EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY

DIRECTORATE D – Nuclear energy, safety and ITER
D.3 – Radiation protection and nuclear safety

Verification under the terms of Article 35 of the Euratom Treaty

Technical Report

IRELAND
Dublin

Routine and emergency radioactivity monitoring arrangements
Monitoring of radioactivity in drinking water and foodstuffs

16 - 19 November 2021

Reference: IE 21-03

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35

OF THE EURATOM TREATY

FACILITIES	Routine and emergency radioactivity monitoring arrangements Monitoring of radioactivity in drinking water and foodstuffs
LOCATIONS	Dublin, Ireland
DATES	16 - 19 November 2021
REFERENCE	IE 21-03
TEAM MEMBERS	Ms E.L. DIACONU (team leader) Mr. R. VAN AMMEL
REPORT DATE	31 January 2023
SIGNATURES	

E.L. DIACONU R. VAN AMMEL

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Abbreviations

AGS	Aerosol Gamma dose rate Stations
CBRN	Chemical, Biological, Radiological, Nuclear
DAFM	Department of Agriculture, Food and the Marine
DECC	Department of Environment, Climate and Communications
DHLGH	Department of Housing, Local Government & Heritage
DF	Defence Forces
EC	European Commission
EOD	Explosive Ordnance Disposal
EPA	Irish Environmental Protection Agency
EURDEP	European Radiological Data Exchange Platform
FWHM	Full Width Half Maximum
FSAI	Food Safety Authority of Ireland
GFA	Glass Microfiber Filter
HPGe	High-Purity Germanium
IAEA	International Atomic Energy Agency
ICT	Information Computer Technology
IEDD	Improvised Explosive Device Disposal
IPA	Instrument Performance Analysis
LIMS	Laboratory Information Management System
LSC	Liquid Scintillation Counting
MDA	Minimum Detectable Activity
NRMN	National Radiation Monitoring Network
ORM	Office of Radiation Protection & Environmental Monitoring
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic (Oslo-Paris Convention)
QA	Quality Assurance
RADD	EC Radioactive Discharge Database
REM	EC Radioactivity Environment Monitoring database
RPII	Radiological Protection Institute of Ireland
SNC	Self Normalisation and Calibration
TEDA	Triethylene di-amine
UCD	University College Dublin
WIT	Waterford Institute of Technology[1]

[1] WIT became the South East Technological University as of May 2022

TECHNICAL REPORT

1 INTRODUCTION

Under Article 35 of the Euratom Treaty, all Member States must establish the facilities necessary to carry out continuous monitoring of the levels of radioactivity in air, water and soil and to ensure compliance with basic safety standards[2]. Article 35 also gives the European Commission the right of access to such facilities to verify their operation and efficiency. The radiation protection and nuclear safety unit of the European Commission's Directorate-General for Energy is responsible for undertaking these verifications. The Joint Research Centre Directorate-General provides technical support during the verification visits and in drawing up the reports.

The main purpose of the verifications under Article 35 of the Euratom Treaty is to provide an independent assessment of the efficiency and adequacy of monitoring facilities for:

- liquid and airborne discharges of radioactivity from a site into the environment;
- levels of environmental radioactivity at the site perimeter and in the marine, terrestrial and aquatic environment around the site, for all relevant pathways;
- levels of environmental radioactivity on the territory of the Member State.

Taking into account previous bilateral protocols, a Commission Communication[3] describing practical arrangements for Article 35 verification visits in Member States was published in the *Official Journal of the European Union* on 4 July 2006.

2 PREPARATION AND CONDUCT OF THE VERIFICATION

2.1 PREAMBLE

The Commission notified Ireland of its decision to conduct an Article 35 verification in a letter addressed to the Ireland Permanent Representation to the European Union. The Irish Environmental Protection Agency (EPA) was designated to lead the preparations for the visit.

2.2 DOCUMENTS

To assist the verification team in its work, the national authorities supplied an information package in advance[4]. Additional documentation was provided during and after the verification visit. The information provided was used as a source for the descriptive sections of the current report.

2.3 PROGRAMME OF THE VISIT

The Commission and the EPA discussed and agreed on a programme of verification activities in line with the Commission Communication of 4 July 2006.

The opening meeting included presentations on environmental radiation monitoring in Ireland, radiation protection regulation, the national radiation monitoring network and emergency preparedness.

[2] Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom (OJ L 13, 17.1.2014)

[3] Commission Communication *Verification of environmental radioactivity monitoring facilities under the terms of Article 35 of the Euratom Treaty — Practical arrangements for the conduct of verification visits in Member States* (OJ C 155, 4.7.2006)

[4] Replies to the preliminary information questionnaire addressed to the national competent authority, received on 29 October 2021

The verification team pointed to the quality and comprehensiveness of all the presentations and documentation.

The team carried out the verifications in accordance with the programme in Annex 1.

The verification team met the following representatives from the Office of Radiation Protection & Environmental Monitoring (ORM) in the Environmental Protection Agency (EPA):

- Patrick Byrne, Programme Manager, Environmental Monitoring and Surveillance
- Lorraine Currivan, Laboratory Manager/Senior Scientist, Radiation Monitoring
- Simon O'Toole, Scientific Officer I, Radiation Monitoring
- Martina Rožmarić, Scientific Officer I, Radiation Monitoring
- Kevin Kelleher, Senior Scientific Officer, Emergency Preparedness

The verification team was accompanied via MS Teams by:

- Micheál Lehane, EPA Office of Radiation Protection & Environmental Monitoring Director
- Andy Fanning, Programme Manager, Environment and Health, EPA
- Noeleen Cunningham, Radiation Protection Regulation, EPA
- Claire Keary, Waterford Institute of Technology (WIT)[5]
- Luis León Vintró, University College Dublin (UCD)
- Other members of the EPA Radiation Monitoring laboratory staff

The verification team met the following representatives of the Defence Forces:

- Lieutenant Colonel George O'Connell (Directorate of Ordnance)
- Lieutenant David McKenna (Cathal Brugha Barracks, Dublin)
- Commandment Dominic Noone (Casement Aerodrome, Baldonnel)
- Captain Ciaran Carey (Gormanston Camp, Co. Meath)

and the representatives from the Civil Defence:

- Paul Brophy (Civil Defence Phoenix Park Training Centre, Dublin)

The verification team met the representative of the Met Éireann, the state meteorological service of Ireland:

- John O'Flanagan (Casement Aerodrome meteorological station, Dublin)

[5] WIT became South East Technological University as of May 2022

3 LEGAL FRAMEWORK FOR RADIOACTIVITY MONITORING IN IRELAND

3.1 LEGISLATIVE ACTS REGULATING ENVIRONMENTAL RADIOACTIVITY MONITORING

In Ireland, the following legal texts regulate the monitoring of radioactivity in the environment:

- Radiological Protection Act, 1991, No. 9 of 1991, https://www.irishstatutebook.ie/eli/1991/act/9/enacted/en/print
- Environmental Protection Agency Act, 1992, No. 7 of 1992, https://www.irishstatutebook.ie/eli/1992/act/7/enacted/en/print
- European Communities (Marine Strategy Framework) Regulations 2011, S.I. No. 249/2011, https://www.irishstatutebook.ie/eli/2011/si/249/made/en/pdf
- Radiological Protection (Miscellaneous Provisions) Act 2014, No. 20 of 2014, https://www.irishstatutebook.ie/eli/2014/act/20/enacted/en/pdf
- European Union (Radioactive Substances in Drinking Water) Regulations 2016, S.I. No. 160 of 2016, https://www.irishstatutebook.ie/eli/2016/si/160/made/en/pdf
- Radiological Protection Act 1991 (Ionising Radiation) Regulations 2019, S.I. No. 30 of 2019, https://www.irishstatutebook.ie/eli/2019/si/30/made/en/pdf

3.2 LEGISLATIVE ACTS REGULATING RADIOLOGICAL SURVEILLANCE OF FOOD AND DRINKING WATER

In Ireland, the following legal texts[6] regulate the monitoring of radioactivity in food and drinking water:

- The Radiological Protection Act, 1991, No. 9 of 1991, https://www.irishstatutebook.ie/eli/1991/act/9/enacted/en/print
- European Communities (Natural Mineral Waters, Spring Waters and other water in bottles or containers) Regulations 2007, S.I. No. 225 of 2007, https://www.irishstatutebook.ie/eli/2007/si/225/made/en/pdf
- European Union (Drinking Water) Regulations 2014, S.I. No. 122 of 2014, https://www.irishstatutebook.ie/eli/2014/si/122/made/en/pdf
- Radiological Protection (Miscellaneous Provisions) Act 2014, No. 20 of 2014, https://www.irishstatutebook.ie/eli/2014/act/20/enacted/en/pdf
- European Union (Natural Mineral Waters, Springwaters and Other Waters in Bottles or Containers) Regulations 2016, S.I. No. 282 of 2016, http://www.irishstatutebook.ie/eli/2016/si/282/made/en/pdf
- European Union (Natural Mineral Waters, Spring Waters and Other Waters in Bottles or Containers) (Amendment) Regulations 2020, S.I. No. 55 of 2020, https://www.irishstatutebook.ie/eli/2020/si/55/made/en/pdf

3.3 LEGISLATIVE ACTS REGULATING EMERGENCY RADIOACTIVITY MONITORING

In Ireland, the following documents regulate the emergency monitoring:

- National Emergency Plan for Nuclear and Radiological Emergency Exposures
- Major Emergency Management Multi-Agency Response to Radiological /Nuclear Emergencies

3.4 INTERNATIONAL LEGISLATION AND GUIDANCE DOCUMENTS

The list below includes the Euratom and the European Union legislation and the main international standards and guidance that form the basis for environmental radioactivity monitoring and the radiological surveillance of foodstuffs and feeding stuffs.

[6] Legal references to Irish national legislation.

Euratom and the European Union legislation

- The Euratom Treaty
- Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom
- Council Directive 2013/51/Euratom of 22 October 2013 laying down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption
- Council Decision 87/600/Euratom of 14 December 1987 on Community arrangements for the early exchange of information in the event of a radiological emergency
- Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety
- Council Regulation (Euratom) 2016/52 of 15 January 2016 laying down maximum permitted levels of radioactive contamination of food and feed following a nuclear accident or any other case of radiological emergency, and repealing Regulation (Euratom) No 3954/87 and Commission Regulations (Euratom) No 944/89 and (Euratom) No 770/90
- Council Regulation (EEC) No 2219/89 of 18 July 1989 on the special conditions for exporting foodstuffs and feeding stuffs following a nuclear accident or any other case of radiological emergency
- Council Regulation (EC) No 733/2008 of 15 July 2008 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station
- Council Regulation (EC) No 1048/2009 of 23 October 2009 amending Regulation (EC) No 733/2008 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station
- Commission Regulation (EC) No 1609/2000 of 24 July 2000 establishing a list of products excluded from the application of Council Regulation (EEC) No 737/90 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station
- Commission Regulation (EC) No 1635/2006 of 6 November 2006 laying down detailed rules for the application of Council Regulation (EEC) No 737/90 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station
- Commission Implementing Regulation (EU) 2016/6 of 5 January 2016 imposing special conditions governing the import of feed and food originating in or consigned from Japan following the accident at the Fukushima nuclear power station and repealing Implementing Regulation (EU) No 322/2014
- Commission Recommendation 2000/473/Euratom of 8 June 2000 on the application of Article 36 of the Euratom Treaty concerning the monitoring of the levels of radioactivity in the environment for the purpose of assessing the exposure of the population as a whole
- Recommendation 2004/2/Euratom of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation
- Commission Recommendation 2003/274/Euratom of 14 April 2003 on the protection and information of the public with regard to exposure resulting from the continued radioactive caesium contamination of certain wild food products as a consequence of the accident at the Chernobyl nuclear power station
- Directive 2008/56/EC of 17 June 2008 establishing a framework for community action in the field of marine policy (Marine Strategy Framework Directive)

International legislation and guidance documents, issued mainly by the International Atomic Energy Agency (IAEA)

- *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards*, IAEA Safety Standards Series No. GSR Part 3, IAEA, Vienna, 2014
- *Clearance of materials resulting from the use of radionuclides in medicine, industry and research*, IAEA-TECDOC-1000, IAEA, Vienna, 1998
- *Generic models for use in assessing the impact of discharges of radioactive substances to the environment*, Safety Reports Series No 19, IAEA, Vienna, 2001
- *Handbook of parameter values for the prediction of radionuclide transfer in temperate environments*, Technical Reports Series No 364, IAEA, Vienna, 1994
- *Management of radioactive waste from the use of radionuclides in medicine*, IAEA-TECDOC-1183, IAEA, Vienna, 2000
- *Regulatory control of radioactive discharges to the environment: Safety Guide*, Safety Standards Series No. WS-G-2.3, IAEA, Vienna, 2000
- *Sources and effects of ionizing radiation*, United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) 2000, Report to the General Assembly, Vol. I, United Nations, New York, 2000
- World Health Organisation (WHO), *Guidelines on the quality of drinking water (Guidelines for drinking-water quality*, 4th ed. 2011)
- 1998 Convention for the Protection of the Marine Environment of the North-East Atlantic (The OSPAR Convention)

4 BODIES HAVING COMPETENCE IN RADIOACTIVITY MONITORING

4.1 ENVIRONMENTAL PROTECTION AGENCY

4.1.1 General

The Environmental Protection Agency (EPA) is the national organisation with regulatory, monitoring and advisory responsibilities in matters pertaining to ionising radiation. This responsibility was assigned to the EPA following the merger of the Radiological Protection Institute of Ireland (RPII) with the EPA under the Radiological Protection Act 2014 (Miscellaneous Provisions). This Act dissolved the RPII, the body previously responsible for these matters, and transferred all of RPII's functions, assets, liabilities and staff to the EPA. The EPA is an independent public body established in July 1993 under the Environmental Protection Agency Act, 1992; its sponsor in the Government is the Department of Environment, Climate and Communications (DECC).

