ARCUS

MOORSHIELD WIND TURBINES PLANNING APPLICATION

APPENDIX **2.**3: HYDROLOGY ASSESSMENT

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Prepared By:

Arcus Consultancy Services

7th Floor
144 West George Street
Glasgow
G2 2HG

T +44 (0)141 221 9997 l E info@arcusconsulting.co.uk
w www.arcusconsulting.co.uk

Registered in England & Wales No. 5644976

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1 INTRODUCTION

This Hydrology Assessment (the Report) assesses the potential hydrological and hydrogeological effects of the proposed Moorshield wind turbines (the Development) within the defined study area on hydrological receptors. The Report has been prepared to accompany a planning application (the Application) submitted to East Renfrewshire Council by Arcus Consultancy Services Ltd (Arcus) on behalf of Moorshield Wind Farm Ltd (the Applicant) for the Development located at Moor Road, East Renfrewshire, approximately 6 kilometres (km) southwest of Eaglesham; National Grid Reference (NGR) 251966, 649283 (the Site).

The Development is described in Section 3 of the accompanying Supporting Statement and is summarised as three turbines with a total of approximately 15 Megawatt (MW) capacity with associated infrastructure, however the grid capacity allows for a generation of up to 18 MW.

This Report includes baseline information, identifies potential pollution events and assesses the implications of these events on the hydrological environment. The Report then sets out the requirement for mitigation, management and monitoring measures, where appropriate.

This Report is accompanied by the following documents:

- Annex A: Figures.

2 METHODOLOGY

2.1 Assessment

This assessment incorporates the following elements, further details of which are provided in the remainder of the Report:

- Desk study, including review of available maps and published information;
- Evaluation of potential pollution events; and
- Evaluation of the implications of potential pollution events.

The assessment follows a source-pathway-receptor methodology which has been developed in consultation with regulatory bodies such as the Scottish Environment Protection Agency (SEPA) and Scottish Natural Heritage (SNH).

2.2 Data Sources and Study Area

The following data sources have been used to inform the site walkover and assessment:

- British Geology Survey (BGS) digital mapping;
- Scotland's Environment databases and mapping;
- SEPA Flood Map 2014;
- Hydrogeological Map of Scotland 1:625,000, 1988;
- UK Hydrogeological Map (1:625,000 scale);
- Ordnance Survey 1:10,000 digital mapping;
- Centre for Ecology and Hydrology National River Flow Archive;
- SNH Designated Sites digital mapping; and
- Aerial photography.

The desk-based study has used a Core Study Area, centred on the Site boundary as shown on Figure 1 and Figure 2 illustrates the private water supply locations which are both contained in Annex A of this Report.

A Wider Study Area of 5 km from the Core Study Area has been considered to ensure that wider hydrological recourses are assessed. Due to attenuation and dilution over distance of potentially polluting chemicals and sediment, the Development is not considered likely to affect hydrological resources at distances greater than 5 km. These study areas are defined based on professional judgement and experience assessing similar scale developments within similar hydrological catchments in Scotland.

3 BASELINE CONDITIONS

3.1 Existing Land Use

The Core Study Area is comprised of heathland, moorland and rough grazing with an area of arable land in the north-west of the Site. The Wider Study Area comprising mainly rough grazing with areas of forestry to the north and west. The Bennan Loch is located approximately 30 metres (m) to the north of the Core Study Area.

3.2 Surface Hydrology

The Core Study Area lies within the surface water catchment of the River Irvine (Cessnock confluence to Tidal Weir) and Kingswell Burn (also known as Fenwick Water and Kilmarnock Water) which has an overall SEPA classification of 'Poor'.

The Kingswell Burn rises approximately 950 m to the east of the Core Study Area as the Soame Burn tributary. The Soame Burn flows west and forms a confluence with the Sheildhill Burn / Bennan Burn approximately 1 km to the west of the Core Study Area, at which point it becomes the Kingswell Burn. The Soame Burn does not cross the Core Study Area but flows approximately 570 m to the south.

