Offshore Wind Power Limited

West of Orkney Windfarm Onshore EIA Report

Volume 1, Chapter 9 - Freshwater Ecology

WO1-WOW-CON-EV-RP-0089: Approved by S.Kerr
Document Control 25/10/2023

ASSIGNMENT L100632-S06

DOCUMENT L-100632-S06-A-ESIA-009

XODUS

West of Orkney Windfarm

REVISIONS & APPROVALS

This report has been prepared by Xodus Group exclusively for the benefit and use of Offshore Wind Power Limited. Xodus Group expressly disclaims any and all liability to third parties (parties or persons other than Offshore Wind Power Limited) which may be based on this report.

The information contained in this report is strictly confidential and intended only for the use of Offshore Wind Power Limited. This report shall not be reproduced, distributed, quoted or made available – in whole or in part – to any third party other than for the purpose for which it was originally produced without the prior written consent of Xodus Group and Offshore Wind Power Limited.

The authenticity, completeness and accuracy of any information provided to Xodus Group in relation to this report has not been independently verified. No representation or warranty express or implied, is or will be made in relation to, and no responsibility or liability will be accepted by Xodus Group as to or in relation to, the accuracy or completeness of this report. Xodus Group expressly disclaims any and all liability which may be based on such information, errors therein or omissions therefrom.

REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
A01	16/10/2023	Issued for Use	Trex Ecology	AF	LS	OWPL
R02	12/06/2023	Re-Issued for Review	Trex Ecology	LS	LS	OWPL
R01	20/12/2022	Issued for Review	TMcD / CC	LF	LS	OWPL

CONTENTS

9 FRESHWATER ECOLOGY

Chapter summary

This chapter of the Onshore Environment Impact Assessment (EIA) Report assesses the potential effects from the onshore Project on freshwater ecology receptors. This includes direct, indirect, whole project assessment (including with the offshore Project), cumulative, inter-related effects, inter-relationships and transboundary effects.

Baseline surveys showed that all habitats for all native fish species and Freshwater Pearl Mussel (FPM) were present within the freshwater ecology study area encompassing parts of the River Thurso and Forss Water catchments. The River Thurso is a Special Area of Conservation (SAC) designated for Atlantic salmon and the SAC overlaps the onshore Project area in several areas of the onshore Export Cable Corridor (ECC). FPM were subsequently scoped out due to results of more detailed field surveys. Suitable spawning habitats for salmonids were found regularly; along with juvenile habitats, and both rivers are functional Atlantic salmon catchments with suitable habitats for brown trout (and any local ecotypes) and eel. Habitats for lamprey juveniles were also found, however published information suggests they may be absent from the catchments assessed. The complex lifecycle patterns of all receptors are recognised.

The following impacts were identified as requiring assessment for construction; operation and maintenance; and decommissioning:

- Mortality of important freshwater ecology receptors;
- Damage to key freshwater habitats; and
- Interruptions to fish passage.

The assessment has taken account of embedded mitigation measures for the assessment of potential effects.

Potential impacts are assessed to be not significant with the appropriate application of the embedded mitigation. This includes measures to protect sensitive life history timings through agreed seasonal closed periods for work in and around watercourses, adherence to best practice and regulatory guidance, and prevention of barriers to fish passage. In addition, the use of Horizontal Directional Drilling (HDD) to install the cables beneath the River Thurso will avoid any direct channel impacts on the River Thurso SAC. These measures will be implemented through an Aquatic Monitoring Plan and Ecological Clerk of Works (ECoW).

No significant impacts to freshwater ecology receptors are predicted, either for the onshore Project or cumulatively with other plans or developments.

Once the final Project infrastructure is confirmed during detailed design (post-consent) and specifically once river crossing locations are known an Aquatic Monitoring Plan will be developed and this will include controls, to quantify a baseline ecological standard.

In addition, the Project is committed where possible to enhancing the environment, and it is proposing a biodiversity enhancement project in relation to freshwater ecology. An outline Biodiversity Enhancement Plan has been provided alongside the Planning Permission in Principle (PPP) Application.

9.1 Introduction

This chapter of the Onshore Environmental Impact Assessment (EIA) Report presents the freshwater ecology receptors of relevance to the onshore Project and assesses the potential impacts from the construction, operation and maintenance and decommissioning of the onshore Project on these receptors. Where required, mitigation is proposed, and the residual impacts and their significance are assessed. Potential cumulative and transboundary impacts are also considered.

The assessment and survey work detailed in this chapter have been undertaken by Trex Ecology Ltd, providing independent and objective reporting based upon sound data collection and analysis in accordance with best practice guidelines and standards of the Chartered Institute of Ecology and Environmental Management (CIEEM).

Table 9-1 below provides a list of all the supporting studies which relate to and should be read in conjunction with the freshwater ecology impact assessment. All supporting studies are appended to this Onshore EIA Report and issued on the accompanying Universal Serial Bus (USB).

Table 9-1 Supporting documents

DETAILS OF STUDY	LOCATIONS OF SUPPORTING DOCUMENT
Freshwater Ecology Technical Survey Report	Onshore EIA Report, Supporting study (SS) 4: Freshwater ecology technical survey report.
Freshwater Pearl Mussel Confidential Annex	Onshore EIA Report, SS 5: Freshwater Pearl Mussel confidential annex. Confidential annex containing sensitive information relating to legally protected species not suitable for general distribution.

The impact assessment presented herein draws upon information presented within other impact assessments within this Onshore EIA Report. Equally, the freshwater ecology impact assessment also informs other impact assessments. This interaction between the impacts assessed within different topic-specific chapters on a receptor is defined as an 'inter-relationship'. The chapters and impacts related to the assessment of potential effects on freshwater ecology are provided in Table 9-2.

Table 9-2 Freshwater Ecology inter-relationships

CHAPTER	IMPACT	DESCRIPTION
Geology and hydrology (chapter 8, Onshore EIA Report)	Changes to flow patterns and drainage.	Any changes that influence flow availability to local catchments, and in particular, smaller high-catchment channels, have the potential to influence fish passage past obstacles for habitat access and local survival during extreme temperatures (hot and cold).

CHAPTER	IMPACT	DESCRIPTION
	Changes to connected landform processes.	Impacts on landform processes have the potential to influence channel flows and channel form, and this has the potential to reduce channel health at multiple scales which could affect fish passage or cause disturbance.
Terrestrial non-avian ecology (chapter 10, Onshore EIA Report) Terrestrial ornithology (chapter 11, Onshore EIA Report)	Direct and indirect mortality.	Changes in the abundance of terrestrial species, and their communities, may lead to changes in predation and food availability.
Noise and vibration (chapter 15, Onshore EIA Report)	Disturbance to fish passage.	Noise and vibration from drilling and piling could impact fish migration acting as an acoustic barrier.
Landscape and visual (chapter 17, Onshore EIA Report)	Indirect mortality.	Changes to landscape elements may influence the recruitment of organic debris, change flow patterns, and reduce channel shading from trees.
Physical and coastal processes (chapter 8, Offshore EIA Report)	Change to migratory pathways.	Any impact to current physical and coastal processes could alter migration patterns to and from river catchments.
Water and sediment quality (chapter 9, Offshore EIA Report)	Direct and indirect mortality.	Any reduction in the quality of water and sediments may result in direct, or via intermediary pathways, indirect mortality of sensitive receptors.
Fish and shellfish ecology (chapter 11, Offshore EIA Report) Commercial fisheries (chapter 14, Offshore EIA Report)	Impacts on marine prey.	Impacts on fish and shellfish could directly impact on prey availability for migrating juvenile and adult anadromous fish potential impacting their survival rates.
Marine mammals and megafauna (chapter 12, Offshore EIA Report) Offshore and intertidal ornithology (chapter 13, Offshore EIA Report)	Direct mortality.	Changes to mammal and bird communities could directly impact migrating juvenile and adult anadromous fish with potential increased risk of predation.

The following specialists have contributed to the assessment:

- Trex Ecology Ltd: survey design, scoping agreement and implementation, reporting and freshwater ecology EIA chapter write-up; and
- Caledonian Conservation Ltd: quality assurance and advice.

Effects on Special Areas of Conservation (SACs) and Ramsar sites have been considered under the Habitats Regulation Appraisal (HRA) process which has been undertaken alongside this Onshore EIA Report. The Onshore RIAA provides the assessment of the onshore Project on SACs and Ramsar sites.

9.2 Legislation, policy and guidance

Over and above the legislation presented in chapter 3: Planning policy and legislative context, the following legislation, policy and guidance are relevant to the assessment of impacts from the onshore Project on freshwater ecology:

- Legislation:
  - The Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) 1979;
  - Salmon and Freshwater Fisheries (Consolidation) (Scotland) Act, 2003, aka the Salmon Act;
  - Nature Conservation (Scotland) Act 2004 (as amended);
  - Natural Environment and Rural Communities (NERC) Act 2006;
  - Wildlife and Countryside Act (WCA) 1981 (as amended in Scotland);
  - The Freshwater Fish Conservation (Prohibition on Fishing for Eels) (Scotland) Regulations 2008; and
  - Wildlife and Natural Environment (Scotland) Act 2011.
- Policy:
  - National Planning Framework 4 (NPF4) (Scottish Government, 2023a):
    - The latest National Planning Framework emphasises the importance of protecting biodiversity, reversing biodiversity loss, delivering positive effects from development, and strengthening nature networks. As part of this, development proposals are expected to contribute towards the enhancement of biodiversity, including restoration of degraded habitats, as well as restoring connections between nature networks. In addition, the intention of the policy is to protect and enhance blue and green infrastructure and their networks where blue and green infrastructure are an integral part of early design and development processes; are designed to deliver multiple functions including climate mitigation, nature restoration, biodiversity enhancement, flood prevention and water management;
  - Scottish biodiversity strategy post-2020: statement of intent (Scottish Government, 2020a):
    - Sets the direction for a new biodiversity strategy which will respond to the increased urgency for action to tackle the twin challenges of biodiversity loss and climate change;
  - Scottish Biodiversity List (SBL) (NatureScot, 2020c):
    - This is a list of animals, plants and habitats that Scottish Ministers consider to be of principal importance for biodiversity conservation in Scotland and helps public bodies apply their biodiversity duty;
  - Caithness and Sutherland Local Development Plan (CaSPlan) (THC, 2018):
    - This sets out the plan for settlement growth in Caithness. The environment is a key outcome and includes consideration for watercourses in various development projects;
  - Highland-Wide Local Development Plans (HwLDP) (THC, 2012):

  - Policy 58 – Protected Species, 2012. The policy states that where protected species are present, the council will require surveys to be carried out to establish presence, and if necessary, mitigation will need to be implemented to avoid or minimise impacts on species;
  - Policy 59 – Other Important Species, 2012. The policy states that species listed under the Habitats Directive, United Kingdom (UK) and Local Biodiversity Action Plans and the SBL will need to be considered in terms of adverse effects from proposals; and
  - Policy 60 – Other Important Habitats and Article 10 Features, 2012. The policy states that the council will seek safeguarding of integrity features of the landscape which are of major importance because of their linear or continuous structures or combination as habitat 'stepping stones' for the movement of wild fauna and flora. This policy also seeks to protect those habitats which are protected under legislation or conservation plans.
- Guidance:
  - Guidelines for Ecological Impact Assessment (EcIA) in the UK and Ireland. Terrestrial, Freshwater and Coastal (CIEEM, 2018);
  - NatureScot (2020a), Freshwater Pearl Mussel (FPM) survey protocol for use in site-specific projects;
  - NatureScot (2020b), Standing advice for planning consultations – FPMs;
  - Scottish Government (2021), Monitoring watercourses in relation to onshore windfarm developments: generic monitoring programme;
  - Scottish Environment Protection Agency (SEPA) (2018). Guidance for Pollution Prevention, Dealing with spills: GPP 22 produced by SEPA, Northern Ireland Environment Agency (NIEA) and Natural Resources Wales (NRW);
  - SEPA (2021). Supporting Guidance (WAT-SG-75). Sector-Specific Guidance: Water Run-off from Construction sites. Version 2.0;
  - SEPA (2022a). The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended): A Practical Guide. Version 9.2; and
  - THC Supplementary Guidance. Highland's Statutory Protected Species (THC, 2013a).

9.3 Scoping and consultation

Stakeholder consultation has been ongoing throughout the EIA and has played an important part in ensuring the scope of the baseline characterisation and impact assessment is appropriate with respect to the Project and the requirements of the regulators and their advisors.

The Scoping Report was submitted to the Scottish Ministers (via Marine Scotland - Licensing Operations Team (MS-LOT[1])) and The Highland Council (THC) on 1st March 2022, who then circulated the report to relevant consultees[2]. A Scoping Opinion was received from THC on 9th May 2022. Relevant comments from the Scoping Opinion specific to freshwater ecology are provided in Table 9-4 below, which provides a high-level response on how these comments

[1] *MS-LOT have since been renamed Marine Directorate - Licensing Operations Team (MD-LOT).*

[2] *The Scoping Report was also submitted to Orkney Islands Council (OIC), as the scoping exercise included consideration of power export to the Flotta Hydrogen Hub, however, this scope is not covered in this Onshore EIA Report and will be subject to a separate planning application to OIC.*

have been addressed within the Onshore EIA Report. The Scoping Opinion supersedes any pre-application advice provided by THC which was received on the 10th February 2021.

Further consultation has been undertaken throughout the pre-application stage. Table 9-3 summarises the consultation activities carried out relevant to freshwater ecology.

Table 9-3 Consultation activities for freshwater ecology

CONSULTEE AND TYPE OF CONSULTATION	DATE	SUMMARY
MD-LOT, NatureScot, Marine Directorate Science, THC, Caithness District Salmon Fishery Board (CDSFB) / Northern District Salmon Fishery Board (NDSFB)	11th April 2022	The focus of the meeting was to agree the freshwater ecology survey approach, enquire on the availability of existing regulator data records for FPM and to clarify the monitoring programme considerations during the construction and operational stages.
Alan Youngson (on behalf of CDSFB)	18th August 2022	A meeting between Trex ecology and CDSFB to discuss the project in relation to potential impacts to freshwater ecology receptors. Information and detail supplied on Seasonal Sensitivity Tables (SST) via email following the meeting with input provided from Alan Youngson (on behalf of CDSFB).
CDSFB and Fisheries Management Scotland (FMS)	30th August 2022	A meeting to provide an update on the progress of the freshwater ecology surveys in support of the Project and to invite discussion on issues such as the potential impact to fisheries and fish ecology.
NDSFB – email	1st November 2022	Confirmation received that the NDSFB will not attend future meetings as this Project is exclusively concerned with the CDSFB only.
NatureScot and CDSFB	1st November 2022	This meeting confirmed the EIA approach, field studies, field study output and monitoring approach for river ecology. New discussion regarding invasive plants and fish pathogens were discussed and this information was duly considered within the relevant sections.

Table 9-4 Comments from the Scoping Opinion responses relevant to freshwater ecology

CONSULTEE	COMMENT	RESPONSE
THC	The EIAR needs to address the nature of the hydrology and hydrogeology of the site, and of the potential impacts on Groundwater Dependent Terrestrial Ecosystems (GWDTEs), watercourses, water supplies including private supplies, water quality, water quantity and on aquatic flora and fauna. Impacts on watercourses, lochs, groundwater, other water features and sensitive receptors, such as water supplies, need to be assessed. Measures to prevent erosion, sedimentation or discolouration will be required, along with monitoring proposals and contingency plans. Assessment will need to recognise periods of high rainfall which will impact on any calculations of run-off, high flow in watercourses and hydrogeological matters. You are strongly advised at an early stage to consult SEPA as the regulatory body responsible for the implementation of the Controlled Activities (Scotland) Regulations 2005 (CAR), to identify if a CAR license is necessary and the extent of the information required by SEPA to assess any license application.	Hydrology and hydrogeology impacts are assessed in Chapter 8: Geology and hydrology. The potential impacts to freshwater ecology from erosion and sedimentation have been considered. Freshwater ecology surveys have been undertaken (see SS4: Freshwater ecology technical survey report). Standard best practice mitigation to avoid sedimentation and pollution are included as embedded mitigation in Section 9.5.4 and will be confirmed with SEPA during the relevant Controlled Activities (Scotland) Regulations (CAR) license applications.
THC	If culverting should be proposed, either in relation to new or upgraded tracks, then it should be noted that SEPA has a general presumption against modification, diversion or culverting of watercourses. Schemes should be designed to avoid crossing watercourses, and to bridge watercourses where this cannot be avoided. The EIAR will be expected to identify all water crossings and include a systematic table of watercourse crossings or channelising, with detailed justification for any such elements and design to minimise impact. The table should be accompanied by photography of each watercourse affected and include dimensions of the watercourse. It may be useful for the Applicant to demonstrate choice of watercourse crossing by means of a decision tree, taking into account factors including catchment size (resultant flows), natural habitat and environmental concerns. Further guidance on the design and implementation of crossings can be found on SEPA's Construction of River Crossings Good Practice Guide.	At this stage of design, a definitive list of watercourses is not available and will be finalised once the final cable route has been selected and the detailed design has been completed. Freshwater ecology surveys have been undertaken to identify sensitive areas and will inform the detailed design (see SS4: Freshwater ecology survey technical report). The use of temporary bridges will be considered where appropriate, and this has been included as embedded mitigation.

CONSULTEE	COMMENT	RESPONSE
THC	The EIAR should address the likely impacts on the nature conservation interests of all the designated sites in the vicinity of the proposed development. It should provide proposals for any mitigation that is required to avoid these impacts or to reduce them to a level where they are not significant. NatureScot have provided advice in respect of the designated site boundaries for SACs and SPAs and on protected species and habitats within those sites. The potential impact of the development proposals on other designated areas such as SSSI's should be carefully and thoroughly considered and, where possible, appropriate mitigation measures outlined in the EIAR.	A Habitats Regulation Assessment (HRA) screening report was produced and identified which sites and qualifying features required an Appropriate Assessment (AA). As per the Habitat Regulations, a Report to Inform Appropriate Assessment (RIAA) (comprising part of the Habitat Regulations Assessment (HRA) process) has been carried out to determine whether or not the development would have an adverse effect on the integrity of any designated sites in the area. The results of the assessment are detailed in the Onshore RIAA which accompanies this Planning Permission in Principle (PPP) application. The potential impact of the onshore Project on other designated areas, including SSSI sites, is discussed in section 9.6. Advice from NatureScot in respect of designated site boundaries for SACs and SPAs has been followed.
THC	The EIAR needs to address the aquatic interests within local watercourses, including downstream interests that may be affected by the development, for example increases in silt and sediment loads resulting from construction works; pollution risk / incidents during construction; obstruction to upstream and downstream migration both during and after construction; disturbance of spawning beds / timing of works; and other drainage issues. The EIAR should evidence consultation input from the local fishery board(s) where relevant.	Freshwater ecology surveys have been undertaken and included downstream interests, and consultation with all relevant DSFBs regarding the timing of works and evidence of consultation is provided above (see SS4: Freshwater ecology survey technical report).
NatureScot	We support the consideration of FPM given that Atlantic salmon (and other salmonids) are integral to the life cycle of this species. Therefore, any impacts to salmonids that prevent them from returning to their natal rivers may have a resulting effect on FPM.	Impacts to FPM have been assessed in the EIA process and scoped out due to results of surveys. Full details of which are provided in SS5: Freshwater Pearl Mussel Confidential annex.

