Appendix 10.6

Outline Peat Management Plan

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1 Introduction

1.1.1 In support of **Chapter 10** (**Volume 1**) of the Design Manual for Roads and Bridges (DMRB) Stage 3 Environmental Impact Assessment (EIA) report; this technical appendix presents an Outline Peat Management Plan (OPMP) for Project 9 – Crubenmore to Kincraig of the A9 Dualling Programme, hereafter referred to as the Proposed Scheme.

1.1.2 The purpose of the OPMP is to present estimated peaty soil/ topsoil and peat excavation volumes, and demonstrate that management of these during construction of the Proposed Scheme has been considered and shall be treated appropriately. It describes the management approach adopted through design development of the Proposed Scheme related to peat, and presents an outline of options that may further minimise impacts and/ or provide mitigation through potential re-use.

1.1.3 The information presented herein supports the impacts assessed in **Chapter 10** (**Volume 1**) and has been prepared utilising available information as described in **Appendix 10.1** (**Volume 2**). This and other relevant aspects of the DMRB Stage 3 EIA should therefore be referred to as necessary.

2 Developments on Peatland

2.1 Definition of Peat

2.1.1 In Scotland, peat is defined as *"an organic soil which contains more than 60 per cent of organic matter and exceeds 50cm in thickness"* (Macaulay Institute, 1984). Scotland's National Peatland Plan also encompasses organic soil less than 50cm, which can support typical peatland vegetation (SNH, 2015a). Organic deposits less than 50cm in thickness are therefore considered in this and related aspects of the DMRB Stage 3 EIA as 'peaty soils'. Joint Nature Conservation Committee (JNCC) (2011) and Scottish Government *et al.* (2017) guidance on peat surveys also follow this peaty soil definition. 'Deep peat' is considered to be a peat soil with a surface organic layer greater than 1.00m thickness (Bruneau and Johnson, 2014).

2.1.2 The structure of a true active peatland typically comprises a thin surface layer of living vegetation (the *acrotelm*) overlying a usually thicker layer of well decayed and humified peat, comprising the consolidated remains of former surface vegetation (the *catotelm*). Below the peat forming layers is the basal *substrate*, either a mineral soil, mineral superficial deposit or bedrock.

2.1.3 The acrotelm is the upper aerobic layer of peat and consists of living and partially decayed plant material. It typically has a higher hydraulic conductivity than underlying peat and is usually defined with relation to the water table. Acrotelm thickness varies with topography – such as hummocks, peat haggs, hollows and with time, especially in dry periods or when it is drained.

2.1.4 The catotelm layer sits beneath the acrotelm and consists of well decayed and humified material, and is denser with a very low hydraulic conductivity. Conditions are anaerobic and anoxic because the catotelm is permanently below the water table. The catotelm is weaker and of lower tensile strength than the acrotelm and is generally considered to be less suitable for storage and re-use.

2.2 Peat Importance

2.2.1 Over 20% of Scotland's land area is covered by peatlands, and Scotland hosts a significant proportion of the European and world resource. Foremost, peatlands are long-term carbon stores, important to tackling climate change; but they are also important to rural farming, tourism, in providing clean water and in lowering flood risks. Scotland's National Peatland Plan published by Scottish Natural Heritage (SNH) also notes that they form beautiful landscapes, represent key habitats and are a defining characteristic of wild Scotland (SNH, 2015a).

2.2.2 Drying and physical damage to peat can release greenhouse gases, reduce water quality and diminish a range of other services. Peat is also geotechnically complex, and special consideration must be given to the practicalities of engineering in peat and peat soils, with careful management of construction activities required to avoid such damage.

2.3 Requirement for an Outline Peat Management Plan

2.3.1 The significance of peatlands is most evident in their protection by various legislation, policy and local, national or international initiatives including, but not limited to; the United Kingdom Biodiversity Action Plan (UKBAP), Scotland's National Peatland Plan (SNH, 2015), European Council Habitats Directive 92/43/EEC (Council of the European Communities, 1992), the Scottish Biodiversity List (SBL) (Scottish Government, 2013), Cairngorms Nature Action Plan (CNAP) (CNPA, 2013), the European Council Water Framework Directive 2000/60/EC (Council of the European Communities, 2000), Scottish Government discussion paper on the Management of Carbon-Rich Soils (Scottish Government, 2010), Scottish Soil Framework (Scottish Government, 2009) and the Climate Change Plan (2017-2032) (Scottish Government *et al.*, 2017).

2.3.1 Indeed, the Scottish Environment Protection Agency (SEPA) has a statutory and legislative duty to ensure that where peat spoil is generated during construction; that it is stored, re-used, treated or disposed of correctly; which may require authorisation or permits.

2.3.2 SEPA's policy on the management of peat spoil is set out within *'Regulatory Position Statement – Developments on Peat'* (SEPA, 2010). This highlights that the best management option for peat spoil is the prevention of its production, by seeking to minimise peat excavation and disturbance. Where this is unavoidable, developers should attempt to re-use as much of the peat produced on site as is possible, in justifiable and environmentally beneficial ways.

2.3.3 The fact that materials have a potential re-use within the site boundary is not sufficient in itself to determine that they are not waste. For example, where there is no justified requirement or demonstrable need for the peat to be used, or it is clearly not suitable for the identified use, it will likely be classed as a disposal operation, and the proposed activity will require authorisation from SEPA accordingly. In this respect, SEPA will seek to ensure that there are no risks to the environment, or human health associated with the proposed activities, and will identify any regulatory requirements that would affect such activities.

2.3.4 It is therefore strongly recommended that OPMPs are formulated to ensure that peatlands are managed in accordance with best practice and specifically, that damage to peatland habitats and vegetation are, wherever possible, avoided during construction and, where this is not possible, that peat is re-instated effectively with a minimal loss of carbon.

2.4 Construction Considerations

Geotechnical Characteristics

2.4.1 Geotechnically, peat soils are complex as previously noted; comprising broken down plant remains rather than mineral particles. As such, conventional soil mechanics theory does not apply well (Hobbs, 1986), and site-specific experience is often as useful in understanding peat behaviour under construction activities as modelled behaviour. The primary geotechnical characteristic of relevance to road construction is the behaviour of peat under loading, which normally occurs as a rapid phase of primary consolidation followed by a much slower phase of secondary compression (SNH, 2005). Scheduling of construction activities must take into account this behaviour to ensure that infrastructure constructed over peat takes account of its settlement characteristics.

2.4.2 In addition, peat strength plays a role in determining the settings in which certain infrastructures are appropriate. The acrotelm is typically stronger than catotelm peat, with the former afforded a degree of tensile strength from its vegetation layer, and the latter lacking this and the cohesion associated with some other soft sediments such as clays.

Construction Methods

2.4.3 The geotechnical characteristics of peat affect the choice of appropriate construction methods that are available for building infrastructure on peatland. Such methods include:

- **Excavation (Cut and Fill):** This is likely to be the most commonly used technique, used in most areas except the deepest peat, or where roads are expected to take low traffic volumes. The technique involves removing peat so that further cuttings can be made into substrate, or so that engineering grade fill can be placed onto a stratum of suitable bearing capacity to achieve the horizontal and vertical alignment required. Auxiliary elements such as Sustainable Drainage Systems (SuDS), compensatory flood storage areas, watercourse diversions and drainage are all likely to be achieved through excavation techniques.
- **Floating:** The technique of floating roads is usually reserved for access tracks, private and low traffic-volume roads. Floating roads can be described as a road that is constructed directly on top of the peat, relying on the strength of the in-situ peat for its support. The road does not actually ‘float’ on the peat, rather, an equilibrium builds up between the weight of the road and the in-situ strength of the peat whereby the combined system comes into balance. Modern construction practice generally calls for a geosynthetic layer to be placed on the surface of the peat, before the road is constructed, to give a working platform for the road and provide a separation layer between the road and the peat below. This layer, however, does not support the road – the road is supported by the peat (FCS and SNH, 2010).
- **Piling:** Piling techniques are usually reserved for areas where major routes need to cross peat consistently in excess of 2.00m deep. The technique involves the laying of a ‘piling mat’ over the peat, through which piles are driven to reach a stratum of suitable bearing capacity, without any excavation taking place. The road is subsequently constructed on the piles.
- **Bridging:** Similar to piling, such a technique would only be considered for major carriageways crossing the deepest areas of peat. Bridging would involve creation of bridge abutments either side of peat areas with a bridge deck being created between the two abutments to carry the road over the peat.

