METROLINK

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Bonneagar Iompair Éireann
Transport Infrastructure Ireland

NTA
Údarás Náisiúnta Iompair
National Transport Authority

Rialtas na hÉireann
Government of Ireland

Tionscadal Éireann
Project Ireland
2040

MetroLink Railway Order

MetroLink PFAS Management Strategy for Dublin Airport

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Acronym	Meaning
µg/kg	Micrograms per kilogram
µg/l	Micrograms per litre
ABP	An Bord Pleanála
AC	Assessment Criteria
AFFF	Aqueous Film Forming Foam
bgl	Below Ground Level
BoD	Base of Drift Deposits
Bw/Day	Bodyweight per Day
C4SLs	Category 4 Screening Levels
CEC	Contaminant of Emerging Concern
CEMP	Construction Environmental Management Plan
CL:AIRE	Contaminated Land: Applications in Real Environments
CLEA	Contaminated Land Exposure Assessment
CMUP	Upper Member of Malahide Formation
CSM	Conceptual Site Model
CTO	Tober Colleen Formation
CWA	Waulsortian Formation
daa	Dublin Airport Authority
DANP	Dublin Airport North Portal
DAS	Dublin Airport Station
DASP	Dublin Airport South Portal
D-Wall	Diaphragm Wall
DWD	Drinking Water Directive
EA	Environment Agency
ECHA	European Chemicals Agency
EFSA	European Food Standards Agency
EIAR	Environmental Impact Assessment Report
EMS	Electro-mechanical Sub-System
EPA	Environmental Protection Agency
EPB	Earth Pressure Balance

Acronym	Meaning
EQS	Environmental Quality Standard
EU	European Union
FCC	Fingal County Council
FT	Fehily Timoney
6:2 FTAB	6:2 fluorotelomer sulfonamidoalkl betaine
FUEL	Furthering Understanding of Emissions from Landfilled Waste Containing POPBFRs and PFASs
GAC	Generic Assessment Criteria/ Granular Activated Carbon
GHG	Greenhouse Gas
GI	Ground Investigations
GQRA	Generic Quantitative Risk Assessment
GSI	Geological Survey Ireland
GWB	Groundwater Bodies
HDPE	High Density Polyethylene
HTI	HighTemperatureIncineration
IARC	International Agency for Research on Cancer
IEX	Ion exchangers
km	Kilometre
LI	Locally Important Aquifer
LOD	Limit of Detection
m	Metre
mbgl	Metres Below Ground Level
m/s	Metres per Second
MAC	Maximum Admissible Concentration
NASAH	North Apron South Apron Hub
ND	Not Detected
ng/L	Nanograms per Litre
OECD	Organisation for Economic Co-operation and Development
OPW	Office of Public Works
PFAS	Per and Polyfluoralkyl Substances
PFECHS	Perflouroethylcyclohexane
PFBS	Perfluorobutane Sulfonate

Acronym	Meaning
PFCAs	Perfluorocarboxylic Acids
PFDA	Perfluorodecanoic Acid
PFHpA	Perfluoroheptanoic Acid
PFHpS	Perfluoroheptanesulfonic Acid
PFHxDA	Perfluorohexadecanoic Acid
PFHxS	Perfluorohexane Sulfonic Acid
PFNA	Perfluorononanoic Acid
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
PFOSA	Perfluorooctanesulfonamide
PFPE	Per- and Polyfluoroalkyl Ether
PFPeA	Perfluorovaleric Acid
PFSAs	Perfluorosulfonic Acids
PI	Poor Aquifer, Bedrock which is Generally Unproductive except for Local Zones
POPs	Persistent Organic Pollutant
QBL	Black Boulder Clay
QBR	Brown Boulder Clay
Qx	Made Ground
RO	Railway Order
SCL	Sprayed Concrete Lining
SWL	Static Water Level
t	Tonnes
T2	Dublin Airport Terminal 2
TBM	Tunnel Boring Machine
TFS	Trans Frontier Shipment
TMMS	Triage and Material Management Centre
TII	Transport Infrastructure Ireland
TWI	Tolerable Weekly Intake
UKEA	United Kingdom Environmental Agency
UWR	Upper Weathered Rock
WFD	Water Framework Directive

1. Introduction

The purpose of this Report is to address the concerns raised by the Wild Ireland Defence/Sabrina Joyce Kemper submission and outline to An Bord Pleanála (ABP) how the MetroLink project (hereafter referred to as the proposed Project) will manage per- and polyfluoroalkyl substances (hereafter referred to as PFAS) contamination if encountered during the proposed Project construction works at Dublin Airport.

This Report also presents an updated assessment of the potential environmental effects of the proposed Project works at Dublin Airport and the manner in which any adverse environmental impacts arising from the presence of PFAS will be mitigated. This updated assessment has been prepared in light of information contained in the Dublin Airport 2021-2023 Environmental Monitoring Report, daa 2024 (Fehily Timoney, 2024, hereafter referred to as the daa Report), which was released into the public domain following the conclusion of the Oral Hearing and on Transport Infrastructure Ireland's (TII's) subsequent sampling and testing at Dublin Airport in September/October 2024. This assessment has been conducted by relevant subject matter experts, who authored the Environmental Impact Assessment Report (EIAR), along with PFAS specialists, and updates the assessment in the EIAR in light of the additional information now available.

TII has prepared a comprehensive management strategy to address the potential risks associated with PFAS at the airport to achieve the following:

- **Prevention of PFAS mobilisation and transfer:** Measures will be implemented to prevent the mobilisation or transfer of PFAS to the receiving environment during the construction and operational phase of MetroLink, should PFAS be encountered; and
- **Avoidance of Preferential Pathways:** The proposed Project will ensure that no preferential pathways are created that could facilitate the transfer or migration of PFAS.

To achieve this, TII will employ a combination of treatment strategies, onsite management practices, and design solutions. These measures will be aligned with international best practices for managing PFAS, ensuring the highest standards of environmental protection and safety.

The proposed Project has adopted an approach to management of PFAS-containing material encountered during the construction phase that is entirely consistent with the precautionary principle. In order to ensure that the environmental assessments carried out in relation to impacts of any such PFAS-containing material encountered are based on conservative assumptions, the project has assumed a worst-case scenario where all excavated material at Dublin Airport has the potential to contain detectable PFAS. This conservative assumption is made to ensure that the magnitude of the impacts is not underestimated.

The precautionary principle, as adopted by TII, pertains to the management, containment and treatment of PFAS-containing material and relates to limits of detection, protection measures and export as a means for dealing with PFAS containing material. TII has adopted this principle as a management strategy to take protective measures to prevent harm, especially given the current uncertainty about the full extent of the PFAS contamination at Dublin Airport and the risk it poses to the wider environment.

The worst case scenario is an assessment methodology used to evaluate the potential impacts of a project under the most adverse conditions. In this case, it involves assuming that all excavated material at Dublin Airport is contaminated with PFAS. This approach ensures that the environmental assessment does not underestimate the potential impacts, allowing for a more comprehensive evaluation of the risks and necessary mitigation measures.

By ensuring that PFAS management approaches are centred around the precautionary principle and combining the worst case scenario with the precautionary principle in its approach to environmental assessments, the project ensures that all potential risks are addressed comprehensively and proactively.

Based on the current availability of treatment options, the project has identified methods to effectively manage PFAS.

Excavated soils that are not impacted by PFAS will be reused subject to meeting the requirements under Article 27 of the European Communities (Waste Directive) Regulations 2011-2020[1]. Due to the lack of a coherent regulatory framework for the management, treatment or re-use of PFAS contaminated material, any excavated material encountered with levels of PFAS above the Limit of Detection will be exported for treatment and/or disposal.

The limit of detection for excavated materials is assumed to be 1µg/kg for most individual PFAS (noting that some PFAS, have a higher limit of detection). A limit of detection of 1µg/kg is considered to be the lowest reliable limit currently offered by analytical laboratories because this represents the threshold at which analytical laboratories can consistently and accurately detect and quantify the presence of PFAS in excavated materials without significant interference or error.

However, if specific limits and/or legislative changes are introduced in Ireland that specify procedures or binding thresholds for the re-use and disposal of PFAS, these requirements will be adhered to.

1.1 Expert Input from PFAS Specialists

Recognising the complexity and importance of managing PFAS contamination, a team of international PFAS specialists were engaged to review information and data on PFAS and contribute to this report with their insights and recommendations. This team of experts provided strategic advice and insights from their extensive experience in working on projects in which PFAS have been found to be present. The specialists involved include:

- Dr Jane Thrasher: Director in Land Quality and Jacobs UK PFAS lead. With 30 years' experience, she provided expert guidance on PFAS characterisation and analysis for MetroLink while overseeing the drafting of this report;
- Dr Karl Bowles: Senior Principal Environmental Scientist with Jacobs and Adjunct Associate Professor at the University of Queensland. With over 30 years of experience, he developed and assessed treatment options for soil and water for MetroLink;
- Brad Simmons: Jacobs' Technical Director for Contaminated Land for Asia Pacific. With 30 years experience, he provided strategic advice on treatment and management of PFAS-contaminated materials during construction; and
- Dr Dora Chiang: Global Principal for PFAS and Contaminants of Emerging Concern (CECs) at Jacobs. With over 25 years experience, she reviewed the report and provided specialist advice to the MetroLink project team.

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[1] A Notification was made to the EPA under Article 27 (now referred to as Regulation 27) of the Waste Management Act (as amended) in November 2021. This notification was made to propose the reuse between 2.1 and 2-7million m3 of suitable excavated soil and rock arising from the MetroLink project on another site. A revised notification was submitted to the EPA in December 2024 where this volume was reduced to between 1.8 and 2.5million m3 to account for potentially PFAS contaminated material and a specified limit for PAH.

The report was also prepared with the necessary input from the various subject matter experts that were involved in the preparation of the EIAR. The following experts were involved:

- Dr. Ronan Hallissey: Environmental Lead for the MetroLink project responsible for the co-ordination and development of this report;
- James Maloney: Construction Advisor who provided logistical detail on material management and construction site layout for the management and triage of material potentially contaminated;
- Matt Foy: Traffic and Transport Advisor for MetroLink, who evaluated the potential for impacts on traffic and transport due to the proposed PFAS Management Strategy;
- Ewan Pringle: Soils and Geology specialist on the MetroLink project who oversaw the consideration of potential impacts on soils and geology associated with the PFAS management activity;
- Carl Hughes/Sara Craze: Waste and Materials Management specialists on the MetroLink project who oversaw the consideration of potential impacts of the PFAS management activity on waste management;
- Teri Hayes: Hydrology and Hydrogeology specialist for the MetroLink project who oversaw the consideration of potential impacts on water quality in surface waters and groundwater;
- Jennifer Harmon: Noise & Vibration specialist for the MetroLink project who oversaw the consideration of potential impacts on the receiving environment resulting from noise and vibration associated with the PFAS management activity;
- Dr. Avril Challoner, Air Quality & Climate specialist for the MetroLink project who oversaw the consideration of potential impacts on air quality and on greenhouse gas (GHG) emissions associated with the PFAS management activity;
- Dr.Martin Hogan: Human Health specialist for the MetroLink project who oversaw the consideration of potential impacts on Human Health associated with the PFAS management activity.

2. Background to PFAS

PFAS are a large group of man-made chemicals with over 4,700 identified compounds. These chemicals have been used in a variety of industrial and consumer products due to their unique properties. They are characterized by multiple fluorine atoms attached to a carbon chain, making them highly resistant to degradation and persistent in the environment (hence why they are often referred to as "forever chemicals"). Due to their strong chemical bonds, PFAS do not easily degrade or break down. This means they can remain in the environment for a long time and some are also considered bio accumulative (meaning that they can build up in the tissues of living organisms over time).

PFAS have been used since the 1950s in various industrial, commercial, and household products due to their water and oil resistance, and chemical and heat stability. Common sources of PFAS contamination include textiles and paper and painting/printing facilities, oil extraction and mining facilities and facilities which produce medical devices, pharmaceuticals and pesticides. A wide variety of everyday consumer goods are produced with PFAS: stain resistant carpets and upholstery, water-repellent clothing, fire-fighting foam, high-performance hydraulic fluids, papermaking, printing inks, sealants, the interior coating of non-stick cookware, greaseproof food packaging, biocides household agents such as cleaning agents and impregnation sprays. Of particular relevance to the proposed Project, PFAS are also found in aqueous film forming foams (AFFF). Although PFAS containing foams have generally been replaced with fluorine free foams, they were in use over many decades in fire suppression systems and in fire-fighting equipment. During historic fire training, fluorinated foams were discharged to ground and this dispersive use has resulted in PFAS contamination at airports throughout the world (Goldenman *et al*., 2019) which is important in the context of Dublin Airport.

Many PFAS are both mobile and soluble in water, which means they can easily move through water systems. However, they also have a tendency to stick to surfaces. Once released, PFAS can persist for decades, and be dispersed many miles from their original point of release. PFAS are not just one substance; they represent a large and diverse group of man-made chemicals. They are typically found as a complex mixture of many substances, all of which have slightly different properties, behaviours and chemical structures.

PFAS are recognised as Contaminants of Emerging Concern, due to their potential adverse ecological and human health effects. This designation means that as scientific understanding continues to evolve, regulations and management strategies are also developing. However, at present, most PFAS remain unregulated, posing challenges due to their persistence and toxicity at low concentrations.

This report uses the term PFAS to refer collectively to all per and polyfluoralkyl substances, as well as to individual PFAS and groups of PFAS. Annex I provides detailed information on the main PFAS relevant to this assessment. The PFAS of most relevance to this assessment includes Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) as they are the most commonly found PFAS at Dublin Airport and are subject to most regulation.

2.1 Health Effects of PFAS

PFAS are a health concern, primarily due to their persistence in the environment and human body. These chemicals have been detected at low levels in people's blood worldwide, with higher levels in communities with contaminated water supplies and workplaces. Research indicates that exposure to certain PFAS may lead to adverse health outcomes, although the full extent and variety of these effects are still being studied.

In 2020, the European Food Standards Agency (EFSA) set a new safety threshold for four specific PFAS (PFOA, PFOS, PFNA, PFHxS) at 4.4 ng/kg bw/day (i.e. 4.4 nanograms per kilogram of body weight per day). This threshold was set with a focus on the immune system's response to vaccination, marking a shift from their 2018 focus on increased cholesterol levels. In 2023, the International Agency for Research on Cancer (IARC) classified PFOA as "carcinogenic to humans" (Group 1) and PFOS as "possibly carcinogenic to humans" (Group 2B), based on varying levels of evidence.

Other health effects associated with exposure to different PFAS include increased cholesterol levels, lower antibody response to vaccines, and impacts on the liver and thyroid. There is currently no consensus on the specific levels of exposure to PFAS that result in adverse health effects, and research globally remains ongoing on this. This uncertainty has led the project to adopt a precautionary approach, one that is conservative to ensure that it is effectively managed. By assuming a worst-case scenario, the project aims to mitigate any potential risks associated with PFAS contamination.

2.2 Legal Regulation of PFAS

In Ireland, the regulation of PFAS is governed by both European Union (EU) law and national legislation. Control and regulation is also supported by existing non-specific guidance referring to e.g. 'polluting substances'. Additionally, some PFAS are also classified as Persistent Organic Pollutants (POPs) under the Stockholm Convention, to which Ireland is a signatory.

2.2.1 Current Regulation

Currently, regulation is focussed on small number of individual PFAS chemicals and related compounds. There are ongoing discussions in the EU regarding updates to PFAS legislation, encompassing a wider range of PFAS. These proposals include:

- Potential restrictions on the future use of any PFAS,
- Establishing stricter drinking water standards, and
- Setting revised Environmental Quality Standards (EQS) for PFAS.

The final form of these legislative changes, their timeline for finalisation, and their implementation is still unclear.

2.2.2 PFAS regulated under the Stockholm Convention

The Stockholm Convention on Persistent Organic Pollutants (**POPs**)[2] was established in the early 1990s in response to growing concerns about the adverse effects of POPs on global human health and the environment. This international treaty aims to eliminate or restrict the production and use of POPs worldwide. Perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and perfluorohexane sulfonic acid (PFHxS) are all currently listed as POPs under Stockholm.

2.2.3 PFAS in the EU POPs Regulation

The EU POPs Regulation (Regulation (EU) 2019/1021 on persistent organic pollutants as amended by Regulation (EU) 2022/2400), which implements the Stockholm Convention in the European Union, categorises substances into different annexes: Annex I lists substances prohibited from manufacturing, placing on the market, and use, while Annex IV lists substances subject to waste management rules as per Annex V.

[2] Persistent Organic Pollutants are organic chemical substances which pose a risk to human health and the environment due to their persistence in the environment, bioaccumulation through the food chain and long-range environmental transport across a wide geographical range. They are present in a variety of manufactured materials including car parts, electronic equipment, soft furnishings, and some firefighting foams.

PFOS and its derivatives are included in both Annex I and IV of the original EU POPs Regulation, with several use and concentration-based specific exemptions on intermediate use or other specification. Since 4 July 2020, PFOA, its salts and PFOA-related substances were included in an amendment to Annex I of the EU POPs Regulation with a number of use and concentration based specific exemptions for intermediate use or other specifications. PFHxS, its salts and PFHxS-related substances were added to Annex 1 in May 2023.

2.2.4 Implementation in Ireland

The European Union (Persistent Organic Pollutants) Regulations 2020 (as amended) implement the EU POPs Regulation in Ireland (the Irish POPs Regulations) and provides the regulatory framework for the management of some PFAS chemicals. This includes prohibiting the production, placing on the market and use of prohibited substances under Article 3, and the managing of stockpiles containing these substances under Article 5 of the EU POPs Regulation.

2.2.5 Current Regulation of PFAS in Environmental Media in Ireland

The current regulatory position relative to the regulation of PFAS in soil, groundwater, surface water and drinking water is set out below.

5.2.2.1 Soil

The EU recognises the need for more comprehensive monitoring and regulation of PFAS across all environmental media, including soil (European Environment Agency, 2024). While some Member States have national legislation with specific thresholds for PFAS in soil, a harmonized EU-wide approach has not yet been developed. In Ireland, there are no specific guidelines, regulatory thresholds or screening criteria for PFAS in soil for on-site or off-site treatment, disposal or containment. The EPA Guidance On The Management Of Contaminated Land And Groundwater at EPA Licensed Sites describes the general risk based approach to be taken to the management of land contamination.

5.2.2.2 Groundwater

The Groundwater Directive does not specify EU-wide quality standards for PFAS, leaving it to Member States to set their own threshold values. A review of the European Communities Environmental Objectives (Groundwater) Regulations 2010, 2016 and 2022 reveals no current threshold values or specific provisions for PFAS chemicals in the context of groundwater quality assessment in Ireland.

5.2.2.3 Surface water

The European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2019 provide specific EQS for PFOS. Table 12 of these regulations lists the EQS for priority hazardous substances, including PFOS:

- AA-EQS (Annual Average): 0.65 x 10^{-4} µg/l (0.65ng/l) for inland surface waters and 1.3 x 10^{-4} µg/l (1.3ng/l) for other surface waters; and
- MAC-EQS (Maximum Allowable Concentration): 36 µg/l (36,000ng/l) for inland surface waters and 7.2 µg/l (72,000ng/l) for other surface waters.

2.2.6 Drinking Water Directive

The Drinking Water Directive (Directive 98/83/EC) concerns the quality of water intended for human consumption. Its objective is to protect human health from adverse effects of any contamination of water intended for human consumption. The limits for PFAS prescribed under the EU Drinking Water Directive (DWD) will become effective in Ireland in on 11 January 2026 under the European Union (Drinking

Water) Regulations 2023. More specifically, a PFAS Total of 0.5µg/l (500ng/l) and a Sum of PFAS of 0.1µg/l (100ng/l) will apply. The Sum of PFAS applies to a specified list of 20 individual PFAS.

2.2.7 Proposed amendments to the Water Framework Directive, the Groundwater Directive and the Environmental Quality Standards (EQS) Directive

In October 2022, the European Commission proposed amendments for consultation to the Water Framework Directive, the Groundwater Directive and the Environmental Quality Standards (EQS) Directive. These amendments proposed a threshold for a sum of 24 PFAS would be 4.4ng/L 'PFOA equivalent' in both groundwater and surface water. The objective was to achieve 'Good' water chemical status by 22 December 2033.

This proposal has since been updated by a mandate for negotiations with the European Parliament dated 19th June 2024. The updated mandate recommends that the groundwater EQS should be harmonised with the drinking water standard, rather than the surface water EQS. Additionally, it recommends an additional groundwater quality standard of 4.4ng/L for the sum of the four 'most problematic' PFAS identified by the EFSA, which include: PFOS, PFOA, PFNA, PFHxS.

3. Baseline Conditions Associated with PFAS in the Dublin Airport Area

3.1 Baseline Conditions and PFAS Monitoring at Dublin Airport

The assessment of baseline conditions where the proposed Project crosses Dublin Airport Authority (daa) lands at Dublin Airport is derived from the following baseline data:

(i) Chapters 18 Hydrology, 19 Hydrogeology and 20 Soils and Geology of the EIAR, and related appendices;

(ii) Monitoring data since the proposed Project RO application; and

(iii) Information from the daa Report.

The primary evidence that the proposed Project works may encounter ground and groundwater impacted by PFAS is derived from the daa Report, which documents the results of PFAS monitoring in and around the airport 2021-2023. This report was released into the public domain by daa in April 2024 (after the conclusion of the six-week Oral Hearing). Having regard to the contents of the daa Report, it was concluded that the proposed Project works will require additional mitigation to protect the environment during the project construction phase and the operational phase.

Monitoring conducted during the preparation of the EIAR for the proposed Project did not detect the presence of PFAS in groundwater in the area of the airport. Although trace PFAS were found in the soil, these were at very low levels – right at the detection limit and below the screening values adopted for the assessment (Section 4.3.1 of Appendix A20.8). As a result, PFAS had not been assessed as contaminants of significant concern in the EIAR.

The daa Report provides detailed information on locations within Dublin Airport where PFAS are known to have been used, including current and former fire stations and fire training grounds. It also provides information on where PFAS have been subsequently found in soils, groundwater and surface water. This includes some areas of stockpiled materials excavated during previous construction projects, as well as areas where PFAS may have migrated from the original source use areas. While none of these areas of known PFAS impact coincide directly with the proposed Project works, the scope of investigation to date has been limited to specific airport project locations. TII are satisfied however that the level of ground investigations and information available for our review is sufficient to inform the Conceptual Site Model (CSM) (discussed further below) and mitigation strategies.

3.2 Geological, Hydrogeological and Hydrological Context for PFAS Migration at Dublin Airport

Understanding the geology, hydrogeology and hydrology is important for interpreting the baseline monitoring data and assessing the potential extent of PFAS migration beyond the initial source areas. The geology of the area consists of fractured limestone bedrock covered by glacial drift deposits. The upper surface of the limestone is weathered. The Dublin Airport Station area is located on a local topographic high, which coincides with a high point in the underlying limestone, resulting in bedrock at the natural ground surface. The limestone is a fractured rock aquifer, and its weathered surface has higher permeability. The drift (soil) deposits are mainly cohesive material with low permeability although there are some sandier layers or horizons.

Based on the data and analysis presented in Chapter 19 Hydrogeology and Appendices of the EIAR, the groundwater flow in the Dublin Airport can be characterised as follows:

(i) Regional groundwater flow: generally towards the east;

(ii) Local groundwater flow: away from the topographic high at the proposed Dublin Airport Station location, along the MetroLink alignment to the north, and also to the south;

(iii) Groundwater presence: found at depth in the limestone and, and shallow groundwater is also locally present within the glacial till;

(iv) Connection Uncertainty: There is some uncertainty with regards to how these water units are connected; and

(v) Surface water bodies: Numerous surface water bodies rise from the topographic high point where the airport is located, and flow eastwards towards the sea. Some of these water bodies receive direct discharges from the airport drainage system.

The ground conditions, hydrogeology and hydrology for the Dublin Airport area are described in Annex A.

3.3 Potential Sources of PFAS at Dublin Airport

The environmental monitoring described in the daa Report shows the presence of PFAS in soil, groundwater and surface water at the following locations at Dublin Airport:

- **Former Fire Station at the North Apron, approximately 400m west of the proposed Project alignment:** Elevated PFAS concentrations were recorded in both the soils and both shallow and deep groundwater sampling at this location. A fire station operated at this site between 1940 and 2000. It is understood PFAS-containing AFFF may have been stored at this site and that PFAS may have been released to ground during fire training exercises.
- **East Area of the North Apron**: Monitoring undertaken at this location approximately 100m east of the proposed Project alignment has identified elevated levels of PFAS here in soil (Monitoring for North Apron South Apron Hub (NASAH) project) and in the groundwater, including deep groundwater at the elevation of the tunnel. The highest PFAS concentrations in groundwater were reported in this area. The source of the PFAS in this area has not been identified by the daa Report.
- **Apron 5H:** Elevated PFAS was identified in stockpiles, made ground and concrete at the northern side of the North Apron, including on land overlying the proposed Project alignment. The material had been reportedly imported to that area from construction projects across the airport campus. The highest soil PFAS concentrations were reported in this material. No groundwater testing was undertaken by daa in the Apron 5H area.
- **Castlemoate House, approximately 250m east of the proposed Project alignment:** Monitoring has identified that PFAS is present in groundwater in the overburden and in relatively shallow bedrock but not in deeper bedrock. This site has been identified as a historic unregulated waste disposal site.
- **Current fire station, approximately 1.1km east of the proposed Project alignment:** PFAS have been identified within surface water. The highest PFAS concentrations in surface water were recorded in these drains.
- **Former Fire Fighting Training Ground at the North Runway (APEC5), approximately 2km west of the proposed Project alignment**: PFAS were identified here in the soil (Fehily Timoney, 2021) and in groundwater. This location was used as a firefighting training ground until 2000.

The available information indicates that PFAS are present at detectable levels in groundwater close to or within the proposed construction area. Therefore, it is possible that PFAS impacted ground and groundwater will be encountered during the construction works if not mitigated. While the PFAS levels are detectable, they are low, making it unlikely that any perceptible impacts from the localised MetroLink activities will be distinguishable from the broader impacts that have already occurred.

3.4 Summary of PFAS in Soils, Groundwater and Surface Water

The following summary provides an overview of PFAS detection in soils, groundwater and surface water, with further technical details available in Annex A.

Due to the available laboratory detection limits and levels at which PFAS can be found within the environment, the use of ng/l for water and µg/kg for soil are commonly used units when discussing PFAS concentrations. These units, nanograms per litre (ng/l) for water and micrograms per kilogram (ug/kg) for soil, represent extremely small amounts of PFAS, highlighting the precision required to measure these contaminants accurately. Essentially, they indicate how many parts of PFAS are present in a billion parts of water or a million parts of soil, respectively.

3.4.1 PFAS in Soils

There are currently no regulatory guideline values for PFAS in *in-situ* soil. For the purposes of this assessment, an environmental limit value of 1 µg/kg is adopted for PFAS in soils. This is the detection limit cited in the Article 27 submission.

The results of PFAS testing of soils included in the daa report can be summarised as follows:

- **Dublin Airport Departures Road:** Six samples, up to 1.5m below ground level (bgl), not detected.
- **West Apron Underpass Project:** Nine boreholes, up to 37m bgl, 27 soil samples, PFAS not detected.
- **North Apron South Apron Hub - South Apron Area:** Eighteen soil samples, all at 0.5m bgl, PFAS not detected.
- **Proposed Apron 5H redevelopment, April 2022:** Thirteen trial pits, 47 samples up to 2m bgl, PFAS detected in 21 samples, highest concentration 141µg/kg PFOS; October 2022-March 2023; PFAS detected in 71 out of 114 samples, highest concentration 568µg/kg PFOS.
- **North Apron South Apron Hub (NASAH):** PFAS detected in 12 out of 61 samples analysed, highest concentration 113µg/kg PFOS.
- **North Runway:** PFAS detected in 10 out of 14 samples, highest concentration 151µg/kg PFOS.

The results of PFAS testing of soils for the proposed Project in the vicinity of Dublin Airport can be summarised as follows:

- **MetroLink 2019:** Four samples, PFOS detected, equalling limit of detection of 1µg/kg in one sample; and
- **MetroLink 2021:** Eighteen soil samples tested for PFAS, PFOS detected, equalling limit of detection of 1µg/kg in one sample.

The sample testing in 2021 was carried out as part of the Article 27 Notification process.

3.4.2 PFAS in Groundwater

There are currently no regulatory guideline values for PFAS in *in-situ* groundwater. For the purposes of this assessment (and in the absence of a regulatory guideline), data have been assessed relative to the drinking water standard of 100ng/l for the sum of 20 PFAS (meaning that the sum of these 20 compounds should not exceed this limit). The surface water environmental quality standard of 0.65ng/l for PFOS is also potentially relevant where groundwater may be discharged to surface waters.

PFAS monitoring of groundwater has been undertaken at various locations both by daa and for the proposed Project. The monitoring shows variable levels of PFAS in the groundwater on different monitoring occasions. Laboratory limits of detection have also varied as described below. It should be noted that the analytical detection limits for PFAS in water are 2 to 3 orders of magnitude lower than the analytical detection limits for PFAS in soil (this means that the smallest amount of PFAS that can be detected in water is 100 or 1,000 times smaller than the smallest amount that can be detected in soil).

The results of PFAS testing of groundwater included in the daa report can be summarised as follows:

- **North Apron:** Nine wells, 12 monitoring rounds, PFAS detected in all wells; highest sum of 20 PFAS concentration 3,180ng/L at GW015D, around 10mbgl, highest PFOS 246ng/l at GW001 around 2mbgl. Monitoring also showed the localised elevated presence of other PFAS typically associated with AFFF and other airport activities, including 6:2 FTAB and Perflouroethylcyclohexane (PFECHS);
- **Castlemoate House:** Seven wells, PFAS occasionally detected in 6 wells, variable levels. Highest sum of 20 PFAS concentration 642ng/L at BH1A, highest PFOS 55.4ng/l at BH06;
- **North Runway / APEC 5:** Eleven wells, 4 monitoring rounds, PFAS detected in 10 wells; highest sum of 20 PFAS concentration 4,111ng/L at GW11, highest PFOS 192ng/l at GW11; and
- **Water Supply Well and Offsite Reservoir:** Two locations, highest sum of 20 PFAS concentration 3.33ng/L at Gardener's Well (note the off-site reservoir is north of Dublin Airport and not within the area of influence of MetroLInk).

The results of PFAS testing of groundwater for the MetroLink project in the vicinity of Dublin Airport can be summarised as follows:

- **MetroLink 2019:** Four wells, 2 monitoring rounds, no PFAS detected above LOD (LOD for PFOS = 50ng/l);
- **MetroLink 2021**: Seven water samples, no PFAS detected above LOD (LOD for PFOS = 100ng/l); 5 water samples, no PFAS detected above LOD (LOD for PFOS = 2ng/l); and
- **MetroLink 2024:** Twelve monitoring wells, 2 rounds of monitoring, PFAS detected at all locations on at least one occasion, maximum sum of 20 PFAS 31 ng/l, maximum PFOS 7.8ng/l (LOD for PFOS = 0.2 ng/l). 6:2 FTAB and PFECHS detected in groundwater in central airport area.

3.4.3 PFAS in Surface Water:

The current environmental quality standard (EQS) for PFOS in surface water is 0.65ng/l (Annual Average). PFOS is currently the only PFAS regulated in surface water in Ireland, however the EU is proposing to introduce for the sum of 24 PFAS (meaning that instead of just regulating PFOS, the new regulations would set limits for the combined factored total of 24 different PFAS compounds).

A comprehensive surface water monitoring program was conducted at Dublin Airport from 2021 to 2023, covering both landside and airside areas. The monitoring locations and waterbody nomenclature are detailed in the daa Report, with specific locations illustrated in Figure A-1 and summarized in Annex A.

3.4.3.1 Surface Water Drainage System:

The airport's surface water drainage system includes pipes and manholes, discharging via oil interceptors at various perimeter points:

- North Apron and north runway drainage flows towards the north-east to the Sluice River;
- North-west airport drainage flows towards the upper tributaries of the Ward River;
- Surface water from the current fire station and fire training ground discharge to the Cuckoo Stream; and

- Other watercourses including Kealy's WAD, Turnapin (Mayne) and Santry are also likely to receive surface water drainage from the airport.

3.4.3.2 Monitoring Data in summary

Monitoring was conducted at discharge points and watercourses around the airport, with data summarized in Table A 8 Summary of daa Surface Water Monitoring:

- PFOS was detected in all locations except S1, S3 (upstream on the Santry), and M1 (a manhole on the Mayne catchment). PFOS was above the EQS of 0.65ng/l in all locations it was detected;
- Individual PFAS were reported at all monitoring locations; and
- Monitoring near the fire station and firefighting training ground showed PFOS concentrations ranging from 16.5 ng/L to 116 ng/L.

3.4.3.3 Key Findings

- Elevated PFAS levels were found at multiple locations within the airport boundary and downstream to the east;
- The highest PFOS concentration in surface water (50.6 ng/L) was detected in the Cuckoo stream;
- Downstream reduction in PFAS concentration was observed but not substantial;
- 6:2 FTAB and/or PFECHS detected in Sluice, Kealy's, Cuckoo, and Mayne up to around 3km downstream of the airport;
- Monitoring of the Santry river south of the airport showed relatively low PFAS levels, indicating a baseline not impacted by direct airport sources; and
- West and north of the airport, Broadmeadow/Ward monitoring showed sporadic elevated PFAS levels, with recent data indicating consistently low levels, possibly due to changes in drainage post-North Runway completion.

3.4.3.4 EPA Monitoring

The EPA monitors surface water quality, including PFAS, and reports data on their website. The MetroLink alignment intersects several watercourses, and available PFAS data for these water bodies have been reviewed. Out of the 10 water bodies crossed by the MetroLink route, water quality data are available for 8, but PFAS data are only available for two: Sluice_010 and Ward_030. The Sluice_010 water body, monitored at station RS09S070200 near Dublin Airport, showed elevated PFAS levels, including 6.8 ng/l PFOS, 99 ng/l 6:2 FTAB, and 7.5 ng/l PFECHS. In contrast, the Ward_030 water body, monitored at two stations north-west of the airport, exhibited low PFAS levels, with PFOS and PFOA below 1 ng/l and other PFAS below 5 ng/l. See Annex A for further detail.

3.5 Interpretation and Contextualisation of Baseline Data

The baseline assessment indicates that historic airport activities have resulted in localised PFAS impact to soil and groundwater at concentrations above the assessment criteria, with some migration from the original source areas into the wider environment within the airport. This includes elevated PFAS in groundwater in the North Apron area, adjacent to the proposed Project and at similar ground elevation to the proposed Project works.

To contextualise the issue at Dublin airport, it is useful to compare these findings against what is happening elsewhere. Brusseau *et al.* (2020) compiled data from published studies of PFAS concentrations in soils. The study examined data from non-contaminated soils and found that total PFAS background concentrations ranged from <0.001µg/kg to 237µg/kg, with a median of 2.7µg/kg. In contrast, concentrations reported for PFAS-contaminated sites were generally orders-of-magnitude greater than background levels, particularly for PFOS. Maximum reported PFOS concentrations ranged upwards of several hundred mg/kg.

In this context the concentrations of PFAS recorded in soil at Dublin Airport, with a maximum of 568µg/kg are lower than those recorded at many published PFAS-impacted source sites. Much of the data fall into the range reported within background soil from around the world.

Ackerman Grunfeld *et al.* (2024) collated PFAS concentration data from over 45,000 surface and groundwater samples from around the world. They showed that a substantial fraction of sampled waters exceeds PFAS drinking water guidance values, with the extent of exceedance depending on the jurisdiction and PFAS source. Around 18% of all samples had less than 4ng/L sum of 20 PFAS, while 21% of samples had more than 100ng/L sum of 20 PFAS. The highest PFAS concentration reported is 27 million ng/L.

The concentrations of PFAS recorded in groundwater at Dublin Airport, with up to 3203.94ng/L recorded in GW15D in the North Apron close to the proposed Metrolink, are relatively high compared to the collated dataset, but well below the highest concentrations recorded on some sites heavily contaminated with PFAS.

Monitoring of surface waters indicates PFOS is above the EQS in all water courses where it was detected at and near the airport. Locally PFOS significantly exceeds the EQS, with elevated PFAS concentrations in watercourses likely related to airport activities, particularly to the east of the airport.

The PFOS levels at Dublin Airport are not unusually high compared to typical PFOS levels reported in Watere Framework Directive (WFD) monitoring in England. The UK Environment Agency (2019) summarised PFOS non-targeted surveillance monitoring data from approximately 470 freshwater sites in England. The data illustrate a wide range in concentrations of PFOS across England and, in some cases, high exceedances of the EQS (0.65ng/L). The annual average EQS for PFOS was exceeded in 92% of freshwater sites monitored. Measured concentrations over 100 times higher than the EQS threshold (above 65ng/l) were recorded in less than 1% of sites monitored. The results from surface waters around Dublin Airport are within this range.

4. MetroLink Construction Phase Sources of PFAS

4.1 Introduction

The MetroLink project will not generate any additional PFAS during the construction phase but has potential, if not mitigated, to mobilise PFAS that is already in the soil, bedrock and/or groundwater.

This section presents an overview of the construction phase of MetroLink at and around Dublin Airport and outlines a PFAS Management Strategy that will ensure that potential for preferential pathways created by the proposed Project for PFAS are minimised during the construction phase.

4.2 Proposed construction works which may encounter materials impacted by PFAS

The construction works with the main risk of encountering and potentially mobilising PFAS contaminated material are:

- ***Diaphragm Wall Piling (D-Walls):***This involves forming reinforced below ground concrete perimeter wall/seals before excavating the station/tunnel portal structures. This process can disturb contaminated soil and groundwater.
- ***Portal and station excavation and dewatering:*** excavation and dewatering within the confines of the D-wall structures until the structure is watertight following completion of the base slab can mobilise PFAS.
- ***Tunnelling works using a Tunnel Boring Machine (TBM):*** to form the main running tunnel and two shorter tunnels either side for ventilation and evacuation. Although the TBM automatically lines the tunnel as it is cuts, resulting in no significant water infiltration during the tunnelling, the initial excavation and set-up can still disturb contaminated materials.
- ***Crossing or Working Adjacent to Water Bodies***: The works will also cross or have works adjacent to a number of rivers and streams along the alignment of the MetroLink immediately to the north and south of Dublin Airport. This proximity increases the risk of PFAS mobilization into surface water bodies.

Once potentially contaminated material has been excavated, the handling and transport of this material could create a significant risk of PFAS mobilisation if not effectively managed. It is estimated that the quantum of excavated material to be managed at Dublin Airport is approximately 304,000m^3 and the breakdown of this figure is provided in Annex B and management of the same is addressed in Annex F.

4.3 Conceptual Site Model for MetroLink Construction

A CSM is a representation of the environmental conditions at site based upon the available information and provides an overview of the site's characteristics, potential contamination sources, pathways, and receptors. A CSM is a tool used in environmental management and remediation to identify contamination sources, map out how contaminants might travel through the environment, and identify potential receptors. A key principle of the CSM is 'pollutant linkage' where a receptor could be exposed to contaminant(s) via a linking pathway, and which requires all three elements of the CSM to be present; a risk from a contaminant is unlikely to be realised if a pathway or receptor are not present. The outputs of the CSM are used to identify effective mitigation measures based on an understanding of the preferential pathways.

A CSM was prepared for the proposed MetroLink construction works. A detailed explanation of the potential PFAS sources which informed this model, along with migration pathways for groundwater, surface water and other potential receptors is provided in Annex C.

Based on the available data on PFAS distribution, the key findings from the CSM are as follows:

- ***PFAS Sources:*** The primary sources of PFAS are linked to historical activities using PFAS containing substances such as firefighting foams and hydraulic fluids in the airside zone of the airport. The primary PFAS source areas identified within the daa report include the current and former fire station and firefighting training grounds, former landfill at Castlemoate House and soil stockpiles at Apron 5H.
- ***Impact on MetroLink:*** MetroLink construction will not interact with or affect the PFAS primary source areas, nor will it contribute further to the PFAS loading contamination in the environment. However, the presence of PFAS has been confirmed in the groundwater within the North Apron area at a depth within the bedrock where tunnelling is proposed.
- ***PFAS Presence at MetroLink Station Location:*** At the proposed Dublin Airport MetroLink station location PFAS have not been detected in the shallow soils or groundwater. However, given the presence of PFAS has been identified elsewhere around the airport, the possibility of PFAS within the groundwater at this location cannot be discounted.
- ***Surface Water Contamination:*** According to the daa Report, surface water from the runways and aprons drains directly to the airside surface water drainage system. The surface water then discharges directly to surface water bodies surrounding the airport via oil / water interceptors around the airport. PFAS have been detected within the Sluice River, the Cuckoo Stream, and the Mayne River which are traversed by the MetroLink. They are also present in Kealy's Stream and the Ward Stream whose catchment areas are traversed by the MetroLink. However, it should be noted that neither the tunnelling nor the major excavation works associated with MetroLink will interact with these watercourses.

While the available information has identified a number of PFAS sources and enabled the development of a conceptual model for potential PFAS transport, there are information gaps. These gaps are primarily due to the lack of PFAS data in soil and groundwater for large areas of the daa land including the south apron, DASP, north runway and DANP. In order to address the uncertainty arising from these identified data gaps, a number of conservative assumptions have been made to ensure that the project's proposed management strategies are developed to address the potential worst-case scenario arising at this location. These assumptions are outlined in the next section.

4.4 Assumptions Used as a Basis for the Proposed Management Strategy

As the full extent of PFAS contamination is unknown, a worst case is assumed that 100% of excavated material at Dublin airport will be contaminated and will require management. This conservative scenario is not expected to be realised but is assumed here to demonstrate that even in this very unlikely scenario PFAS will be effectively managed. A full list of assumptions is outlined in Table 4.1.

Table 4.1 Assumptions

Ref	Assumption
1	**Screening Criteria for Soil Management**: For the purposes of assessing options for soil management, it is assumed that the screening criteria for which soil arisings will be deemed to require further management for PFAS will be the limit of detection, which is assumed to be 1µg/kg for most individual PFAS (noting that some PFAS, have a higher limit of detection). A limit of detection of 1µg/kg is considered to be the lowest reliable limit currently offered by analytical laboratories.

