	1	1	182.5	182.5	182.5	NA	ND	ND
Cattle meat	NC	NC	NC	NC	NC	NC	ND	ND
Pig meat	NC	NC	NC	NC	NC	NC	ND	ND
Sheep meat	NC	NC	NC	NC	NC	NC	ND	ND
Poultry	NC	NC	NC	NC	NC	NC	ND	ND
Eggs	1	1	3.0	3.0	3.0	NA	ND	ND
Wild/free foods	NC	NC	NC	NC	NC	NC	ND	ND
Rabbits/hares	NC	NC	NC	NC	NC	NC	ND	ND
Honey	NC	NC	NC	NC	NC	NC	ND	ND
Wild fungi	NC	NC	NC	NC	NC	NC	ND	ND
Venison	NC	NC	NC	NC	NC	NC	ND	ND

ND = not determined

NC = not consumed

NA = not applicable

**Table 11. Adult consumption rates of green vegetables in the Chapelcross area (kg/y)**

Observation number	Artichoke	Broccoli	Brussel sprout	Cabbage	Calabrese	Cauliflower	Chard	Courgettes	Cucumber	Herbs	Kale	Lettuce	Marrow	Spinach	Total
<b>228-231</b>			<b>4.6</b>	<b>11.7</b>		<b>6.8</b>			<b>4.3</b>						<b>27.3</b>
<b>291-292</b>				<b>15.3</b>	<b>2.0</b>	<b>2.0</b>		<b>4.6</b>					<b>2.7</b>	<b>0.4</b>	<b>27.1</b>
<b>255</b>		<b>2.4</b>	<b>3.2</b>	<b>3.0</b>		<b>2.4</b>		<b>14.7</b>							<b>25.6</b>
<b>25-28</b>				<b>19.1</b>		<b>3.4</b>									<b>22.5</b>
<b>256-260</b>				<b>9.7</b>			<b>0.6</b>	<b>3.7</b>		<b>0.3</b>		<b>0.6</b>			<b>14.9</b>
<b>357-358</b>				<b>9.1</b>						<b>0.7</b>		<b>4.5</b>			<b>14.3</b>
<b>5-6</b>			<b>4.7</b>	<b>4.1</b>		<b>3.3</b>					<b>0.7</b>				<b>12.8</b>
<b>139</b>												<b>10.0</b>			<b>10.0</b>
64-65								7.4				1.2			8.6
7-10			2.8	1.8											4.7
232-233	2.7														2.7

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of green vegetables based on the 21 highest adult consumers is 19.9 kg/y

The observed 97.5 percentile rate based on 29 observations is 27.3 kg/y

**Table 12. Adult consumption rates of other vegetables in the Chapelcross area (kg/y)**

Observation number	Broad bean	French bean	Pea	Runner bean	Tomato	Total
<b>158-159</b>			<b>9.1</b>	<b>9.1</b>		<b>18.1</b>
<b>55-56</b>					<b>16.2</b>	<b>16.2</b>
<b>139</b>				<b>13.6</b>		<b>13.6</b>
<b>5-6</b>			<b>10.8</b>			<b>10.8</b>
<b>64-65</b>			<b>2.2</b>		<b>8.6</b>	<b>10.8</b>
<b>291-292</b>		<b>0.7</b>	<b>1.1</b>	<b>6.1</b>	<b>2.3</b>	<b>10.2</b>
<b>228-231</b>			<b>1.7</b>		<b>4.5</b>	<b>6.2</b>
90-91					3.6	3.6
25-28				3.6		3.6
255	2.8					2.8
7-10			2.3			2.3
256-260			0.9			0.9

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of other vegetables based on the 15 highest adult consumers is 11.4 kg/y

The observed 97.5 percentile rate based on 31 observations is 18.1 kg/y

**Table 13. Adult consumption rates of root vegetables in the Chapelcross area (kg/y)**

Observation number	Beetroot	Carrot	Garlic	Leek	Onion	Parsnip	Shallot	Spring onion	Swede	Turnip	Total
<b>255</b>		<b>13.5</b>	<b>2.3</b>	<b>10.0</b>	<b>27.0</b>		<b>2.3</b>		<b>23.8</b>		<b>78.8</b>
<b>158-159</b>	<b>11.3</b>	<b>11.3</b>		<b>6.8</b>	<b>11.3</b>						<b>40.8</b>
291-292	1.1	4.1		6.0	4.3	0.8	1.0	0.1	3.4		20.8
228-231	5.6	5.6		2.5			3.8				17.5
7-10	6.2	3.4		2.3	0.9						12.7
64-65		6.5				3.5					9.9
5-6	2.4			2.6							5.0
90-91					4.3						4.3
293-294										2.5	2.5
256-260		0.5		0.9				0.4			1.8
357-358		0.7									0.7

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of root vegetables based on the 3 highest adult consumers is 53.5 kg/y

The observed 97.5 percentile rate based on 28 observations is 53.2 kg/y

**Table 14. Adult consumption rates of potato in the Chapelcross area (kg/y)**

Observation number	Potato
<b>262-266</b>	<b>160.0</b>
<b>228-231</b>	<b>82.6</b>
<b>158-159</b>	<b>82.1</b>
<b>280-281</b>	<b>54.4</b>
90-91	51.2
255	45.0
5-6	44.7
270-271	25.0
139	22.7
7-10	20.5
357-358	20.5
291-292	16.4
64-65	13.1
25-28	12.3
256-260	3.6

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of potato based on the 13 highest adult consumers is 107.9 kg/y

The observed 97.5 percentile rate based on 40 observations is 160.0 kg/y

**Table 15. Adult consumption rates of domestic fruit in the Chapelcross area (kg/y)**

Observation number	Apple	Blackberry	Blackcurrant	Blueberry	Damson	Gooseberry	Pear	Plum	Pumpkin	Raspberry	Redcurrants	Rhubarb	Strawberry	Whitecurrant	Total
<b>232-233</b>	<b>10.0</b>		<b>10.0</b>		<b>10.0</b>	<b>2.5</b>					<b>1.0</b>			<b>5.0</b>	<b>38.5</b>
<b>255</b>	<b>2.3</b>	<b>2.3</b>	<b>2.3</b>	<b>1.1</b>			<b>1.1</b>	<b>0.7</b>	<b>4.4</b>	<b>6.8</b>	<b>1.1</b>	<b>1.1</b>			<b>23.2</b>
<b>5-6</b>										<b>3.0</b>		<b>3.7</b>	<b>10.9</b>		<b>17.6</b>
7-10			3.0							0.6		2.3	2.5		8.4
64-65	1.8									1.5		3.7	0.7		7.7
291-292			5.7												5.7
143-144	5.4														5.4
156-157			2.3					2.3							4.5
228-231			2.8										0.6		3.4
256-260												1.4			1.4
125-126												0.9			0.9
357										0.2			0.2		0.5
358										0.2			0.2		0.5