2.4.4 Generally; floating, piling and bridging do not require, or at least substantially limit, excavation of peat, and can be key techniques to reduce the impact of road construction in peatlands.

2.4.5 Vibro-replacement is another technique which is sometimes considered to improve the bearing capacity of soft soils. However, such an approach is not considered appropriate in peat due to the lack of lateral confinement offered by the peat material (Vibro Menard, 2017).

Re-use Considerations

2.4.6 Minimising the volumes of peat generated by construction is preferable in order to preserve the various ecosystem services associated with peatlands, and to reduce potential carbon losses associated with construction. The key guiding principle is only to re-use peat where it is suitable for the identified and required use, as previously noted. Careful handling is essential in order to retain the structure and integrity of the excavated materials and thereby maximise the potential for excavated material to be re-used.

2.4.7 *'Developments on Peatland: Guidance on the Assessment of Peat Volumes, Re-use of Excavated Peat and the Minimisation of Waste'* (Scottish Renewables (SR) and SEPA, 2012) identifies examples of valid re-uses of excavated peat during construction, to potentially include dressing off and re-instating peat on the slopes and edges of constructed infrastructure, such as road and access track verges, re-instatement of service trenches and foundations, and peatland restoration via water table restoration, habitat enhancement or wetland creation.

3 Peat Conditions

3.1 Study Area

3.1.1 The study area for the Proposed Scheme is situated entirely within the Cairngorms National Park, extending from just north of Loch Etteridge near Crubenmore in the south, to the recently opened dual carriageway at Meadowside Quarry, near Kincraig, in the north. The River Spey runs generally parallel and to the north of the existing A9 in the south of the Proposed Scheme and to the south of it in the north. The River Spey is crossed near Kingussie, and several major and/ or minor watercourse tributaries also pass under the existing carriageway.

3.1.2 There are a wide range of habitats present in the study area, including upland and lowland woodland, heaths, mires, marsh, swamp, semi-natural and improved grasslands. The majority of the study area is low-lying and flat, or of gentle relief, particularly within the extensive floodplain of the River Spey and Insh Marshes. The slightly more elevated and upland areas are mainly located to the east and south of the existing A9, south of Ruthven, and extending towards Crubenmore.

3.1.3 As well as the existing A9 carriageway and associated infrastructure, land uses within the study area include rough sheep grazing, arable farmland, woodland and residential/ commercial developments at Kingussie and Newtonmore. Most of the vegetation and habitats in the study area have been impacted anthropogenically over time, via muirburn, grazing and drainage, but also forestry and agricultural practices.

3.2 Geomorphology

3.2.1 The study area is situated within Badenoch landscape character area (SNH, 1996), with the southern extents predominantly located to the south of the River Spey on the river terraces and sloping ground which ultimately lead to the Cairngorm Massif. The study area then crosses the flat open Strath floor and the River Spey itself. North of the River Spey, the study area covers the very lowest parts of the gently undulating hills which lead up to Monadhliath Mountains.

3.2.2 Much of the flat-lying floor of the Strath Spey valley is occupied by extensive marsh and wetlands of northern fen. The predominant influences on the landscape have been glaciation and subsequent deglaciation during the Pleistocene, with powerful flows of ice over 700m thick across the study area, directed along Strath Spey from Rannoch Moor (Young, 1978; Hall *et al.*, 2016). Glaciation, deglaciation and associated processes have therefore created many of the landforms, as there is little to no observable geological control on either the topography or the drainage systems (Young, 1978). The predominant controls on the current landscape appearance are either erosion, deposition or subsequent erosion and reworking of glacial deposits by glacial movement and melt before circa 13,000 years ago; evidenced by the presence of glacigenic features such as dead ice topography and kettle holes, and glaciofluvial features such as outwash fans (Sissons and Walker, 1974; Young, 1978).

3.2.3 As shown in **Drawing 10.1** (**Volume 3**), published BGS mapping indicates that the study area is predominantly comprised of widespread alluvial deposits and less widespread peat in the valley bottom, above which river terrace deposits (floodplain abandoned as the river has cut down) and glaciofluvial deposits in some areas are often found. Alluvial fans are also present at the outflow of larger tributaries to the River Spey, including the River Calder, Gynack Burn, Allt Cealgach and Raitts Burn. A substantial alluvial fan also exists between Gynack Burn and Allt Cealgach on an unnamed watercourse. The formation of these fans again relates to a glacial control, as a result of large volumes of meltwater containing great sediment loads draining directly towards the current course of the River Spey along meltwater channels. Some of these meltwater channels, as indicated, are presently streamless (Young, 1978) or contain streams too small to have formed the alluvial fans through which they flow. The hillslopes further from the existing A9 in the study area are mantled with diamicton till, with peaty soils and some areas of peat. Bedrock is generally reached at shallow depths except in some locations on the strath floor (Young, 1978).

3.2.4 Based on the geology and wider geomorphological context (Evans and Warburton, 2007), the study area provides two principal environments (‘macrotopes’) in which discontinuous mosaics of peat-forming areas exist; flatter flood plains and terraces (where local areas of peatland are low lying and marshy, most comparable to low-lying fens, floodplain and other mires) and hillslopes (where areas of peatland are most comparable to upland blanket peat).

3.2.5 Peat cover deeper than 0.50m is discontinuous in these mosaic environments and smaller-scale morphological (‘mesotope’ and ‘microtope’) features are therefore sporadic. However, some are evident within and to the south and east of the study area; including flushes and hummocks on sloping ground, and some localised hollows and/ or bog pools around Newtonmore, Nuide, south of Kingussie and across the Insh Marshes.

3.2.6 No peat gullies or pipes have been identified and the otherwise lack of these smaller-scale hydro-ecological features is likely to be a result of anthropogenic impacts over time throughout the study area via muirburn, grazing, drainage, agricultural land use and woodland.

3.3 Habitats and Vegetation

3.3.1 Based on Phase 1 Habitat and NVC Surveys, peatland habitats and peat-forming or successional vegetation types have been identified locally in the study area. These include mire, blanket mire, wet heaths or mosaics of these and others, with some of the typical and indicative core vegetation ranges (Bruneau and Johnson, 2014) of **blanket bog** (M17, M19 and M1 to M3), **wet heaths** (M15 and M16), **degraded bog** (M25), **fens and flushes** (M4, M5, M6 and M10) and **wet woodland** (W3, W4, W6 and W7) represented. Semi-natural vegetation not associated with waterlogged peat formation, but that can occur over thinner organic and peaty soils on shallow peatlands includes **dry heath** (H10 and H12), **acid grasslands** (U2 and U4 to U6), **semi-natural grasslands** (MG9 and MG10), **bracken** (U20) and **scrub** (W23).

3.3.2 The distribution of habitats and vegetation types within the study area is shown in **Drawings 12.8** to **12.27** (**Volume 3**) and described within **Chapter 12** (**Volume 1**). In summary and approximately however, those which are indicative of blanket bog account for 2% in total, with wet heaths (including areas in mosaic with blanket bog) accounting for 4%, dry heath around 17%, grasslands approximately 33%, and fens, flushes and swamp around 6%. Most of the vegetation appears to have been impacted anthropogenically over time. However, some areas of wet heath, blanket bog, other mires, fen, marsh and swamp located within and adjacent to the Proposed Scheme at

Newtonmore, Nuide and across the Insh Marshes also appear sufficiently wet and/ or contain bog pool communities indicative of good condition.

3.4 Hydrology

3.4.1 A detailed hydrological catchment baseline survey for the study area based on field visits (CFJV, 2016 and 2017) and desk-based data assessments is presented in **Appendix 11.4** (**Volume 2**). This indicates that the study area drains to the River Spey. There are also several major and/ or minor watercourses present, the majority of which are direct tributaries of the River Spey; and **Chapter 11** (**Volume 1**) identifies individual sub-catchments for each of these.