A number of minor unnamed tributaries of the Soame Burn rise in the centre of the Core Study Area where the elevation is higher (260 m Above Ordnance Datum [AOD]) and flow west. An unnamed watercourse, and an associated tributary, rise in the north of the Core Study Area at an approximate altitude of 265 m AOD and flow north into the Bennan Loch.

There are two minor drains in the north of the Core Study Area associated with the arable crop fields.

3.3 Solid Geology

The British Geological Survey (BGS) 1:625,000 scale mapping indicates the underlying solid geology across the majority of the Core Study Area is comprised of unnamed extrusive igneous rocks (mafic and felsic lava and tuff).

3.4 Superficial Geology

The BGS 1:625,000 scale mapping indicates superficial peat deposits are present across the southern extent of the Core Study Area.

3.5 Hydrogeology

The BGS 1:625,000 scale hydrogeological map identifies the unnamed extrusive igneous bedrock as a low productivity aquifer with small amounts of groundwater in the near surface weathered zone and secondary fractures. Rare springs may yield some groundwater.

Superficial peat deposits and peaty soils on site are likely to store groundwater however, peaty deposits typically overlie less permeable units and groundwater flow is typically limited within peat.

Scotland's Environment digital mapping service[1] shows the Core Study Area is underlain by the Newton Mearns groundwater body in the north and the Whitelee groundwater body to the south. Both groundwater bodies lie within the Clyde sub-basin district and have an overall SEPA classification of 'Good'.

[1] Scotland's Environment (2019) Digital Mapping Service [Online] Available at: https://map.environment.gov.scot/sewebmap/ [Accessed 13/02/2020]

Data on hydrogeology was obtained from the SEPA and SNIFFER Groundwater Vulnerability Map (SEPA and SNIFFER, 2004). The Vulnerability Map represents the strata overlying the aquifer ('vertical pathway'). These maps provide the following information for the Site:

- Vulnerability Class: 4a and 4b.

Vulnerability classes range from 1 to 5, with 5 being most vulnerable. Class 4 is subdivided into 4a and 4b. It is the hydrogeological characteristics within the pathway rather than the 'importance' of a particular aquifer that results in the final vulnerability classification. The methodology behind the classification assumes that where contaminants move through unsaturated fractured bedrock, no attenuation of pollutants can take place. Large parts of Scotland show areas of Classes 4 and 5, reflecting the widespread occurrence of rocks dominated by fracture flow located exposed at the surface where the potential for attenuation of contaminants, from overlying strata, in the pathway is very limited.

3.6 Public and Private Water Supplies

The Core Study Area is located within a Drinking Water Protected Area (surface water), which is an area where a waterbody is used for the abstraction of Scottish Water public supply drinking water as shown in Figure 2 – Private Water Supply Location in Annex A of this report.

The online Private Water Supply Map provided by the Drinking Water Quality Regulator (DWQR) for Scotland was also consulted[2], and identified a Type A PWS located approximately 500 m to the south-east of the Core Study Area associated with the Whitelee Visitor Centre. A Type A PWS supply is defined by the DWQR as a supply for more than 50 people or an abstraction of 10 m^3 per day or greater, and any PWS which is used for commercial or public activity (DWQR, 2018).

The DWQR online Private Water Supply Map also identified one Type B PWS located within 1 km of the Site boundary located at Sheildhill, approximately 300 m west of the Core Study Area.

The Council was also consulted on the location of PWS within a 1 km buffer of the Site boundary and have confirmed there are no additional PWS to that provided by the DWQR.

3.7 Flooding

The SEPA flood map shows the areas of Scotland with a 0.5 % (1 in 200 years) or greater chance of flooding, identified as medium to high risk areas for flooding.

The Core Study Area shows areas of medium to high risk of surface water flooding on the unnamed tributaries of the Soame Burn and the flooding is contained within the extent of watercourse channels.

3.8 Climate

The National River Flow Archive (NRFA) reports Average Annual Rainfall within the River Irvine catchment as 1228 millimetres (mm).

The National River Flow Archive (NRFA) does not have any surface water gauging stations, upstream of the Development. The closest gauging station is the River Irvine at Shewalton which is located approximately 20 km to the south-west of the Core Study Area.