Ref	Assumption
2	**Extent of PFAS Contamination in Excavated Material:** As limited information is known about the extents of PFAS contamination, it is assumed that 100% of excavated material will be contaminated and will require management (with the 100% scenario being considered to be extremely conservative to the point of being highly unlikely).
3	**Extent of PFAS Contamination in Water:** As limited information is known about the extents of contamination, it has been conservatively assumed that 100% of the surface water and groundwater are contaminated.
4	**Turnaround Time for Lab Results**: While an approved laboratory has confirmed their standard turnaround time for provision of results from subsoil sample collection is 15 days, we have conservatively assumed material will be stored on site for up to 28 days in case of any delay.
5	**Types of PFAS expected:** Based on the daa Report, the types of PFAS which are anticipated to be encountered are those associated with aviation activities, which include a wide range of long chain, short chain PFAS and precursors.
6	**Sampling for *Ex Situ* Soil Classification:** If *Ex-situ* soil classification is to be undertaken, it is assumed that one representative composite sample will be undertaken per 1,200m^3 of material and that this will represent a maximum volume for individual stockpiles (this is also the maximum daily excavation volume). EPA guidance for sampling for waste disposal is 1 sample per 2000 tonnes (t), which is c. 1,400m^3 of material.
7	**PFAS in Limestone Rock:** While no data has identified the presence of PFAS concentrations in limestone rock within the vicinity of the project area or the wider airport; the potential for PFAS to be present (in concentrations above 0.5 µg/kg) in rock is based on the known presence of PFAS in groundwater in the limestone in the vicinity of the project works, as per The daa Report.
8	**Soil Treatment:** While it is anticipated that technological readiness and commercial availability for the treatment or disposal of PFAS in large volumes of soil will continue to improve in the coming years, the evaluation undertaken within this Report was conservatively based on the technological readiness and commercial availability of treatment technologies available at the time of writing.
9	**Water Treatment**: Technological readiness and commercial availability for the treatment of PFAS in water is currently available and well established overseas. While it is anticipated that this situation will improve in Ireland in the coming years, the evaluation undertaken within this Report was conservatively based on the lack of availability in Ireland at the time of writing
10	**Requirement for Waste Licence:** Any on-site management of potentially contaminated material may require a waste licence from the EPA. The transport of potentially contaminated material would require a waste transfer permit from the relevant Local Authority.

The proposed Project has undertaken significant work to characterise the potential for PFAS mobilisation arising from the proposed Project works at Dublin Airport and on this basis has adopted a highly precautionary and conservative stance to managing potential PFAS contamination. This strategy involves two key components: (1) the development of a comprehensive CSM based on a detailed analysis of available baseline data and (2) the adoption of conservative assumptions to address data gaps so as to ensure that the environmental assessments adequately assess the impacts even in a worst case scenario. The CSM provides a detailed representation of the site's environmental conditions, based on available data identifying potential contamination sources, pathways, and receptors. Although the CSM provides a robust representation of the potential sources, pathways and receptors, it is acknowledged that a full characterisation of the sources of PFAS airport is not available. In order to address this uncertainty, the project has assumed a worst-case scenario where 100% of the excavated material is contaminated, even though this is a highly unlikely scenario.

This approach guarantees that management strategies are robust enough to handle the most severe potential outcomes, thereby preventing unforeseen environmental impacts. By preparing for the worst-case scenario, the project aligns with the precautionary principle, ensuring compliance with environmental regulations and providing additional assurance to stakeholders that all necessary precautions are being taken to protect the environment.

5. Management Strategy for Soil

An evaluation was undertaken to identify effective treatment options for managing soils/rock contaminated with PFAS, specifically for the proposed Project works at Dublin Airport. The evaluation began with a longlist of potential technologies, which were then narrowed down based on their effectiveness, availability and suitability for this specific site. The process was informed by the experiences and practices from other jurisdictions. The longlist of treatment options considered and the final shortlist of treatment options are provided in Annex D.

A range of *in-situ* remedial options are widely used to manage PFAS contamination globally. They are however unsuitable for this project as the material to be managed is excavated soil and rock from tunnelling. A range of *ex-situ* remedial options effective at managing PFAS contamination have been identified and considered. *Ex-situ* destructive methods including high temperature incineration are unlikely to be a practicable solution for large volumes of soil and rock with low concentrations of PFAS contamination and are not available in Ireland.

Ex-situ Immobilisation, involving treating the soil to immobilise PFAS contamination within the soil matrix prior to disposal in a landfill or engineered containment cell, was identified as a potential option. These methods do not destroy the PFAS, but are effective at reducing the risk by locking the PFAS in and preventing migration. However, this option was deemed impractical within Ireland due to the lack of available suitable landfill sites and local treatment facilities with the necessary permissions from the EPA.

Ex-situ soil treatment has also been considered. However there is just one such facility in Ireland licenced to receive any material containing PFAS (operated by Enva, https://enva.com/news-pr/soil-treatment-and-site-decontamination-services) and its capacity is understood to be limited.

The evaluation concluded that the only workable strategy is to export the contaminated materials for treatment overseas. This strategy involves transporting the contaminated soil/rock/fill overseas for either treatment, destruction, or landfill. This approach is necessary due to the absence of local facilities within Ireland capable of handling such PFAS materials at volume. This ensures that the contaminated materials are handled in a manner that mitigates environmental and health risks, given the current limitations of local treatment options.

This approach has been adopted by daa for the remediation of stockpiles of PFAS contaminated soil associated with the Apron 5H redevelopment at Dublin Airport. It is understood that over 150,000 tonnes of PFAS impacted soil was removed and treated in overseas facilities, including in Belgium and Norway (See https://www.dublinairport.com/docs/default-source/sustainability-reports/daa-PFAS-FAQ.pdf).

Another example of this approach is the remediation of a former airport at Svea in Svalbard, Arctic Norway (https://perpetuum.no/en/about-pfas/disposal-of-afff-foam-from-airport/). A total amount of 50,000 tonnes of PFAS contaminated soil was transported from Svalbard by ship to a landfill in northern Norway.

There are a number of licenced facilities in other European countries where there is capacity for treatment of PFAS contaminated soils including an Indaver site in Belgium where incineration and encapsulation solutions at large scale are offered.

6. Management Strategy for Water

An evaluation was also undertaken of the available PFAS treatment technologies for water contaminated with PFAS that may be encountered during excavation works, soil leachate generation and water run off from stockpiled soils. This assessment identified several treatment methodologies (including a combination of treatment/management options) to manage PFAS contaminated water:

- Granular Activated Carbon: this method uses activated carbon to adsorb PFAS from water, effectively removing the contaminants;
- Ion Exchange: this process involves exchanging ions in the water with ions in synthetic and polymeric media, which captures and removes PFAS; and
- Foam Fractionation: this technique separates PFAS from water that uses air and turbulence to generate bubbles creating a foam of concentrated contaminants at the top of the water column for removal.

All three of the above treatment options are viable for the treatment of PFAS impacted waters for the proposed Project. A treatment train comprising a combination of one or more of these technologies will be deployed.

Technology selection requires consideration of water quality, throughput, treatment objectives (endpoints), and regulatory compliance requirements. It is important to note that none of these methods actually destroy the PFAS, rather they concentrate the PFAS in a form which can then be destroyed, for example by high temperature incineration. Residues will need to be treated for spent sorbent, particularly if granular activated carbon is utilised. This will be achieved by transport (likely export) for reactivation or incineration. A summary of the water treatment options is provided in Annex E.

7. Site, Material Handling and Transport Management

7.1 Introduction

A strategic plan has been developed for the management of excavated materials during the construction phase to ensure there is no potential for PFAS contamination to the environment resulting from the proposed Project during this phase. Included in this strategic plan are proposals for:

- Management & Control protocols, which are an addendum to the Outline Construction Environmental Management Plan (CEMP);
- Further ground investigation; and
- Water Treatment.

7.2 Overview

The quantity of excavated materials containing PFAS to be managed will be determined by early identification of the three main construction sites and tunnel at Dublin Airport. In advance of construction commencement, *in-situ* classification of soils and water through Dublin Airport will be carried out by ground investigation sampling and tests at each location and where access is available across the tunnel alignment under the airport. The results from the pre-construction *in-situ* classification process will determine the baseline for the control of PFAS contamination levels at these sites.

However, for the purpose of establishing a robust PFAS management plan, a preliminary estimate based on the worst-case scenario that 100% of excavated material has the potential to be contaminated has been undertaken. For this analysis, it is conservatively assumed that all excavated material will be contaminated with PFAS and will need to be stored on-site while testing confirms or otherwise the presence of PFAS.

While engagement with testing laboratories suggests that test results can be achieved in 21 days experience from projects around the world including UK, Australia and the United States indicates that laboratory analysis times can be extended when industry capacity cannot meet demand, so a minimum of 28 days storage is assumed for excavated material.

While awaiting test results, materials will be safely stored and securely covered to prevent leachate runoff into surrounding sites, streams, or groundwater. Excavated materials will be stockpiled in a segregated area, with a single test conducted on a composite sample from each stockpile. (See Annex F for further detail) Once classified based on test results, materials will be diverted to an approved site for re-use in Ireland if within PFAS acceptance limits, or to an approved treatment facility in Europe for treatment and disposal if outside of PFAS acceptance limits.

To control the potential volume of excavated materials, assuming 100% of material will need to be tested, an area of approximately 25,000m² will be required to triage for PFAS by holding materials for testing and classification prior to onward transport to disposal. The best available option for a holding centre is located at Dardistown, within the proposed Project boundary on land proposed to be temporarily acquired in the EIAR. This site, approximately 44,000m², is situated between the M50 Motorway and the future railway Depot at Dardistown, outside of any land required for permanent works but within an area designated for temporary works in the RO application. The land is accessible by road and is a short distance from the three main site compounds of Dublin Airport.

As confirmed by the pre-construction *in-situ* tests, where PFAS contaminated materials are anticipated to be found, then the site will be set up to contain and control PFAS migration through the control of materials and surface water movement, using the following key principles:

- Each works compound perimeter where excavation is taking place or where materials are being temporarily stored are isolated from the surrounding site with suitable bunding and covered;
- Within that isolated worksite, all surface water runoff is collected and treated on site prior to reuse or disposal off site and all required licences will be obtained in advance;
- Excavated materials held temporarily on site will be stockpiled on ground that has been prepared with suitable hardstanding and appropriately lined to prevent the movement of PFAS to ground through water ingress and the potential of leachate;
- All stockpiles are covered and maintained during periods of storage to limit water ingress and reduce dust activation;
- All plant and vehicles exiting the isolated site are washed within an appropriated sized washing plant with the water collected and treated prior to reuse or disposal;
- Dedicated plant and equipment will be used exclusively for these activities; and
- The transport of all excavated materials from the isolated sites must be completed within sealed and covered trucks, with the risk of water loss during transport mitigated by ensuring that either the materials are at close to optimum moisture content levels, or the trucks are suitably sealed to prevent water loss during transport.

Further details on these principles with supporting details are provided in Annex F.

The strategy for exporting PFAS-contaminated materials from Dublin port involves using covered barges/ships for sea transport to an appropriate licenced receptor in Europe, either for treatment and reuse or for disposal to landfill. Once the materials are loaded onto the barges, they are covered prior to transport. This method is deemed the most appropriate, especially under the worst-case scenario where all excavated material is contaminated. The plan includes securing agreements with the Dublin Port Company. Further detail on this is provided in Annex F.

Following completion of all excavation activities at the main airport sites, where PFAS mobilisation is a potential risk, each site will undergo a thorough clearance process, returning each site to its preconstruction condition. The level of clearance required will depend on the PFAS concentrations encountered and recorded in the pre-construction *in-situ* classification test together with the measures taken to segregate and control PFAS-contaminated materials and water at the site. Again, and prior to commencing clearance, *in-situ* testing will take place to determine any levels of PFAS present for removal. The infrastructure used, dewatering plant, bunding and material storage hardstanding to contain and control PFAS will also be dismantled and removed and disposed of appropriately. Certification of site clearance will necessitate appropriate test certificates, approved in writing by a MetroLink Authorised person (the lead from either the engineering or environmental teams) responsible for accepting and approving the designs.

PFAS has been detected in the waters of the Sluice River, Mayne River and Santry River near Dublin Airport. To mitigate the risk of PFAS contamination during works in proximity to these streams, several measures will be implemented. The work sites will be delineated and segregated from adjacent areas, with dedicated access routes established. All excavated material will be transported to the PFAS management site for appropriate handling. Instream works will be conducted in dry or very low flow conditions to minimise the risk of contamination. Any potentially contaminated water will be treated according to methods outlined in the report. Dedicated plant and equipment will be used exclusively for these activities, stored securely, and cleaned regularly, with the cleaning water segregated and stored for proper disposal. Diversion works and changes in flow will be monitored for PFAS levels throughout the project. Suitable barriers will be installed to limit PFAS migration downstream, and any inline watercourse works will include river diversion and realignment upon completion. Backfilling will be carried out using only clean, suitable fill material to ensure no further contamination takes place.

7.3 Protocols for Management of Potential Material Classified as PFAS-impacted during Construction

PFAS management protocols have been prepared and incorporated into an updated Addendum to the EIAR Appendix A5.1 Outline Construction Environmental Management Plan (CEMP) to ensure that there is no potential for the mobilisation of PFAS.

The additional PFAS management protocols cover the following:

- Site Isolation.
- Water Management during excavation.
- Material transport and handling.
- Protection during holding and testing.
- Air and dust Monitoring; and
- Mitigate exposure to site workers.

Further details on these management protocols and an update to the Outline CEMP are set out in Annex F.

7.4 Further Ground Investigations

Further ground investigations (GI) will be conducted in advance of the construction phase to classify soils and waters at each of the structure and tunnel locations. This will help to manage any potential contamination. It is proposed that further GI will take place informing the design development for procurement of the works.

7.4.1 In-Situ and Ex-Situ Testing

Where *in-situ* testing cannot be undertaken to allow for a classification of the excavated materials, then *Ex-situ* testing and classification will be required to confirm whether PFAS contamination is present in any excavated materials arising. *Ex-situ* testing and classification will require that the excavated materials are considered to contain PFAS contamination until proven otherwise. In this scenario the plans and protocols referenced above will be implemented. This will require the isolation and holding of excavated materials until test results are obtained to determine if the material is contaminated or not.

7.5 Water Treatment

The original EIAR assessment for the Railway Order considered water collection and treatment at each of the main construction compounds at Dublin Airport during the construction phase. To deal with the potential for PFAS contaminated water, minor modifications to the water collection and treatment processes would be needed with a process for removing PFAS added. This would mean the adoption of one or a combination of the following: Carbon Filtering, Ion Exchange or Foam Fractionation, as recommended in Section 6 and Annex E. The water treatment process to manage PFAS contamination will consider:

- The risk of PFAS within groundwater at the site, determined by the *in-situ* tests undertaken prior to construction commencement;
- The area of excavation and ground water to be managed during excavation;
- Other sources of site water to be managed, for example from site runoff, wastewater from offices and plant cleaning facilities;
- The amount of water recycled and reused on the site for site management purposes; and

- Subject to a discharge licence, the volume and timing of discharge from site to an available sewer or tankered to a sewage treatment facility.

In addition to the three main Dublin Airport sites, the proposed Material Triage and Material Management Centre located at Dardistown, set aside to hold and test excavated materials with the potential for PFAS contamination prior to disposal, will also be set up with a suitable water treatment facility. The EIAR update for the Triage and Material Management Centre is included in Section 9 and Annex H.

Details of a typical layout of a proposed water treatment facility to deal with water with potential PFAS contamination is contained in Annex F.

8. Operational Phase

No disturbance of PFAS containing material will occur during the operational phase of the proposed Project at Dublin Airport as the tunnels, tunnel portals, and station are designed to be watertight, preventing groundwater ingress and potential PFAS contamination. Hydrogeological modelling undertaken for the EIAR indicates no barrier effect, and any minimal water ingress will be collected, treated, and discharged to the public wastewater sewer. The risk of accidental chemical release from MetroLink is minimal as firefighting systems within the stations and tunnels will use PFAS-free foams. Additionally, operational controls and mitigation measures, such as injection resin grouting and ongoing water testing, ensure that any unforeseen groundwater ingress is effectively managed and treated. For more detail on the management of PFAS during the operational phase (specifically, in respect of structures and tunnels, barrier effects, water management, tunnel and underground station drainage, operational controls, leak management and firefighting), see Annex G.

9. Update to the Assessments presented in the EIAR

An addendum to the EIAR has been prepared (See Annex H) in order to describe the potential for additional environmental effects resulting from the presence of PFAS within the environs of Dublin Airport and resulting from the mitigation measures required to manage these contaminants as outlined in the PFAS Management Strategy.

This updated assessment has regard to all environmental disciplines in the EIAR and presents additional analysis undertaken to assess potential additional environmental effects. Additional mitigation measures are outlined where required and any residual effects following the implementation of mitigation measures are outlined.

The assessment has identified that while the Metrolink project is not introducing new sources of PFAS with the potential to impact the environment, it is potentially disturbing existing PFAS and is implementing additional mitigation measures to ameliorate any potential environmental effects arising from PFAS which is already in the environment, from legacy activities at Dublin Airport. The assessment has considered the additional environmental effects associated with the implementation of these measures and has identified the following:

Traffic & Transport: Overall, there will be no significant change in the traffic flow on the existing road network, with the exception of the section of the R108 from the M50 junction to the access junction to the proposed Triage and Material Management Site, about 400m away short term where a slight negative impact will result. All roads including the R108 will continue to operate within capacity and as a result, there are no additional temporary traffic management measures required above what is contained within the EIAR. There will be no further lane or road closures and therefore there will be no additional significant impacts on private vehicles, public transport, cyclists, pedestrians, local access or parking, above those identified in the EIAR.

Airborne Noise & Vibration: The location of the proposed Triage and Material Management Site at Dardistown is within the south-western area of the proposed MetroLink works area adjacent to the M50 Motorway and the closest residential NSL is located south of the compound across the M50 at Santry Lodge and St Annes, Northwood at a distance of approximately 250m. The activity associated with Triage and Material Management Site will be largely limited to vehicles entering and exiting the compound and some plant operating at the site. There are no significant on-site processing activities. The distance to the closest NSLs coupled with the low noise sources associated with the management compound will ensure there are no significant noise impacts associated with this site at the closest NSLs.

Any additional traffic movements associated with transporting material to and from the Triage and Material Management Site are determined to be equivalent to those set out in Chapter 13 of the EIAR. With the inclusion of the proposed PFAS management strategy, there is no change in construction noise or vibration impacts, construction traffic noise impacts or operational noise impacts over and above those described in Chapter 13 of the Metrolink EIAR.

Air Quality: The implementation of the Dust Management Measures outlined in Appendix A16.4 of the EIAR will ensure that there are no additional impacts associated with the generation of dust at the proposed Triage and Material Management Site.

An analysis undertaken of additional vehicle movements associated with PFAS management identified that there will be no additional impacts on air quality associated with these vehicle movements.

Climate: Additional calculations were undertaken to identify potential GHG emissions associated with the PFAS Management Strategy. The assessment considered the worst-case scenario where 100% of material excavated would need to be exported to sites for disposal and treatment in Norway and

Belgium respectively. In addition to the potential for 1,813 Tonnes CO_2e associated with the Irish based HGV transport and handling of the excavated materials, there are predicted to be between 3,280 Tonnes CO_2e to 3,620 Tonnes CO_2e associated with international shipping and HGV transportation overseas. However the use of HVO fuels within the local operation will reduce these potential emissions by 678 tonnes CO_2e. The overall greenhouse gas emissions associated with the PFAS Management Strategy will result in a less than 1% increase in emissions associated with MetroLink. This does not result in a change of the predicted significance of impact identified in the EIAR.

Material and Waste Management: Assuming the worst case scenario that 100% of the material excavated from the environs of Dublin Airport is contaminated, then the quantity of material that can be re-used as outlined in EIAR Chapter 24 and Errata Appendix 13 Addendum to the EIAR Chapter 24 submitted at the Oral Hearing would be reduced significantly as presented in Table 9.1.

Table 9.1: Quantities of excavated material for reuse and disposal

	EIAR	Within the Metrolink PFAS Management Strategy for Dublin Airport Report*
Quantity of Material for Re-use	2,715,271m^3	2,411,652m^3
Quantity of Material for Disposal	310,317m^3	514,005m^3
All figures in the table are calculated as solid. An average buking figure of 1.3 should be applied to all materials when in transport or in stockpiles		

As detailed above with 100% of material excavated at Dublin Airport assumed to contain PFAS, this increases the quantity of hazardous excavated material requiring management. As reported in the EIAR there is no significant commercial hazardous waste landfill capacity in Ireland and a large percentage of hazardous waste is currently exported. As the additional quantity of 304,000m^3 of contaminated material would not be treated and/or treated in Ireland and so not take up the limited available capacity here, the impacts associated with the FPAS management strategy presented in the EIAR do not change.

There is however a large capacity of hazardous landfill and treatment in Europe and this will be utilized only where required. It is considered that the majority of the PFAS containing material will treated rather than landfilled (90%) as PFAS has been identified at very low levels in the soils in the Environs of Dublin Airport.(See Section 3 of this report).

Hydrology & Hydrogeology: The mitigation measures outlined in the EIAR to mitigate potential impacts during the construction phase will be implemented in full. These measures include the commitment not to discharge any wastewater to streams or rivers (see Chapter 18 of the EIAR). Any potentially contaminated water/wastewater generated will be discharged to sewer or will be tankered to a Wastewater Treatment Plant (WwTP) for treatment. However, considering the nature of PFAS and the fact that most WwTPs do not treat PFAS, there will be a requirement should PFAS be encountered, to implement pre-treatment measures such as activated carbon filtration on-site prior to discharge, as outlined in Chapter 5 of this report.

With the full implementation of the management strategies for soils (Chapter 5), water (Chapter 6) and the proposed site management measures (Chapter 7) it is concluded that there are no likely significant effects from PFAS arising in respect of the MetroLink Project (including the grid connection works) during the construction phase. Furthermore, the management measures outlined in Chapter 8 of this report will ensure that the MetroLink Project will have no significant impacts on water quality (groundwater/surface water).

Biodiversity: The additional works required to manage PFAS will not have any additional significant impacts on ecological receptors. The area to be cleared for the Triage and Material Management Site has already been assessed as being cleared in the EIAR. In addition, the proposed measures for the management of PFAS contaminated material have been reviewed and based on the principle that no additional pathways for PFAS mobilisation into groundwater, surface water or soils, it is concluded that there is no potential for significant effects on biodiversity. It was also concluded, based on the proposed construction and operation mitigation and design measures and distance to downstream European sites, that there is no potential for water quality changes within the European habitats.

Population & Land Use, Human Health: The impact of the transport of the PFAS containing materials will result in short term slight negative impact on the receiving environment and does not change the assessment presented within the Metrolink EIAR.

Measures proposed throughout the EIAR and within the MetroLink PFAS Management Strategy for Dublin Airport Report will ensure that there are no potential impacts with regards to human health. Proposed measures will ensure that there are no potential pathways for PFAS to transmit to population during either construction or operational phases.

Given the management strategies for soils and groundwater that will be employed, there are no likely significant effects from PFAS arising in respect of the MetroLink Project (including the grid connection works) either alone or cumulatively with other projects for the purposes of EIA Directive.

These measures will prevent PFAS from reaching the population during both construction and operational phases. Therefore, there are no adverse health effects expected from this activity, and the conclusions in the EIAR remain.

10. Conclusions and Recommendations

PFAS has been found in surface water, groundwater and shallow soils in some areas around Dublin Airport. The main sources of PFAS are understood to be historical releases to the environment of PFAS containing firefighting foams, although other sources of PFAS may also be present in the airport area. The proposed Project will pass through Dublin Airport in a tunnelled section with surface interfaces including Dublin Airport Station, Dublin Airport North Portal (DANP), Dublin Airport South Portal (DASP). While the proposed Project itself is not a source of PFAS, it is likely to encounter areas where PFAS are present in soil and groundwater. Soil excavated for tunnel construction may be impacted by PFAS.

To manage PFAS contamination during the proposed Project construction phase, potential treatment and site management options have been identified. For this analysis, a worst-case scenario assumes widespread PFAS presence in the subsurface. This assessment demonstrates that even if all excavated material is contaminated with PFAS, it will be effectively managed through treatment and/or disposal at specialist facilities overseas.

As the proposed Project progresses, further pre-construction characterization of the subsurface and excavated material is expected to significantly reduce the estimated volumes of material requiring treatment and disposal. This expectation is based on experiences from similar projects overseas where PFAS was encountered.

Additionally, it should be noted that engagement has been undertaken with key stakeholders as outlined below in Table 10.1 and this will continue.

Table 10.1 Stakeholder Engagement

Stakeholder	Engagement	Notes
Dublin Airport Authority	2 consultation meetings (11/11/24 & 19/12/24)	Discussion with daa on their understanding and approach to management of PFAS issues at the airport.
Fingal County Council	2 consultation meetings (3/12/24 & 15/01/24)	Engagement to consult on the proposed MetroLink PFAS Management Strategy and explain TII's approach to managing this issue.
Environmental Protection Agency	TII Input	Response to Request for Further Information from the EPA, explaining the potential for some material to be contaminated with PFAS. This was submitted to the EPA on 20 December 2024. It set out TII's proposed PFAS management strategy and highlighted the potential need to export some material that will not be processed under any Article 27 notification.

It is important to re-iterate that the proposed Project is not introducing new sources of PFAS. Instead, it is managing existing PFAS contamination from legacy activities at Dublin Airport.

Given the worst-case assumptions used in this assessment, TII are satisfied that a conservative approach has been adopted to PFAS management. This methodology ensures a robust approach to this issue which accords with the precautionary principle, and aligns with best practices in environmental management for the management of PFAS. This approach will be adjusted to reflect any regulatory changes which may arise (given the growing and continued focus on this at an EU level). Similarly, TII will ensure that our practices are in full alignment with any domestic legislation, guidance or policies which are published. Should PFAS contamination be encountered elsewhere along the proposed

Project alignment outside of the airport campus the approach /management strategy and protective measures outlined within this report will inform the approach at any such locations.

Annex A. Baseline Conditions at Dublin Airport

A.1 Introduction

The purpose of this Annex is to present an overview of the baseline geotechnical and hydrogeological conditions at Dublin Airport and environs which has informed the PFAS Management Strategy.

The available baseline data on PFAS in soils, groundwater and surface water is derived from three sources:

- Chapter 19 Hydrogeology and Chapter 20 Soils and Geology of the EIAR;
- Monitoring data undertaken since the lodgement of the MetroLink RO application (the detail of which is explained further in Section 3.3); and
- Information/data made available by daa, from the daa Report.

A.2 Ground Conditions at Dublin Airport and Environs

This summary of ground conditions has been derived from published geological information, available ground investigation data sourced from the MetroLink Ground Investigations (GIs) (Refer to EIAR Appendix A20.1) and supplemented with data from daa.

A.2.1 MetroLink Alignment

The ground conditions along the proposed Project alignment in the environs of Dublin Airport are summarised as follows:

- Made Ground (Qx): identified during GI within the area of Dublin Airport Station at depths of up to 2.7m comprising asphalt, concrete, sandy gravel and sandy gravelly clay with various anthropogenic inclusions. The area at the proposed station was identified by historical records as a former quarry. Qx has not been identified in other areas of the proposed alignment however it is considered likely to be present beneath areas of airport infrastructure such as buildings and runways/aprons;
- Till derived from limestone: glacial till is present across the airport section of the alignment with the exception of the proposed Dublin Airport Station location where bedrock is close to the surface. The glacial till primarily comprises cohesive beds of sandy gravelly clay with occasional cobbles, interbedded with and underlain by beds of sand and gravel which often contain cobbles and boulders. The till has been divided into layers colloquially known as the 'Upper Black Boulder Clay' typically at depths of 0m to 10m, and the 'Lower Black Boulder Clay'; and
- Bedrock: Bedrock comprises limestones of the Upper Member of Malahide Formation (CMUP), Waulsortian Formation (CWA) and Tober Colleen (CTO) Formations (described from north to south). CMUP is present to the north of the proposed Dublin Airport Station and comprises an argillaceous bioclastic limestone with interbedded shales. The CWA is a predominantly pale grey, crudely bedded or massive lime-mudstone, biomicritic in nature and typically formed by mounds or reefs and found within the vicinity of DAS. The boundary between the CMUP and the CWA is marked by a fault. The CTO Formation is found to the south of the proposed Dublin Airport Station and comprises a dark-grey calcareous, commonly bioturbated mudstone with subordinate thin argillaceous micritic limestones. A weathered bedrock layer (Upper Weathered Rock, UWR) is present at the boundary between the bedrock and the superficial deposits, which comprises a fractured / fissured boundary grading into sands and gravels.

Depth to bedrock is variable across this section, from up to approximately 30m to 35m below ground level (mbgl) around the proposed DANP and DASP to less than 2 mbgl at the proposed Dublin Airport Station. Geological long sections of the proposed Project in the vicinity of Dublin Airport can be viewed in the EIAR Appendix A20.9.

A.2.2 Dublin Airport Area

There is a historic unregulated waste disposal site (landfill) to the north east of the airport at Castlemoate House. This landfill is not within the footprint of the proposed Project.

Bedrock is indicated as being exposed at the western daa land boundary around where the air control tower and current firefighting training area are located. Bedrock is also exposed near the north western boundary of the airfield.

Bedrock mainly comprises CMUP and CTO formations across the airfield with a smaller area of the CWA around the terminal buildings. Several faults are also noted in the bedrock. The Lucan Formation (fine grained, occasionally cherty, micritic limestone) is also indicated at the far south eastern boundary of the daa land.

A.2.3 Hydrogeology at Dublin Airport and Environs

A.2.3.1 Aquifer Characteristics

Chapter 19 Hydrogeology of the MetroLink EIAR refers to extensive historical and contemporary site investigation works completed across the proposed Project alignment in the environs of Dublin Airport.

The bedrock outlined above is generally described as *'moderately weak to very strong, grey, fresh to slightly weathered limestone'*. The limestone rock type is also prone to karstification effects which invariably will impact on local/other flows within the underlying bedrock. However, no significant karst (or fault/fracture) features are reported from the exploratory boreholes drilled in the area or detected by surface geophysical surveys carried out close to the proposed Dublin Airport Station location.

Information on regional groundwater characteristics and behaviour is summarized in the GSI 2022 report 'initial characterization summaries' for the two relevant groundwater bodies (GWBs), the Swords GWB and the Dublin GWB.

Figure 19.4 of the EIAR shows the location of the Swords GWB and the Dublin GWB. This shows that the proposed Project location and also Dublin Airport fall into both GWBs, with the proposed Project alignment crossing the boundary between the GWBs in several locations.

The GSI 'initial characterisation summaries' for the Swords GWB (GSI, 2022a) and Dublin GWB (GSI, 2022b) make clear that the general groundwater flow direction in both aquifers is towards the coast and also towards the overlying rivers. The GSI summaries go on to state "*This aquifer is not expected to maintain regional groundwater flow paths. Groundwater circulation from recharge to discharge points will more commonly take place over a distance of less than a kilometre. The majority of groundwater flow will be a rapid flow in the upper weathered zone but flow in conduits is commonly recorded at depths of 30 to 50 m bgl. The aquifer is not considered to have any primary porosity and flow will be through fractures, some of which will have been enlarged by karstification and dolomitisation. The fissured nature and the moderate permeability of the bedrock close to the surface imply that water will move at high velocities.*"

Permeability is a key aquifer characteristic and is a measure of the ability of a given rock or overburden material to transmit water. In terms of the Dublin Airport section, permeability values for the superficial deposits from Dublin Airport boundary north to Dublin Airport boundary south are reported in the EIAR for Qx at 7.65E-07m/s, Upper Black Boulder Clay 0m-10m, at 7.21E-07m/s, Lower Black Boulder Clay >10m, at 7.15E-07m/s and the Base of Drift Deposits (BoD) at 2.90E-04m/s. The equivalent permeability for Brown Boulder Clay (QBR) subsoils at Dublin Airport Station is 2.35E-06m/s.

With regard to bedrock aquifer permeability, the EIAR presents values derived for the CTO at 1.40E-06m/s, CWA at 5.69E-07m/s, and for the UWR at 5.63-06m/s. Locally, the field test data shows a range in hydraulic conductivity in the CWA at Dublin Airport between 10-3m/s to 10-6m/s. The higher permeability values are likely to be due to 'fracture flow', whilst the lower permeability values indicate mainly 'matrix flow' where only small-scale [often with limited connectivity] fractures are likely intersected in this rock. The equivalent permeability used for bedrock at Dublin Airport Station is 6.27E-07m/s to 5.40E-07m/s (CWA).

Section A.2.3.2 below discusses the potential for groundwater movement within the Airport area in further detail.

A.2.3.2 Interaction between Aquifers

The degree of hydraulic connection potential between the aquifer units is limited and often arises due to discrete fractures at the local scale. The GSI public groundwater database indicates a structural fault trending north east – south west and to the north west of the proposed station box and tunnel alignment.

Faults can be hydraulically conductive in terms of groundwater movement potential including deflection of flow however these features may also be 'dry' or represent geological barriers. For the faulted contact between the CMUP and CWA Formations, and the zone of disturbance or 'fault zone', there is potential for a higher degree of fracturing and associated higher groundwater flows (including locally).

The GSI database does not indicate the presence of any local/ regionally important gravel aquifer units in the area and this conclusion is supported by the localised shallow depth to bedrock as well as the recorded (often thick; range of 2m to 34m) sequences of stiff to very stiff/ hard and predominantly cohesive glacial tills underlying the Qx (including hardstanding) in the area around the airport.

It is anticipated that the stiff to very stiff glacial tills in the area (with typically isolated granular lenses) will limit the potential for both horizontal and vertical contaminant groundwater transport and that this predominantly cohesive layer provides a natural geological protective barrier to the bedrock below including to the north and south of the proposed station box. Where the contact between the CWA and the overlying Qx is more direct (refer to Figure A-2), due to historical (glacial) subsoil stripping - then there is potential for localised contamination of the underlying bedrock aquifer.

When considering the potential interaction between the Locally Important (LI) and Poor Aquifer (PI) aquifers in the vicinity of Dublin Airport then one must consider both the characteristics of the bedrock types (as discussed in Section A.2.1 above) and the interpreted regional groundwater flow patterns. In the context of regional groundwater movement then the assessment covered in the EIAR (refer Appendix A19.10: Hydrogeological Plan) indicates the modelled regional groundwater flow regime in the vicinity of Dublin Airport which is based on a comprehensive database of water levels for this and the wider proposed Project area. For the proposed (tunnel and station box) alignment at Dublin Airport, the interpreted angle of trajectory of groundwater flow is near parallel (which also indicates no potential for the groundwater barrier effect to occur here) and the interpreted flow orientation within the bedrock units is defined as presented in Figure A-1

The interpreted equipotential lines also indicate the potential for a groundwater divide centred near the +65mOD groundwater elevation. The hydrogeological plan therefore presents a South-North flow orientation from ca. chainage ch:7+060 – ch:5+500 as shown, and a North-South flow orientation from ca. chainage ch:7+060 – ch:8+500 as presented below. This inferred groundwater divide also generally coincides with the CWA recorded at shallow depth near the proposed station box and to the south of which the PI aquifer unit (CTO) is recorded (refer also Figure A-2 below).

Recent (September 2024) field monitored groundwater levels within the CWA screened groundwater monitoring wells indicate a static water level (SWL) between +65.2mOD (borehole ABH13) to +63.6mOD (borehole ABH12), which also coincides with the interpreted groundwater flow patterns as depicted in Figure A-1

In general, the hydraulic flow conditions in the Greater Dublin Area aquifers relate primarily to shallow groundwater associated with fluvio-glacial and alluvial sand and gravel deposits, and the deeper groundwater associated with the BoD as well as within the Carboniferous Limestone bedrock which is controlled by fissure permeability.

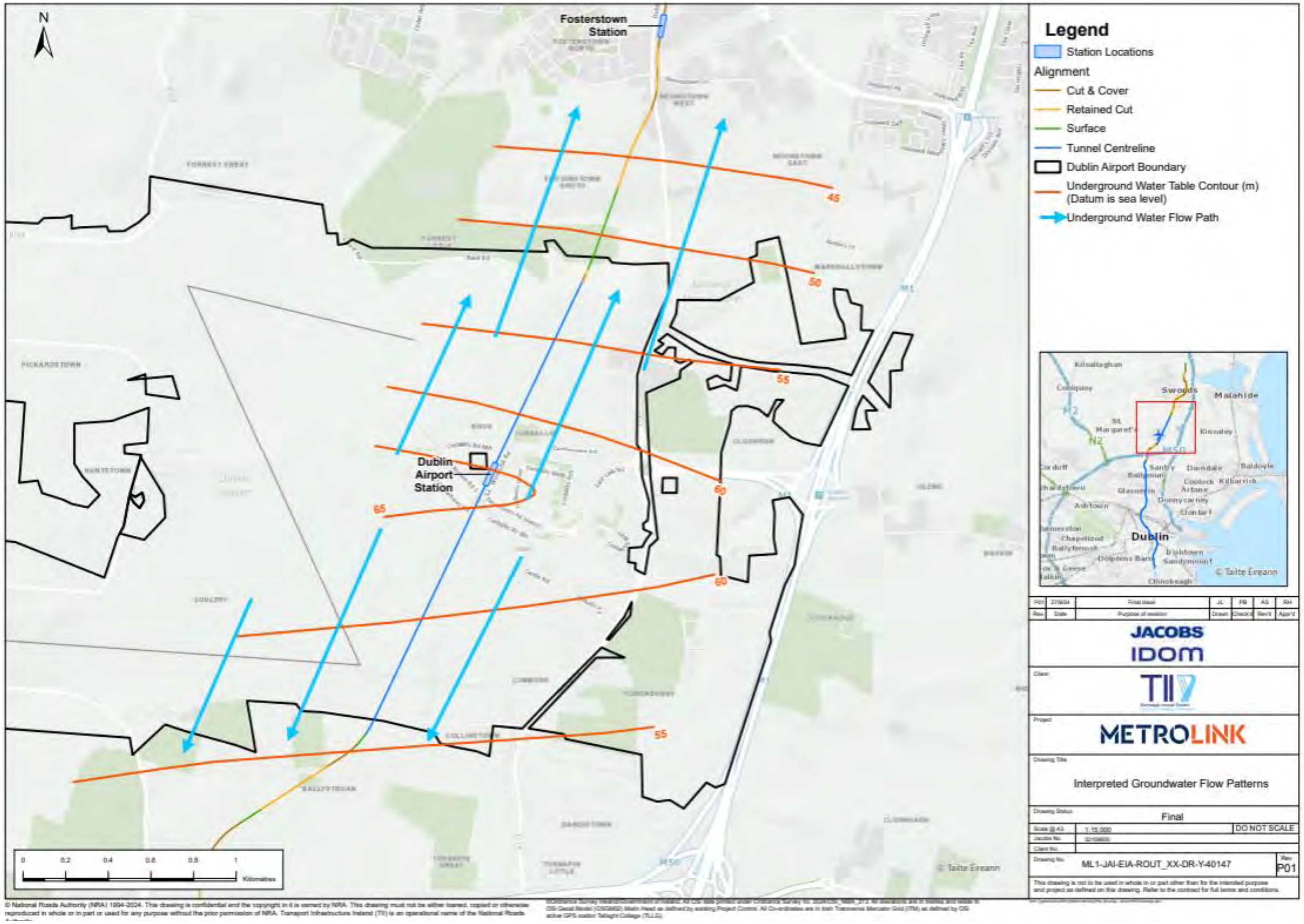

Figure A-1: Interpreted Groundwater Flow Patterns

As per Chapter 19 Hydrogeology of the EIAR, the BoD/UWR is the 'contact' between the glacial deposits (Dublin Boulder Clay, QBL near Dublin Airport) and the underlying Carboniferous rocks and includes the basal glacial sediments which is material with a very high porosity and permeability. This layer is therefore potentially a highly transmissive layer in terms of groundwater movement (consistent with the detail from the GSI on groundwater flow paths within both the Swords and Dublin Groundwater Bodies) and is shown to cross the bedrock and aquifer types listed above. The BoD/UWR layer is depicted in Figure A-2 below however its 'discontinuous extent' is shown at the location of the proposed Dublin Airport Station box where the shallow CWA bedrock (overlain with Qx following historical alterations to ground in the area) is recorded. The localised removal/ alteration of this transmissive layer will therefore affect local groundwater movement patterns in the area where the inferred groundwater divide is also noted.

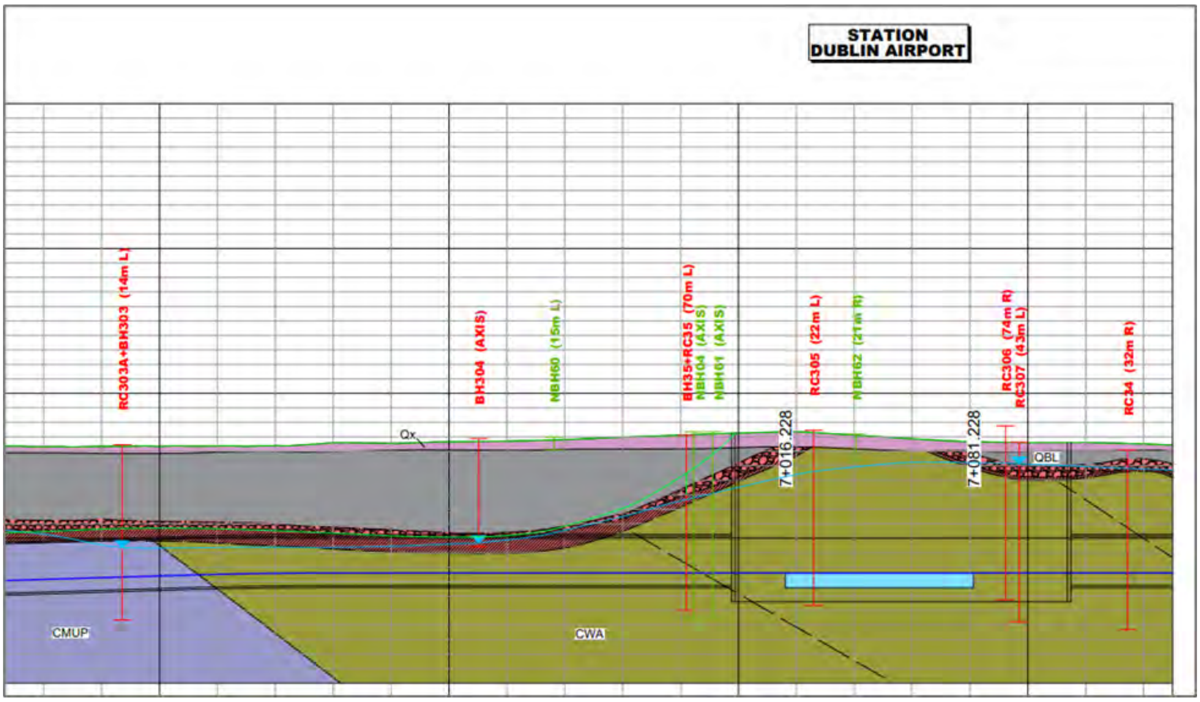

Figure A-2: MetroLink - Geological Cross Section (Ch:6+760 – Ch:7+150)

Figure A-2 presents the geological cross sections for the proposed Project including at the daa lands (refer EIAR Appendix A20.9, Sheet 9 & 10 of 28).