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of domestic fruit based on the 5 highest adult consumers is 27.1 kg/y

The observed 97.5 percentile rate based on 30 observations is 38.5 kg/y

**Table 16. Adult consumption rates of milk in the Chapelcross area (l/y)**

Observation number	Milk
<b>128-131</b>	<b>365.0</b>
<b>274-276</b>	<b>365.0</b>
<b>286-287</b>	<b>365.0</b>
<b>161-164</b>	<b>285.2</b>
<b>282-285</b>	<b>284.2</b>
<b>125-126</b>	<b>273.8</b>
<b>143-144</b>	<b>219.0</b>
<b>123-124</b>	<b>206.9</b>
<b>280-281</b>	<b>190.4</b>
<b>165-168</b>	<b>136.9</b>
160	103.7
148-151	91.3

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of milk based on the 29 highest adult consumers is 272.1 l/y

The observed 97.5 percentile rate based on 34 observations is 365.0 l/y

**Table 17. Adult consumption rates of cattle meat in the Chapelcross area (kg/y)**

Observation number	Beef
<b>277-279</b>	<b>63.1</b>
<b>232-233</b>	<b>50.0</b>
<b>133-138</b>	<b>31.5</b>
<b>270-271</b>	<b>23.7</b>
13-14	20.8
314-321	15.8

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of cattle meat based on the 13 highest adult consumers is 40.4 kg/y

The observed 97.5 percentile rate based on 23 observations is 63.1 kg/y

**Table 18. Adult consumption rates of pig meat in the Chapelcross area (kg/y)**

Observation number	Pork
<b>277</b>	<b>33.7</b>
<b>278</b>	<b>33.7</b>
<b>279</b>	<b>33.7</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of pig meat based on the 3 highest adult consumers is 33.7 kg/y

The observed 97.5 percentile rate based on 3 observations is 33.7 kg/y

**Table 19. Adult consumption rates of sheep meat in the Chapelcross area (kg/y)**

Observation number	Lamb
<b>139-142</b>	<b>13.5</b>
<b>232-233</b>	<b>11.3</b>
<b>13-14</b>	<b>7.5</b>
<b>203-208</b>	<b>7.5</b>
<b>161-164</b>	<b>5.7</b>
270-271	2.8
66-67	1.9

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of sheep meat based on the 18 highest adult consumers is 8.9 kg/y

The observed 97.5 percentile rate based on 22 observations is 13.5 kg/y

**Table 20. Adult consumption rates of poultry in the Chapelcross area (kg/y)**

Observation number	Chicken	Duck	Partridge	Pheasant	Pigeon	Total
<b>326-327</b>			<b>11.7</b>	<b>7.5</b>	<b>3.8</b>	<b>23.0</b>
<b>364</b>		<b>2.3</b>	<b>3.5</b>	<b>5.4</b>	<b>0.6</b>	<b>11.7</b>
232-233	4.5					4.5
297				3.6		3.6
291-292				1.4		1.4

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of poultry based on the 3 highest adult consumers is 19.2 kg/y

The observed 97.5 percentile rate based on 8 observations is 23.0 kg/y

**Table 21. Adult consumption rates of eggs in the Chapelcross area (kg/y)**

Observation number	Chicken egg	Duck egg	Total
<b>92</b>	<b>35.6</b>		<b>35.6</b>
<b>326-327</b>	<b>28.5</b>		<b>28.5</b>
<b>291-292</b>	<b>22.8</b>		<b>22.8</b>
<b>277-279</b>	<b>19.0</b>		<b>19.0</b>
<b>156-157</b>	<b>17.8</b>		<b>17.8</b>
<b>232-233</b>	<b>17.8</b>		<b>17.8</b>
<b>270-271</b>		<b>16.1</b>	<b>16.1</b>
<b>331</b>	<b>16.0</b>		<b>16.0</b>
<b>293-294</b>	<b>15.7</b>		<b>15.7</b>
<b>246-247</b>	<b>14.2</b>		<b>14.2</b>
<b>329-330</b>	<b>11.9</b>		<b>11.9</b>
286-287	10.9		10.9
314-321	8.0		8.0
256-260	1.8		1.8

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of eggs based on the 21 highest adult consumers is 19.0 kg/y

The observed 97.5 percentile rate based on 36 observations is 29.4 kg/y

**Table 22. Adult consumption rates of wild/free foods in the Chapelcross area (kg/y)**

Observation number	Blackberry
<b>232-233</b>	<b>1.5</b>
291-292	0.2

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of wild/free foods based on the 2 highest adult consumers is 1.5 kg/y

The observed 97.5 percentile rate based on 4 observations is 1.5 kg/y

**Table 23. Adult consumption rates of rabbits/hares in the Chapelcross area (kg/y)**

Observation number	Rabbit
<b>326-327</b>	<b>7.5</b>
<b>364</b>	<b>2.7</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of rabbits/hares based on the 3 highest adult consumers is 5.9 kg/y

The observed 97.5 percentile rate based on 3 observations is 7.5 kg/y

**Table 24. Adult consumption rates of honey in the Chapelcross area (kg/y)**

Observation number	Honey
<b>242-245</b>	<b>11.8</b>
<b>344</b>	<b>5.4</b>
228-231	1.1

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of honey based on the 5 highest adult consumers is 10.2 kg/y

The observed 97.5 percentile rate based on 9 observations is 11.8 kg/y

**Table 25. Adult consumption rates of wild fungi in the Chapelcross area (kg/y)**

Observation number	Mushrooms
<b>353-354</b>	<b>1.7</b>
<b>201</b>	<b>1.6</b>
<b>232-233</b>	<b>1.0</b>
125-126	0.2