The key functions of the EPA relevant to Article 35 EURATOM are:

- To maintain and develop a national laboratory for the measurement of levels of radioactivity in the environment, and to assess the significance of these levels for the Irish population;
- To regulate the custody, use, manufacture, importation, transportation, distribution, exportation and disposal of radioactive substances, irradiating apparatus and other sources of ionising radiation;
- To assist in the development of national plans for emergencies arising from nuclear accidents and to act in support of such plans.

Set up in 1993, the EPA is managed by a full time Board, consisting of a Director General and five Directors. The work is carried out across five Offices, with each Director responsible for an Office (*Figure 1.*).

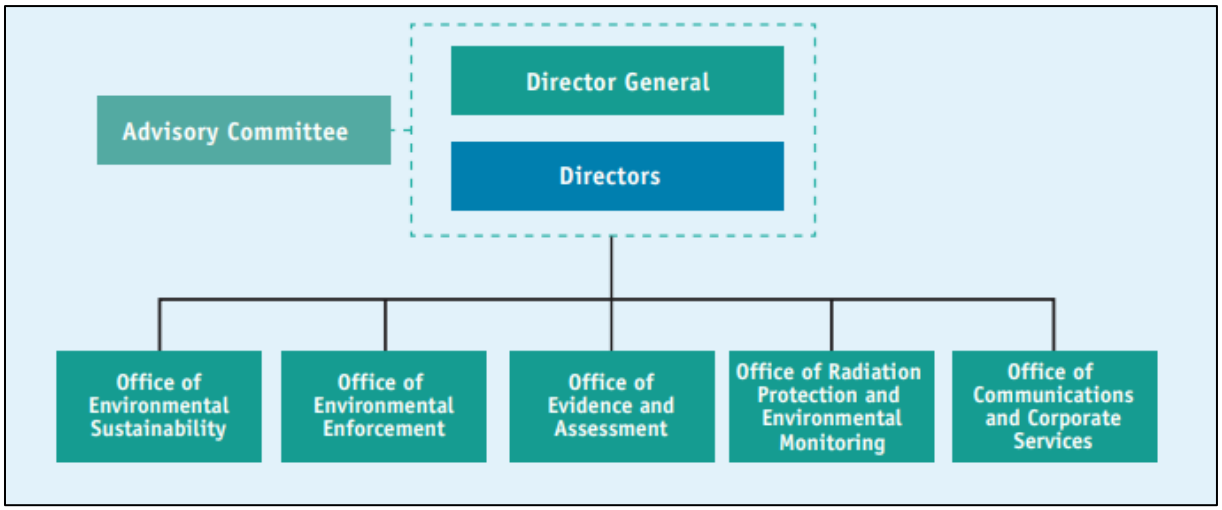

Figure 1. Organisational chart of the EPA offices

The EPA is assisted by an Advisory Committee which meet regularly to provide advice to the Board on matters relating to the EPA's functions, as well as a Radiological Protection Advisory Committee of sixteen members nominated by organisations with expertise relevant to the radiological protection functions of the EPA.

4.1.2 Office of Radiation Protection and Environmental Monitoring

The EPA's Office of Radiation Protection and Environmental Monitoring (ORM)[7] is responsible for implementing the environmental monitoring programme in Ireland. The principal aims of the EPA's radiation monitoring programme are:

- To assess doses to individuals and the population;
- To assess temporal and geographical distribution of radionuclides in the environment;
- To maintain systems, procedures and expertise in emergency situations;
- To provide up to date and accurate information on radiation levels in the environment to stakeholders;
- To support EPA's role to provide advice to DECC;
- To support the Irish food and agriculture industry.

The EPA radiation monitoring laboratory is located in Dublin; the four EPA water laboratories are located in Castlebar, Dublin, Kilkenny and Monaghan.

The ORM undertakes routine monitoring of ambient radioactivity in the Irish environment including air, drinking water, soil, food and the marine through laboratories; provides a calibration service to industry for radiation measuring instruments and provides advice and information.

The ORM Radiation Monitoring Team structure is outlined in *Figure 2*.

Analytical measurements relevant for Article 35 are performed at the EPA's radiation monitoring laboratory in Clonskeagh, Dublin.

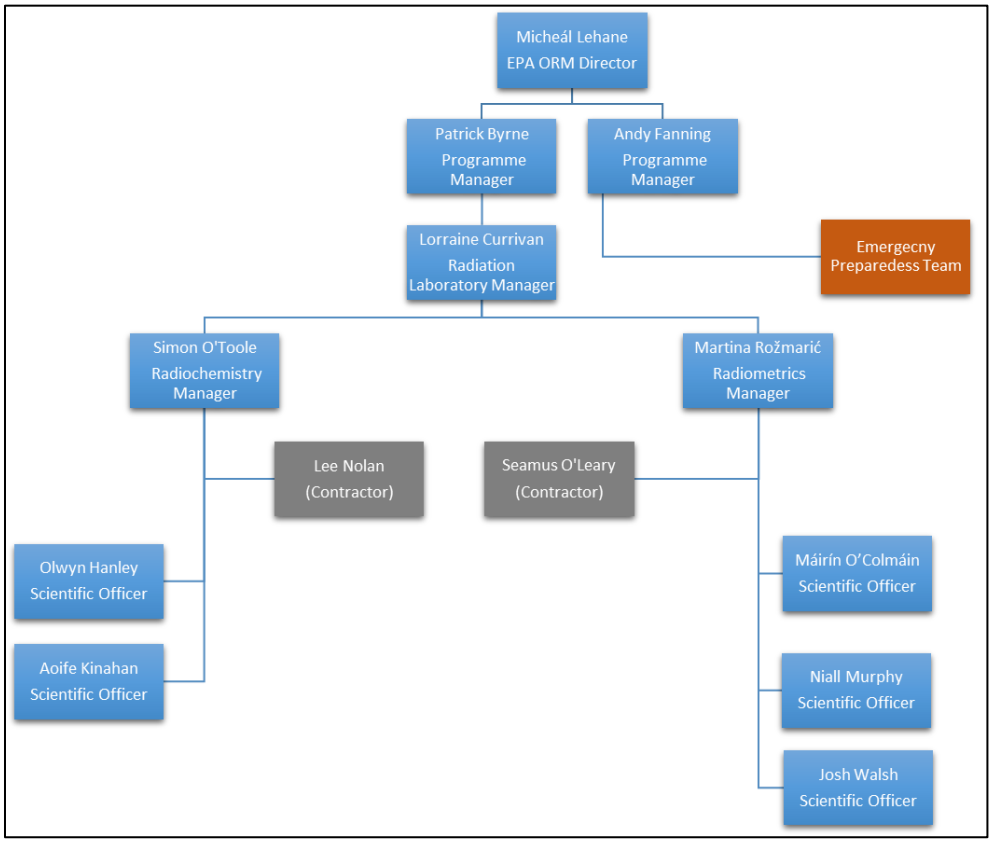

Figure 2. EPA ORM Radiation Monitoring Team Structure

[7] https://www.epa.ie/who-we-are/roles--responsibilities/organisational-structure/the-office-of-radiation-protection-and-environmental-monitoring/

4.2 OTHER ORGANISATIONS INVOLVED IN ENVIRONMENTAL RADIOACTIVITY MONITORING

Other organisations involved in the environmental radioactivity monitoring programme are the Food Safety Authority of Ireland (FSAI), which operates under the aegis of the Department of Health, the Health Service Executive, the Department of Agriculture, Food & the Marine, Irish Water, the Department of Housing, Local Government & Heritage (DHLGH) and the Office of Emergency Planning in the Department of Defence.

5 RADIOACTIVITY MONITORING IN IRELAND

5.1 INTRODUCTION

Ireland organises routine monitoring of radioactivity in the environment (including the marine environment), foodstuffs and drinking water. The environmental monitoring programme in Ireland is implemented by the EPA. The programmes includes the assessment of:

- Ambient radioactivity based on measurements of radioactivity in air and external gamma dose rate at permanent monitoring stations located throughout the country;
- Levels of radioactivity in drinking water;
- Levels of radioactivity in foodstuffs based on measurements of total diet, milk and miscellaneous ingredients;
- Levels of radioactivity in the marine environment based on sampling and measurements of seawater, sediment, seaweed, fish and shellfish.

The National Emergency Plan for Nuclear and Radiological Emergency Exposures (the National Plan) was published by the Department of Environment, Climate and Communications in 2019. It outlines the framework for response to a large scale nuclear or radiological emergency in Ireland. The new plan replaces the previous National Emergency Plan for Nuclear Accidents published in 2005.

The EPA's Nuclear and Radiological Emergency Plan sets out the EPA's responsibilities under the National Plan. It includes details on EPA's preparedness arrangements, the EPA radiation emergency response structure and the roles of teams and individual staff members in responding to a radiation emergency.

5.2 NATIONAL ENVIRONMENTAL RADIATION MONITORING NETWORK

The National Radiation Monitoring Network (NRMN) focusses on regional to national scale alert and characterization of radionuclides arriving at Ireland via atmospheric dispersal, from a major incident at a nuclear installation, or the confirmation of non-arrival.

The institutions collaborating in the NRMN are:

- Met Éireann
- Defence Forces
- Waterford Institute of Technology (WIT)[8]
- University College Dublin (UCD)
- Local Authorities

The NRMN currently contains capabilities for ambient gamma dose rate monitoring, aerosol and precipitation monitoring. The network consists of monitors, samplers, telemetry, ICT infrastructure and live data feeds, focussed on dose rate, aerosols and rainwater (Air Monitoring). The network would be used to confirm the arrival or non-arrival, of any radioactive plume from an overseas nuclear or radiological accident. A critical review of the existing network was conducted by a cross-institutional working group in 2017 and 2018.

[8] WIT became the South East Technological University as of May 2022

5.3 AMBIENT RADIATION DOSE AND DOSE RATE

The EPA operates a network of 15 permanent radiation monitoring stations across Ireland, which constantly monitor radiation levels in the environment (Figure 3). The Irish Meteorological Service (Met Éireann), Local Authorities and the Defence Forces support the work of the permanent radiation monitoring stations. These stations include air samplers and gamma dose rate monitors. Twenty-four-hour monitoring ensures that the EPA is always aware of the levels of naturally occurring radiation in the environment but also that the EPA obtains the first measurements in the event of a radioactive plume reaching Ireland. All data from the monitoring stations is transferred to a central database at the EPA to process and evaluate the data. The data is made available to the public through the EPA website[9] and sent to the EURDEP platform.

The current network includes two sensor models:

- Technidata (Envinet) AGS-421S dose rate monitor – Solar Powered with 48-hour minimum battery backup. Transmits data using the GSM Network. Built in Y/N rain sensor.
- Technidata (Envinet) DLM-1450 dose rat monitor with IGS421-H probe – powered with 48-hour battery backup. Transmits data using the analog landline network. External Y/N rain sensor.