3.4.2 A network of artificial drainage channels of varying continuity and length also exist across parts of the study area, variably draining to existing watercourses and the points at which they cross the existing A9; as illustrated in **Drawings 10.5.8** (**Volume 3**). These are most frequent at the margins of existing or recent infrastructure and arable fields; and some are located in or adjacent to areas of peat. Where present, such artificial drainage will lower water table levels in and degrade areas of peat to make them more amenable for a particular purpose, but water has been observed at, or near, the surface in or nearby some areas; indicating local saturation as previously noted.

3.4.3 No sub-surface peat pipes were identified in the peat profiles during investigations, peat probing or other walkover surveys completed.

3.5 Peat Depth and Characteristics

3.5.1 All available data has been used to generate a detailed map of peaty soil and peat depth for the Proposed Scheme. This is shown in **Drawings 10.11** to **10.22** (**Volume 3**), and the methodology used to create the map is described in **Appendix 10.1** (**Volume 2**). Approximately 7% of the permanent and temporary works boundaries of the Proposed Scheme does not have peat depth data coverage. However, desk-based information and ecological surveys indicate that peat greater than 0.50m thickness is unlikely to be present in most of these areas, particularly as they are predominantly situated on superficial deposits of glaciofluvial origin.

Peat Depth

3.5.2 The full range of recorded peat and peaty soil depths across areas investigated varied from 0.00m to 4.85m, as illustrated in **Drawing 10.11** to **10.22** (**Volume 3**). The vast majority of areas (around 77%) within the permanent and temporary works boundaries are underlain by peaty soil or topsoil less than 0.50m thickness, and around 11% is underlain by no peat. Shallow peat is present underlying less than 4% of the areas and less than 1% is underlain by deep peat. Available GI has also identified peat strata, between 0.10 and 3.30m thickness, buried beneath granular horizons of made ground and/ or sands and gravels at several locations.

3.5.3 The occurrences of peaty soils and peat correspond reasonably well with the ecology survey findings; with peaty soils and topsoil (less than 0.50m thickness) predominant in areas of dry or wet heath and mosaics of these and grassland transitions. These ranged from 0.05 to 0.50m in thickness and were generally described to vary from sandy, silty, clayey soil or topsoil that is variably peaty or contains pockets of peat with fibrous or pseudo-fibrous elements, but also occasional thin fibrous or pseudo-fibrous peat horizons. Discontinuous pockets of shallow peat (between 0.50 and 1.00m thickness) are present in similar areas locally, with some areas of deep peat (greater than 1.00m thickness) located in areas of wet heath, blanket bog, mosaics of these, other mires, fens, marshes and swamp.

3.5.4 The peat depth model is based on a substantial dataset of real data points acquired in the field and is believed to be of very high quality. The interpolation methods used have been shown to be suitable for this kind of assessment in other peat-related assessments (RWE, 2013). However, it should be noted that the peat depth model is, by its nature, an interpolation between real data points and there remains the possibility that deeper or shallower peat than that represented by the model may be present between the real data points.

Peat Characteristics

3.5.5 The true depth of the acrotelm is often difficult to determine in the field and may be deeper than suggested by indicators such as living mosses and poorly decomposed plant material. Indeed, it has frequently been the case from investigation information available for the Proposed Scheme that the acrotelm (i.e. that part of the peat profile which experiences fluctuations in water table) was recorded to be impacted or degraded.

3.5.6 In this respect, the acrotelm across the Proposed Scheme has been observed to predominantly comprise thin (0.05 to 0.30m) variably decomposed (H1 to H6, locally greater) layers and variably distinct semi-natural vegetation. The decomposition varied throughout, with several areas with decomposition ratings higher than would be expected for an acrotelm that is healthy and actively peat-forming. However, areas showing no or only very slight decomposition (H1 to H3) with distinct vegetation indicating good condition were also observed locally – around the proposed Newtonmore junction (ch. 42,700 to ch. 43,600) and an area of mire located at Nuide (ch. 46,000). In areas conducive to flooding, within the River Spey floodplain and Insh Marshes, high proportions of mineral content (sand, gravel and silt) were observed in the acrotelm layers.

3.5.7 The catotelm layers underlying the acrotelm were recorded to vary between spongy, plastic and firm condition. The type of peats also varied from dark brown and black fibrous to pseudo-fibrous, and locally amorphous; with highly variable root, wood, sand and silt content. Pseudo-fibrous peat was typically described as H3 to H7 on the von Post scale (very slight to strong decomposition), fibrous peat was typically described as H1 to H5 (no decomposition to moderate decomposition), while locally more amorphous peat or amorphous content within it was described as H8, H9 or H10 (very strong, nearly complete or complete decomposition).

3.5.8 The recorded humification ratings show a very weak trend for humification to increase with depth as identified in **Appendix 10.1** (**Volume 2**), due to some instances of strong decomposition (H8 or greater) observed at relatively shallow depths less than 0.50 or 1.00m. This may reflect the modified nature of the peatland environments in the vicinity of the Proposed Scheme.

3.5.9 Estimated water contents in samples have covered the full range of possible values on the von Post scale, but with practically no correlation between water content and depth.

Laboratory Testing

3.5.10 Laboratory testing of peaty soil and peat samples for all, or a selection of the following; loss on ignition, moisture content, bulk density, pH, total carbon and total organic carbon from selected trial pit/ borehole and peat core locations, was undertaken as part of ground investigation works for the Proposed Scheme, as noted in **Chapter 10** (**Volume 1**) and **Appendix 10.1** (**Volume 2**).

3.5.11 Peaty soil/ topsoil samples were recovered across a range of habitat types, including wet heath, mire, mosaics of these, dry heath, grasslands and woodland. The testing results indicate bulk densities for these ranging between 0.07 and 0.29 Mg/m^3, dry densities between 0.02 and 0.05 Mg/m^3 and moisture contents of between 98 and 1443%. Results for total organic carbon ranged from 6.8 to 46%, from 5.5 to 44% for total carbon content and from 19 to 97% for mass loss on ignition. pH values ranged from 3.6 to 5.9.

3.5.12 Shallow peat samples were recovered across wet heath, blanket mire, swamp/ mire mosaic and woodland habitats, with bulk densities ranging between 0.33 and 0.49 Mg/m^3, dry densities ranging from 0.03 to 0.09 Mg/m^3 and moisture contents of between 272 and 1423%. Results for total organic carbon ranged from 4.9 to 51%, from 5.4 to 43% for total carbon content and from 15 to 94% for mass loss on ignition. pH values ranged from 3.5 to 5.3.

3.5.13 Within local deeper peat profiles in areas of mire, blanket mire, wet heath, mosaics of these or swamp, bulk densities ranged between 0.14 to 0.58 Mg/m^3, dry densities ranged from 0.02 to 0.22 Mg/m^3 and moisture contents were recorded between 98 and 1372%. Results for total organic carbon varied between 15 and 54%, between 11 and 55% for total carbon content and from 30 to 100% for mass loss on ignition. pH values ranged from 3.7 to 6.6.

4 Peat Management

4.1 Management Approaches

4.1.1 The hierarchy of management approaches in relation to developments on peat provided by SEPA is as follows (SR and SEPA, 2012; SEPA, 2010):

- **Prevention:** avoiding generating excess peat during construction (e.g. by avoiding areas of peat or by using construction methods that do not require excavation, such as floating tracks)
- **Re-use:** use peat produced on site in designated areas in an environmentally beneficial and suitable way, in the restoration of temporary works areas or as part of landscaping strategy
- **Recycling/ recovery/ treatment:** modification of peat produced on site for use as a fuel, or as a compost/ soil conditioner, or dewater peat to improve its mechanical properties in support of re-use
- **Storage:** temporarily store peat on-site (for example, during short periods in the construction period) and then re-use.

4.1.2 Throughout the DMRB Stage 3 design development process for the Proposed Scheme described in **Chapter 4** (**Volume 1**); environmentally-led workshops considered aspects of the developing design and made recommendations for certain features to be included, or aspects to be reconsidered. Peat was afforded consideration throughout this process where practicable and was informed by the progressive collection of peat survey information as described in **Appendix 10.1** (**Volume 2**).