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of wild fungi based on the 5 highest adult consumers is 1.4 kg/y

The observed 97.5 percentile rate based on 7 observations is 1.7 kg/y

**Table 26. Adult consumption rates of venison in the Chapelcross area (kg/y)**

Observation number	Venison
<b>364</b>	<b>7.0</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of venison based on the only adult consumer is 7.0 kg/y

The observed 97.5 percentile rate is not applicable for 1 observation

**Table 27. Children's consumption rates of green vegetables in the Chapelcross area (kg/y)**

**15 year old age group**

Observation number	Age	Brussel sprout	Cabbage	Chard	Courgettes	Herbs	Lettuce	Total
<b>261</b>	<b>15</b>		<b>9.7</b>	<b>0.6</b>	<b>3.7</b>	<b>0.3</b>	<b>0.6</b>	<b>14.9</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of green vegetables based on the only 15 year old consumer is 14.9 kg/y

The observed 97.5 percentile rate is not applicable for 1 observation

**10 year old age group**

Observation number	Age	Brussel sprout	Cabbage	Chard	Courgettes	Herbs	Lettuce	Total
<b>11</b>	<b>11</b>	<b>2.8</b>	<b>1.8</b>					<b>4.7</b>
<b>12</b>	<b>9</b>	<b>2.8</b>	<b>1.8</b>					<b>4.7</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of green vegetables based on the 2 highest 10 year old consumers is 4.7 kg/y

The observed 97.5 percentile rate based on 2 observations is 4.7 kg/y

**Table 28. Children's consumption rates of other vegetables in the Chapelcross area (kg/y)**

**15 year old age group**

Observation number	Age	Pea
<b>261</b>	<b>15</b>	<b>0.9</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of other vegetables based on the only 15 year old consumer is 0.9 kg/y

The observed 97.5 percentile rate is not applicable for 1 observation

**10 year old age group**

Observation number	Age	Pea
<b>11</b>	<b>11</b>	<b>2.3</b>
<b>12</b>	<b>9</b>	<b>2.3</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of other vegetables based on the 2 highest 10 year old consumers is 2.3 kg/y

The observed 97.5 percentile rate based on 2 observations is 2.3 kg/y

**Table 29. Children's consumption rates of root vegetables in the Chapelcross area (kg/y)**

**15 year old age group**

Observation number	Age	Beetroot	Carrot	Leek	Onion	Spring onion	Turnip	Total
<b>295</b>	<b>15</b>						<b>2.5</b>	<b>2.5</b>
<b>261</b>	<b>15</b>		<b>0.5</b>	<b>0.9</b>		<b>0.4</b>		<b>1.8</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of root vegetables based on the 2 highest 15 year old consumers is 2.1 kg/y

The observed 97.5 percentile rate based on 2 observations is 2.5 kg/y

**10 year old age group**

Observation number	Age	Beetroot	Carrot	Leek	Onion	Spring onion	Turnip	Total
<b>11</b>	<b>11</b>	<b>6.2</b>	<b>3.4</b>	<b>2.3</b>	<b>0.9</b>			<b>12.7</b>
<b>12</b>	<b>9</b>	<b>6.2</b>	<b>3.4</b>	<b>2.3</b>	<b>0.9</b>			<b>12.7</b>
296	11						2.5	2.5

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of root vegetables based on the 2 highest 10 year old consumers is 12.7 kg/y

The observed 97.5 percentile rate based on 3 observations is 12.7 kg/y

**Table 30. Children's consumption rates of potato in the Chapelcross area (kg/y)**

**15 year old age group**

Observation number	Age	Potato
<b>272</b>	<b>16</b>	<b>25.0</b>
<b>273</b>	<b>14</b>	<b>25.0</b>
261	15	3.6

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of potato based on the 2 highest 15 year old consumers is 25.0 kg/y

The observed 97.5 percentile rate based on 3 observations is 25.0 kg/y

**10 year old age group**

Observation number	Age	Potato
<b>11</b>	<b>11</b>	<b>20.5</b>
<b>12</b>	<b>9</b>	<b>20.5</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of potato based on the 2 highest 10 year old consumers is 20.5 kg/y

The observed 97.5 percentile rate based on 2 observations is 20.5 kg/y

**Table 31. Children's consumption rates of domestic fruit in the Chapelcross area (kg/y)**

**15 year old age group**

Observation number	Age	Apple	Blackcurrant	Raspberry	Rhubarb	Strawberry	Total
<b>145</b>	<b>16</b>	<b>5.4</b>					<b>5.4</b>
<b>146</b>	<b>12</b>	<b>5.4</b>					<b>5.4</b>
261	15				1.4		1.4

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of domestic fruit based on the 2 highest 15 year old consumers is 5.4 kg/y

The observed 97.5 percentile rate based on 3 observations is 5.4 kg/y

**10 year old age group**

Observation number	Age	Apple	Blackcurrant	Raspberry	Rhubarb	Strawberry	Total
<b>11</b>	<b>11</b>		<b>3.0</b>	<b>0.6</b>	<b>2.3</b>	<b>2.5</b>	<b>8.4</b>
<b>12</b>	<b>9</b>		<b>3.0</b>	<b>0.6</b>	<b>2.3</b>	<b>2.5</b>	<b>8.4</b>
<b>147</b>	<b>7</b>	<b>5.4</b>					<b>5.4</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of domestic fruit based on the 3 highest 10 year old consumers is 7.4 kg/y

The observed 97.5 percentile rate based on 3 observations is 8.4 kg/y

**Table 32. Children's consumption rates of milk in the Chapelcross area (l/y)**

**15 year old age group**

Observation number	Age	Milk
<b>288</b>	<b>14</b>	<b>365.0</b>
<b>289</b>	<b>12</b>	<b>365.0</b>
<b>145</b>	<b>16</b>	<b>219.0</b>
<b>146</b>	<b>12</b>	<b>219.0</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of milk based on the 4 highest 15 year old consumers is 292.0 l/y

The observed 97.5 percentile rate based on 4 observations is 365.0 l/y

**10 year old age group**

Observation number	Age	Milk
<b>290</b>	<b>8</b>	<b>365.0</b>
<b>169</b>	<b>9</b>	<b>273.8</b>
<b>147</b>	<b>7</b>	<b>219.0</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of milk based on the 3 highest 10 year old consumers is 285.9 l/y