The NRMN renewal project is moderately increasing site density up to median EU levels per capita and per km^2, which give 23 stations for Ireland. A major improvement in capability is being developed by equipping as many sites as possible for collection of online dose rate data, aerosol data/sampling, and rainwater samples. Sensitivity of stakeholders to staff-time commitments and the increasing facility need for live reporting systems are driving increased automation and evolution of siting and promoting collaboration with Defence Forces. Telemetry and ICT infrastructure are being updated and optimised using parallel data pathways, to provide combined emergency resilience and business continuity. A key aim is to harmonise the systems across the EPA.

The ambient gamma dose rate (H*10) is automatically monitored within the range 10 nSv/h - 10 Sv/h. Each monitoring station consists of three GM detectors mounted in a single housing. Two duplicated detectors cover the low dose range and one is used for the high dose range. The energy range is 38 keV- 1.3 MeV and 70 keV – 1.3 MeV respectively for the low dose and high dose detectors. Sampling is continuous with a base interval of 1-minute, 10-minute and two-hour averages calculated. Values are pulled by the EPA server every hour. Each station location has an associated long-term background value. Email/SMS alarms can be programmed into the software that trigger an alarm on defined elevated gamma dose rates or equipment malfunction. EPA's Duty Officers will receive a notification if the mean station background is exceeded by 1 standard deviation. The EPA operates an on-call Duty Officer system whereby a senior staff member is contactable 24 hours a day, 7 days a week. Station gamma dose rate data is published to the EPA web site hourly where it can be viewed graphically[10].

The network will be renewed with 23 new MIRA dose rate stations and 3 SARA spectrometric detectors, which will be installed alongside MIRA stations.

- Scienta Envinet MIRAGDR – Solar powered and 48 h backup battery. 4G, 3G, 2G communication over secure Government APN. Rain sensor integrated.
- SARA spectrometric detectors – 1.5'' $LaBr_3$(Ce) detector or 3'' NaI(Tl) detector. Directional Cellular Antenas, solar powered and a backup battery for 48 h. 4G, 3G, 2G communication over secure Government APN.

The project completion is due for the end of 2023.

[9] https://www.epa.ie/our-services/monitoring--assessment/radiation/national-radiation-monitoring-network/

[10] https://www.epa.ie/our-services/monitoring--assessment/radiation/mapmon

Figure 3. Gamma dose rate monitoring network

5.4 AEROSOLS AND ATMOSPHERIC DEPOSITION

5.4.1 Introduction

The EPA carries out continuous monitoring of radioactivity in air. The air sampling network in Ireland comprises 2 high volume monitors, 5 low volume monitors and 6 low volume samplers, as it is shown in Figure 4.

The air samplers collect samples over a finite period of time while the continuous air monitors are air sampling systems that perform a real-time analysis of airborne radioactive material.

Figure 4. Air sampling network

Legend
Low Volume Monitors; 5 locations
Low Volume Samplers; 6 locations
High Volume Monitors; 2 locations

5.4.2 On-line air monitoring

The on-line air monitoring units are based on a Berthold Technologies BAI 9128-ENV Moving Filter instrument. A 600 mm^2 PIPS Silicon semi-conductor detector is used for the detection of artificial alpha and beta particulates. The monitor will report radioactivity in Bq/m^3 to the EPA using landline telephone. A single 35 m filter belt will last typically 18 months of continuous operation. The base measurement interval is 10 minutes and a typical MDA 0.2 – 0.3 Bq/m^3.

All on-line monitoring units are fitted with TEDA Carbon Cartridges. An electromechanical air flow valve can be activated at the central server to allow a sub-stream air flow to pass through cartridge. The cartridges are replaced at each filter belt replacement interval, typically every 18 months.

5.4.3 Off-line air sampling

High volume air sampling

One high volume (900 m^3/h) air sampler operates continuously at the University College Dublin on the Irish east coast. The equipment is manufactured by Senya, Finland. It is the JL-900 model (Snow White; Figure 5.). Filter changes are usually performed weekly. Filters are combined together into a monthly sample for analysis by high-resolution gamma spectrometry in a 1,000 ml Marinelli container with a counting time of seven days.

A method for the preparation and measurement of charcoal samples from the high-volume sampler has been developed and validated, in a new laboratory procedure and published as a scientific paper[11]. Based on this, a 500 ml Marinelli charcoal standard is used as a check source in gamma spectrometry calibrations, in combination with correction factors calculated in GESPECOR. This standard is measured as a normal sample on all detectors able to measure a Marinelli. Comparison of results with expected activity levels demonstrates accurate measurement results of a range of nuclides from a charcoal sample.

Under the EPA-Waterford Institute of Technology (WIT)[12] Service Level Agreement, a second Senya JL-900 (Snow White) high volume air sampler was installed in 2021 to provide additional laboratory measurement capability to the EPA in support of the National Plan for Nuclear and Radiological Emergency Exposures.

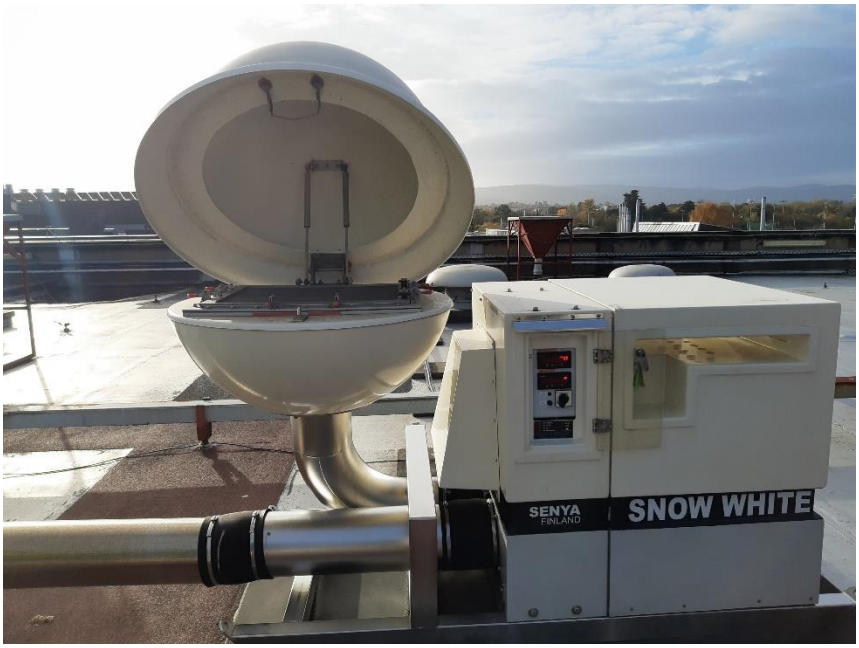

Figure 5. High volume air sampler at the University College Dublin

Low volume air sampling

Six low volume (approx. 6 m^3/h) air-sampling stations (*Figure*) are operated continuously in Ireland. Five of these stations are operated by the Irish Meteorological Service and one by the EPA in Dublin. Routine operation involves particulate sampling using a glass fibre filter. A supply of charcoal filters is available at each monitoring site for sampling gaseous iodine.

[11] ''Nolan L, Murphy NM, Burbidge CI, O Brien D, Leon Vintró L, Hanley O, Currivan L. Gamma spectrometry analysis of radioiodine in charcoal from high volume aerosol samples. Appl Radiat Isot. 2021 Dec; 178:109984. doi: 10.1016/j.apradiso.2021.10998422''

[12] WIT became the South East Technological University as of May 2022

The complete off-line system is a bespoke unit designed by Berthold Technologies. The pump with electronics is mounted inside a standard aluminium meteorological Stephenson Housing from Hi-Q products (USA). The sampling head consists of metal holder with a 47mm circular diameter GFA filter and TEDA impregnated charcoal cartridge (only fitted during emergencies or tests). A carbon vane pump pulls air through the system at a variable flow rate of approx. 5 - 6 m^3/h, depending on filter loading. The airflow through the filter is measured using an ultrasonic (Vortex) airflow meter, calibrated by the manufacturer. The sampling interval is usually seven days; approximately 900 m^3 of air is sampled in that period. Filters are collected by hand and posted to the EPA for gamma spectroscopic analysis using a HPGe detector and total beta analysis using a gas flow proportional counter. The Minimum Detectable Activity for this method is typically 15 mBq gross Beta (based on a 2-hour count and after a minimum of five days' delay to allow radioactive decay of short-lived natural radionuclides). Typical service interval of the system is 18 months with flow meter cleaning part of service.

No radioactivity detectors are fitted to the low volume, off-line air samplers.

Figure 6. Low volume air sampler at the EPA garden

5.4.4 Dry/wet deposition sampling

Total fallout sampling is not routinely performed in Ireland. Rainwater is collected continuously at ten stations, spread around the country, so that in the event of an accidental release of radioactivity into the atmosphere, concentrations in rainwater could quickly be assessed. Samples are not analysed routinely. The location of rainwater sampling stations is shown in Figure 7.

Figure 7. Rainwater sampling locations

The equipment used as rainwater collector is a high density polyethylene precipitation collector with 2.5 litre collection bottle (NILU Products AS). The funnel of rain water collector is mounted approx. 1.75 m above ground.

The rainwater sample is collected for two weeks at all stations (except in Dublin, where the collection is monthly) and the sample is kept for two weeks, then disposed of, unless requested by the EPA.

Rainwater samples can be assessed for Cs-137 and other gamma emitting radionuclides.

5.5 WATER

5.5.1 Surface water

The EPA's surface water monitoring programme is embedded in the National Surveillance Monitoring Programme for Radioactivity in Drinking Water 2017-2022.

In Ireland there is a high number of surface water sampling locations (approximately 364). A 1 litre water sample is taken for Gross alpha/beta analysis. When suspended matter is present in significant quantities on receipt of a sample, filtration is required before acidification. The sample is prepared for analysis within 48 hours of being taken.

The water sample is acidified to a pH of 2.7 ± 0.2 and undergoes thermal pre-concentration to increase the sensitivity of the method. The final pH should be 1.7 ± 0.2, it is adjusted if required. An aliquot of sample is transferred into a scintillation vial and mixed with scintillation cocktail. The vials are counted by liquid scintillation counting (LSC) using predetermined alpha and beta counting efficiencies.

Gross alpha/beta analysis is performed on all surface water samples. If the levels of gross alpha activity are below 100 mBq/l and the levels of gross beta activity are below 1000 mBq/l, the water sample is deemed to be compliant with the Euratom Drinking Water Directive and no further analyses are carried out. If the screening limits are exceeded, then subsequent analyses are carried out to determine the activity concentrations of the individual radionuclides: K-40, U-238, U-234, Ra-226, Ra-228, Po-210 and Pb-210.

Radon is not measured in surface water, as it is volatile and readily diffuses to the atmosphere. Tritium is not analysed in waters, as there are no significant sources in Ireland.

5.5.2 Ground water and drinking water

A national surveillance monitoring programme of all regulated water supplies with a volume supplied of greater than 10 m^3 per day was carried out over a six-year period (2017 – 2022).

In Ireland, the EPA is currently conducting a survey of potable drinking water supplies and sources, to determine whether the monitoring of water supplies is required at the frequencies outlined in the *National Surveillance Monitoring Programme for Radioactivity in Drinking Water 2017-2022.* To determine the water supplies likely to exceed the parametric values for Indicative Dose and Radon, the EPA uses a risk-based approach, taking into consideration:

- Population served
- Volume supplied (m^3/day)
- Type of water supply i.e. surface water or ground water supply

Based on the EPA's 2015 drinking water supply data, there are approximately 1391 drinking water supply zones that are regulated by the EPA[13]. These supplies comprise 673 public water supplies, 182 private supplies and 536 private group water schemes. A summary of these supply types is outlined in in Table I.

Irish Water and local authorities are responsible for sampling of these supplies, as directed by the EPA. The Irish Water is Ireland's national water utility that is responsible for providing water services throughout Ireland[14]. A water sample is collected from each supply on a six-yearly rotation.

[13] Legal reference

[14] www.water.ie

Table I. Number of water supplies monitored as part of the National Surveillance Monitoring Programme

Volume of supplies to be monitored (m^3/day)	Surface Water	Ground Water	Spring Water	Mixed	Supplies to be monitored
Volume > 10,000	20	0	2	0	22
1,000 <Volume ≤ 10, 000	103	44	21	32	200
100 < Volume ≤ 1000	153	279	65	21	518
10 ≤ Volume ≤ 100	88	460	101	0	651
Total	365	784	189	53	1391

The schedule for the national surveillance monitoring programme for the period 2017 to 2022 is outlined in table II.