A.2.4 Hydrology

Dublin Airport is located within two main water body catchment areas:

- The Liffey and Dublin Bay Catchment area to the south and east, and
- The Nanny-Devlin to the north and west.

These catchments include various sub-catchments and waterbodies that are relevant to the proposed Project and PFAS monitoring at the airport. This is detailed in Table A 1

Table A 1 River Sub-Catchments

Catchment	Sub-catchment	Waterbody	Tributary / Local Name	Relevance to MetroLink
Nanny-Devlin	Broadmeadow _SC_010	Broadmeadow _040	Broadmeadow	Viaduct crossing (with Ward)
		Ward_040	Ward	Viaduct crossing (with Broadmeadow)
		Ward_030	Multiple – including: Killeek, Ballystrahan, Huntstown, Barberstown	Receiving waters for drainage from north-western parts of airport; upstream of Ward
Liffey and Dublin Bay	Mayne_SC_010	Gaybrook_010	Gaybrook	Rises downstream of MetroLink and airport
		Sluice_010	Forest Little	Tributary rising north of Sluice; culverted below MetroLink
		Sluice_010	Sluice	Receiving waters for drainage from north-eastern parts of airport including North Apron, culverted below MetroLink north of the DANP
		Sluice_010	Wad Stream	Receives drainage from airport central area, no interface with MetroLink which is in tunnel section; downstream drainage to Sluice
		Sluice_010	Kealy's Stream	Receives drainage from airport central area, no interface with MetroLink which is in tunnel section; downstream drainage to Sluice
		Mayne_010	Cuckoo Stream	Receives drainage from airport central area, no interface with MetroLink which is in tunnel section.
		Mayne_010	Mayne / Turnapin	Rises immediately south of airport in area of proposed Dardistown Depot, south of DASP; river diversion required for MetroLink
		Santry_010	Santry	Rises in the south-west of the airport. Minor channel alterations required for MetroLink crossing.

Nanny-Devlin Catchment: Includes the Broadmeadow and Ward water bodies, which are relevant for viaduct crossings and drainage from the north-western parts of the airport.

Liffey and Dublin Bay Catchment: Includes several water bodies like Gaybrook, Sluice, Wad Stream, Kealy's Stream, Cuckoo Stream, Mayne/Turnapin, and Santry. These water bodies are involved in drainage from different parts of the airport and have various interactions with the proposed Project, such as culverting (enclosing in a tunnel) and minor channel alterations

A.3 Baseline PFAS Monitoring Data

There is reliable and robust data available from several sources to allow us to categorise the known occurrence of PFAS in the environs of Dublin Airport. This includes information from areas where PFAS were known to have been used, and information where PFAS have been tested for in environmental monitoring.

The data sources used in this characterisation are as follows:

- MetroLink Phase 1 - 4 GI (2019 – 2020), summarised in the EIAR;
- MetroLink Phase 5 GI (2021);
- The daa Report; and
- EPA Water Framework Directive Monitoring.

A.3.1 MetroLink Monitoring

The proposed Project GI included monitoring of soil and groundwater samples within the vicinity of the proposed Dublin Airport Station for PFAS. The GI, monitoring and analysis are described in Chapter 19 Hydrogeology and Chapter 20 Soils and Geology of the EIAR; the information relevant to PFAS is summarised here.

A.3.1.1 Soil Analysis

As part of the GI undertaken to support the proposed Project, 20 exploratory holes were sited within the Dublin Airport area. Four soil samples from two of the exploratory hole locations within the proposed Dublin Airport Station site were analysed for PFAS in 2019. The four boreholes sampled were within the vicinity of the proposed station box where significant excavation of material would be undertaken.

Soil samples were analysed for a suite of 16 PFAS as was standard at the time of testing. The results show that all PFAS were below the levels of detection (LoD) with the exception of NBH60 where PFAS were identified at 0.5m bgl with PFOS detected at 0.001mg/kg, equal to the analysis method detection limit. (Since the PFOS concentration was equal to the analysis method detection limit, this meant that the Project did not identify any significant PFAS contamination in the soil samples, indicating that PFAS levels were generally non-detectable).

A.3.1.2 Groundwater Analysis

Groundwater monitoring was undertaken in January and March 2021 including four locations within the footprint of the proposed Dublin Airport Station. The results of the monitoring are summarised Table A 2. PFAS were not detected within any of the samples collected. The analysis was for a standard suite of 17 PFAS, with individual detection limits varying from <50ng/L to < 500ng/L (detection limit < 50ng/L for PFOS).

Table A 2 Summary of the proposed Project PFAS Groundwater Monitoring at Terminal 2

Monitoring Location Ref.	Round 1 PFAS Result	Round 2 PFAS Result
NBH60	Not detected (ND)	No sampling possible (borehole dry during sampling)
NBH61	ND	No sampling possible (borehole dry during sampling)
NBH62	ND	ND
NBH04	ND	ND

Figure A-3 below shows the locations of the baseline groundwater quality monitoring locations.

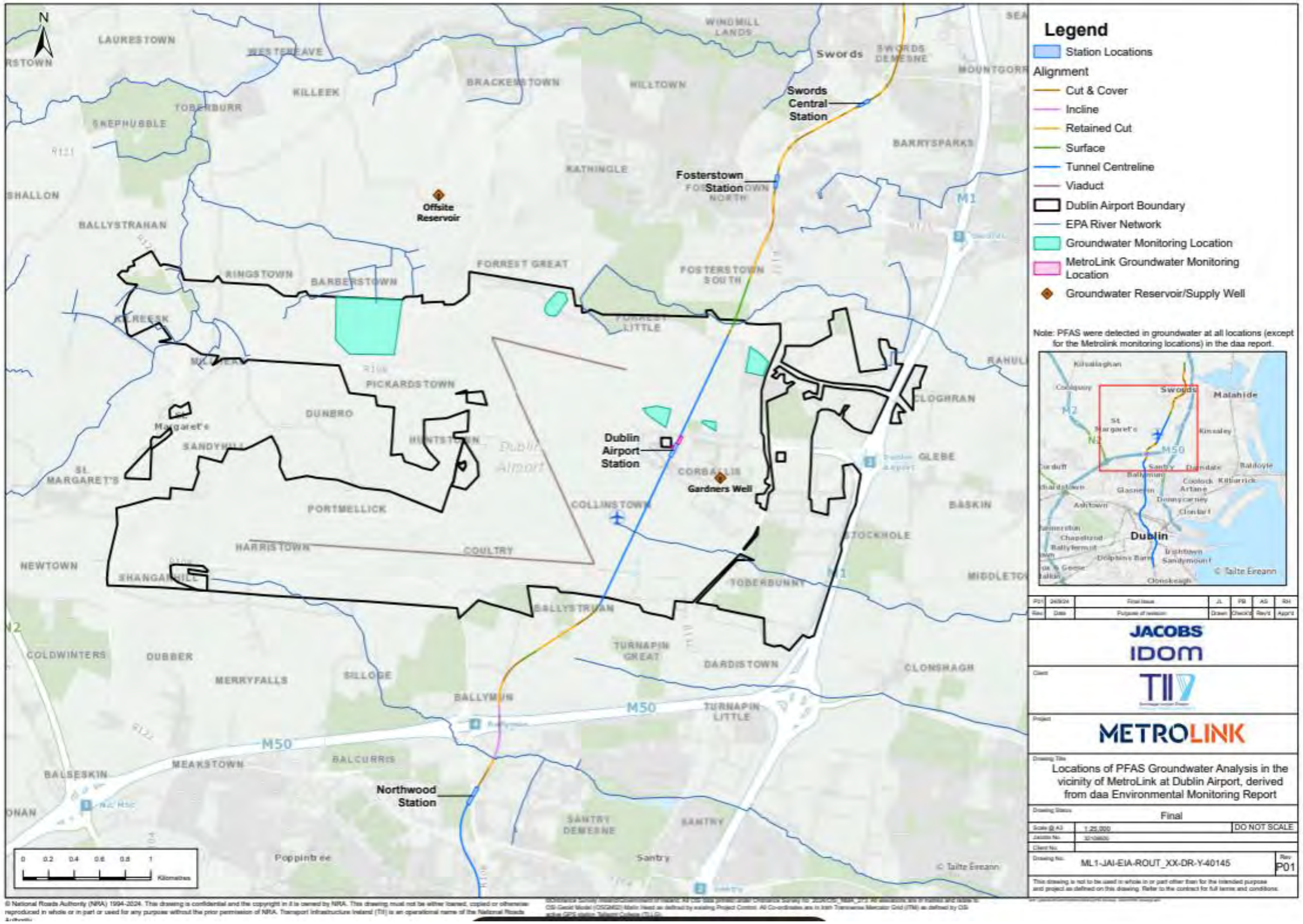

Figure A-3: PFAS Groundwater Analysis

A.3.1.3 Phase 5 Ground Investigation (2021)

The Causeway Geotech MetroLink Phase 5 Ground Investigation (2021) included some testing for PFAS in soil and water at locations within the area of Dublin Airport and this was undertaken to inform the Article 27 notification to the EPA. This data was not available for inclusion in the EIAR.

The data are included within a factual report with a review of the raw data provided within the report summarised as follows:

- Both soil and water samples from the airport area were tested for PFAS. Different test methods were used with varying LODs as detailed below;
- No PFAS were detected above the LOD in any soil or water samples with the exception of one soil sample in the central airport area where PFOS was reported equalling the LOD of 1 µg/kg;
- Thirteen no. soil samples were tested for a suite of 16 PFAS including 6:2FTS, with LOD generally <1 µg/kg, no PFAS were detected; this included mainly shallow soil /overburden samples. Limestone bedrock samples were analysed in ABH12 (2.5m, 16.3m) and ABH13 (2.7m, 3.7m);
- Five no. soil samples were tested for PFOS and PFOA only; LOD <1 µg/kg; no PFAS were detected except ABH14A 1.3m in the central airport area where total PFOS was reported as equalling the LOD of 1 µg/kg;
- Seven no. water samples were tested for a PFAS suite with LOD <0.1 µg/l (100 ng/l); no PFAS detected (but note elevated LOD); and
- Five no. water samples were tested for a PFAS suite with LOD <2ng/l; no PFAS were detected.

A.3.2 daa Monitoring and Investigation

The daa Report, which was completed in April 2024, identifies known occurrence and potential sources of PFAS at the Airport based on the following:

- Monitoring data (including outputs from a site investigations) collected between June 2021 and November 2023;
- A comparative analysis of surface and groundwater data against the relevant GAC and an identification of spatial and temporal trends in the monitoring data; and
- An analysis of potential historical sources of PFAS at Dublin Airport.

A.3.2.1 PFAS in Soils

The daa Report presents monitoring results for PFAS in soils at the Airport recorded from Geotechnical Investigations undertaken for various projects as identified in Table A 3 below.

Table A 3 PFAS in Soils at Dublin Airport

Location/Project	Details	PFAS in Soils
Dublin Airport Departures Road	6 samples analysed for PFAS from two shallow slit trenches to maximum depth 1.5m bgl	Not detected
West Apron Underpass Project	9 boreholes to maximum 37m bgl, 3 soil samples per borehole analysed for PFAS	Not detected

Location/Project	Details	PFAS in Soils
North Apron South Apron Hub - South Apron Area	18 trial pits and 3 boreholes (no depth information available) 18 soil samples analysed, all from 0.5m bgl	Not detected
Proposed Apron 5H redevelopment	13 no. trial pits were completed in April 2022 in the proposed Apron 5H development area in the fill deposited material. The maximum investigation depth was 2m bgl.	PFAS was identified, with the highest PFAS concentrations towards the west (TP7, TP8 and TP9) with maximum concentrations of 141µg/kg reported for individual PFAS constituents. Lower concentrations were identified in the central and eastern sections and were typically restricted to the top 0.5m. Between October 2022 and March 2023 a further programme of investigation was undertaken in this area comprising 197 no. trial pits and soil sampling. PFAS was detected in 71 of 114 samples across the area at concentrations of up to 568µg/kg PFOS and 416µg/kg summed PFAS (excluding PFOS).
North Apron South Apron Hub (NASAH)	Sampling locations for the NASAH project within the North Apron area are summarised in Figure A-4 (extracted from Figure 4-10 in The daa Report). 21 trial pits were advanced to a maximum depth of 4m bgl.	Sampling locations for the NASAH project within the North Apron area are summarised in Figure A-4 (extracted from Figure 4-10 in the daa Report). 21 trial pits were advanced to a maximum depth of 4m bgl. PFAS was detected above the laboratory LoD in 12 samples from 8 no. trial pit locations. PFAS constituent concentrations ranged from 0.564µg/kg to 113µg/kg with the highest concentration (113µg/kg PFOS) encountered in TP109 (location of a former fire station).
North Runway	The Groundwater and Surface Water Risk Assessment and Remediation Options Appraisal Report (Fehily Timoney, 2021) for the North Runway includes some PFAS soil monitoring data. This relates to the site of the former fire training ground which was within the footprint of construction for the new north runway, and the impacted soil was excavated as part of construction. The former fire training ground (APEC5) was located approximately 3km west of the MetroLink alignment. The report summarises data from 15 trial pits to a maximum depth of 1.05m bgl	14 soil samples were analysed for PFOS and PFOA and PFOS and/or PFOA were detected in 10 samples with a maximum individual PFAS concentration of 151µg/kg for PFOS.

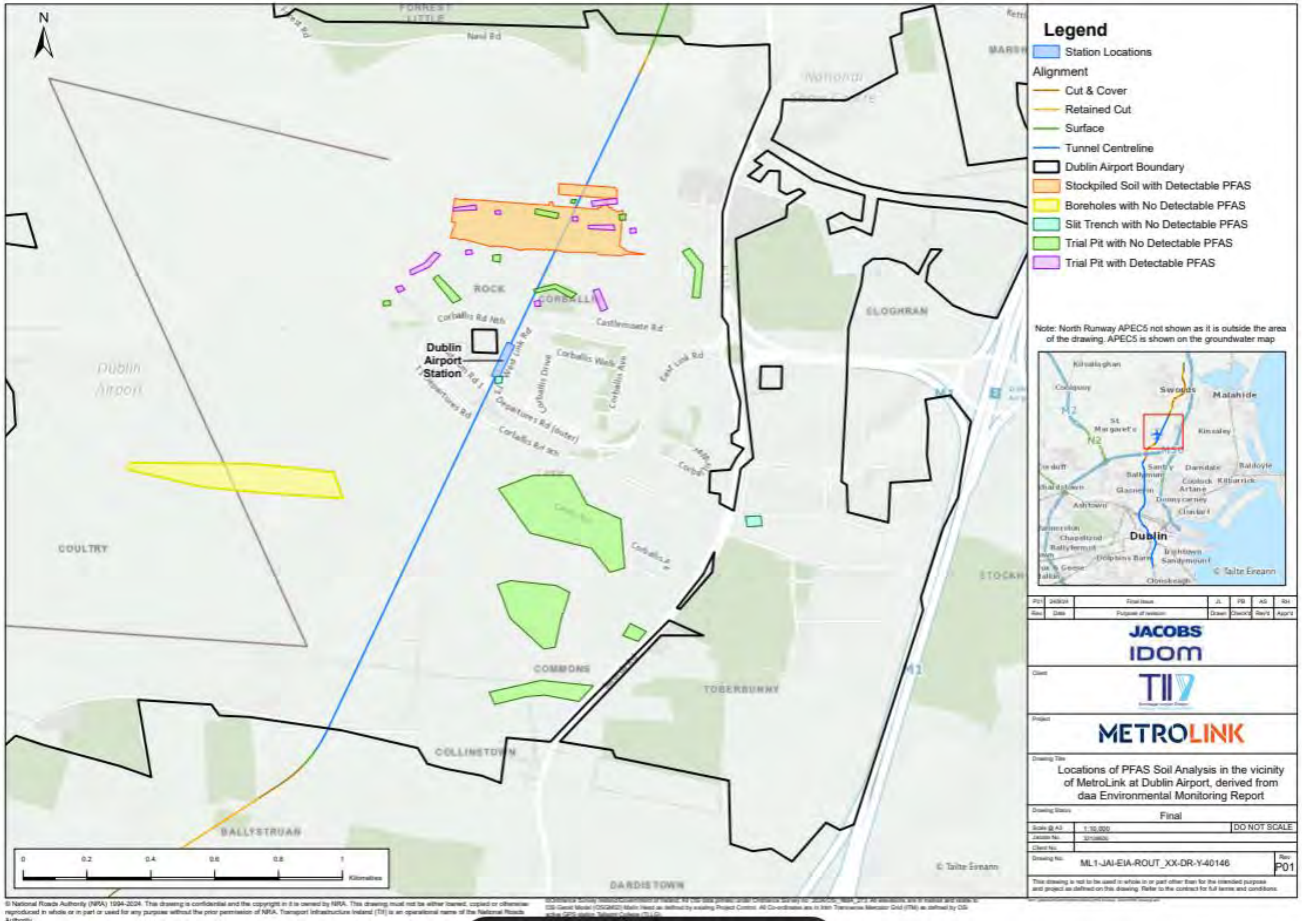

Figure A-4: PFAS Soil Analysis

A.3.2.2 PFAS in Groundwater

Groundwater sampling and analysis for PFAS has been undertaken at various locations across the airport curtilage as part of the environmental monitoring and reported in the daa Report:

- North Apron – 9 No. groundwater monitoring wells;
- Castlemoate House (Historic Unregulated Waste Disposal Site) - 7 No. groundwater monitoring wells;
- North Runway (APEC5);
- Reservoir (Offsite Reservoir) - 1 No; and
- Water supply well (Gardener's Well) – 1 No. well.

North Apron

The daa Report included monitoring of nine no. groundwater wells within the vicinity of the proposed Project in the North Apron area. The groundwater monitoring is summarised in Figure A-3 (extracted from Figure 4-2 in The daa Report).

The borehole references, well depth and targeted groundwater horizon are summarised in Table A 4.

Table A 4 North Apron Groundwater Monitoring

Monitoring Location Ref.	Total Well Depth	Well Screen Lithology	Depth to Groundwater (mbgl) range*	Maximum total PFOS (ng/L)	Maximum Sum of 20 PFAS (ng/L)	Maximum Sum of PFAS (ng/L)
GW001	3.00	Glacial till	0.78 – 2.28	246	515.24	855.14
GW002D	20.00	Bedrock	9.31 – 10.58	112	557.69	652.94
GW003D	19.30	Bedrock	9.36 – 10.76	26.4	2205.90	2217.1
GW004	3.50	Glacial till	0.62 – 1.52	158	505.8	644.8
GW005D	22.00	Bedrock	8.91 – 10.32	79.1	432.06	589.69
GW007	2.58	Glacial till	1.19 – 2.25	29.1	236.95	281.15
GW008	4.85	Glacial till	1.00 – 2.38	99.6	126.69	126.69
GW014	3.20	Glacial till	0.62 – 2.02	12.4	52.59	71.35
GW015D	21.40	Bedrock	9.10 – 10.68	6.21	3180.44	3203.94
* Range across the 10 groundwater level monitoring events for each well						

Sum of 20 PFAS concentrations were consistently above the LoD during the monitoring rounds for all locations except GW003D and GW014, and the GAC for sum of 20 PFAS (100ng/L) was exceeded at all locations except GW014.

The highest sum of 20 PFAS concentration recorded was 3,180ng/L at GW015D towards the east of the North Apron (screened within the bedrock). This monitoring well had the lowest maximum PFOS of all the North Apron boreholes, with the predominant PFAS being short chain PFHxA, PFPeA and PFBA. When 6:2 FTAB was added to the monitoring suite in November 2023 it was also detected in GW015D at higher concentrations than other PFAS in the groundwater.

The next highest sum of 20 PFAS concentrations were encountered in GW001, GW002D and GW003D towards the west of the apron within the vicinity of a former fire station. These boreholes are screened in both the glacial till and bedrock. The monitoring results for bedrock well GW003D appear to fluctuate, with some monitoring rounds showing no detectable PFAS and others showing elevated PFAS up to a maximum of 2205.9ng/L, but no PFAS detected since May 2023.

A CCTV survey of the storm and foul sewer lines at Hangar 2 and Hangar 3 were carried out in 2021 which indicated that ingress of shallow groundwater through pipe defects and unsealed joints was occurring, potentially including groundwater passing beneath the former fire station (potential PFAS source). Sampling of the manholes MH2 and MH4 closest to the former fire station indicated similar PFAS concentrations as within the shallow groundwater in this area. This indicates that the drainage system may be a potential pathway both for transmitting PFAS from the original source locations into groundwater in other parts of the site, and also as an ongoing source of legacy PFAS in groundwater being discharged via the surface water drainage system

Castlemoate House

7 no. groundwater monitoring wells were monitored as reported in The daa Report. The details of the monitoring locations and results of the PFAS analysis are summarised in Table A 5

Table A 5 Groundwater Monitoring at Castlemoate House

Monitoring Location Ref.	Total Well Depth	Well Screen Lithology	Depth to Groundwater (mbgl) range*	Maximum Sum of 20 PFAS (ng/L)
BH1A	3.01	Overburden	0.51-2.21	642
BH5	12.21	Bedrock	3.91-6.82	32.1
BH6	6.17	Overburden	1.14-2.60	67.0
BH7	14.03	Overburden	1.59-2.29	346.7
BH8D	15.02	Overburden	0.93-2.80	43.39
BH8S	3.52	Overburden	0.96-2.79	39.01
BH9	20.00	Bedrock	9.39-10.36	<LoD
* Range across the 9 groundwater level monitoring events for each well				

Sum of 20 PFAS concentrations were consistently above the LoD during the monitoring rounds for all locations except BH9, and the GAC for sum of 20 PFAS (100ng/L) was exceeded in 2 locations.

The daa Report considered the elevated PFAS concentrations at this location to be a result of unregulated historical waste disposal which took place at Castlemoate House rather than being a result of airport activities.

North Runway/APEC 5

The daa Report included monitoring of 11 no. groundwater wells within the area of the North Runway at the locations detailed in Figure A-3 (extracted from Figure 4.3 in the daa Report).

The borehole references, well depth and targeted groundwater horizon are summarised in Table A 6.

Table A 6 Summary of daa North Runway / APEC 5 Groundwater Monitoring

Monitoring Location Ref.	Total Well Depth	Well Screen Lithology	Depth to Groundwater (mbgl) range*	Maximum Sum of 20 PFAS (ng/L)
GWMP4	15.0	N/A	NS	216.2
GWMP5	19.5	N/A	1.96-5.08	187.4
GW11	10.0	Bedrock	0.00-1.58	4,111
GW12	10.0	Bedrock	2.47-2.64	90.2
GW13	10.0	Bedrock	0.11-2.84	6.72
GW14	10.0	Bedrock	0.43-0.79	1,712
GW15	10.0	Bedrock	0.68-1.96	23.3
GW16	10.0	Bedrock	1.15-2.27	257.7
GW17	10.0	Bedrock	0.12-1.53	71.1
GW18	10.0	Bedrock	1.15-1.52	<LoD
GW19	10.0	Bedrock	0.86-1.44	3.38
* Range across the 4 groundwater level monitoring events for each well				

Sum of 20 PFAS concentrations were consistently above the LoD during the monitoring rounds for all locations except GW18, and the GAC for sum of 20 PFAS (100ng/L) was exceeded in 5 locations.

The highest sum of 20 PFAS concentration recorded was 4,111ng/L at GW11 within the former fire fighting area. PFAS was also identified in GWMP4 and GWMP5 near the northern perimeter of the daa lands.

Private Water Supply Well and Offsite Reservoir

A Private Reservoir and water supply well (Gardener's Well) were also sampled as part of the daa monitoring programme. The locations of these features are presented in Figure A-3.

The monitoring results are summarised in Table A 7

Table A 7 Summary of Water Supply Well and Offsite Reservoir Monitoring Results

Monitoring Location Ref.	Maximum Sum of 20 PFAS (ng/L)
Gardener's Well	3.33
Offsite Reservoir	2.47

Sum of 20 PFAS concentrations were consistently above the LoD in both locations however all concentrations were below the GAC for sum of 20 PFAS (100ng/L).

A.3.2.3 Surface Water Analysis

A programme of landside and airside surface water monitoring was also undertaken between 2021 and 2023. Locations are summarised in Figure A-5 (extracted from Figure 4-4 in The daa Report).

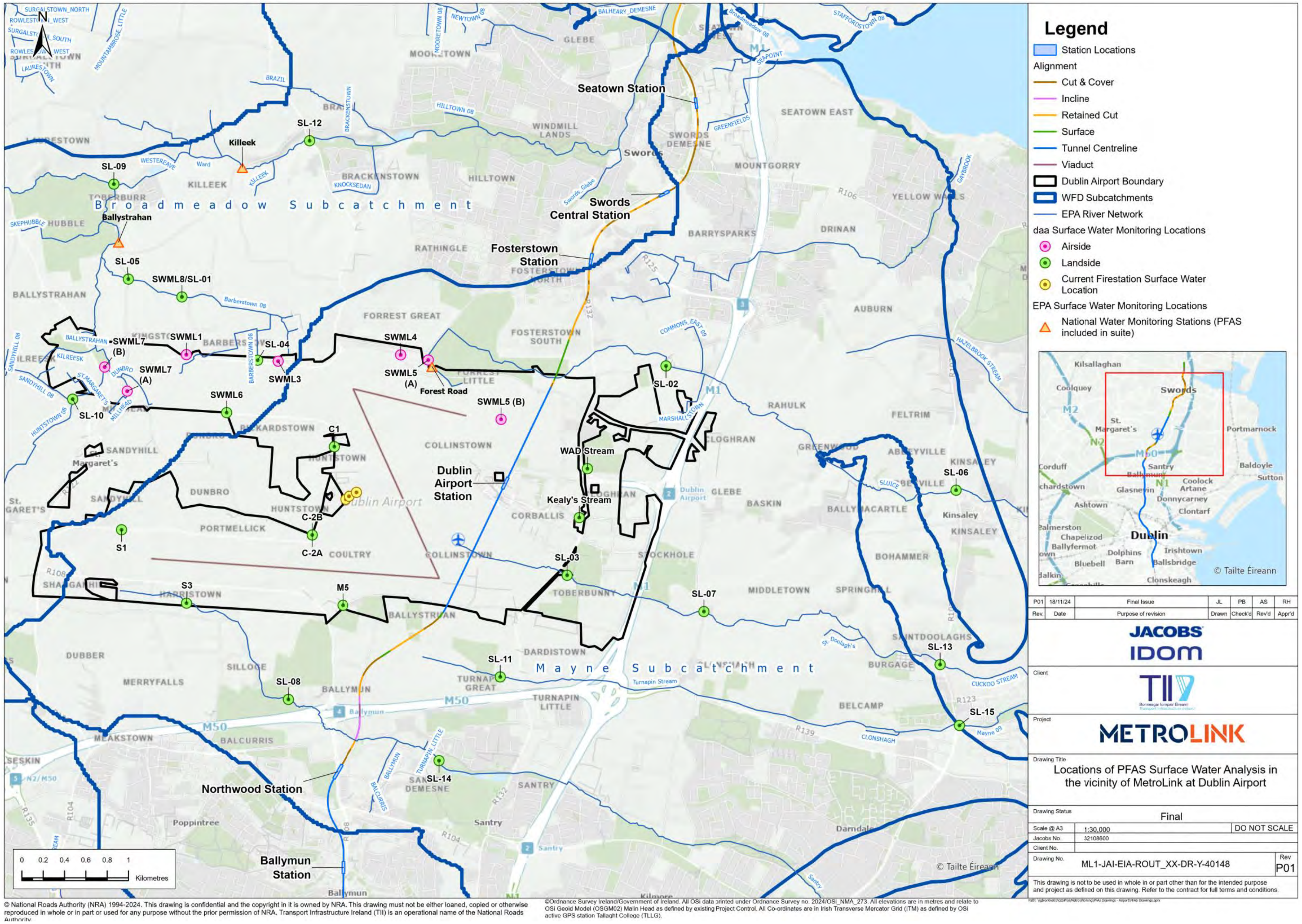

Figure A-5: PFAS Surface Water Monitoring Locations

The surface water drainage system for the airport is connected via pipes and a series of manholes and discharges via oil interceptors to surface water at various points around the perimeter of the airport. Surface water drainage from the North Apron and north runway discharges towards the north-east, to the Sluice River. Surface water drainage from the north-west of the airport discharges towards the north-west, to the upper tributaries of the Ward River. daa have undertaken monitoring at discharge points and in water courses around the airport as shown in Figure A-5. Surface water monitoring data are summarised in Table A8 which provides the maximum and average PFOS from the daa Report, and also the maximum total sum of all PFAS detected at each monitoring location as summarised in the daa Report. PFOS was detected in all locations in all watercourses with the exception of S1 and S3 (upstream on the Santry) and M1 (a manhole on the Mayne catchment, location not certain). Some individual PFAS (contributing to the sum of total PFAS detected) were reported in all monitoring locations.

Monitoring was also undertaken in the vicinity of the current fire station and firefighting training ground towards the west of the airport. The drain and interceptor monitoring locations in this area identified PFOS concentrations in the range of to 16.5ng/L to 116ng/L. Surface water monitoring data from these airside locations are summarised Table A 8.

Review of the surface water data monitoring provides broader information on the current baseline of PFAS in the surface water in the vicinity of Dublin Airport as well as in the watercourses that will be directly impacted by the MetroLink.

The daa Report focusses on the monitoring data for PFOS, summarising maximum and average PFOS detected and comparing with the EQS. The report also includes monitoring data for up to a total of 48 individual PFAS, which provide useful information on the types of PFAS present and inform the existing baseline even though there are no current regulatory standards for PFAS other than PFOS.

Table A 8 Summary of daa Surface Water Monitoring

Monitoring Location Ref.	Surface Water Body / Area	Surface Water Course	Maximum PFOS (ng/L)	Average PFOS (ng/l)	Maximum Sum of all PFAS detected ng/l)
SWML3	Airside / Unnamed	Sluice_010	34.2	12.03	314.42
SWML4	Airside / Unnamed	Sluice_010	138	17.03	1066.54
SWML5a	Airside / Sluice	Sluice_010	85.2	28.15	477.39
SWML5b	Airside / Drainage Channel	Mayne_010	1430	232.8	5186.97
SWML7a	Airside / Unnamed	Ward_030	7.22	3.25	239.32a
SWML7b	Airside / Huntstown 08	Ward_030	18	3.63	176.58b
SL-01	Barberstown 08	Ward_030	9.58	1.66	70.6
SL-02	Sluice	Mayne_010	25.2	12.19	214.7
SL-03	Cuckoo Stream	Mayne_010	50.6	13.67	343.74

Monitoring Location Ref.	Surface Water Body / Area	Surface Water Course	Maximum PFOS (ng/L)	Average PFOS (ng/l)	Maximum Sum of all PFAS detected ng/l)
SL-04	Ward_030	Ward_030	17.5	3.78	351.38
SL-05	Ward_030	Ward_030	3.26	1.34	47.91
SL-06	Sluice	Mayne_010	12.4	8.07	225.55
SL-07	Cuckoo Stream	Mayne_010	23.7	11.06	203.89
SL-08	Santry	Mayne_010	1.99	1.42	17.6
SL-09	Westereave	Ward_030	2.51	1.05	22.48
SL-10	Sandyhill 08	Ward_030	3.45	1.47	29.32
SL-11	Mayne 09	Mayne_010	7.26	3.52	173.33
SL-12	Ward	Ward_030	22.5	4.97	18.33c
SL-13	Cuckoo Stream	Mayne_010	23.1	8.56	210.97
SL-14	Santry	Mayne_010	13.2	2.32	94.42
SL-15	Mayne 09	Mayne_010	5.41	2.12	148.02
C1	Drainage Channel	Sluice_010	1.74	1.72	14.89
C2A	Manhole	Mayne_010	0.99	0.99	160.31
C2B	Manhole	Mayne_010	2.57	2.47	82.16
Kealy's stream	Drainage Channel	Sluice_010	28.6	22.08	563.57
M5	Drainage Channel	Mayne_010	1.37	1.13	37.51
S1	Drainage Channel	Santry_010	<LOD	<LOD	13.47
S3	Santry	Santry_010	<LOD	<LOD	15.64
WAD	Drainage Channel	Sluice_010	2.84	1.9	53.02
M1	Manhole	Mayne_010	<LOD	<LOD	24.53

a: sporadic elevated PFAS, mainly less than 100 ng/l

b: maximum 30.97 ng/l since Nov 2020; elevated PFAS first two rounds only

c: also includes one much higher result high of 165.96 ng/l excluded from this maximum as does not appear representative

Table A 9 Summary of daa Surface Water Monitoring Manholes and Current Fire Station

Monitoring Location Ref.	Surface Water Body / Area	Receiving Surface Water Course	Maximum PFOS (ng/L)	Average PFOS (ng/l)	Maximum Sum of all PFAS detected ng/L)
MH1	North Apron Manhole	SL02 / Sluice_010	92.50	48.7	193.33
MH2	North Apron Manhole	SL02 / Sluice_010	88.50	50.5	450.73
MH3	North Apron Manhole	SL02 / Sluice_010	136	56.4	227.77
MH4	North Apron Manhole	SL02 / Sluice_010	133	66.7	579.73
ACO Drain	Current fire station drainage	Sewer	116	83.3	3348.88
Interceptor	Current fire station drainage	Sewer	16.5	14.0	1071.39
Sewer	Current fire station drainage	Sewer	<0.65	<LOD	232.8

The monitoring shows the presence of elevated PFAS at multiple locations within the airport boundary, and in downstream surface water monitoring to the east of the airport.

Monitoring of the Sluice, Kealy's, Cuckoo and Mayne streams to the east of the airport all show elevated PFAS. The highest PFOS concentration was found in the Cuckoo stream at 50.6ng/l PFOS. While some downstream reduction in PFAS concentration is observed, this is not substantial. All show the presence of individual PFAS including 6:2 FTAB and/or PFECHS which are noted within source areas within the airport and are associated with AFFF and aviation activities.

Monitoring of the Santry south of the airport shows relatively low levels of PFAS. S1, S3 and SL-08 all show very low levels of PFAS which may represent a baseline not impacted by direct sources of PFAS from the airport. SL-14 on the Santry, downstream of the proposed MetroLink, appears to have slightly higher PFAS levels.

West of the airport, monitoring of the Broadmeadow/Ward shows some elevated PFAS in the airside monitoring locations, although these appear quite sporadic and have been consistently low in the more recent monitoring (potentially reflecting changes in drainage following the completion of the North Runway). Downstream monitoring shows generally very low levels of PFAS. 6:2 FTAB and PFECHS are not detected in any samples. The PFAS levels at these locations appear to reflect a baseline not impacted by direct sources of PFAS from the airport.

A.3.3 EPA Monitoring

The EPA undertake surveillance monitoring of surface water quality and report the data on their website, including PFAS monitoring for some locations. The monitoring data for the watercourses intersected by the MetroLink alignment have been reviewed and available PFAS data extracted.

Table A 10 lists the water bodies crossed by the MetroLink route and the available data. While water quality data are available for 8 out of the 10 water bodies, PFAS data are only available for two water bodies: the Sluice_010 (one location) and the Ward_030 (two locations).

Table A 10 Summary EPA Water Quality Monitoring of Waterbodies

Catchment	Sub Catchment	Waterbody	Water Quality Monitoring data available	PFAS data available
Nanny-Devlin	Broadmeadow_SC_010	Broadmeadow_040	Yes	No
	Broadmeadow_SC_010	Ward_040	Yes	No
	Broadmeadow_SC_010	Ward_030	Yes	Yes
Liffey and Dublin Bay	Mayne_SC_010	Gaybrook_010	No	No
	Mayne_SC_010	Sluice_010 (Forest Little)	Yes	Yes
	Mayne_SC_010	Sluice_010 (Sluice)	Yes	No
	Mayne_SC_010	Sluice_010 (Wad, Kealy's)	No	No
	Mayne_SC_010	Mayne_010 (Cuckoo stream)	Yes	No
	Mayne_SC_010	Mayne_010 (Turnapin)	Yes	No
	Mayne_SC_010	Santry_010	Yes	No

A.3.3.1 PFAS Monitoring in Sluice_010

There is one river monitoring station with PFAS data on the Sluice_010 water body, station code RS09S070200 known as "SLUICE - Sluice River DS Cottages". The monitoring point is located off Forest Road just north of the airport boundary and is very similar in location to daa monitoring point SWML5(A). The monitoring point is about 1km upgradient of the MetroLink watercourse crossing near the Dublin Airport north portal. The monitoring location is believed to receive drainage from the north-east of the airport including the north apron.

The EPA monitoring at RS09S070200 includes monitoring for PFOS and PFOA on six occasions from March 2023 to May 2024, and extended suite PFAS monitoring for 48 PFAS for 8th August 2024.

Thirteen different PFAS were reported above the detection limit and show the presence of elevated concentrations of PFAS with a similar suite to those identified in the daa monitoring. This includes:

- 6.8 ng/l PFOS (compared to EQS of 0.65 ng/l);
- 99 ng/l 6:2 FTAB (highest individual PFAS); and
- 7.5 ng/l PFECHS (a PFAS associated with aviation activities).

The results appear broadly similar to the daa monitoring at SWML05(a).

A.3.3.2 PFAS Monitoring in Ward_030

There are two EPA river monitoring stations with PFAS data on the Ward_030 water body, station code RS08W010300 known as "Br N of Killeek" (Killeek) and RS08H020500 known as "HUNTSTOWN STREAM - Br nr Luttrell's Crossroads ('Ballystrahan')" (Ballystrahan). Both are located north-west of the airport. As shown on Figure B-4, the Ward at the west end of the airport has many tributaries, potentially receiving drainage from several different points around the airport.

The Ballystrahan monitoring location is downstream of the confluence of the Barberstown tributary and the Ballystrahan and Huntstown and other tributaries and may be receiving water from daa airside monitoring points SWML1, SWML3, SWML7(a), SWML7(b), and daa landside monitoring points SL-04, SL-10, SWML8, SL-05.

The Killeek monitoring location is further downstream, after confluences with the Skephubble and Ward. The daa landside monitoring point SL-09 is located between Ballystrahan and Killeek. The daa landside monitoring point SL-12 is located downstream of Killeek. The Ward flows west to Swords and then north to enter the sea.

The EPA monitoring at Ballystrahan includes monitoring for PFOS and PFOA only on two occasions in March 2024 and May 2024, and extended suite PFAS monitoring for 48 PFAS for 8th August 2024. The data for Killeek includes monitoring for PFOS and PFOA only on six occasions from March 2023 to May 2024, and extended suite PFAS monitoring for 48 PFAS for 8th August 2024.

PFAS were detected at both locations, but results are generally low and close to laboratory detection limits, with PFOS and PFOA below 1 ng/l in all samples, and other individual PFAS below 5 ng/l in all extended suite monitoring.

A.3.4 Further Monitoring

A.3.4.1 2024 MetroLink Groundwater Monitoring

A programme of groundwater monitoring of available monitoring borehole locations within the vicinity of the proposed MetroLink project at Dublin Airport was undertaken by AWN on behalf of TII in September and October 2024.

A.3.4.2 Scope and Objectives

The key objective of the monitoring programme was to obtain up to date information on the existence of PFAS in the groundwater within the area of the proposed MetroLink project, using existing groundwater monitoring installations. This was achieved by obtaining representative samples of groundwater from existing installations in the vicinity of the proposed MetroLink project. The scope of work included the following:

- Review of existing monitoring borehole location conditions and suitability via a site walkover.
- Development of a sampling methodology including measures to minimise the potential for cross-contamination with PFAS.
- Appointment of an analysis laboratory (Eurofins) with the capability to undertake PFAS analysis to the required LoDs.
- Monitoring of groundwater standpipes at the proposed Dublin Airport North Portal (DANP), Dublin Airport Station and Dublin Airport South Portal (DASP) locations.
- Review of the results of the monitoring programme.

A.3.4.3 Methodology and Locations

The sampling locations used during the groundwater monitoring are summarised in Table A 11 and shown in Figure A-6. All available MetroLink boreholes in and around the airport were sampled. The sampling included the following steps:

- Site inspection/reconnaissance: On 30 August 2024, AWN and Eurofins conducted a site inspection to assess the suitability of the locations and determine specific requirements. This included measuring the water level;
- Trial Run: A trial run was set-up at a dry well to ensure the full sampling methodology was appropriate;
- Installation of dedicated sampling tubing: Pre-cleaned, PFAS free sampling tubing was installed at the selected locations;
- Sampling Process: A low flow pump was used to collect samples. During this process, field physical-chemical parameters (such as pH, redox potential, Dissolve Oxygen (DO), pH, temperature) were measured to ensure adequate purging and the collection of representative samples; and
- Sample Collection: Samples were collected in dedicated containers. Quality assurance and quality control (QA/QC) measures included field rinsate and field duplicate samples and trip blanks.