CONSULTEE	COMMENT	RESPONSE
Northern District Salmon Fishery Board	NDSFB has a statutory duty to protect salmon in its area of responsibility. This area includes all the five rivers on the north coast between, and including, the Kinloch River in the west and the Halladale River in the east.	As consultation on the Project progressed it became apparent for the onshore Project that the relevant board to consult with was the CDSFB, and their statutory duty is acknowledged and understood.
Northern District Salmon Fishery Board	The NDFSB rivers are among those most likely to be at risk from the proposed West of Orkney Windfarm due to their relative proximity to the development. However, the NDSFB area is bounded to the west by the North & West DSFB and, on the east, by the Caithness DSFB and these bodies should also be consulted at an early stage. It is not clear from the Scoping Report that either of these bodies has been consulted to date.	As consultation on the Project progressed it became apparent for the onshore Project that the relevant board to consult with was the CDSFB. This organisation was then the focus for all onshore related consultation.
Northern District Salmon Fishery Board	Furthermore, because of its location near the western entrance to the Pentland Firth, a notable pinch-point for salmon returning to Scottish rivers, the proposed development will potentially affect salmon populations in rivers distributed much further south along the Scottish east coast. The DSFBs likely to be affected should also be consulted or, failing this, the views of Fisheries Management Scotland, the DSFBs' umbrella organisation, must be sought. Again, it is not clear from the Scoping Report that this has already been done.	FMS and relevant DSFBs have been consulted and this will continue as part of ongoing consultation.
Northern District Salmon Fishery Board	In general, NDSFB is content with the ecological data gathering intended to support the onshore component of the development. Melvich in the NDSFB area is only one of the four potential locations for landfall of the southern cable route. It should be noted that the other three potential landfall sites, and the termination of the cable route at Spital, all lie within the jurisdiction of CDSFB and its involvement at an early stage will therefore be paramount.	Surveys were carried out as per Scoping proposals. Following the removal of Melvich from consideration of a landfall option, it was agreed that NDSFB did not need to be involved with any further consultation associated with the onshore application. CDSFB have been consulted during the EIA.

CONSULTEE	COMMENT	RESPONSE
Northern District Salmon Fishery Board	NDSFB considers that the major risks to its local salmon populations arise from the offshore construction works and from the subsequent operation of the windfarm. Any negative effects on migratory fish will be most clearly evident some distance away as changes in population abundance in local rivers. The Scoping Report does not disclose any plan to monitor local salmon populations in the pre-construction stage in order to establish a baseline for detecting within-river changes during and after windfarm construction. This omission should be rectified in the very near future in order to ensure that the predevelopment time series is sufficient to support analysis.	The potential impacts from offshore works on Atlantic salmon have been assessed in the Offshore EIA Report (chapter 11: Fish and shellfish ecology). An Aquatic Monitoring Plan will be developed (and approved) post-consent as detailed in section 9.5.4 and this will include controls to quantify a baseline ecological standard.
SEPA	Do you agree that all receptors and impacts have been identified? Yes. We recommend consideration of the use of Horizontal Directional Drilling (HDD) for not only coastal habitats / the cable landing but also as a possible mitigation measure through sensitive habitats, watercourses etc. Avoidance should be the first principle should GWDTE be present with floating tracks or HDD considered as mitigation measures only if avoidance is not possible.	This approach is advised where possible, freshwater ecology surveys have been undertaken to identify sensitive areas and the findings will be used to inform the locations of crossing points as the Project goes through to detailed design and appropriate crossing technique selected (see SS4: Freshwater ecology survey technical report). Horizontal Directional Drilling (HDD) will be undertaken at major river crossings including Forss Water and River Thurso.

9.4 Baseline characterisation

The key sensitive receptors have been identified and within this Onshore EIA Report, the term 'key sensitive receptors' is equivalent to the CIEEM term 'important ecological feature'.

At Scoping, a Habitat-Based Approach (HBA) for delivery of the freshwater ecology surveys was agreed. This meant that no electrofishing or invertebrate identification surveys were needed at this stage, except where they were specifically required by guidance (e.g., NatureScot 2020a for FPM). This was agreed upon due to the large freshwater ecology study area which could not be reasonably surveyed for fish and invertebrates completely; to produce a more robust baseline characterisation with less susceptibility to interannual variation; and the acknowledgement that the survey extent would be subject to refinement and reduction in spatial scale.

To characterise the baseline conditions in terms of freshwater ecology, the following receptors were identified at scoping:

- The key sensitive receptors that were considered were freshwater pearl mussel (*Margaritifera margaritifera*) and fish species, in particular, Atlantic salmon (*Salmo salar*), sea / brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*); and
- The three species of native lamprey, brook (*Lampetra planeri*), river (*Lampetra fluviatilis*), and sea (*Petromyzon marinus*), were also considered.

A baseline for these receptors was established using the following approach:

- A high-level, Desk-Based Assessment (DBA) to prioritise watercourses for field surveys;
- A rapid reconnaissance walkover survey to identify critical habitat features for all key receptors and prioritise areas that require more detailed habitat surveys; and
- Detailed habitat walkover surveys at crossing locations.

This approach provides a time-invariant description of the potential for channels to host the species of interest based on the presence of key, discrete habitat elements linked to their specific life history stages. It precludes the requirement for a direct survey in this case (unless specified by guidance – e.g., NatureScot, 2020a for FPM). The reason for this is that the presence and distribution of fish species, which often migrate between fresh and saline environments (diadromy – salmon, sea trout, river and sea lamprey, and eel) or which can undertake significant in-catchment migrations (brown trout), are often subject to inter-annual variation in climactic conditions at multiple spatial scales (river reach to oceanic basins). Therefore, the absence of these fish in a given year does not guarantee their absence in successive years. However, the absence of suitable habitat (e.g., accumulations of mobile coarse substrates for spawning) does limit their distribution across the temporal scale.

9.4.1 Study area

The freshwater ecology study area is defined as the onshore Project area that borders, or is within, a channel of the Thurso and Forss River catchments. The onshore Project area encompasses the proposed landfall points, the onshore export cable corridor and the location of the proposed onshore substation search area.

Several watercourses, including the main Rivers Thurso and Forss Water and many of their tributaries, fall within the freshwater ecology study area and receptors within these catchments have the potential to be impacted by the onshore Project, both directly and indirectly.

The Forss Water flows from its source at Loch Shurrery and runs north until it meets the sea at Crosskirk Bay, approximately 8 kilometres (km) west of Thurso. The Forss Water meanders its way through a mix of rough pasture, marshland and arable land. There is a set of Falls approximately 1.5 km upstream of Crosskirk Bay, 'Forss Falls' (ND 03673 68681).

The River Thurso is known as one of the best salmon rivers in Scotland. It is approximately 41 km long and rises in the foothills of Cnoc Cromuillt and flows eastward, then north-eastward, before passing through Loch More. It then turns north, flowing through the villages of Gerston and Halkirk and discharges into Thurso Bay at Thurso. The river meanders through a mix of peatland and rough pasture agricultural land.

Detailed habitat walkover surveys were undertaken of the watercourses within the defined onshore Project area for the River Thurso and Forss Water catchments as shown in Figures 9-1 and 9-2. In addition, a fish habitat survey would generally be undertaken to encompass any watercourse crossing point required as part of a development, along with 100 metres (m) upstream of that point and 500 m downstream. The watercourse crossing points will be defined during detailed design (post-consent); however, the surveys encompassed the watercourses that could be affected within the proposed onshore export cable corridor to establish the baseline conditions, which can be expanded upon if required at a later date, once the final cable route has been defined.

The DBA encompasses the freshwater ecology study area plus consideration for the potential for migratory fish to access the site from connecting watercourses.

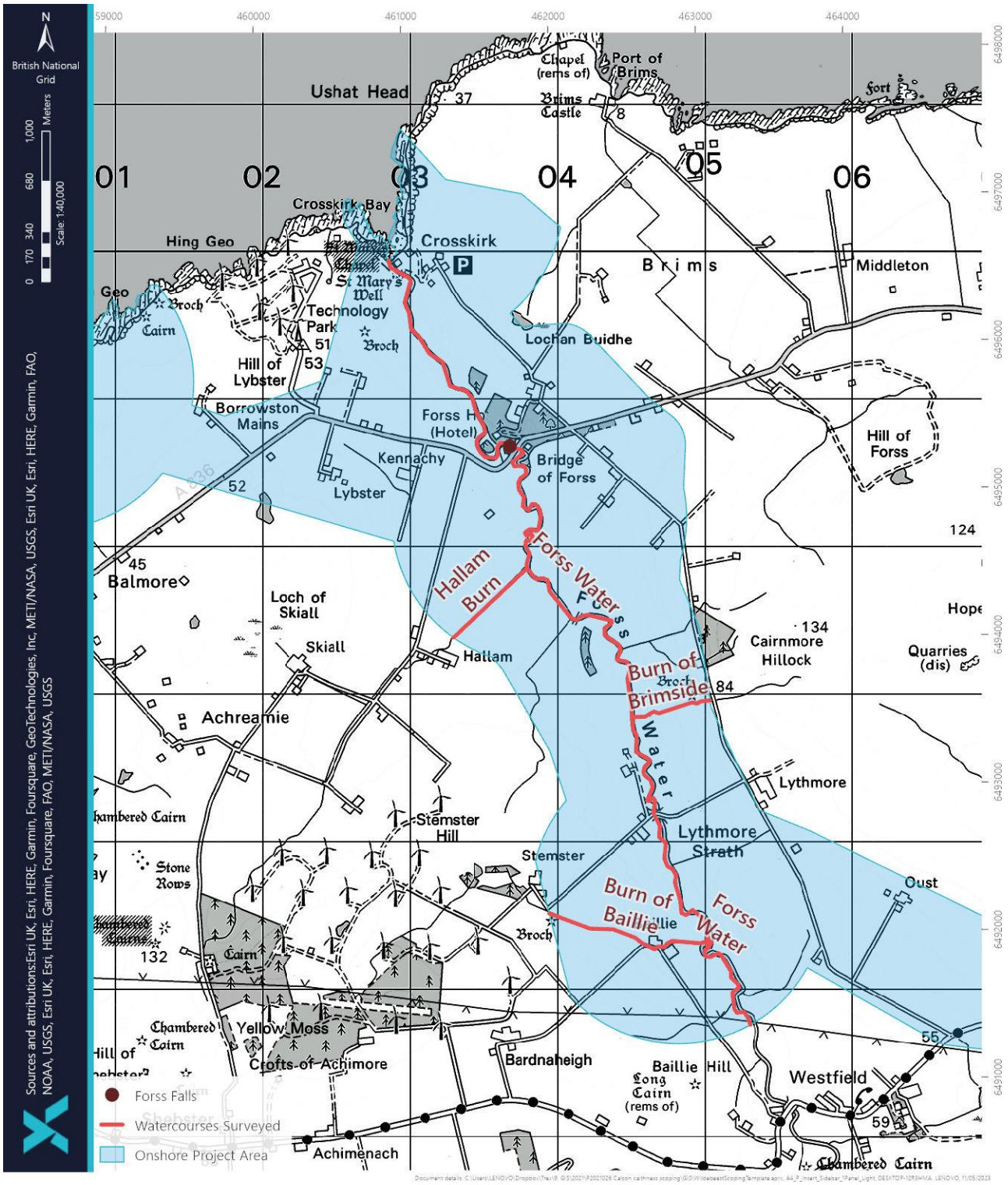

Figure 9-1 Forss Water catchment watercourses surveyed during detailed walkover survey

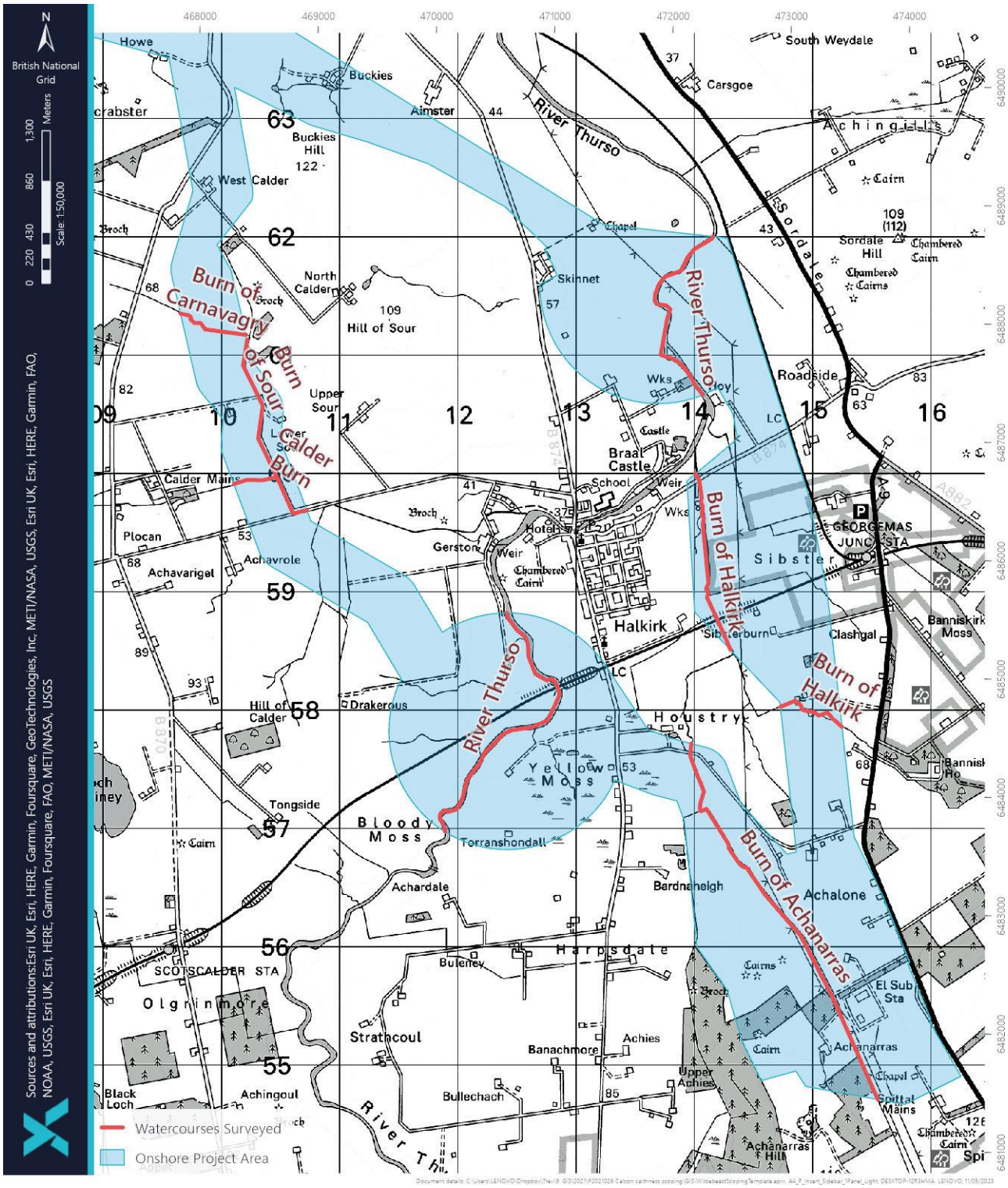

Figure 9-2 River Thurso catchment watercourses surveyed during detailed walkover survey

9.4.2 Data sources

The existing data sets and literature with relevant coverage to the onshore Project, which have been used to inform the baseline characterisation for freshwater ecology, are outlined in Table 9-5.

Table 9-5 Summary of key datasets and reports

TITLE	SOURCE	YEAR	AUTHOR
Mapping and aerial imagery	Ordnance Survey Maps	2022a	Ordnance Survey
	Google Earth Pro App	2022	Google
	Ordnance Survey Terrain 5 dataset	2022b	Ordnance Survey
Protected species and habitats	https://sitelink.nature.scot/home	2022	NatureScot
Water Framework Directive (WFD) status	https://www.sepa.org.uk/data-visualisation/water-environment-hub	2022b	SEPA
National Marine Plan Interactive (NMPi) - Barriers to fish migration	https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=1746	2022a	Marine Directorate
NMPi – Salmon Distribution Map	https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=843	2022b	Marine Directorate
National Electrofishing Programme for Scotland (NEPS)	https://scotland.shinyapps.io/sg-national-electrofishing-programme-scotland/	2019	Marine Directorate

9.4.3 Project site-specific surveys

Several surveys were undertaken within the freshwater ecology study area to identify the potential impacts on the sensitive receptors from all stages of the Project, i.e., construction, operation and maintenance, and decommissioning. The findings define the baseline condition, assist with identifying mitigation requirements, and inform the design of a construction and operational monitoring programme. The surveys were conducted in two catchments; the Forss Water and River Thurso, and the findings are described on this basis. Details of spatial extents and with summary figures are presented in section 9.4.4.

The surveys were based on the findings of the DBA which prioritised the watercourses that could be potentially impacted by the onshore Project. Available mapping and other datasets (see section 9.4.2) were used to assess characteristics such as river deposition features, channel slope, catchment position, channel typology, and overall catchment form to identify the main areas of risk for the primary sensitive receptors and to prioritise the subsequent field surveys.

- The findings of the DBA were used to prioritise watercourses for field surveys in two phases:
  - A series of rapid reconnaissance walkover surveys were undertaken on several watercourses to highlight important reaches for sensitive receptors; and
  - A detailed habitat walkover survey was undertaken to confirm the HBA baseline. This was based on the rapid reconnaissance walkover survey findings and the revised onshore Project area (following revised definition of the onshore Red Line Boundary).

Further details of the surveys and survey methodology are presented in SS4: Freshwater ecology technical survey report.

9.4.4 Existing baseline

A review of literature and available data sources, augmented by consultation and Project site-specific surveys, has been undertaken to describe the baseline environment for the freshwater ecology study area.

9.4.4.1 Review of available data

9.4.4.1.1 Desk-based assessment

A high-level DBA was undertaken to determine potential areas of risk for fish populations using available mapping and other datasets (Table 9-5) in order to prioritise subsequent field surveys. Details are provided in subsequent sections on the results of the DBA with full details presented in SS4: Freshwater ecology technical survey report.

Each catchment was assessed for potential ecological quality by reviewing the channel characteristics linked to habitat type and quality. Characteristics such as stream order, channel slope, catchment position, presence of lochs at the headwaters of channels, and overall catchment form were used to assess the likelihood that habitats would be present.

9.4.4.1.2 Protected areas and species

There are no specific designations relating to the freshwater ecology sensitive receptors identified within the Forss Water catchment. However, there are two Sites of Special Scientific Interest (SSSIs), Westfield Bridge and Loch Lieurary, which are notified for important fen habitat which will have connections to river habitats that may provide refuge and resilience for the target fish species from the Forss Water catchment.

The River Thurso is a Special Area of Conservation (SAC) designated for Atlantic salmon. The SAC is currently assessed as '*Unfavourable Recovering*' condition, with overgrazing and forestry as causal pressures. The SAC boundary overlaps in several areas with the onshore Project area (see Figure 9-3). The upper part of the river is also designated as an SSSI but this lies outside the onshore Project area. It is recognised for the nationally important floodplain fen habitat and flowering plants that grow along the margins and banks of the river.