The observed 97.5 percentile rate based on 3 observations is 360.4 l/y

**5 year old age group**

Observation number	Age	Milk
<b>170</b>	<b>4</b>	<b>273.8</b>
<b>132</b>	<b>2</b>	<b>91.3</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of milk based on the 2 highest 5 year old consumers is 182.5 l/y

The observed 97.5 percentile rate based on 2 observations is 269.2 l/y

**1 year old age group**

Observation number	Age	Milk
<b>127</b>	<b>1</b>	<b>182.5</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of milk based on the only 1 year old consumer is 182.5 l/y

The observed 97.5 percentile rate is not applicable for 1 observation

**Table 33. Children's consumption rates of cattle meat in the Chapelcross area (kg/y)**

**15 year old age group**

Observation number	Age	Beef
<b>272</b>	<b>16</b>	<b>23.7</b>
<b>273</b>	<b>14</b>	<b>23.7</b>
<b>15</b>	<b>15</b>	<b>20.8</b>
<b>322</b>	<b>15</b>	<b>15.8</b>
<b>323</b>	<b>13</b>	<b>15.8</b>
<b>324</b>	<b>12</b>	<b>15.8</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of cattle meat based on the 6 highest 15 year old consumers is 19.2 kg/y

The observed 97.5 percentile rate based on 6 observations is 23.7 kg/y

**10 year old age group**

Observation number	Age	Beef
<b>325</b>	<b>9</b>	<b>7.9</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of cattle meat based on the only 10 year old consumer is 7.9 kg/y

The observed 97.5 percentile rate is not applicable for 1 observation

**Table 34. Children's consumption rates of sheep meat in the Chapelcross area (kg/y)**

**15 year old age group**

Observation number	Age	Lamb
<b>15</b>	<b>15</b>	<b>7.5</b>
<b>272</b>	<b>16</b>	<b>2.8</b>
<b>273</b>	<b>14</b>	<b>2.8</b>
68	16	1.9
69	14	1.9
70	13	1.9

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of sheep meat based on the 3 highest 15 year old consumers is 4.4 kg/y

The observed 97.5 percentile rate based on 6 observations is 6.9 kg/y

**10 year old age group**

Observation number	Age	Lamb
<b>71</b>	<b>11</b>	<b>1.9</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of sheep meat based on the only 10 year old consumer is 1.9 kg/y

The observed 97.5 percentile rate is not applicable for 1 observation

**Table 35. Children's consumption rates of poultry in the Chapelcross area (kg/y)**

**15 year old age group**

Observation number	Age	Partridge	Pheasant	Pigeon	Total
<b>328</b>	<b>15</b>	<b>11.7</b>	<b>7.5</b>	<b>3.8</b>	<b>23.0</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of poultry based on the only 15 year old consumer is 23.0 kg/y

The observed 97.5 percentile rate is not applicable for 1 observation

**Table 36. Children's consumption rates of eggs in the Chapelcross area (kg/y)**

**15 year old age group**

Observation number	Age	Chicken egg	Duck egg	Total
<b>328</b>	<b>15</b>	<b>28.5</b>		<b>28.5</b>
<b>272</b>	<b>16</b>		<b>16.1</b>	<b>16.1</b>
<b>273</b>	<b>14</b>		<b>16.1</b>	<b>16.1</b>
<b>295</b>	<b>15</b>	<b>15.7</b>		<b>15.7</b>
<b>288</b>	<b>14</b>	<b>10.9</b>		<b>10.9</b>
<b>289</b>	<b>12</b>	<b>10.9</b>		<b>10.9</b>
322	15	8.0		8.0
323	13	8.0		8.0
324	12	8.0		8.0
261	15	1.8		1.8

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of eggs based on the 6 highest 15 year old consumers is 16.4 kg/y

The observed 97.5 percentile rate based on 10 observations is 25.7 kg/y

**10 year old age group**

Observation number	Age	Chicken egg	Duck egg	Total
<b>296</b>	<b>11</b>	<b>15.7</b>		<b>15.7</b>
<b>248</b>	<b>8</b>	<b>14.2</b>		<b>14.2</b>
<b>290</b>	<b>8</b>	<b>10.9</b>		<b>10.9</b>
325	9	4.0		4.0

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of eggs based on the 3 highest 10 year old consumers is 13.6 kg/y

The observed 97.5 percentile rate based on 4 observations is 15.6 kg/y

**5 year old age group**

Observation number	Age	Chicken egg	Duck egg	Total
<b>249</b>	<b>6</b>	<b>14.2</b>		<b>14.2</b>
<b>250</b>	<b>6</b>	<b>14.2</b>		<b>14.2</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of eggs based on the 2 highest 5 year old consumers is 14.2 kg/y

The observed 97.5 percentile rate based on 2 observations is 14.2 kg/y

**1 year old age group**

Observation number	Age	Chicken egg	Duck egg	Total
<b>251</b>	<b>1.2</b>	<b>3.0</b>		<b>3.0</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of eggs based on the only 1 year old consumer is 3.0 kg/y

The observed 97.5 percentile rate is not applicable for 1 observation

**Table 37. Children's consumption rate of wild fungi in the Chapelcross area (kg/y)**

**15 year old age group**

Observation number	Age	Mushrooms
<b>355</b>	<b>14</b>	<b>1.7</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of wild fungi based on the only 15 year old consumer is 1.7 kg/y

The observed 97.5 percentile rate is not applicable for 1 observation

**10 year old age group**

Observation number	Age	Mushrooms
<b>356</b>	<b>11</b>	<b>1.7</b>
<b>202</b>	<b>10</b>	<b>1.6</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of wild fungi based on the 2 highest 10 year old consumers is 1.6 kg/y

The observed 97.5 percentile rate based on 2 observations is 1.7 kg/y

**Table 38. Children's consumption rates of rabbits/hares in the Chapelcross area (kg/y)**

**15 year old age group**

Observation number	Age	Rabbit
<b>328</b>	<b>15</b>	<b>7.5</b>

**Notes**

Emboldened observations are the critical group consumers

The critical group consumption rate of rabbits/hares based on the only 15 year old consumer is 7.5 kg/y