Table II. Schedule for the National Surveillance Monitoring Programme (2017-2022)

Year	Supplies to be monitored (m^3/day)	Estimated Number of Supplies
2017	Volume > 1,000	198
2018	100 < Volume ≤ 1,000 Surface Water and Mixed Supplies	108
2019	100 < Volume < 1,000 Ground Water Supplies	241
2020	100 < Volume < 1,000 Spring Water Supplies and 10 ≤ Volume ≤ 100 Surface Water, Spring Water and Mixed Supplies	313
2021-2022	10 ≤ Volume ≤ 100 Ground Water Supplies	531

All water samples are analysed for gross alpha and gross beta activity. If the levels of gross alpha activity are below 100 mBq/l and the levels of gross beta activity are below 1000 mBq/l then the water sample is deemed to be compliant with the Euratom Drinking Water Directive and no further analyses are carried out. If the screening limits are exceeded, subsequent analyses are carried out to determine the activity concentrations of the individual radionuclides K-40, U-238, U-234, Ra-226, Ra-228, Po-210 and Pb-210.

Analyses for individual radionuclides (U-234/238, Ra-226/228, Po-210, Pb-210) are performed if the Indicative Dose (ID) is exceeded.

Ground water, spring water supplies and potable drinking water are monitored for radon concentrations and compared with a parametric value of 500 Bq/l.

Monitoring of drinking water supplies for tritium or artificially occurring radionuclides in Irish water supplies is not done, as there are no significant sources of tritium or artificial radioactivity in the catchments of Irish water supplies.

5.5.3 Bottled water

Prior to 2021, the last bottled water survey was undertaken in Ireland 2013. In 2020 the next survey in bottled water was planned (Radon and Gross alpha/beta analysis) but due to the COVID-19 pandemic the Department of Health was delayed in designating the EPA for official control services. The survey of all bottled water plant supplies in Ireland was completed in November 2021.

The EPA and FSAI will assess the results of the survey in conjunction with the results of the EPA National Surveillance Monitoring Programme for Radioactivity in Drinking Water planned for 2023.

5.5.4 Sea water

Radioactivity levels in the Irish marine environment are monitored extensively by the EPA to assess the radiation dose received by the Irish population. The radionuclide measured in seawater is Cs-137 to study geographic and temporal trends of low-level liquid discharges from the Sellafield nuclear

reprocessing facility in the UK. Discharges from Sellafield (low levels of artificial radioactivity) can be detected in sediments, seawater, seaweeds, fish and shellfish taken from the Irish Sea.

Seawater sampling locations are shown in Figure 8.

Figure 8. Seawater sampling locations

Seawater sampling from the Ballagan, Woodstown and Galway is undertaken by the EPA staff. Sampling at nodal locations in the Irish Sea (N1-N3, N7-N9) is performed by the Irish Naval Service on behalf of the EPA.

A sample volume of 20 litres is collected on the east and south coast of Ireland. The collected seawater samples are adjusted to a pH < 2 within 12 hours of collection using nitric acid and filtered to remove sand or silt. The sample is then eluted through an AMP-PAN resin column. The resin is transferred from the column into a 5ml counting vial for counting in a HPGe well detector.

The sampling frequencies for each of the monitoring locations are outlined in Table III.

Table III. Seawater sampling frequencies

Sampling Location	Sampling Frequency
Ballagan	Quarterly
N1 – N3, N8-N10	Annually
Galway	Biennially
Woodstown	Biennially

The EPA has recently commissioned a research project entitled "Radioactivity in the Irish Coastal Environment". It is a three-year project carried out in collaboration with the Waterford Institute of Technology (WIT)[15], University College Dublin (UCD) and the National University of Ireland Galway (NUIG). The aim of the project is to provide a status update on artificial radioactivity levels in the Irish coastal environment by revisiting some of the sites from previous surveys carried out in the 1980s and 1990s. The scope of these surveys is to include a range of natural radionuclides with a view to establish a baseline with which to assess future levels. Sample locations subject to, or potentially subject to the accumulation of naturally occurring radioactive material (NORM), such as ports and harbours, could be identified and included in the sampling.

5.6 SOIL AND MARINE SEDIMENTS

5.6.1 Soil

The EPA commenced a soil monitoring programme in 2018. The programme is primarily focused on the south-east of the country where agriculture area is located; the main radionuclide measured is Cs-137.

Three samples are collected annually from the locations marked on Figure 9. A flat site is selected with short grass, which is at least 10 m away from any buildings, ditches, rivers or roads. A clean hand scoop or similar tool is used to remove the top layer of soil (1 – 2 cm) and this is placed directly into a container. Upon receipt in the laboratory, the sample is logged into the lab database (labware LIMS) and a 250 GEO is prepared which is analysed by gamma spectrometry. The sample is routinely screened for Cs-137 and K-40. The procedure can be adapted in an emergency.

The National Civil Defence has been trained and receives regular refresher training to conduct soil sampling if required in an emergency.

[15] WIT became the South East Technological University as of May 2022

Figure 9. Soil sampling locations

5.6.2 Marine sediments

The primary focus of marine sediment programme in Ireland is on north-east coast and the Irish Sea. The goal is to assess the radiation doses arising from Sellafield and the distribution of artificial radionuclides.

Marine sediment samples are taken on a bimonthly basis from Ballagan Co Louth and biennially from Galway and Woodstown Co Waterford (Table IV).

Table IV. Marine sediment sampling locations and frequency

Marine sediment sampling location	Sampling frequency
Ballagan	Bimonthly
Galway	Biennially
Woodstown	Biennially

Cs-137, K-40 and other gamma emitting radionuclides are measured in sediment to monitor levels of radionuclides from historic discharges (remobilisation from sediments is now the predominant source of marine radioactivity in the Irish Sea).

A clean hand scoop or similar tool is used to remove the top layer of sediment (1 – 2 cm) and this is placed directly into a container. Approx. 1 kg of wet sample is taken. In the laboratory, the sample is logged into the LIMS database. The sample is dried in an oven; after dying it is sieved and prepared into a 500 ml Marinelli container and analysed by gamma spectrometry.

The EPA Laboratory also carries out the analysis of dredge samples as requested by customers. Samples are prepared as above and are analysed for Cs-134, Cs-137, I-131, K-40, Am-241, Ra-226 and Ra-228.

5.7 TERRESTRIAL BIOTA AND FAUNA

The EPA does not routinely measure terrestrial biota and flora.

5.8 MARINE BIOTA AND FAUNA

The EPA has a marine monitoring programme that routinely measures aquatic biota and flora. The sampling locations are outlined in Figure 10. *Figure* The sampling locations, frequencies and sample types for biota and fauna sampling are outline in Table V.

Figure 10. Marine biota and fauna sampling locations

Table V. Sampling locations, frequencies and sample types for marine biota and fauna

Sampling Location	Sampling Frequency	Sample Type		Radionuclides
Carlingford	Quarterly	Mussels		Cs-137, other gamma emitters Pu-238/239, Pu-240 and Am-241
Carlingford	Quarterly	Oysters		
Carlingford	Annually	Winkles		
Ballagan	Bimonthly	Bladder wrack		Cs-137, other gamma emitters, Tc-99
Clogherhead	Quarterly	Fish[16]		Cs-137, other gamma emitters
Clogherhead	Quarterly	Prawns, Lobster		Cs-137, other gamma emitters Pu-238/239, Pu-240 and Am-241, Tc-99 (as annual composite)
Kilmore Quay	Annually	Fish[1]		Cs-137, other gamma emitters
Galway	Biennially	Bladder wrack		Cs-137, other gamma emitters
Woodstown	Biennially	Bladder wrack		Cs-137, other gamma emitters.
Killybegs	Annually	Fish[1]		Cs-137, other gamma emitters.

For seaweed samples, a sample size of approximately 2-3 kg (wet weight) is required

- Plant stems are to be avoided.
- The non-reproductive tissue is selected (leaving the roots in-situ and undamaged).
- Each sample includes seaweed material from as many individual plants as is practical, selected randomly from a wide area of the beach (close to and removed from the top of the shore).
- Plant material is taken from an individual single plant at a time by tracing back to the root of the plant before removing a grab sample - each sample should contain material from a single plant to avoid mixing in different plant species in a sample.

Approximate sample sizes for seafood are:

- Cod (Flesh) 3 kg
- Plaice (Flesh) 3 kg
- Whiting (Flesh) 3 kg
- Herring (Flesh) 2.5 kg
- Mackerel (Flesh) 2.5 kg
- Ray (Flesh) 3 kg

[16] Includes Cod, Plaice, Haddock, Mackerel and Ray

- Prawn tails (Flesh) 4 kg
- Mussels 12 kg
- Oysters 120 shells minimum

Samples are dried and homogenised before subsequent analyses. Cs-137 and Tc-99 are measured in seaweed to study geographic and temporal trends. Cs-137, Tc-99 and isotopes of plutonium and americium are measured in seafood (fish and shellfish) to determine the ingestion dose to the Irish public.

5.9 FOODSTUFFS AND FEEDING STUFFS

5.9.1 Milk

Milk samples are taken from four of the largest dairy processing facilities in Ireland, taking into consideration geographical location. These facilities were chosen in consultation with the Irish Department of Agriculture, Food and the Marine (DAFM). The sampling locations are identified in Figure 11.

Figure 11. Milk sampling locations

Raw milk samples (unpasteurised) are collected monthly by dairy inspectors from the DAFM and delivered to the EPA in a 2 litre plastic container.

Milk samples from Ballyragget (one of Europe's largest butter processing plants) are analysed monthly for Cs-137, I-131 and other gamma emitters. Milk samples from all locations are bulked and homogenised on a quarterly basis and analysed for Cs-137, Sr-90 and other gamma emitters. These

radionuclides may concentrate in milk in the event of an accidental release of radioactivity from a nuclear facility abroad which gives rise to radioactive contamination in Ireland.

5.9.2 Foodstuffs

Foodstuffs samples (malting barley, milling oats and milling wheat) are collected on an annual basis and analysed for Cs-137 and other gamma emitting radionuclides.

Figure 12 illustrates the spatial spread of sampled locations, which are representative of the main growing regions across Ireland.

Figure 12. Grain sampling locations

A minimum of 500 g is sampled by a DAFM inspector and delivered to the EPA Radiation Laboratory. Sampling of Irish grain takes place during the harvest season. Table VI shows a list of the three main grain samples and counties sampled from 2011 – 2020.

Table VI. Grain type and sample numbers per county

County	Malting Barley	Milling Wheat	Milling Oats	Total for each County
Carlow	0	1	0	1
Cork	2	5	2	9
Donegal	0	1	0	1
Dublin	1	1	0	2
Galway	1	0	0	1
Kerry	0	1	0	1
Kildare	8	2	4	14
Kilkenny	1	1	1	3
Laois	1	0	0	1
Louth	1	8	8	17
Tipperary	1	0	1	2
Waterford	0	1	4	5
Wexford	1	9	2	12
Total (60)	14	26	20	70

The EPA provides, on request, a service to test and certify the radioactivity of Irish food products that may be required by producers exporting to third countries. Certificates of Radioactivity Measurement are issued based on both individual sample results for the product concerned and the national monitoring programme. A range of meat, dairy and processed food products are routinely screened for gamma-emitting radionuclides as part of the product certification programme**.**

5.9.3 Feeding stuffs

The EPA does not routinely measure feeding stuffs produced in Ireland for radioactivity. Feeding stuffs imported from third countries are sampled by the DAFM. Table VII provides a list of the types of feed received for analysis, giving the number and location of each feed type. Most of the feed originates in Russia, Ukraine and Belarus.