According to the SAC Citation, '*the Thurso supports a higher proportion of multi sea-winter salmon than is found in many rivers further south in the species' range*'. The northerly location and the cooler water temperature result in slower-growing juveniles, which take longer to smolt, and may return as older multi sea-winter salmon (Welton *et al.*, 2001). In addition, to these multi sea-winter fish, grilse (single sea-winter fish) also return to the River Thurso, meaning that the river can support both sub-populations of salmon life history types.

Atlantic salmon (freshwater phase)

Atlantic salmon are of high conservation value and protected under the European Habitats Directive and the Salmon Act as listed in Section 9.2. They are listed as 'Least Concern' globally and 'Vulnerable' in Europe on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. However, the abundance of Atlantic salmon has declined markedly since the 1970s (NASCO, 2019). According to the Atlantic Salmon Trust, wild salmon are in crisis, with a decline of 70% in just 25 years. They are listed as a priority species for conservation on the SBL (NatureScot, 2020c). Atlantic salmon are an anadromous migratory species, i.e., adults migrate from the sea to reproduce in freshwater, with a complex life cycle (e.g., Armstrong *et al.*, 2003). See Figure 9-4 for a pictorial representation of the lifecycle.

After they return from sea, adults gather in areas of suitable habitat (accumulations of coarse mobile substrates in shallow, fast water) to spawn in excavated nests called redds in winter (normally late November to January). The majority of adults die, but some return to the sea as kelts (a salmon that has spawned and survived to return to sea). After a period of time, typically related to total cumulative temperature, the ova (fertilised egg) hatch and alevins (larvae) emerge in spring (usually April / May). The next phase involves 'swim-up', where the fry (young fish, less than one year) emerges from the interstitial spaces and become free-swimming in early summer. After the first winter, during which many fry have moved to winter habitats, they become parr (1-3 year old young fish). Depending on several factors, following one to six winters, parr undergo an endocrinological-driven change (Bjornsson *et al.*, 2011) where they begin the transition to a marine physiology and migrate to sea as smolts.

Each of the life history stages presented here has a defined habitat niche. This means that during an EIA process where Atlantic salmon may be subject to impacts, each individual stage requires consideration, and impacts which affect any of these stages have the potential to impact an entire cohort, depending on the scale of that impact. The species is subject to many pressures, including pollution, barriers to migration, and physical degradation of their spawning and nursery habitat.

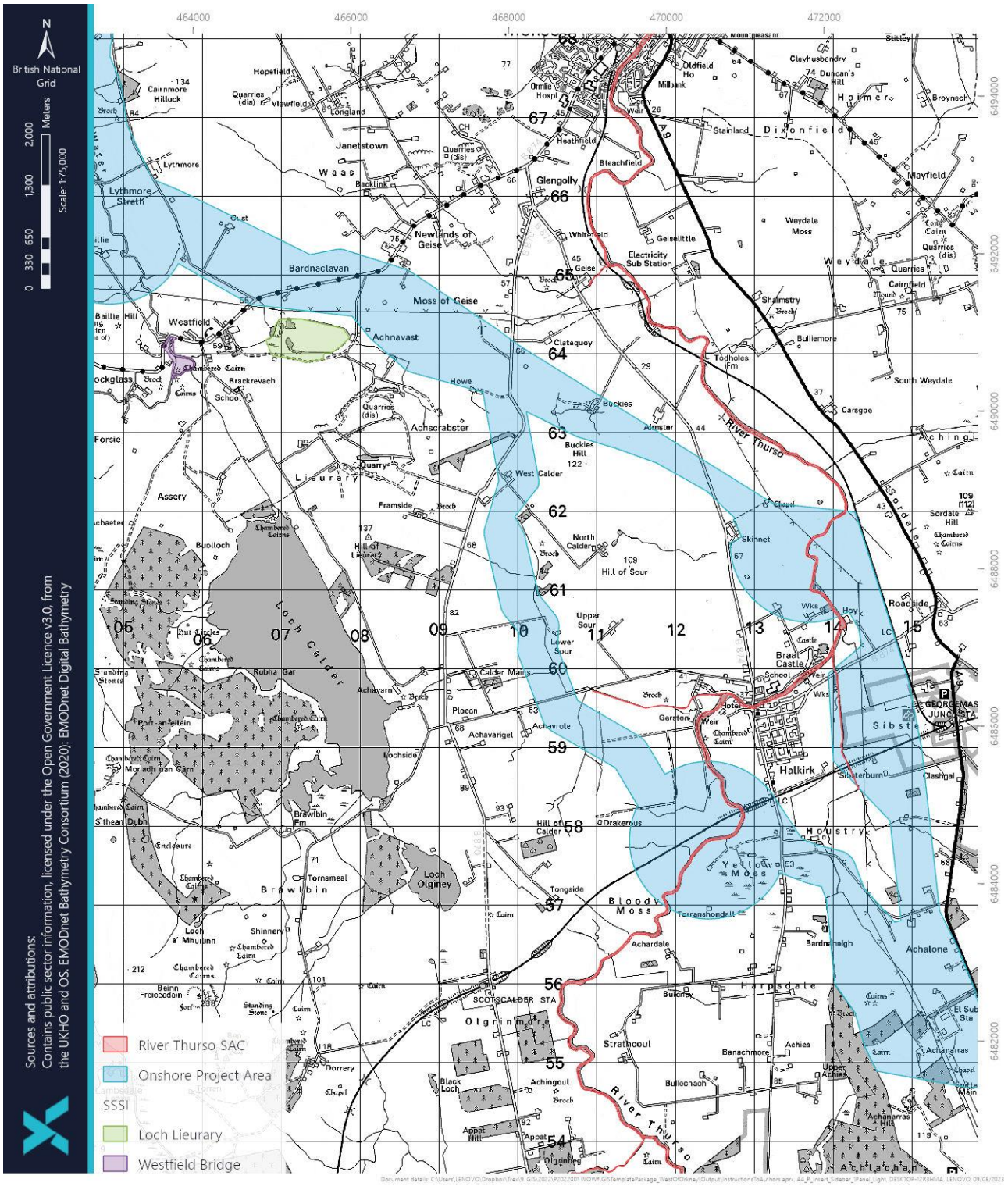

Figure 9-3 Designated sites and onshore Project area

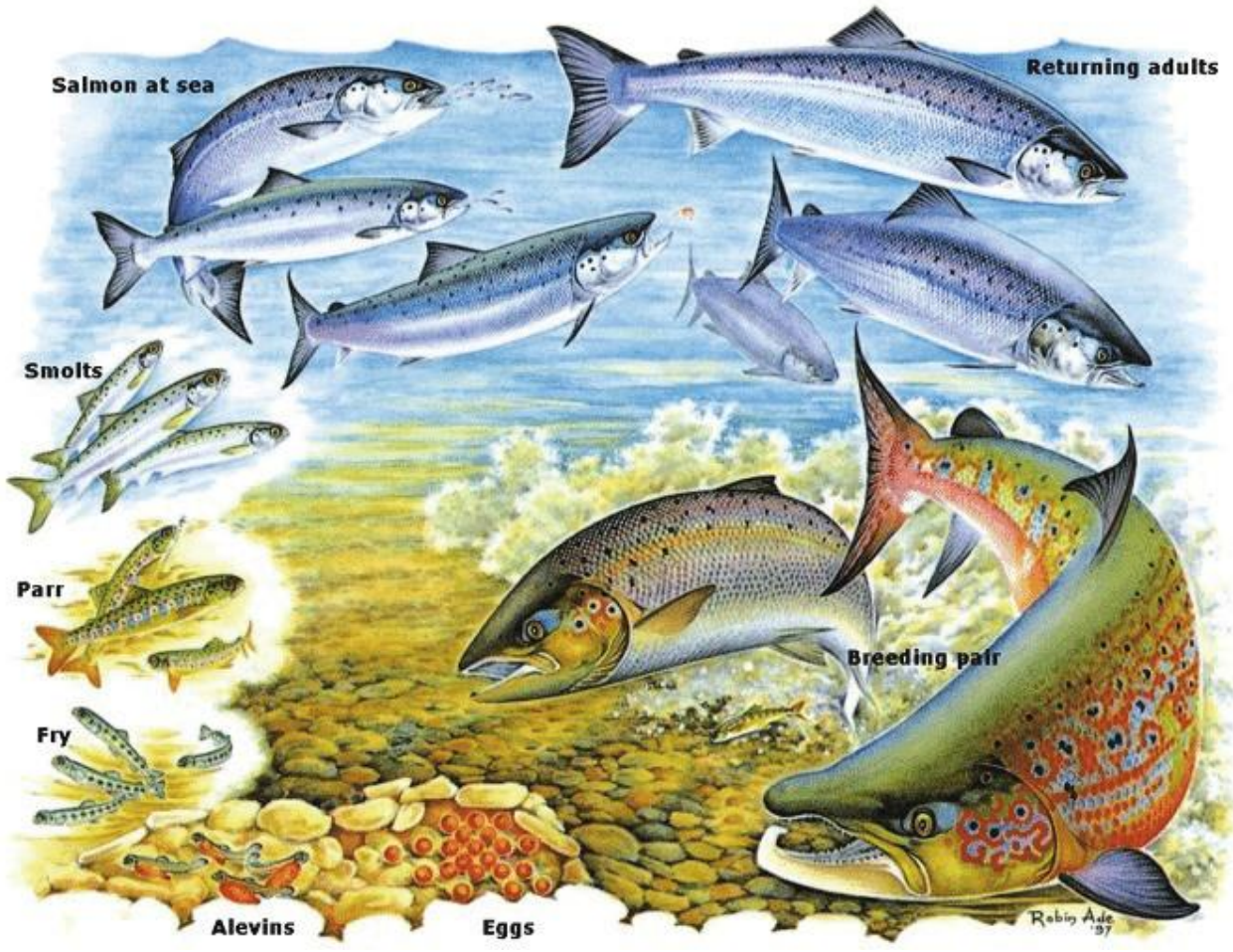

Figure 9-4 Atlantic salmon lifecycle © Robin Ade and Atlantic Salmon Trust

Brown trout

Brown trout are an ubiquitous salmonid fish naturally occurring (post-glacially) in all rivers in Scotland. The species represents a complex range of life history traits grounded in a mosaic of genetic diversity, founder populations, and lineages (McKeown *et al.*, 2010). Like salmon, they are obligate freshwater spawners (Klemetsen *et al.*, 2003) (i.e., they only spawn in freshwater) and demonstrate a similar life history pattern – rheophilic (prefers fast moving water) spawning with interstitial incubation within redds; emergence as alevins while remaining within the river substrate followed by free-swimming fry and a parr stage. However, unlike Atlantic salmon, smoltification (the physiological changes required to live in marine water) is not required by all fish, and the overwhelming majority of trout remain in freshwater. Brown trout do not normally die after spawning. All brown trout do undertake some measure of migration to spawn; from loch to river, within rivers and from sea to river. The latter group are known as sea trout and these are the most important group from the EIA perspective because, as an anadromous salmonid, sea trout have the same legal protection as an Atlantic salmon under the Salmon Act.

At the fry and parr stage, and indeed after returning adults have 'coloured up' (losing their silver colour and taking the classic, spotted, dark freshwater marking) during their freshwater return, sea trout are indistinguishable from resident brown trout, and they may demonstrate an identical genome with only variation in expression leading to

distinct life history behaviours (Amstutz *et al.*, 2006). It is therefore not possible to establish with absolute certainty whether a given trout is a sea trout or resident brown trout based on observation. This is an important consideration given the legal protection afforded to the anadromous variants (fish that are born in freshwater, migrate out to the ocean to mature into adults, and then swim back to freshwater to spawn).

Resident brown trout which do not migrate to saline environments are not afforded such measures of protection; however, locally, they may evolve into distinct 'types' of local and cultural importance. They are listed as a priority species for conservation on the SBL, and their exploitation and capture are reserved under the Salmon Act. As their life history stages and habitats closely echo those of salmon, mitigation measures to protect the latter will also protect the trout.

European eel

The European eel is protected under The Freshwater Fish Conservation (Prohibition on Fishing for Eels) (Scotland) Regulations 2008 and is also protected by measures relating to previous compliance with Council Regulation (European Commission (EC) No 1100 / 2007 – *Establishing measures for the recovery of the stock of European eel*. An eel management plan has been produced for Scotland (Department for Environment, Food & Rural Affairs (DEFRA), 2010) in support of this regulation, and they are also a priority species for conservation in the SBL. They are listed as *Critically Endangered* (Jacoby & Gollock, 2014) both globally and in Europe on the IUCN Red List of Threatened Species. Up-to-date information on their distribution and abundance in Scotland is sparse, and despite their extensive presence within the Scottish faunal list, very basic elements of their ecology and behaviour are still only being uncovered (e.g., Wright *et al.*, 2022).

The European eel is widely distributed within European freshwaters and can be found in a range of habitats from small streams, large rivers, lakes, estuaries and coastal waters. They are catadromous – living in fresh, brackish and coastal waters but migrating to the Sargasso Sea to breed. Their decline is due in part to anthropogenic activities, including barriers to their migration and pollution. Their distribution in Scotland is poorly understood, and they are often only an incidental catch in standard fish monitoring surveys. It is worth noting that surveys carried out on the Burn of Isauld in 2019, a small northern catchment very close to the onshore Project area, demonstrated very high densities of eel (Trex Ecology and CDSFB, 2020, unpublished).

European eel are a complex species. A review by van Ginneken & Maes, (2005) consolidates much of the known information; however, Wright *et al.*, (2022) demonstrate that much information remains to be uncovered. Following hatch, the leptocephali larvae use a range of currents to return to Europe, taking 8 to 9 months. They metamorphose into glass eel and migrate up rivers in spring and early summer, attracted by olfactory cues. Their entry is influenced by the tide and lunar cycles and are easily observed. After 6 to 10 years as yellow eels, they transition into pre-mature silver eels, migrate downstream and to their spawning areas in the Sargasso, where they breed and die.

Lamprey

Three species of lamprey are potentially found within the freshwater ecology study area. Brook and river lamprey (*Lampetra* spp.) are related lamprey species commonly found in Scotland. Brook lamprey completes their entire life cycle within freshwater, while river lamprey migrates to coastal areas, parasitising marine fish before returning to local rivers to spawn. The sea lamprey is a much larger fish, but displays a similar life history to the river lamprey (Maitland, 2003). Although none of these species holds specific protected status other than restrictions on their method of

capture (Schedule 3 Conservation (Natural Habitats, &c.) Regulations 1994) (as amended), they can form the basis of protected area designations elsewhere in Scotland. They are also listed as priority species for conservation on the SBL.

Lamprey spawn in late spring and early summer using habitats similar to trout (with perhaps a slightly higher level of finer material). Following hatch, these ammocoete larvae (first stage juvenile lamprey) find patches of organically rich silt where they graze on fine particulate matter. Residence time depends on species, with river lamprey metamorphosing after four years, six years for brook lamprey, and around five years for sea lamprey. After this period, river and sea lamprey transform and migrate to sea; brook lamprey transform, mate and die. Adult river and sea lamprey return after 2 to 3 years, mate and die.

There is some discussion on whether brook and river lamprey may be life history variants of the same species (Maitland, 2003) or at least pair species (Hume *et al.*, 2013). Their distribution is well understood in broad terms; however, there is some evidence that they may be absent from the onshore Project area (Hume, 2017). However, as standard mitigations to protect the species align with those for other species, they have been retained for consideration in the EIA. Given the absence of widespread sampling programmes utilising specific surveys which confidently define their distribution in Scotland, a precautionary approach here is valid.

Freshwater pearl mussel

FPM are afforded legal protection under International, European and UK law. Within the UK, they are listed under Annex II and V of the Habitats Directive (1992) (translated into Scottish law as Conservation (Natural Habitats, &c.) Regulations 1994) and in Schedule 5 of the Wildlife and Countryside Act 1981, and as amended in Scotland through the Nature Conservation (Scotland) Act 2004 and the Wildlife and Natural Environment (Scotland) Act 2011. This legislation makes it illegal to intentionally or recklessly disturb, injure, take, kill, or possess FPM or their shells. Therefore, it is a requirement for all works that may impact FPM to establish their presence with subsequent measures implemented depending on survey findings.

FPM is a large bivalve mollusc that was once widespread across the Holarctic Atlantic region. In the last century, however, they have declined rapidly and are classified as *Endangered* globally and *Critically Endangered* in Europe (Moorkens, 2011) by the IUCN Red List of Threatened Species. The species has declined due to a range of factors, including pearl fishing and anthropogenic influences. The overwhelming majority of population declines in Europe have been due to sediment accumulation in the riverbed gravels, cutting off the supply of oxygen to juvenile mussels (Moorkens, *et al.*, 2018). Juvenile salmonids are hosts to the obligate parasitic larval (glochidial) stage of the FPM lifecycle. A healthy population of salmonids is, therefore, essential for the survival of this species. Due to sensitivities surrounding the protection of FPMs, further information is provided in SS5: Confidential annex.

9.4.4.1.3 Water Framework Directive

Although there are two river catchments within the onshore Project area, Forss Water and River Thurso, there are three defined Water Bodies (WBs) within the freshwater ecology study area as determined and used by SEPA for regulatory purposes (WFD). However, it should be noted that not all channels capable of hosting key species and their habitats are assessed under WFD in Scotland, with only those over an 11 hectares (0.11 km^2) catchment size receiving a designation. The three WFD WBs are, River Forss, River Thurso and Burn of Halkirk.

The Rivers Forss and Thurso are listed at Good Overall Status, supporting the view of mostly functionally intact WBs with sufficient quality to sustain quality river biotic communities over the long term. Burn of Halkirk, in the River Thurso

catchment, is listed as Moderate, downgraded for Physical Condition and also a reduced ecological quality based on "impacted" fish communities. No further information on, or cause of, the downgrade is provided.

9.4.4.1.4 Obstacles

There is one marked barrier within the freshwater ecology study area according to the SEPA barriers database (Marine Directorate, 2022a). This is within the Forss Water catchment and is recorded as a passable natural barrier, the Forss Falls. The Falls (ND 03676 68679) are approximately 1.5 km upstream of the estuary at Crosskirk (see Figure 9-1). No other barriers are listed; therefore, all channels within the onshore Project area footprint should permit access to migratory salmonids and other diadromous fish.

9.4.4.1.5 Salmonid distribution

The salmonid distribution database available on NMPi indicates that salmon are 'present' in the Forss Water, the River Thurso, Burn of Halkirk, Calder Burn and 'likely to be present' in the Burn of Sour (see Figure 9-1 and Figure 9-2).

9.4.4.1.6 National electrofishing programme for Scotland

A review of the most recent available regional NEPS data from 2019 (Marine Directorate, 2022b) shows widespread salmon access across the freshwater ecology study area. These data, which are divided between Northern and Caithness DSFBs, indicate the presence of both fry (salmon hatched in the year in question, also called 0+ fish) and parr (juvenile fish hatched prior to the year in question, >0+ fish). This indicates that local rivers are regularly supporting spawning by salmon. The picture with respect to trout is less clear; however, both species use broadly the same habitats, and the presence of one usually supports the conclusion that habitat is available for both species.

9.4.4.2 Field surveys

9.4.4.2.1 Rapid reconnaissance walkover survey

The rapid reconnaissance survey was used to record key habitat criteria, in particular, the presence and composition of deposition features, salmonid and lamprey spawning habitat, the presence of juvenile lamprey habitat, along with instream structures such as Large Woody Debris (LWD), debris dams and bank undercuts. The presence of other pressures such as weirs, fords, morphological alteration (e.g., straightening) and livestock poaching was also included. Full details of the survey including maps is provided in SS4: Freshwater ecology technical survey report. A summary of the findings is provided below, within section 9.4.4.2.2.