The observed 97.5 percentile rate is not applicable for 1 observation

**Table 39. Percentage contribution each food type makes to its terrestrial food group for adults**

<b>Domestic fruit</b>		<b>Other vegetables</b>	
Blackcurrant	25.8	Tomato	38.1
<b>*Apple</b>	15.4	<b>*Pea</b>	31.9
Strawberry	15.0	Runner bean	27.9
<b>*Rhubarb</b>	14.1	Broad bean	1.3
<b>*Damson</b>	8.4	French bean	0.7
Raspberry	7.7		
Whitecurrant	4.2	<b>Root vegetables</b>	
Plum	2.2	<b>*Carrot</b>	25.7
Gooseberry	2.1	Beetroot	20.4
Pumpkin	1.8	Onion	18.7
Redcurrants	1.3	Leek	17.1
Blackberry	1.0	Swede	8.1
Blueberry	0.5	Shallot	5.1
Pear	0.5	Parsnip	2.3
		<b>*Turnip</b>	1.3
<b>Green vegetables</b>		Garlic	0.6
<b>*Cabbage</b>	52.1	Spring onion	0.6
Courgettes	12.4		
Cauliflower	11.7	<b>Eggs</b>	
Brussel sprout	9.2	Chicken egg	93.5
Lettuce	5.3	Duck egg	6.5
Cucumber	3.7		
Artichoke	1.2	<b>Wild/free foods</b>	
Marrow	1.2	Blackberry	100.0
Calabrese	0.9		
Chard	0.7	<b>Poultry</b>	
Herbs	0.6	<b>*Partridge</b>	36.7
Broccoli	0.5	<b>*Pheasant</b>	36.5
Kale	0.3	Chicken	12.4
Spinach	0.2	Pigeon	11.3
		Duck	3.1

**Notes**

Food types asterisked and emboldened were monitored by SEPA in 2004 (EA, EHS, FSA and SEPA, 2005)  
 Other foods monitored were milk, barley, comfrey, elderberries, maize, nettles, potatoes and rosehips  
 Percentages are based on the consumption of all adults in the survey consuming that particular food group

**Table 40. Intertidal occupancy rates in the Chapelcross area (h/y)**

Observation number	Location	Activity	Mud	Salt marsh	Sand
<b>36</b>	<b>Opposite Seafield</b>	<b>Stake and haaf netting</b>	<b>1066</b>		34
<b>37</b>	<b>Opposite Seafield</b>	<b>Stake and haaf netting</b>	<b>1066</b>		23
<b>13</b>	<b>Opposite Newbie Mains</b>	<b>Stake netting</b>	<b>718</b>		
340	Eastriggs to Gretna	Wildfowling	340		
15-16	Opposite Newbie Mains	Stake netting	320		
326-327	Priestside to Caerlaverock	Wildfowling	280		
38-40	Opposite Seafield	Stake netting	270		
353	Eastriggs to Gretna/River Sark & River Kirtle	Wildfowling/angling	200		10
<b>190</b>	<b>Annan area/Caerlaverock salt marsh</b>	<b>Coastguard duties/marsh warden, wildfowling</b>	48	<b>831</b>	
291	Dornockbrow & Torduff Point	Wildfowling	20		
<b>195</b>	<b>Caerlaverock salt marsh</b>	<b>Marsh warden</b>		<b>581</b>	
<b>196</b>	<b>Caerlaverock salt marsh</b>	<b>Marsh warden</b>		<b>500</b>	
<b>220-226</b>	<b>Priestside Marsh</b>	<b>Wildfowling</b>		<b>474</b>	
<b>203</b>	<b>Priestside Marsh</b>	<b>Wildfowling, tending livestock</b>		<b>349</b>	
<b>184-189</b>	<b>Caerlaverock salt marsh</b>	<b>Wildfowling</b>		<b>338</b>	
183	Caerlaverock saltmarsh	Wildfowling, walking		254	
343	Seafield to Waterfoot	Tending livestock		140	
352	Browhouses	Bird watching, angling		120	
201	Caerlaverock salt marsh	Tending livestock		91	
199-200	Caerlaverock salt marsh	Marsh warden		64	
197	Caerlaverock salt marsh	Marsh warden		60	
198	Caerlaverock salt marsh	Marsh warden		40	
<b>54</b>	<b>Opposite Whinnyrig</b>	<b>Poke and haaf netting</b>			<b>508</b>
<b>3</b>	<b>Opposite Whinnyrig</b>	<b>Poke netting</b>			<b>485</b>
<b>17</b>	<b>Opposite Whinnyrig</b>	<b>Poke netting</b>			<b>485</b>
<b>18</b>	<b>Opposite Whinnyrig</b>	<b>Poke netting</b>			<b>485</b>
<b>34</b>	<b>Opposite Seafield/Seafield to Battlehill</b>	<b>Haaf netting/walking</b>			<b>193</b>
42	Opposite Whinnyrig	Haaf netting			44
51	Opposite Whinnyrig	Haaf netting			38
45	Seafield to Battlehill/opposite Seafield	Walking/haaf netting			25
21	Opposite Whinnyrig	Haaf netting			24
43	Opposite Whinnyrig	Haaf netting			21

**Table 40. Intertidal occupancy rates in the Chapelcross area (h/y)**

Observation number	Location	Activity	Mud	Salt marsh	Sand
49	Opposite Whinnyrig	Haaf netting			20
53	Opposite Whinnyrig	Haaf netting			15
46	Seafield to Battlehill	Walking			5

**Notes**

Emboldened observations are the critical group members

The critical group intertidal occupancy rate over mud based on 3 observations is 950 h/y

The observed 97.5 percentile rate based on 14 observations for mud is 1066 h/y

The critical group intertidal occupancy rate over salt marsh based on 17 observations is 447 h/y

The observed 97.5 percentile rate based on 25 observations for salt marsh is 681 h/y

The critical group intertidal occupancy rate over sand based on 5 observations is 431 h/y