Table VII. Third Country Food & Feeding stuff sample types received 2011 - 2020

Sample Type	No. Samples	Countries
Maize	67	Canada (1), Romania (2), Russia (10), Ukraine (54)
Soyahulls	31	Russia
Sugarbeet	44	Belarus (7), Russia (37)
Sunflower Seed Extract	19	India (1), Russia (18)
Molasses	11	India (2), Iran (1), Mauritius (2), Pakistan (2), Thailand (2), Russia (1), Laos (1)
Rapeseed	7	Belarus (2), Russia (3), Ukraine (2)
Soya Fat	4	Egypt (2), Morocco (2)
Vinasses	4	Thailand (1) Vietnam (3)
Palm Kernel Expeller	3	Indonesia (1), Malaysia (2)
Seaweed	2	Iceland
Copper Sulphate	2	Russia

Palm Fatty Acid	2	Morocco
Camelina Meal	1	Russia
Horsefeed	1	Switzerland
Maerl	1	Iceland
Magnesium Oxide	1	Turkey
Niger Seed	1	India
Rice Fermented	1	Japan
Vegetable Oil	1	UAE
Zinc Oxide	1	Turkey
Garlic	1	China
Peas	1	Moldova

A minimum of 500 g is analysed by the EPA's radiation monitoring laboratory for Cs-137 and other gamma emitting radionuclides. The laboratory receives and analyses an average of 30 samples throughout the year.

5.10 MIXED DIET

Mixed diet is sampled from complete meals from large consumption centres, such as canteens or restaurants to give a representative figure for the average level of radioactivity in the diet. The sampling methodology for mixed diet is duplicate diet/canteen survey. Samples are collected as per Commission Recommendation 2000/473/EURATOM.

Sampling is carried out by EPA staff on a monthly basis from the main restaurant in University College Dublin, Belfield. Between 1.5 and 2 kg fresh weight is collected. Recently, due to the COVID-19 restrictions implemented in May 2020, mixed diet samples have been sourced from an alternative restaurant within proximity to the EPA radiation monitoring laboratory. Caesium-137 and K-40 are analysed on monthly samples and Sr-90 analysis is performed on annual bulked samples.

A medium scale project (24 – 36 months) is currently ongoing to determine a dose assessment in total diet samples of the Irish population. This project will gather information on the radionuclides of interest (C-14, H-3, Po-210, Pb-210). There may also be the possibility of investigating the dose from the thorium series, specifically Ra-228. This will allow for an up to date and in-depth review of the breakdown of naturally occurring radionuclides on total diet of the Irish population. This project will give information on the dose assessment on the ingestion of food for the Irish Population and help the development of novel rapid radio-analytical techniques for the use in the EPA Radiation Laboratory.

5.11 EMERGENCY MONITORING

5.11.1 EPA

The EPA maintains a stock of radiation monitoring instruments (Figure 13), which may be brought offsite to measure ambient background radiation, to detect radioactive contamination and to identify contaminating radionuclides. Under the Emergency Preparedness Arrangements, the Defence Forces provides a mobile monitoring capability available on request to supplement the EPA's fixed stations. Civil Defence teams can also be called to provide additional radiological monitoring in the event of wide scale contamination.

The EPA emergency preparedness team has recently purchased five radiological food and environmental sample screening systems that have been delivered to the EPA Regional Water Laboratories in Kilkenny, Monaghan, Castlebar and Dublin. These instruments can screen for a variety of sample types, including water, seawater, dairy products, vegetation, grains, meat, eggs, fish, baby food, etc.

The EPA Water Laboratories and offices in Castlebar, Cork, Kilkenny and Monaghan are equipped with survey meters and electronic personal dosimeters with certain staff trained to use this equipment to make dose rate measurements in the event of a radiological incident.

Figure 13. Emergency mobile kit available in the EPA

5.11.2 Defence Forces

The EPA has a Service Level Agreement (SLA) with the Defence Forces (DF) whereby the DF, emergency preparedness arrangements, will provide a mobile radiological monitoring capability to supplement the EPA's fixed stations, some of which are located in DF facilities. The SLA currently provides for 19 such monitoring teams to deploy to specific locations, however the number of teams and locations can be adjusted as a situation evolves.

The DF's mobile monitoring teams are equipped with the RADOS RDS-200 Universal Survey Meter. This instrument can also be supplemented with the Canberra RDS-100 Radiation Detection System which can be fitted with a gamma probe configured to measure dose rate and accumulated dose as well as Alpha and Beta Probes measuring respective dose rates.

In addition, the DF provides a nationwide Explosive Ordnance Disposal (EOD) capability to the Police, specialising in Improvised Explosive Device Disposal (IEDD). These specialist EOD Teams are also equipped to respond to Chemical, Biological, Radiological, Nuclear (CBRN) incidents and have the capability to detect and identify such substances including a broad range of radioisotopes. EOD teams are also available to the EPA on request through the Police.

In nuclear or radiological emergencies, whether accidental or malign in nature, in the emergency preparedness plan it is anticipated that the Police will most likely be the first responder with the DF acting as a support agency providing the nearest on call EOD Team. For radiological substance detection and identification the EOD Teams are equipped with:

- Siemens Electronic Personal Dosimeter, EPD Mk2.
- Canberra RDS-100 Radiation Detection System (handheld).
- Exploranium GR-135 DNC Radiation Identification Device (handheld).

5.11.3 Civil Defence

The Civil Defence has dose rate meters (complete stock replaced in 2020 with new instruments) in every local authority region in Ireland. Arrangements are in place for them to take ambient dose rate measurements and to collect soil and grass samples in case of emergency. These new instruments are Kromek D3M PRD model (Figure 29) which have a range of up to 1S Sv/h using the high dose tube and a CsI (Tl) detector, which allows it to work as a rudimentary gamma spectrometer to identify various radionuclides. The EPA provides training to Civil Defence volunteers the Civil Defence organises an exercise every year to test emergency arrangements.

5.12 INFORMATION FOR THE GENERAL PUBLIC

The gamma dose rate data from the Irish network are shared with the EU EURDEP system and published online on the EPA's website for public access since 2005[17]. The EPA reports gamma dose rate monitoring data to the EURDEP on an hourly basis.

Results from the food, water and marine monitoring programmes are annually reported on the EC REM database.

The EPA reports environmental monitoring data to the Irish public via the EPA website and EPA Environmental Open Data Portal[18].

Results from the marine monitoring programme are submitted to the European Commission as part of Ireland obligations under the Marine Strategy Framework Directive. Specific marine monitoring data is annually submitted to the OSPAR Radioactive Substances Committee.

Ireland and the UK share data from their national gamma dose rate monitoring stations, with data automatically exchanged every hour.

[17] https://www.epa.ie/our-services/monitoring--assessment/radiation/mapmon

[18] https://data.epa.ie/api-list/radiation-monitoring-open-data/

6 RADIOACTIVITY MONITORING IN DUBLIN

6.1 GENERAL

Environmental radioactivity in the city of Dublin is monitored as a part of the national monitoring programme in Ireland. The primary focus is on the NE coast and Irish Sea to assess the radiation doses arising from Sellafield and distribution of artificial radionuclides. The coast of Dublin is part of the environmental monitoring for surface water sampling, rain water sampling and sampling of seawater.

6.2 DOSE RATE MONITORING

Continuous ambient dose rate monitoring in the Dublin region is performed with two IGS DLM dose rate stations, one in the EPA headquarters, Clonskeagh, and another one in the Casement area. A third station is installed in the airport area (Figure 14).

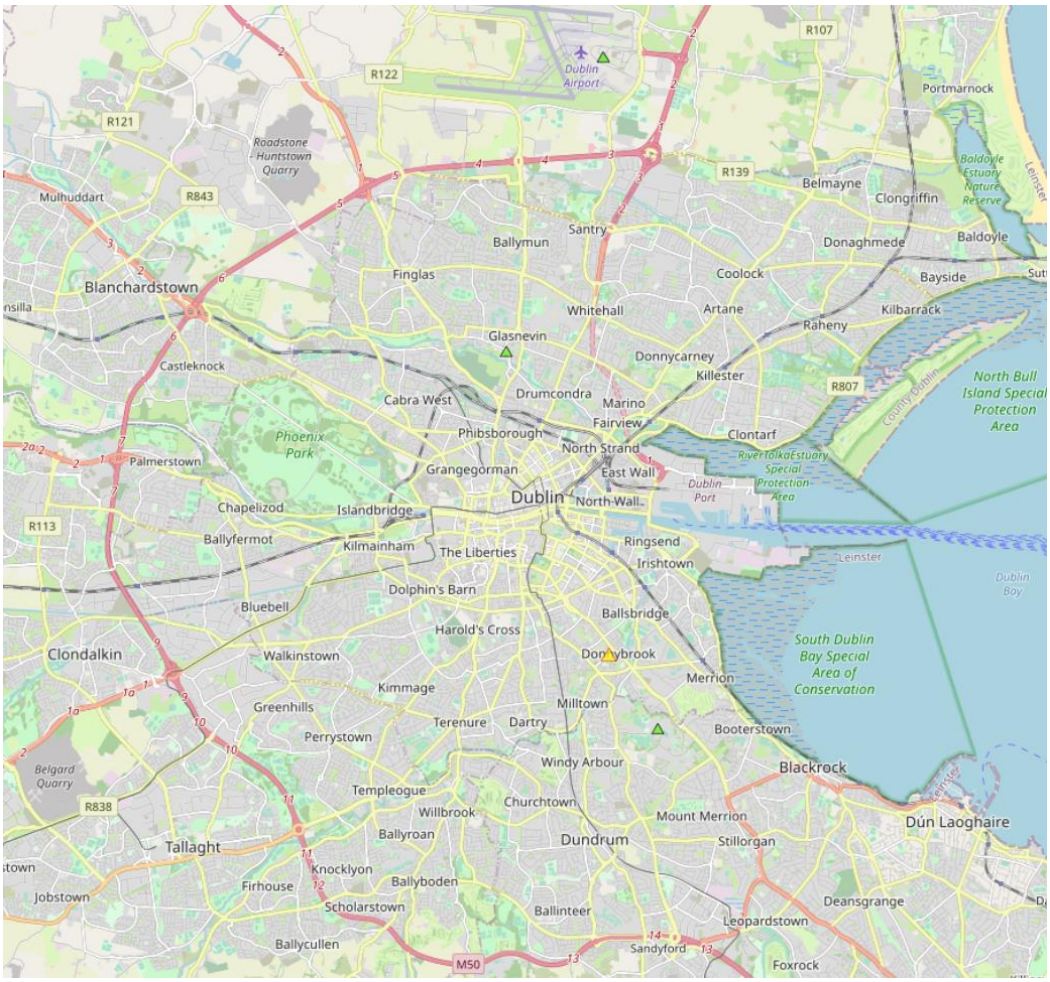

Figure 14. Gamma dose rate stations in Dublin (green triangles)

6.3 ATMOSPHERIC RADIOACTIVITY MONITORING

The automatic air radioactivity monitoring in Dublin consist of the following stations (Figure 15):

- one low volume monitor and one low volume sampler installed at the EPA on Clonskeagh Road
- one high volume monitor installed on the roof of UCD
- one low volume air sampler installed in the north part of the Dublin area

Figure 15. Air sampling network – Dublin region

Legend
Low Volume Monitors
Low Volume Samplers (offline); 2 locations
High Volume Monitors

6.4 ENVIRONMENTAL SAMPLING

Environmental sampling in Dublin is performed under the national sampling programme.

6.4.1 Water

Surface water

The EPA's surface water monitoring programme is embedded in the National Surveillance Monitoring Programme for Radioactivity in Drinking Water 2017-2022.

Surface water is sampled in the Dublin region in five locations: Dublin City Council_Zone1 (82022 m^3/day), Dublin City Council_Zone6 (70512 m^3/day), Dublin City Council_Zone2 (15636 m^3/day), Fingal_ZONE1 (78187 m^3/day) and Fingal_ZONE3 (2787 m^3/day). Gross alpha/beta analysis is performed on all surface water samples. If the levels of gross alpha activity are below 100 mBq/l and the levels of gross beta activity are below 1000 mBq/l, the water sample is deemed to be compliant with the Euratom Drinking Water Directive and no further analyses are carried out. If the screening limits are exceeded, then subsequent analyses are carried out to determine the activity concentrations of the individual radionuclides: K-40, U-238, U-234, Ra-226, Ra-228, Po-210 and Pb-210.

Ground water and drinking water

A water sample is collected from each supply on a six-yearly rotation. Samples are analysed for Indicative Dose on each supply and radon if required for ground water, spring water and mixed sources only.

Ground water samples are collected from three collection points in County Dublin: South Dublin County Council_Zone3 (85 m^3/day), Fingal_Zone3 (7029 m^3/day) and Dún Laoghaire-Rathdown_Zone4 (92 m^3/day).