4.1.3 The OPMP for the Proposed Scheme has therefore been developed as part of an iterative and informed process, and has adopted prevention, minimisation and re-use as the core management principles where possible, together with an element of temporary storage as means of managing peat excavated during construction.

4.2 Prevention

4.2.1 Prevention and avoidance of peat excavation has been achieved through detailed assessment of the distribution of peat across the Proposed Scheme and adjacent areas. This has informed local infrastructure layout and positioning changes and alternatives considered for particular scheme elements including the proposed Newtonmore junction and the positioning of compensatory flood storage areas, as further described in **Chapter 4** (**Volume 1**).

4.2.2 It is difficult to be precise given the iterative nature of the design development process, the progressive collection of peat survey information and the stages at which estimated excavation volumes were calculated. However, it is estimated that design changes and the consideration of alternatives (compensatory flood storage areas in particular) have resulted in at least **15,000m3** of reductions of estimated shallow and deep peat excavation volumes. Additional actions to further avoid or reduce excavation may also still be achievable during detailed design and construction-stage micrositing.

4.3 Re-instatement

4.3.1 Although the Proposed Scheme layout has avoided peat excavation as far as is practicable at this stage, the nature of the various other constraints detailed in **Chapter 4** (**Volume 1**) has meant that some infrastructure is located in areas within or adjacent to areas where peat is present. As this cannot be avoided in these instances, the subsequent management option adopted for the Proposed Scheme is to re-instate that peat at the point of excavation wherever possible. This will principally be limited to the following instances:

- Where peat or peaty soil must be excavated to accommodate embankment slopes which must be taken below existing ground level, but once constructed, a proportion of the peat excavated can be re-instated at the embankment toe.
- Where excavation must occur for compensatory flood storage areas, but peaty soil or peat turves up to 0.50m thickness can be set aside and re-instated once excavation of the substrate or deeper material is removed.

4.4 Re-use

4.4.1 Where the excavation cannot be prevented or avoided, and re-instatement at the point of excavation cannot be achieved; the management option for the Proposed Scheme is for excavated peat and peaty soil to be re-used in suitable ways that maintain their provisioning, regulating, cultural and ecosystem supporting services. In this respect, the following have been identified as the core potential opportunities for re-use as part of the Proposed Scheme:

- **Landscaping Restoration and Habitat Re-instatement:** Re-instatement and re-use of peaty soils and topsoil as dressing for widening, cutting and embankment slopes and verges to assist in creating tie-ins with the surrounding topography, landscape and habitats to reduce visual impacts. Additional peaty soil, topsoil and shallow peat re-use capacity may be available in this way surrounding SuDS basins and/ or in areas identified for dry and wet heath/ blanket bog re-instatement, as set out in the Outline Habitat Management Plan (OHMP) in **Appendix 12.13** (**Volume 2**) and/ or shown in **Drawings 6.1** to **6.12** (**Volume 3**). It may also be possible for proportions of excavated and sympathetically handled shallow peat finished with acrotelm peat turves, to be re-used for dressing and verge re-instatement on particular sections of access track, where consistent with adjacent soils and vegetation, and where the adjacent substrate (placed or *in situ*) is peat.
- **Sustainable Drainage Systems (SuDS) Basins:** Re-use of peat as a natural filter material in the main basin of selected permanent SuDS for the Proposed Scheme, to reduce the rate at which road run-off is discharged and improve the quality of the water discharged to watercourses. The method of peat placement in the SuDS basins will require detailed design consideration, but should aim to maximise the filtration surface area and where possible, be lined with vegetated acrotelm turves.
- **Compensatory Flood Storage Areas:** Re-use of peat for the retention, creation or extension of wetland-based habitats within proposed compensatory flood storage areas, which by their

nature, will generally be lower-lying and wetter than surrounding areas. The specific design and practice of peat re-use in each area will be further developed during detailed design, but this would include consideration of whether sufficient hydrological conditions can be achieved to maintain the condition of the peat that is re-used.

4.4.2 In addition to the above, **Appendix 6.2** (**Volume 2**) and **Mitigation Item P09-E25** in **Chapter 12** (**Volume 1**) identify proposals for the creation of breeding wader habitat at the Dellmore of Kingussie – through the creation of wetland habitat via hydrological and vegetation management. The potential for peat re-use in this context would be similar to compensatory flood storage areas; as the wetland areas would be created via soil scraping, and by their nature, would be lower-lying and wetter than their surroundings; while water table restoration may also be assisted by peat re-use for drainage management and maintaining of wetland conditions. These possibilities have been discounted from consideration at this stage however, given that the habitat creation works are proposed prior to construction, in order for the habitat to be functional for the first affected breeding season. As a result, the works are anticipated to be undertaken prior to peat associated with the Proposed Scheme construction being excavated.

4.4.3 Appraisal of other potential peat re-use options for habitat restoration or creation in the study area was also undertaken and, with the exception of a small area of possible historical peat cutting located near Loch an Torra Ghairbh (450m south east of the Proposed Scheme at ch. 40,000); no specific potentially suitable candidate re-use areas were identified. The Loch an Torra Ghairbh area was also discounted from consideration given its distance from the Proposed Scheme and the intervening topography, with potentially difficult access.

4.4.4 Based on the above, it is therefore assumed that excavated peaty soils and peat can be re-used in one of the ways described previously and as set out within this OPMP. However, should none of these be achievable for a particular portion of the excavated peat, then this peat will be considered as 'waste' and an appropriate licence or exemption for the use of the material would be applied for.

4.5 Temporary Storage

4.5.1 Temporary storage of peat should be avoided wherever possible by transporting it to an allocated re-use location as soon as is practicable, to help retain as much structural integrity within the peat as possible, minimise volumes in storage and minimise the likelihood of drying. However, this should not be undertaken at the expense of re-instatement, re-use or restoration outcomes (i.e. if, on balance, storage will produce a better long-term outcome, then it should be used prior to the re-use).

4.5.2 For instances where this may be required during construction of the Proposed Scheme therefore, outline provisional locations for the temporary storage of peat have been identified and are shown in **Drawings 10.47** to **10.58** (**Volume 3**). These take into account land available within the permanent and temporary works boundaries of the Proposed Scheme, proximity to the points of excavation and watercourses, the presence of existing woodland, areas of floodplain, the existing presence of deep peat and the level of peat landslide hazard determined by **Appendix 10.5** (**Volume 2**). Where temporary storage is necessary, it will be undertaken in line with the outline measures provided in Paragraph 6.3.5 to 6.3.8, and **Annex 6.1.1** of this OPMP.

5 Peat Balance

5.1 Proposed Scheme Elements

5.1.1 The development of a peat balance for the Proposed Scheme has involved calculation of volumes excavated during construction, volumes re-instated during or following construction, residual volumes, and volumes of re-use that may be achieved via landscaping restoration and habitat re-instatement, or re-use within selected SuDS basins and/ or compensatory flood storage areas.

5.1.2 Taken together, these describe whether the Proposed Scheme may have a positive, negative or neutral peat balance (i.e. produces more, less or approximately the same amount of peat as can be suitably re-used within the permanent and temporary works boundaries or wider land made available (LMA)).

5.1.3 The following sections describe the calculations for each element of the Proposed Scheme. Mean peat depths referred to are derived from the peat depth model shown in **Drawings 10.11** to **10.22** (**Volume 3**) and are specific to the footprint of each element of the Proposed Scheme considered, which are as follows:

- Mainline alignment and junctions, including embankments, widenings and cuttings
- Side roads and access tracks, including embankments, widenings and cuttings
- Permanent SuDs basins
- Watercourse diversions
- Drainage, including cut-off drains
- Compensatory flood storage areas.

5.1.4 Each element required a slightly different approach to, as accurately as possible, represent the initial peat excavation that will be required and any subsequent re-instatement at the point of excavation that may be possible, to arrive at residual excavation volumes.

5.1.5 The linear nature and extent of some elements such as the mainline, junctions and access tracks means that peat depth varies throughout their footprint. These features were therefore divided into 50m sections, such that total volumes and the mean depth of peat beneath each 50m section could be used to calculate the required excavation.