The observed 97.5 percentile rate based on 16 observations for sand is 499 h/y

**Table 41. Handling rates of fishing gear and sediment in the Chapelcross area (h/y)**

Observation number	Location	Activity	Fishing gear	Sediment
<b>36</b>	<b>Opposite Seafield</b>	<b>Stake and haaf netting</b>	<b>618</b>	<b>1066</b>
<b>209</b>	<b>River Nith at Conheath</b>	<b>Haaf netting</b>	<b>528</b>	
<b>213</b>	<b>River Nith at Conheath</b>	<b>Haaf netting</b>	<b>528</b>	
<b>217-219</b>	<b>River Nith at Conheath</b>	<b>Haaf netting</b>	<b>528</b>	
<b>37</b>	<b>Opposite Seafield</b>	<b>Stake and haaf netting</b>	<b>360</b>	<b>1066</b>
<b>183</b>	<b>River Nith/Caerlaverock salt marsh</b>	<b>Haaf netting, inshore lifeboat/wildfowling</b>	<b>360</b>	150
<b>54</b>	<b>Opposite Whinnyrig</b>	<b>Stake and Haaf netting</b>	<b>318</b>	140
<b>38-40</b>	<b>Opposite Seafield</b>	<b>Setting/dismantling stake nets</b>	<b>270</b>	270
<b>42</b>	<b>Opposite Whinnyrig</b>	<b>Haaf netting</b>	<b>268</b>	
<b>51</b>	<b>Opposite Whinnyrig</b>	<b>Haaf netting</b>	<b>225</b>	
<b>34</b>	<b>Opposite Whinnyrig</b>	<b>Haaf netting</b>	<b>216</b>	
3	Opposite Whinnyrig	Poke netting	183	140
17-18	Opposite Whinnyrig	Poke netting	183	140
13	Opposite Newbie Mains	Stake netting	160	320
15-16	Opposite Newbie Mains	Stake netting	160	320
45	Opposite Whinnyrig	Haaf netting	120	
49	Opposite Whinnyrig	Haaf netting	120	
43	Opposite Whinnyrig	Haaf netting	98	
53	Opposite Whinnyrig	Haaf netting	90	
21	Opposite Whinnyrig	Haaf netting	74	
<b>220-226</b>	<b>Priestside Marsh</b>	<b>Wildfowling</b>		<b>474</b>
340	Eastriggs to Gretna	Wildfowling		340
184-189	Caerlaverock salt marsh	Wildfowling		338
326-327	Priestside to Caerlaverock	Wildfowling		280
190	Caerlaverock salt marsh	Wildfowling		250
353	Eastriggs to Gretna	Wildfowling		200
203	Priestbank salt marsh	Wildfowling		75
291	Dornockbrow & Torduff Point	Wildfowling		20

**Notes**

Emboldened observations are the critical group members

The critical group fishing gear handling rate based on 15 observations is 388 h/y

The observed 97.5 percentile rate based on 26 observations for fishing gear is 562 h/y

The critical group sediment handling rate based on 9 observations is 606 h/y

The observed 97.5 percentile rate based on 33 observations for sediment is 1066 h/y

**Table 42. Gamma dose measurements over intertidal substrates in the Chapelcross area ( $\mu\text{Gy/h}$ )**

<b>NGR</b>	<b>Location and substrate</b>	<b><math>\mu\text{Gy/h}</math></b>
NY 209 648	Opposite Whinnyrig - Mud	0.081
NY 145 653	Powfoot beach - Sand	0.064
NY 317 661	River Esk channel, opposite Gretna - Sand	0.080
NY 282 649	Browhouses - Saltmarsh	0.085
NY 210 640	Poke nets opposite Whinnyrig - Sand	0.056
NY 018 652	Caerlaverock Nature Reserve - Saltmarsh	0.074
NY 133 651	Beach opposite Moss-side - Sand	0.071
NY 133 653	Saltmarsh opposite Moss-side - Saltmarsh	0.077
NY 206 646	Stake nets at pipeline - Mud	0.086
NY 302 651	Redkirk Point - Mud	0.077

**Table 43. Occupancy rates in and on water in the Chapelcross area (h/y)**

Observation number	Location	Activity	In water	On water
209	River Nith at Conheath	Haaf netting	528	
213	River Nith at Conheath	Haaf netting	528	
217	River Nith at Conheath	Haaf netting	528	
218	River Nith at Conheath	Haaf netting	528	
219	River Nith at Conheath	Haaf netting	528	
183	River Nith at High Kelton/River Nith area	Haaf netting/boating	360	60
42	Opposite Whinnyrig	Haaf netting	268	
51	Opposite Whinnyrig	Haaf netting	225	
34	Opposite Whinnyrig	Haaf netting	216	
36	Opposite Whinnyrig	Haaf netting	204	
332	River Nith	Haaf netting	160	
54	Opposite Whinnyrig	Haaf netting	135	
45	Opposite Whinnyrig	Haaf netting	120	
49	Opposite Whinnyrig	Haaf netting	120	
43	Opposite Whinnyrig	Haaf netting	96	
37	Opposite Whinnyrig	Haaf netting	90	
53	Opposite Whinnyrig	Haaf netting	90	
21	Opposite Whinnyrig	Haaf netting	72	
190	River Nith at High Kelton/River Nith area	Haaf netting/boating	36	60
171	River Nith area	Boating		60
173	River Nith area	Boating		60
174	River Nith area	Boating		60
175	River Nith area	Boating		60
176	River Nith area	Boating		60
177	River Nith area	Boating		60
178	River Nith area	Boating		60
179	River Nith area	Boating		60
180	River Nith area	Boating		60
181	River Nith area	Boating		60
182	River Nith area	Boating		60
334	Old Graitney	Boating		40
335	Old Graitney	Boating		40
336	Old Graitney	Boating		40
337	Old Graitney	Boating		40
338	Old Graitney	Boating		40
339	Old Graitney	Boating		40
353	Old Graitney	Boating		40
333	Browhouses	Boating		30

**Table 44. Occupancy rates (h/y) and gamma dose rate measurements ( $\mu\text{Gy/h}$ ) in the Chapelcross direct radiation survey**