Two monitoring events were undertaken in September and in October 2024. The monitoring frequency was informed by the need to obtain a good indication of the presence of PFAS in the groundwater and feasibility (bearing in mind project constraints).

Table A 11 Summary of 2024 PFAS Groundwater Monitoring Locations

Location	Borehole Reference	Well Depth (mbgl)	Standing Groundwater Level on 30th August (mbgl)	Screened Geology
Dublin Airport North Portal (DANP)	ABH09	17.00	8.56	Superficial Deposits (sand / gravelly clay)
Dublin Airport Station	NBH04	31.00	4.60	Bedrock (limestone)
	NBH60	1.40	Dry	Made ground
	NBH61	2.25	Dry	Made ground
	NBH62	2.55	1.60	Made ground
	ABH12	25.00	3.92	Bedrock (limestone)
	ABH13	25.00	2.67	Bedrock (limestone)
	ABH15	27.50	12.08	Bedrock (limestone)
Dublin Airport South Portal (DASP)	NBH05 (S)	20.00	5.83	Superficial deposits (gravel)
	NBH05 (D)	38.00	5.94	Bedrock (limestone)
	NBH06A	22.50	6.75	Superficial deposits (gravel)
	NBH06W	45.00	6.37	Bedrock (limestone)
	NBH07 (S)	19.50	6.31	Superficial deposits (gravel / cobbles)
	NBH07 (D)	40.80	6.13	Bedrock (limestone)

A.3.4.4 Results

The results of the PFAS monitoring are summarised in Table A 12.

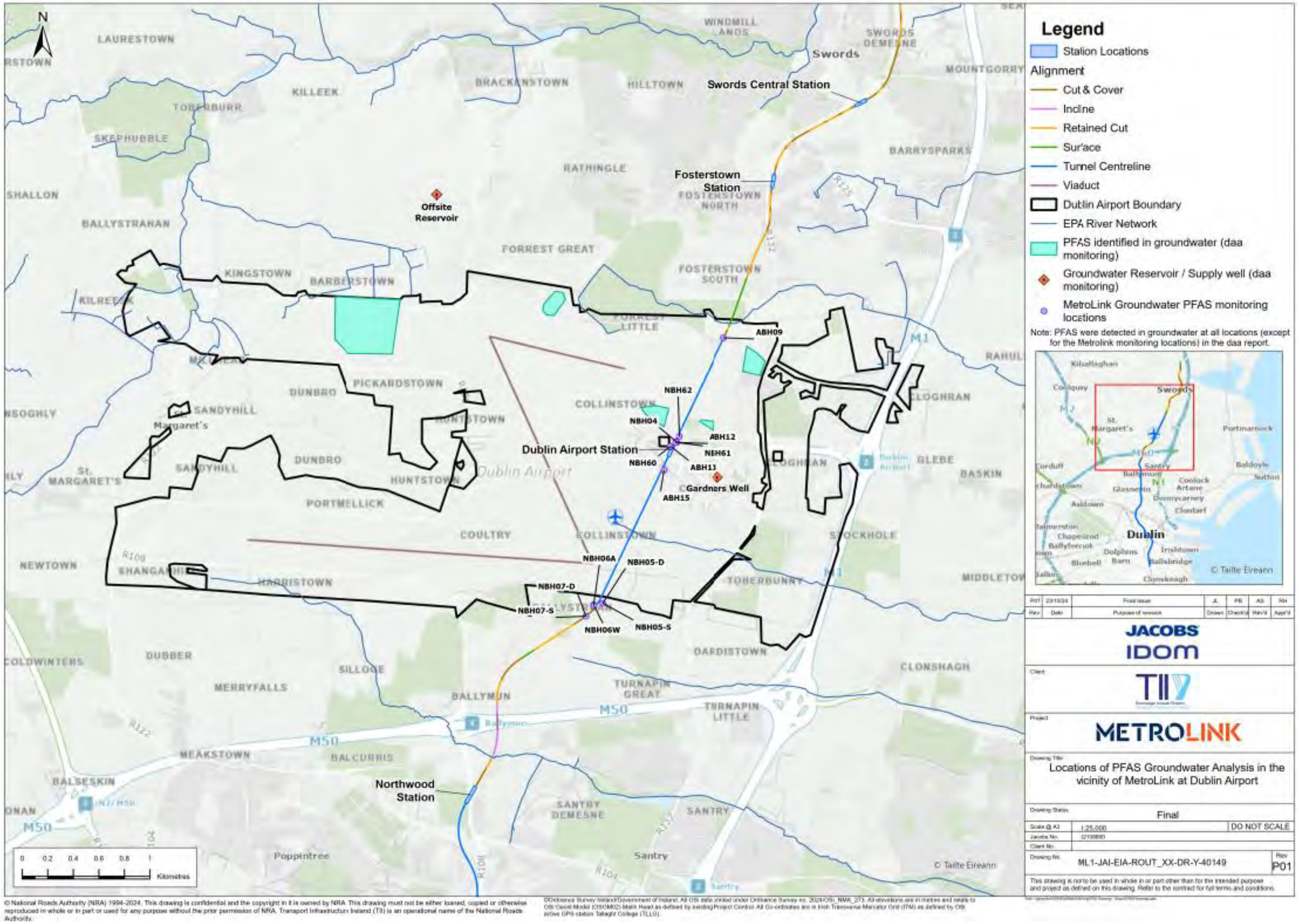

Figure A-6: Locations of PFAS Groundwater Analysis in the Vicinity of Metrolink at Dublin Airport

Table A 12 Summary of 2024 PFAS Groundwater Monitoring Results

Location	Borehole Reference	Screened Geology	Round 1 - September 2024 (ng/l)					Round 2 - October 2024 (ng/l)				
			6:2 FTS	8:2 FTS	Sum of 20 PFAS	Sum of 4 PFAS	Sum of 21 PFAS	6:2 FTS	8:2 FTS	Sum of 20 PFAS	Sum of 4 PFAS	Sum of 21 PFAS
Trip Blank			<LoD	<LoD	ND	ND	ND	<LoD	<LoD	ND	ND	ND
Field Rinsate			26	0.49	ND	ND	26	NT	NT	NT	NT	NT
Rinsate blank			NT	NT	NT	NT	NT	<LoD	<LoD	ND	ND	ND
DANP	ABH09	Superficial Deposits (sand / gravelly clay)	11	<LoD	7.1	ND	18	0.33	<LoD	11	ND	11
Dublin Airport Station	NBH04	Bedrock (limestone)	2.5	<LoD	12	5.6	15	2.5	<LoD	12	3.3	14
	NBH04 (Duplicate		1.4	<LoD	13	5.8	14	3.1	<LoD	13	5.6	16

Location	Borehole Reference	Screened Geology	Round 1 - September 2024 (ng/l)					Round 2 - October 2024 (ng/l)				
			6:2 FTS	8:2 FTS	Sum of 20 PFAS	Sum of 4 PFAS	Sum of 21 PFAS	6:2 FTS	8:2 FTS	Sum of 20 PFAS	Sum of 4 PFAS	Sum of 21 PFAS
	NBH60	Made ground	Dry – not sampled									
	NBH61	Made ground	Dry – not sampled									
	NBH62	Made ground	<LoD	<LoD	12	3.7	12	2.1	<LoD	12	3.3	14
	ABH12	Bedrock (limestone)	5.9	<LoD	14	6.7	20	1.6	<LoD	13	5.7	15
	ABH13	Bedrock (limestone)	11	<LoD	31	13	42	1.0	<LoD	20	7.3	21
	ABH15	Bedrock (limestone)	2.8	<LoD	ND	ND	2.8	3.3	<LoD	ND	ND	3.3
DASP	NBH05 (S)	Superficial deposits (gravel)	<LoD	<LoD	ND	ND	ND	7.2	<LoD	1.7	0.55	8.9

Location	Borehole Reference	Screened Geology	Round 1 - September 2024 (ng/l)					Round 2 - October 2024 (ng/l)				
			6:2 FTS	8:2 FTS	Sum of 20 PFAS	Sum of 4 PFAS	Sum of 21 PFAS	6:2 FTS	8:2 FTS	Sum of 20 PFAS	Sum of 4 PFAS	Sum of 21 PFAS
	NBH05 (D)	Bedrock (limestone)	0.72	<LoD	2.0	0.99	2.7	1.8	<LoD	2.7	0.68	4.5
	NBH06A	Superficial deposits (gravel)	<LoD	<LoD	ND	ND	ND	2.1	<LoD	ND	ND	2.1
	NBH06W	Bedrock (limestone)	<LoD	<LoD	ND	ND	ND	5.6	<LoD	ND	ND	5.6
	NBH07 (S)	Superficial deposits (gravel / cobbles)	8.3	<LoD	ND	ND	8.3	1.6	<LoD	0.84	ND	2.4
	NBH07 (D)	Bedrock (limestone)	1.8	<LoD	5.0	0.84	6.8	2.9	<LoD	0.78	ND	3.7

Notes: <LOD below Limit of Detection   ND Not detected - all relevant determinands below LOD   NT Not tested

Sum of 20 PFAS: sum of 20 PFAS included in the Irish PFAS drinking water standard of 100 ng/l.

Location	Borehole Reference	Screened Geology	Round 1 - September 2024 (ng/l)					Round 2 - October 2024 (ng/l)				
			6:2 FTS	8:2 FTS	Sum of 20 PFAS	Sum of 4 PFAS	Sum of 21 PFAS	6:2 FTS	8:2 FTS	Sum of 20 PFAS	Sum of 4 PFAS	Sum of 21 PFAS

Sum of 4 PFAS: Sum of PFOS, PFOA, PFNA, PFHxS; these are recognised by the European Food Standards Agency as the most toxic PFAS and the EU has proposed (Council of the European Union, 2024) a future revision of the drinking water standard to 4.4 ng/l for the sum of 4 PFAS.

Sum of 21 PFAS: sum of 20 PFAS included in the Irish PFAS drinking water standard plus 6:2 FTS.

See text for description of 'field rinsate' and 'rinsate blank'

A.3.4.5 QA/QC

Results of QA/QC analysis

The QA/QC analysis involved several checks to ensure the accuracy and reliability of the groundwater monitoring results:

Trip Blanks

Trip blanks were analysed for both monitoring rounds. Trip blanks are bottles of PFAS free water filled by the laboratory. These bottles are shipped to the site, along with the empty sampling bottles, and then returned to the laboratory for testing alongside the collected samples. No PFAS were detected in any of the trip blanks from both monitoring rounds. This indicates that no PFAS contamination occurred during transit or in the laboratory.

Rinsate samples

Rinsate samples are used to check for potential cross-contamination from sampling equipment.

Round 1: a rinsate sample was collected at the time of cleaning the equipment used for sampling at location ABH15. This sample, referred to as a 'field rinsate' in Table A-12 contained detectable levels of PFAS 6:2 FTS (26 ng/l) and 8:2 FTS (0.49 ng/l).

Round 2: a rinsate sample was collected by rinsing out the monitoring equipment with PFAS-free water after it had been cleaned and before use. This sample, referred to as a 'rinsate blank' in Table A-12, showed no detectable PFAS.

Field Duplicates

Field duplicates were collected from location NBH04 in each monitoring round. A duplicate sample is collected by filling a second sample bottle when collecting the primary sample. The results of duplicate analysis show very good correlation between the primary and duplicate results, indicating consistent reproducibility of laboratory results.

A.3.4.6 Groundwater Results

PFAS were detected in groundwater samples from all locations in Round 2 and in 10 out of 13 groundwater samples at Round 1.

DANP

PFAS were detected in both monitoring rounds in the groundwater samples from location ABH09, which is situated in the superficial deposits at the north portal. The detected PFAS included both 6:2 FTS and also short chain Perfluoroalkyl carboxylic acids (PFCAs). No long chain PFAS were detected. The maximum total concentration of 20 PFAS (excluding 6:2 FTS) was 11 ng/l and the maximum total concentration of 21 PFAS (including 6:2 FTS) was 18 ng/l. These very low levels of PFAS in groundwater are highly unlikely to result in detectable PFAS in associated soil due to the higher method detection limits for soil analysis.

Dublin Airport Station

A variety of PFAS were detected in all groundwater samples within the main airport campus area, with the exception of ABH15 (south of the central area) where only 6:2 FTS was detected.

PFAS were detected in all groundwater samples, including those with response zones in both Made Ground (NBH62) and bedrock (ABH12, ABH13, NBH04A and NBH04B). The PFAS present include long and short chain PFCAs and Perfluoroalkyl sulfonic acids (PFSAs) as well as 6:2 FTS. All but one of the samples from the bedrock also contained the cyclic PFAS Perfluoroethylcyclohexane sulfonate (PFECHS) at concentrations marginally above the detection limit. PFECHS was also reported at substantially higher concentrations in several groundwater samples in the daa Report. PFECHS is associated with specialist hydraulic fluids including aviation fluids. The PFAS present at this location suggest a similar source to those reported in the daa Report in the north apron. However, the overall concentrations are substantially lower than those identified in the daa Report with a maximum total sum of 21 PFAS of 42 ng/l (compared to a maximum sum of PFAS of 3204ng/l in GW015D, and more general range of the sum of 20 PFAS in the north apron of around 500-800ng/l). While the monitoring results indicate the presence of PFAS of similar nature to that reported in the daa Report, such low levels of PFAS are unlikely to result in detectable PFAS in rock/soil in contact with this groundwater.

Location ABH15, situated to the south of the main airport campus area, had a standing groundwater level significantly deeper than other boreholes (12m bgl), indicating the location is hydrogeologically distinct from the monitoring points further north. The absence of PFAS (other than 6:2 FTS) is consistent with the limestone aquifer in this area not being impacted by the PFAS contamination known to be present further north as discussed above.

DASP

PFAS were either not detected or present at only low concentrations in all the groundwater monitoring locations in the area of the south portal.

In NBH06(A), NBH06(W), NBH07(S) PFAS were either not detected, or the only PFAS detected was 6:2 FTS, which may not be representative of groundwater, These locations include both superficial deposits and limestone.

PFAS were detected in other groundwater samples in the area, including long and short chain PFSAs and PFCAs. The concentrations of all PFAS (other than 6:2 FTS) were within 3x the method detection limit indicating very low levels of PFAS.

The maximum total 20 PFAS (which excludes 6:2 FTS) was 5 ng/l in NBH07(D) with a response zone in limestone bedrock. The maximum total PFAS (sum of 21 PFAS) was 8.9 ng/l in NBH05(S).

These very low levels of PFAS in groundwater are highly unlikely to result in detectable PFAS in associated soil due to the higher method detection limits for soil analysis.

Occurrence of 6:2 Fluorotelomer Sulfonate (6:2 FTS)

The PFAS 6:2 FTS was detected in 9 out of 13 groundwater samples in Round 1, with concentrations ranging from less than 0.3ng/l to 11ng/l. In Round 2, it was also detected in all groundwater samples, with concentrations ranging from 0.33ng/l to 7.2ng/l. Additionally, 6:2 FTS was found in the Round 1 rinsate blank at a concentration of 26ng/l, indicating its potential presence in field equipment prior to cleaning. These reported concentrations are very low, and close to the laboratory limits of detection. It is also unexpected to find 6:2FTS related to airport activities in all these locations and the following text details background information supporting the hypothesis that these results are do not indicate significant PFAS impact.

In Ireland, 6:2 FTS is not subject to current or proposed water regulations. It is not included in the suite of PFAS currently regulated under Irish legislation, nor is it one the of 24 PFAS compounds proposed for a revised Environmental Quality Standard by the EU.

6:2 FTS has been used as a replacement for PFOS in many applications including waterproof coatings, stain resistant finishes, surfactants and fire fighting foams. There is no requirement for manufacturers to explicitly state the presence of 6:2 FTS in their products, and it is therefore difficult to completely avoid potential sources (Wang *et al.* 2013).

Several studies have noted the challenges associated with low level background contamination with 6:2 FTS. For example:

- Chow et al. (2021), in their study of PFAS in bottled waters, refer to 'sporadic elevated concentrations of 6:2 FTS in QC samples leading to a higher MDL' (method detection limit) 'which may be attributed to background contamination in laboratory consumables given its widespread use in manufacturing" and reported an MDL of 10.3ng/l for 6:2 FTS, substantially higher than the MDL for C4-C12 PFCAs and PFSAs (0.11 to 0.68 ng/l);
- Teymoorian et al. (2023) also referred to 6:2 FTS being occasionally found at problematic levels in blanks; and
- A US EPA interlaboratory validation study of PFAS in aqueous matrices (US EPA 2019), reported that 'multiple laboratories reported high or variable background levels of this chemical, including in method blanks and calibration standards', potentially leading to erratic QA/QC performance.

The analytical laboratory responsible for the 2024 monitoring, Eurofins Sweden, did not report any QC concerns regarding 6:2 FTS. The trip blanks showed no detected 6:2 FTS, and the laboratory confirmed and reviewed the presence of 6:2 FTS in the samples according to all QA/QC protocols. However the laboratory did note sporadic elevated concentrations of 6:2 FTS at levels close to the limit of quantification in urban environments. It is important to highlight that such variability is not observed at higher PFAS concentrations.

It is considered possible that the presence of 6:2 FTS in some of these samples is related to background contamination (possibly consumables used in borehole construction or sampling) or other ambient sources. The presence of 6:2 FTS in the Round 1 field rinsate supports this hypothesis.

In summary, the laboratory reports of low concentrations of 6:2 FTS are inconclusive regarding the definite presence of 'any' 6:2 FTS in groundwater at these locations. They do however indicate the absence of 6:2 FTS in the ground at concentrations sufficient to be detectable in associated soil samples (particularly considering the much higher detection limits for PFAS in soil.)

Conclusions

The 2024 monitoring programme has confirmed the presence of low levels of PFAS in groundwater from boreholes located within the MetroLink footprint. In the Dublin Airport Station area the distribution of PFAS shows some similar characteristics to the PFAS identified in the north apron (by daa), suggesting an airport source. The overall concentrations however are much lower than those reported in the north apron within the daa Report, and at such low levels of PFAS that it seems unlikely to result in detectable PFAS in rock from this depth which has been in contact with this water.

Groundwater samples from the DANP and DASP were also found to contain very low levels of PFAS. There were no specific characteristics in the PFAS distribution to enable attribution to any particular source. Again, the levels of PFAS are so low that it seems unlikely to result in detectable PFAS in soil or rock from this depth which has been in contact with this water.

A.4 Extent of Potential PFAS Impacts

The scope of this report includes a review of the potential impacts of PFAS from Dublin Airport activities on the MetroLink project and a consideration of the extent of those impacts within the footprint of the

MetroLink to define an appropriate study area. The text below reviews the potential study area in the context of groundwater (hydrogeology) and surface water (hydrology).

A.4.1 Defining the Study Area based on Hydrogeology

This section reviews the potential for PFAS from activities at Dublin Airport to be impacting groundwater in the wider area outside the Dublin Airport extent.

The potential for long distance migration of PFAS in groundwater at Dublin Airport has been considered, and is considered unlikely based on the following evidence:

- Regional Groundwater Flow: groundwater flow is expected to occur within fractures within the bedrock aquifer, including the higher permeability weathered limestone at the base of drift. According to information from GSI (2022) (summarised in Section A.2.3.1), support only short distance groundwater flow. While fracture flow may occur locally, groundwater circulation from recharge to discharge points will more commonly take place over a distance of less than a kilometre;
- Ground Investigation and Monitoring Data: this data suggests groundwater flow directions within the vicinity of Dublin Airport are parallel to the MetroLink alignment with a local groundwater level high within the vicinity of the proposed Dublin Airport Station. However, this is not expected to be the case within the wider region based on the general aquifer characteristics;
- Groundwater Divide: The presence of a groundwater divide around the proposed Dublin Airport station box has been identified. Towards the north of this, groundwater flows north, including through the higher permeability weathered bedrock zone within the area of the airport and at the depth of construction of the MetroLink. However north from around chainage 6+100 (which is located south of the DANP and within the airport area) the elevation of the weathered top of bedrock drops and is below the depth of construction of MetroLink for the next 1.5km. Therefore, even if there was groundwater flow in the weathered zone in this area, it would not be encountered by MetroLink. The MetroLink construction does extend into the weathered top of bedrock again around chainage 4+400 (Fosterstown Station) but based on both regional flow direction (east towards the sea) and distance from the airport (> 1.5km) regional flow of PFAS impacted groundwater in this direction appears highly unlikely;
- South of the Dublin Airport Station Box: predominant groundwater flow flows towards the south, towards the Mayne River. Between approximate chainages 7+500 to 7+900 and 8+200 to the DASP at 8+700 the MetroLink tunnel is above the elevation of the weathered bedrock and would not be expected to encounter PFAS in groundwater. The alignment of the Mayne River (around chainage 9+000) appears to be a groundwater low, and to the south groundwater flow direction appears northwards towards the Mayne. This groundwater flow regime will limit the extent of groundwater flow paths in this direction; and
- Monitoring Results: monitoring near the daa North Runway APEC5, as reported in the daa Report, shows relatively high levels of PFAS in groundwater within the original source area. However, two monitoring wells about 250m north (downgradient) have either non-detectable or occasional trace PFAS. A further groundwater monitoring location at an off-site reservoir some 1km north of APEC 5 found only occasional trace concentrations of PFAS.

Based on the hydrogeological setting, the study area is considered to be from the DANP to the DASP. Given the distance and direction from the MetroLInk project, the off-site reservoir (1km north of APEC 5), is considered unlikely to be a PFAS source to any of the proposed MetroLink works.

A.4.2 Defining the Study Area based on the Presence of PFAS in Surface Waters

The results of surface water monitoring by daa and the EPA demonstrate the presence of PFAS in surface water near the airport, likely due to airport activities. Dublin Airport is located on a topographic high, with surface water bodies arising within and around the airport, all of which ultimately flow east to the sea.

Immediately north of the DANP, the MetroLink crosses the Sluice waterbody within the Mayne sub catchment. Monitoring of this waterbody upstream of the crossing demonstrates the presence of PFAS discharged from the airport.

Between the DANP and the DASP the MetroLink is in a tunnel and therefore below the level of surface water bodies draining east from the airport. Monitoring of these waterbodies shows varied levels of PFAS likely related to airport activities.

South of the DASP the relevant waterbodies are the Mayne/Turnapin (which rises immediately south of the airport in the area of the proposed Dardistown Depot) and the Santry (which rises in the south-west of the airport). They show low levels of PFAS which may represent a baseline not impacted by direct sources of PFAS from the airport. However, given their proximity to the airport and the limited monitoring data they are included within the study area.

Annex B. MetroLink Construction Phase relative to PFAS

B.1 Overview of the Proposed Construction Works

The MetroLink construction works in the environs of Dublin Airport is presented in Chapter 5 of the EIAR and its associated appendices. A summary of the proposed works is provided below. For visual reference, please see to Figure B1:

- **DASP** – The location of the tunnel drive site for the Airport tunnel. The site is located within existing agricultural land lands off and to the South of the Old Airport Road, Dardistown, immediately outside of the Airport Boundary;
- **Dublin Airport Station** – This is the site where the proposed Dublin Airport Station will be constructed. It is in an area currently occupied by a surface level car park to the east of Terminal 1 and Terminal 2;
- **DANP** – The location of the main Airport tunnel boring machine reception chamber, within lands to the North of the Naul Road, immediately outside of the Airport Boundary;
- **Main Tunnel Works** - The MetroLink main running tunnel, from the Tunnel Boring Machine (TBM) launch site at DASP via the Station and extracted from DANP; and
- **Other Tunnel Works:** Comprising two short tunnels either side of the main tunnel, one for ventilation and the other for emergency/evacuation with each TBM launched from the DASP; and tunnel connections works, using mining with Sprayed Concrete Lining (SCL) construction techniques, linking these tunnels to the completed main running tunnel.

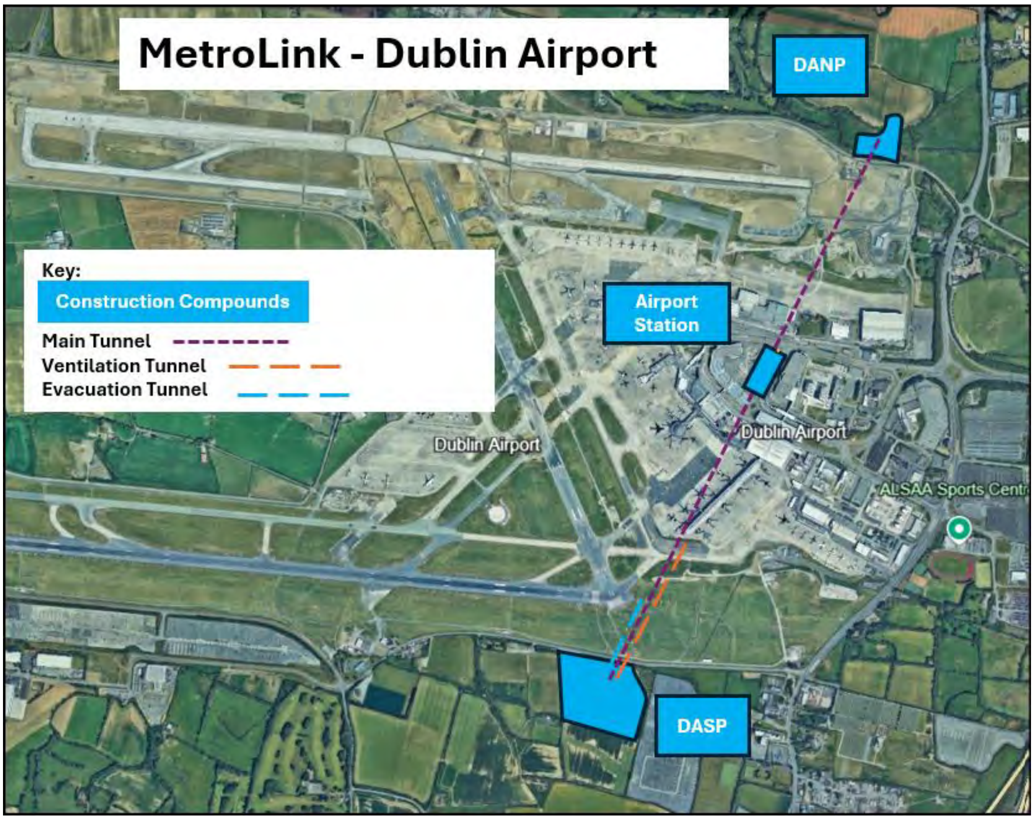

Figure B-1: MetroLink Dublin Airport Section

The construction works proposed at each site where there is potential to mobilise PFAS if present comprise of the following:

- **The Enabling Works:** will entail works at or just below surface level required for the construction site establishment. This work includes site clearance works, the establishment of the site compounds, utility diversions and the provision of site services and the undertaking of preconstruction surveys;
- **Main Construction Works:** This phase of works will entail the main civil works required to construct the structures required for MetroLink including the station box construction, excavation and the tunnelling activity which will also generate significant volumes of spoil material. Other major civil construction works include the construction of the tunnel portals at DASP and DANP. In addition, there remains a risk of encountering PFAS within water courses during construction in the immediate vicinity of the Airport as the MetroLink alignment crosses The Sluice and Forest Little Stream, north of the Airport and The Mayne River and Turnapin Stream and Santry River, to the south; and
- **Managing PFAS Contamination:** Once excavated soils or water with the potential to contain PFAS are encountered, the process of managing the containment and transport of these soils and the containment, treatment and transport of these waters from excavation through to safe disposal.

B.2 Construction Works with Potential for PFAS Mobilisation

Construction works phases with the potential of encountering PFAS contaminated material are the works undertaken during the D-Wall excavation, construction of structures, the excavations of soil and rock material, dewatering activity and tunnelling.

B.2.1 Diaphragm Wall (D-Wall) Piling

In accordance with the MetroLink design presented and assessed in the EIAR, the external supporting structure of the MetroLink Tunnel Portals and Station at Dublin Airport are reinforced concrete D-Walls.

D-Walls are continuous, reinforced (steel or fibre glass) concrete walls placed in the ground as individual panels, prior to the excavation of the station/basement structure.

B.2.1.1 Site Preparation and Construction Sequence

The outline site layout during D-Wall activities for Dublin Airport is provided in Figure B-2.

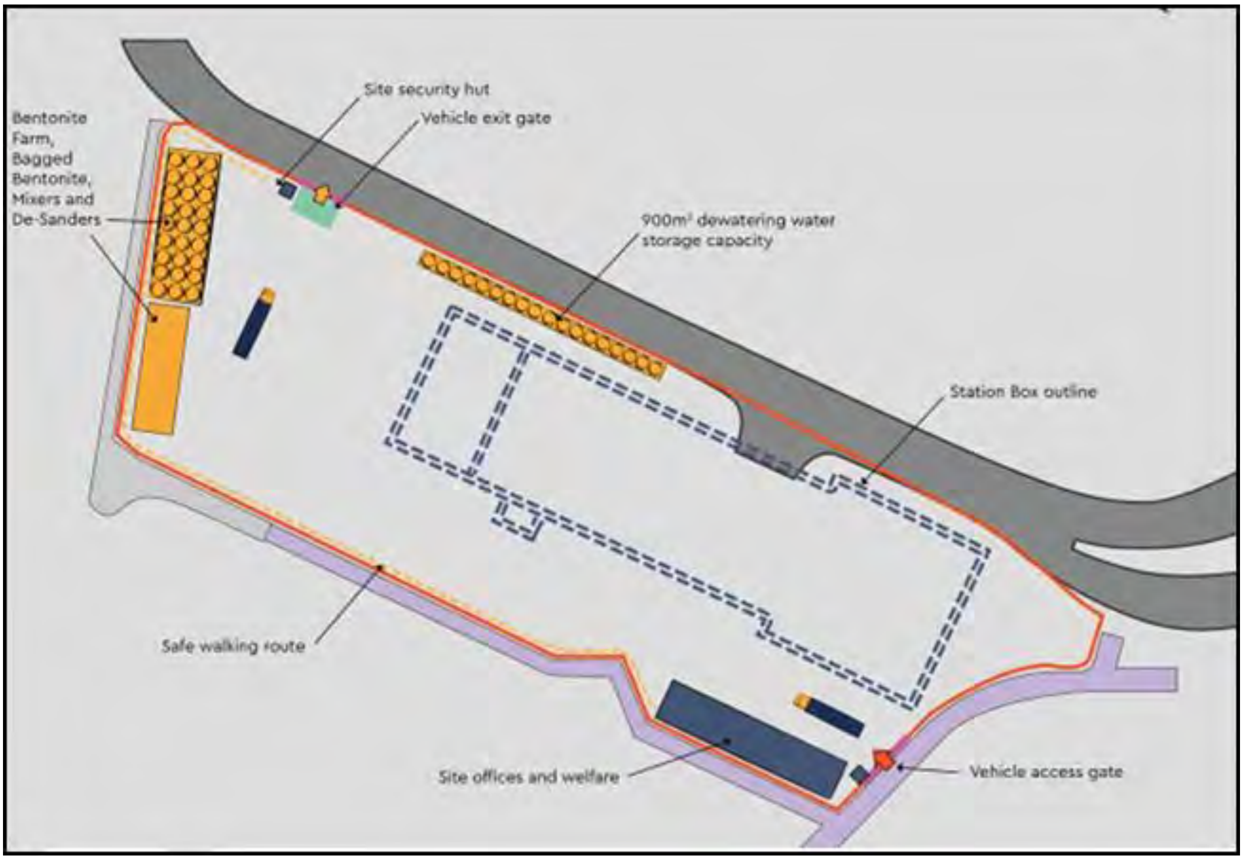

Figure B-2: Dublin Airport Site Layout during D-Wall Activities

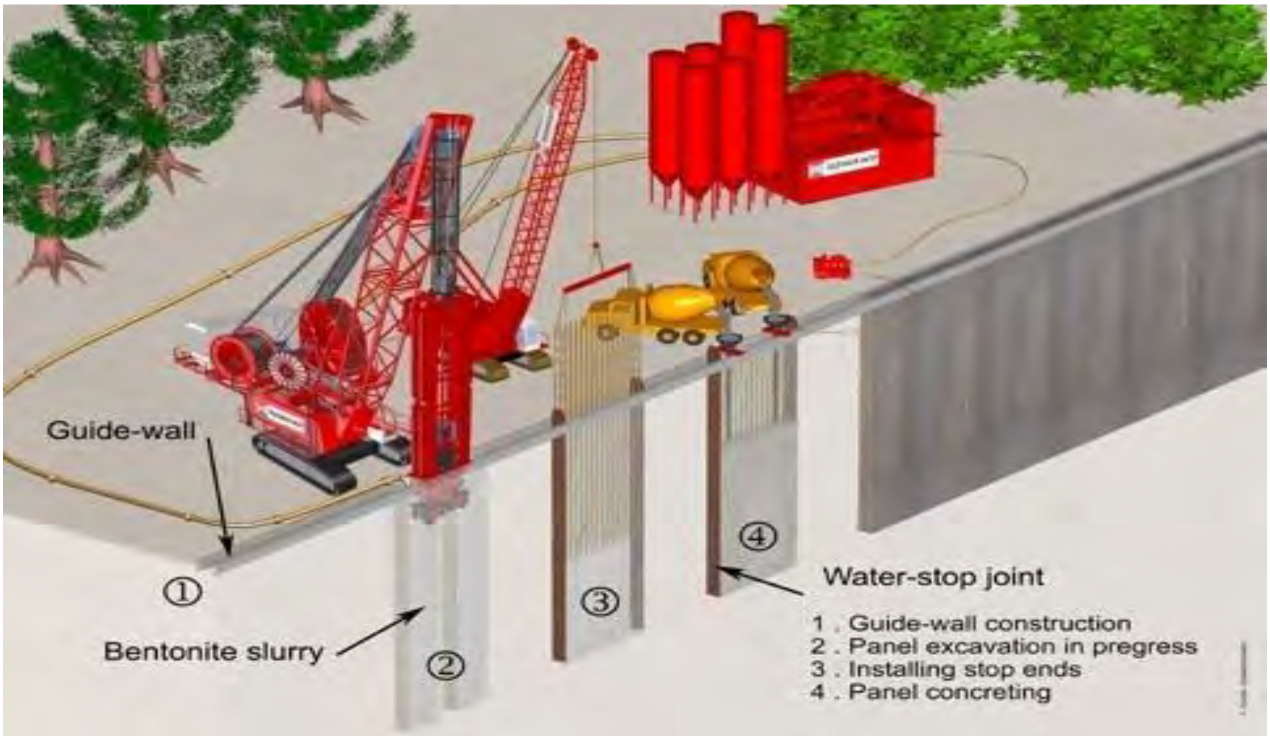

Figure B-3: D-Wall Construction Sequence

The depths of D-Walls required for the construction of the structures in the environs of Dublin Airport Station are as follows:

- DANP – 28m.
- Dublin Airport Station – 32m.
- DASP – 33m.

The D-wall excavation entails the excavation of a trough using a hydrofraise which is then filled with concrete. Each excavation is typically between 3m to 7m in width and are progressed to the depth listed above and are filled with bentonite slurry to provide support to the ground and prevent ground collapse of the walls of the trench during the excavation and concreting process. In supporting the excavation, the bentonite slurry acts to prevent groundwater ingress into the excavated panel, and in doing so will prevent the migration of groundwater and any contaminants into the excavation.

The introduction of the concrete displaces the bentonite slurry, allowing it to be pumped into tanks to be recycled for future use. The process is then repeated for adjacent panels constructed to form a continuous sealed wall.

Once the wall is complete and the required concrete strength attained, excavation inside the D-wall will proceed. At this juncture, the concrete wall now acts as a barrier preventing the movement of groundwater from entering the excavation. The structural wall created by D-Wall therefore will limit the level of any potential PFAS to within the confines of the completed structural walls. As the excavation proceeds further support from lateral propping and anchoring will be required as the excavation progresses to depth. Annex G provides further information on possible mitigation measures should groundwater seepages be identified through the D-Wall structure, including the injection of resin grouting at the point of water ingress.

B.2.1.2 Bentonite

As stated above the process of D-Walling utilises bentonite slurry to retain the excavation. On completion of all the diaphragm works the bentonite slurry used for providing support will be stored securely, tested for any contaminates, including PFAS and disposed of to an appropriately licenced facility.

B.2.1.3 Excavation and Dewatering - Structure Construction.

The construction process for the portals and stations structures progresses with the installation of the dewatering systems inside the completed D-Wall structures. The excavation then progresses with the construction of the roof and intermediate slabs, or temporary propping as required until the structure is watertight with the completion of the base slab. Once the base slab is completed, dewatering is no longer required and is switched off and the dewatering points grouted up. Annex GAnnex F provides further information on possible mitigation measures should unexpected groundwater conditions/flow be encountered during construction resulting in groundwater ingress within the sealed system.

Dublin Airport is referred to as a 'TBM First' Station, and the typical construction sequence of: Excavation, propping and construction for this underground station are provided in EIAR Chapter 5 Section 5.5.9 Underground Stations, and Appendix A5.3 Construction Sequence, Section 9.1 Typical TBM First Station Cross Sections Pages 166 to 184.

The construction sequence for both portals either side of the airport are similar to the sequence outlined in EIAR Chapter 5 Section 5.5.9, with the following exceptions:

- The portals are left open until the completion of all tunnelling operations, when the remaining structures and roof slab are constructed; and
- The portals are watertight with the base slab completed prior to tunnelling commencing.

Based on the assessment in the EIAR, the estimated volume of water to be managed per day with toe grouting in place are:

- DANP – 310L/day.
- Dublin Airport – 21,400L/day with toe grouting.
- DASP – 2510L/day.
- The proposal for the management of groundwater, treatment and disposal is outlined within Annex F.

As assessed in Chapter 19 (Hydrogeology), generally there is no potential for a significant impact predicted to the groundwater arising from the limited de-watering predicted. However, there is the potential for PFAS migration into the excavations from the dewatering process during construction until such time as the excavation is sealed. Should water containing PFAS be encountered, the implementation of mitigation measures for water treatment described in Annex E and F will result in no significant impact.

B.2.1.4 Main Tunnel Work.

A TBM will be used in Earth Pressure Balance (EPB) Mode to excavate the proposed tunnel in the environs of Dublin Airport. In the TBM the excavated material is mixed with spoil conditioning additives to make the cut rock material more consistent and easier to handle. Bentonite slurry will also be used here in a smaller quantity for injecting around the TBM shield during long stoppages.

Tunnel grout is also pumped continuously with tunnel excavation and TBM advancement into the annulus around the tunnel ring. The grout will be a two-component grout (stabilised mix and accelerator) which mix at the nozzle and start to gel straight away. Any voids will be filled with grout which is controlled for both pressure and volume. A quality management system will be implemented to ensure that the grout mix performs as designed and the annulus around the tunnel ring is fully filled. This approach is standard in the industry and MetroLink will ensure that best practice is achieved by developing the requisite Specifications for the Control of the Works.

Because the tunnel boring machine operates in EPB mode and because the tunnel is automatically lined as it is cut, there will be no significant water infiltration during the process of tunnelling.

B.2.2 Other Works in the Vicinity of Rivers and Streams

The project will cross or have works adjacent to several watercourses (Rivers and Streams) along the alignment of MetroLink either side of Dublin Airport.

A review of available monitoring data has identified the presence of PFAS likely to be related to airport activities in surface waters in the vicinity of the airport: The Sluice and Forest Little Stream to the North of the Airport; and The Mayne River and Turnapin Stream and Santry River to the south of the Airport. See Annex F. Further *in-situ* testing of soils and water in advance of construction commencement will be undertaken to establish the levels of PFAS present to be managed as the works are progressed.

The works on or near water courses at Dublin Airport are described within the following chapters of the EIAR:

- The Sluice and Forest Little Stream, refer to Chapter 5, section 5.7.13.3.
- The Mayne River and Turnapin Stream, refer to Chapter 5, section 5.9.11.
- The Santry River, refer to Chapter 5, section 5.9.2.1 South of the M50.
- Culverts and Watercourses Construction Methodologies, EIAR Volume 5 Appendix 5.10.

The proposed MetroLink Depot is located at the head of the Mayne River system and diversion of the Turnapin Stream, which is a tributary of the Mayne River, will be required to facilitate the construction of the proposed depot. The location of the stream to be diverted is shown in Figure F-9 and typical construction methods are presented in Appendix A5.10 of the EIAR. Relevant approvals will be obtained for this diversion from the Office of Public Works (OPW), as required under Section 50 of the Arterial Drainage Act, 1945.

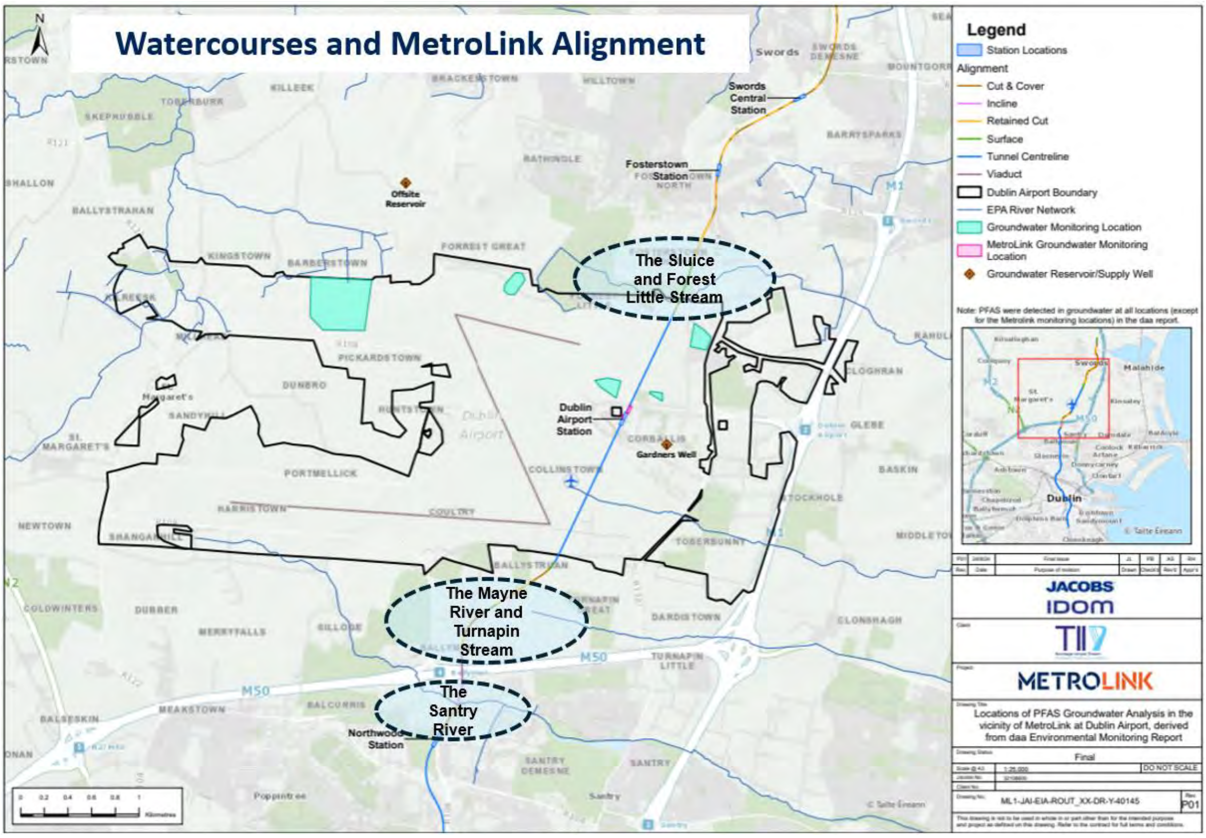

Figure B-4: Rivers and Streams at Dublin Airport

B.3 Summary of Excavated Material Quantities

The predicted quantities of bulk material excavated during the proposed Construction Phase within the environs of Dublin Airport are set out in Table B 1 below.