9.4.4.2.2 Detailed habitat walkover survey

The findings of the rapid reconnaissance survey allowed for several watercourses or parts of watercourses to be scoped out from the detailed habitat surveys. As a result, detailed fish habitat surveys were undertaken on ten watercourses, as detailed in Table 9-6 and Figure 9-5.

Table 9-6 Channels for detailed habitat walkover survey

CATCHMENT	CHANNEL ID	CHANNEL NAME	SURVEY DISTANCE (METRES)
Forss Water	ML21	Forss Water	7,847
	ML22	Hallam Burn	690
	ML27	Burn of Brimside	560
	ML23	Burn of Baillie	1,182
River Thurso	ML34	River Thurso	4,573
	ML38	Burn of Carnavagry	655
	ML31	Burn of Sour	1,249
	ML33	Calder Burn	830
	ML37	Burn of Halkirk	2,216
	ML36	Burn of Achanarras	3,560

The detailed habitat walkover survey was used to assess the quantity and quality of available habitat for the sensitive receptors. Full details of the survey, including maps, are provided in SS4: Freshwater ecology technical survey report. The findings are summarised below for the Forss Water and River Thurso catchments.

Forss Water catchment

The Forss Water catchment is considered to be accessible to migratory salmonids. The Forss Falls are known locally to be difficult for some fish to migrate upstream; however, the Falls are recorded as passable on the SEPA database. The Falls are likely to impede further upstream migration to some extent however, and the presence of sea and river lamprey above this point is unlikely. Eel may also struggle to pass, but their passage cannot be discounted. While the Falls are sizeable, their complexity suggests that sea trout and salmon can pass them given suitable flow conditions. Below the Falls, all native fish species are expected to be present, along with the discrete habitat niches required for life history stages of anadromous salmonids. The data from NEPS and the salmonid distribution map (Marine Directorate, 2022b) indicate that salmon are present within the onshore Project area for this catchment.

Based on the onshore Project area (see Figure 9-1 and Figure 9-2), 7.8 km of the Forss Water and three of its tributaries, Hallam Burn, Burn of Baillie and Burn of Brimside, fall within the potential onshore export cable corridor.

The upstream extent of the survey area for Forss Water has only a few areas recorded as suitable for salmonid spawning due to the lack of available smaller substrates. However, as the river continues its course downstream, spawning habitat was recorded throughout the survey area, with potential juvenile lamprey habitat recorded in the lower sections of the river. In addition, habitats are available for juvenile and adult salmonids and eel.

Of the three tributaries, Burn of Brimstone was dry and therefore unsuitable for fish. The Burn of Baillie could not be surveyed due to access restrictions, so it is assumed that fish could use it. Hallam Burn is a highly modified burn in poor condition with extensive silt and algae observed during the July survey; however, spawning and juvenile lamprey habitat were identified in the lower reaches near the confluence with the Forss Water.

River Thurso catchment

The River Thurso catchment is considered to be accessible to migratory salmonids and is known as one of the best salmon rivers in Scotland. It is designated as a SAC for Atlantic salmon. The data from NEPS and the salmonid distribution map (Marine Directorate, 2022b) indicate that salmon are present within the onshore Project area for this catchment.

Based on the onshore Project area (see Figure 9-2), 4.5 km of the River Thurso and five of its tributaries, Burn of Carnavagry, Burn of Sour, Calder Burn, Burn of Halkirk and Burn of Achanarras, fall within the potential onshore export cable corridor.

The survey area for the main River Thurso was split into two sections, both of which had habitats that would support both salmonid and juvenile lamprey, as well as habitats for juvenile and adult salmonids, and eel.

Four of the five tributaries were highly or partly modified channels. The Burn of Halkirk was much more complex and diverse. However, all five tributaries had habitat that would support salmonid spawning and juvenile lamprey habitat.

It should be considered that works have potential to impact the identified receptors, and suitable mitigation will be required to ensure impacts on the spawning activities are not impeded. Mitigation will also be needed to ensure the unhindered passage of adult fish upstream and juvenile fish downstream, particularly salmonid smolts. Lamprey will broadly use similar spawning habitat to salmonids, so protection of the latter will extend to lamprey species. Eel will be protected by ensuring channel connectivity; protection of their prey resources which include salmon and trout fry; and by ensuring there is no deterioration in the complexity of available habitat.

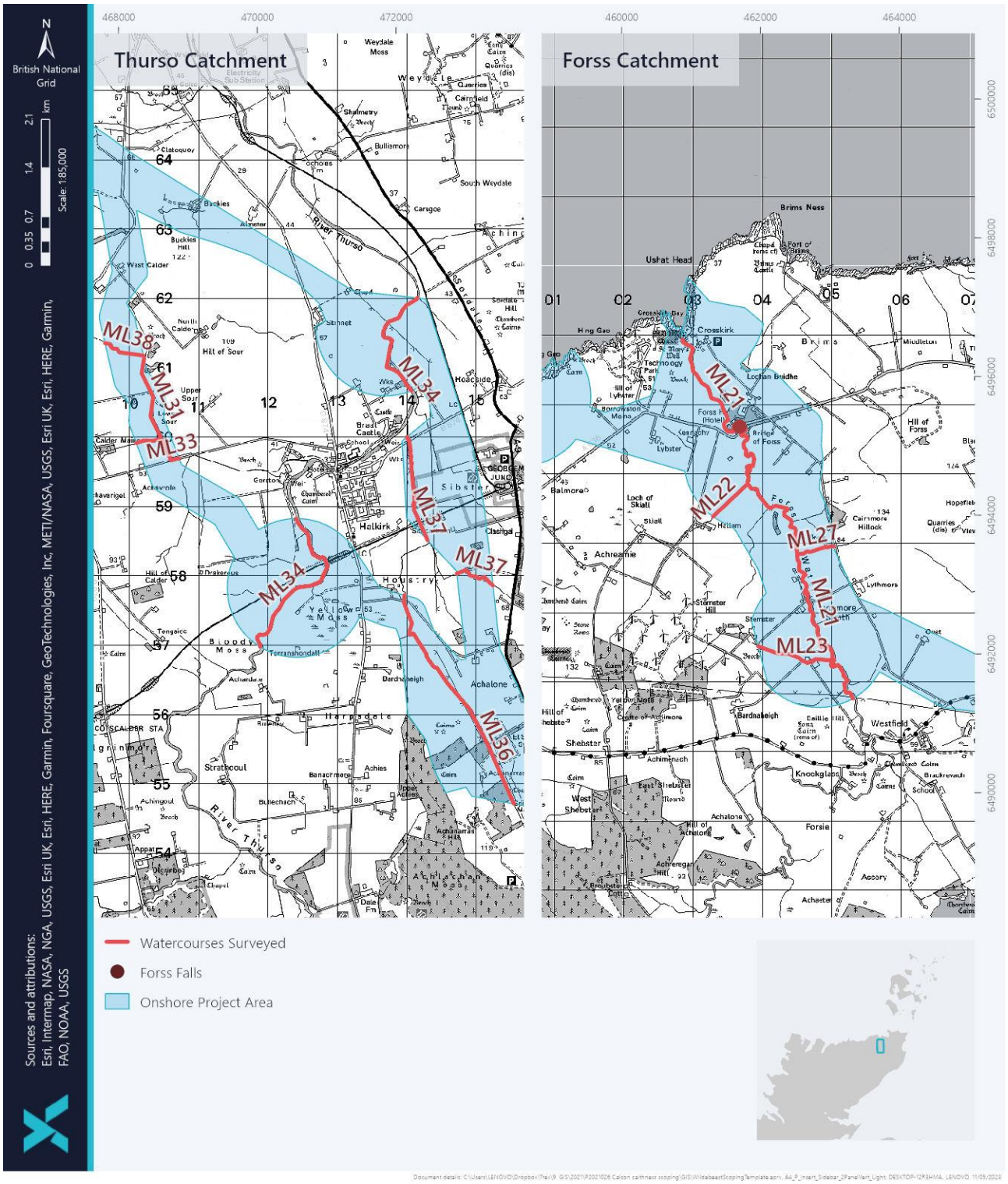

Figure 9-5 Detailed walkover extents - River Thurso catchment watercourses surveyed during detailed walkover. Forss Water catchment watercourses surveyed during detailed walkover

9.4.5 Future baseline

This section focuses on the potential changes in the baseline of the freshwater ecology chapter for the lifetime of the onshore Project. It should be noted that for the purposes of this assessment, in line with CIEEM (2018) guidelines, the baseline is considered to be the habitats and species likely to be present at the time the onshore Project proceeds.

In the absence of the onshore Project, no significant land use changes are anticipated within the coming years (up to the point where the onshore Project is constructed and becomes operational). Whilst a number of proposed, consented and operational developments were identified during scoping that could have a direct impact upon the onshore Project area, no significant impact upon the majority of the habitats and species present were anticipated (see section 9.7, assessment of cumulative effects).

The HBA used to undertake the baseline surveys provides a time-invariant description of the potential for channels to host the species of interest based on the presence of key, discrete habitat elements linked to their specific life history stages. Using this approach reduces the dependence on relying on the unpredictability of the fluctuations in fish population dynamics in terms of their presence and distribution and impacts to their survival from anthropogenic issues and climate change.

However, Atlantic salmon, in particular, are undergoing severe declines across their range, despite cessation in widespread exploitation of the species as a food resource in high seas and local fisheries. These declines are linked to a host of factors within the marine and freshwater environment (Bull *et al.*, 2022), and while Atlantic salmon are not on an extinction pathway as a species, significant reductions in the numbers are ongoing in Scotland.

While numbers are not generally reducing (currently) across the Thurso River, the Forss Water stock is generally believed to be facing an uncertain future (Youngson, 2022). Climate change impacts, particularly mediated through temperature and flow regimes, have the potential to change the River Thurso and may already be changing the Forss Water. Climate change predictions for rivers in Scotland (Jackson *et al.*, 2018) show that both catchments may be subject to the highest maximum temperatures, which are very likely to impact all native fish species. The absence of widespread riparian shade may be a considerable issue for the future of both catchments. Given the lifecycle of the Project and the receptors present, it is possible that a widespread reduction in abundance could be recorded in the absence of any further works in the catchments. Therefore, systematic decreases in Atlantic salmon should be expected throughout the lifecycle of the Project.

European eel are also generally in decline, particularly linked to glass eel recruitment into river systems. Overall patterns of this species should continue to be understood throughout the Project lifetime.

It is important to note that the future baseline is a projection, with a range of possible future conditions, and it is subject to uncertainty associated with the available projections.

9.4.6 Summary and key issues

The key sensitive receptors and issues for the freshwater ecology study area are provided in Table 9-7.

Table 9-7 Summary and key issues for freshwater ecology

SUMMARY AND KEY ISSUES	ONSHORE PROJECT AREA
	The key sensitive receptors are: • Atlantic salmon and sea trout; • European eel; and • Sea, river and brook lamprey. The key issues are: • The protection of these species; • The protection of the habitats of these species; and • The protection of their access to those habitats.

9.4.7 Data limitations and uncertainties

A multi-tiered approach was undertaken to gather information on the sensitive receptors within the freshwater ecology study area, involving a high-level DBA, and a rapid reconnaissance walkover survey, followed by detailed habitat surveys. The results of these surveys provide a robust baseline for the impact assessment based on receptor habitat, rather than specific fish surveys.

Data gaps exist in several ways. The survey team were unable to gain access to the Burn of Baillie in the Forss Water catchment. As a precautionary approach, it will be considered that there is potential for this burn to have habitat that would support the sensitive receptors.

Significant data gaps exist in terms of the distribution and current state of eel populations in Scotland. Escapement, in terms of overall production, is falling based on Marine Directorate data (Scottish Government 2020) but is not yet reaching the levels seen following the crash in eel productivity observed in the period 2008 to 2013. There is no mention of eel in the most recent report from CDSFB (Youngson, 2022), but they were not the focus of the reporting. The same is true of lamprey populations, but information does suggest they may be absent (Hume 2017). However, again the HBA ensures protection for these species despite the relative paucity of data on their local presence within the freshwater ecology study area.

A key uncertainty relates to the specific locations of the watercourse crossing points as these will not be confirmed until detailed design which will be post-consent. However, it is known that HDD will be used for the main river crossings at the River Thurso and Forss Water and Open Cut Trench (OCT) will be used on the minor tributaries and ditches. Once the locations of the crossings are confirmed, the pre-construction survey area around the crossing points should encompass 100 m upstream of the crossing point, the crossing point itself and 500 m downstream. Consideration will need to be given as to whether the existing survey extents cover this requirement. If this is the case, then further surveys may be required pre-construction. However, the surveys that were undertaken encompassed all the significant channels within the onshore Project area.

Smaller channels, burns and ditches which were judged not to have significant ecological productivity for fish during the DBA have not been surveyed, as agreed at the Scoping stage. These should be reviewed once the final crossing locations have been determined and, if necessary, a similar HBA, as proposed above should be undertaken.

9.5 Impact assessment methodology

9.5.1 Impacts requiring assessment

The impacts identified as requiring consideration for freshwater ecology are listed in Table 9-8. Information on the nature of impact (i.e., direct, or indirect) is also described.

Table 9-8 Impacts requiring assessment for freshwater ecology

POTENTIAL IMPACT	NATURE OF IMPACT
Construction and decommissioning	
Mortality of important freshwater ecology receptors	Direct and indirect
Damage to key freshwater habitats	Direct and indirect
Interruptions to fish passage	Direct and indirect
Operation and maintenance	
Mortality of important freshwater ecology receptors	Direct and indirect
Damage to key freshwater habitats	Direct and indirect
Interruptions to fish passage	Direct and indirect

**** In the absence of detailed information regarding decommissioning works, and unless otherwise stated, the impacts during the decommissioning of the onshore Project considered analogous with, or likely less than, those of the construction stage.***

9.5.2 Impacts scoped out of the assessment

All impacts relating to FPM have been scoped out (Table 9-9) from further assessment as part of the freshwater ecology considerations. Further information on this and justification is provided within SS5: Confidential annex.

Table 9-9 Impacts scoped out for freshwater ecology

IMPACTS SCOPED OUT	JUSTIFICATION
Construction, operation and maintenance and decommissioning	
Direct and indirect mortality on FPM	Justification included in SS5: Confidential annex.
Damage to key freshwater habitats of FPM	
Interruptions to fish passage, implications for FPM	

9.5.3 Assessment methodology

The approach adopted for the assessment of ecological impacts on freshwater ecology is in line with published guidance for EcIA produced by CIEEM (CIEEM, 2018). This approach is reflected in the assessment of potential effects set out in section 9.6. CIEEM (2018) guidelines set out the process for assessment through the following stages:

- Determination of the importance of ecological features through desk study and surveys;
- Identification and characterisation of potential effects to determine level of impact;
- Assessment of likely significant impacts;
- Identification of requirement for measures to avoid and mitigate (reduce) these impacts; and assessment of the significance of any residual impacts after mitigation;
- Identification of any monitoring requirements; and
- Assessment of the significance of any residual impacts after mitigation.

The worst case scenario estimates habitat loss in the event that the onshore construction works take place within the most sensitive habitats.

9.5.3.1 Determining importance

According to the CIEEM guidance (2018), determining which ecological features are important and should be subject to detailed assessment is one of the key challenges in the EcIA process. Ecological features can be important for a variety of reasons, and may relate, for example to:

- Quality or extent of designated sites or habitats;
- Habitat / species rarity;
- The extent to which they are threatened throughout their range; or
- Their rate of decline.

The level of importance of ecological features identified at the onshore Project area has been determined using the criteria defined in Table 9-10. In line with CIEEM guidance, these criteria have been determined with regard to statutory requirements and policy objectives for biodiversity. Note that in this assessment 'receptor' is used to refer to Important Ecological Features as defined in CIEEM guidance (CIEEM, 2018), so as to ensure consistency with the broader EIA assessment methodology as defined in chapter 7: EIA methodology.

In addition, where relevant and where available, use is made of contextual information about distribution of habitats and species, and species abundance, including trends based on historical records.

As available quantitative data on a particular habitat or species may be limited, particularly below the international and national level, the evaluation of importance may also involve an element of professional judgement.

Evaluations are based upon a combination of information gathered via the desk study and field survey results, along with professional experience and judgement. Social and economic factors are also considered when assessing ecological features if appropriate.

Table 9-10 Sensitivity criteria

SENSITIVITY OF RECEPTOR	DEFINITION
High	Internationally important habitats or species that are part of an internationally important population. For example: • An internationally designated site, candidate site, or an area meeting the criteria for an international designation (e.g. an SAC); • Large areas of priority habitat listed under Annex I of the Habitats Directive, and smaller areas of such a habitat that are essential to maintain the viability of that ecological resource; or • A regularly occurring, nationally significant population of any internationally important species, listed under Annex II or Annex IV of the Habitats Directive. Nationally important habitats, or species that are part of a nationally important population. For example: • A nationally designated site, or area meeting criteria for national level designations (e.g. a SSSI); • Significant extents of a priority habitat identified in the SBL, or smaller areas which are essential to maintain the viability of that ecological resource; or • A regularly occurring, regionally significant population of any nationally important SBL priority species, or species listed under Schedule 1 or Schedule 5 of the WCA, Annex II or Annex IV of the Habitats Directive.
Medium	Regionally important habitats or species that are part of a regionally important population. For example: • Viable areas of key semi-natural SBL priority habitat; • A regularly occurring, locally significant population of any nationally important SBL priority species, or species listed under Schedule 1 or Schedule 5 of the WCA, Annex II or Annex IV of the Habitats Directive; or • Sites which exceed the local authority-level designations but fall short of SSSI selection guidelines.

SENSITIVITY OF RECEPTOR	DEFINITION
Low	Habitats or species that are part of a locally important population. For example: • Sites of Importance for Nature Conservation or equivalent sites selected on local authority criteria; • Local Nature Reserves; • Other species of conservation concern, including species under the Local Biodiversity Action Plan, in this case the Highland Biodiversity Action Plan (HBAP); or • Areas of habitat or species considered to appreciably enrich the ecological resource within the local context.
Negligible	Common and widespread habitat, or species of little or no intrinsic nature conservation value. For example: • All other species and habitats that are widespread and common and which are not present in locally, regionally, or nationally important numbers, or habitats which are considered to be of poor ecological value.

In addition, as identified in section 9.4.4, the fish ecology receptors have complex life histories, with each stage often requiring distinct assessment based on differing habitat associations. This is further complicated as native fish species are adapted to specific catchment characteristics which influence their presence within the river system at any given time. To incorporate this complexity and draw in local knowledge, the Impact Assessment Methodology has been supplemented by SST commonly used by Trex Ecology in support of EIA and Planning Applications and specifically tailored for this assessment by Alan Youngson on behalf of the CDSFB. These are presented in Table 9-11 for the Forss Water catchment and Table 9-12 for the River Thurso and are reflected in the embedded mitigation (Table 9-14). These SSTs are taken account within the impact assessment (section 9.6). The timings of key life stages are presented as high sensitivity in red, medium sensitivity in orange, and low sensitivity in yellow. Periods where the receptor is absent or not sensitive, are white.