[2] Drinking Water Quality Regulator for Scotland (2018) Private Water Supply Map [Online] Available at: http://dwqr.scot/private-supply/pws-location-map/ [Accessed 13/02/2020]

3.9 Statutory Designations

There is one statutory designated site located within the 5 km Wider Study Area as outline in Table 1.

Table 1: Statutory Designations within the Core Study Area

Designation	Distance from the Development	Qualifying Interest	Hydrologically Linked to the Development
Brother and Little Lochs SSSI	2.65 km north-west	Oligotrophic loch; varnished hook-moss	No - upstream of the Development and hydrologically separated by the Blackloch Burn

3.10 Groundwater Dependent Terrestrial Ecosystems (GWDTEs)

An Extended Phase 1 Habitat Survey and NVC Survey identified habitats of acid/ neutral flush and spring (M6c and M6d NVC communities) and marsh and marshy grassland (M23b NVC communities) in the Core Study Area, which are defined by the SEPA technical guidance provided in LUPSGU31[3] as high groundwater dependency habitats.

The habitats of blanket sphagnum bog (M15b and M17 NVC communities), dry heath/ acid grassland (U6b NVC communities) and neutral grassland (MG9 NVC communities) are identified by the SEPA technical guidance as moderate groundwater dependency habitats.

The Extended Phase 1 Habitat Survey and NVC Survey is provided in Appendix 5.

3.11 Fisheries

There are no fisheries designations hydrologically connected to the Core Study Area.

3.12 Information Gaps

All data considered necessary to identify and assess the potential pollution events resulting from the construction of the Development were available and used in the assessment reported in this Report, and as such there were not considered to be any information gaps.

3.13 Sensitivity of Receptors

The sensitivities of the identified receptors, and their relationship to the potential effects from the construction of the Development are outlined in Table 2.

[3] SEPA (2017) SEPA Guidance Note 31 [Online] Available at: https://www.sepa.org.uk/media/144266/lups-gu31-guidance-on-assessing-the-impacts-of-development-proposals-on-groundwater-abstractions-and-groundwater-dependent-terrestrial-ecosystems.pdf [Accessed 13/02/2020]

Table 2: Sensitivity of Receptors to Potential Pollutants or Construction Scenarios

Receptor	Potential Pollutants or Construction Scenarios	Sensitivity of Receptor	Comments
Watercourses	Increased run-off, erosion and sedimentation, stream flow impediments and pollution as a result of track construction and chemical handling / storage.	High	The Kingswell Burn has a SEPA classification of 'Poor'. However, the area is a DWPA for surface water. Type A and Type B PWS are located within 1 km of the Site boundary. As a result of the presence of the DWPA and PWS, the sensitivity is considered to be High.
Groundwater	Chemical Pollution as a result of construction.	High	Considered High sensitivity as hydrocarbon pollution in bedrock fissures has a lengthy attenuation period. Groundwater bodies within the Core Study Area will provide baseflow to watercourses. Type A and Type B PWS are located within 1 km of the Core Study Area (source unknown). Groundwater vulnerability is classified as 4a to 4b (high).
Soils	Pollution as a result of track and turbine construction.	Moderate	Considered Moderate sensitivity as the receptor has capacity to filter and attenuate most excess runoff and sediment.
GWDTEs	Changes to groundwater interflow patters as a result of construction.	High	Considered High sensitivity as habitats identified within the Core Study Area are classed as having high and moderate groundwater dependency.

3.14 Embedded Design and Pollution Prevention Measures

A 50 m buffer zone has been established for the turbine base and ancillary structures / infrastructure around natural watercourses on the Site. Beyond this, the separation of construction ground-works from watercourses has been maximised.

The proposed access track crosses one watercourse as shown on the 1:50,000 ordnance survey map. Where necessary the access tracks and watercourse crossings will be constructed and upgraded in line with best practice guidance[4],[5],[6].

A 10 m buffer has been established for the turbine base and ancillary structures / infrastructure around seasonal (ephemeral) and minor field drains.