Table B 1 Excavated Material Quantities

Location	Depth	Volume	Excavated Material: Soil & Rock						
	m	m3	Made Ground	Black Boulder Clay	Sands and Gravel Transition	Weathered Limestone	Upper member of Malahide Formation	Waulsortian Formation	Tober Colleen Formation
North Portal	**19**	9,660	966	8,694					
Plus D Wall	**28**	1,840	184	1,656					
Total		**11,500**	**1,150**	**10,350**	**0**	**0**	**0**	**0**	**0**
Running Tunnel (North)		**59,862**	**0**	**7,520**	**8,623**	**5,065**	**27,528**	**11,126**	**0**
Airport Station	**26**	66,120	4,628	3,637	5,951	992	0	50,912	0
Plus D Wall	**31**	9,880	790	543	988	148	0	7,410	0
Total		**76,000**	**5,418**	**4,180**	**6,939**	**1,140**	**0**	**58,322**	**0**
Running Tunnel (South)		**85,827**	**0**	**55,606**	**3,410**	**2,273**	**0**	**5,584**	**18,954**
Ventilation Tunnel		**22,325**	**0**	**15,013**	**1,316**	**0**	**0**	**0**	**5,996**
Evacuation Tunnel		**7,605**	**0**	**6,583**	**184**	**0**	**0**	**0**	**838**
South Portal	**23**	32,805	3,281	29,524					
Plus D Wall	**34**	7,695		7,695					
Total		**40,500**	**3,281**	**37,219**	**0**	**0**	**0**	**0**	**0**
Total D Wall Excavation		19,415	974	9,894	988	148	0	7,410	0
Total Structures Excavation		108,585	8,875	41,855	5,951	992	0	50,912	0
Total Tunnel Excavation		175,619	0	84,722	13,533	7,339	27,528	16,710	25,788
Total Airport Excavation		**303,619**	**9,849**	**136,470**	**20,472**	**8,479**	**27,528**	**75,032**	**25,788**

Note: All materials in this table are calculated in the solid. An average bulking factor of 1.3 should be applied to all materials when in transport or in stockpiles.

B.4 Site Controls

The outline principles and plans to control PFAS migration where encountered, either in the excavated materials or water management during the excavation phase, are set out in Annex F. Site, Material Handling, and Transport Management, with an update to the Outline CEMP to include PFAS mitigation controls also included in Annex F.

Annex C. Conceptual Site Model

C.1 Conceptual Site Model

Based on the data and information presented in previous Sections of this Report, a CSM was developed. The CSM is a representation of the environmental conditions at site based upon the available information and provides an overview of the site's characteristics, potential contamination sources, receptors and linking pathways. This was created to inform the potential for effective mitigation of any PFAS arising from within the vicinity of the proposed Project.

C.1.1 Known Sources

As detailed in Annex A, the daa Report has identified six no. potential sources of PFAS at Dublin Airport:

- **Former fire fighting training ground / APEC 5**. Located towards the western end of the North Runway, residual PFAS present in the soil, bedrock and shallow / deep groundwater after construction of the runway;
- **Former North Apron fire station.** Located towards the west of the north apron, residual PFAS in the soil, bedrock and shallow / deep groundwater and potentially in concrete;
- **North Apron (east).** Separate area of PFAS in soil and groundwater towards the east of the North Apron;
- **Apron 5H**. PFAS present in stockpiles, Qx and concrete at the northern side of the North Apron. No shallow or deep groundwater sampling has been undertaken in this area. However it is understood that this material has been removed from the site;
- **Current fire station.** PFAS present within surface water drainage towards the west of the airport; and
- **Castlemoate House (former Landfill).** PFAS in groundwater within area of landfill towards the north east of daa land.

These source areas are summarised in Figure 5.1, along with an indication of the regional groundwater flow direction as described in A.2.3.

The CSM presented here is based on the information currently available, and, while some data gaps relating to the presence of PFAS in the soil and groundwater within the vicinity of the MetroLink are present these gaps are taken into account within the development of the CSM and subsequently the proposed PFAS management strategy.

C.1.2 PFAS Contamination

PFAS have been detected in shallow soils and groundwater in the North Apron area. The daa Report suggests that two localised PFAS groundwater plumes result from vertical migration from the surface through the glacial till to bedrock. However, the cohesive glacial till will likely slow down this vertical transport to deeper groundwater. There may be areas where cohesive till is absent, which could provide a migration pathway, however geological logs for the source areas within the North Apron are not currently available.

PFAS could enter deep groundwater wherever cohesive glacial till deposits are absent, or where bedrock and transition deposits are present at the ground surface. Once in the groundwater, PFAS can be transported both north and south via the transition deposits and via fissures / fractures within the bedrock including any created by the MetroLink tunnelling.

C.1.3 Groundwater Migration Pathways

As identified within the MetroLink EIAR regional groundwater exhibits a local 'high' point at the location of the Dublin Airport terminal buildings, corresponding to where bedrock is near or at the ground surface. Groundwater piezometric levels then drop away towards the north northeast / south southwest (refer to Figure A-1). This pattern is consistent with the groundwater levels shown in the cross sections included within the EIAR. Sheet 9 of the cross sections indicates that near the proposed Dublin Airport Station, groundwater rest levels are close to the ground surface along with bedrock and the sands and gravels which mark the base of the glacial till. This 'transition' layer at the top of the bedrock has a higher permeability than the overlying cohesive till and is saturated along the length of the MetroLink airport tunnel section and in hydraulic continuity with the underlying bedrock.

C.1.4 Likelihood of PFAS Encounter During Construction

No PFAS source areas have been identified by the daa Report to the south of the groundwater divide in the area of the Dublin Airport Station. Based on available information, the likelihood of encountering PFAS during tunnel construction in this area appears low. However, further investigation will be undertaken to characterise the extent of any PFAS contamination before construction, as explained further in Annex F. The additional groundwater monitoring undertaken in this area in 2024 (3.4) also did not find PFAS in the one monitoring location in this area.

PFAS sources and impacted groundwater have been identified to the north of the groundwater divide including in the North Apron and Apron 5H. Based on available evidence, there is a higher likelihood of PFAS impact in this area. The extent to which lateral flow is occurring within the bedrock or transition deposits cannot be determined based on the currently available data and limited amount of ground investigation airside within the airport along the MetroLink alignment. However, as noted in Section 3.4, it is considered unlikely that PFAS impact from the airport will extend north of the DANP. Furthermore, the depth to limestone is such that the proposed construction will be above the level of the transition deposits to the north of the DANP, reducing the potential likelihood of encountering groundwater.

C.1.5 Surface Water Migration Pathways

According to the daa Report surface water from the runways and aprons drains directly to the airside surface water drainage system. The surface water then discharges directly to surface water bodies surrounding the airport via oil / water interceptors around the airport.

Drainage monitoring and surveys within the daa Report have shown that PFAS is within the surface water drainage network near the current fire station and training area, and within the surface water drainage system at the North Apron. The daa Report also states that surface water from the current Fire Station and training area discharges to the Cuckoo Stream, via the Dublin Airport Drainage system. Surface water from the North Apron and the North Runway source areas discharges to the Sluice. The catchment areas for the Wad Stream and Kealy's Stream are not known.

A CCTV survey suggested that integrity of the surface water drains in the North Apron area was poor, and that PFAS contaminated groundwater ingress and leakage to the drainage could be occurring. This could also be the case in other parts of the drainage network which have not been investigated.

As such, in the existing conditions, migration pathways are present where PFAS can be washed directly into the surface water drainage network from source areas and then infiltrate to or from groundwater through defects in the drainage. However, it should be noted that none of the proposed tunnelling or major excavation works at the proposed Dublin Airport station, DANP and DASP occur in proximity to surface water bodies.

During construction, where the PFAS source term is the excavated material, potential migration pathways during construction include PFAS leaching to ground, surface water and groundwater during transport and stockpiling. There are also potential pathways for construction drainage including surface water and groundwater arising from the construction works (through either active or passive dewatering) to run off to surface water, or ground and groundwater.

C.2 Potential Receptors

In terms of the proposed MetroLink the intermediate receptor for PFAS contamination will be the groundwater and bedrock, which will be directly affected by the tunnelling and excavation. This will create a secondary source term as described above.

Potential primary receptors include groundwater and surface water. The daa Report demonstrates that there are existing source-pathway-receptor linkages to these receptors.

During the Construction Phase, potential receptors for PFAS from the secondary source term (excavated soil) include ground, surface water, groundwater, air and human health (construction workers and general public) during transport and stockpiling. There is also a potential risk of introducing new migration pathways during the construction activities as previously described. The potential risks to the environment, construction workers and adjacent site users during earthworks and material handling are to be mitigated through the implementation of the Outline Construction Environmental Management Plan (CEMP) as amended and explained in further detail within the addendum to the CEMP included in Annex F.

Future MetroLink users will not be exposed to PFAS contaminated soils and groundwaters due to the excavation of soils during construction of the station and tunnel structures (soil source removal) and the sealing of the structures and to prevent groundwater ingress (groundwater pathway removal).

C.3 Data Gaps

While the available information has identified a number of PFAS sources and enabled a conceptual model of potential PFAS occurrence and migration to be developed, there are some information gaps related to the following: Where PFAS solid phase or leachability data are not available for bedrock and superficial deposits; and

- The absence of PFAS data in areas of the airport land which have not been investigated (South Apron);
- Where PFAS solid phase or leachability data are not available for bedrock and superficial deposits; and
- Where local gaps in groundwater data are present (e.g. between North Apron and DANP).

C.4 Overall Conclusions and CSM

Based on the available data on PFAS distribution, several conclusions can be made about the MetroLink Project:

- PFAS sources stem from historical activities using PFAS containing substances such as firefighting foams and hydraulic fluids in the airside zone of the airport;
- MetroLink will not affect the PFAS source areas or further contribute to the PFAS loading in the environment. However, PFAS has been confirmed in the groundwater within the North Apron area at a depth within the bedrock where tunnelling is proposed;
- Within the proposed Dublin Airport Station location PFAS were not identified in the shallow soils or groundwater in the investigations for the EIAR. However, the 2024 monitoring identified very low levels of PFAS in groundwater (at concentrations below the original LoD for the environmental monitoring for the MetroLink); and

- PFAS are present within the Sluice River, the Santry River, and the Mayne River which MetroLink will cross. However, neither the tunnelling or the major excavation works will occur in proximity to these rivers.

The PFAS sources and potential pollutant linkages during construction of the MetroLink are summarised in Table C 1 and a strategy to manage any potential mobilisation associated with the Construction Phase are presented in Annex F below. In addition the design and mitigation measures required to ensure no PFAS mobilisation during the Operational Phase of MetroLink are presented in Annex G.

Table C 1 Summary PFAS Construction Conceptual Site Model (CSM) for the MetroLink Project

Source	Receptor	Pathway
PFAS within airside soils and groundwater	Human health (construction workers and general public)	Dermal contact, ingestion and inhalation of impacted soil and waters
	Groundwater	Leaching and migration through existing natural deposits and made ground and preferential pathways.
		Surface water run-off from stockpiled excavated material
		Discharge of intercepted contaminated groundwater during passive or active dewatering
	Surface water, ecological receptors	Migration/ mobilisation of contaminated groundwater through drift deposits / made ground, and preferential pathways.
		Surface water run-off from stockpiled excavated material
		Discharge of intercepted contaminated groundwater during passive or active dewatering

Annex D. Treatment Options for Soils

D.1 Introduction

This Annex presents an analysis of available technologies for the treatment of soil/rock for PFAS in order to identify feasible options for the treatment of potentially contaminated material arising from the MetroLink construction works at Dublin Airport.

D.1.1 Screening Factors

With respect to choosing a preferred treatment technology (or technologies) several factors must be considered. Key factors are noted below:

D.1.1.1 Understanding of PFAS Contamination

The current understanding of the extent, magnitude and nature of PFAS contamination is summarised in Annex A of this Report and reviewed in the context of a CSM for the MetroLink construction in Annex C of this Report. The scope of previous investigations was not undertaken to specifically evaluate the PFAS contamination likely to impact the proposed MetroLink construction activities. Therefore, there are data gaps with respect to the understanding of PFAS contamination at Dublin Airport (see Annex C). However improved characterisation of soil and water PFAS contamination (likely to be encountered during the construction program) will be undertaken through further ground investigation prior to construction to refine our understanding of the extent of PFAS contamination and this will influence the specific remediation technologies utilised.

D.1.2 Longlist of Treatment Technologies

A literature review, which was largely based on the Concawe Soil Report (Concawe Report No. 8/24 PFAS Soil Treatment Processes – A Review of Operating Ranges and Constraints) and the ITRC website (ITRC Website, PFAS — Per- and Polyfluoroalkyl Substances, 12 Treatment Technologies https://pfas-1.itrcweb.org/12-treatment-technologies/), was undertaken to identify a longlist of potential treatment technologies to treat PFAS in soils. This longlist doesn't consider the readiness level of the technologies or their commercial availability. Technologies in the longlist are summarised in Table D 1 below.

Table D 1 Longlist of Soil Treatment Technologies

In-Situ / Ex-Situ	Type	Soil Treatment Technology	Technology Readiness Level (1 = Low, 9 = High)	Commercial Availability
In-Situ	Sorption	PFAS Immobilisation	8-9	Established
	Physico-Chemical Separation	Soil Flushing	7	Emerging
		Phytoremediation	1	Emerging
	Destruction	Smouldering Combustion	1-2	Emerging
		Biodegradation	1	Emerging
	Pathway Management	On Site Engineered Containment	9	Established
Ex-Situ	Sorption	PFAS Immobilisation	8-9	Established

In-Situ / Ex-Situ	Type	Soil Treatment Technology	Technology Readiness Level (1 = Low, 9 = High)	Commercial Availability
	Deposition	Landfilling	9	Established
	Physico-Chemical Separation	Soil Flushing	7	Emerging
		Soil Washing	9	Established
		Thermal Desorption	6-7	Emerging
	Destruction	High Temperature Incineration	9	Established
		Cement Kiln Incineration	9	Established
		Ball Milling	6-7	Emerging
		High Energy Electron Beam	5-6	Emerging
		Hydrothermal Alkaline Treatment	2-3	Emerging
		Smouldering Combustion	5-6	Emerging
		Supercritical Water Oxidation	4	Emerging
	Re-Use	Beneficial reuse for soils	9	Established
Varies	Treatment Train (Separation + Destruction)	Soil Washing (either *in-situ* or ex-situ) + Destructive Technologies	Varies	Varies

D.1.3 Short List of Potential Treatment Technologies

The key 'variable' that drives the selection of an appropriate PFAS management and treatment strategy is characterisation of the materials (soil/fill/rock and water) to be managed and treated.

The longlist of treatment technologies has been sifted based on the following criteria:

- Treatment technology has been proven to be ineffective in the treatment of PFAS; and/ or
- The technology readiness level is currently low; and/ or
- The commercial availability of the treatment technology has not yet been established.

This sifting process results in the shortlist of soil treatment technologies, as identified in Table D 2 below

Table D 2 Shortlist of Potential Soil Treatment Technologies

In-Situ / Ex-Situ	Type	Soil Treatment Technology
Ex-Situ	Sorption	PFAS Immobilisation
	Disposal	Landfilling
	Physico-Chemical Separation	Soil Washing
	Destruction	High Temperature Incineration
		Cement Kiln Incineration

In-Situ / Ex-Situ	Type	Soil Treatment Technology
	Re-Use	Beneficial Re-Use of Soils
Varies	Treatment Train (Separation + Destruction)	Soil Washing (either *in-situ* or *ex-situ*) + Destructive Technologies

D.1.4 Screening and Evaluation of the Potential Treatment Technologies

The potential soil treatment technologies currently available that could treat PFAS on MetroLink based on the available information is reproduced below in Table D3, together with the additional factors added for consideration when assessing the shortlist of options. These factors include:

- Technical;
- Logistical;
- Regulatory Approvals (e.g. EPA);
- Other Stakeholders (i.e. Airport operator/owner, airlines, general public and media); and
- Cost (comparative cost evaluation against other shortlisted options).

The final selection will be dependent upon several factors that are yet to be fully quantified (including the degree and extent of PFAS contamination encountered during construction works at the airport). Furthermore, there will be a requirement for approval and/or agreement of the proposed treatment technologies and approach generally to PFAS management from the EPA. However it is important to note that currently due to the absence of sufficient available treatment facilities in Ireland, there will be a requirement to export contaminated materials for treatment.

Table D 3 Screening and Evaluation of Potential Soil Treatment Technologies

In-Situ / Ex-Situ	Type	Soil Treatment Technology	Description	Technical Considerations	Logistics	Relative Cost	Conclusions / effectiveness
Ex-Situ	Sorption	PFAS Immobilisation	PFAS Immobilisation involves chemical fixation and often physical solidification of soil by mechanically mixing the soil with binders and other additives to reduce leachability and/or bioavailability of PFAS and obtain the required geotechnical characteristics. The approach is also referred to as Stabilisation and Solidification. PFAS are not destroyed during Immobilisation but remain stabilised within soils in order to manage the potential risk of PFAS leaching from the soil. Immobilisation is increasingly being considered as a means to pre-treat soil prior to off-site disposal at landfill.	A practicable and proven technology for treatment of soil/rock with low concentrations of PFAS. The dosage of the sorption product is based on the concentration of PFAS present in the source material. Pilot trial will need to be conducted to prove application effectivity by evaluation of the leachate potential of treated and untreated soil/rock material.	Requires excavated soil/rock to be 'blended/mixed' with a sorption product post excavation (e.g. in a trommel mill or similar). Larger rock sizes will need to be crushed to a suitable size for treatment. Requires the establishment of (an above ground) mixing facility with sufficient capacity to mix and store treated soil/rock while mixing and sampling occurs. The retention time will need to be evaluated to determine the size (area) of the facility.	Low cost when compared to other treatment options.	A practicable and proven technology for treatment of soil/rock with low concentrations of PFAS. Recommended for treatment of soil to immobilise PFAS contamination within the soil matrix prior to disposal to landfill (or engineered containment cell). It should be noted that the method is non-destructive, the PFAS remains following treatment, but is immobilised so it does not present a risk to the environment. Treatment and disposal on-site maybe possible if agreed with the regulator and the airport operator/operator. Depending on the final volumes of impacted soil and degree of contamination this treatment technology may be adopted at the overseas treatment facility.
	Disposal	Landfilling	Excavated PFAS contaminated soils as well as other PFAS containing wastes, such as crushed concrete from construction and demolition activities, can be transported to landfill facilities for disposal. This can provide a rapid and complete removal of PFAS soil sources from leaching to underlying groundwater.	Characterisation/classification of waste prior to disposal to landfill will be required. Characterisation/classification of waste likely to include concentration-based values and maximum leachate values for PFAS.	On-site: Construction of a new on- site landfill for PFAS containment is unlikely to be a feasible option due to permitting requirements for new landfills. Off-site (Ireland): Will require contaminated material to be transported (via truck) to the designated off-site disposal location. Pre-treatment, stabilisation and/or dewatering maybe required prior to transport. Off-site (Overseas): Same as for disposal to Ireland, with additional logistical constraints related to overseas shipping. Transport and shipping of large volumes of soil/rock to an overseas location is likely to be a significant logistical issue.	Landfill disposal in Ireland is likely to be low cost when compared to other treatment option, however is currently unavailable. Overseas disposal for treatment/landfill is likely to have a high cost compared to other (in country) treatment options.	A practicable and viable option for disposal/management of soil/rock with low concentrations of PFAS. Overseas disposal is only option currently available due to the lack of in-country capacity.
	Physico-Chemical Separation	Soil Washing	Soil washing is a physical and/ or chemical separation-based remediation process where excavated soils are washed within a specialised plant to transfer PFAS from soil to process water and separate high surface area fines fraction, producing cleaned sands and gravels which can often be reused. Soil washing provides a means to separate	Is most effective on soil/rock/fill with moderate to high levels of PFAS contamination. Less effective on soil/rock/fill with lower levels of PFAS contamination (which are more likely to be encountered during excavation works by the project).	Requires excavated soil/rock to be 'blended/mixed' prior to treatment (e.g. in a trommel mill or similar). Larger rock sizes will need to be crushed to a suitable size for treatment. Requires the use of a mixing facility with sufficient capacity to mix and store treated soil/rock while mixing and	Moderate cost when compared to other treatment options.	Possible treatment technology for soil/rock/fill with moderate to high levels of PFAS contamination. Unlikely to be a practicable solution for large volumes of soil/fill/rock with low concentrations of PFAS contamination. Depending on the final volumes of impacted soil and degree of

In-Situ / Ex-Situ	Type	Soil Treatment Technology	Description	Technical Considerations	Logistics	Relative Cost	Conclusions / effectiveness
			PFAS from soils and concentrate contamination into a smaller volume and thus reduce the costs associated with any PFAS destruction or disposal.	Requires the addition of water to 'wash' PFAS from the soil into the water. Contaminated water is then collected and treated to remove PFAS. Water is then filtered to remove PFAS into a filter medium (that then required off-site disposal). Maybe a viable treatment technology where elevated concentrations of PFAS are reported that are unable to be treated by other preferred methods. Concentration based performance targets for the treated soil/rock maybe difficult to achieve if set too low (e.g. PFAS concentrations below the laboratory detection limit). Dewatering of treated material maybe challenging in the wet and cool local environment A pilot trial (or similar) would be required to evaluate the feasibility of this option.	sampling occurs. The retention time will need to be evaluated to determine the size (area) of the facility.		contamination this treatment technology may be adopted at the overseas treatment facility.
	Destruction	High Temperature Incineration (HTI)	Incineration is defined as "burning hazardous materials at temperatures high enough to destroy the contaminants" . High Temperature Incineration (HTI) is destruction (mineralisation) using combustion, which requires heat and oxygen. Heat is applied directly to the PFAS-contaminated solids or liquids. Vaporised combustion products can be captured (precipitation, wet scrubbing) and/or further oxidised at elevated temperature.	Is most effective on soil/rock/fill with moderate to high levels of PFAS contamination. Requires pre-treatment to dewater and dry out soil/rock/fill. Likely to use large amounts of energy. PFAS and other noxious gasses potentially emitted via the exhaust stack maybe an issue to the regulator and public.	Requires excavated soil/rock to be 'blended/mixed' prior to treatment (e.g. in a trommel mill or similar). Larger rock sizes will need to be crushed to a suitable size for treatment. Requires a mixing and treatment facility with sufficient capacity to mix and store treated soil/rock while mixing and sampling occurs. The retention time will need to be evaluated to determine the size (area) of the facility. A fuel source/storage facility would also need to be established to provide fuel to the incinerator.	Moderate to high cost when compared to other treatment options.	Possible treatment technology for soil/rock/fill with moderate to high levels of PFAS contamination. Unlikely to be a practicable solution for large volumes of soil/fill/rock with low concentrations of PFAS contamination.
		Cement Kiln Incineration	A cement kiln is a long, cylindrical, slightly inclined rotating furnace designed to calcine a blend of raw materials such as limestone, shale, clay, or sand to produce a key ingredient of Portland cement. Most of them burn liquid waste; some may also burn solids and small containers containing viscous or solid hazardous waste fuels The co-processing of various hazardous wastes in rotary cement kilns is				

In-Situ / Ex-Situ	Type	Soil Treatment Technology	Description	Technical Considerations	Logistics	Relative Cost	Conclusions / effectiveness
			characterised by very high kiln temperatures (~1,200–1,400°C) with long residence times				
	Re-use	Beneficial Re-Use of Soils	In some instances, soils with very low PFAS impacts may be reused for engineering purposes such as constructing roads, berms, etc. This can be highly advantageous for avoiding costs from both disposing of impacted soil, and sourcing soil for engineering needs. This approach also recognises the importance of sustainability by reusing valuable resources that would otherwise be destroyed or permanently disposed.	Characterisation/classification of soil/rock prior to re-use will be required. Approval to re-use treated or untreated soil will likely be subject to maximum concentration-based values and maximum leachate values for PFAS. Backfilling and compaction requirements would also need to be considered	A suitable location for re-use would need to be identified and agreed with stakeholders. Suitable re-use locations are likely to be where engineering controls restrict access to soils (e.g. under paving, roadways, etc.). Any such re-use option(s) would need to be occurring at the same time as production/excavation occurs (with a small buffer for processing and testing). Where this is not aligned stockpiling soil for long	Low cost when compared to other treatment/disposal options. On-site reuse potential the lowest cost option	Potentially applicable for a treated waste stream (e.g. soil immobilisation or soil washing), as an alternative to disposal to landfill. This option should be explored to reduce waste (treated soil, going to landfill). Consider as an alternative to disposal to landfill, however, regulatory acceptance/approval will be required. Excavated soils that are not impacted by PFAS will be reused subject to meeting the requirements under Article 27 of the European Communities (Waste Directive) Regulations 2011-2020. Huntstown Quarry in County Dublin has been identified as the preferred location to accept excavated material classified under Article 27.
Varies	TreatmentTrain (Separation + Destruction)	Soil Washing (either *in-situ* or *Ex-Situ*) + Destructive Technologies	Combination of one or more technology describe above.	Separation and destruction more applicable to soil/fill with moderate to high levels of PFAS contamination. Immobilisation and landfilling/re-use is likely a more viable option for soil/fill with lower levels of PFAS contamination	As per above noted logistical consideration. However, where a treatment train is deployed the combined considerations of treatment area, transport, wastewater management and stockpiling/soil management need to be considered		

Annex E. Treatment Options for Water

E.1 Introduction

This Annex presents an analysis of available technologies for the treatment of water for PFAS in order to identify feasible options for the treatment of potentially contaminated material arising from the MetroLink construction works at Dublin Airport.

The same evaluation process adopted for soils (see Annex D) has been adopted for a list of viable treatment technologies for the treatment of liquids.

E.2 Long List of Water Treatment Technologies

A literature review, which was largely based on the Concawe Water Report (Concawe Report No. 14/20 Review of water treatment systems for PFAS removal) and the ITRC website (ITRC Website, PFAS — Per- and Polyfluoroalkyl Substances, 12 Treatment Technologies https://pfas-1.itrcweb.org/12-treatment-technologies/), was undertaken. This was done to identify a longlist of potential treatment technologies to treat PFAS in liquids that have been utilised, as summarised in Table E 1 below.

Table E 1 Longlist of Liquid Treatment Technologies

In-Situ / Ex-Situ	Type	Liquid Treatment Technology	Technology Readiness Level (1 = Low, 9 = High)	Commercial Availability
In-Situ	Sorption	Injected Colloidal Activated Carbon	9	Emerging
		Granular Activated Carbon	6	Emerging
	Physico-Chemical Separation	*In-Situ* Foam Fractionation	7	Emerging
		Phytoremediation / Floating Wetlands	6	Emerging
	Destruction	Sonolysis in Horizontal Wells	7	Emerging
Ex-Situ	Sorption	Granular Activated Carbon	9	Established
		Ion Exchange	9	Established
		Novel Sorbents	4-8	Emerging
	Physico-Chemical Separation	Flocculation	7	Emerging
		Deep Well Injection	9	Established
		Foam Fractionation	9	Established
		Nanofiltration / Reverse Osmosis	7-8	Established
	Destruction	Plasma Technology	7	Emerging
		Supercritical Water Oxidation	8	Emerging
		Hydrothermal Alkaline Treatment	8	Emerging
		Electrochemical Oxidation	7	Emerging
		Off-Site Incineration	9	Established

In-Situ / Ex-Situ	Type	Liquid Treatment Technology	Technology Readiness Level (1 = Low, 9 = High)	Commercial Availability
		Sonolysis in Horizontal Wells	6-7	Emerging
		Advanced Oxidation Processes	5-6	Emerging
		Photolysis	4	Emerging
Varies	Treatment Train (Separation + Destruction)	Foam Fractionation + destructive technologies	Varies	Varies
		Nanofiltration + destructive technologies	Varies	Varies
		Ion Exchange + destructive technologies	Varies	Varies

E.3 Short List of Potential Water Treatment Technologies

The longlist of treatment technologies has been sifted based on the following criteria:

- Treatment technology has been proven to be ineffective against treating PFAS; and/ or
- The technology readiness level is currently low; and/ or
- The commercial availability of the treatment technology has not yet been established; and
- This sifting process results in the shortlist of water treatment technologies, as demonstrated in Table E 2 below.

Table E 2 Shortlist of Water Treatment Technologies

In-Situ / Ex-Situ	Type	Liquid Treatment Technology
Ex-Situ	Sorption	Granular Activated Carbon
		Ion Exchange
	Physico-Chemical Separation	Foam Fractionation

The water treatment technology review does not differentiate between the potential sources of water, i.e. surface water, groundwater, rainwater runoff, and it should be noted that some water will likely require some level of 'pre-treatment' to remove suspended solids that could interfere/foul the PFAS treatment equipment. None of these methods actually destroy the PFAS; rather, they concentrate the PFAS in a form which can then be destroyed, for example by high temperature incineration.

All three of the above treatment options are technically viable for the treatment of PFAS impacted waters for the proposed Project. A treatment train comprising a combination of one or more of these technologies will be deployed.

E.4 Screening and Evaluation of the Short List of Potential Treatment Technologies

The potential water treatment technologies currently available that could treat PFAS on MetroLink based on the available information is reproduced below, together with the additional factors added for consideration when assessing the shortlist of options. These factors include:

- Technical;
- Logistical; and
- Cost (comparative cost evaluation against other shortlisted options).

Table E 3 Screening and Evaluation of Potential Water Treatment Technologies

In-Situ / Ex-Situ	Type	WaterTreatment Technology	Description	Technical Considerations	Logistics	Relative Cost	Conclusions / effectiveness
Ex - Situ	Sorption	Granular ActivatedCarbon	Adsorption of PFAS onto granular activated carbon (GAC) within a water treatment facility is a field-proven technology that is often used as a cost benchmark. GAC often includes pre-treatment, which involves the removal of iron and manganese when treating groundwater. When the loading capacity for the target PFAS is reached and breakthrough begins, the GAC has to be replaced with either fresh or thermally reactivated carbon.	A practicable and proven technology for treatment of water with PFAS. Some ‘pre-treatment’ of water likely to be required to ensure efficient running of the system. Pretreatment may include but not limited to removal of suspended solids and pH adjustment. Spent/used Granular Activated Carbon will need to be replaced, the rate of Granular Activated Carbon usage depends on the magnitude of PFAS contamination and other factors that could ‘foul’ the filter medium. Spent Granular Activated Carbon would need to be collected for disposal to landfill or destruction. The design for the operational capacity of the treatment system will need to include all potential sources of potentially PFAS contaminated water requiring treatment.	Requires the establishment of a treatment facility with sufficient capacity treated water. The processing capacity will need to be evaluated to determine the size of pre- treatment holding tanks. Will likely need to be co-located with soil storage treatment facilities at the Dardistown Triage and Soil Management Facility. Water may need to be collected at multiple points then transported to the treatment facility. Treated wastewater may need to be discharged to sewer, not surface water. The location of a sewer discharge point should be considered in the positioning of the facility.	Cost is a factor of the volume of water to be treated, concentration of PFAS and presence of other contaminants/water quality (e.g. TDS, pH, suspended solids).	A practicable and proven technology for treatment of water with low concentrations of PFAS. Recommended for treatment of water to remove PFAS contamination. However, removal of PFAS to very low concentrations (at or approaching the laboratory detection limit) would likely require further treatment an extended treatment train of a combination of technologies (e.g. GAC followed by foam fractionation).
		Ion Exchange	Ion exchangers (IEX) are synthetic and polymeric media that have been used in industry and water treatment for many years. Pretreatment of water to obtain appropriate water chemistry may be necessary when treating groundwater, perhaps more so than for activated carbon.	Similar to Granular Activated Carbon considerations. Ion exchange is an alternate filter medium to Granular Activated Carbon.	As per Granular Activated Carbon considerations.	As per Granular Activated Carbon considerations.	As per Granular Activated Carbon considerations.
	Physico-Chemical Separation	Foam Fractionation	Foam fractionation is a subset of a larger treatment of practice known as adsorptive bubble separation technologies. Foam fractionation is a physical separation process that traditionally uses air and turbulence to generate bubbles rising through a water column to strip amphiphilic substances such as PFAS from the bulk liquid. PFAS that accumulate at the top of the column as a concentrated foamate are then removed for further treatment or disposal.	Similar to Granular Activated Carbon considerations. Foam fractionation produces a PFAS ‘concentrate’ waste stream that needs to be disposed to a licenced facility.	As per Granular Activated Carbon considerations.	As per Granular Activated Carbon considerations.	As per Granular Activated Carbon considerations.

Annex F. PFAS Material Handling and Transport Management Strategy

F.1 Introduction

In anticipation that PFAS contaminated material will be excavated through Dublin Airport, the following strategy for PFAS Material Handing and Transport Management has been developed, covering:

- Outline Soils Characterisation Plan;
- Excavation, Storage and Transport Management;
- Exporting from Dublin Port;
- Works in proximity to Streams & Watercourses;
- Demobilisation of the Sites; and
- Protocols for Management & Control: Addendum to the Outline CEMP.

F.2 Overview

The quantity of excavated materials containing PFAS to be managed will be determined by the early identification of the potential for this to occur at the three main construction sites at Dublin Airport and along the tunnel alignment. The *In-situ* classification of soils and water through Dublin Airport will be achieved by ground investigation sampling and tests at each of these locations and where access is available across the tunnel alignment under the airport. The outline plans for further soils and water classification are contained in the next section.

However, for the purpose of this analysis informing the PFAS Material Handing and Transport Management Strategy presented in this report, a very conservative assumption is made that 100% of the estimated material to be excavated has the potential to be contaminated with PFAS and therefore will need to be stored temporarily on site while testing confirms or otherwise the presence of PFAS.

For this worst-case scenario there needs to be sufficient area to store and segregate all excavated materials while awaiting test results and before they are transferred for re-use or exported for treatment or disposal.

While discussions with testing laboratories suggest that test results can be achieved in 21 days, experience from Australia and the United States indicates that laboratory analysis times become extended when industry capacity cannot meet demand. To account for uncertainty in the laboratory turnaround time an assumption was made that a minimum of 28 days storage will be required for material excavated. For practical management reasons, excavated materials with the potential to contain PFAS contamination will be stockpiled in daily segregated areas. A single test will be conducted on a composite sample derived from several representative samples from each daily stockpile.

As considered within the EIAR, each of the sites at Dublin Airport have some capacity to hold excavated materials for a short period of time, approximately one week. However, these sites do not have the capacity to hold excavated materials for up to 28 days. Therefore, additional land is required to hold excavated material securely while the tests are undertaken and the results processed. An area for this purpose, referred to as the Excavated Materials Triage and Material Management Centre, has been identified on land within the planning boundaries of the project, immediately south of the proposed MetroLink Depot at Dardistown and north of the M50 motorway.

While awaiting test results, the materials will be safely stored and securely covered to prevent any risk of leachate run off into surrounding sites, streams or groundwater. Any areas proposed to be set aside to store excavated materials with the potential to contain PFAS will be designed to contain and control PFAS migration through the control of materials, water runoff and surface water movement, under the following key principles:

- Each works compound perimeter where excavation is taking place or where materials are being temporarily stored are isolated from the surrounding site with bunding;
- Within that isolated worksite, all surface water runoff is collected and treated on site prior to reuse or disposal off site through appropriate licences;
- Excavated materials held temporarily on site will be stockpiled on ground that has been prepared with suitable hardstanding and appropriately lined to prevent the movement of PFAS to ground through water ingress and the potential of leachate;
- All stockpiles are covered and maintained during periods of storage to limit water ingress and reduce dust activation;
- All plant and vehicles exiting the isolated site are washed within an appropriately sized washing plant with the water collected and treated prior to reuse or disposal;
- Dedicated plant and equipment will be used exclusively for these activities; and
- The transport of all excavated materials from the isolated sites must be completed within sealed and covered trucks, with the risk of water loss during transport mitigated by ensuring that either the materials are at close to optimum moisture content levels, or the trucks are suitable sealed to prevent water loss during transport.

Once the excavated material has been classified based on test results, the materials will then be diverted to:

- An approved site for re-use in Ireland (as already assessed in the EIAR); or
- Disposal to an approved treatment facility in Europe (via Dublin Port) for treatment and disposal (Material outside of PFAS acceptance limits).

F.3 Outline Soil Characterisation Plan

While information gaps remain as outlined in Annex C, a worst-case scenario is assumed, which is that all excavated materials and extracted water may be contaminated with PFAS. Although it is not considered that this scenario will be realised, it is assumed here in order to demonstrate that even under this worst-case scenario MetroLink can effectively manage PFAS during the Construction Phase.

This assumption will remain until further *in-situ* soil and groundwater investigations prove otherwise. Further testing must be undertaken to refine the understanding of the PFAS risk during the main Construction Phase at Dublin Airport and the classification of the PFAS likely to be encountered.

The purpose of this section is to provide an outline characterisation plan to support the identification of PFAS contaminated material and water. It is intended that this additional ground investigation is undertaken in advance of the commencement of MetroLink to support further plans on the treatment of PFAS in the vicinity of Dublin Airport, including the realisation of any opportunity to rationalise the current management strategy that has assumed that 100% of material excavated has the potential to be PFAS contaminated.

F.3.1 Sampling Zones

For the purpose of determining the scope of additional ground investigation, the alignment has been broken down into zones based on tunnel / structure depth and ground conditions. Additionally, a risk rating (high, medium and low), based on the predominant ground conditions and tunnel/structure depth, has been provided for each zone. The glacial till is relatively impermeable and is consequently less likely to act as a pathway for PFAS transport or a repository for PFAS.

Where tunnel/construction is through bedrock, these are considered to be highest risk, mixed glacial till / bedrock medium risk and glacial till (e.g. DANP and DASP) lowest risk. Details are provided in Table F 1, which is also represented pictorially in Figure F-1.

Table F 1 Breakdown of Dublin Airport Chainage into Sampling Zones

Sampling Zone	Chainage	Length (m)	Ground Conditions	Risk
Dublin Airport North Portal (DANP)	6+000 - 6+110	110	Glacial till	L
Tunnel – Section A	6+110 - 6+450	340	Bedrock / glacial till	M
Tunnel – Section B	6+450 - 7+250	800	Bedrock	H
Dublin Airport Station (DAS)	7+000 - 7+120	120	Bedrock	H
Tunnel – Section C	7+250 - 7+500	250	Bedrock / glacial till	M
Tunnel – Section D	7+500 - 7+920	420	Glacial till	L
Tunnel – Section E	7+920 - 8+160	240	Bedrock / glacial till	M
Tunnel – Section F	8+160 - 8+650	490	Glacial till	L
Dublin Airport South Portal (DASP)	8+160 - 8+800	150	Glacial till	L

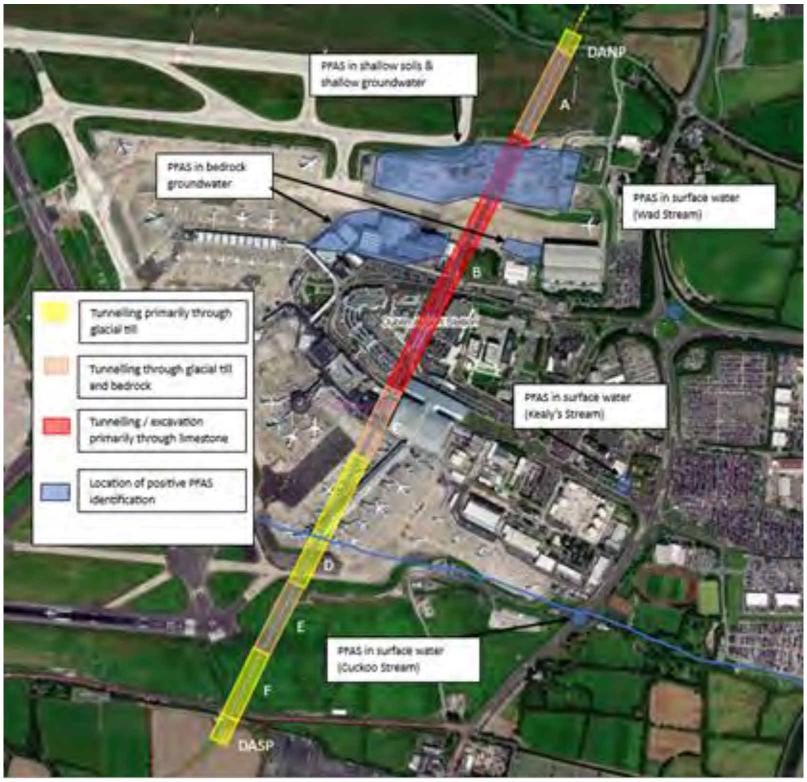

Figure F-1: Breakdown of Dublin Airport Chainage into Zones

F.3.2 Outline Sampling Plan

The outline sampling plan, based on the risk classification, is outlined in Table F 2 below:

Table F 2 Outline Sampling Plan

Sampling Zone	Outline Sampling Recommendations
DANP	1 no. location for soil & groundwater sampling, at tunnel elevation
A	2 no. locations for soil & groundwater sampling, at tunnel elevation
B	Groundwater & rock sampling at 100 m centres (50 m centres 6+700 to 7+000 in primary PFAS risk area) , at tunnel elevation
DAS	2 no. additional locations in station box, soil sampling for full depth of station box (every 5 m of depth) and groundwater sampling.
C	1 no. bedrock location for soil & groundwater sampling, at tunnel elevation
D	2 no. location for soil & groundwater sampling, at tunnel elevation
E	1 no. bedrock location for soil & groundwater sampling, at tunnel elevation
F	2 no. locations for soil and groundwater sampling, at tunnel elevation
DASP	1 no. locations for soil and groundwater sampling, at tunnel elevation

Notes:

- The specific details of this proposed sampling plan will be agreed with daa;
- If PFAS is identified at any of the lower risk areas, further sampling will be undertaken in the vicinity;
- Aquifer protection measures shall be implemented to prevent cross-contamination; and
- If boreholes are undertaken along the alignment, they are not to be left *in-situ* as a tunnelling obstruction.