5.1.6 Estimated volumes are expressed to the nearest m^3. However, the uncertainty in the figures makes it prudent to consider any figure as correct to the nearest $10m^3$ where less than $100m^3$, the nearest $100m^3$ where less than $10,000m^3$ and the nearest $1,000m^3$ where over $10,000m^3$.

5.2 Excavation and Re-instatement Volumes

5.2.1 The estimated volumes of peaty soil and peat, and the way they have been calculated for each element of the Proposed Scheme, is described below and supported with schematic diagrams where necessary. In all instances, the excavation volumes have been uprated to account for the areas not yet covered by the peat depth model. This uprating assumes that excavation volumes (and their distribution between peaty soil, shallow and deep peat) is proportionally the same in the 'no data' area as it is in the area where data is available.

Mainline Alignment and junctions

5.2.2 The mainline alignment for the Proposed Scheme covers approximately 16.5 kilometres, with proposed junctions at Newtonmore and Kingussie, and left in/ left out accesses at Ralia, Nuide Farm and Balavil. For the purposes of this assessment, these mainline alignment and junction scheme elements comprise embankments, widenings, cuttings and 'other earthworks' (areas of cut or fill between embankments, widenings or cuttings such as verges, carriageways and the central reserve).

5.2.3 It is assumed that under the embankments and other earthworks, all peat will be excavated in order to found construction on strata of a suitable bearing capacity. Theoretical exceptions to this would be where the road was of floated construction, of piled construction or where a structure is used to carry the road across an area of softer ground. However, peat conditions beneath the mainline alignment (particularly peat depths, which do not exceed 2.00m) do not lend themselves to such methods and therefore none are anticipated.

5.2.4 Additionally, in areas of embankment fill where peat is present, a structural embankment will be required to continue below existing ground level to support structural elements and landscape fill above ground. Due to the slope of the structural embankment required below ground (assumed to be 1:2), this will require a lateral extension of the excavation footprint equivalent to twice the depth of the peat, in order to accommodate the below ground part of the embankment. A further lateral extension to accommodate a return slope which will be formed from a series of 0.50m high benches will also be required. To calculate the distance of this lateral extension, the mean peat depth under a 50m section of embankment or at grade stretch of road has been used.

5.2.5 **Figure 1** shows a schematic diagram to illustrate the considerations in this calculation and also shows that, following construction, some excavated peat can be re-instated at the point of excavation. The volume of peat that will be re-instated is therefore included within the initial excavation volumes but not in net residual excavation volumes.

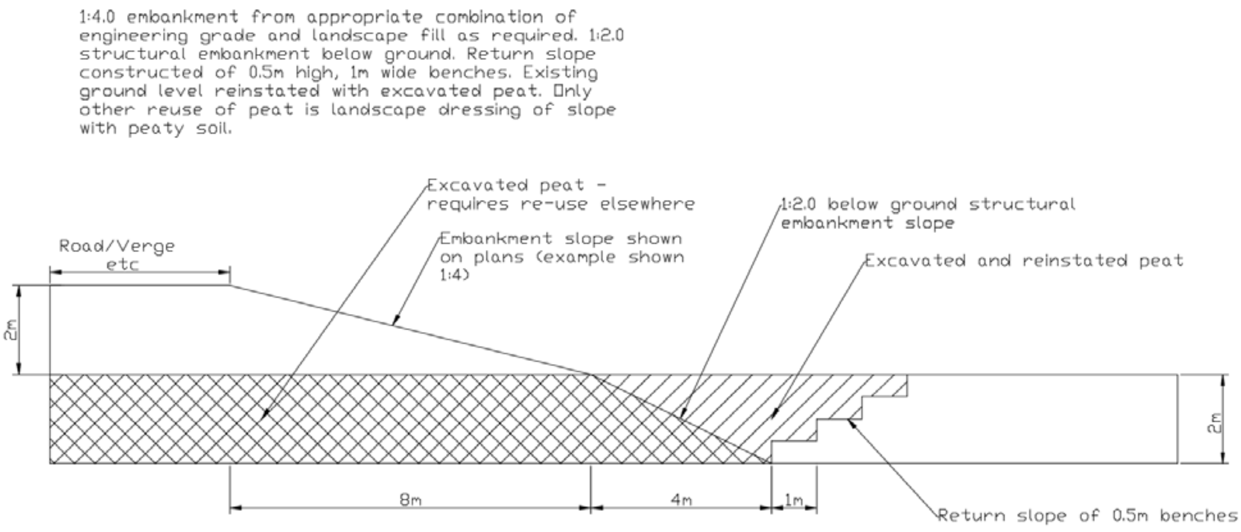

Figure 1: Calculation of Excavation and Re-instatement Volumes (Embankments and At Grade)

5.2.6 Where cut slopes are present on either side of the mainline, it is assumed that total excavation of peat will be required, with the exception of a band at the top of the cutting equivalent to four times the depth of the peat, where only 50% of the peat will require excavation. **Figure 2** shows a schematic diagram of the considerations in this calculation on the assumption that the part of the cut slope in peat is at 1:4.

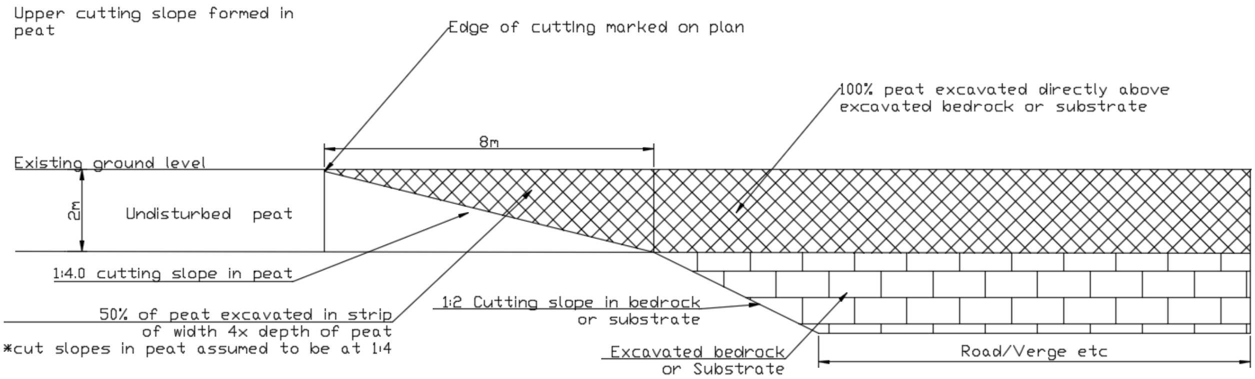

Figure 2: Calculation of Excavation and Re-instatement Volumes (Widenings and Cuttings)

Side Roads and Access Tracks

5.2.7 Side roads and access tracks are proposed at several locations throughout the Proposed Scheme. These are often parallel to the mainline alignment and provide access to SuDS basin maintenance or for landowners.

5.2.8 The volumes of peat that will need to be excavated for the access tracks have been calculated on the same basis as for the mainline alignment and junctions, insomuch as the access tracks are formed of embankments, widenings, cuttings and 'other earthworks'. In this respect, embankments and other earthworks in peat will require excavation beyond the design footprint to accommodate a below-ground structural embankment, and earthworks widening or cuttings will have a band equivalent to a width four times the depth of the peat in which only 50% of the peat need be excavated.

5.2.9 The excavation figures presented in **Table 1** assume that any access tracks or parts thereof will not be floated, as this is a matter for detailed design. However, peat conditions beneath the tracks have been assessed as being unlikely to lend themselves to floated construction methods as previously noted, and therefore, none are anticipated at this stage.

Permanent SuDS Basins

5.2.10 The permanent SuDS basins proposed are considered to consist of a combination of cuttings and bunds to form enclosed basins in which road run-off can be temporarily retained to filter solid and solute contaminants, and reduce the rate of run-off to watercourses.

5.2.11 Under the footprint of bund areas, it is assumed that, similar to embankments where they are constructed in areas of peat, there will need to be a lateral extension of the footprint to accommodate a below ground extension of the bund to a stratum of sufficient bearing capacity. Under the footprint of cuttings, it is assumed that all peat will be excavated except in a band equivalent to four times the depth of the peat at the top of the cutting slope. Within this band it is assumed that only 50% of the peat will need to be excavated, as shown in **Figure 3**.