The life stages of Atlantic salmon and trout is expectedly complex. Adult salmon can return to the Forss Water during any period in the year, with peak run timings occurring from April to November. Young salmon remain in the redds until May and migrate to winter habitats from September to November. Another important period, smolt migration, occurs from March to June. The movement of kelts seaward occurs in December and January.

Brown trout, including sea trout, reproductive movements are limited to the period of September to November, with young fish leaving the redds by the end of April. Winter dispersal is similar to Atlantic salmon, as is smolt migration. However, sea trout may not be a significant receptor on the Forss Water (A. Youngson, pers. comm, 2022).

Adult eel may leave the Forss Water at any time of the year. Juvenile river entry is marked as April to August, peaking during June and July. For lamprey spp., spring and early summer are sensitive (for spawning), with incubation and juvenile movements occurring into late summer.

As would perhaps be expected, eel and lamprey within the River Thurso is very similar to that on the Forss Water, most likely reflecting the less well-understood life history of those four species. Similarly, to salmon, river entry could be expected throughout the year, with the peak period from April to November. Juvenile timings are as per the Forss

Water. Once again, sea trout may not be a significant receptor on the River Thurso (A. Youngson, pers. comm, 2022), and the timings relating to brown trout life history sensitivities are as per the Forss Water.

Table 9-11 Forss Water catchment SST

SPECIES	LIFE STAGE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
Atlantic salmon	Adult migration												
	Spawning												
	Incubation												
	Swim up												
	Winter dispersal												
	Smolt migration												
	Kelts												
Brown trout (*sea trout)	Adult migration												
	Spawning												
	Incubation												
	Swim up												
	Winter dispersal												
	Smolt migration*												
	Kelts												
Eel	Adult migration												
	Juvenile migration												
River, sea and brook lamprey	Adult migration												
	Spawning												
	Incubation												
	Juvenile migration												

Key

	High sensitivity
	Medium sensitivity
	Low sensitivity
	Non sensitive / absent

Table 9-12 River Thurso catchment SST

SPECIES	LIFE STAGE	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
Atlantic salmon	Adult migration												
	Spawning												
	Incubation												
	Swim up												
	Winter dispersal												
	Smolt migration												
	Kelts												
Brown trout (*sea trout)	Adult migration												
	Spawning												
	Incubation												
	Swim up												
	Winter dispersal												
	Smolt migration*												
	Kelts												
Eel	Adult migration												
	Juvenile migration												
Lamprey (3 spp.)	Adult migration												
	Spawning												
	Incubation												
	Juvenile migration												

Key

	High sensitivity
	Medium sensitivity
	Low sensitivity
	Non sensitive / absent

9.5.3.2 Identification and characterisation of potential effects

In line with CIEEM guidance (2018), reference is made to the following characteristics when describing potential ecological effects:

- Nature of impact: whether an impact is positive / beneficial to habitats (e.g. by improving habitat structure) or to species (e.g. by increasing species diversity or extending habitat) or negative / detrimental to habitats (e.g. by direct habitat destruction) or to species (e.g. by loss of or displacement from suitable habitat);
- Extent: the spatial or geographical area over which the effect may occur;
- Magnitude: the size, amount, intensity and volume. This should be quantified if possible and expressed in absolute or relative terms (e.g. the amount of protected habitat lost or percentage decline in a species population);
- Duration: the length of time the activity occurs over. This should be defined in relation to ecological characteristics (e.g. a species lifecycle) as well as human timeframes. It should also be noted that the duration of an activity may differ from the duration of the resulting effect (e.g. if short-term construction activities cause disturbance to Atlantic salmon during their breeding period, there will be long-term implications from failure to reproduce that season);
- Reversibility: an irreversible effect is one from which recovery is not possible within a reasonable timescale or there is no reasonable chance of action being taken to reverse it. A reversible effect is one from which spontaneous recovery is possible or which may be counteracted by mitigation;
- Frequency: the number of times an activity occurs. This may influence the resulting effect; and
- Timing: the time of year during which the activity occurs. This may result in an effect on an ecological feature if it coincides with critical life-stages or seasons (e.g. fish migration).

The timescales of potential effects on ecological features are considered. Incorporated into this evaluation is the reversibility of the effect, which is based on the duration of the impact, or the time required for the feature to return to baseline pre-construction conditions (Regini, 2000). Knowledge of how rapidly the population or performance of a species is likely to recover following loss or disturbance (e.g. by individuals being recruited from other populations elsewhere) is used to assess reversibility, where such information is available.

The following definitions have been applied with regard to timescales:

- Immediate: within approximately 12 months;
- Short-term: within approximately one to five years;
- Medium-term: within approximately six to 15 years; and
- Long-term: more than 15 years.

9.5.3.3 Geographic context

Impacts on freshwater ecology are assessed in local and, if necessary, regional context as appropriate. For the purposes of the assessment, a local population refers to the population within Caithness. If a potentially significant impact on a local population or habitat extent is identified, the assessment is extended to consider potential impacts on the wider regional population or habitat extent. However, if no significant effect on the local population or habitat

extent is identified, consideration of the wider geographical area is not considered necessary since this will result in potential effects that are of the same or lower level for those wider populations or habitat extents.

NatureScot has defined Natural Heritage Zones (NHZs) within Scotland (Scottish Natural Heritage (SNH), 2002), which they consider to be appropriate biogeographical spatial units against which regional effects of proposed developments can be assessed. NHZ classifications represent areas with a high level of biogeographic coherence and are unrelated to administrative boundaries. The onshore Project area lies within NHZ 2: Orkney and North Caithness. Where an assessment of a regional ecological feature is necessary, effects are assessed within this NHZ as far as possible. However, there are limited data on habitats and populations of species available at the NHZ level.

9.5.3.4 Determining magnitude of effects

For the purposes of this assessment, the potential effects are assigned to different magnitude levels to assist the assessment process, so as to remain consistent with the broader EIA assessment methodology described in chapter 7: EIA methodology. The magnitude level of an effect is defined using the criteria in Table 9-13. Note that these effects relate to negative effects; where positive effects are predicted, these are not assigned different levels.

Table 9-13 Magnitude criteria

MAGNITUDE CRITERIA	DEFINITION
High	Total or almost complete loss of an ecological feature (habitat or population), likely to result in a permanent effect on its long-term ecological integrity and affect its conservation status. Large-scale, permanent changes to an ecological feature, and likely to change its ecological integrity and affect its conservation status.
Medium	Moderate-scale, long-term changes to an ecological feature, or larger-scale temporary changes, but its long-term ecological integrity is unlikely to be affected and any changes in conservation status are reversible.
Low	Small-scale, temporary effects on an ecological feature that do not affect ecological integrity or conservation status.
Negligible	Little or no detectable effect on an ecological feature.

9.5.3.5 Significance of impact

For freshwater ecology, potential effects are identified and significance of impact is assessed for each stage of the Project lifecycle. Significance is attributed relative to the background conditions.

The latest CIEEM guidance on EcIA (CIEEM, 2018) avoids and discourages use of the matrix approach to determining significance and describes only two categories: "significant" or "not-significant". According to the CIEEM guidance, for the purpose of EcIA, a "significant effect" is an effect that either supports or undermines biodiversity conservation objectives for important ecological features and biodiversity in general. Effects can be considered significant at a wide range of scales from international to local.

The guidance further states that "in broad terms, significant effects encompass impacts on structure and function of defined sites, habitats, or ecosystems and the conservation status of habitats and species (including extent, abundance and distribution)".

In line with this guidance, rather than using a matrix to determine significance, the approach used in this chapter is to consider the importance and sensitivity of the habitats and populations and the characteristics and severity of the effect. Professional judgement is applied as to whether the ecological integrity of a habitat or population will be affected.

The term "ecological integrity" refers to the maintenance of the conservation status of a habitat or population of a species at a specific location or geographical scale. This is used here in accordance with the definition adopted by the Office of the Deputy Prime Minister (ODPM) Circular 06 / 2005 on Biodiversity and Geological Conservation ODPM, 2005), whereby designated site integrity refers to "the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified".

Effects are more likely to be significant where they affect a habitat or species of higher levels of importance, threaten the integrity of a habitat or population, or where the severity of the effect is high. Effects not considered to be significant would be those that do not threaten the integrity of an ecological feature or where the habitat or population affected is considered to be of low importance.

In this assessment, an effect that threatens the integrity of a habitat or species population is considered to be significant. Effects that do not threaten the integrity of a habitat or population are considered to be not significant. Where appropriate, mitigation measures are identified to avoid and reduce potentially significant effects. It is also good practice to propose mitigation measures to reduce negative effects that are not significant. The significance of residual effects on habitats and populations following implementation of mitigation is then determined along with any monitoring requirements.

9.5.4 Embedded mitigation

As described in chapter 7: EIA methodology, certain measures have been adopted as part of the Project development process in order to reduce the potential for impacts to the environment, as presented in Table 9-14. These have been accounted for in the assessment presented below. The requirement for additional mitigation measures (secondary mitigation) is dependent on the significance of the effects on freshwater ecology receptors.

In line with CIEEM guidance (2018) the principal mitigation measure adopted to minimise the impact of the onshore Project on freshwater ecology receptors has been the use of an iterative design process, which has involved consideration of key ecological issues and constraints throughout the design process. As a result, most of the mitigation measures are embedded within the overall design.

In accordance with the onshore PPP application, the embedded mitigations listed below have been attributed to particular Development Zones within the onshore Project area, these are detailed in Table 9-14 and the Development Zones are shown in Figure 9-6.

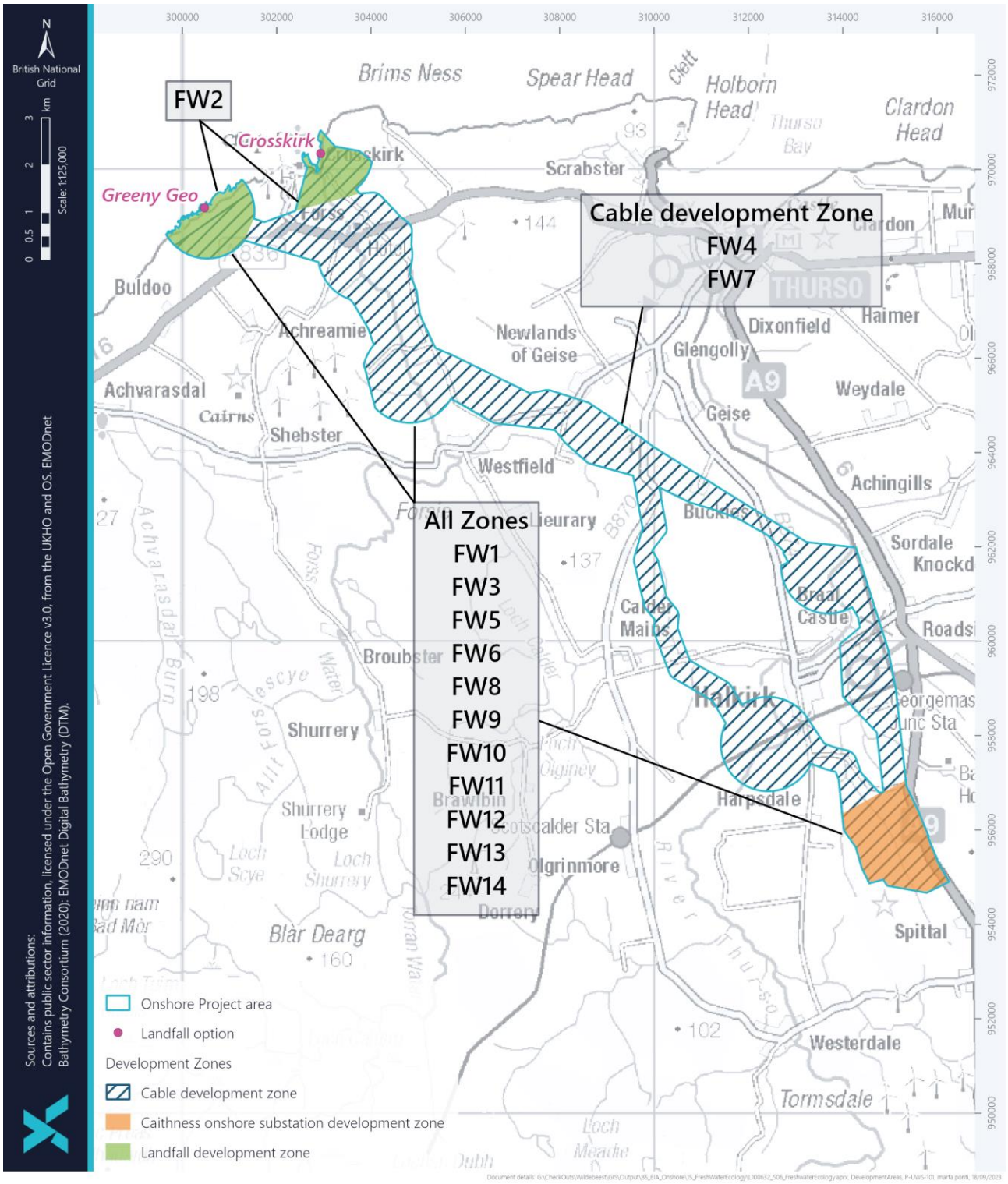

Figure 9-6 Development Zones for the onshore Planning Permission in Principle

Table 9-14 Embedded mitigation measures relevant to freshwater ecology

ID	MITIGATION MEASURE	TYPE	DESCRIPTION	HOW MITIGATION WILL BE SECURED	DEVELOPMENT ZONE
FW1	Onshore cable routing and avoidance of sensitive areas	Primary	Consideration of freshwater ecology sensitivities as part of the constraints mapping exercise to inform final cable route and associated construction infrastructure (see SST Table 9-11 and Table 9-12).	Established through design principles (secured through Construction Method Statements (CMSs)).	All zones.
FW2	Work in tidal reaches	Primary	Protect salmonid river entry by avoiding works within tidal river reaches from April to November (see SST Table 9-11 and Table 9-12).	Established through design principles (secured through CMSs and CAR licensing). These measures will also be established within the Aquatic Monitoring Plan which will be secured through a condition attached to the PPP.	Landfall zone.
FW3	Salmonid spawning and incubation	Primary	Protect salmonid spawning and incubation through no in-channel working between October to May where appropriate (see SST Table 9-11 and Table 9-12).	Established through design principles (secured through CMSs and CAR licensing). These measures will also be established within the Aquatic Monitoring Plan which will be secured through a condition attached to the PPP.	All zones.
FW4	Sustain passage of fish at watercourse crossing locations	Primary	Sustain passage of fish through the onshore Project area during works at watercourse crossing locations, where appropriate (see SST Table 9-11 and Table 9-12).	Established through design principles (secured through CMSs and CAR licensing). These measures will also be established within the Aquatic Monitoring Plan which will be secured through a condition attached to the PPP.	Cable development zone.
FW5	No post-construction channel barriers	Primary	No post-construction channel barriers will be left/put in place.	Established through design principles (secured through CMSs and CAR licensing). These measures will also be established within the Aquatic Monitoring Plan which will be secured through a condition attached to the PPP. .	All zones.

ID	MITIGATION MEASURE	TYPE	DESCRIPTION	HOW MITIGATION WILL BE SECURED	DEVELOPMENT ZONE
FW6	Fish rescues to be undertaken at all in-channel working areas	Primary	Prevent fish mortality with rescues being undertaken at all working areas within channels where appropriate.	Established through design principles (secured through CMSs and CAR licensing). These measures will also be established within the Aquatic Monitoring Plan which will be secured through a condition attached to the PPP.	All zones.
FW7	Cable burial methodology	Primary	Cables to be drilled at sufficient depth to shield electrosensitive species from the potential impacts of Electromagnetic Field (EMF) and to prevent channel alteration, or exposure, during a channel-forming event, e.g., storm event.	Established through design principles (secured through CMSs and CAR licensing). These measures will also be established within the Aquatic Monitoring Plan which will be secured through a condition attached to the PPP.	Cable development zone.
FW8	Temporary bridges/spanning structures	Primary	The use of temporary bridges/spanning structures, rather than pipework, will be used in watercourses where appropriate for the haul roads to reduce potential impacts to migrating fish.	Established through design principles (secured through CMSs and CAR licensing). These measures will also be established within the Aquatic Monitoring Plan which will be secured through a condition attached to the PPP.	All zones.
FW9	Return location to pre-construction state	Primary	Where riverbed or river bank has been subject to construction, full reinstatement will be delivered.	Established through design principles (secured through CMSs and CAR licensing). These measures will also be established within the Aquatic Monitoring Plan which will be secured through a condition attached to the PPP.	All zones.
FW10	Ecological Clerk of Works (ECoW(s))	Primary	Ensure appropriately qualified ECoW(s) presence at sensitive locations and/or sensitive periods where appropriate.	The requirement for an ECoW will be secured through CAR licensing and PPP conditions. The Aquatic Monitoring Plan will outline the requirement for an ECoW which will be secured through a condition attached to the PPP.	All zones.

ID	MITIGATION MEASURE	TYPE	DESCRIPTION	HOW MITIGATION WILL BE SECURED	DEVELOPMENT ZONE
FW11	CEMP	Tertiary	The CEMP will outline how the onshore Project will ensure the suitable implementation and control of the mitigation measures during construction. An outline CEMP (OMP1: Outline CEMP) is provided alongside the application for PPP.	As per OMP1: Outline CEMP, the final CEMP will be provided at post-consent. The final CEMP will be secured through a condition attached to the PPP.	All zones.
FW12	Pollution prevention and control	Tertiary	A Pollution Prevention and Control Plan will be established for the onshore Project. Pollution prevention and control measures will be implemented in accordance with the latest legislation and guidance from Scottish Environment Protection Agency (SEPA), such as, WAT-SG-745 (SEPA, 2021) and GPP-22 (SEPA 2018). This includes utilisation of best practice sediment management techniques and employment of best practice pollution prevention techniques for dealing with groundwater, surface water and soil pollution risk.	As per OMP1: Outline CEMP, these measures will be established within the Pollution Prevention and Control Plan which will be appended to the final CEMP. The CEMP will be secured through a condition attached to the PPP. These measures will also be secured through conditions of CAR authorisations, if required.	All zones.
FW13	Aquatic Monitoring Plan	Tertiary	Create and implement, an Aquatic Monitoring Plan, including controls, to quantify a baseline ecological standard.	Established through design principles (secured through CMSs and CAR licensing). The Aquatic Monitoring Plan will be secured through a condition attached to the PPP.	All zones.
FW14	Decommissioning, Restoration and Aftercare Plan	Tertiary	A Decommissioning, Restoration and Aftercare Plan will be prepared for the onshore Project and agreed with THC prior to decommissioning works being undertaken. The plan will include any measures required to protect ecological features during decommissioning which are likely to be similar to those proposed within the CEMP.	Established within the design principles (secured through CMSs) and the Decommissioning, Restoration and Aftercare Plan which will be secured through a condition attached to the PPP.	All zones

9.5.5 Worst case scenario

As detailed in chapter 7: EIA methodology, this assessment considers the worst case scenario for the onshore Project parameters which are predicted to result in the greatest environmental impact, known as the 'worst case scenario'. The worst case scenario represents, for any given receptor and potential impact on that receptor, the design option (or combination of options) that would result in the greatest potential for change.

Given that the worst case scenario is based on the design option (or combination of options) that represents the greatest potential for change, the development of any alternative options within the design parameters will give rise to no worse effects than those assessed in this impact assessment. Table 9-15 presents the worst case scenario for potential impacts on freshwater ecology during construction, operation and maintenance, and decommissioning.