F.4 Excavation, Storage and Transport Management

F.4.1 Predicted Volumes of Excavated Material

To allow for a determination of the likely size of the site required to manage potentially PFAS contaminated material (for a worst-case scenario) an analysis of the quantum of excavated materials over time has been undertaken based on the material quantities set out in Annex B. The analysis provided the following daily excavation rates, together with stockpile sizes, summarised in Table F 3 below.

Table F 3 Excavated Materials Anticipated Quantities and Capacity Scenarios

Potential Contaminated Scenario	Volume (Peak)	Bulk Vol	Stockpile		Area Storage m^2
	m^3/day	m^3/day	height m	width m	28 days
Estimated Capacity Required: 3 month rolling Mean m^3/Day - All 100% potential for contamination	1000	1300	3	24	25,000
Note: Bulk volume assumed at 1.3 times excavated in the solid. The holding area includes up to +50% additional area to segregate between stockpiles for transport access.					

F.4.2 Capacity for Holding and Sampling on Sites

With the various site establishment requirements at the construction compounds for the proposed Dublin Airport station, DASP and DANP, there is limited area available to manage potential PFAS contaminated material during the Main Excavation Phases of MetroLink. The table below (Table F 4) sets out the available area capacity and the durations of storage for the main excavation phase at the three main construction compounds at Dublin Airport.

Table F 4 Anticipated Compound Storage and Capacity Duration

Location	Compound Area m^2	D-Wall Area m^2	Excavation Area m^2	Capacity Storage Days
DANP	14000	3700	3750	8
Dublin Airport	10900	2300	4300	11
DASP	83700	12000	12000	14

F.4.3 Proposed Excavated Material Triage and Material Management Centre

To control the potential volume of excavated materials, assuming 100% of material has the potential to have PFAS contamination and therefore will need to be tested, an area of 25,000m^2 will be required to triage for PFAS by holding materials for testing and classification prior to onward transport to disposal.

In addition to space for holding and segregating excavated materials, further area will be required for plant and equipment, access and areas for additional treatments such as water storage, vehicle washing facilities, welfare etc. Considering these additional site elements the site will require a total area of approximately 44,000 m² (See Figure F-2).

The proposed site is between the M50 Motorway and the future railway Depot at Dardistown. The land proposed is located outside of any land required to deliver the permanent works at this location, namely the main MetroLink alignment coming from Dardistown Rail Depot and Station and the M50 bridge, crossing the M50. However, the site is fully within the proposed MetroLink works area as indicated in Appendix A5.3 of the EIAR and was proposed to support construction activities such as soil stockpiling for MetroLink, as referred to in EIAR Chapter 5, section 5.9. As a result, the use for this area of the site is not materially different from that assessed in the EIAR, although the levels of controls required to manage potential PFAS contamination will be more stringent, as set out in this section, than for the original use intended. The impacts from this proposed change of use have been considered further in the EIAR Addendum to the Outline Construction Environmental Management Plan (CEMP) in Annex F.

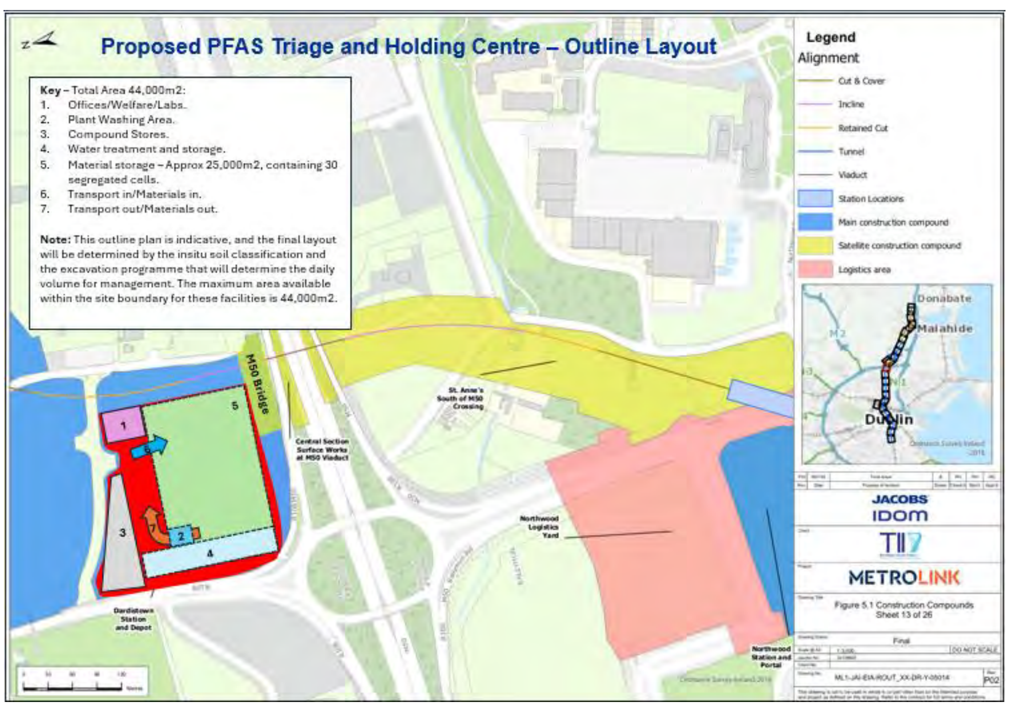

Figure F-2 Proposed Excavated Material Triage and Material Management Centre – Dardistown

The land is accessible by road and is located a short distance from the three main site compounds of Dublin Airport, with DANP being the furthest away at approximately 5km by road.

F.4.4 Compound Controls

Where there is any risk of PFAS contamination being encountered during the excavation process at any of the Dublin Airport Sites, or in the process of transporting and storing excavated materials at the Triage and Ho Centre at Dardistown, the key management principles outlined in Section F.1 above will be followed. Figure F-33 below presents an overview of the proposed typical site layout for the Dublin Airport, DANP and DASP compounds that will be utilised to ensure PFAS containment and isolation. Figure F-44 presents an overview of the Dardistown Triage and Material Management Centre.

The principles outlined above are illustrated below:

- For a typical compound at Dublin Airport, including DASP; Dublin Airport and DANP during the excavation phase.
- The proposed layout for the Triage and Material Management Centre; and
- The proposed layout of the water treatment process for dealing with water containing PFAS contaminates.

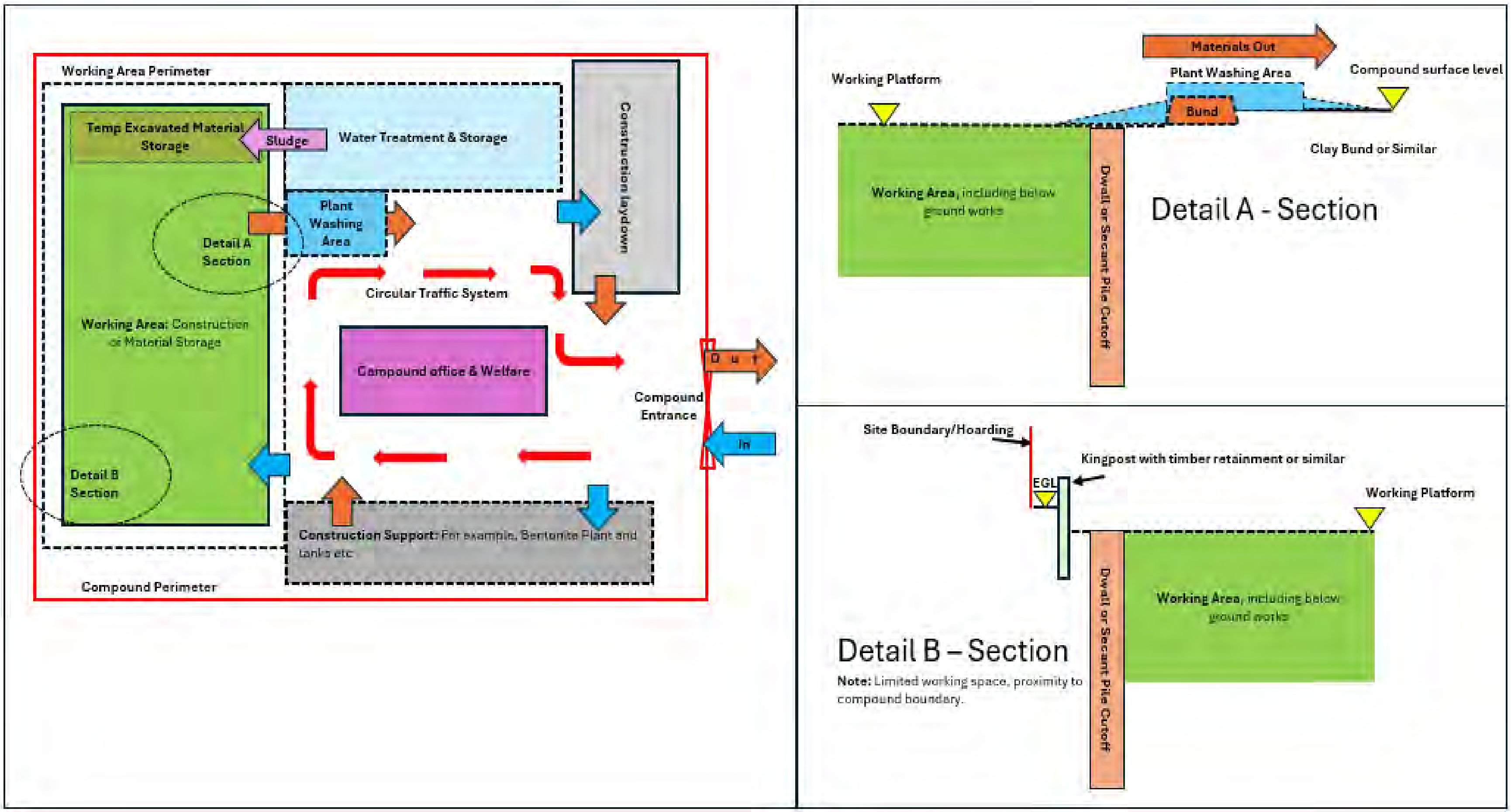

Figure F-3: Typical Layout Dublin Airport Compounds during excavation phase.

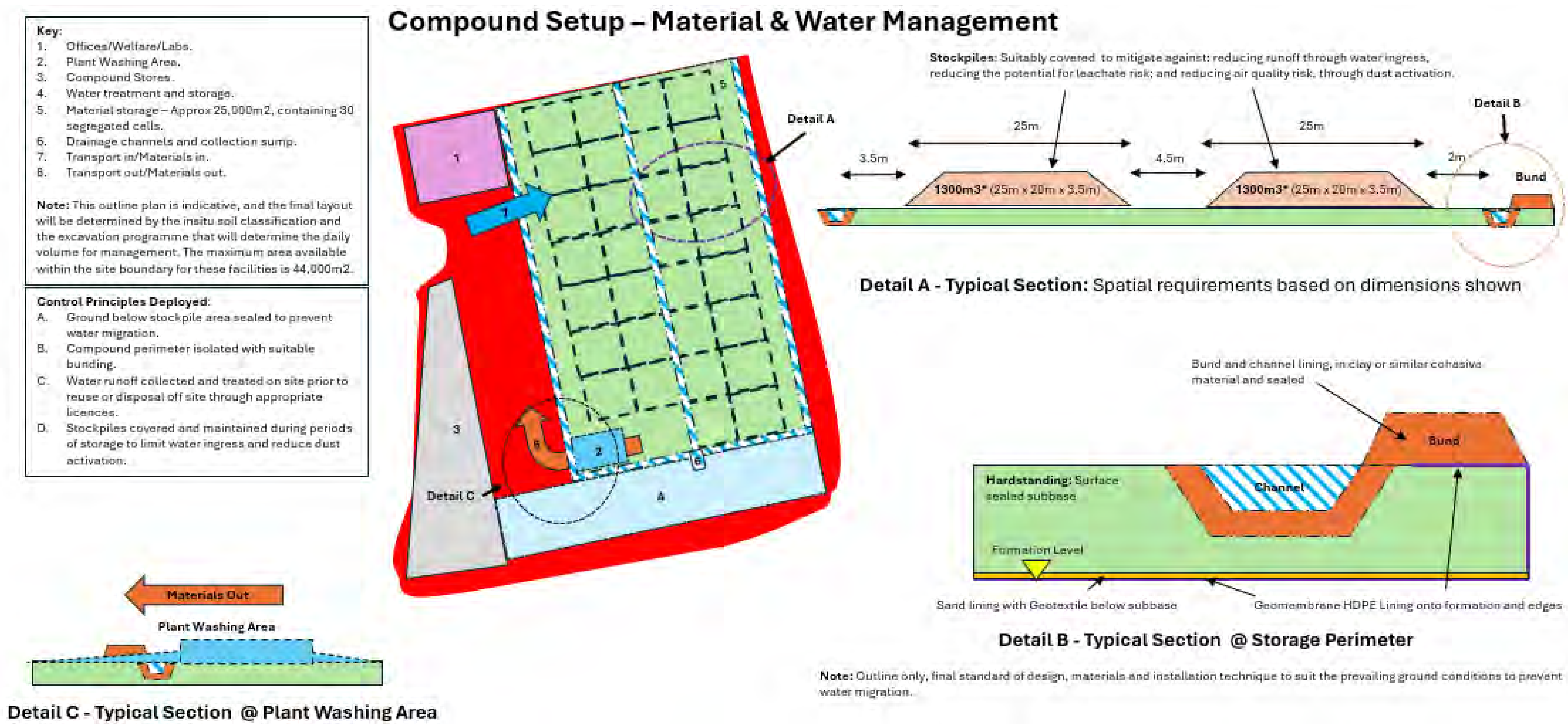

Figure F-4: Outline Layout Triage and Material Management Centre

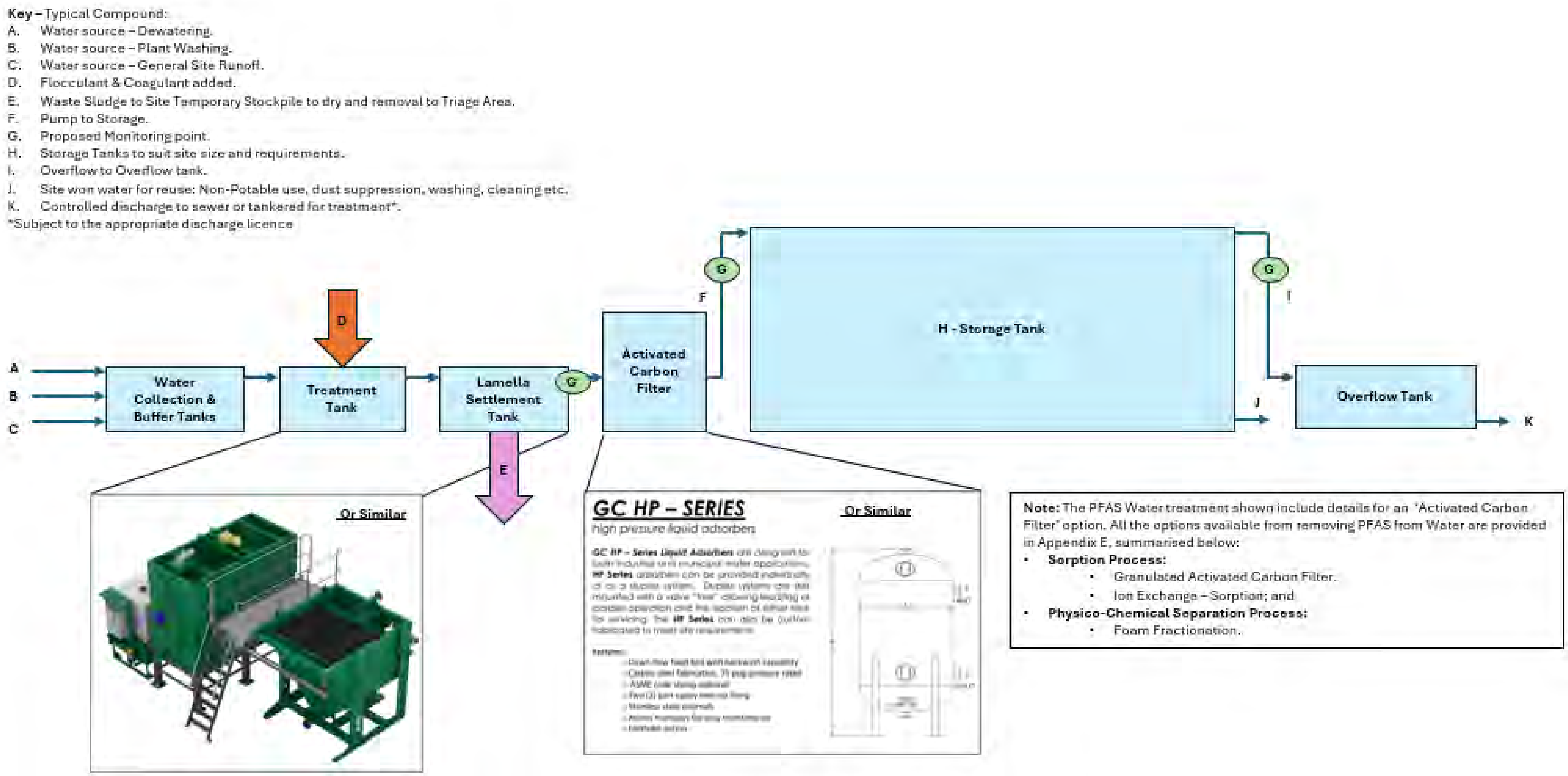

Figure F-5: Outline Water Treatment, Storage and Disposal

F.4.5 Transportation

F.4.5.1 Routes to Proposed Materials Triage and Holding Location

The haulage routes from each of the main Dublin Airport Sites to the proposed location of the materials storage locations are as set out within the EIAR. Please refer to EIAR Chapter 19, Appendix A19.5 Scheme Traffic Management Plan.

F.4.5.2 Routes for Disposal

The routes for disposal of materials from the Excavated Materials Triage and Material Management Centre for either re-use (west along the M50 to Huntstown) or for export (To Dublin Port via M50 and M1) are set out below.

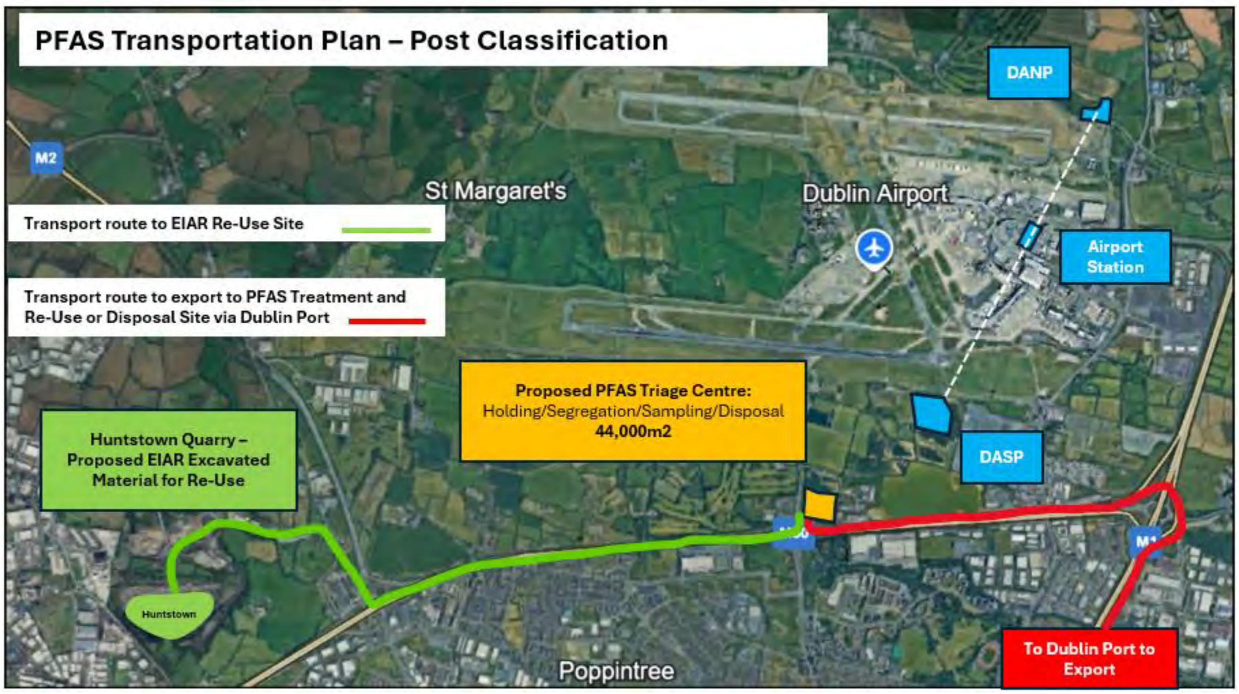

Figure F-6: Routes for Disposal

F.5 Exporting from Dublin Port

The most appropriate method of transporting contaminated material by sea will be by barge/ship, and in planning for the worst possible scenario that 100% of excavated material is contaminated a detailed strategy will be developed that will consider amongst other matters:

- Agreements with the Dublin Port Company;
- Land available next to an operating and available quay;
- Barge loading facilities available;
- The procurement of suppliers of barges/ships and tugs;

- Confirmation that the receiver of the soil/rock material has similar facilities to unload the materials and transfer to their facilities.
- Agreements with the receiving port facilities; and
- Agreement of the full process with the relevant local authorities and stakeholders.

To avoid the need to stockpile materials on the quay it is proposed that the materials be loaded directly onto the barge/ship. The process required to handle and load the materials for export will be consulted upon and agreed with Dublin Port and will have regard to the following:

- Be fully cognisant of Dublin Port procedures for exporting waste and provide the management controls to meet those requirements;
- The maximum volume of 1000m^3 of materials, circa 2200t of soil and rock to be transported every day.
- Up to 12,500t to be transported per week, 8 x 1500t barges;
- Allowance in timings for the transport, offloading of the barges/ships at the destination and return; and
- Once each barge/ship is loaded, the materials will be covered to keep them dry while waiting for transit and during transit.

F.6 Works in proximity to Streams & Watercourses

As presented in Annex B above current data identifies that PFAS has been detected in the waters of the Sluice River, Mayne River and Santry River in the vicinity of the airport. As a result, the following additional mitigation measures are proposed while working in close proximity to these rivers:

- The works site will be delineated, segregating the site from any adjacent site with a dedicated access route.
- The works are completed in stages and at each stage the soils to be excavated and water to be removed or managed are tested for PFAS.
- All excavated material or water collected will be removed and transported to the Triage and Material Management Centre for testing and onward transportation.
- Instream works will be undertaken and completed in dry or very low flow conditions. All potentially contaminated water extracted in the course of the works, will be treated as per appropriate methods identified in Annex E of this report.
- To prevent any cross contamination, dedicated plant and equipment will be used for the activity, stored within a secure location and cleaned when leaving the secure area with the water from this process also segregated and stored for suitable disposal.
- The works required for the proposed diversion works on the Turnapin Stream (Mayne) and other instream works will include for monitoring upstream and downstream in order to track any changes in the levels of PFAS during the full progression of the works. For the provision of the diversion works, suitable barriers, Geomembrane HDPE or similar, are to be procured to line the diversion excavations to prevent PFAS migration downstream of any inline watercourse works, and when rediverting the river and realigning the river at the completion of the instream culvert; and
- Backfilling will be undertaken with clean suitable fill material only.

Furthermore, the EIAR proposed mitigation measures for the protection of watercourses when working on or near them are detailed in the sections below:

- All works adjacent to watercourses, refer to Chapter 15 Biodiversity section 18.5 and Chapter 18 Hydrology, section 18.6.
- All works adjacent to watercourses, refer to Chapter 15 Hydrology, section 15.5.
- All works adjacent to watercourses, refer to Chapter 18 Hydrology, section 18.7.
- Outline Construction Environmental Management Plan (CEMP), Appendix A5.1 of the EIAR with an addendum to the Outline CEMP for specific PFAS mitigation controls provided in Section F.

In addition to the provisions made above, the outline methodology presented in the EIAR Chapter 5 for both watercourses are summarised below in Section F.8.1.

F.6.1 The Sluice and Tributary

The alignment to the north of the airport crosses the Sluice River and tributary (Forest Little Stream) in the agricultural land to the north of the Naul Road. These rivers are contained in bank with very little natural floodplain. Consequently, both watercourses will be culverted under the railway. The culvert for the Sluice River will include an underpass to allow the service roads on either side to be connected and provide connectivity for farm machinery and animals.

The typical construction methods are presented in Appendix A5.10, sections 2.3.2 and 2.6 of the EIAR. Figure F-7 below, taken from EIAR Chapter 5 (Figure 5.37) illustrates a typical temporary river diversion to be established prior to commencing the installation of the permanent box culvert structures for the permanent diversion of a river or stream. These works will be subject to a Section 50 of the Arterial Drainage Act 1945 application and approval by the OPW. It is likely that off-site precast concrete sections will be delivered to site and installed sequentially.

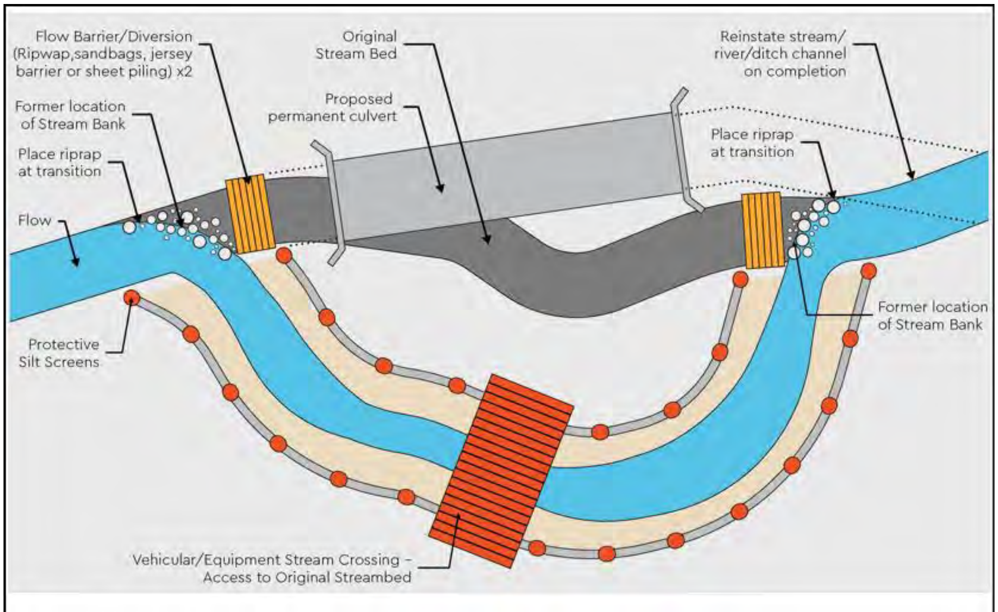

Diagram 5.37: Illustration Showing a Typical Temporary Diversion Channel

Figure F-7: Illustration Showing a Typical Temporary Diversion Channel

Details of the works on the Sluice River and tributary is captured in Chapter 5, section 5.7.13.3 Boland Satellite Construction Compound.

Further information on the construction methodology for the culverts is provided in the EIAR Appendix A5.10, section 2.3.2, where Diagram 2.3 (included below) illustrates the proposed diversions of the watercourse to complete the construction. The Potential environmental impacts from works in watercourses have been assessed in Chapter 18 (Hydrology) and Chapter 15 (Biodiversity) in addition with the environmental mitigation measures outlined in the outline CEMP in Appendix A5.1.

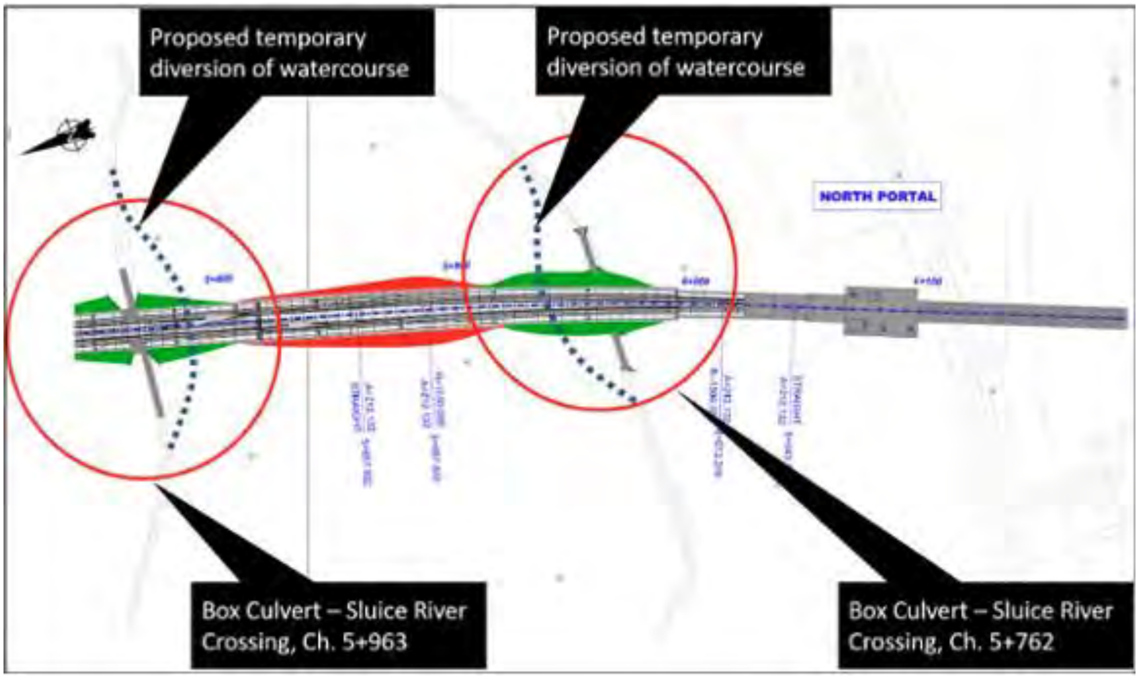

Figure F-8: Proposed Culvert Works - Sluice River Crossing

Further details of the structures and layout at the two proposed culverts are provided in the EIAR Structures Details Book 3 of 3 Other Line wide Structures Fingal County Council and Dublin City Council, pages 16 and 17 of 89, drawing reference ML1-JAI-SRD-ROUT_XX-DR-Y-01006 Rev P02 (Sheets 1 and 2 of 2).

F.6.2 The Mayne River

The proposed MetroLink Depot is located at the head of the Mayne River system and a diversion of the Turnapin Stream, which is a tributary of the Mayne River, will be required to facilitate the construction of the proposed depot. The location of the stream to be diverted is shown in Figure F-9 and typical construction methods are presented in Appendix A5.10 of the EIAR. Relevant approvals will be obtained for this diversion from the Office of Public Works (OPW), as required under Section 50 of the Arterial Drainage Act, 1945.

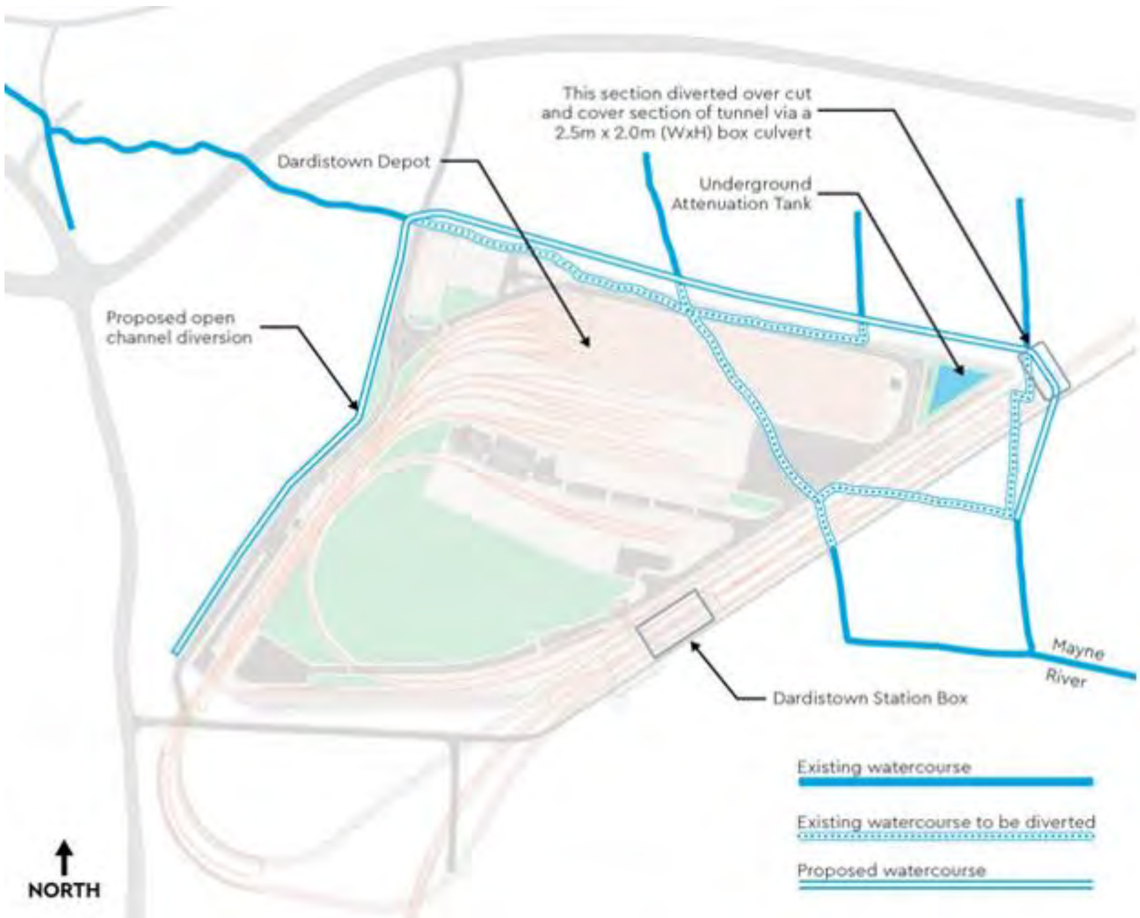

Figure F-9: Mayne River Diversion at Dardistown

Further details of the works on the Mayne River and the Turnapin tributary are captured in Chapter 5, section 5.9.1 Dardistown Depot and Station.

F.6.3 The Santry River

To accommodate construction works at the Santry River crossing location, some minor alterations are proposed to the Santry River immediately downstream of the proposed M50 crossing. Details of the works on the Santry River are captured in Chapter 5, section 5.9.2.1 South of the M50 and comprise minor alterations to straighten the channel, including the addition of scour protection, immediately downstream of the culvert outlet. The location of the works is indicated on Figure 18.14 in the EIAR Book of Figures (Refer to Figure 4.7). These alterations have been assessed in the EIAR Chapter 15 (Biodiversity) and Chapter 18 (Hydrology) in addition with the environmental mitigation measures outlined in the outline CEMP in Appendix A5.1.

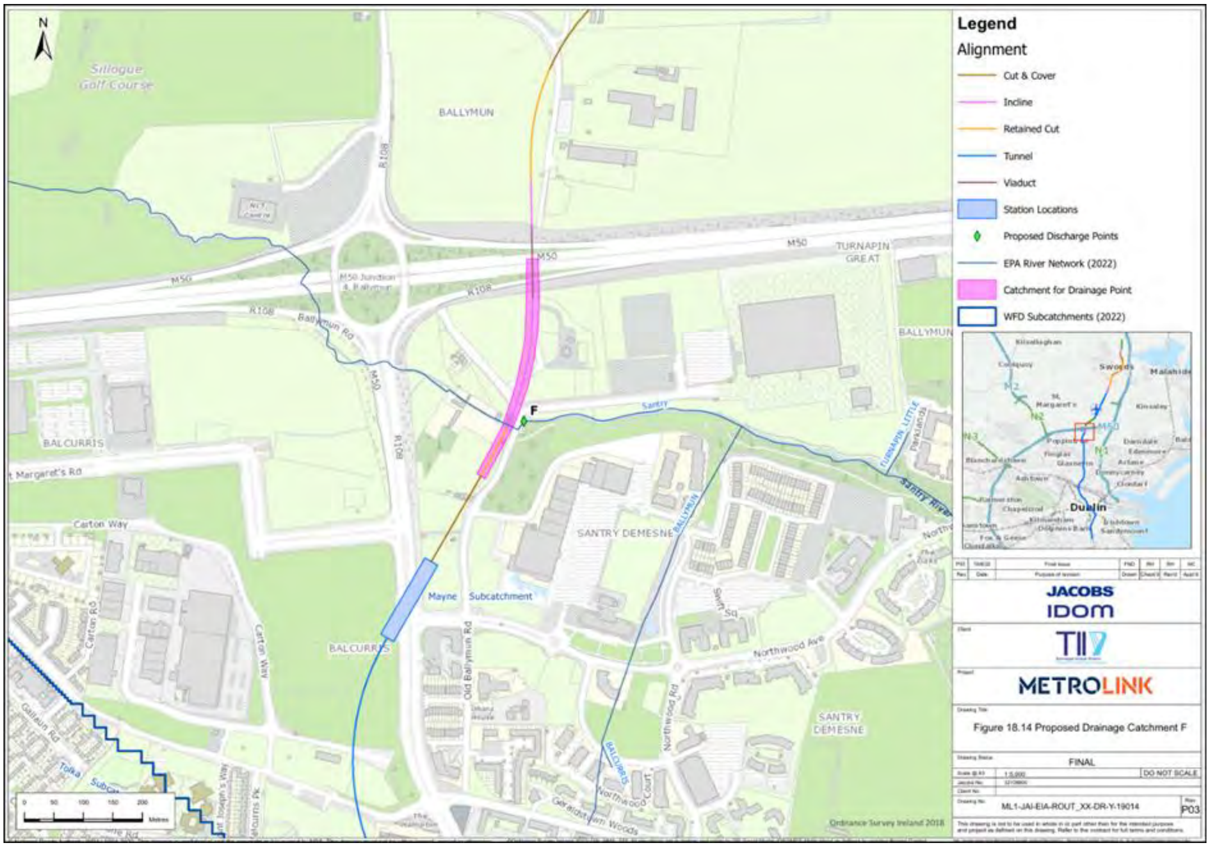

Figure F-10: Santry River Culvert

F.7 Demobilisation of the Sites

After the completion of excavation activities at each of the main sites, where the mobilisation of PFAS is a potential risk, each site area will be cleared of all PFAS management infrastructure and materials and the site returned to normal construction management control or returned to its preconstruction condition. The sites impacted by this process are as follows:

- Dublin Airport North Portal (DANP);
- Dublin Airport Station (DAS);
- Dublin Airport South Portal (DASP);
- The PFAS Triage and Material Management Centre (TMMC); and
- Dublin Port loading facility.

The level of clearance required at each site will be determined by:

- The levels of PFAS encountered, determined by the testing and sampling at completion of the excavation works to record the levels and locations of any PFAS present for removal together with comparison with the baseline levels recorded prior to construction commencement;
- The process for segregating and controlling PFAS containing excavated materials and extracted water from non-impacted materials and water; and

- The infrastructure provided to contain and control the PFAS.

The sequence for demobilising PFAS management controls at the Dublin Airport sites will be as follows:

- **Each of the main worksites at Dublin Airport:** At the completion of all excavation works at DANP, DAS and DASP materials will be taken to the TMMC for processing and disposal as described in this report; and
- The phased reduction of the **TMMC:** The TMMC will gradually be reduced in size, using the existing infrastructure as the volume of excavated materials decreases after peak production. The final demobilisation will confirm that the site is returned to its pre-construction condition.

Once the TMMC is restored to its pre-construction condition, the export facilities at **Dublin Port** will be demobilised. Any PFAS contaminated materials will be loaded onto barges/ships for treatments and/or disposal in Europe as necessary.

Certification of the clearance of each of these sites will be accompanied with appropriate test certificates and confirmed in writing by the MetroLink Authorised person (i.e. The lead from either the engineering and environmental teams) responsible for accepting and approving the designs.

F.8 Protocols for Management & Control: Addendum to the Outline CEMP

F.8.1 Construction Environmental Controls

F.8.1.1 Outline Construction Environmental Management Plan (CEMP)

The proposed construction works will be delivered through the controls set out in Appendix A5.1 Outline CEMP provided within the EIAR supporting the draft Railway Order. The outline CEMP contains the following references specific to the management and control of contaminates on the MetroLink Project. These measures will now apply to the management and control of PFAS. The contractor(s) will be required to implement these as a minimum for the construction of the works.