Observation number	Sex	Age	Indoor occupancy (h/y)	Outdoor occupancy (h/y)	Total occupancy (h/y)	Gamma dose rate in the property ( $\mu\text{Gy/h}$ )	Gamma dose rate outside the property ( $\mu\text{Gy/h}$ )
<b>Adult observations</b>							
109	M	20	1598	282	1880	0.083	NM
110	M	25	1598	282	1880	"	"
111	M	28	1598	282	1880	"	"
112	M	30	1786	94	1880	"	"
113	M	32	1598	282	1880	"	"
114	M	35	1598	282	1880	"	"
115	M	37	1598	282	1880	"	"
116	M	39	1598	282	1880	"	"
117	M	41	1598	282	1880	"	"
118	M	43	1598	282	1880	"	"
119	M	44	1598	282	1880	"	"
120	M	46	1598	282	1880	"	"
121	F	35	1880		1880	"	"
122	F	22	1880		1880	"	"
62	M	29	5100	182	5282	0.099	0.073
63	F	27	5450	182	5632	"	"
72	M	45	6814	410	7224	NM	NM
73	F	43	6052	410	6462	"	"
246	F	32	7755	104	7859	0.094	0.081
247	M	35	4340	4200	8540	"	"
252	M	40		2184	2184	"	"
253	M	40		2184	2184	"	"
74	M	18	1880		1880	0.100	0.105
75	M	22	1880		1880	"	"
76	M	22	1880		1880	"	"
77	M	22	1880		1880	"	"
78	M	35	1880		1880	"	"
79	M	35	1880		1880	"	"
80	M	35	1880		1880	"	"
81	M	35	1880		1880	"	"
82	M	43	2162		2162	"	"
83	M	42	2162		2162	"	"
84	M	45	2162		2162	"	"
85	M	44	1081	1081	2162	"	"
86	M	43	1081	1081	2162	"	"
87	F	33	2162		2162	"	"
238	M	35	4811	208	5019	0.097	0.071
239	F	35	7269	364	7633	"	"
66	M	45		365	365	NM	NM
93	M	53	1617	85	1702	0.079	0.079
94	M	60	1617	85	1702	"	"
95	M	42	1617	85	1702	"	"
96	M	42	1617	85	1702	"	"

**Table 44. Occupancy rates (h/y) and gamma dose rate measurements ( $\mu\text{Gy/h}$ ) in the Chapelcross direct radiation survey**

Observation number	Sex	Age	Indoor occupancy (h/y)	Outdoor occupancy (h/y)	Total occupancy (h/y)	Gamma dose rate in the property ( $\mu\text{Gy/h}$ )	Gamma dose rate outside the property ( $\mu\text{Gy/h}$ )
97	M	55	1617	85	1702	"	"
98	M	37	1617	85	1702	"	"
99	M	53	1617	85	1702	"	"
100	M	59	1617	85	1702	"	"
101	M	40	1617	85	1702	"	"
102	M	45	1617	85	1702	"	"
103	M	23	1617	85	1702	"	"
104	M	21	1617	85	1702	"	"
105	M	24	1617	85	1702	"	"
106	M	17	1617	85	1702	"	"
107	M	65	1617	85	1702	"	"
108	M	40	1617	85	1702	"	"
55	M	65	3286	194	3480	0.100	0.066
56	M	64	3286	194	3480	"	"
254	M	58	1440	360	1800	0.073	NM
234	F	45	6672	542	7214	0.108	0.074
235	M	46	6260	118	6378	"	"
236	M	18	6280	104	6384	"	"
57	M	40	500	1997	2497		0.075
60	M	60	5551	1092	6643	0.081	0.073
61	F	60	7440	868	8308	"	"
357	F	33	5650	170	5820	0.102	0.077
358	M	35	5557	650	6207	"	"
89	M	26	2141	113	2254	0.087	NM
88	M	68	6400	104	6504	NM	NM
<b>Child observations</b>							
248	M	8	5321	1430	6751	0.094	0.081
249	M	6	5321	1430	6751	"	"
250	M	6	5321	1430	6751	"	"
251	F	1	7787	104	7891	"	"
240	M	6	5711	1348	7059	0.097	0.071
241	M	4	6224	1348	7572	"	"
237	M	15	6280	104	6384	0.108	0.074

NM - Not measured

**Background gamma dose rates**

NGR	Location and substrate	$\mu\text{Gy/h}$
NY 265 747	5.5km north-east of site - Grass	0.073
NY 275 685	5.5km south-east of site - Grass	0.075
NY 114 658	East Howcreek farm - Grass	0.063
NY 090 723	Carrutherstown - Grass	0.081
NY 000 670	Kenneth Bank - Salt marsh	0.087
NY 978 545	Southernness Point - Sand	0.063
NX 994 685	River Nith, Glencaple - Mud	0.091

**Table 45. Occupancy rates (h/y) and gamma dose rate measurements ( $\mu\text{Gy/h}$ ) along the Chapelcross pipeline**

Observation number	Sex	Age	Pipeline (Housing estate)	Pipeline (Scrap yard)	Pipeline (Seafield)	Pipeline (Sports centre)	Total
299	M	54			670		670
306	M	48			500		500
298	F	43			340		340
362	M	65			340		340
363	F	64			340		340
300	M	56			170		170
301	F	40			170		170
302	M	56			170		170
303	F	55			170		170
29	M	18	48	24		72	144
30	M	19	48	24		72	144
31	M	20	48	24		72	144
32	M	22	48	24		72	144
33	M	25	48	24		72	144
309	M	37			100		100
310	F	37			100		100
311	M	9			100		100
312	M	8			100		100
313	M	5			100		100
307	F	11			50		50
308	F	11			50		50
45	M	57			20		20
46	F	54			20		20
304	F	75			20		20
305	F	73			20		20
359	M	18			20		20
360	F	18			20		20
361	F	17			20		20
34	M	48			17		17

**Pipeline gamma dose rates**

NGR	Section number, description and substrate	$\mu\text{Gy/h}$
NY 209 694	Section 11 - Under the farm track bridge - Grass	0.216
NY 210 690	Section 65 - 500m south of farm track bridge - Grass	0.127
NY 201 665	Section 141 - Opposite playground - Grass	0.241
NY 202 658	Section 285 - Seaforth Bridge - Concrete	0.124
NY 203 653	Section 300 - 400m south of Seaforth Bridge - Stones	0.066