[4] SEPA (2008) Construction of River Crossings [Online] Available at: http://www.sepa.org.uk/planning.aspx
[5] Forestry Commission (2011) Forest and Water Guidelines, 5th Edition [Online] Available at: https://www.confor.org.uk/media/246145/forest-and-water-guidelines.pdf [Accessed 13/02/2020]
[6] SEPA (2015) Culverting of Watercourses: Position Statement and Supporting Guidance v 2.0 [Online] Available at: https://www.sepa.org.uk/media/150919/wat_ps_06_02.pdf [Accessed 13/02/2020]

The 50 m buffer zone of natural watercourses, in conjunction with the 10 m buffer of drains should avoid potential effects on onsite watercourses and is considered as embedded design of the Development.

Good practice will be followed in all aspects of construction, operation and decommissioning, specifically through the overall Construction and Environmental Management Plan (CEMP). The CEMP will be produced by the construction contractor incorporate a Pollution Prevention Plan (PPP).

The PPP will set out measures to be employed to avoid or mitigate potential pollution incidents for all phases of the Development, and will also include an Incident Plan to be followed should a pollution event occur. The Incident Plan will be produced following consultation and agreement with SEPA and all appropriate personnel working on Site will be trained in its use. The Construction Project Manager will have specific responsibility for implementation of the PPP.

Method statements for watercourse crossings and excavations will also be applied, which will follow the principles laid out in relevant SEPA Guidelines for Pollution Prevention and guidance for watercourse crossings[7].

3.15 Chemical Pollution

Watercourses, soils and groundwater could be at risk from a pollution incident during construction, however good practice and proper management will avoid pollution incidents.

Potential risks include the spillage or leakage of chemicals, foul water, fuel or oil, during use or storage on site. These pollutants have the potential to adversely affect the quality of surface water resources, soils and groundwater.

The 50 m buffer between watercourses and the construction compounds, and measures including absorbent spill pads and impermeable geosynthetic membranes, will limit the uncontained release of chemicals to minor fugitive releases.

Any material or substance which could cause pollution, including fuels / oils, pumped mud or silty water will be prevented from entering surface water drains or watercourses by the appropriate use of and placement of silt fences, cut-off drains, silt traps and drainage matting.

To prevent pollution, all concrete pours will be planned and specific procedures adopted where there may be a risk of groundwater or surface water contamination, in accordance with CIRIA C532. These procedures will likely include:

- Turbine foundations are constructed in excavations that are typically de-watered, and hence water flow is typically into the foundation area. This will prevent concrete leaching into groundwater in the event of shutter collapse;
- Ensuring that all excavations are sufficiently dewatered before concrete pours begin and that dewatering continues while the concrete cures. However, construction good practice will be followed to ensure that fresh concrete is isolated from the dewatering system; and
- Ensuring that covers are available for freshly placed concrete to avoid the surface of the concrete washing away during heavy precipitation.
- Additionally, no chemical additives will be used during the concrete pour for the turbine foundation.

[7] SEPA (2010) Engineering in the Water Environment: Good Practice Guide [Online] Available at: https://www.sepa.org.uk/media/151036/wat-sg-25.pdf [Accessed 13/02/2020]

3.16 Erosion and Sedimentation

Erosion and sedimentation can occur from excavations, de-watering, ground disturbance (including soil stripping), overburden stockpiling and tracks crossing watercourses and drains. Sediment entering nearby watercourses has the potential to impact on water quality.

One watercourse is crossed by the proposed access track route. All track construction and the sole watercourse crossing will be constructed in line with best practice guidance[8].

Adoption of best practice measures including silt traps, silt fencing, swales and interception bunds, will prevent sediment entering surface watercourses and groundwater.

3.17 Increase in Runoff and Flooding

The increase in hardstanding area associated with construction and operation of the Development could increase the volume and rate of localised surface run-off, although the majority of the proposed infrastructure hardstanding, including access tracks and crane hardstandings, would be permeable to some extent. The impermeable nature of the underlying geology, however, means that, in the baseline scenario, there will be relatively low infiltration and relatively high run-off rates, and hence the addition of the Development would have a minimal effect from the existing scenario.

The design of the Development layout has incorporated a buffer zone of 50 m between natural watercourses and turbine bases.

Measures, including Sustainable Drainage Systems (SuDS) measures, to attenuate run-off and intercept sediment prior to run-off entering watercourses will be used onsite, where appropriate.