Table F 5 CEMP Implementation Requirements for Contractor(s)

Outline CEMP Section	Description	Other
3.2	Responsibilities	
3.2.6	Engage Environmental Specialists	
5.10	Emergency Response Plan	
6.1	Traffic and Transport	See Table 6.1: Traffic and Transport Measures
6.3	Air Quality and Climate	See Table 6.3: Air Quality and Climate Measures
6.4	Water	See Table 6.4: Water Measures
6.5	Soils and Geology	See Table 6.5: Soils and Geology Measures
6.6	Materials and Waste	See Table 6.6: Materials and Waste Management
6.7	Biodiversity	See Table 6.7: Biodiversity Measures

Outline CEMP Section	Description	Other
6.9	Population and Human Health	See Table 6.11: Population and Human Health Measures
6.10	Agronomy	See Table 6.12: Agronomy Measures

On the granting of an Enforceable Railway Order, the CEMP for the project will set out the full construction and operating environment measures described in the EIAR and conditioned under the Railway Order and the outline CEMP will be updated accordingly.

The appointed contractors will submit the CEMPs to Fingal County Council for approval. In addition, they will consult on the CEMP with daa. The controls proposed by the contractor in the CEMP and approved by FCC will be based on the most up to date information on the design and proposed delivery methodology of the MetroLink Works. The CEMP will set out the contractor's management plans and procedures to protect and mitigate impacts to the environment. No works will be permitted to commence until the CEMP has been approved by both FCC and TII.

F.8.1.2 PFAS Management Protocols

In addition to the controls outlined above, in advance of the Construction Phase, and based upon the conclusion of any additional *in-situ* tests, the PFAS Protocols will be prepared and submitted to FCC for approval prior to any works commencing. Based upon the PFAS management strategy provided in this report, the following additional protocols will be included in the CEMP:

- Site Isolation;
- Water Management during excavation;
- Material transport and handling;
- Protection of the materials from Rainfall during Holding and Testing;
- Air and Dust Monitoring; and
- Mitigate exposure to site workers.

F.8.1.3 Site Isolation

Isolate the affected area from the remainder of the site and instigate management and control plans to control PFAS contamination from spreading from the identified area to the remaining area of each compound. Site isolation includes but is not limited to:

- Fencing to delineate the site and proposed controls within;
- The collection, storage, treatment, reuse and final disposal of all water runoff and wastewater generated within the affected area identified;
- Provision of small material storage areas within the site, in a scenario that the materials are too wet for transport to the Storage Area and require a period of *In-situ* drying. The available areas at each site are set out in Annex F, and Figure F-3;
- Vehicle and plant washing facilities at the juncture of the isolated site to reduce the potential for PFAS to migrate to other site areas outside of the site; and
- Site isolation protocols will also apply to material holding areas where potential material containing PFAS are stored for testing and characterisation purposes, prior to disposal.

F.8.1.4 Water Management During Excavation

During the excavation process, water from the dewatering operation together with any rainfall across a designated ‘isolated site’ and water used for washing and cleaning will be collected, stored, treated and discharged via active carbon filters prior to discharge to sewer and stored for reuse and final disposal when required. The potential treatment processes are set out in Annex E above.

Conditions of compliance for discharge (such as a discharge licence) will be agreed with local authorities and water companies.

F.8.1.5 Material Transport and Holding

- All potentially PFAS contaminated materials will be transported to the designated holding area for segregation and further tests to confirm classification for disposal or reuse;
- The materials will be segregated into single standalone stockpiles every 24 hours, and each daily stockpile is subject to sampling for testing;
- When the material is segregated into a 24-hour stockpile, two composite samples will be taken, one for the immediate test and analysis and one for future record. Each composite sample will consist of at least 5 but no more than 10 samples taken randomly from the stockpile surface when the stockpile is completed;
- Transport of materials from site will be in trucks of suitable quality and covered to ensure there is no spillage or dust separation during transport between locations on site or public roads;
- To avoid any potential for cross contamination with other sites and projects, the transport suppliers will maintain vehicles for the sole purpose of this activity with regular washing in designated areas; and
- Materials will be transported at an acceptable optimum moisture content to prevent dusting and the potential for material leachate discharging from the trucks during transport.

F.8.1.6 Protection During Holding and Testing

- The PFAS management area will include the mitigation measures outlined in Section 18.6.1.1 of Chapter 18 of the EIAR to manage any potential contaminated runoff. This will entail preparing a site specific water management plan to control runoff in line with Ciria publications - C532: Control of water pollution from construction sites (CIRIA, 2001), C648: Control of water pollution from linear construction projects: technical guidance (CIRIA, 2006a) and C649: Control of water pollution from linear construction projects: site guide (CIRIA, 2006b);
- All construction staff will be suitably trained to respond to accidental discharge/leaks and appropriate spill management kits will be in place to allow rapid response on site. An Incident Response Plan will be in place detailing the procedures to be undertaken in the event of spillage;
- The holding area for excavated material stockpiles will be provided with an external cutoff and all internal drainage is contained and stored for subsequent treatment and disposal;
- The temporary stockpiles of excavated material will be isolated from watercourses, open excavations, as well as identified [storm/combined] sewers in the area;
- To prevent rainwater adding to any potential for leachate, stockpiles will be covered with suitable secured membrane; and
- As outlined in Annex E of this strategy document, the application of granular activated carbon, ion exchange or foam fractionation as appropriate will be implemented to treat any potentially

contaminated water from this site. A combination of one or more of these technologies will also be applicable.

F.8.1.7 Trans Frontier Shipment (TFS) of PFAS Contaminated Soil as a Waste

In the event that material is identified as contaminated and there is no availability within Ireland for landfill or treatment as per Article 27 Regulation, it will be necessary to arrange for transportation to European countries for treatment and/or disposal. This will trigger the application of country specific waste regulations as well as cross country rules like the TFS Regulation EU 1157/2024 that is applicable for all the countries in the EU.

F.8.1.8 Air and Dust Monitoring

The proposals for dealing with dust during the Construction Phase will ensure that PFAS mobilisation is minimised during the construction works. The measures outlined in the EIAR Chapter 16 Air Quality Section 16.6 Construction Phase, in Appendix A16.4 Dust Minimisation Plan and in Appendix A5.1 CEMP will be used to guard against any airborne emissions. These plans will be further developed with the Main Works Contractors and submitted for the approval of Fingal County Council. The Dust Management Plan will include:

- An inventory and timetable of activities which may give rise to emissions or dust;
- Alert levels;
- Alert system to be used (including notification process);
- Details of dust control measures; and
- Details of dust monitoring arrangements, including the location of sensitive receptors, monitoring locations, and monitoring equipment to be used.

In order to ensure that no dust nuisance occurs, a series of mitigation measures will be implemented, as detailed in Appendix A16.4. In summary, the measures which will be implemented will include:

- Material handling systems and site stockpiling of materials will be designed and laid out to minimise exposure to wind. Water misting or sprays will be used as required if particularly dusty activities are necessary during dry or windy periods;
- Any blasting will be completed by specialised contractors with a specific blasting dust management plan;
- Liaison with local authorities and community groups;
- Hoarding will be provided around the construction compounds; and
- It is anticipated that methods of collecting rainwater and recycling for general site use, will be adopted where practical. Strict dust prevention will always be in place, to minimise any potential emissions and these procedures will be strictly monitored and assessed. In the event of dust nuisance occurring outside the site boundary, movements of materials likely to raise dust will be curtailed and satisfactory procedures implemented to rectify the problem before the resumption of construction operations.

In advance of construction commencement, dust and air quality monitoring will be established at each of the main construction sites to ensure dust is effectively controlled.

F.8.1.9 Mitigation to minimise Site Workers exposure to PFAS

Given the low levels of PFAS identified to date, no specialised protection equipment is required for employees. The use of standard Personnel Protective Equipment (PPE) (i.e. gloves, long sleeve protective clothing, mask to protect against inhalation) will be sufficient based on current information.

As more data on onsite PFAS concentrations becomes available, a thorough risk assessment will be conducted to determine if any additional protective measures are necessary for worker safety. The primary focus will be on mitigating the risk of PFAS ingestion or inhalation, whether airborne in dust or present in extracted water

Furthermore, the control strategy will include comprehensive PFAS risk awareness and training for all operatives involved in these operations, along with continuous monitoring of the working environment. Appropriate PPE to eliminate any risk of exposure and the provision of washing and drying facilities will be made available as required.

F.8.1.10 Materials Approval

All materials required for the construction of the MetroLink project are to be specified as PFAS free and will be subject to review and approval by the Engineering and Environment Teams responsible for accepting and approving the design and construction methodologies. The following materials have been identified as having particular potential to include PFAS additives:

- **Bentonite:** Specialist bentonite products including some ‘coated bentonite’ have been found to contain PFAS. All bentonite materials are to be specified as PFAS free;
- **Spoil conditioning additives**: Soil conditioning foams may contain low concentrations of PFAS additives to improve performance. Only biodegradable, PFAS free products are to be used; and
- **Chemicals used** in the coagulation and flocculation process in site wastewater treatment will be PFAS free.

Annex G. Management during the Operational Phase

G.1 Introduction

If PFAS are present in the groundwater surrounding the tunnels and the Station and Tunnel Portals at Dublin Airport, the external lining and walls of these tunnels and structures will act as barriers to prevent groundwater from entering the MetroLink operating environment.

The EIAR Chapters 6 (Operations), 18 (Hydrology), and 19 (Hydrogeology); sets out the provisions made for how MetroLink will work in operation. The operational provisions on MetroLink through Dublin Airport relevant to the management of potential PFAS-containing groundwater flows, taken from these Chapters are set out below.

The tunnels and structures for the Station and Portals at Dublin Airport are designed to be watertight based on the current understanding of the hydrogeology. However, this section also outlines potential mitigations if PFAS-containing groundwater is encountered, due to leaks or water ingress. However, this section also outlines mitigations if PFAS-containing groundwater is encountered, due to leaks or water ingress.

G.2 The Structures and Tunnels

The external structures of the tunnels, tunnel portals and the Dublin Airport station under the Airport will act as barriers to prevent ground water ingress and any potential PFAS contamination.

The completed tunnel and the Dublin Airport station are enclosed structures, protected from the external elements of weather, potential for flooding etc, and will be designed and constructed to be watertight. The tunnel design will include transverse grated channels located immediately upstream of the tunnel portals, to stop surface water (rainfall) flows entering the tunnel. The tunnel lining will be designed with gaskets to deal with the prevailing groundwater conditions, while it is recommended that the structures of the stations and portals are designed and constructed to the highest standard grade of waterproof protection against water ingress, BS8102: 2022, with any external perimeter secant or diaphragm wall achieving a Grade 1b, prior to the application of secondary waterproofing.

With the average tunnel depth under the airport ranging from between 9m to 11m below existing ground level to the crown (top) of the tunnel (depth at the station is 17m), and the tunnelling construction methodology comprising continuous sealing as the TBM advances, it is not expected that any of the watercourses will be affected in terms of adding to groundwater inflow potential along tunnel sections or at the stations. (See EIAR Chapter 18: Hydrology, Section 18.4.4). In addition, during the TBM advancement there will be ongoing grouting to ensure that any preferential pathways i.e rock fractures will be sealed. This will ensure that the tunnelling process will not create preferential pathways.

G.2.1 Barrier Effects

Hydrogeological modelling has assessed the potential ‘Barrier Effect’ of underground structures under the airport. Where a barrier effect occurs, there is a greater risk of water ingress through the structures owing to the active build-up of water pressure against the external face of the structures, as the prevailing water flow path is perpendicular to the structure.

The EIAR Chapter 19, Hydrogeology, Appendix A19.10 presents the hydrogeological plan which also indicates areas where groundwater flow paths run parallel to MetroLink alignment, such as through the airport section, which indicates that the barrier effect will not occur at this location.

Figure 3.2 within Section 3.3 provides a geological long section showing the main geotechnical features around the airport tunnels and structures.

G.2.2 Groundwater levels

The monitoring records show that the groundwater depths ranged from 3.1mbgl to 10.12mbgl. The fluctuation in groundwater levels in individual installations ranged from 0.1 to 0.2m over the monitoring period. See Annex A of this report and Chapter 19 of the EIAR for further information on the hydrogeology including permeability.

G.3 Water Management

The tunnels and Dublin Airport Station will be designed as "watertight" structures, and this will minimise the potential of water ingress and collection within the tunnels and station environment. While it is expected to be limited, any water ingress will be collected into the track drainage systems and discharged to public wastewater sewer. In the event that water sampling identifies the presence of PFAS, onsite treatment will be implemented prior to discharge and this will be in line with technologies outlined in Annex E of this report.

As no active dewatering will be taking place during the operational phase, there will be no long-term drawdown effects either at or beyond the footprint of the sealed Station, Tunnel Portals and the tunnel itself.

G.3.1 Tunnel and Underground Station Drainage

The tunnelled sections will not be exposed to any rainfall and are designed as water-tight structures. Any drainage within the tunnels will be collected internally and gravitated to sumps at the low points along the alignment where it will be collected and discharged by pumping externally into the public foul drainage system following treatment in line with the recommended methodologies outlined in Annex E (subject to agreement with Uisce Eireann).

Within the tunnels and stations, all track drainage is directed to the centre of the track, where a main channel is located to convey the flow to the designated discharge point. The slope of the channel generally follows the gradient of the track. When the track grade is flat, for example at the station, the channel will have a built-in minimum slope to achieve a minimum velocity of 0.5m/s.

At the station, the low sump point will be fitted with two pumps sets, for duty and standby, sized for capacity. These pumps will transfer water up a rising main to a reception manhole and then on to the approved outfall point.

For the Airport Tunnel (AZ2), the tunnel has two low points, both of which are some distance from a portal or station. Therefore, low point sumps must be constructed consisting of:

- A niche cut out of the side of the tunnel, with a shaft descending below it;
- Installation of a pipe connecting the tunnel drainage gully with the shaft for water to drain into the sump;

- Installation of two electric pumps, float switches to monitor water level; Installation of power supplies and control equipment; Installation of atmospheric monitoring (to monitor for gasses that can collect at low points); and
- A steel pump main taking water from the pumps to the sump in the nearest adjacent station or portal. The steel pump main is installed in the tunnel by placing on, and then clamping to, steel brackets which are fixed to the tunnel lining. The pipe is lifted onto the brackets by a hiab-type arm mounted on a rail wagon.

G.3.2 Discharge of Water within the Tunnel Station System

All wastewater arising from the tunnel alignment (including from the tunnel itself, emergency access and ventilation shafts, portals) and foul water from station boxes will ultimately be discharged to public foul sewer under formal consent by Uisce Eireann following appropriate treatment. Water runoff collected from the tunnel alignment (including from stations) will be minimal in terms of volumes by comparison with the open sections and will be attenuated/treated prior to an authorised discharge to sewer, nevertheless all will be monitored for volume and quality.

G.3.3 Firefighting

Section 18.6.2.3 of Chapter 18 (Hydrology) in the EIAR explains the management of firewater during the Operational Phase of MetroLink with emphasis on fire detection and automatic shut off systems including containment and subsequent off-site disposal. Based on the proposed EU-wide ban the use of fluorinated foams from the European Chemicals Agency (ECHA) all firefighting foams that will be used on MetroLink will be PFAS free.

In the case that a fire breaks out in an underground station or along the alignment, the drainage system will be designed with an automatic shut off valve which will constrain all firewater to ensure that there are no discharges of contaminated water. The firewater will then be contained within the drainage system prior to pumping it out for appropriate treatment and disposal.

G.3.4 Operational Controls

Once tested and commissioned the SCADA Electro-mechanical Sub-System (EMS) will be used to monitor and control a wide range of electro-mechanical equipment including pumps for drainage water, fire pumps, fire detection and fire extinguishing systems.

G.3.5 Potential for Leaks in the Tunnel or Structure

The design for both the tunnels and structures under the Airport will exclude groundwater within a sealed structural system. If unforeseen ground conditions or leakages occur, the following mitigation measures will be implemented to address this:

- Injection resin grouting at the point of water ingress (tunnel of structure) or other designer approved methods to remove this potential entirely, or at the very least reduce the volume of any water flows. The injection pressure of the selected material will be monitored and controlled using pressure gauges. This would ensure sufficient pressure is applied to inject the material while ensuring the structure or the surrounding ground is not overstressed.
- Ongoing testing of any water collected within the drainage system to identify the presence of any PFAS.

- If confirmed through the classification that PFAS containing water is present, then it is to be collected and treated prior to any discharges.
- If PFAS containing water is to be managed, then the drainage cut off system will be utilised to ensure that there are no discharges of contaminated water, and a treatment system will be integrated into the system similar to those identified in Annex E of this report. The proposed outline layouts of underground water storage at both DANP and DASP are provided below.

Annex H. EIAR Addendum

METROLINK

Integrated Transport. Integrated Life.

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

NTA
Údarás Náisiúnta Iompair
National Transport Authority

Rialtas na hÉireann
Government of Ireland

Tionscadal Éireann
Project Ireland
2040

MetroLink Railway Order

Supplementary EIAR for PFAS Management Strategy at Dublin Airport

Contents

1. Introduction and Background

1.1 Introduction

The purpose of this addendum to the Environmental Impact Assessment Report (EIAR) is to identify, describe and assess the potential for additional environmental effects resulting from the presence of PFAS within the environs of Dublin Airport and outline the management and mitigation measures required to manage PFAS at this location as outlined in Section 7 and Section 8 of the MetroLink PFAS Management Strategy for Dublin Airport Report. This supplementary assessment has been necessitated by the additional information presented at the MetroLink Oral Hearing in relation to PFAS at Dublin Airport.

This assessment will include:

- Reference information considered in assessing the PFAS at Dublin Airport;
- A technical overview of the proposed PFAS management strategies assessed;
- Details of the assessment methodology used;
- A review and assessment of potential environmental effects arising from this change; and
- Conclusions of the review.

1.2 Reference Information

The information reviewed and taken account of in the development of this addendum includes the following information.

1.2.1 Documents and Drawings

- Wild Ireland Defence Submission to the MetroLink Oral Hearing;
- Dublin Airport, 2021 – 2023 Environmental Monitoring Report, prepared on behalf of daa, April 2024;
- The MetroLink PFAS Management Strategy for Dublin Airport Report; and
- MetroLink RO Application
  - First Schedule
  - Railway Order drawings
  - MetroLink EIAR

1.2.2 Limitations on Information Received

The data available provided sufficient detail to allow for an assessment of potential environmental effects.

2. Proposed Works

2.1 Introduction

The MetroLink PFAS Management Strategy for Dublin Airport Report has been prepared to address the concerns raised by the Wild Ireland Defence/Sabrina Joyce Kemper submission relating to the recent identification of PFAS contamination at Dublin Airport (April 2024). The PFAS Management Strategy also explains to An Bord Pleanála (ABP) how the MetroLink project (hereafter referred to as the proposed Project) will manage per- and polyfluoroalkyl substances (hereafter referred to as PFAS) contamination if encountered during the proposed Project construction works and operation in the environs of Dublin Airport.

The management strategy has been developed to manage PFAS contamination based on the following principles:

- **Prevention of PFAS mobilisation and transfer:** Measures will be implemented to prevent the mobilisation or transfer of PFAS to the receiving environment during the construction and Operational Phase of MetroLink, should PFAS be encountered; and
- **Avoidance of Preferential Pathways:** The proposed Project will ensure that no preferential pathways are created that could facilitate the transfer or migration of PFAS.

To achieve this, TII will employ a combination of treatment strategies, onsite management practices, and design solutions which are aligned with international best practices for managing PFAS, ensuring the highest standards of environmental protection and safety.

In order to ensure that the environmental assessments done in relation to impacts of any such PFAS-containing material encountered are based on conservative assumptions, the project has assumed a worst-case scenario where all excavated material at Dublin Airport has the potential to contain detectable PFAS.

This EIAR Addendum updates the assessment of the potential for environmental impacts from the proposed Project works at Dublin Airport and describes how any negative effects from PFAS will be managed.

2.2 PFAS Management Strategy for Dublin Airport

Full details of the proposed PFAS Management measures that are required due to the recent identification of PFAS contamination at Dublin Airport are detailed in Sections 7 and 8 and Annex F and G of the above mentioned report. The measures have been developed based on a set of PFAS protocols which are:

- Site isolation: keeping the contaminated area separate;
- Water management: controlling water during excavation.
- Material transport and handling: safe movement and handling of materials;
- Protection during holding and testing: ensuring safety and no PFAS migration while materials are held and tested;
- Air and dust monitoring: reviewing air and dust quality; and
- Mitigation of exposure to site workers: protecting workers from exposure.

2.2.1 Transport of the potentially PFAS contaminated material

Once potentially contaminated material is excavated from the Dublin Airport North Portal (DANP), Dublin Airport South Portal (DASP), Dublin Airport station site, it will then be transported to the proposed Triage and Material Management Centre.

The haulage routes outlined within the EIAR Chapter 19, Appendix A19.5 Scheme Traffic Management Plan will generally follow, albeit with the following exceptions:

- HCVs moving towards the Triage and Materials Management Centre will exit the M50 at Junction 4 and proceed north along the R108 to the Triage and Materials Management Centre; and
- HCVs moving towards Dublin port will leave the Triage and Materials Management Centre and will continue south to the M50 Junction 4, before travelling eastbound on the M50 towards the M1. The vehicles will then progress southbound on the M1 towards Dublin Port.

Transport of materials from site will be in trucks of suitable quality and covered to ensure there is no spillage or dust separation during transport between locations on site or public roads.

In order to avoid any potential for cross contamination with other sites and projects, the transport suppliers will maintain vehicles for the sole purpose of this activity with regular washing in designated areas and all materials will be transported at an acceptable optimum moisture content to prevent dusting and the potential for material leachate discharging from the trucks during transport.

2.2.2 Testing and Classification

A Triage and Material Management Centre will be established at Dardistown for the purpose of testing and holding of excavated material to identify the presence of PFAS and the requirement for export for treatment or landfilling.

2.2.3 Triage and Material Management Centre

To control the potential volume of excavated materials, assuming 100% of material has the potential to have PFAS contamination and therefore will need to be tested, an area of up to 25,000m^2 will be required to triage for PFAS by holding materials for testing and classification prior to onward transport to disposal. When the provision of access and other elements of infrastructure are included the site size will be approximately 44,000m^2.

The Triage and Material Management Centre will hold the excavated materials until test results are available. Based on test results, both PFAS acceptance limits (as detailed in the PFAS Management Strategy) and other waste acceptance/reuse limits, or to an approved treatment facility in Europe for treatment and disposal if outside of PFAS acceptance limits.

While waiting for test results, the excavated materials will be covered to prevent any risk of potential leachate from affecting nearby areas (like run off into surrounding sites, streams or groundwater). Any potentially contaminated water arising from this site will be collected and treated before being discharged or transported by tanker to a licensed disposal site.

The proposed area being used for the Triage and Material Management Centre is within the proposed temporary land take required for the construction of the proposed Project. (Refer to

Figure 2-1 Location of proposed Triage and Material Centre for proposed location and to Figure 2-2 for site details).

2.2.4 Works Management

In addition to the management of materials excavation additional measures are also included in the PFAS management strategy to ensure that there are no perceptible impacts on the receiving environment including waterbodies. These measures include the following:

- The works site will be delineated, segregating the site from any adjacent site with a dedicated access route;
- The works are completed in stages and at each stage the soils to be excavated and water to be removed or managed are tested for PFAS;

- All excavated material or water collected will be removed and transported to the Triage and Materials Management Centre for testing and onward transportation;
- Instream works will be undertaken and completed in dry or very low flow conditions. All potentially contaminated water extracted in the course of the works, will be treated as per appropriate methods identified in Annex E of this report;
- The works required for the proposed diversion works on the Turnapin Stream (Mayne) and other instream works will include for monitoring upstream and downstream in order to track any changes in the levels of PFAS during the full progression of the works. For the provision of the diversion works, suitable barriers, Geomembrane HDPE or similar, are to be procured to line the diversion excavations to prevent PFAS migration downstream of any inline watercourse works, and when rediverting the river and realigning the river at the completion of the instream culvert; and
- Backfilling will be undertaken with clean suitable fill material only.

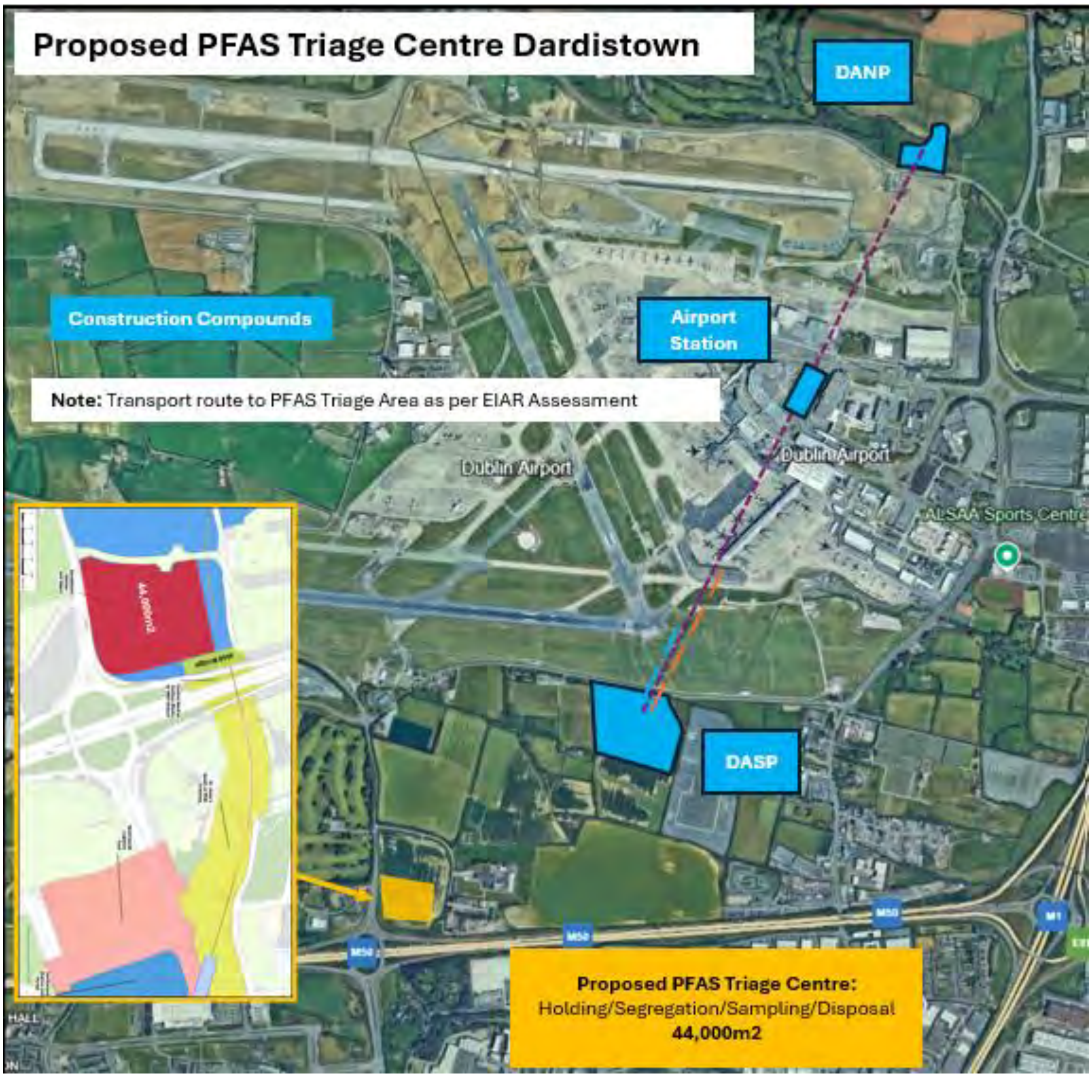

Figure 2-1 Location of proposed Triage and Material Management Centre

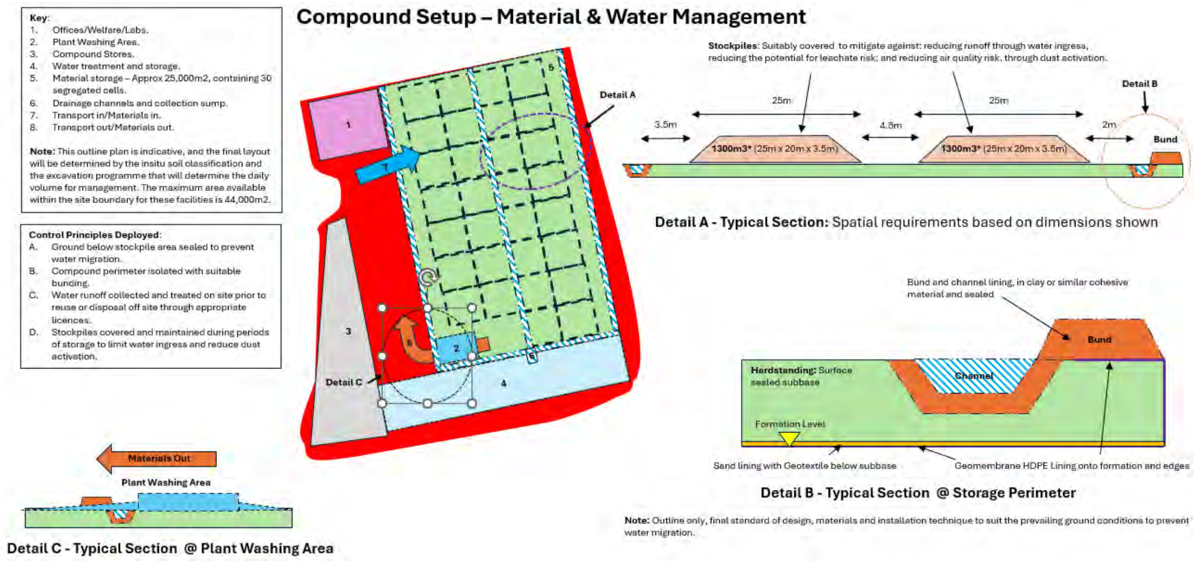

Figure 2-2 PFAS Triage and Material Management Centre

2.2.5 Operational Phase Management

The tunnels and structures for the Station and Portals at Dublin Airport will be designed to be watertight based on the current understanding of the hydrogeology limiting water ingress. However, if PFAS containing water is found to be present during the Operational Phase, this will be collected, and treated prior to discharge to the foul sewer system, subject to license from Uisce Éireann.

3. Assessment Methodology

An analysis of the Proposed Works has been undertaken to determine the environmental effects of the potential disturbance of PFAS at Dublin Airport and the proposed PFAS management strategy in order to identify any potential for additional significant environmental effects beyond those identified in the MetroLink EIAR. The assessments presented here have been undertaken by the same competent experts that prepared the EIAR chapters. This assessment consisted of a two-stage process:

- **Stage 1 Assessment of Potential for Environmental Effects:**
  - This stage involved a review of the potential for additional environmental effects that were not previously considered by the MetroLink EIAR as a result of the Proposed Works.
- **Stage 2 Assessment of Significance of Environmental Effects:**
  - This stage involved evaluating the identified potential environmental effects identified to determine their significance, the required mitigation measures and any residual effects.

This environmental review (see Section 3) considered the following key issues:

- The potential for increased construction activity and extended duration of construction activities.
- The potential for increased traffic movements; and the effects on the population and human health arising from this activity.
- The potential for generating additional emissions, materials or waste that were not considered in the MetroLink EIAR, and
- The potential increase in emissions from works at new locations, particularly in relation to sensitive receptors beyond those assessed in the MetroLink EIAR.

4. Environmental Assessment

4.1 Introduction

This section summarises the environmental review, undertaken in accordance with the two-stage methodology described by Section 3 to determine if there will be additional impacts on the receiving environment beyond those assessed in the MetroLink EIAR.

4.2 Stage 1 – Assessment of Potential for Environmental Effects

Table 4-1 summarises the results of the environmental assessment exercise, identifying the environmental effects that have the potential for significant environmental effects above those already assessed in the EIAR. These effects are then taken forward for Stage 2 Assessment.

Table 4-1: Environmental Assessment

Environmental Effects	Potential for Additional Significant Effects	Rationale
Traffic and Transport	Yes	While the RO provides a full assessment of the impacts of the MetroLink Works on traffic and transport, the proposed works required to manage PFAS will add additional traffic movements to the road network over and above those assessed in the original EIAR. In addition, the use of a different route associated with the movement of material to Dublin Port for export needs to be assessed.
Human Health	Yes	There is potential for adverse health impacts from exposure to PFAS, including immune system effects and cancer, if the proposed mitigation measures are not implemented
Population and Land Use	Yes	Potential for additional noise and emissions to air arising during the management of PFAS material at the proposed Dardistown site and due to associated traffic movements.
Electromagnetic Compatibility and Stray Current	No	No Change from the RO.
Airborne Noise & Vibration	Yes	There is potential for some additional impact as a result of noise arising from the material management at the proposed Dardistown site and associated with traffic movements (using different routes). In relation to vibration, the additional works will not entail any significant subsurface works in close proximity to sensitive receptors and thus, vibration is not considered further in this assessment.
Groundborne Noise & Vibration	No	The additional works will not entail any significant subsurface works in close proximity to sensitive receptors.

Environmental Effects	Potential for Additional Significant Effects	Rationale
Biodiversity	Yes	The additional works will not have any additional significant impacts to ecological receptors. The area to be cleared for the materials management has already been assessed as being cleared in the assessment presented in the EIAR. However, the increased potential for impacts associated with the excavation and management of potentially PFAS contaminated material requires assessment.
Air Quality	Yes	There is potential for some additional impact as a result of dust emissions arising from the material management at the proposed Dardistown site and due to emissions to air associated with traffic movements (using different routes) and
Climate	Yes	There is potential for some additional impacts as a result of carbon emissions associated with traffic movements and potential requirement for export of contaminated material.
Hydrology	Yes	The identification of PFAS at Dublin Airport means that there is potential for PFAS emissions to surface water if not mitigated.
Hydrogeology	Yes	The identification of PFAS at Dublin Airport means that there is potential for PFAS emissions to surface water if not mitigated.
Soils & Geology	Yes	There is potential for impacts from disturbance of PFAS within soils and groundwater from airport activities impacting human health, groundwater, surface water and materials management if the proposed mitigation measures are not implemented.
Land Take	No	No change in land take is proposed from that in the Railway Order (RO). The proposed area being used for material management is within the previously proposed temporary land take.
Infrastructure & Utilities	No	No additional impacts on utilities and infrastructure above those already assessed in the EIAR.
Agronomy	No	No change from the RO as the required land take will not change from that assessed in the EIAR.
Material and Waste Management	Yes	Requirement for significant volumes of material to be exported should it be identified as contaminated.
Archaeology and Cultural Heritage	No	No change from the RO as the required land take will not change from that assessed in the EIAR.
Architectural Heritage	No	No change from the RO as the area of assessment remains the same.

Environmental Effects	Potential for Additional Significant Effects	Rationale
Landscape & Visual	No	No change from the RO as the area of assessment remains the same with no significant structures being introduced.
Risk of Major Accidents and Disasters	No	There is no increase in risk of a major accident or a natural disaster due to this proposed change.

4.3 Stage 2 – Environmental Assessment

4.3.1 Traffic and Transport

Chapter 9 of the EIAR presents an assessment of the potential impacts on Traffic and Transport. This section updates the assessment to identify any additional effects associated with the implementation of the MetroLink PFAS Management Strategy for Dublin Airport during the Construction Phase. There is no potential for traffic and Transport impacts associated with the MetroLink PFAS Management Strategy for Dublin Airport Report during the Operational Phase as the activity will be complete.

4.3.1.1 Methodology

As part of the methodology identified in EIAR Chapter 9 Traffic and Transport Section 9.4.8.2.2, the magnitude of impacts on Heavy Commercial Vehicle (HCV) flows during the Construction Phase is based on the percentage increase in HGV flows from the baseline scenario. The Classifications are as follows:

- Increases of less than 5% are considered to be Slight,
- Increases of between 5% and 10% are considered Moderate, and
- Increases of over 10% are considered to be Severe.

When the magnitude of the impact is considered in conjunction with the sensitivity of the road link (i.e. a local road, a regional road, motorway), the overall significance of the impact can be determined.

4.3.1.2 Impact Assessment

During the management of potentially PFAS contaminated material there will be additional HCV movements on the road network in and around Dublin Airport due to the transfer of material from the construction sites at Dublin Airport and the proposed Triage and Material Management Centre at Dardistown.

The HCVs will utilise the haulage routes presented within the MetroLink EIAR, Appendix 9.5, to access the Triage and Material Management Centre at Dardistown. The routes for disposal of material from the Triage and Material Management Centre are illustrated in Figure 4-1 below.

Figure 4-1: Routes for Reuse

The impact on traffic flows has also been considered. Based on the additional predicted construction movements provided in Table 4-2, the assessment has utilised the higher average HCV movements which is an average of 113 movements per a day.

Table 4-2: Estimated HCV Movements associated with PFAS

Volume Excavated	Duration (weeks)	Average HCV Movements/Day
Above 2,000m^3 week	72	113
Below 2,000m^3 week	148	35

In the worst case scenario, 100% of the material is contaminated and needs to be transferred to Dublin Port. This will result in some increase in traffic flows on the M50 from Junction 4(J4) to Junction 3(J3) and from J3 to the end of Port Tunnel, compared to the analysis presented within the MetroLink EIAR.

The percentage impact of the additional daily HCV movements associated with the management of the PFAS materials is presented within Table 4-3 below. The table also presents the % impact of the overall proposed Project construction traffic, i.e. the analysis presented within the EIAR, and the traffic associated with the PFAS management strategy.

With reference to the table, in the worst case scenario the percentage increase in traffic flows on Site 2, Site 3, Site 4 and Site 5 are all less than <5% and the impact is as per the EIAR, constitutes a slight impact.

The percentage increase on the section of the R108 between the M50 junction and the entrance to the PFAS site is estimated to be 5%. Using the KPIs from the Metrolink EIAR this impact would be classed as a Moderate impact. Further assessment of the capacity of the R108, indicates that this road will operate well within capacity with the additional traffic associated with the proposed Project, accordingly the impact of this additional traffic on road users will be short-term slight negative.

Table 4-3: Traffic Flow Changes due to PFAS - AADT Flows

Summary	Do Minimum	Metrolink Construction (EIAR)	Metrolink Construction +PFAS	Change in AADT due to PFAS (daily flow)	Change in AADT due to Do Scheme+ PFAS	Change Do Scheme %	Change Do Scheme+ PFAS
Site 1: R108	5,920	6,096	6,211	125	301	3%	5%
Site 2: M50 (J4 to J3)	81,685	82,820	82,820	125	1,261	1%	2%
Site 3: M1 (J1 to J2)	92,015	92,094	92,094	0	79	0%	0%
Site 4: M50 (J3 to Port Tunnel)	67,220	67,186	67,311	125	91	0%	0%
Site 5: Port Tunnel	21,930	21,933	22,184	125	128	0%	1%

4.3.1.3 Conclusion

Accordingly, the impact of the transport of the PFAS contaminated materials will result in short term slight negative impact on the receiving environment and does not change the assessment presented within the Metrolink EIAR.

Overall, there will be no significant change in the traffic flow on the existing road network. Additionally, there are no temporary traffic management measures proposed above what is contained within the EIAR, with no further lane or road closures. Therefore, there will be no additional significant impacts on private vehicles, public transport, cyclists, pedestrians, local access or parking, above those identified in the EIAR and it does not impact on the conclusions within the traffic and transport chapter of the EIAR. Accordingly, the impact of the transport of the PFAS contaminated materials will result in short term slight negative impact on the receiving environment and does not change the assessment presented within the Metrolink EIAR.

4.3.2 Population & Land Use, Human Health

Chapter 10 of the EIAR presents an assessment of the potential for impacts on Human Health and Chapter 11 presents an assessment of potential impacts on the local population. These two aspects are considered together here as they are intrinsically linked and overlap significantly. The assessment presented here is an update to identify any additional effects associated with the implementation of the MetroLink PFAS Management Strategy for Dublin Airport Report.

4.3.2.1 PFAS and Human Health

PFAS are a group of chemicals that have raised health concerns due to their persistence in the environment and the human body. PFAS break down very slowly, leading to their accumulation over time. Studies have detected PFAS at very low levels in the blood of people worldwide. Higher levels have been found in communities with contaminated local water supplies and in individuals exposed to PFAS in the workplace. Current scientific research suggests that exposure to certain PFAS may lead to adverse health outcomes. Research is ongoing to determine how different levels of exposure to different PFAS can lead to a variety of health effects.

In 2020, the European Food Standards Agency (EFSA) set a new safety threshold for a group of four PFAS; PFOA, PFOS, perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS). This threshold was a tolerable weekly intake (TWI) of 4.4ng/kg bw/day based on the main critical effect to humans of a decreased response of the immune system to vaccination. This differed from the previous EFSA opinion on PFAS from 2018, which considered increased cholesterol as the main critical effect (EFSA, 2020). EFSA considered that these four PFAS were the primary PFAS of concern to human health based on exposure and toxicity.

In 2023 the International Agency for Research on Cancer (IARC) which is part of the World Health Organization (WHO) published an opinion classifying PFOA as “carcinogenic to humans” (Group 1), based on sufficient evidence it can cause cancer in lab animals and strong evidence that it has some of the key properties of a carcinogen in people who are exposed to it. IARC also notes there is limited evidence in people that PFOA can cause testicular and kidney cancer. IARC has classified PFOS as “possibly carcinogenic to humans” (Group 2B), based on strong evidence that it has some key properties of a carcinogen in people who are exposed to it, although the current evidence that PFOS can actually cause cancer in humans is considered inadequate and there is only limited evidence that it can cause cancer in lab animals.

PFAS Management Strategy

The potential for health impacts associated with high levels of exposure to PFAS underscores the importance of effective management of material potentially containing PFAS. The measures proposed in the PFAS Management Strategy will ensure that there are no significant impacts on human health. These measures include:

- Design Considerations: The MetroLink design ensures that there are no preferential pathways created that will result in PFAS mobilisation into groundwater and/or surface water.
- Construction Methods: The use of a Tunnel Boring Machine (TBM) and the isolation of excavation sites from surrounding soils, bedrock and groundwater will control any potential mobilization of PFAS during construction.
- Material Handling: All potentially contaminated material will be removed from the construction sites and isolated on the Triage and Material Management Centre until such time as the presence of PFAS is identified. Contaminated material will then be exported for treatment or disposed at appropriately licensed facilities.
- Transport and Containment: During the handling of PFAS contaminated material it will be transported in a standalone fleet of vehicles that will be cleaned down daily thereby minimizing the potential for cross contamination of other clean material.
- Run off Management: Runoff from vehicles, stockpiles of contaminated material or potentially contaminated works areas will be collected and treated using a carbon filter before re-use or disposal.
- Dust management: A dust management plan will be implemented in line with that outlined in Appendix A16.4 of the EIAR; and
- Worker Safety: Risk awareness training will be provided for construction workers. Appropriate Personnel Protective Equipment (PPE) will be provided, and continuous monitoring of the working environment will be undertaken. Given the low levels of PFAS identified in this area, specialised PPE will not be required.