Table 9-15 Worst case scenario specific to freshwater ecology

POTENTIAL IMPACT	WORST CASE SCENARIO	JUSTIFICATION
Construction and decommissioning		
Mortality of important freshwater ecology receptors	Landfall • Preparation of the working area at the landfall site to accommodate 5 boreholes (plus one contingency), HDD drilling equipment, utilities, and welfare facilities with an estimated area of 7,500 m^2; • Storage of excavated materials from the boreholes estimated to be up to 1,630 m^3 per HDD bore prior to disposal off-site; • Materials used during drilling of bores, e.g., drilling muds and grout; and • Fuel used in plant machinery. Onshore export cable corridor • Construction and reinstatement of temporary laydown areas (estimated to be every 2 km along the route) and access roads for trench / HDD works; • Potential use of trench boxes and/or sheet piling during trenching; and • Excavation of trenches / HDD and storage of excavated materials estimated to be up to 162,525 m^3 per trench (five trenches) for the working corridor estimated to be 33 km long and 100 m wide. • Watercourse crossing techniques and access: - For minor watercourse / ditch crossings dry OCT methodology will be used. In dry open cut methods water flow is maintained by damming and over pumping or using	These activities / parameters are considered to represent the maximum adverse scenario with regard to potential pollution of watercourses e.g., from excess silt, hydrocarbons, chemicals, and concrete could result in the mortality of freshwater receptors. The installation of SuDs and septic tank (only at the substation) have the potential to affect receptors if there is a failure in the system. These cable-laying methods and provision of temporary and permanent access are considered to represent the worst case scenarios that have the potential to directly result in the mortality of sensitive receptors.

POTENTIAL IMPACT	WORST CASE SCENARIO	JUSTIFICATION
	temporary "flume" pipes installed in the bed of the watercourse. Burial depth to be between 1.0 m to 1.8 m. The excavation rate for crossings will be <10 m per day; - HDD or other trenchless techniques (e.g., auger bore or pipe ramming) will be required at significant rivers (the Forss Water and River Thurso) and may exceed a depth of 1.8 m; - Ditches and small watercourses that are crossed by the Project haul roads will have appropriately sized pipework installed to maintain water conveyance capacity. Such pipework will be removed when the haul roads are removed; - Temporary bridges / spanning structures will be considered for appropriate locations for haul roads; and - Permanent access roads will be required at several locations, with one crossing over a tributary of the River Thurso, Yellowmoss Burn. Onshore substation • Preparation of temporary work compound for substation 62,500 m^2 (including compound and welfare facilities); • Substation permanent area (including landscaping and Sustainable Drainage Systems (SuDS) allowance) of approximately 23.9 hectares (ha), with maximum excavated material 1,207,000 m^3; • Potential for on-site batching of concrete; • SuDS system will be required for surface water drainage. Transformer and shunt reactor areas are at higher risk of oil contamination. Runoff from the transformer bunds and shunt reactor bunds will discharge to the surface water drainage system through a bund water control unit; and • Installation of septic tank system and subsequent discharges.	

POTENTIAL IMPACT	WORST CASE SCENARIO	JUSTIFICATION
Damage to key freshwater habitats	• Preparation of working areas, excavation activities, use and storage of materials as described above; and • Water crossing techniques, temporary and permanent access requirements as described above.	These activities / parameters are considered to represent the maximum adverse scenario with regards to potential pollution of watercourses that could result in damaging key freshwater habitats e.g., silt deposition in gravels affecting the potential for fish reproduction. In addition, the temporary loss of habitat during dry OCT methods on smaller watercourses and tributaries and temporary loss of habitat due to the installation of pipework to accommodate haul roads, temporary and permanent access tracks.
Interruptions to fish passage	• Preparation of working areas, excavation activities, use and storage of materials as described above; and • Water crossing techniques, temporary and permanent access requirements as described above.	These activities / parameters are considered to represent the maximum adverse scenario with regards to potential pollution of watercourses that could result in interruptions to fish passage in terms of pollutants affecting water and substrate quality. In addition to the physical barriers to passage during the process of cutting cable trenches across watercourses (e.g. ditches and tributaries). The installation of pipes in these watercourses may impede fish passage depending on width and length. Temporary and permanent access tracks have potential to impede fish passage if using pipes in the watercourse.
Operation and maintenance		
Mortality of important freshwater ecology receptors	• SuDS will be required for surface water drainage at the onshore substation. Transformer and shunt reactor areas are at higher risk of oil contamination. Runoff from the transformer bunds and shunt reactor bunds will discharge to the surface water drainage system through a bund water control unit; • Installation of septic tank system and subsequent discharges at the onshore substation; and	SuDS and discharges from the sewage system at the onshore substation have the potential to pollute watercourses and result in the mortality of freshwater ecology receptors if there is a failure in the system.

POTENTIAL IMPACT	WORST CASE SCENARIO	JUSTIFICATION
	• Maintenance activities may be required due to events causing deterioration or damage of areas surrounding cables including other services, crossings, roads, farmland etc.	Maintenance activities (in particular along the cable routes) have potential to result in the mortality of freshwater receptors from potential pollutants should excavation work be required to repair or replace cables and other services near the River Thurso or Forss Water and smaller watercourses or in the maintenance of permanent access tracks crossing watercourses.
Damage to key freshwater habitats	• Water crossing techniques and permanent access requirements as described above for construction; and • Maintenance activities may be required due to events causing deterioration or damage of areas surrounding cables including other services, crossings, roads, farmland etc.	These activities are considered to represent the maximum adverse scenario with regard to potential long-term damage to freshwater habitats e.g., channel instability and changes to hydrodynamics as a result of the works. Permanent access tracks have the potential to result in loss of fish habitat if using pipes in ditches or tributaries of the River Thurso and Forss Water. Non-routine activities that require excavation works near watercourses have the potential to damage habitats from bank destabilisation and pollutants.
Interruptions to fish passage	• Water crossing techniques and permanent access requirements as described above for construction; • Installation of pipework as described above for construction; and • Maintenance activities may be required due to events causing deterioration or damage of areas surrounding cables including other services, crossings, roads, farmland etc.	These activities are considered to represent the maximum adverse scenario with regard to potential fish passage should a problem occur post reinstatement of the habitats from water crossing techniques and installation of pipework for haul roads. Maintenance activities that require excavation works near watercourses have the potential to interrupt fish passage should temporary barriers, both physical and/or pollution occur.

9.6 Assessment of potential effects

9.6.1 Evaluation of sensitivity

A summary of the evaluation of the sensitivity of receptors recorded within the onshore survey area during the 2022 baseline surveys (undertaken by Trex Ecology Ltd) is provided in Table 9-16.

Table 9-16 Evaluation of the sensitivity of receptors recorded within the onshore survey area during the 2022 baseline surveys

SENSITIVITY	RECEPTOR	JUSTIFICATION
High	Atlantic salmon	Atlantic salmon are protected under Schedule 3 of the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland) (Annex II species under the Habitats Directive 1992) and are also protected Salmon Act 2003. The River Thurso is designated as an SAC for Atlantic salmon. According to the SAC Citation, '*the Thurso supports a higher proportion of multi sea-winter salmon than is found in many rivers further south in the species' range*'. They are listed as a priority species for conservation on the SBL. They are listed as 'Least Concern' globally and 'Vulnerable' in Europe on IUCN Red List of Threatened Species. However, the abundance of Atlantic salmon has declined markedly since the 1970s (NASCO, 2019). According to the Atlantic Salmon Trust, wild salmon are in crisis, with a decline of 70% in just 25 years. The baseline surveys undertaken in 2022 identified habitat present to support Atlantic salmon.
High	Sea / brown trout	Sea trout are protected under the Salmon Act 2003. It is not possible to establish with absolute certainty whether a given trout is a sea trout or resident brown trout based on observation. This is an important consideration given the legal protection afforded to sea trout under the Salmon Act. Sea / brown trout are listed as a priority species under the SBL and are listed as 'Least Concern' globally and in Europe on IUCN Red List of Threatened Species. The baseline surveys undertaken in 2022 identified habitat present to support sea / brown trout.

SENSITIVITY	RECEPTOR	JUSTIFICATION
High	European eel	The European eel is protected under The Freshwater Fish Conservation (Prohibition on Fishing for Eels) (Scotland) Regulations 2008 and is also protected by measures relating to previous compliance with Council Regulation (EC) No 1100 / 2007 - Establishing measures for the recovery of the stock of European eel. An eel management plan has been produced for Scotland (DEFRA, 2010) in support of this regulation. They are a priority species for conservation in the SBL. They are listed as 'Critically Endangered' both Globally and in Europe on the IUCN Red List of Threatened Species. Their distribution in Scotland is poorly understood, and they are often only an incidental catch in standard fish monitoring surveys. It is worth noting that surveys carried out on the Burn of Isauld in 2019, a small northern catchment very close to the onshore Project boundary area, demonstrated very high densities of eel (Trex Ecology and CDSFB, 2020, unpublished). The baseline surveys undertaken in 2022 identified the potential for eel to be present within the onshore Project area.
High	Lamprey (brook, river, and sea)	River lamprey are protected under Schedule 3 of the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland). All three species of lamprey are listed as priority species for conservation on the SBL and are listed as 'Least Concern' globally and in Europe on IUCN Red List of Threatened Species Their distribution is well understood in broad terms; however, there is some evidence that they may be absent from the onshore Project area (Hume, 2017). However, as standard mitigations to protect the species align with those for other species, they have been retained for consideration in the EIA. Given the absence of widespread sampling programmes utilising specific surveys which confidently define their distribution in Scotland, a precautionary approach here is valid. The baseline surveys undertaken in 2022 identified habitat present to support lamprey.

9.6.1 Species not taken forward to the assessment

Species of negligible importance would not be considered further in this assessment however, there were no species within this category. As discussed in section 9.5.2 FPM is not further assessed.

9.6.1 Species taken forward to the assessment phase

In this section, results from the desk study and all relevant field surveys have been reviewed to describe the baseline environment for freshwater ecology, providing an overview of the existing ecological environment within the onshore Project area and wider landscape. Following assessment of the baseline, the likely impact of each stage of the project upon the freshwater ecology features is assessed.

Due to various limitations (see section 9.4.7), precautionary measures are considered prudent.

9.6.2 Potential effects on receptors of high sensitivity

All key sensitive receptors for freshwater ecology have been evaluated to be of high sensitivity. As set out in Table 9-7, all key sensitive receptors have been assessed against the following impacts: mortality of receptors, damage to key freshwater habitats and interruptions to fish passage for each stage of the Project lifecycle.

9.6.2.1 Baseline

Details of the surveys undertaken to determine baseline characterisation for the key freshwater ecology receptors are provided in section 9.4 and full details of the survey results are provided in SS4: Freshwater ecology technical survey report. The following is a summary of the findings:

9.6.2.1.1 Forss catchment

The Forss catchment is considered to be accessible to migratory salmonids. However, river and sea lamprey are highly unlikely to pass the Forss Falls into the upper catchment area. Eel may be able to climb using moss and macrophytes on the wetted margins of the fall. The data from the desk-based assessment indicate that salmon are present within the Project area for this catchment. Discussion with the regulator during this EIA process suggests that salmon are in significant decline within this catchment.

Surveys were undertaken on 7.8 km of the Forss Water and three of its tributaries, Hallam Burn, Burn of Baillie and Burn of Brimstone (see Figure 9-1).

The upstream extent of the survey area for Forss Water has limited areas recorded as suitable for salmonid spawning. However, as the river continues its course downstream, spawning habitat was recorded throughout the survey area, with potential juvenile lamprey habitat recorded in the lower sections of the river. In addition, habitats are available for juvenile and adult salmonids and eel.

Of the three tributaries, Burn of Brimstone was dry and therefore unsuitable for fish and can be scoped out. The Burn of Baillie could not be surveyed due to access restrictions, and it should be assumed that fish could use it. Hallam

Burn is a highly modified burn in poor condition with extensive silt and algae observed during the July survey; however, spawning and juvenile lamprey habitat were identified in the lower reaches near the confluence with the Forss Water. Site conditions may be sufficient to support healthy salmonid reproduction during colder wetter months.

The Forss Water and its tributaries, apart from the Burn of Brimside, are therefore likely to host all life history stages of brown trout, sea trout and Atlantic salmon, European eel and river lamprey.

9.6.2.1.2 Thurso catchment

The Thurso catchment is accessible to migratory salmonids. The data from the desk-based assessment indicate that salmon are present within the Project area for this catchment and, clustered, but abundant spawning habitat was recorded throughout the walkover surveys.

Surveys were undertaken on 4.5 km of the River Thurso and five of its tributaries, Burn of Carnavagry, Burn of Sour, Calder Burn, Burn of Halkirk and Burn of Achanarras (see Figure 9-2).

The River Thurso and its tributaries are likely to host all life history stages of brown trout, sea trout and Atlantic salmon. European eel and all three species of lamprey may be present, particularly in the lower reaches.

9.6.2.2 Potential construction effects

9.6.2.2.1 Mortality of important freshwater ecology receptors

The construction element of the Project has the potential to cause mortality of the key freshwater ecology receptors. Due to the Falls of Forss, sea and river lamprey are unlikely to be above this natural barrier and, therefore will not be impacted in the upper part of the Forss Water catchment and will only need to be considered in the lower reaches from the Falls to the sea.

During the construction of temporary compounds, temporary and permanent access tracks, excavation of HDD bores and cable trenches, storage of excavated material, construction of the new substation, use of fuel, chemicals, and drilling muds, there is the potential for accidental release of excess silt, hydrocarbons, concrete leachate etc. into watercourses which has the potential to result in fish mortality including fish eggs within redds.

The use of different methods that will be used for installing cables across watercourses has the potential to cause mortalities. OCT requires a dry area with requirements for damming and over-pumping or using 'flume' pipes installed in the riverbed. OCT will only be used for minor watercourses (ditches and tributaries), whilst HDD and other trenchless techniques will be used for larger watercourses (i.e. River Thurso and Forss Water). If this work is undertaken at certain times of the year, this could result in the loss of fish eggs from redds, and increased risk to juvenile fish during the required fish rescues for the dry area for the OCT.

All freshwater fish present or passing through the onshore Project area are sensitive to pollutants with low ability to recover, depending on the magnitude of the event, and no ability to adapt. The SST (Table 9-11 and Table 9-12) show that there are times when different life stages of each species are at higher risk, e.g., during migration and reproduction. The risk to redds and early-stage juvenile fish from the excavation of trenches affects all species which reproduce in freshwater (i.e., excluding eel). Atlantic salmon and trout fry, European eel, and all three species of

lamprey (sea, river and brook) are unlikely to attempt to swim away from pressure, preferring to take cover as a behavioural response to pressures.

In the absence of appropriate mitigation, there is the potential for construction activities to adversely impact the freshwater receptors within the onshore Project area. However, the implementation of the embedded mitigation listed in section 9.5.4 will reduce the likelihood of any direct or indirect impacts associated with potential pollution events and cable laying activities. Should an event occur, this can be managed through the application of appropriate emergency procedures to ensure any resulting impact is small-scale and temporary and does not affect the ecological integrity of the watercourses in the area. The impact is therefore defined as being of low magnitude, and no significant effect is predicted.

9.6.2.2.2 Damage to key freshwater habitats

The construction element of the onshore Project has the potential to cause damage to key freshwater habitats for the different life history stages of Atlantic salmon, sea / brown trout, European eel and sea, river and brook lamprey.

Fish are dependent on the availability of quality habitats for all parts of their life history stages e.g., accumulations of clean, mobile, coarse substrates for spawning, presence of cover from predators, and refuge habitats to avoid extreme climate events. During the construction of temporary compounds, temporary and permanent access tracks, excavation of HDD bores and cable trenches, storage of excavated material, construction of the new substation, use of fuel, chemicals, and drilling muds, there is the potential for accidental release of excess silt, hydrocarbons, concrete leachate etc. into the watercourse which has the potential to result in damage to these key freshwater habitats. Habitats may also be damaged physically through construction operations such as trenching, tracking and potential changes to the flow patterns through a site, either temporarily or permanently.

There will be a temporary loss of freshwater habitat during the process of cable laying at watercourse crossing points where dry OCT methods are used. This method will only be used on smaller watercourses, such as ditches and tributaries, with HDD being used on the River Thurso and Forss Water. OCT requires a dry working area where water flow is maintained by damming and over-pumping or using temporary 'flume' pipes installed in the bed of the watercourse. Fish need to be rescued from these areas by an appropriately qualified fish rescue team and released elsewhere in the river to ensure they are not harmed. HDD activities and other trenchless techniques can also disturb fish during spawning and incubation of eggs, during larval fish interstitial residence and during older juvenile life history stages (lamprey ammocoetes). The installation of in-channel pipes to accommodate haul roads that will be removed post-construction will also lead to a temporary loss of habitat. Permanent access tracks across watercourses have the potential to affect habitat availability and use depending on the type of crossing installed. These works also have the potential to destabilise banks, leading to erosion and changes in hydrodynamics, which impact on habitat availability and quality.

All freshwater ecology receptors have the potential to be affected by these impacts through loss of spawning, nursery, shelter, or feeding habitats. As older salmonids are mobile, they can avoid temporary disturbances. Juvenile fish are less mobile and likely to be more affected. However, there is some tolerance to recover and adapt to small-scale, temporary effects to their habitat. At medium and large spatial scales, the total area of channel potentially impacted will be minor, and habitats are abundant elsewhere, both within and outside the onshore Project area. In addition, the proposal to use temporary bridges / spanning structures for appropriate locations for haul roads rather than pipework and with just one permanent access track across a minor watercourse planned, this will reduce potential

impacts further. Furthermore, the implementation of the embedded mitigation listed in section 9.5.4, particularly timing works to avoid spawning and incubation periods reduces the likelihood of direct or indirect impacts on freshwater habitats from construction, and therefore effects are expected to be of low magnitude and no significant effect is predicted.

9.6.2.2.3 Interruptions to fish passage

Atlantic salmon, brown trout, European eel, sea and river lamprey are all diadromous migratory species (or have diadromous forms). Resident brown trout and brook lamprey undertake in-river migrations. Fish migrate through a river system for spawning, feeding and refuge purposes. Migrations are not solely the preserve of adults with seasonal (e.g., overwintering), age-dependent and salmonid smolt / lamprey transformer transitions to the marine environment, demonstrating the overwhelming role of migration in native fish species ecology.

The construction element of the onshore Project has the potential to affect the passage of fish through the onshore Project area particularly at the most sensitive times of their life stages as highlighted in the SST (Table 9-11 and Table 9-12). There will be temporary physical barriers to fish passage during the cable laying across watercourses. In particular, when using the dry OCT method, where a dry in-channel working area will be required where water flow is maintained by damming and over-pumping or using temporary 'flume' pipes installed in the bed of the watercourse. This method will only be used on minor tributaries and ditches. HDD and other trenchless techniques that will be used for the main River Thurso and Forss Water, can also disturb fish passage from noise and vibration impacts. The installation of in-channel pipes to accommodate haul roads that will be removed post-construction may also impede fish passage, depending on timing, width and length. Permanent access tracks across watercourses could also impede migration depending on the type of crossing installed. Barriers that could result from the works may be physical (dry working areas), chemical (pollution), electromagnetic and acoustic (drilling and piling).