Furthermore, the area of new tracks and hardstanding, in terms of the percentage of the relevant catchments that may be affected, is small, hence the addition of the Development would have a minimal effect from the existing scenario.

3.18 Hydrological Function of GWDTEs

Temporary sub-surface water controls and physical sub-surface barriers resulting from turbine foundation, hardstanding and access track construction have the potential to change the quality and quantity of water supplying GWDTEs.

Due to the limited productivity of the groundwater units and the elevation at the Site (265 mAOD), it is considered that the habitats with high potential for groundwater dependency (M6c, M6d and M23b communities) are ombrotrophic, fed by precipitation and by water from minor watercourses and surface and near-surface run-off, rather than by groundwater.

Regardless, prior to construction, site operatives will identify flush areas, depressions or zones which may concentrate water flow. Measures to maintain hydrological connectivity of GWDTEs will be implemented within these areas during construction of the Development, including the following:

- Areas of site identified as being saturated will be spanned with plastic pipes or drainage matting to ensure hydraulic conductivity under the track, and reduce water flow over the road surface during heavy precipitation;
- Lining the foundation excavation with an impermeable geotextile membrane to ensure that any exposed bedrock is covered. This will limit the potential for concrete fines to enter groundwater via fissures in the bedrock;

[8] SEPA (2008) Construction of River Crossings [Online] Available at: http://www.sepa.org.uk/planning.aspx [Accessed 13/02/2020]

- An impermeable geotextile membrane will be placed around wooden shutter casings during concrete pouring. This will prevent concrete leaching into groundwater or the M25 community in the event of shutter collapse and will reduce the potential for a preferential hydrological pathway to be created to draw water from upslope; and
- Ensuring that covers are available for freshly placed concrete to avoid the surface of the concrete washing away during heavy precipitation.

Taking these measures into account, any impact on groundwater or near-surface water flow and GWDTEs (of moderate groundwater dependency) will be minimal.

3.19 Effects on Water Supplies

Sheildhill, approximately 300 m west of the Core Study Area, is located outside the assessment distance as stipulated in SEPAs Land Use Planning System SEPA Guidance Note 31[9].

Due to the Development being located within a DWPA, it is recommended that a programme of Water Quality Monitoring (WQM) is undertaken during the construction phase. This will ensure that any deviation from baseline levels will be detected at the earliest opportunity and measures taken to rectify site procedures implemented.

It is also recommended that property owners, occupants and neighbours who have the potential to use a PWS are consulted. This will aim to identify the source of PWS supplies. Following consultation, if the source of a PWS supply is considered to be connected to the Development, it is recommended water quality monitoring of PWS source(s) and supply (or supplies) is undertaken during construction. This will ensure that any deviation from baseline levels will be detected at the earliest opportunity and measures taken to rectify site procedures implemented.

Along with embedded design measures and good construction practice (outlined in a CEMP and PPP), WQM will ensure there is limited potential for DWPA to be impacted.