Analyses for individual radionuclides (U-234/238, Ra-226/228, Po-210, Pb-210) are performed if the ID is exceeded.

Ground water, spring water supplies and potable drinking water are monitored for radon concentrations and compared with a parametric value of 500 Bq/l.

Dry/wet deposition sampling

Sampling of rainwater in the Dublin region is performed monthly for gamma emitters in Glasnevin and Clonskeagh (EPA). Water is collected in a high-density polyethylene precipitation collector with 2.5 litre collection bottle, model NILU Products AS. The collector is mounted approx. 1.75m above ground (Figure 16).

Figure 16. Precipitation collector at the EPA garden

The locations of rainwater sampling stations are shown in Figure 17.

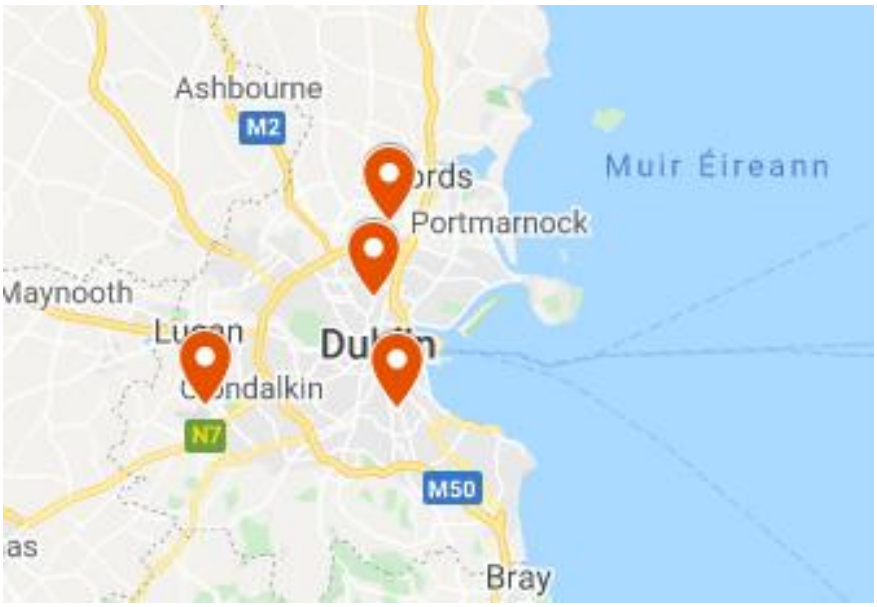

Figure 17. Rainwater sampling locations – Dublin region

Seawater

The Irish Navy collects annual samples on behalf of the EPA from six nodal points in the Irish Sea. Two of these nodal points (N1 and N2) are located off the County Dublin coast. The radionuclide measured in seawater is Cs-137. See Figure 18 below for nodal locations N1 and N2 off the County Dublin coast.

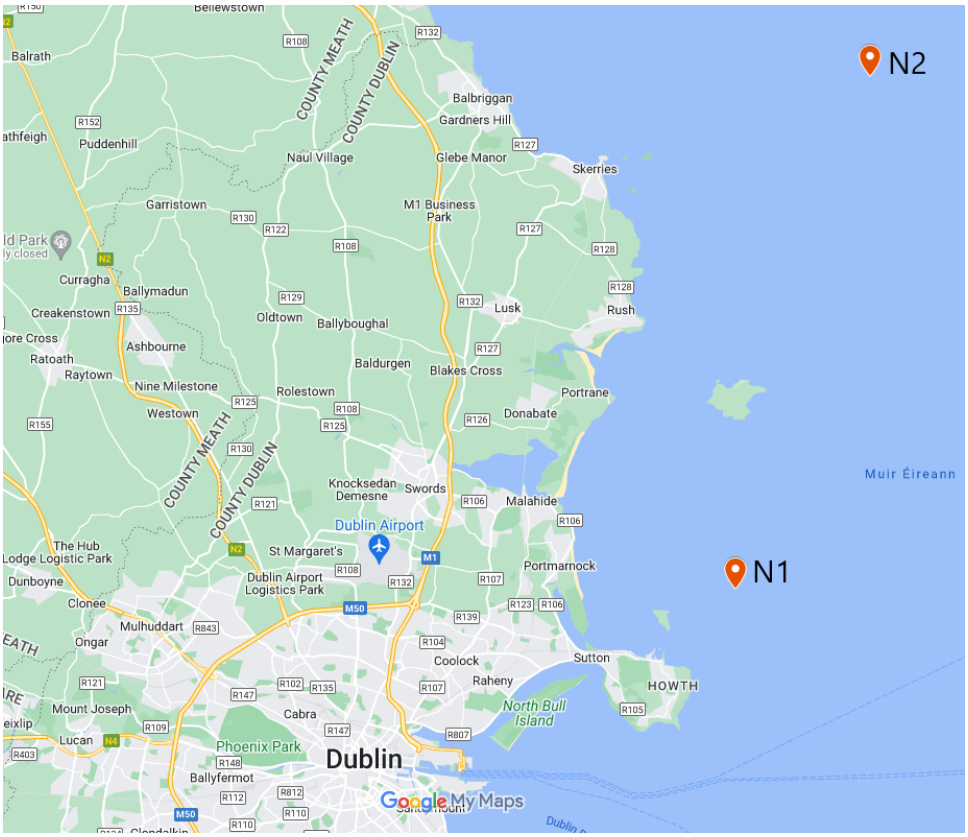

Figure 18. N1 and N2 Irish Sea nodal seawater sampling locations off the Dublin coast

6.4.2 Soil and sediments

The EPA commenced a soil monitoring programme in 2018. The soil analysis programme in Ireland is primarily focused on South-East of the country where the agriculture area is located; the main radionuclide measured is Cs-137.

Soil is sampled on one location in Dublin region (Figure 19).

Figure 19. Soil sampling locations

The primary focus of marine sediment programme in Ireland is on north-east coast and the Irish Sea. The goal is to assess the radiation dose to people in Ireland arising from discharges from Sellafield and the distribution of artificial radionuclides. Caesium-137, Potassium-40 and other gamma emitting radionuclides are measured in sediment to monitor levels of radionuclides from historic discharges; remobilisation from sediments is now the predominant source of marine radioactivity in the Irish Sea.

6.4.3 Foodstuffs

Two types of grains are sampled in Dublin region: Malting Barley and Milling Oats.

6.4.4 Mixed diet

Mixed diet sampling is carried out by EPA staff on a monthly basis from the main restaurant in the University College Dublin, Belfield. 1.5 – 2 kg fresh weight is collected. Recently, due to the COVID-19 restrictions implemented in May 2020, mixed diet samples have been sourced from an alternative restaurant within proximity to the EPA Radiation Laboratory. Caesium-137 and Potassium-40 are analysed on monthly samples and Sr-90 analysis is performed on annual bulked samples.

6.4.5 Feeding stuffs

No samples of individual feeding stuffs from the Dublin area are included in the monitoring program. Table VII shows a list of grains sampled in Dublin among other counties.

6.4.6 Marine biota

No samples of marine biota are included in Dublin monitoring programme.

7 ANALYTICAL LABORATORIES

7.1 RADIATION LABORATORY OF THE EPA

7.1.1 Introduction

The only laboratory participating in national environmental radioactivity monitoring in Ireland is the EPA radiation monitoring laboratory. It has ISO17025:2017 accreditation, awarded by the Irish National Accreditation Board (INAB)[19].

Since 2019, the EPA and Waterford Institute of Technology (WIT)[20] have a Service Level Agreement (SLA), which includes development of a new gamma spectrometry laboratory at the College to support the national monitoring arrangements under the 'National Plan'. To accommodate this arrangement, a new gamma detector was purchased and loaned to the WIT under the SLA to establish a new environmental radioactivity measurement service. Collaboration with the WIT continues with EPA Radiation Laboratory staff hosting training sessions for WIT staff as required.

For many years, EPA has had an informal arrangement with the Radiation Physics Laboratory, School of Physics, University College Dublin to ensure their analytical equipment remains available for use by the EPA in the event of failure of EPA analytical equipment, power failure in Dublin or for additional analysis capacity.

The EPA signed a cooperation agreement with Hirosaki University Japan in 2019 which strengthens collaboration on radioanalytical laboratory projects and facilitates staff exchange.

Tc-99 measurements in seaweed and biota are outsourced to the GAU-Radioanalytical Laboratories (UK) that have performed these tests in recent years.

7.1.2 Sample registration and preparation

Sample registration and identification is done through the EPA's Laboratory Information Management System (LIMS). This is a commercially available LIMS (Labware LIMS Version 7) configured for use in the EPA.

Each sample is logged in the laboratory's sample preparation area with a unique identifier for tracking in the laboratory and for reporting purposes. The EPA Radiation Laboratory uses the *Handling of Test and Calibration Items* procedure (QP7.4) for the registration and identification of samples. This procedure includes requirements for the transportation, receipt, handling, protection, storage, retention, and disposal or return of test or calibration items, including all provisions necessary to protect the integrity of the test or calibration item, and to protect the interests of the laboratory and the customer. Appropriate precautions are taken to avoid deterioration, contamination, loss or damage to the item during handling, transporting, storing/waiting, and preparation for testing or calibration.

Upon receipt of the test or calibration item, any deviations from specified conditions are recorded. When there is doubt about the suitability of an item for test or calibration, or when an item does not conform to the description provided, the laboratory consults the customer for further instructions before proceeding and records the results of this consultation. When the customer requires the item to be tested or calibrated acknowledging a deviation from specified conditions, the laboratory includes a disclaimer in the report indicating which results may be affected by the deviation.

When items need to be stored or conditioned under specified environmental conditions, these conditions are maintained, monitored and recorded.

[19] http://www.inab.ie/

[20] WIT became the South East Technological University as of May 2022

Methodologies used to prepare samples before measurement are detailed in Table VIII. Radionuclides assessed on each type of sample and the measurement devices used are detailed in Table IX.

Table VIII. Sample preparation and counting techniques

Sample Type	Measurement	Sample Preparation	Counting Technique
High Volume Air Filter	Gamma emitters	Pack into 250 GEO, wait 5 days for decay of short-lived radon decay products	HPGe
Low Volume Air Filter	Gross beta	Wait 5 days for decay of short-lived radon decay products	Gas flow proportional counter
	Gamma emitters	None	HPGe
Rainwater	Gamma Emitters	None	HPGe
Drinking water	Gross alpha and beta	Acidification and thermal pre-concentration	LSC
	Radon	None	LSC
Mixed Diet	Gamma emitters	Drying and homogenisation	HPGe
	Sr-90	Ashing and Liquid-Liquid extraction	LSC Cerenkov counting
Milk	Gamma emitters	None	HPGe
	Sr-90	Ashing and Liquid-Liquid extraction	LSC Cerenkov counting
Fish, Shellfish and Seaweed	Gamma emitters	Drying and homogenisation	HPGe
	Pu238/239, Pu-240 and Am-241	Acid digestion and radiochemical separation using extraction chromatography	Alpha spectrometry
	Tc-99	Radiochemical separation (carried out by third party)	Gas flow proportional counting
Seawater	Cs-137	Radiochemical separation using AMP-PAN resin	HPGe

Table IX. Radionuclides assessed on different samples

Sample Type	Sample Measurement	Radionuclides assessed	Measurement Device Used	Counting Times
High Volume Air Filter	Bulked sample (4 filters per month)	Cs-137, Be-7	HPGe	7 days
Low Volume Air Filter	Individual filter (1 filter per month for each location)	Gross beta	Gas flow proportional counter	2 hours
	Individual filter (1 filter per month for each location)	Cs-137	HPGe	24 hours
Drinking water	Individual sample	Gross alpha and beta	Liquid Scintillation Counting	12 hours
	Individual sample	Cs-137	HPGe	24 hours
Mixed Diet	Individual sample	Cs-137	HPGe	24 hours
	Bulked sample (quarterly for each location)	Sr-90	LSC Cerenkov counting	100 minutes
Milk	Bulked sample (quarterly for each location).	Cs-137 I-131	HPGe	24 hours

	Individual sample for Ballyraggett			
	Bulked sample (quarterly for each location)	Sr-90	LSC Cerenkov counting	100 minutes
Fish, Shellfish and Seaweed	Individual sample	Cs-137, K-40	HPGe	3.5 days
	Annual composite for each location	Pu238/239, Pu-240 and Am-241	Alpha spectrometry	6 days
	Annual composite for each location	Tc-99	Gas flow proportional counting	Unknown
Seawater	Individual sample	Cs-137	HPGe	3.5 days

7.1.3 Measurement devices

The EPA Radiation Laboratory is equipped with the devices listed in Tabel X.