All freshwater ecology receptors have the potential to be affected by this impact through loss of access to spawning, nursery, shelter, or feeding grounds. However, the risk can be minimised for diadromous fish if works are undertaken at appropriate times of the year, but less so for resident species for their in-channel migrations. The wide window for certain migrations (e.g., river entry or smolt migration), which are often delayed naturally, suggests some resilience to the receptors from temporary barriers. There is therefore some tolerance to recover and adapt to temporary impacts to their passage. However, it may not be possible to completely reduce the temporary impact of some barriers.

The proposal to use temporary bridges / spanning structures for appropriate locations for haul roads rather than pipework and with just one permanent access track across a minor watercourse planned will reduce potential impacts. In addition, the implementation of the embedded mitigation listed in section 9.5.4, particularly timing works in watercourses and HDD activities to avoid spawning and incubation periods reduces the likelihood of direct or indirect impacts on fish passage from cable laying activities and installation of haul road pipe work and therefore effects are expected to be of low magnitude and no significant effect is predicted.

9.6.2.3 Potential operation and maintenance effects

9.6.2.3.1 Mortality of important freshwater ecology receptors

The potential effects from the operation and maintenance stage of the Project to the mortality of important freshwater ecology receptors are much reduced from the construction stage. The main potential effects stem from the SuDS and sewage treatment system at the onshore substation, should there be a failure in the system. Discharges from these systems have the potential to pollute the nearby watercourse which is a tributary of the River Thurso. However, the surface water drainage network for the onshore substation will be designed taking into account THC's Supplementary Guidance: Flood Risk and Drainage Impact Assessment (THC, 2013b), SUDSWP's Water Assessment and Drainage Assessment Guide (SUDSWP, 2016) and CIRIA Publication C753 – the SuDS Manual (Woods, 2015). In addition, the septic tank system will need to meet the discharge standards under a CAR licence from SEPA.

Maintenance activities that require excavation works, e.g., cable repair or replacement have the potential to cause mortality should they result in pollutants entering watercourses, similar to that identified for the construction stage. As routine maintenance works during operation are likely to be infrequent and small-scale, and with the implementation of the embedded mitigation as detailed in section 9.5.4 it is likely that these would be short-term and localised events. The impact is therefore defined as being of low magnitude and no significant effect is predicted.

9.6.2.3.2 Damage to key freshwater habitats

There is less potential for freshwater habitats to be damaged from the operation stage. Permanent access tracks across watercourses have the potential to affect habitat availability and use depending on the type of crossing installed. However, just one permanent access track is planned across a minor watercourse, which is Yellowmoss Burn, a tributary of the River Thurso. In addition, there are potential longer-term legacy effects from some of the construction activities. In particular, from the dry OCT for cable laying across the minor watercourses and ditches (HDD will be used on the River Thurso and Forss Water) and the installation and subsequent removal of in-channel pipe work to accommodate haul roads where used. The works could result in the de-stabilisation of the riverbanks, and changes to channel morphology and flow regime in the longer-term not evident until during the operation stage, which could affect the quality and availability of habitats for the different life history stages of the sensitive receptors. The proposal to consider the use of temporary bridges / spanning structures for appropriate locations for haul roads rather than pipework will reduce these impacts.

Maintenance activities that require excavation works, e.g., cable repair or replacement have the potential to cause damage to habitats should they result in pollutants entering watercourses and bank destabilisation, similar to that identified for the construction stage. However, it is likely that these would be short-term and localised events.

All freshwater ecology receptors have the potential to be affected by these impacts through loss of spawning, nursery, shelter, or feeding habitats. However, as older salmonids are mobile, they can avoid temporary disturbances. Juvenile fish are less mobile and likely to be more affected. The implementation of the embedded mitigation provided in section 9.5.4 will reduce the likelihood for freshwater habitats to be damaged. Taking this into account and that maintenance activities are likely to be occur over a local to medium scale, the impact is defined as being of low magnitude and no significant effect is predicted.

9.6.2.3.3 Interruptions to fish passage

There is less potential for fish passage to be impacted by the operation stage of the Project based on the embedded mitigation provided for the construction stage as presented as detailed in section 9.5.4. Permanent access tracks across watercourses could impede migration depending on the type of crossing installed. Currently, one of the permanent access tracks will cross a minor tributary of the River Thurso. In addition, there are potential effects from the reinstatement of the channel upon the removal of the in-channel pipe work that was in place to accommodate haul roads and from the OCT cable laying activities that will be undertaken on the minor watercourses (HDD method is planned for the River Thurso and Forss Water). These sections could impact fish movement if a problem occurs post reinstatement and should be continually assessed to ensure fish passage is unimpeded. These impacts may evolve slowly over time, taking a number of years to establish.

Maintenance activities that require excavation works, e.g., cable repair or replacement have the potential to interrupt fish passage should temporary barriers, physical, chemical and/or acoustic occur, similar to that identified for the construction stage. However, it is likely that these would be short-term and localised events.

All freshwater ecology receptors have the potential to be affected by these impacts through loss of access to spawning, nursery, shelter, or feeding grounds. The creation of a new barrier has the potential to reduce or remove receptor presence from upstream of the barrier. The implementation of the embedded mitigation as detailed in section 9.5.4 and the proposal to consider the use of temporary bridges / spanning structures where appropriate for haul roads during any maintenance will reduce this impact. It is considered that therefore, that the potential effects would be small-scale and temporary and of low magnitude and no significant effect is predicted.

9.6.2.4 Potential decommissioning effects

In the absence of detailed information regarding decommissioning works, the impacts during the decommissioning of the onshore Project are considered analogous with, or likely less than, those of the construction stage.

Should the cables be removed during the decommissioning stage, similar activities required for laying the cables during the construction stage would be required, including OCT, construction of temporary compounds, access tracks and haul roads. The potential effects on the mortality of important receptors, damage to key freshwater habitats and interruptions to fish passage would, therefore, all apply with the same magnitude as that assessed for the construction stage. Therefore, no significant effect is predicted on key freshwater ecology receptors.

9.6.3 Summary of potential effects

A summary of the outcomes of the assessment of potential effects from the construction, operation and maintenance and decommissioning of the Project is provided in Table 9-17.

No significant effects on freshwater ecology receptors were identified. Therefore, mitigation measures in addition to the embedded mitigation measures listed in section 9.5.4 are not considered necessary.

Table 9-17 Summary of potential effects

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF IMPACT	SIGNIFICANCE OF EFFECT	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL SIGNIFICANCE OF EFFECT
Construction and decommissioning*						
Mortality of important freshwater ecology receptors	Atlantic salmon, sea / brown trout, European eel, sea, river and brook lamprey.	High	Low	Not significant	None required above embedded mitigation measures.	Not significant
Damage to key freshwater habitats	Atlantic salmon, sea / brown trout, European eel, sea, river and brook lamprey.	High	Low	Not significant	None required above embedded mitigation measures.	Not significant
Interruptions to fish passage	Atlantic salmon, sea / brown trout, European eel, sea, river and brook lamprey.	High	Low	Not significant	None required above embedded mitigation measures.	Not significant

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF IMPACT	SIGNIFICANCE OF EFFECT	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANCE OF EFFECT)
Operation and maintenance						
Mortality of important freshwater ecology receptors	Atlantic salmon, sea / brown trout, European eel, sea, river and brook lamprey.	High	Low	Not significant	None required above embedded mitigation measures.	Not significant
Damage to key freshwater habitats	Atlantic salmon, sea / brown trout, European eel, sea, river and brook lamprey.	High	Low	Not significant	None required above embedded mitigation measures.	Not significant
Interruptions to fish passage	Atlantic salmon, sea / brown trout, European eel, sea, river and brook lamprey.	High	Low	Not significant	None required above embedded mitigation measures.	Not significant

**** In the absence of detailed information regarding decommissioning works, and unless otherwise stated, the impacts during decommissioning of the onshore Project are considered analogous with those of the construction stage.***

9.7 Assessment of cumulative effects

9.7.1 Introduction

Cumulative effects can result from individually insignificant actions that, collectively, result in a significant effect on ecological features; even when effects may not be detected when considering the onshore Project in isolation. It is important to take such actions into account as cumulative effects can make habitats and species more vulnerable or sensitive to change, in particular for features that may already be exposed to background levels of disturbance or pressure that take them close to their critical threshold (CIEEM, 2018). Therefore, the need to consider cumulative effects is a requirement under CIEEM guidelines (CIEEM, 2018). Developments to be incorporated in such an assessment must include existing and consented developments, as well as those at the application stage.

Impacts of negligible magnitude are not considered in the cumulative impact assessment as they cannot measurably affect the outcome of an impact in combination with other developments. Effects of higher than negligible magnitude were predicted for each of the Project stages for all freshwater receptors. They were all assessed as low magnitude. Impacts likely to affect freshwater receptors are therefore likely to relate to concurrent construction. As such, developments which may be constructed at the same time as the onshore Project have been considered. However, in reality, it is unlikely that all developments will be constructed concurrently. Decommissioning effects are likely to be similar, and as with construction, it is unlikely that this will occur concurrently with all developments.

The consideration of developments which could result in potential cumulative effects is based on the results of the freshwater ecology impact assessment together with the expert judgement of the specialist consultant. Taking into account the nature and extent of the ecological features recorded within the onshore Project, it is unlikely that the developments outwith these areas will have any notable impact upon the freshwater species and habitats present within the onshore Project area or wider study area.

As different developments often employ differing baseline and impact assessment methods, it is not always possible to directly compare data. Therefore, quantitative assessment of cumulative effects is often not possible. Furthermore, as it is not compulsory for developers to share commercial data with other companies, full datasets are not always readily available. As a result, a comprehensive and quantitative cumulative impact assessment is not always possible. However, every effort has been made to provide a qualitative assessment that is as robust as the available public data allows.

Detailed cumulative assessment of the potential for a number of proposed and consented developments in the wider area is provided below. Details of developments considered in this assessment of cumulative effects are provided in Table 9-18.

Table 9-18 List of developments considered for the freshwater ecology cumulative impact assessment

LOCATION	DEVELOPMENT TYPE	DEVELOPMENT NAME	DISTANCE FROM ONSHORE PROJECT AREA (KM)	DISTANCE FROM ONSHORE SUBSTATION SEARCH AREA (KM)	STATUS	CONFIDENCE[3]
Forss, Caithness	Onshore windfarm	Forss Windfarm Extension	0.51	18.21	Application	Low
Tormsdale, Caithness	Onshore windfarm	Tormsdale Windfarm	4.75	5.54	Application	Low
Spittal, Caithness	Substation	Electricity Supply Board (ESB) Asset Development Synchronous Compensator	0	0	Application	Low
Spittal, Caithness	Cables	Spittal Synchronous Compensator Grid Connection	0	0.24	Consented	Medium

The main cumulative effects on the freshwater ecology receptors are likely to be:

- Mortality of important freshwater ecology receptors;
- Damage to key freshwater habitats; and
- Interruptions to fish passage during construction, operation, maintenance and decommissioning.

9.7.2 Cumulative construction effects

Forss Windfarm Extension comprises the erection and operation of a windfarm for a period of 30 years, comprising two wind turbines (maximum blade tip height 100 m), access tracks, communications substation building, substation, transformer units and ancillary infrastructure. The proposal is located to the west of Forss Water and within 500 m of the onshore Project Area. The planning decision is still under consideration and therefore it is unknown as to whether there would be cumulative construction effects at this point.

[3] *Confidence ratings have been applied to each cumulative development where: 'Low' = pre-application or application, 'Medium' = consented and 'High' = under construction or operational.*

Tormsdale Windfarm comprises the development of a 12-turbine windfarm (maximum blade tip height 149.9 m) with associated infrastructure including, underground cabling, access tracks and an on-site control building. It will be in operation for a period of 30 years. The proposal is located 1.5 km south of the Bridge of Westerdale Halkirk and is within approximately 5 km of the onshore Project Area. The planning decision is still under consideration and therefore it is unknown as to whether there would be cumulative construction effects at this point.

The ESB Asset Development Synchronous Compensator proposal involves the erection and operation of grid stability facility including synchronous compensator, ancillary equipment, access, landscaping, drainage, car parking and boundary enclosures. The proposal is immediately adjacent / partially overlaps the onshore substation search area and is within the onshore Project area and has the potential to impact on the Burn of Achanarras and associated ditches. An EIA is not required for this development. It is unknown when construction will commence and whether there would be cumulative construction effects.

Spittal Synchronous Compensator and associated Grid Connection involves a high voltage underground grid connection for a proposed synchronous compensator outlined in the previous paragraph. The proposal is located within close proximity to the onshore substation search area, approximately 0.24 km south west and also within the onshore Project area and has the potential to impact on the Burn of Achanarras and associated ditches. This application has been permitted and due to the required start date time frame and nature of the development it is likely to be constructed by March 2026, before the commencement of the onshore Project and therefore will be unlikely to have any cumulative construction effects.

It is unclear at this stage for the majority of these proposals as to whether there could be cumulative impacts associated with construction activities as the construction timetable is unknown. Until further information is available it is assumed that there will be no temporal overlap of the construction stages of these developments and therefore, there is no requirement to consider potential cumulative impacts associated with construction activities for these proposals and should be re-assessed as further information becomes available.

9.7.3 Cumulative operation and maintenance effects

9.7.3.1 Mortality of important freshwater ecology receptors

The potential cumulative effects from the operation and maintenance stage of the Forss Windfarm Extension, Tormsdale Windfarm and the Spittal Synchronous Compensator and associated Grid Connection on fish mortality is unlikely, subject to implementation of the appropriate embedded mitigations.

The main cumulative risk from the ESB Asset Development proposal stem from the potential to pollute the watercourse from discharges from the drainage systems that will be required at each site, in combination with the new system proposed for the onshore Project substation. However, similar to the onshore Project, the ESB proposal have identified mitigation and installation of SuDS in accordance with best practice and guidance (ESB, 2020).

The embedded mitigation and implementation of best practice and guidance minimises the likelihood of cumulative effects on the key freshwater ecology receptors. The cumulative effects are therefore considered to be of low magnitude and not significant in EIA terms.

9.7.3.2 Damage to key freshwater habitats

The main potential cumulative risk from the operation and maintenance stage in relation to damage to key freshwater habitats is from the Spittal Synchronous Compensator and associated Grid Connection proposal. In particular, from the trenching of the Burn of Achanarras to lay the cable, which could result in the de-stabilisation of the riverbanks and changes to channel morphology and flow regime over the long term. In addition, given the proximity of the Tormsdale Windfarm proposal to the River Thurso should watercourse crossings be required, these changes could also occur here.

This could affect the quality and availability of habitats for the different life history stages of the sensitive receptors. However, there is some tolerance for receptors to recover and adapt to temporary impacts to their habitat. The Outline Construction Method Statement (ESB, 2021) for the Spittal Synchronous Compensator and associated Grid Connection proposal and the embedded mitigation outlined for the Tormsdale development (Abbey Properties, 2021) and those identified above for the onshore Project means that potential risks are minimised. The cumulative effects are therefore considered to be of low magnitude and not significant in EIA terms.

9.7.3.3 Interruptions to fish passage

There is little potential for cumulative effects on fish passage during the operation and maintenance stage of the proposals listed above. However, there are potential cumulative effects from the Spittal Synchronous Compensator and associated Grid Connection proposal in relation to the reinstatement of the Burn of Achanarras after the OCT cable laying activities. This could impact fish movement if a problem occurs post re-instatement of riverbanks in the longer term post construction and should be continually assessed to ensure fish passage is unimpeded. This is also the case for Tormsdale Windfarm should any water crossings be required.

The Outline Construction Method Statement for the Spittal Synchronous Compensator and associated Grid Connection (ESB, 2021) proposal and the embedded mitigation outlined for the Tormsdale development (Abbey Properties, 2021) and those identified above for the onshore Project means that potential risks are minimised. The cumulative effects are therefore considered to be of low magnitude and not significant in EIA terms.

9.7.4 Cumulative decommissioning effects

The Forss Windfarm Extension and Tormsdale Windfarm proposals are expected to be operational for 30 years and the other three proposals listed are of unknown duration. No overlap in decommissioning activities is therefore identified and as such there will be no cumulative effects resulting from decommissioning. Therefore, no significant cumulative effects are predicted for any freshwater ecology receptors.

9.7.5 Summary of cumulative effects

A summary of the outcomes of the assessment of cumulative effects for the construction, operation and maintenance and decommissioning stages of the onshore Project is provided in Table 9-19.

Table 9-19 Summary of assessment and cumulative effects

POTENTIAL IMPACT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF IMPACT	SIGNIFICANCE OF EFFECT	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL SIGNIFICANCE OF EFFECT
Construction and decommissioning						
N/A						
Operation and maintenance						
Mortality of important freshwater ecology receptors	Atlantic salmon, sea / brown trout, European eel, sea, river and brook lamprey.	High	Low	Not significant	None required above embedded mitigation measures.	Not significant
Damage to key freshwater habitats	Atlantic salmon, sea / brown trout, European eel, sea, river and brook lamprey.	High	Low	Not significant	None required above embedded mitigation measures.	Not significant
Interruptions to fish passage	Atlantic salmon, sea / brown trout, European eel, sea, river and brook lamprey.	High	Low	Not significant	None required above embedded mitigation measures.	Not significant

9.8 Inter-related effects

Inter-related effects are the potential effects of multiple impacts, affecting one receptor or a group of receptors. Inter-related effects include interactions between the impacts of the different stages of the onshore Project (i.e., interaction of impacts across construction, operation and maintenance and decommissioning), as well as the interaction between impacts on a receptor within an onshore Project stage. The potential inter-related effects for freshwater ecology receptors are described below.

9.8.1 Inter-related effects between onshore Project stages

The potential exists for spatial and temporal interactions between mortality, habitat damage and interruptions to fish passage from the construction and operational stages of the onshore Project. However, with the embedded mitigation for freshwater ecology in place, as detailed in section 9.5.4, these have been assessed as not significant. As a result significant inter-related effects are therefore not predicted.

9.8.2 Inter-related effects within an onshore Project stage

Over the longer time period between construction and operation, there exists the potential for impacts to interact. For the freshwater ecology sensitive receptors, changes to patterns of connectivity related to the impact 'Interruption to Fish Passage', have the greatest potential to cause long-term shifts in local population abundance and presence. However, the embedded mitigation proposed and the onshore Project Aquatic Monitoring Plan should ensure that these impacts are not significant. Should issues begin to develop, these will be identified as part of monitoring and addressed prior to resulting in a negative impact. It is therefore not anticipated that any inter-related effects will be produced that are of greater significance than the assessments presented for each individual stage.

9.9 Whole Project assessment

The offshore Project is summarised in chapter 5: Project description and a summary of the effects of the offshore Project is provided in chapter 18: Offshore EIA summary. These offshore aspects of the Project have been considered in relation to the impacts assessed in section 9.6. The findings are presented below.

All freshwater ecology receptors identified are species or have life history strategies that require access to and from the marine environment. Therefore, any impacts which originate within the marine ecosystem will translate to the freshwater ecology study area. Subsequently, and perhaps more than any other receptor group, freshwater fish populations are at risk from both the onshore and offshore aspects of the Project. The embedded mitigation provided in this chapter should ensure that, over the life of the Project, there are no negative impacts delivered to the freshwater ecology receptors. However, for all species, their presence and persistence are tied to offshore factors. Any influence the Project exerts on the offshore life history stages of eel and salmonids, in particular, has the potential to impact the presence of the onshore receptors.