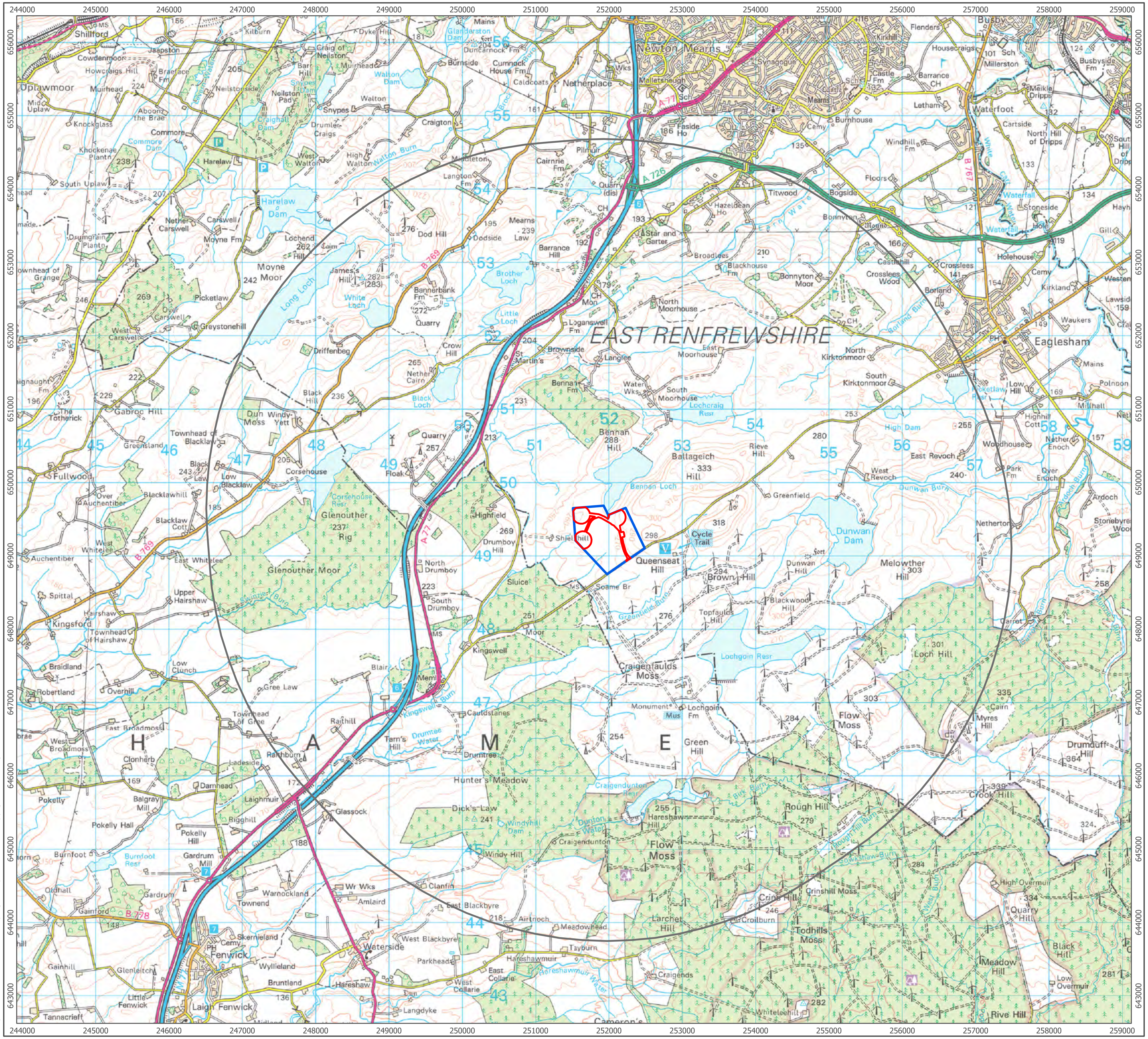
4 CONCLUSION

An appraisal has been undertaken to identify and assess the possible pollution scenarios that the Development may have on the hydrological and hydrogeological resource within the Core and Wider Study Areas.

With the embedded design and the implementation of suggested mitigation and construction good practice measures, potential effects on the identified receptors arising from the construction and operation of the Development are considered to be unlikely.

[9] Scottish Environment Protection Agency (SEPA). Land Use Planning System: Guidance Note 31. Available online at: https://www.sepa.org.uk/media/144266/lups-gu31-guidance-on-assessing-the-impacts-of-development-proposals-on-groundwater-abstractions-and-groundwater-dependent-terrestrial-ecosystems.pdf [Accessed 13/02/2020]