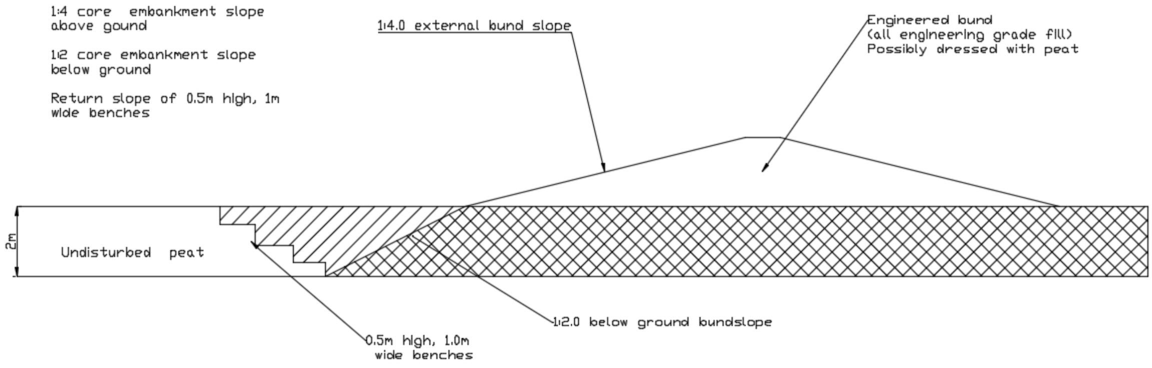

Figure 3: Calculation of Excavation and Re-instatement Volumes (Permanent SuDS Basins)

Drainage

5.2.12 Throughout the Proposed Scheme, there are a series of open cut-off drains to capture upslope run-off before it reaches the tops of widenings and cuttings, and to capture run-off from embankments on the downslope side. There are also a more limited number of linear open drains which transfer water to SuDS basins from buried drainage under the footprint of the road, or from SuDS basins to the point of discharge into a watercourse. The linear nature, and consistent cross-sectional geometry of these drains, allows for peat excavation volumes to be calculated using the average peat depth within a 50m long section of drain and hence the area of the trapezoidal cross-section of the drain occupied by that depth of peat.

5.2.13 **Figure 4** shows the considerations in this calculation and it is assumed that all peat excavated to create the drain will require re-instatement and re-use.

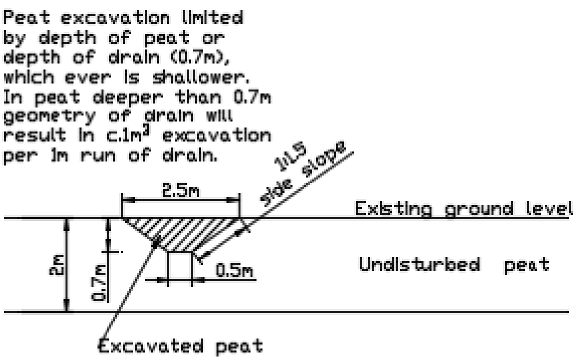

Figure 4: Calculation of Excavation and Re-instatement Volumes (Cut-off Drains)

Watercourse Diversions

5.2.14 The Proposed Scheme crosses numerous existing surface watercourse features; some of which are artificial drains cut to facilitate the existing road, and some of which are natural watercourses. Watercourse diversions have been designed to ensure the continued transfer of flow from the upslope/ upstream side to the downslope/ downstream side via bridges or culverts. These watercourse diversions are of varying dimensions and so have been assessed individually, with the required excavation volumes calculated based on peat depth and the dimensions of the watercourse diversion. It is assumed that all peat excavated for the watercourse diversion will require re-instatement or re-use.

Compensatory Flood Storage Areas

5.2.15 Several compensatory flood storage areas are proposed throughout the Proposed Scheme, to compensate for the loss of existing flood storage capacity through construction within the extent of the 1:200 return period flood level. Each of these areas will be subject to detailed design, may be terraced in nature and some will involve both excavation and displacement. However, it is presently assumed that their construction will typically require removal and setting aside of soils or peat turves, to a maximum depth of 0.50m, removal of the underlying material (be that deeper peat, substrate or bedrock) by a further 1.00m, before re-instatement of soils or peat turves to create an area 1.00m lower than existing ground level.

5.2.16 **Figure 5** shows the consideration applied in the calculation of excavation volumes for these.

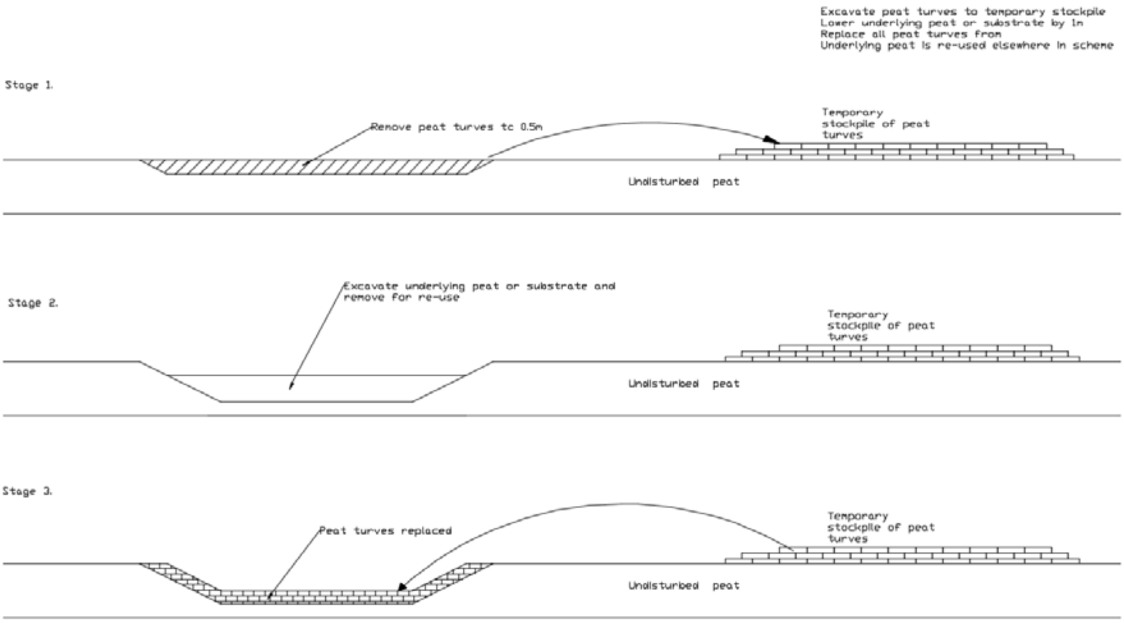

Figure 5: Calculation of Excavation and Re-instatement Volumes (Compensatory Flood Storage)

Temporary Works

5.2.17 Although land is included within the Proposed Scheme boundaries for temporary works, the locations and nature of temporary activities do not form part of the design at this stage. The impacts of these activities on peat excavation volumes therefore cannot be quantified. However, it is anticipated that the following temporary works activities may result in impacts on peat:

- Temporary SuDS requirements
- Haul roads for construction traffic and material transport
- Temporary storage of excavated materials (including peat).

5.2.18 For temporary SuDS and related drainage, peat disturbance shall be avoided by additional micro-siting during detailed design and construction to avoid excavation in areas of peat and, where this is not possible, the use of above-ground solutions requiring no or limited excavation, such as siltbusters. Any areas of peat which are unavoidable, and in which excavation is required for temporary SuDS, shall be fully re-instated by the Contractor following construction.

5.2.19 In the case of haul roads, these shall avoid areas of peat wherever possible and, where they must cross areas of deep peat (deeper than 1.00m), floated track construction shall be considered and implemented where peat depth and conditions permit. It is anticipated that all temporary access roads will be fully re-instated following construction.