These measures will effectively prevent any potential pathways for PFAS to transmission to the population during either both the Construction and/or Operational Phases. Consequently, there is no potential for adverse health effects associated from this activity. Therefore, there are no changes to the conclusions that are detailed in the EIAR chapters relative to population and land use, and human health.

4.3.3 Airborne Noise and Vibration

Chapter 13 of the EIAR evaluates the airborne construction noise impacts associated with the construction activities at Dublin Airport Station, at the DANP and DASP within the Dardistown Depot and Station, M50 Viaduct and the construction compound at Northwood TBM Launch site and Northwood Station.

Noise sensitive locations (NSLs) in this study area include hotels and office buildings at the Airport, Our Lady Queen of Heaven Church and residential buildings along the Old Airport Road, at Ballymun Cross immediately south of the M50 Motorway, along the R108 Ballymun Road and residential buildings within Ballymun North. The potential noise impacts associated with the following activities were assessed within Chapter 13:

- Enabling works;
- Demolition (where required);
- Diaphragm wall (D-wall) construction (where required);
- Excavation;
- Construction activity associated with Dublin Airport and Dardistown Stations;
- TBM support activities;
- Depot site preparation works and construction works;
- Concrete batching;
- Construction Compound activity;
- Portal decommissioning and finishing works;
- Track Laying;
- Road Works;
- Landscaping; and
- Construction Traffic.

There is no potential for noise impacts associated with the MetroLink PFAS Management Strategy for Dublin Airport during the Operational Phase as the activity will be complete.

4.3.3.1 Dublin Airport North Portal

The assessment presented in Chapter 13 of the EIAR identified that with mitigation there are no significant residual construction noise effects at the closest NSLs. The noise impact of construction traffic along the surrounding road network is determined to be not significant.

The MetroLink PFAS Management Strategy for Dublin Airport Report will not result in any significant additional activity at this site as the excavation and transport of the excavated material from the site will not entail any additional noise generating activity.

4.3.3.2 Dublin Airport Station

The assessment presented in the EIAR identified potentially moderate to significant effects associated with piling and excavation phases at Our Lady Queen of Heaven church following mitigation. These impacts are primarily driven by the proximity of the Dublin Airport station construction site to the Church. Noise associated with construction traffic was assessed as being not significant. There will be no additional traffic movements at this location due to the MetroLink PFAS Management Strategy for Dublin Airport, therefore impacts at the station construction compound at Dublin Airport will not change from those assessed in the EIAR.

4.3.3.3 Dublin Airport South Portal and Dardistown

The assessment presented in Chapter 13 of the EIAR identified that there are no exceedances of the construction noise threshold (CNT) associated with any of the construction activity required to construct the DASP and Dardistown Depot. This is largely due to the distance between construction activities and the nearest NSLs. Noise impacts associated with the traffic movements to the Dardistown compound were considered to be of slight to moderate impact along the R180 Naul road primarily due to construction traffic volumes during the peak hour.

There is potential for high noise levels related to track laying activities at Dardistown. During tracklaying activities, impacts will be brief at any one location due to the progression rate of approximately 100m per day or night. In line the construction noise and control mitigation approach, advance notice of these scheduled works will be communicated to NSLs, and the resultant impact is determined to be not significant at any one location. In addition, track laying will not run concurrently with the proposed activity at the Dardistown Triage and Material Management Centre.

The location of the proposed Triage and Material Management Centre at Dardistown is within the south-western area of the proposed Project works area adjacent to the M50 Motorway. The closest residential NSLs are located south of the compound across the M50 at Santry Lodge and St Annes, Northwood at a distance of approximately 250m. The activity associated with Triage and Material Management Centre will be largely limited to vehicles entering and exiting the compound in addition to some plant operating at the site. There are no significant on-site processing activities that would generate any significant noise emissions beyond the site boundary. The distance to the closest NSLs coupled with the low noise sources associated with the management compound will ensure there are no significant noise impacts associated with this site at the closest NSLs.

As there will be no significant additional construction activity associated with the Triage and Material Management Centre at Dardistown, the assessment presented in the EIAR will not change for this location.

Additional traffic movements have been predicted due to the transport of material to the proposed Triage and Material Management Centre along the M1 southbound from Dublin Airport, on the M50 Motorway both eastbound and westbound, and on the R108 northbound from the M50 to the proposed site. Section 4.3.1 of this document describes the traffic scenarios assessed for a ‘worst case’ assessment of traffic haul routes and associated volumes. The ‘worst case’ scenario traffic has been used to assess the potential traffic noise impacts along the surrounding road network. Traffic noise impacts are determined to be negligible due to the low volume of additional traffic along the road network during the Construction Phase scenario when added to existing flows. This is unchanged from the EIAR.

A further sensitivity assessment was undertaken of the peak traffic flows along the haul route network in line with the sensitivity assessment in Chapter 13 of the EIAR. In line with the EIAR, the highest change in noise levels are calculated along the R108 Naul Road to the west of Dardistown Compound. Construction traffic will access the compound along this road between the M50 and the site entrance. The closest sensitive area along this road is the Silloge Golf Course. The change in traffic noise is defined as minor along this road when added to existing traffic in this peak hour period.

4.3.3.4 Conclusion

The management of PFAS using the proposed Triage and Material Management Centre at Dardistown will not generate any significant noise or vibration impacts on its surrounding environment due to the low noise generating activities and distance to the nearest noise sensitive locations. There is no change to the construction noise and vibration impacts set out in Chapter 13 of the EIAR with this proposed facility in place.

Any additional traffic movements associated with transporting material to and from the Triage and Material Management Centre are determined to be equivalent to those set out in Chapter 13 of the EIAR.

Overall, with the inclusion of the MetroLink PFAS Management Strategy Report for Dublin Airport, there is no change in construction noise or vibration impacts, construction traffic noise impacts or operational noise impacts over and above those described in Chapter 13 of the EIAR.

4.3.4 Air Quality

Chapter 16 of the EIAR presents an assessment of the potential impacts on Air Quality. This section updates the assessment to identify any additional effects associated with the implementation of the proposed PFAS Management Strategy during the Construction Phase.

During the Construction Phase there are two potential significant sources of air quality impacts;

- Construction Phase dust impacts; and
- Construction Phase emissions from traffic movements.

There is no potential for air quality impacts associated with the MetroLink PFAS Management Strategy for Dublin Airport during the Operational Phase as the activity project will be complete. The Operational Phase does not involve activities that generate significant dust or emissions, ensuring that air quality remains unaffected.

4.3.4.1 Construction Phase - Dust

The proposed additional works (which require PFAS management) are within the works area assessed in the EIAR and a high level of dust mitigation will be applied across all works within this area, as set out in Appendix 16.4. Dust Mitigation of the EIAR. With this mitigation in place no additional impacts are predicted to occur due to the required PFAS management works. The IAQM 2024 Guidance states that once mitigation measures are put in place, the residual risk is considered "not significant". They also state that *"it is important to consider the specific characteristics of the site and the surrounding area to ensure that the conclusion of no significant effect is robust*." Given the applicability of the mitigation set out in the EIAR and no change in the proposed works area, there is no potential for likely additional, significant effects as a result of the implementation of the MetroLink PFAS Management Strategy for Dublin Airport Report.

In order to ensure the mitigation measures are functioning dust deposition monitoring will be conducted at the boundary of the site. In Chapter 16 of the EIAR the limit values for dust deposition are provided. The dust deposition limits for the proposed project will adhere to the Verein Deutscher Ingenieure (VDI) German Technical Instructions on Air Quality Control – TA Luft standard. This sets a maximum permissible emission level of 350mg/(m^2*day) averaged over a one-year period at any receptors outside the site boundary. This standard is applicable in Ireland and is included in the Department of the Environment, Health and Local Government (DEHLG) guidelines for quarries and ancillary activities. The project will implement this guidance value to manage dust impacts during construction

4.3.4.2 Construction Traffic

A detailed model of Construction Phase traffic emissions and redistribution was conducted as part of the assessment in Chapter 16 of the EIAR. The potential for impacts due to construction traffic is assessed with respect to the appropriate standard, *Air Quality Assessment of Proposed National Roads – Standard (PE-ENV-01107)* which was published in 2022 by TII. The TII Standard (TII 2022a) states that the following scoping criteria shall be used to determine whether the air quality impacts can be scoped out or require an assessment based on the difference between the Do Something traffic (with the proposed development) compared to the Do Minimum traffic (without the proposed development):

- Road alignment will change by 5 m or more; or
- Annual average daily traffic (AADT) flows will change by 1,000 or more; or
- Heavy duty vehicle (HDV) (vehicles greater than 3.5 tonnes, including buses and coaches) flows will change by 200 AADT or more; or
- Daily average speed change by 10 kph or more; or
- Peak hour speed will change by 20 kph or more.

The above scoping criteria is used in the current assessment to determine if the changes in traffic have the potential to cause significant effects at sensitive receptors (as per Section 3.8.5.3 of PE-ENV-01107). In Section 4.3.1 of this report, the changes to traffic volumes as a result of the PFAS management works have been considered. The changes in traffic (see Section 4.3.1) as a result of the PFAS works fall below the scoping criteria set out above, indicating there is no potential for significant effects as a result of vehicle emissions. The location with the maximum increase in HGV movements is on the L2015 and will last for a period of 72 weeks during peak works.

The cumulative increase from the proposed Project construction, as detailed in the EIAR, and the PFAS works remains below the scoping criteria (detailed above) for all but one road link. This road link has an increase in AADT of over above 1,000. This is due to as a result of redistribution of private vehicles being redistributed trying to avoid construction traffic. The impact of HCV movements and traffic redistribution was previously assessed within the EIAR in Section 16.5.2.4 of the EIAR. This has been updated above to reflect the PFAS Management Strategy. This shows that the additional traffic from the PFAS Management works will not significantly affect the outcomes of the EIAR assessment. This is because conservative approach already taken in the EIAR already accounts for increases in AADT greater than those specified in Section 4.3.1 for both the proposed Project works and the PFAS Management works combined.

4.3.5 Climate

Chapter 17 of the EIAR presents an assessment of the potential impacts on Climate. This section updates the assessment to identify any additional effects associated with the implementation of the proposed PFAS Management Strategy during the Construction Phase. The principle additional carbon emissions would result from the potential requirement to transport the PFAS contaminated material to sites in Europe for treatment and/or disposal. These transport routes are modelled here based on predicted haul routes and potential end use/treatment locations within Europe. The minor site works required for the management of material will not result in significant carbon emissions.

When considering the effect of the export of the potentially contaminated material overseas, which were not included within the MetroLink EIAR, the impacts have been considered over the full project's lifecycle and with respect to the significance criteria set out in TII's Guidance PE-ENV-01104 and the Institute of Environmental Management and Assessment's Guidance on *Assessing Greenhouse Gas Emissions and Evaluating their Significance*. These significance criteria are not based on the quantity of overall carbon emissions but on the two principles:

1. The project's GHG trajectory against Ireland's net zero trajectory; and
2. The level of mitigation taking place

4.3.5.1 Material Extraction, Transport and Carbon Calculations:

It is estimated that approximately 304,000 m^3 or 699,000 tonnes of material is to be extracted and in a worst-case scenario be exported overseas for treatment and/or disposal. This would be transported via 69,900 HGV movements. 67% of which will be from the DASP, 3% from the DANP and the remaining 30% from the main airport station. Distances are calculated based on the defined haul routes.

The carbon emission rates are derived from the TII Carbon tool[1] for assessing lifecycle carbon emissions for national road and light rail infrastructure projects in Ireland. Where material is brought to the Triage and Material Management Centre for testing this will require additional handling of the material above it being simply extracted and brought to its destination.

The emissions calculations included the double handling of the material and the use of two excavators, loaders and generators at the site offices. These operations will be over 220 weeks at a 40% utilisation rate working at standard hours.

[1] Emission rates taken in January 2025, using Version 0.7.9 of the TII Carbon Tool from November 2024.

4.3.5.2 Sea and Land Transport Emissions

Emissions for the export of the material using barges/ships have been extracted from the Department for Energy Security and Net Zero GHG reporting conversion factors 2024 for bulk carrier cargo ships (average)[2] with the rates based on emissions due to the transportation of 1 tonne of material over 1km. The distances at sea used for these calculations are based on an assumption that exported material will be sent to Belgium and Norway and are as follows:

- Dublin to Antwerp at sea: 1,172 km
- Dublin to Markenes, Norway at sea: 2,500 km

Once unloaded at the respective ports, the round-trip distances on land to appropriate facilities are estimated based on he following:

- Antwerp – To a soil treatment facility: 5 km
- Markenes – To a landfill facility: 6.6 km

These figures are indicative only, and the final destinations may change, but they are provided to give context for likely distances to landfill and treatment facilities.

4.3.5.3 Material Management Stages

There are two stages in the material management that are considered for the purposes of this assessment:

- The extraction of the material and movement to the Triage and Material Management Centre in Dardistown for pre-disposal testing and classification. At stage two the soil is 100% uncontaminated and diverted to Huntstown Quarry for use (as assessed in the EIAR) (best-case); and
- 100% of the materials transported to Dublin Port for export and disposal, this is the worst-case.

The carbon associated with these two options is detailed in Table 4-4 below.

Table 4-4: Carbon Associated with the Worst-Case Scenario Emissions Source

Emissions Source	Worst-Case (Material Exported)
Emissions due to HGVs (Tonnes CO_2e)	973
Emissions due to handling at Material Triage Centre (MTC) (Tonnes CO_2e)	840
Total (Tonnes CO_2e)	1,813

Once the material arrives at Dublin Port it will be shipped for reprocessing and reuse, or to a specialised landfill. These two potential options have been assessed with respect to carbon emission as follows:

- When the excavated materials are exported, the best-case option is where 100% of the material can be reprocessed for reuse and is exported to a facility close to the port in Antwerp, Belgium (1,172km by sea followed by a 5 km HGV roundtrip).
- The worst case is where 10% of excavated material is highly contaminated and diverted to a landfill in Norway, with the nearest Port being Markenes (2,500km by sea followed by a 6.6km HGV roundtrip). The remaining 90% of exported materials would be transferred to Antwerp for reprocessing (1,172km by sea followed by a 5 km HGV roundtrip). 10% is considered a reasonable worst case estimate of the likely heavily contaminated material as the assumptions on the overall quantity of PFAS contaminated material is highly conservative in the first instance

[2] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2024

and testing results presented in the PFAS Management Strategy Report indicates that concentrations of PFAS in soils are at low levels.

The difference between the two options relates to the 10% of soil that has the potential to be too contaminated for reprocessing and reuse and the emissions additional distance for transportation at sea (1,172km versus 2,500km). The distances for transport by land are similar given that one location has a 5km roundtrip and the other a 6.6km roundtrip. However, transportation by boat is a lower carbon solution than other transportation options.

Table 4-5: Carbon associated with exported material

Emissions Source	Export Best Case Option – 100% to Antwerp for Reuse	Worst Case Option – 90% to Antwerp for Reuse, 10% to Markenes for Landfill
Total Carbon (Tonnes CO2e)	3,280	3,620

Where applicable, carbon reduction mitigation measures as set out in Chapter 17 of the EIAR and supplemented in Avril Challoner's witness Statement on Day 1 of the Oral Hearing will be applied to the above predicted emissions, including the following:

- No idling of vehicles both on and off-site including HGVs;
- All plant and machinery will be maintained and serviced regularly;
- Efficient scheduling of deliveries will be undertaken to minimise emissions; and
- The use of use of Hydrotreated vegetable oil (HVO) rather than diesel in HCVs and plant on construction sites.

While the savings based on the first three of these four applicable mitigation measures are difficult to quantify, the savings due to the use of HVO can be quantified. The use of HVO reduces emissions due to handling at MTC from 840Tonnes CO_2e to 162 Tonnes CO_2e, a saving of 678 Tonnes CO_2e.

The significance criteria of the carbon assessment are based on the level of mitigation proposed and the alignment with Ireland's trajectory to net zero by 2050. While there are carbon emissions associated with international shipping and HGV movements outside of Ireland, such emissions are not considered within the Irish carbon budgets. The national targets apply to emissions that occur within Ireland. On this basis the emissions detailed in Table 4-5, which are mitigated through the use of HVO and other carbon emission minimisation techniques are annualised over the projected 220-week period to complete the work and compared to the 2030 Transport Sector Budget. The emissions are estimated to be 0.007% of this budget.

However, if emissions from outside of Ireland associated with the transport of contaminated material are included and compared to the 2030 Transport Sector Budget, the emissions associated with the PFAS Management Strategy constitute 0.019% of that budget. The emissions associated with this activity constitute just 0.97% of the estimated emissions arising from the proposed Project.

When this mitigation, which was committed to at the time of the MetroLink OH, is applied, the additional emissions associated with the PFAS Management works will not have the potential to significantly affect the outcomes of the assessment presented in the EIAR for climate.

4.3.6 Materials and Waste Management

The MetroLink PFAS Management Strategy for Dublin Airport Report assumes a worst-case scenario whereby 100% of the material excavated 304,000 m^3 at Dublin Airport contains PFAS. In this case, the volume of material that can be reused under Article 27 will reduce significantly from 2,715,271m^3 to 2,411,652m^3 and therefore the quantity of material to be disposed of will increase from 310,371m^3 (which is the quantity presented in EIAR Chapter 24 and Errata Appendix 13 Addendum to the EIAR Chapter 24 which was submitted to ABP on 19th February 2024 during the Oral Hearings) to 514,005m^3.

Table 4-6 provides a summary of the excavated material quantities that are presented in the EIAR compared against those quantities where all the PFAS containing material that would be generated at Dublin Airport is sent for disposal.

Table 4-6: Quantities of excavated material for reuse and disposal

	EIAR	Within the MetroLink PFAS Management Strategy for Dublin Airport Report*
Quantity of excavated material for re-use	2,715,271m^3	2,411,652m^3
Quantity of excavated material for disposal	310,317m^3	514,005m^3
All figures in the table are calculated as solid. An average buking figure of 1.3 should be applied to all materials when in transport or in stockpiles		

4.3.6.1 Conclusion

As detailed above with 100% of material excavated at Dublin Airport assumed to contain PFAS, this increases the quantity of hazardous excavated material requiring management. As reported in the EIAR there is no significant commercial hazardous waste landfill capacity in Ireland and a large percentage of hazardous waste is currently exported. As the additional quantity of 304,000m^3 of contaminated material would not be treated and/or treated in Ireland and so not take up the limited available capacity here, the impacts associated with the PFAS management strategy presented in the EIAR do not change.

There is however a large capacity of hazardous landfill and treatment in Europe, and this will be utilized only where required. It is considered that the majority of the PFAS containing material will be treated rather than landfilled (90%) as PFAS has been identified at very low levels in the soils in the environs of Dublin Airport (see Section 3 of the MetroLink PFAS Management Strategy for Dublin Airport Report).

4.3.7 Soils & Geology

PFAS identified within the MetroLink EIAR, and sampling/analysis of soil and groundwater samples undertaken within the vicinity of the proposed Dublin Airport Station as reported within the Soils and Geology chapter. After completion of the Oral Hearing the daa issued a report on PFAS monitoring which highlighted the presence of detectable PFAS in the soil, surface water and groundwater within and around Dublin Airport resulting from historical airport operations.

TII conducted further assessment based on the newly available information on PFAS in the soil, groundwater and surface water in the vicinity of Dublin Airport to assess the risks of environmental effects from disturbance of soil potentially containing PFAS during construction and operation of the MetroLink, and to identify mitigation measures to manage risks. The detail, potential effects and proposed mitigations are detailed within the MetroLink PFAS Management Strategy for Dublin Airport Report.

4.3.7.1 Conclusion

With respect to the MetroLink EIAR there is no change in impact or in the assessment of significance of effect for the majority of attributes assessed under soils and geology (geomorphology, soils and superficial geology, geological heritage, economic geology, radon and ground gas). Potential risks from PFAS in the soils and groundwater are associated with land contamination:

- Human Health: Exposure of construction workers to PFAS in sub-surface soil and groundwater, and risks of PFAS migration/exposure during excavated material storage and transport. Potential risks and mitigations are covered in detail in Section 4.3.2 of this report (Human Health). The proposed mitigations do not result in an increased significance of effect to that presented in the EIAR.

- Surface water and groundwater: Risk of mobilizing PFAS in the soil and groundwater during construction activities (including excavation, transport and storage), and migration via groundwater and surface water. Potential risks and mitigations are detailed in Section 4.3.8 of this report (Hydrology and Hydrogeology), with the implementation of the mitigations will not result in an increased significance of impact to that presented within the EIAR.
- Excavated material management: Increased disposal costs and landfill use of landfill capacity. As detailed in Section 4.3.6 of this report (Materials and Waste Management) the significance of effect has not changed from that presented within the EIAR.

4.3.8 Hydrology & Hydrogeology

The MetroLink baseline assessment (including Ground Investigation (GI)) involved monitoring soil and groundwater samples near the proposed Dublin Airport Station for PFAS. The GI, monitoring and analysis are detailed in Chapter 19 Hydrogeology and Chapter 20 Soils and Geology of the EIAR. Four soil samples from the airport complex were analysed for PFAS. All determinants were below the analytical limit of detection with the exception of one location where PFOS concentration was at the detection limit but below the soil screening value utilised for the assessment.

Following the publication of the daa report, TII conducted further assessments based on the newly available information indicating the potential presence of PFAS in soils, groundwater and surface water at Dublin Airport. This work has been carried out in order to assess the risk of environmental effects arising from the disturbance of soil potentially contaminated by PFAS in the course of the works in the vicinity of Dublin Airport and to identify appropriate measures to mitigate this risk should PFAS be encountered.

It is important to note that the proposed Project will not introduce new sources of PFAS that could impact the water environment. However, there may be a requirement to manage existing PFAS which is already in the soil and water environment, primarily arising from legacy activities at Dublin Airport.

The mitigation measures outlined in the EIAR to mitigate potential impacts during the Construction Phase will be implemented in full. These measures include the commitment not to discharge any wastewater to streams or rivers during the Construction Phase (see Chapter 18 of the EIAR). Any potentially contaminated water/wastewater generated will be discharged to sewer or will be tankered to a Wastewater Treatment Plant (WwTP) for treatment. However, considering the nature of PFAS and the fact that most WwTP's do not treat PFAS, pre-treatment measures such as activated carbon filtration will be required on-site before discharge, as outlined in the MetroLink PFAS Management Strategy for Dublin Airport Report.

Current daa records indicate that PFAS has been detected in the waters of the Sluice River, Mayne River, Turnapin Stream and Santry River in the vicinity of the airport. Assuming PFAS is present in these river systems additional mitigation measures for works in, or in proximity to, these watercourses will be applied. These additional mitigation measures are detailed in Section 8.6 of the Strategy Report, as follows:

- The works site will be delineated, segregating the site from any adjacent site with a dedicated access route;
- All excavated material will be removed to the PFAS Triage and Holding Centre for appropriate management;
- Any instream works will be undertaken and completed in dry or very low flow conditions. Any potentially contaminated water will be treated as per the methods identified in Section 7 of The MetroLink PFAS Management Strategy for Dublin Airport Report;
- To prevent any cross contamination, dedicated plant and equipment will be used for the activity, stored within a secure location and cleaned regularly during each shift with the water from this process also segregated and stored for suitable disposal;

- Any diversion works and change of flows are to be monitored for any increase levels of PFAS during the full progression of the works. Suitable barriers are to be procured to limit PFAS migration downstream of any inline watercourse works, diverting the river and realigning the river at completion of the instream culvert; and
- Backfilling will be undertaken with clean suitable fill material only.

The potential for PFAS contamination arising from the construction works (as a result of disturbance of existing soil and water contamination) required for the proposed Project via surface water run-off and groundwater filtration is fully assessed and addressed in the MetroLink PFAS Management Strategy for Dublin Airport Report.

As detailed above, given the management strategies for soils and groundwater that will be employed, there are no likely significant effects from PFAS arising in respect of the proposed Project (including the grid connection works) either alone or cumulatively with other projects for the purposes of EIA Directive.

4.3.8.1 Conclusion

With the full and effective implementation of the MetroLink PFAS Management Strategy for Dublin Airport Report at both construction and operational stages it has been concluded that the proposed Project will have imperceptible impacts on water quality in the receiving estuaries and marine environment that forms part of, and supports, the downstream European sites. This includes for aquatic and/or coastal species including SCI bird species, QI otter, a range of marine QI mammals and non-SAC population QI fish e.g. Atlantic salmon. Furthermore, the proposed Project is sufficiently remote from any European sites that there is no possibility of any disturbance effects to affect any QI or SCI populations within any SAC or SPA sites.

It is concluded that there is an imperceptible cumulative impact on water quality and imperceptible cumulative impact on water body status with the proposed design and mitigation measures in place. This does not affect the status of any water bodies. The contractor will be obliged to operate in compliance with the CEMP and the PFAS Management Strategy. Based on the proposed construction and operation mitigation and design measures and distance to downstream European sites, there Is no potential for water quality changes within these European habitats.

4.3.9 Biodiversity

From the outset, the proposed Project included has incorporated mitigation measures in respect of avoiding or reducing to mitigate potential impacts from the proposed Project on biodiversity, particularly from the perspective concerning hydrological effects. These measures aim to protect water courses and the downstream hydrological environments and including downstream European sites with and their Qualifying Interests and Special Conservation Interests. There have been no significant changes in the likely impacts to biodiversity Key Environmental Receptors (KERs) that were previously identified, described assessed and mitigated.

PFAS have been detected in the surface water, groundwater and shallow soils in some areas in and around Dublin Airport. This was highlighted by a monitoring report commissioned by the daa[1] and during Ground Investigation (GI) works for the proposed Project.

No additional field surveys were required to assess potential PFAS effects on biodiversity. The potential for PFAS contamination arising from the construction (as a result of disturbance of existing soil and water contamination) required for the proposed Project via surface water run-off and groundwater filtration is fully assessed and addressed in the MetroLink PFAS Management Strategy for Dublin Airport Report. This report assessed the potential effects on biodiversity KERs. The proposed Project, particularly the tunnelled section through Dublin Airport Station, DANP and DASP) is not a source of PFAS (although it is recognised that construction activities may interact with areas where PFAS is present in soil and groundwater).

The proposed PFAS mitigation strategy triage site, has been assessed in the EIAR Chapter 15 Biodiversity and the EIAR Biodiversity update report submitted during then Oral Hearing. Based on this assessment, and considering the location of the likely contaminated PFAS areas, including the wider surface and ground water pathways for spread and the full implementation of the MetroLink PFAS Management Strategy for Dublin Airport Report, it remains the case that there is no additional habitat loss or negative effects on any biodiversity receptors.

During construction, without mitigation, contaminated surface-water runoff and/or an accidental spillage or pollution event into any surface water feature could have a significant negative impact on water quality and consequently affect aquatic and wetland habitats in the receiving environment. Prolonged pollution events could have extensive, long-term effects, potentially reaching estuarine and coastal habitats downstream. However, with the effective implementation of the PFAS management strategy during both construction and operational stages, it is concluded that there will be no significant effects on biodiversity KERs from PFAS, either alone or cumulatively with other projects (including the grid connection works). There will be no residual negative effects at any geographic scale on Biodiversity receptors.

The proposed Project is sufficiently remote from any European sites that there is no possibility of any disturbance effects on any QI or SCI populations within any SAC or SPA sites. This conclusion is supported by the Post Oral Hearing AA update report which confirms that the proposed Project will not adversely affect the integrity of any European sites or their QIs/SCIs (including ex-situ sites or those for which a hydrological or groundwater pathway exists), either directly or indirectly, in respect of PFAS.

The overall likely significant residual effects on biodiversity, considering the proposed mitigation remains as published in Section 15.9 of Chapter 15 of the EIAR.

4.4 Environmental Conclusions

The assessment detailed above has had regard to all environmental disciplines in the EIAR and presents additional analysis undertaken to assess potential additional environmental effects arising from PFAS at Dublin Airport. Additional mitigation measures are outlined where required and any residual effects following the implementation of mitigation measures are outlined.

The proposed Project is not introducing new sources of PFAS with the potential to impact the environment. Instead, it is managing existing PFAS, which is already present in the environment, present, due to legacy activities at Dublin Airport. The assessment has considered the additional environmental effects associated with the implementation of these measures and has identified the following:

- Traffic & Transport: Overall, there will be no significant change in the traffic flow on the existing road network, with the exception of the section of the R108 from the M50 junction to the access junction to the proposed Triage and Material Management Site, about 400m away short term where a slight negative impact will result. All roads including the R108 will continue to operate within capacity and as a result, there are no additional temporary traffic management measures required above what is contained within the EIAR. There will be no further lane or road closures and therefore there will be no additional significant impacts on private vehicles, public transport, cyclists, pedestrians, local access or parking, above those identified in the EIAR.
- Population & Landuse, Human Health: As detailed above in Section 4.3.1, the impact of the transport of the PFAS containing materials will result in short term slight negative impact on the receiving environment and does not change the assessment presented within the Metrolink EIAR. Measures proposed throughout the EIAR and within the MetroLink PFAS Management Strategy for Dublin Airport Report will ensure that there are no potential impacts with regards to human health. Proposed measures will ensure that there are no potential pathways for PFAS to transmit to population during either Construction or Operational Phases.
- Airborne Noise & Vibration: The location of the proposed Triage and Material Management Site at Dardistown is within the south-western area of the proposed MetroLink works area adjacent to the M50 Motorway and the closest residential NSL is located south of the compound across

the M50 at Santry Lodge and St Annes, Northwood at a distance of approximately 250m. The activity associated with Triage and Material Management Site will be largely limited to vehicles entering and exiting the compound and some plant operating at the site. There are no significant on-site processing activities. The distance to the closest NSLs coupled with the low noise sources associated with the management compound will ensure there are no significant noise impacts associated with this site at the closest NSLs. Any additional traffic movements associated with transporting material to and from the Triage and Material Management Site are determined to be equivalent to those set out in Chapter 13 of the EIAR. With the inclusion of the proposed PFAS management strategy, there is no change in construction noise or vibration impacts, construction traffic noise impacts or operational noise impacts over and above those described in Chapter 13 of the Metrolink EIAR.

- Air Quality: The implementation of the Dust Management Measures outlined in Appendix A16.4 of the EIAR will ensure that there are no additional impacts associated with the generation of dust at the proposed Triage and Material Management Site. An analysis undertaken of additional vehicle movements associated with PFAS management identified that there will be no additional impacts on air quality associated with these vehicle movements.
- Climate: Additional calculations were undertaken to identify potential greenhouse gas (GHG) emissions associated with PFAS management. The assessment considered the worst-case scenario where 100% of material excavated would need to be exported to sites for disposal and treatment in Norway and Belgium respectively. In addition to the 1,570 Tonnes CO2e to 1,813 Tonnes CO2e associated with the Irish based HGV transport and handling of the excavated materials, there are from 3,280 Tonnes CO2e to 3,620 Tonnes CO2e associated with international shipping and HGV transportation. These emissions could be reduced significantly if hydrotreated vegetable oil (HVO) was used for HGV movements rather than diesel.
- Material and Waste Management: Assuming the worst-case scenario that 100% of the material excavated from the environs of Dublin Airport is contaminated, increases the quantity of excavated material requiring disposal and decreases the quantity of material that can be reused under Article 27. The additional quantity of 304,000m3 of PFAS containing material would not have a significance effect on the hazardous landfill and treatment capacity within Europe including Belgium and Norway. Further details on site, material handling and transport management of the PFAS containing material is outlined in Section 7 of the MetroLink PFAS Management Strategy for Dublin Airport Report.
- Soils & Geology: TII conducted further assessment based on the newly available information on PFAS in the soil, groundwater and surface water in the vicinity of Dublin Airport to assess the risks of environmental effects from disturbance of soil potentially containing PFAS during construction and operation of the MetroLink, and to identify mitigation measures to manage risks. The potential risks and proposed mitigations are detailed within the MetroLink PFAS Management Strategy for Dublin Airport Report.
- Hydrology & Hydrogeology: The mitigation measures outlined in the EIAR to mitigate potential impacts during the Construction Phase will be implemented in full. These measures include the commitment not to discharge any wastewater to streams or rivers (see Chapter 18 of the EIAR). Any potentially contaminated water/wastewater generated will be discharged to sewer or will be tankered to a Wastewater Treatment Plant (WwTP) for treatment. However, considering the nature of PFAS and the fact that most WwTPs do not treat PFAS, there will be a requirement should PFAS be encountered, to implement pre-treatment measures such as activated carbon filtration on-site prior to discharge, as outlined in Section 5 of this report.
- Biodiversity: The additional works required to manage PFAS will not have any additional significant impacts on ecological receptors. The area to be cleared for the Triage and Materials Management Site has already been assessed as being cleared in the EIAR. In addition, the proposed measures for the management of PFAS contaminated material ensure that there will be no pathways for PFAS mobilisation into groundwater, surface water or soils. It is concluded that there is no potential for significant effects on biodiversity. It was also concluded, based on the proposed construction and operation mitigation and design measures and distance to downstream European sites, that there is no potential for water quality changes within the European habitats.

With the full implementation of the management strategies presented in the PFAS Management Strategy for Dublin Airport Report for soils (Section 5), water (Section 6) and the proposed site management measures (Section 7) it is concluded that there are no likely significant effects from PFAS arising in respect of the proposed Project (including the grid connection works) during the Construction Phase. Furthermore, the management measures outlined in Section 8 of this report will ensure that the proposed Project will have no significant impacts during the Operational Phase. The assessment presented in this document identifies that the outcomes of the assessment presented in the EIAR will not be significantly affected by the implementation of the MetroLink PFAS Management Strategy for Dublin Airport Report.

Annex I. Background Information on PFAS

I.1 Introduction

The purpose of this Annex is to provide additional information in relation to PFAS. The first section presents details of the most relevant PFAS to the assessment presented in this report along with their typical uses. The second section notes the threshold levels for a number of PFAS which have been developed in various European countries and indicates the lack of cohesion/uniformity at present at an EU level to this problem.

I.2 Summary of PFAS

PFAS is the abbreviation for per- and polyfluoroalkyl substances which are a very large group of thousands of man-made chemicals that have multiple fluorine atoms attached to a carbon chain. To date, over 4,700 PFAS compounds have been identified globally but may be in the millions depending on which definition of PFAS is used. There is no single commonly accepted definition of PFAS, but the following definition proposed by the Organisation for Economic Co-operation and Development (OECD) is widely used:

'*PFASs are defined as fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it), i.e. with a few noted exceptions, any chemical with at least a perfluorinated methyl group (–CF3) or a perfluorinated methylene group (–CF2–) is a PFAS'*.

While there a large number of PFAS, regulatory, contamination management and monitoring is focused on a smaller number of individual PFAS. Table I 1 summarises the main PFAS discussed in this report.

Table I 1 List and Details of Select PFAS

Acronym	Chemical Name	Description	Uses	Included in Irish DWS 'sum of 20'
PFAS	Per and Polyfluoralkyl Substances	An umbrella term for all PFAS, as defined by OECD.	n/a	n/a
PFOS	Perfluorooctane Sulfonate	Most prominent perfluoralkyl sulfonic acid, most commonly investigated and encountered in the environment and biota. Classified as a Persistent Organic Pollutant under the Stockholm Convention and use in EU restricted since 2006. Laboratories may report branched and linear PFOS separately.	Prior to restriction, widely used in aqueous fire fighting foams, and other applications.	Yes
PFOA	Perfluorooctanoic Acid	Most prominent perfluoralkyl carboxylic acid, most commonly investigated and encountered in the environment and biota. Classified as a Persistent Organic Pollutant under the Stockholm Convention in 2015 and use now restricted.	Prior to restriction widely used in many applications requiring surfactant properties.	Yes
Short chain PFCAs	C4-C7 Perfluorocarboxylic acids PFBA, PFPeA, PFHxA, PFHpA	Use currently not restricted.	Wide use in a range of products, co-occurrence with other PFAS in legacy and modern AFFF and other products, terminal transformation products of other PFAS, in particular 6:2 fluorotelomers	Yes
Long chain PFCAs	C8 – C13 Perfluorocarboxylic acids PFOA, PFNA, PFDA, PFUnA, PFDoDa, PFTrDA	Long chain PFCAs proposed restriction under Stockholm Convention	Wide use in a range of products, co-occurrence with other long chain PFAS, e.g. as impurities.	Yes
Short chain PFSAs	C4-C5 Perfluorosulfonic Acids PFBS, PFPeS	No current restriction.	Widely used as replacement products for PFOS. Also present as impurities.	Yes

Acronym	Chemical Name	Description	Uses	Included in Irish DWS 'sum of 20'
Long chain PFSAs	C6 – C13 Perfluorosulfonic Acids PFHxS, PFHpS, PFOS, PFNS, PFDS, PFUnDS, PFDoDS, PFTrDS	PFHxS and PFOS restricted under Stockholm Convention. Others not specifically restricted but phased out with PFOS.	PFHxS widely used as a replacement for PFOS until restricted. Others generally occur as impurities with PFOS.	Yes
6:2 FTS	6:2 Fluorotelomer sulfonate	No current restriction.	Widely used as replacement product for PFOS, also a stable transformation product of other replacement PFAS, including 'C6 technology' 'modern' fluorinated fire fighting foams. Can degrade to short chain PFCAs.	No
8:2 FTS	8:2 Fluorotelomer sulfonate	Restricted as PFOA precursor.	Previously used as a replacement product for PFOS. Can degrade to PFOA.	No
6:2 FTAB	6:2 fluorotelomer sulfonamidoalkyl betaine	No current restriction.	Major component of 'C6 technology' 'modern' fluorinated fire fighting foams. Appears stable in the environment but can degrade to short chain PFCAs.	No
PFECHS	Perfluoroethyl cyclohexane sulfonate	No current restriction.	An 8-carbon cyclic PFAS, known to have been used in aircraft hydraulic fluids. Extent of current and ongoing use unknown.	No

I.3 Generic Assessment Criteria for PFAS in soil in other European Countries

Several European regulators have developed generic assessment criteria (GAC) for PFAS in soil, which can be equated to sensitive or unrestricted end uses. Table I 2. summarises soil criteria which have been developed for PFAS in six European countries, including links to the original regulatory websites from which the information has been sourced. The original sources should be referred to for further details of the derivation, application and limitations of these screening criteria.

The criteria for individual PFAS range from 2µg/kg for PFOA in Belgium to 7µg/kg for PFOA in the Netherlands. Some jurisdictions also have criteria for the cumulative sum of PFAS. The German soil re-use criteria are based on leachable PFAS.

Table I 2 Generic Assessment Criteria for PFAS in Soil in some European Countries

Country	Standards	Reference	Comment
Denmark	Sum of 22 PFAS including: PFCAs, PFSAs, Perfluorooctane sulfonamide (PFOSA), 6:2 FTS - 0.4mg/kg (400µg/kg). Sum of 'EFSA 4' PFAS - PFOA, PFOS, PFNA and PFHxS- 0.01mg/kg (10µg/kg)	https://edit.mst.dk/media/twgdlftx/liste-over-jordkvalitetskriterier-juli-2021_final-rev.pdf. In Danish. Accessed 19/9/24	Unrestricted land use for health
Norway	PFOS 0.003mg/kg (3µg/kg) PFOA 0.003mg/kg (3µg/kg)	https://hoering.miljodirektoratet.no/LastNedVedlegg/10020 In English. Accessed 19/9/24	If the normative values are not exceeded, the soil is considered to be acceptable (or without risk) for all applications
Netherlands	PFOS 0.003mg/kg (3µg/kg) PFOA 0.007mg/kg (7µg/kg) GenX 0.003mg/kg (3µg/kg)	https://www.rivm.nl/documenten/risicogrenzen-voor-pfos-pfoa-en-genx-voor-toepassen-van-grond-en-bagger In Dutch. Accessed 19/9/24	Available risk limits for agriculture/natural soil function classes for the purpose of determining Maximum Values for the application of soil or dredged material
Sweden	PFOS 0.003mg/kg (3µg/kg)	https://swedgeo.diva-portal.org/smash/get/diva2:1300083/FULLTEXT01.pdf https://www.sgi.se/sv/vagledning-i-arbetet/fororenade-omraden/hogfluorerade-amnen-pfas/riskbedomning-pfas/ In Swedish. Accessed 19/9/24	For sensitive land uses and protection of soil environment.
Belgium	PFOS 0.003mg/kg (3µg/kg) PFOA 0.002mg/kg (2µg/kg) Sum of measured PFAS 0.008mg/kg (8µg/kg)	https://assets.vlaanderen.be/image/upload/v1690203007/PFAS_-_tijdelijk_handelingskader_voor_het_gebruik_van_PFAS-houdende_bodemmaterialen_-_Besluit_Vlaamse_Regering.pdf_rjv4zu.pdf In Flemish. Accessed 19/9/24	Preliminary guidance values from 2015. 2024 update confirms 2015 values should be used whilst a decision is pending for the new guideline values
Germany	All liquid-to-solid 2:1 eluate in µg/L • PFBA ≤ 10.0 • PFHxA ≤ 6.0	https://www.bmuv.de/fileadmin/Daten_BMU/Download_PDF/Bodenschutz/pfas_leitfaden_2022_en_bf.pdf	Guideline values based on leachable PFAS. Temporary framework for action for the use of PFAS-containing soil materials.

Country	Standards	Reference	Comment
	• PFOA ≤ 0.1 • PFNA ≤ 0.06 • PFBS ≤ 6.0 • PFHxS ≤ 0.1 • PFOS ≤ 0.1 • PFPeA ≤ 3.0 • PFHpA ≤ 0.3 • PFDA ≤ 0.1 • PFHpS ≤ 0.3 • 6:2 FTSA ≤ 0.1 • PFOSA ≤ 0.1 • Other PFAS ≤ 0.1	In English. Accessed 19/9/24	

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