The offshore Project EIA demonstrates that there is potentially some effect on migrating diadromous fish populations from EMF and predator aggregations; but these effects were deemed minor, and taking account of embedded mitigation, not of a scale to impact on the populations of diadromous fish. However, these conclusions were based on limited information and the Offshore EIA Report did highlight that there remains data gaps in our understanding

of the spatial and temporal patterns of diadromous fish movements not only in the offshore Project area, but around Scotland. Strategic research initiatives in partnership with other developers and Scottish Government may be required to address these data gaps as identified in the ScotMER diadromous fish and fish and fisheries evidence maps (Scottish Government, 2023b and c).

9.10 Transboundary effects

Transboundary effects arise when impacts from a development within one European Economic Area (EEA) state's territory affects the environment of another EEA state(s). There is no potential for transboundary impacts upon freshwater ecology receptors due to the construction, operation and maintenance and decommissioning of the onshore Project. The potential impacts are localised and will not affect other EEA states. Therefore, transboundary effects for freshwater ecology receptors do not need to be considered further. However, it should be noted that the freshwater receptors may transition to the marine environment. Any transboundary effects at this stage will be assessed within chapter 11: Fish and shellfish ecology of the Offshore EIA Report.

9.11 Summary of mitigation and monitoring

No secondary mitigation, over and above the embedded mitigation measures proposed in section 9.5.4, is either required or proposed in relation to the potential effects of the onshore Project on freshwater ecology as no adverse significant impacts are predicted.

This chapter has used the best available evidence to inform the assessment of potential effects on freshwater ecology. However, the outcome of the EIA, including consultation with the statutory advisors has determined the requirement for monitoring to ensure the receptors remain unimpacted by the Project and this will be implemented via an Aquatic Monitoring Plan. This Aquatic Monitoring Plan will also ensure that any changes to the receptor baselines that are not attributable to the Project are recognised, thereby ensuring the true cause of receptor impact can be investigated by a competent agency. The Aquatic Monitoring Plan will include controls, to quantify a baseline ecological standard. This is expected to use standard family-level benthic macroinvertebrate surveys, annual fully quantitative electrofishing surveys and post-construction walkovers.

The specific detail of the monitoring cannot be determined as yet, because the specific watercourse crossing locations have not been finalised. Once the final Project infrastructure and cable routing is confirmed during detailed design (post-consent), the Aquatic Monitoring Plan will be developed, approved and implemented based on consultation with relevant statutory regulator.

The Project is committed to protecting the environment by ensuring best practice and embedded mitigation measures are followed at all times during construction, operation and maintenance and decommissioning. Additionally, the Project is committed to enhancing the environment, to the benefit of all. The approach includes, but is not limited to, partnering with key stakeholders, neighbouring developers and the local community to ensure that any proposed enhancements are suited to their local environment and benefit not only the primary species but the wider ecosystem. The Project is proposing a biodiversity enhancement project to include all relevant aquatic receptors. Rivers, in particular, are a key risk habitat from climate change in combination with channel modifications. The Project therefore proposes that an outline Biodiversity Enhancement Plan is submitted alongside the PPP application and will be finalised after planning consent has been granted, in line with further consultations.

9.12 References

Amstutz. U., Giger, T., Champigneulle, A., Day, P, &. Largiadèr, C.R. (2006). Distinct temporal patterns of Transaldolase 1 gene expression in future migratory and sedentary brown trout (*Salmo trutta*). Aquaculture. 260,326-336.

Abbey Properties Cambridgeshire Ltd (2020). Forss Windfarm Extension - Environmental Statement, Chapter 15: Traffic and Transport. Application reference: 20/04455/FUL. Available online at: https://wam.highland.gov.uk/wam/ [Accessed 21/02/23].

Armstrong, J., Kemp, P., Kennedy, G., Ladle, M. & Milner, N. (2003). Habitat requirements of Atlantic salmon and brown trout in streams. *Fisheries Research*. 62,143-170.

Bull, C., Gregory, S., Rivot, E., Sheehan, T., Ensing, D., Woodward, G. & Crozier, W. (2022). The likely suspects framework: the need for a life cycle approach for managing Atlantic salmon (*Salmo salar*) stocks across multiple scales. ICES Journal of Marine Science. 79,1445-1456.

Bjornsson, B., Stefansson, S. & McCormick, S. (2011). Environmental endocrinology of salmon smoltification. 2011. General and comparative Endocrinology. 170,290-298.

Chartered Institute of Ecology and Environmental Management (CIEEM) (2018). Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine version 12 – Updated April 2022. Available online at: https://cieem.net/wp-content/uploads/2018/08/ECIA-Guidelines-2018-Terrestrial-Freshwater-Coastal-and-Marine-V1.2-April-22-Compressed.pdf [Accessed 4/10/22].

Department for Environment, Food and Rural Affairs (DEFRA) (2010). Eel Management plans for the United Kingdom: Scotland River Basin District. Department for Environment, Food and Rural Affairs Commissioned Report.

Electricity Supply Board (ESB) Asset Development (UK) Ltd. (2020). Environmental Report – Spittal Synchronous Compensator. Application reference: 20/05118/FUL. Available online at: https://wam.highland.gov.uk/wam/ [Accessed 08/08/2023].

ESB Asset Development (UK) Ltd. (2021). Spittal Synchronous Compensator Grid Connection Outline Construction Method Statement. Available online at: https://wam.highland.gov.uk/wam/applicationDetails.do?activeTab=documents&keyVal=R58LJ4IHGE500 [Accessed 21/02/23].

Google (2022). Google Earth Pro App. Available online at: https://www.google.com/intl/en_uk/earth/about/versions/#earth-pro [Accessed 4/10/22].

Hume, J.B., Adams, C.E., Mable, B. & Bean, C.W. (2013). Post-zygotic hybrid viability in sympatric species pairs: a case study from European lampreys. Biological Journal of the Linnean Society. 108,378-383.

Hume, J.B. (2017). A review of the geographic distribution, status and conservation of Scotland's lampreys. The Glasgow Naturalist. 26,1-10.

Jackson, F.L., Fryer, R.J., Hannah, D.M., Millar, C. & Malcolm, I.A. (2018). A spatio-temporal statistical model of maximum daily river temperatures to inform the management of Scotland's Atlantic salmon rivers under climate change. Science of The Total Environment. 612,1543-1558.

Jacoby, D. & Gollock, M. (2014). *Anguilla anguilla*. The IUCN Red List of Threatened Species 2014. Available online at: https://www.iucnredlist.org/species/pdf/45833138 [Accessed 20/09/22].

Klemetsen, A., Amundsen, P.A., Dempson, J., Jonsson, B., Jonsson, N., O'Connell, M, & Mortensen, E. (2003). Atlantic salmon *Salmo salar* L., brown trout *Salmo trutta* L. and Arctic charr *Salvelinus alpinus* (L.); a review of aspects of their life history. *Ecology of Freshwater Fish*. 12,1-59.

Maitland, P.S. (2003). Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature Commissioned Report.

McKeown, N., Hynes, R., Duguid, A., Ferguson, A, & Prodohl, P. (2010). Phylogeographic structure of brown trout *Salmo trutta* in Britain and Ireland: glacial refugia, postglacial colonization and origins of sympatric populations. *Journal of Fish Biology*. 76,319-347.

Moorkens, E. (2011). *Margaritifera margaritifera*. The IUCN Red List of Threatened Species 2011: e.T12799A3382660. Available online at: https://www.iucnredlist.org/species/12799/128686456 Accessed 26/09/22].

Moorkens, E., Cordeiro, J., Seddon, M.B., von Proschwitz, T. & Woolnough, D. (2018). *Margaritifera margaritifera*. The IUCN Red List of Threatened Species 2017: e.T12799A128686456. Available online at: https://www.iucnredlist.org/species/12799/128686456m [Accessed 26/09/22].

Marine Directorate (2019). National Electrofishing Programme for Scotland (NEPS). Shiny App R. Available online at: https://scotland.shinyapps.io/sg-national-electrofishing-programme-scotland/ [Accessed 23/08/2023].

Marine Directorate (2022a). National Marine Plan Interactive (NMPi). Obstacles to Fish Passage (SEPA WMS). Available online at: https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=1746 [Accessed 23/08/2023].

Marine Directorate (2022b). National Marine Plan Interactive (NMPi): Salmon and Sea Trout – Scottish Salmon Rivers. Available online at: https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=843 [Accessed 23/08/2023].

North Atlantic Salmon Conservation Organisation (NASCO) (2019). State of North Atlantic Salmon. Available online at: https://nasco.int/wp-content/uploads/2020/05/SoS-final-online.pdf [Accessed 5/10/22].

NatureScot (2020a). Freshwater pearl mussel. Available online at: https://www.nature.scot/plants-animals-and-fungi/invertebrates/freshwater-invertebrates/freshwater-pearl-mussel [Accessed 23/09/22].

NatureScot (2020b). Standing advice for planning consultations - Freshwater Pearl Mussels. Available online at: https://www.nature.scot/doc/standing-advice-planning-consultations-freshwater-pearl-mussels [Accessed 23/09/22].

NatureScot (2020c). Scottish Biodiversity List. Available online at: https://www.nature.scot/doc/scottish-biodiversity-list [Accessed 26/09/22].

NatureScot (2022). SiteLink Map. Available online at: https://sitelink.nature.scot/map [Accessed 23/08/2023].

Office of Deputy Prime Minister (ODPM) (2005). Government Circular: Biodiversity and Geological Conservation – Statutory Obligations And Their Impact Within The Planning System. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/7692/147570.pdf [Accessed 08/08/23].

Ordnance Survey (2022a). Ordnance Survey Maps. Available online at: https://shop.ordnancesurvey.co.uk/maps/ [Accessed 23/08/2023].

Ordnance Survey (2022b) Ordnance Survey Terrain 5 Dataset. Available online at: https://www.ordnancesurvey.co.uk/products/os-terrain-5 [Accessed 23/08/2023].

OWPL (2023). West of Orkney Windfarm, Outline Biodiversity Enhancement Plan. WO1-WOW-CON-EV-RP-0011. Available online at: https://www.westoforkney.com/document-library#gsc.tab=0 [Accessed 31/08/2023].

Regini, K. (2000). Guidelines for Ecological Evaluation and Impact Assessment. *Ecology & Environmental Management In Practice, Bulletin of the Institute of Ecology and Environmental Management*.

Scottish Government (2020a). Scottish biodiversity strategy post-2020: statement of intent. Available online at: https://www.gov.scot/publications/scottish-biodiversity-strategy-post-2020-statement-intent/ [Accessed 23/08/2023].

Scottish Government (2020b). Salmon and recreational fisheries monitoring: Eels. Available online at: https://www.gov.scot/publications/salmon-and-recreational-fisheries-monitoring-eels/ [Accessed 4/10/22].

Scottish Government (2021). Monitoring watercourses in relation to onshore windfarm developments: generic monitoring programme. Available online at: https://www.gov.scot/publications/monitoring-watercourses-in-relation-to-onshore-wind-farm-developments-generic-monitoring-programme/ [Accessed 4/10/22].

Scottish Government (2023a). National Planning Framework 4. February 2023. Available online at: https://www.gov.scot/publications/national-planning-framework-4/documents/ [Accessed 18/05/2023].

Scottish Government (2023b). Fish and Fisheries ScotMER Receptor Group Evidence Map. Available online at: https://www.gov.scot/publications/fish-and-fisheries-specialist-receptor-group/ [Accessed 02/02/2023].

Scottish Government (2023c). Diadromous Fish ScotMER Receptor Group Evidence Map. Available online at: https://www.gov.scot/publications/diadromous-fish-specialist-receptor-group/ [Accessed 02/02/2023].

Scottish Natural Heritage (SNH) (2002). *Natural Heritage Zones: A National Assessment of Scotland's Landscapes.* SNH. Available online at: https://digital.nls.uk/pubs/e-monographs/2020/216666906.23.pdf [Accessed 23/08/2023].

Scottish Environment Protection Agency (SEPA) (2018). Guidance for Pollution Prevention, Dealing with spills: GPP 22 produced by SEPA, NIEA and NRW.

SEPA (2021). Supporting Guidance (WAT-SG-75). Sector-Specific Guidance: Water Run-off from Construction sites. Version 1. Guidance document produced by SEPA.

SEPA (2022a). The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended): A Practical Guide. Version 9.2. Guidance document produced by SEPA.

SEPA (2022b). SEPA Water Environment Hub. Available online at: https://www.sepa.org.uk/data-visualisation/water-environment-hub [Accessed 23/08/2023].

Sustainable Urban Drainage Scottish Working Party (SUDSWP) (2016). Water Assessment and Drainage Assessment Guide. A guidance document for developers, planners and others involved in water and drainage. Available online at: https://www.sepa.org.uk/media/163472/water_assessment_and_drainage_assessment_guide.pdf [Accessed 23/08/2023].

The Highland Council (THC) (2012). Highland-wide Local Development Plan. Available online at: https://www.highland.gov.uk/info/178/local_and_statutory_development_plans/199/highland-wide_local_development_plan [Accessed 08/09/2022].

THC (2013a). Supplementary Guidance: Highland's Statutorily Protected Species. Available online at: https://www.highland.gov.uk/downloads/file/3026/highland_statutorily_protected_species_supplementary_guidance [Accessed 11/09/2023].

THC (2013b). Supplementary Guidance: Flood Risk & Drainage Impact. Available online at: https://www.highland.gov.uk/downloads/file/2954/flood_risk_and_drainage_impact_assessment_supplementary_guidance [Accessed 23/08/2023].

THC (2018). Caithness and Sutherland Local Development Plan. Available online at: https://www.highland.gov.uk/info/178/local_and_statutory_development_plans/283/caithness_and_sutherland_local_development_plan [Accessed 06/07/2022].

Trex Ecology Ltd. (2020). Burn of Isauld pipeline crossing – Instream ecology site review Year 1. Report prepared for Caledonian Conservation. Unpublished.

Van Ginneken, V.J.T & Maes, G.E. (2005). The European eel (*Anguilla anguilla*, Linnaeus), its lifecycle, evolution and reproduction: a literature review. *Rev Fish Biol Fisheries* 15,367-398.

Welton, J.S., Beaumont, W.R.C. & Ladle, M. (2001). Timing of migration and changes in age structure of Atlantic salmon, *Salmo salar* L., in the River Frome, a Dorset chalk stream, over a 24-year period. *Fisheries Management and Ecology*. 10,1365-2400.

Woods Ballard, B., Wilson, S., Udale-Clarke, H., Illman, S., Scott, T., Ashley, R., Kellagher, R. (2015). The SuDS Manual (C753F). CIRIA.

Wright, R.M., Piper, A.T., Aarestrup, K., Azevedoe, J.M.N., Cowan, G., Don, A., Gollock, M., Ramallo, S.R., Velterop, R., Walker, A., Westerberg, H. & Righton, D. (2022). First direct evidence of adult European eels migrating to their breeding place in the Sargasso Sea. *Scientific Reports*. 12,1562-1568.

Youngson, A. (2022). 2021 Survey of Juvenile Salmonids in Caithness Rivers. Caithness District Salmon Fishery Board Commissioned Report. 53 pp.

Youngson, A. (2022). pers. comm, Caithness District Salmon Fishery Board, Tommy McDermott, Trex Ecology, 2022.

9.13 Abbreviations

ACRONYM	DEFINITION
CAR	Controlled Activities (Scotland) Regulations
CaSPlan	Caithness and Sutherland Local Development Plan
CDSFB	Caithness District Salmon Fishery Board
CEMP	Construction Environmental Management Plan
CIEEM	Chartered Institute of Ecology and Environmental Management
CMS	Construction Method Statements
DBA	Desk-Based Assessment
DEFRA	Department for Environment, Food & Rural Affairs
DSFB	District Salmon Fishery Board
EC	European Commission
EcIA	Ecological Impact Assessment
ECoW	Ecological Clerk of Works
EEA	European Economic Area
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
ESB	Electricity Supply Board
FMS	Fisheries Management Scotland
FPM	Freshwater Pearl Mussel
GWDTE	Groundwater Dependent Terrestrial Ecosystems
Ha	Hectares
HBA	Habitat-Based Approach
HBAP	Highland Biodiversity Action Plan

ACRONYM	DEFINITION
HDD	Horizontal Directional Drilling
HRA	Habitat Regulations Assessment
HwLDP	Highland-wide Local Development Plan
IUCN	International Union for Conservation of Nature
km	Kilometres
km^2	Kilometres squared
LWD	Large Woody Debris
m	Metres
m^2	Metres squared
m^3	Metres cubed
MD-LOT	Marine Directorate - Licensing Operations Team
MS-LOT	Marine Scotland - Licensing Operations Team
NASCO	North Atlantic Salmon Conservation Organisation
NDSFB	Northern District Salmon Fishery Board
NEPS	National Electrofishing Programme for Scotland
NERC	Natural Environment and Rural Communities
NHZ	Natural Heritage Zone
NIEA	Northern Ireland Environment Agency
NMPi	National Marine Plan Interactive
NPF4	National Planning Framework 4
NRW	Natural Resource Wales
OCT	Open Cut Trench
ODPM	Office of the Deputy Prime Minister

ACRONYM	DEFINITION
OIC	Orkney Islands Council
OMP	Outline Management Plan
PPP	Planning Permission in Principle
RIAA	Report to Inform Appropriate Assessment
SAC	Special Area of Conservation
SBL	Scottish Biodiversity List
SEPA	Scottish Environment Protection Agency
SNH	Scottish Natural Heritage
SRMP	Soil Resource Management Plan
SS	Supporting Study
SSSI	Site of Special Scientific Interest
SST	Seasonal Sensitivity Tables
SuDS	Sustainable Drainage System
THC	The Highland Council
UK	United Kingdom
USB	Universal Serial Bus
WB	Water Bodies
WCA	Wildlife and Countryside Act
WFD	Water Framework Directive

9.14 Glossary

TERM	DEFINITION
Alevin	First (larval) hatched stage in salmonid life cycle, still attached to egg sac.
Ammocoete	Juvenile lamprey.
Anadromous	Fish that are born in freshwater, migrate out to the ocean to mature into adults, and then swim back to freshwater to spawn
Ecotypes	Unique populations that are adapted to their local environment.
Fry	Free-swimming juvenile salmonid hatched in that year.
Glass eel	Transparent juvenile eel, commonly seen during river entry.
Grilse	Adult salmon which returns after one winter at sea
Kelt	Salmon that have entered the river the previous season / year, successfully spawned and now recovering prior to their migration back to sea.
Leptocephalus	Post hatch juvenile eel during migration.
Multi sea winter	Adult salmon which returns after more than one winter at sea.
Ova	Fertilised egg.
Parr	Juvenile salmonid following at least one winter.
Post-smolt	Juvenile salmonid immediately after leaving the freshwater environment.
Redd	Nest excavated by spawning salmonids and lamprey.
Rheophillic	An animal that prefers living in fast flowing water.
Riparian	Lands that occur along the edges of rivers, streams, lakes, and other water bodies.
Silver eel	Eel transitioning to marine form prior to and during seaward and sea migration.
Smolt	Juvenile salmonid undertaking physiological change while migrating to sea.
Transformer	Juvenile lamprey transitioning to marine form. Analogous to smolt.
Yellow eel	Eel residing in freshwater.