5.2.20 As previously noted, temporary storage of peat shall also be avoided wherever possible by transporting excavated peat and peaty soil to potential re-use locations. However, for instances where this may not be possible during construction; outline provisional locations for the temporary storage of peat have been identified and are shown in **Drawings 10.47** to **10.58** (**Volume 3**). These take into account land available within the permanent and temporary works boundaries of the Proposed Scheme, proximity to the points of excavation and watercourses, the presence of existing woodland, areas of floodplain, the existing presence of deep peat and the level of peat landslide hazard determined by **Appendix 10.5** (**Volume 2**).

5.2.21 Preliminary analysis of these areas indicates that there is likely to be sufficient space for the currently estimated shallow and deep peat and the vast majority of peaty soil and topsoil volumes to be stored close to the points of excavation and areas of potential re-use. The remaining amounts of peaty soil and topsoil should be able to be accommodated through sensible sequencing of construction.

Excavation and Re-instatement Volumes

5.2.22 The excavation and re-instatement volumes for the Proposed Scheme are presented as volumes of peaty soil and topsoil (less than 0.50m thickness), shallow peat (between 0.50 and 1.00m thickness) and deep peat (greater than 1.00m thickness) in **Table 1**. The residual estimated excavation volumes for each category are also highlighted and illustrated for each section and element of the Proposed Scheme considered in **Drawings 10.6.1** to **10.6.18** (**Volume 3**). Each category refers to the total peat depth in a given m^2 area. As such, all volumes in **Table 1** include both acrotelm and catotelm, with this further considered below.

Table 1: Estimated Peaty Soil/Topsoil and Peat Excavation and Re-instatement Volumes

Scheme Element[1]	Initial Excavation (m^3)			Volume of Re-instatement at the Point of Excavation (m^3)			Residual Excavation Volume (m^3)		
	Peaty Soil/ Topsoil	Shallow Peat	Deep Peat	Peaty Soil/ Topsoil	Shallow Peat	Deep Peat	Peaty Soil/ Topsoil	Shallow Peat	Deep Peat
Side Roads and Access tracks	19,056	1,775	442	412	184	11	18,644	1,591	431
River Spey Bridge Piers	44	0	0	2	0	0	42	0	0
Drainage	9,937	2,108	633	0	0	0	9,937	2,108	633
Mainline and junctions (excluding New tonmore junction)	79,886	11,760	4,570	385	343	162	79,501	11,417	4,409
New tonmore junction	2,350	1,343	1,992	22	5	9	2,328	1,338	1,984
Permanent SuDS Basins	8,949	1,967	0	36	1	0	8,913	1,966	0

Scheme Element[1]	Initial Excavation (m³)			Volume of Re-instatement at the Point of Excavation (m³)			Residual Excavation Volume (m³)		
	Peaty Soil/ Topsoil	Shallow Peat	Deep Peat	Peaty Soil/ Topsoil	Shallow Peat	Deep Peat	Peaty Soil/ Topsoil	Shallow Peat	Deep Peat
Compensatory Flood Storage Areas	7,723	709	99	7,723	567	44	0	142	55
Watercourse Diversions	1,934	847	59	0	0	0	1,934	847	59
Totals	**129,879**	**20,509**	**7,795**	**8,580**	**1,100**	**226**	**121,299**	**19,409**	**7,571**

Table Notes:

1. In all instances, the excavation volumes have been uprated to account for the areas not yet covered by the peat depth model. This includes substantial proportion of a large compensatory flood storage area located near the Mains of Balavil (CSA 10 (ch. 53,400)). The available desk-based and ecological survey information indicate peat greater than 0.50m is unlikely in this area, but as previously noted the uprating conservatively assumes that excavation volumes (and their distribution between peaty soil, shallow and deep peat) is proportionally the same as it is in the areas where data is available.

5.2.23 Based on acrotelm-catotelm contact observed within the study area and the total estimated excavation volumes, **Table 2** provides details of the estimated volume split between these two layers for shallow and deep peat. In doing so, an average acrotelm depth of 0.15m has been applied across all Proposed Scheme elements.

Table 2: Estimated Peat Excavation and Re-instatement Volumes (Acrotelm-Catotelm)

Scheme Element	Initial Excavation (m³)		Volume of Re-instatement at the Point of Excavation (m³)		Residual Excavation Volume (m³)	
	Acrotelm[1]	Catotelm	Acrotelm[1]	Catotelm	Acrotelm[1]	Catotelm[2]
Side Roads and Access tracks	462	1,754	78	117	384	1,638
River Spey Bridge Piers	0	0	0	0	0	0
Drainage	987	1,754	0	0	987	1,754
Mainline and junctions (excluding New tonmore junction)	3,186	13,144	188	317	2,998	12,827
New tonmore junction	514	2,821	4	10	510	2,812
Permanent SuDS Basins	481	1,487	1	0	480	1,486
Compensatory Flood Storage Areas	183	625	92	520	92	105
Watercourse Diversions	285	621	0	0	285	621
Totals	**6,098**	**22,206**	**363**	**964**	**5,736**	**21,243**
Ratio (acrotelm: catotelm)	**1:4**		**1:3**		**1:4**	

Table Notes:

1. Although acrotelm layer depths have been not been recorded in all locations, and were occasionally impacted or thin; it is recommended that for the purposes of construction, re-use and re-instatement, that where a sufficient peat depth exists, the top 0.50m should be treated as acrotelm. This will allow excavation of intact turves for re-instatement purposes which may facilitate quicker regeneration of disturbed areas or areas where peat is re-used. If this were applied to the above, the acrotelm volumes would increase and catotelm would decrease.

2. Based on data presented in **Appendix 10.1** (**Volume 2**), evidence of strongly decomposed peat has been observed in selected areas based on von Post (Hobbs, 1986) classifications. Of the calculated residual catotelm quantities, approximately 10% (equivalent to **2,124m³**) may be strongly decomposed (H7 or greater) and for which re-use options may be more limited than less decomposed peat.

5.3 Residual Excavation and Re-use Volumes

Landscape Restoration and Habitat Re-instatement

5.3.1 Residual peaty soil and topsoil volumes may be re-used as dressing of widening, cutting and embankment slopes and verges within the Proposed Scheme; to assist creating tie-ins with the surrounding topography, habitats and landscape. This would be undertaken in accordance with the requirements of the OHMP in **Appendix 12.13** (**Volume 2**) and soils would be removed as turves where necessary and possible, to keep as much of these with the vegetation mat, and re-instated as such.

5.3.2 It is estimated that the Proposed Scheme has capacity for all peaty soil and topsoil generated to be used this way, based on a topsoil depth of 0.20m; which can be increased if greater volumes are generated, or if turves are of a greater thickness. Additional peaty soil, topsoil and shallow peat capacity may also be available in this way surrounding SuDS basins and in areas identified for dry and wet heath/ blanket bog re-instatement within the OHMP in **Appendix 12.3** (**Volume 2**) and/ or on **Drawings 6.1** to **6.12** (**Volume 3**).

5.3.3 It may also be possible for proportions of excavated and sympathetically handled shallow peat finished with acrotelm peat turves, to be re-used for slope dressing and re-instatement on particular access track sections, where consistent with adjacent soils and vegetation, and where the adjacent substrate (placed or *in situ*) is peat. In such instances, peat and acrotelm peat turves could be deposited on one or both sides of the tracks and used to form variably gentle slopes (minimum 1:5) which gradually grade the verges into the surrounding land and retain existing habitat and vegetation. Low angles of re-instated slopes would reduce run-off and therefore reduce peat loss, improving the likelihood of successful vegetation regeneration along verges.

5.3.4 Finally, in areas where new or compensation woodland or other planting is proposed, it may be possible for proportions of more strongly decomposed peat (**Table 2**) to be used as an admixture to the replanting areas as a soil improver, to assist the success of the vegetation being planted.