ANNEX A: FIGURES



wind2

ARCUS

- Hydrology Study Areas
- Planning Application Boundary
- Site Boundary

1:50,000 Scale @ A3

0 1 2 km

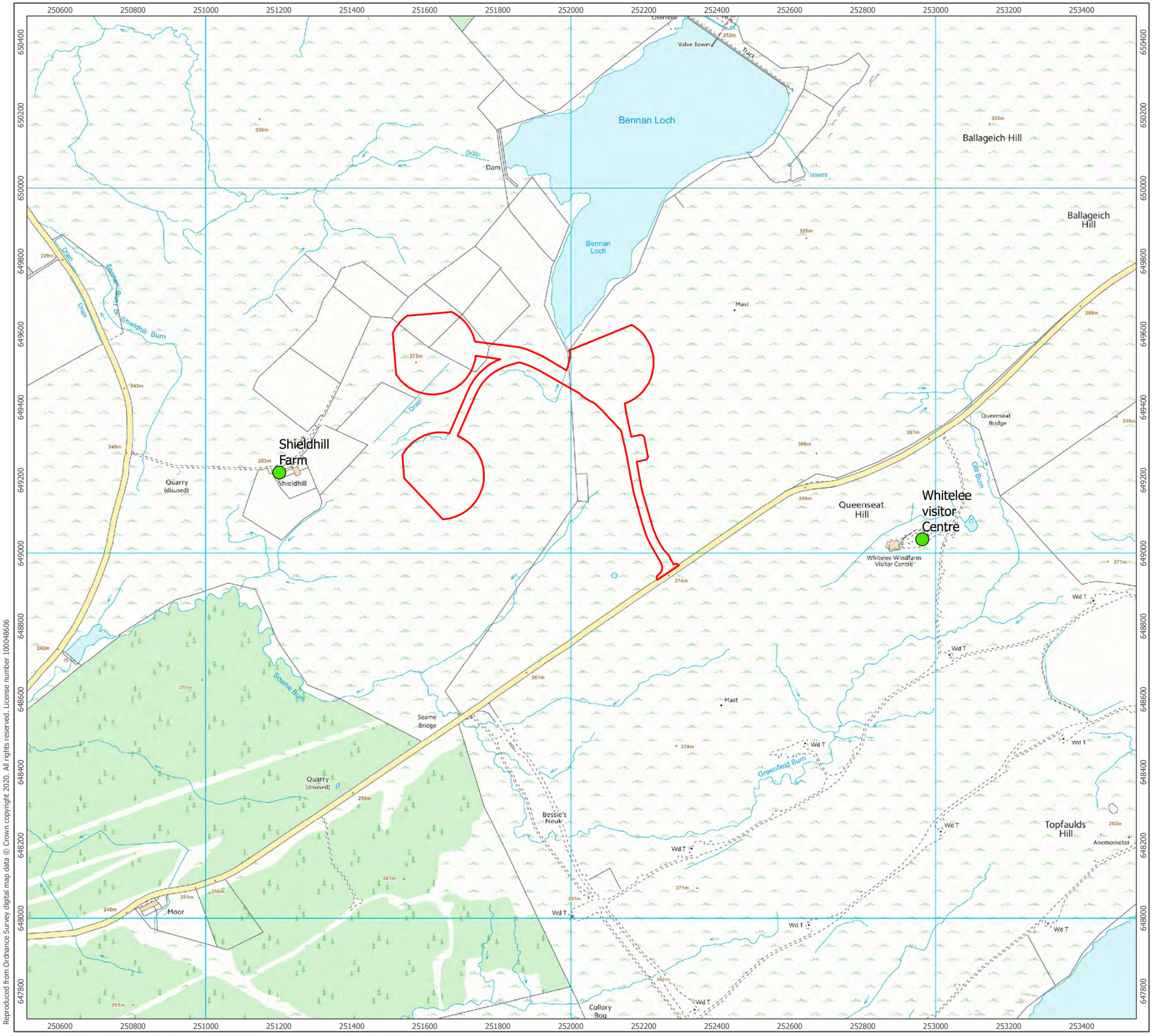
NORTH

Produced By: HC	Ref: 3520-REP-025
Checked By: SC	Date: 01/04/2020

Hydrology Study Area
Figure 1

Moorshield Wind Turbines
Hydrology Assessment

P:\Projects\Hydrology\Projects\3520 Moorshield\3520 Moorshield.aprx\3520-REP-025 Fig01 Hydrology Study Area



P:\Projects\Hydrology\Projects\3520 Moorshield\3520 Moorshield.aprx\3520-REP-033 Fig02 Private Water Supply Locations

wind2

ARCUS

- PWS
- Planning Application Boundary

1:10,000 Scale @ A3

0 200 400 m

NORTH

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Checked By: SC	Date: 01/04/2020

Private Water Supply Locations
Figure 2

Moorshield Wind Turbines Hydrology Assessment