Table X. Measurement devices in the EPA Radiation Laboratory (status at the time of the verification)

Measurement Device	Detector #	Technical Details	Status
HPGe Gamma Spectrometry	1	Ortec GMX(co-ax, n)	Operational
	3	Ortec / Canberra(co-ax, p)	Under repair
	4	Ortec GMX(co-ax, n)	Under repair
	6	Canberra GCW2023 (well)	Under repair
	7	Ortec GMX(co-ax, n)	Operational
	8	Ortec GMX(co-ax, n)	On loan to WIT
	9	Ortec GMX(co-ax, n)	Not in operation
	10	Canberra GC7520/S (co-ax, p)	Operational
	11	OrtecGEM (co-ax, p)	Not in use
	12	OrtecGEM (co-ax, p)	Operational
	13	Canberra BEGe (semiplanar, p/tsw)	Operational
	14	Canberra SAGe (well, tsw)	Under repair
	15	Ortec GEM (co-ax, p/tsw)	Under repair
LSC	-	Perkin Elmer Tri-Carb 3170 TR/SL	Operational
	-	Hidex 300 SL	Operational
	-	Perkin Elmer Quantulus GCT 6220	Operational
Alpha spectrometry	1-32	4 x Canberra Alpha Analyst with 32PIPS detectors	Operational
Gas flow proportional counting	-	Berthold LB 770 10 channel low level counter	Operational
	-	Protean MPC 9604	Operational for air filters
NaI(Tl) Gamma Spectroscopy (5 No.)		Mirion Mobile Radiological FoodScreen System	Commissioned in 2022

7.1.4 Gamma spectrometry

At the time of the verification, the gamma spectrometry system in the EPA comprised 5 operational (and 5 under repair) HPGe detectors and 3 sample changers controlled by the Canberra Apex Gamma spectrometry software. Detectors are calibrated at least once every 3 years or when necessary, using certified multigamma standard solutions. Calibration is carried out using the ApexGamma software in

conjunction with GESPECOR software to take into consideration coincidence summing corrections. Annual background measurements are carried out by the EPA staff.

The gamma spectrometry system is maintained in-house using weekly QA checks with control charts investigating background, energy calibration and Full Width Half Maximum (FWHM) criteria for specific gamma energies, namely, Am-241 (59 keV), Cs-137 (661 keV) and Co-60 (1332 keV). Maintenance is carried out on the gamma spectrometry system every six months, as part of the laboratory's ISO 17025 QA and maintenance procedures. In addition, the EPA has a service contract with Mirion to resolve any major issues that arise with the system, this contract also includes two preventive maintenance visits from Canberra UK per year.

All gamma spectrometry results are calculated by the ApexGamma software using Canberra's Genie2000 software. The results are then imported into the EPA LIMS and any subsequent calculations to take into consideration e.g. dry to wet activity concentrations are performed there.

7.1.5 Liquid scintillation counting

The EPA Radiation Laboratory has three liquid scintillation counters, a Perkin Elmer TriCarb 3170 TR/SL, a Perkin Elmer Quantulus GCT 6220 and a Hidex 300SL super low level TDCR counter (*Figure* gure 20).

The Hidex 300 SL has been commissioned for non-accredited analyses (Wipe Tests). An operating procedure has been established and calibration performed. Instrument performance analysis is carried out as required.

The Tri-Carb 3170 TR/SL and Quantulus GCT 6220 LSCs are maintained in-house using Self Normalisation and Calibration (SNC) and Instrument Performance Analysis (IPA) checks on a weekly basis. These checks look at the instrument background and H-3/C-14 efficiency using control charts. In addition, the EPA has a preventative maintenance contract with Perkin Elmer Ireland that includes annual performance and maintenance checks.

Sr-90 counting efficiencies are determined on an annual basis. Gross Alpha Beta counting efficiencies are determined on an annual basis or following the change of scintillator batch. Radon in water counting efficiencies are determined on an annual basis or following the change of scintillator batch.

All activity calculations are performed in the EPA LIMS after the input of cpm results and other relevant data from the LSC.

Figure 20. Liquid scintillation counting equipment

7.1.6 Gas flow proportional counting

The EPA Radiation Laboratory has two gas flow proportional counters: one Berthold LB 770 and one Protean MPC 9604 (Figure 21). The Protean MPC 9604 is used to determine the gross beta activity in air filters. Berthold maintain their GPC on request and the most recent visit was in 2022. Maintenance on the Protean is carried out every six months by the EPA staff as part of the laboratory's ISO 17025 QA and maintenance procedures and external maintenance is provided by Ametek, the last visit occurring in 2022. It includes a background and counting efficiency checks on the detector's chambers. The Protean is calibrated for air filters every 12 months and QA is maintained through weekly checks and the use of control charts on the Protean system.

Figure 21. Gas flow proportional counter

7.1.7 Alpha spectrometry

The alpha spectrometry system comprises 32 PIPS detectors contained in 4 Canberra Alpha Analyst vacuum chambers operated by Canberra's ApexAlpha software. The PIPS detectors are annually calibrated using a certified multinuclide source. Annual background spectra are acquired and analysed using the ApexAlpha software. Maintenance on the alpha system is carried out every 12 months by EPA staff as part of the laboratory's ISO 17025 QA and maintenance procedures.

All activity calculations for plutonium and americium analyses are performed in the EPA LIMS after the manual input of raw counts from the alpha spectrometry system.

7.1.8 Quality assurance

Records of original observations, derived data, calibration records, test results and any other information necessary to establish an audit trail are kept for at least 5 years, according to the requirements of ISO 17025:2017 and the EPA's records management system.

Data on paper records is kept on the EPA filing system for a minimum of 1 year and might be transferred after this period to an external archive company. The computer records data is retained for a minimum of 5 years.

The laboratory uses the Compliance Management Software Paradigm 3[21] to maintain its procedures, staff training, auditing records and equipment records.

The determination of whether an analytical result is above or below detection limits is done using the Currie Minimum Detectable Activity (MDA) method.

[21] http://www.paradigm3.com.au/

For drinking water testing, the performance characteristics and methods of analysis (Rn-222, Gross Alpha/Beta, Ra-226 and Ra--228) are determined following ISO 11929:2019 regarding the decision threshold, detection limit and limits of the confidence interval.

The Labware LIMS is used by the laboratory to store all relevant information relating to individual samples (including sample type, location, test and result(s)). All sample tracking, from sample registration, test assignment, result entry (including automatic result import from other systems), sample authorisation and reporting is handled in the EPA LIM SQL server database. The LIMS handles also QA/QC control charts.

Other software used in the EPA radiation monitoring laboratory includes ApexGamma, ApexAlpha, Vista and Oracle. ApexGamma is a SQL server database containing all calibration, background, QA/QC and gamma result data related to gamma spectrometry. ApexAlpha is an MS Access server database containing all calibration, background and alpha result data related to alpha spectrometry.

The Vista database stores information such as calibration, background, QA/QC and gross beta activity in air results related to the Protean gas flow proportional counter.

The Oracle database stores the data of gamma dose rate measurements and the configuration of station parameters.

The laboratory participates annually in a range of interlaboratory comparison and proficiency test exercises. Recently it participated in:

- NPL Environmental Radioactivity Proficiency Test Exercises (Gamma Analysis)
- IAEA-ALMERA Intercomparison Exercises
- Max Rubner Institute; Raw Milk Proficiency Test Exercise (Gamma Spec and Strontium Analysis)
- EC Joint Research Centre; various schemes including Radon in Drinking water, Gross Alpha/Gross Beta in Drinking Water
- LGC Aquacheck; Gross Alpha and Gross Beta in Drinking Water and Air filters.

The EPA also participates in other relevant ILC/PT schemes as they arise.

8 VERIFICATIONS

8.1 INTRODUCTION

Verification activities were carried out in accordance with the agreed programme. This chapter summarises the verifications carried out by the verification team. The team has assessed the monitoring arrangements based on their own expertise and comparison with similar arrangements in other Member States.

The outcome of the verification is expressed as follows:

- A '*Recommendation*' is made when there is a clear need for improvement in implementing Art. 35. These are included in the main conclusions of the verification. The Commission requests a report on the implementation of the recommendations – lacking implementation of a recommendation can lead to a reverification.
- A '*Suggestion*' is made when the verification team identifies an action, which would further improve the quality of the monitoring.

In addition, the team may '*commend'* particularly good arrangements, which could serve as a best practice indicator for the other EU Member States.

8.2 RADIATION LABORATORY OF THE EPA

8.2.1 General

The verification team visited the radioanalytical laboratories of the EPA (Radiation Monitoring Laboratory) located in the same building as the EPA offices in Dublin. The EPA Radiation Monitoring Laboratory is the only ISO 17025 accredited laboratory in the country for the measurement of radioactivity in environmental and food samples. The laboratory runs different surveillance programmes related to water, marine, food, drinking water, soil, air, etc.

The radioanalytical laboratories of EPA are well equipped with state of the art equipment. Written procedures are in place for all analytical techniques used in the laboratory. Most of the analyses are accredited under ISO 17025 accreditation. The Irish authorities (INAB) regularly audit the system.

LIMS is used to manage the different samples and their related analytical data for most of the analytical techniques. Only trained staff is allowed to use LIMS.

All counting equipment is situated in the same room, while samples are prepared in a different area.

The laboratory has good working facilities and adequate staff. No equipment shortage was noticed by the verification team. The EPA Radiation laboratory operates with five permanent employees and one contractual staff member, supplemented by three senior laboratory managers. Staff members are trained to perform the different analyses. In case of a radiation emergency, external assistance may be needed to cope with the increased workload.

The EPA's water laboratories located in Kilkenny, Monaghan, Castlebar and Dublin are equipped with gamma monitors used to screen a variety of samples for radioactivity including water, seawater, dairy products, vegetation, grains, meat, eggs, fish, baby food, etc..

No remarks.

8.2.2 Sample collection and preparation

EPA has arrangements in place for the collection of samples by other organisations:

- Dairy inspectors collect milk samples.
- Agricultural/Veterinary inspectors collect meat, grain.
- Local authorities collect drinking water samples from public and private supplies.
- Met Eireann collects air filter samples.

- Environmental Health officers sample food/pharma imports.
- Civil Defence collects soil and grass samples in an emergency scenario.

The verification team visited the sample receipt and preparation room. Different types of samples (food, water, filters) are handled separately. At the time of the visit a PhD student was working on marine samples for radioactivity analysis. An example of the labelling and preparation of a food sample was shown to the verification team.

The verification team also visited the chemistry laboratory where samples are prepared for liquid scintillation counting, using physico-chemical preparation techniques. The chemistry laboratory is accredited for Sr-analyses.

No gamma analyses are performed for water samples at the moment in the laboratory; the EPA has no plans to introduce these analyses in the monitoring programme at present.

The verification team notes that grass and vegetables are not part of the routine EPA sampling programme. The verification team was informed that a comprehensive soil and grass survey was undertaken in 2022 in Ireland.

The Radiation Monitoring Laboratory in the EPA has a separate room for handling contaminated samples. A separate entry in the laboratories building can be used in case of an emergency.

No remarks.

8.2.3 Gamma spectroscopy

The Radiation laboratory is equipped with ten HPGe gamma detectors for gamma analyses of radionuclides. Calibration of the gamma detectors is done every third year. Efficiency, energy and FWHM checks are performed weekly. A 24h background check is performed every 3 months. Procedures which form part of the quality system are used for all analyses. The analysis is operated under ISO17025 accreditation.

No remarks.

8.2.4 Liquid scintillation counting

The laboratory is equipped with two Perkin Elmer LSCs (Quantulus GOT 6220 and Tri-Carb 3170 TR/SL) and one HIDEX (Figure 20). The analyses performed with the liquid scintillation counters are gross alpha/beta in water and mixed diet samples, Sr-90 analyses in water, wipe tests and C-14 analyses. The equipment suppliers perform the maintenance of the equipment: Canberra, Perkin Elmer. The majority of the analyses are carried out under ISO17025 accreditation.

No remarks.