**Notes**

The section number refers to the number painted onto each pipe section

**Table 46. Ratios for determining consumption rates for children**

Food group	Ratio child/adult <sup>(1)</sup>	
	1 yr old	10 yr old
Fish <sup>(2)</sup>	0.050	0.200
Crustaceans <sup>(2)</sup>	0.050	0.250
Molluscs <sup>(2)</sup>	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 <sup>(3)</sup>	0.110	0.490
Game <sup>(4)</sup>	0.140	0.500
Honey	0.789	0.789
Wild fungi	0.150	0.450
Freshwater fish <sup>(2)</sup>	0.050	0.250
Direct radiation	1.000	1.000
External exposure	0.500	0.030
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. Adult consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Chapelcross area:

Observation number	Sex (U if unknown)	Age in years (U if unknown)	Fish	Wildfowl	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Pig meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over sand	Intertidal occupancy over salt marsh	Handling fishing gear	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy	Pipeline occupancy	
66	M	45											1.9																		
67	F	43											1.9																	365	
72	M	45																													
73	F	43																										6814	410		
74	M	18																											1880		
75	M	22																											1880		
76	M	22																											1880		
77	M	22																											1880		
78	M	35																											1880		
79	M	35																											1880		
80	M	35																											1880		
81	M	35																											1880		
82	M	43																											2162		
83	M	42																											2162		
84	M	45																											2162		
85	M	44																											1081	1081	
86	M	43																											1081	1081	
87	F	33																											2162		
88	M	68																											6400	104	
89	M	26																											2141	113	
90	M	62				3.6	4.3	51.2																							
91	F	61				3.6	4.3	51.2																							
92	F	61													35.6																
93	M	53																											1617	85	
94	M	60																											1617	85	
95	M	42																											1617	85	
96	M	42																											1617	85	
97	M	55																											1617	85	
98	M	37																											1617	85	
99	M	53																											1617	85	

















**Annex 2. Children's consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Chapelcross area**

Observation number	Sex	Age in years	Fish	Wildfowl	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Rabbits/hares	Wild fungi	Intertidal occupancy over mud	Handling sediment	Indoor occupancy	Outdoor occupancy	Pipeline occupancy
<b>15 year old age group</b>																					
146	F	12	2.2						5.4	219.0											
192	M	12	8.2	17.9																	
289	M	12								365.0				10.9							
324	M	12									15.8			8.0							
70	M	13										1.9									
323	M	13									15.8			8.0							
58	M	14	3.1																		
69	F	14										1.9									
273	M	14	6.5					25.0			23.7	2.8		16.1							
288	M	14								365.0				10.9							
355	F	14	4.8	17.2											1.7						
15	M	15	7.8								20.8	7.5					320	320			
237	M	15																	6280	104	
261	F	15	3.9		14.9	0.9	1.8	3.6	1.4					1.8							
295	M	15					2.5							15.7							
322	F	15												8.0							
328	M	15		17.5									23.0	28.5	7.5						
68	F	16										1.9									
145	M	16	2.2						5.4	219.0											
272	F	16	6.5					25.0			23.7	2.8		16.1							

**Annex 2. Children's consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Chapelcross area**

Observation number	Sex	Age in years	Fish	Wildfowl	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Rabbits/hares	Wild fungi	Intertidal occupancy over mud	Handling sediment	Indoor occupancy	Outdoor occupancy	Pipeline occupancy
<b>10 year old age group</b>																					
147	F	7	2.2						5.4	219.0											
248	M	8												14.2				5321	1430		
290	M	8								365.0				10.9							
312	M	8																			100
12	F	9			4.7	2.3	12.7	20.5	8.4												
59	M	9	3.1																		
169	F	9								273.8											
311	M	9																			100
325	F	9									7.9			4.0							
154	M	10	0.9																		
193	M	10	8.2	17.9																	
194	F	10	8.2	17.9																	
202	M	10														1.6					
347	M	10	3.5																		
11	M	11			4.7	2.3	12.7	20.5	8.4												
71	M	11										1.9									
296	F	11					2.5							15.7							
307	F	11																			50
308	F	11																			50
356	F	11	4.8	13.4												1.7					

**Annex 2. Children's consumption rates (kg/y or l/y) and occupancy rates (h/y) in the Chapelcross area**

Observation number	Sex	Age in years	Fish	Wildfowl	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Sheep meat	Poultry	Eggs	Rabbits/hares	Wild fungi	Intertidal occupancy over mud	Handling sediment	Indoor occupancy	Outdoor occupancy	Pipeline occupancy
<b>5 year old age group</b>																					
132	F	2								91.3											
241	M	3.5																	6224	1348	
170	M	4								273.8											
313	M	5																			100
155	F	6	0.5																		
240	M	6																	5711	1348	
249	M	6												14.2					5321	1430	
250	M	6												14.2					5321	1430	
<b>1 year old age group</b>																					
127	F	1								182.5											
251	F	1.2												3.0					7787	104	

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

Combination number	Fish	Wildfowl	Green vegetables	Other vegetables	Root vegetables	Potato	Domestic fruit	Milk	Cattle meat	Pig meat	Sheep meat	Poultry	Eggs	Wild/free foods	Rabbits/hares	Honey	Wild fungi	Venison	Intertidal occupancy over mud	Intertidal occupancy over sand	Intertidal occupancy over salt marsh	Handling fishing gear	Handling sediment	Occupancy in water	Occupancy on water	Indoor occupancy	Outdoor occupancy	Pipeline occupancy	
1	*																		*	*		*	*	*					
2	*		*	*	*	*	*								*					*			*	*	*				
3	*								*		*									*			*	*					
4	*																			*	*		*	*				*	
5	*			*																			*			*	*	*	
6											*																*	*	
7	*		*				*		*		*	*	*	*			*												
8							*	*			*	*	*				*												
9	*		*	*		*					*																		
10	*						*	*																					
11								*			*																		
12	*	*																		*	*		*	*	*	*			
13	*	*																		*	*		*	*	*	*			
14																	*				*								
15		*									*										*		*						
16													*													*	*		
17	*	*	*	*	*	*	*					*	*	*						*			*				*	*	
18	*					*			*		*		*																
19	*							*	*	*			*																
20						*		*					*																
21							*					*	*																
22		*										*	*		*					*	*		*	*	*	*	*	*	*
23	*	*															*			*	*		*	*	*	*	*	*	*
24			*		*	*	*					*			*											*	*	*	*
25											*				*			*									*	*	*