8.2.5 Alpha counting

In the EPA Radiation monitoring laboratory four Canberra Alpha Analyst spectrometers are used for multi-isotope sample measurements. Long background counting is performed once a year (two weeks) and quick background checks (20 min) weekly. The analysis is operated under ISO17025 accreditation.

The alpha analysers are used for Pu/Am determination in marine samples and for Polonium analysis in marine biota samples for the PhD project ‘Radioactivity in the Irish Coastal Environment‘.

No remarks.

8.2.6 Proportional counters

The verification team verified the two Gross Proportional Counters (Ar gas): one Protean and one Berthold, located in the Counting room. The detectors are used for gross beta analysis of low-volume air filters. Efficiency checks are conducted on an annual basis. Once a week, standard checks are performed. The background is monitored once a month.

Data is stored on the PC and on the paper files, there is no direct data input to LIMS.

Standards are prepared on site, but there is a plan to buy also commercial standards.

The verification team suggests further automation of the data transfer to the LIMS system.

8.2.7 Sample storage

Environmental monitoring samples are kept until they have been authorised and reported, or for a maximum period of 5 years. Food is kept for 3 months and then disposed of. Marine biota and fauna samples are frozen and kept for three years. Air filters are kept for maximum 1 year.

No remarks.

8.3 ENVIRONMENTAL SAMPLING

8.3.1 Air

Radioactivity concentration in air is continuously monitored in Ireland with low volume monitors, low volume samplers and two high volume air samplers. The EPA Radiation Laboratory at Clonskeagh Road in Dublin hosts one Low Volume Monitor and one Sampler.

EPA

The verification team verified the new aerosol sampler recently installed, replacing the old sampler at the outside backyard of the EPA (Figure 22). The sampler is a low volume air sampler and it is operated by the EPA. The complete system is a Bespoke unit designed by Berthold technologies with an airflow of approx. 6 m^3/h. The system is equipped with a GFA filter and a TEDA impregnated charcoal cartridge, which is only installed during an emergency or tests. Gaseous iodine is not yet measured routinely in Ireland but there is a plan to measure it in the near future.

Figure 22. Aerosol sampler at the EPA garden

No radioactivity detectors are fitted to the low volume sampler. The filter is collected weekly and analysed in the EPA laboratory for gamma spectroscopic analysis using a HPGe detector and total beta analysis using a gas flow proportional counter.

The verification team was informed that under the redevelopment plan, the air monitoring network will comprise 11 low volume offline monitors, 11 low volume online samplers and two high volume samplers. From all planned 11 locations for aerosol samplers, 8 are already ready to receive the new equipment. 3 new sites are being reconsidered due to local siting arrangements.

The verification team suggests that the EPA establish gaseous iodine measurement capabilities in routine operation.

University College Dublin

The verification team verified the high volume air sampler in University College Dublin, Belfield. This Snow White high volume air sampler is currently installed on the roof of a building of UCD (Figure 23). The system is functional, airflow was 900 m^3/h. Filter change procedure was explained to the team.

A new site at UCD for the high volume aerosol/monitoring is being built on the ground to replace the existing site on the roof, as that building is due to be demolished as part of a UCD campus upgrade.

No remarks.

Figure 23. Snow white (high-volume air sampler) at the UCD

8.3.2 Atmospheric deposition

The verification team verified the precipitation/rain collector installed at EPA garden (Figure 24). There are 10 such collectors in Ireland, 4 in the Dublin region. The collector is a high density polyethylene precipitation collector with a 2.5 litre collection bottle. The funnel for rain water collection is mounted approx. 1.75 m above ground. In Dublin rainwater is collected over one month, then measured for Cs-137 and other gamma emitting radionuclides. The sample is kept for two weeks, then disposed of.

Figure 24. Precipitation collector at the EPA

During the visit at the Casement Aerodrome site, the verification team verified the precipitation collector, similar with the collector installed at the EPA garden (Figure 27).

No remarks.

8.4 ON-LINE AND OFF-LINE MONITORING STATIONS

8.4.1 EPA

The verification team visited the equipment installed at the EPA premises in Clonskeagh.

The verification team visited the ambient gamma dose rate IGS421-H DLM-1450 station located at the EPA garden (Figure 25). There are 6 such stations in Ireland as part of the current network. In the same garden, one MIRA GDR station was being tested before installation at the final location. Several other MIRA stations (part of the network redevelopment plan) were waiting to be tested and installed in the final position. In total 23 MIRA GDR stations will be installed in Ireland.

No remarks.

Figure 25. Ambient gamma dose rate station IGS at the EPA garden

8.4.2 Defence Forces, Gormanston Camp

The verification team verified the GDR MIRA station installed at the Gormanston Camp (Figure 26). The station is the first GDR MIRA installed on the final position as part of the network redevelopment plan. 23 MIRA gamma dose rate stations will be installed in Ireland, replacing the old GDR stations.

No remarks.

Figure 26. GDR MIRA at the Gormanston Camp

8.4.3 Casement Aerodrome

The verification team verified the gamma dose rate station located on the Casement Aerodrome site, (Figure 27). The station is an IGS421-H DLM-1450 with monitoring range 10nSv/h – 10Sv/h, duplicated LD tubes and a rain sensor. The IGS station is electrical powered, has a 48 h min battery backup and dial up data transmission. There are 6 similar IGS stations installed in Ireland. Data collected from the stations is transmitted to EURDEP.

The verification team was informed, that a new site for the environmental monitoring equipment is being built at the Casement Aerodrome.

No remarks.

Figure 27. Precipitation collector and GDR IGS station at the Casement Aerodrome

8.5 EMERGENCY MONITORING

8.5.1 Environmental Protection Agency

In Emergency the EPA relies on co-operation with the Defence Forces and the Civil Defence Units, providing advice to the monitoring teams. However, these services do not have mobile capability for air sampling.

The EPA possess dose rate meters and contamination monitors which can be used for emergency monitoring.

The verification team suggests that the EPA establishes air sampling (particulate and gaseous iodine) mobile capability.

8.5.2 Defence Forces

Defence Forces Units have the capability to monitor dose rates, in addition specialist DF EOD Teams can identify radionuclides and take samples if required. The DF does not have an airborne capability for radiation monitoring.

The verification team verified the following equipment available at the Cathal Brugha Barracks in Dublin (Figure 28):

- Siemens Electronic Personal Dosimeter, EPD Mk2
- Canberra RDS-100 Radiation Detection System (handheld)
- RADOS RDS-200 Universal Survey Meter (handheld)
- Exploranium GR-135 DNC radiation Identification Device (handheld)

No remarks.

Figure 28. Equipment available at the Gormanston Camp

8.5.3 Civil Defence

The verification team visited the Civil Defence Unit in Dublin. The Civil Defence has 28 units spread through the country, which operate under the local organization. Approximately 2500 people are involved in total; each unit has one permanent officer and one assistant; the rest are volunteers.

The Civil Defence Branch Headquarters provide radiation training to all teams and perform tasks under the National Plan, including sampling of grass and soil around the country for analysis by the EPA, and organize exercises periodically.

The verification team was informed that EPA organised and facilitated a national nuclear emergency exercise on 29th September 2022, chaired by the Department of the Environment, Climate and Communications (DECC) with over 20 government departments and public bodies participating, as well as observers from the UK and Northern Ireland.

All Civil Defence Units are equipped with portable gamma and gamma - neutron detectors, with integrated software for measurement readings (Kromek D3M PRD). 38 dose rate meters are available in all counties, with 3 pieces and a few spares available in Dublin. 25 drones are ready to be used nationwide by the members of the units using artificial intelligence and machine learning to position a drone with a radio repeater. These drones do not have the capability of radiation monitoring, but Civil Defence is exploring the development of an application for mobile devices to send dose rates directly to Civil Defence HQ and to the EPA. There is a possibly of adding more value with photos of samples, sample sites, and meteorological observations at the time of sampling.

The verification team verified the available equipment (dose rate meters) (Figure 29).

No remarks.

Figure 29. Dose rate meters used by the Civil Defence

9 CONCLUSIONS

All planned verification activities were completed successfully. The information supplied in advance of the visit, as well as the additional documentation received during and after the verification activities, proved very useful.

The information provided and the verification findings gave rise to the following observations:

(1) Overall, the environmental radioactivity monitoring programmes in Dublin comply with the requirements of Article 35 of the Euratom Treaty.

(2) The verification activities found that the facilities needed to carry out continuous monitoring of levels of radioactivity in air, water and soil in Dublin are adequate. The Commission ascertained that these facilities are in operation and running efficiently.

(3) The verification activities found that the facilities needed to carry out monitoring of levels of radioactivity in the air, water and soil in the event of a radiological emergency in Dublin are adequate. The Commission ascertained that these facilities are continuously available.

(4) A few suggestions have been formulated. They concern in particular monitoring of gaseous radioactive iodine in routine operation and in an emergency. Notwithstanding these suggestions, the verified parts of the monitoring system for environmental radioactivity in Dublin are in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

(5) The team's conclusions are set out in the 'Main Conclusions' document addressed to the Irish competent authority through the Ireland Permanent Representative to the European Union.

(6) The verification team acknowledges the excellent cooperation it received from all people involved in the activities it undertook during its visit.

ANNEX 1

VERIFICATION PROGRAMME

EURATOM ARTICLE 35 VERIFICATION IRELAND (DUBLIN)

16 - 19 NOVEMBER 2021

Tuesday, 16 November 2021

15:30 - 17:00 Opening meeting

The Environmental Protection Agency (EPA)

(*Block 3, Clonskeagh Square, Clonskeagh Road, Dublin 14, D14 H424, Ireland*)

- European Commission Art. 35 verification programme introduction
- Discussion on past verifications in Ireland by the Commission
- Overview of radioactivity monitoring arrangements in Ireland
    - Presentations
        i. The National Radiation Monitoring Network - Niall Murphy
        ii. Environmental Radiation Monitoring – Simon O'Toole
        iii. Emergency Preparedness – Kevin Kelleher
        iv. Radiation Protection Regulations – Noeleen Cunningham
- Verification planning

Wednesday 17 November 2021

09:00 – 10:00 Radioactivity monitoring arrangements in Ireland and Dublin

The Environmental Protection Agency (EPA)

- Dose and dose rate monitoring
- Air sampling
- Soil sampling
- Water sampling
- Food sampling
- Mobile monitoring systems
- Emergency monitoring systems
- Public information arrangements

10:00 – 12:00 Visit of monitoring facilities close to Dublin

- The dry/wet deposition collector, the air sampler (off-line) and the gamma dose rate station in Clonskeagh
- The high volume air sampler in University College Dublin, Belfield
- The gamma dose rate station and the rainwater sampler in Casement Aerodrome

13:00 – 17:00 Visit of selected monitoring facilities

- National Radiation Monitoring Network site (airborne particulates station) at Gormanston Camp, Camp Rd, Irishtown, Co. Meath.

Thursday 18 November 2021

09:00 – 13:00 **Verification of radioactivity monitoring laboratory ORM**

Environmental Protection Agency,
(*3 Clonskeagh Square, Clonskeagh Road, Dublin 14, Ireland*)

- Introduction to the analytical programme of the laboratory
  - Introduction – Lorraine Currivan
- Visit to the laboratory facilities
  - PPE/Lab coats, H&S/Emergency Exits, COVID etc.
  - Introduction to Lab Facilities – Held in Main Labs
    - 0930-0955 hrs; Food – Aoife Kinahan (25 mins)
    - 0955-1020 hrs; E-DWD – Lee Nolan (25 mins)
    - 1020-1115 hrs; Counting Room (LSC, GPC, Gamma, Alpha system) (All) (55 mins)
    - 1135-1200 hrs; Instrument Calibration Laboratory – Josh Walsh (25 mins)
    - 1200-1225 hrs; Product Certification Service – Máirín O'Colmáin (25 mins)
    - 1225-1250 hrs; Marine/Soil & Emergency Preparedness – Olwyn Hanley (25 mins)

14:00 **Verification of emergency radioactivity monitoring facilities**
(Defence Force's Radiological Monitoring teams)

- Mobile radiation equipment (Cathal Brugha Barracks, Rathmines, Dublin)

16:00 **Verification of Civil Defence Team's mobile emergency monitoring systems**
(Civil Defence, Phoenix Park, Dublin)

- Emergency monitoring equipment verification (Civil Defence, Ratra House, Phoenix park)

Friday 25 November

09:00 – 11:00 **Closing meeting**

Environmental Protection Agency