Potential Re-use for Other Purposes

5.3.5 A total of fifteen SuDS detention basins form part of the Proposed Scheme, with some of these potentially representing an opportunity to re-use a proportion of deeper excavated peat in an environmentally beneficial way, and in some locations, close to the point of excavation. In such circumstances, peat could potentially be included within the main (downstream) basin, which may carry the following benefits:

- Unlike the sediment forebay, which receives run-off directly from the road, the main basin of the SuDS would not require periodic maintenance emptying and would receive already filtered water. The predominant function of the peat and the main basin more generally would be to reduce the rate of run-off from the road and to capture any remaining carbon-based contaminants which pass through the sediment forebay
- SuDS basins can be over-excavated (over-deepened) by up to 2.00m into substrate or bedrock, to generate the capacity for the peat, at the same time generating additional fill for use in road construction. Where peat is removed from the footprint of the basin in this respect, it could be placed directly back into the basin
- The detailed design of the main basins can be such that the outfall is above the level of the re-used peat, ensuring that fully saturated conditions exist in the peat before any of the water is drained

- Depending on the location of the basin and the nature of the excavated peat, detailed design of the main basin can either incorporate lining, to prevent seepage to surrounding soils and prevent nutrient inputs from groundwater sources, or leave the basin unlined so that exchange of nutrients from shallow groundwater can take place. Discussion with SEPA Regulatory Services and the local water team would be required during detailed design to determine whether a lining is required.

5.3.6 At the locations of some proposed SuDS basins, excavations of shallow and deep peat are anticipated in proximity and the above would potentially enable at least some of this to be re-used close to the point of excavation. Specific SuDS of note in this respect, include SuDS 417, 427, 434, 493 and 509. Based on this, **Table 3** presents the maximum potential capacity of potential peat re-use within SuDS basins at varying depth.

Table 3: SuDS Basin Potential Capacity for Peat Re-use

SuDS Ref.	Approximate Chainage (Ch.)	Maximum Potential Capacity for Re-use			Comments/ Considerations for Re-use
		0.50m deep (m^3)	1.00m deep (m^3)	2.00m deep (m^3)	
SuDS 417	ch. 41,700	1,098	2,195	4,390	Existing area of wet heath with blanket bog, with measured peat depths between 0.10 and 0.50m. Shallow peat in vicinity and shallow and deep peat present along alignment of outfall drain.
SuDS 427	ch. 42,700	345	691	1,381	Nested between grassland and wetland containing mire and acid flush. Peat depths up to 0.60m recorded in the footprint, with areas of shallow and buried peat in the vicinity.
SuDS 434	ch. 43,400	773	1,546	3,091	Located in an area of woodland and scrub with only peaty soil/ topsoil up to 0.10m recorded. Opposite area of shallow and deep peat to be excavated for New tonmore Junction.
SuDS 458	ch. 45,800	562	1,124	2,248	Area of calcifugous grassland with peaty soil/ topsoil up to 0.15m, and shallow / deep peat in the vicinity.
SuDS 461	ch. 46,100	313	627	1,254	Area of calcifugous and mesotrophic grassland, with peaty soil/ topsoil around 0.10m thick, but shallow and deep peat in the vicinity.
SuDS 474	ch. 47,500	862	1,725	3,451	Open vegetation and grassland mosaic, with peaty soil/ topsoil up to 0.15m and shallow / deep peat in the vicinity.
SuDS 487	ch. 48,700	139	279	558	Calcifugous grassland over peat soil/ topsoil up to 0.15m.
SuDS 490	ch. 49,000	347	695	1,389	Calcifugous grassland over peat soil/ topsoil up to 0.19m, and shallow / deep peat in the vicinity.
SuDS 493	ch. 49,300	739	1,477	2,955	Mire and calcifugous grassland mosaic near Ruthven Barracks, with peaty soil/ topsoil up to 0.10m, but shallow and deep peat in the vicinity.
SuDS 507	ch. 50,700	97	194	387	Calcifugous grassland with peaty soil/ topsoil up to 0.30m and shallow peat in the vicinity.

SuDS Ref.	Approximate Chainage (Ch.)	Maximum Potential Capacity for Re-use			Comments/ Considerations for Re-use
		0.50m deep (m^3)	1.00m deep (m^3)	2.00m deep (m^3)	
SuDS 509	ch. 50,900	601	1,202	2,403	Calcifugous grassland encroaching into plantation woodland over mostly peaty soil/ topsoil, but also shallow peat up to 1.00m.
SuDS 513	ch. 51,300	333	666	1,332	Calcifugous grassland over peaty soil/ topsoil up to 0.10m.
SuDS 530	ch. 53,000	380	761	1,521	Calcifugous and wet grassland with mire over peat soil/ topsoil up to 0.30m but underlain by a 1.00m buried peat horizon 1.50m below existing ground level.
SuDS 534	ch. 53,300	204	408	816	Calcifugous grassland over peaty soil/ topsoil up to 0.18m.
SuDS 537	ch. 53,700	1,520	3,041	6,081	Mesotrophic grassland over peaty soil/ topsoil up to 0.20m amongst low-lying ground between the A9 and Highland Mainline railway, with deep peat and waterlogged conditions in the vicinity.
Totals		**8,313**	**16,627**	**33,257**	

5.3.7 There are also six proposed compensatory flood storage areas which form part of the Proposed Scheme. It is already assumed in the excavation calculations that the top 0.50m of peat (or the maximum depth of peaty soil or topsoil) will be re-instated following the excavation for these areas to the required depth. However, there is also the possibility of over-excavating some, or some parts of the storage areas, with the specific purpose of creating low-lying wet areas which may be able to receive groundwater or surface water inputs from the surrounding ground. Not all parts may be appropriate for over-excavation. However, given their locations, it is unlikely that over-excavation would require the removal of more peat than is currently anticipated. In this respect, all compensatory flood storage areas should therefore be considered as potential candidates for the re-use of peat in this way.

5.3.8 Based on these considerations, and in outline, initial estimates indicate that there is a maximum potential capacity for the re-use of **45,000m³** of shallow and deep peat, if additional re-use depths were limited to an average of 1.00m, and more if average re-use depths are greater. Detailed design of the compensatory flood storage areas would be required to consider the net peat balance of each storage area, its capacity to accommodate additional peat of an appropriate nature and expected fluctuations in water table depth to ensure the peat does not dry out.

5.4 Net Balance

5.4.1 At this stage, it is not possible to be any more precise about the volumes of peat that will be re-used in the ways and opportunities identified. Further stages of design beyond this OPMP will be required to refine the re-use proposals, and identify those which are most suitable. Notwithstanding, the peat balance indicates there is sufficient capacity within the permanent and temporary works boundaries, for re-use of the residual **121,299m³** of peaty soil/ topsoil, **19,409m³** of shallow peat and **7,571m³** of deep peat estimated.

5.4.2 For shallow and deep peat, the balance is comprised of a potential capacity for re-use of between **8,300m³** and **33,300m³** if SuDS basin over-excavation is undertaken (**Table 3**), and up to **45,000m³** if compensatory flood storage areas were also over-excavated. Additional, though unquantified, capacity is also likely to be possible via local access track-side re-instatement, planting areas and other re-instatement required for temporary works or storage areas. In particular, this may also include re-use of some peaty soils, topsoil and shallow peat in areas identified for dry and wet heath/ blanket bog re-instatement within the OHMP in **Appendix 12.13** (**Volume 2**) and/ or shown in **Drawings 6.1** to **6.12** (**Volume 3**)

5.4.3 As a result, the estimates indicate that no, or very little, surplus peat will be generated; resulting in no, or a very limited, net loss from construction of the Proposed Scheme. It will, however, still be essential that opportunities to further avoid and/ or minimise peat disturbance during detailed design and construction of the Proposed Scheme are taken by the Contractor where possible.

6 Excavation, Storage, Re-use and Monitoring

6.1 General

6.1.1 While the peat balance has estimated that the Proposed Scheme has appropriate provision for peat excavated during construction, it will be essential that good practice measures are employed by the Contractor prior to, during and following the construction period. The following sections outline minimum good practice measures that the Contractor shall adopt in this respect, to ensure that peat deposits are appropriately handled, managed and re-used. Additional detail on these measures is also included in **Annex 10.6.1**.

6.2 Good Practice Prior to Construction

Peat Model Refinement

6.2.1 Prior to construction, the peat depth model for the Proposed Scheme shall be refined by the Contractor in light of any additional ground investigation or survey information that becomes available in preparation for construction. The revised model should then provide even more sufficient information to enable additional refinement of the volume estimates for all Proposed Scheme elements, such that additional design and micro-siting can be employed to further minimise excavation volumes where possible.

Construction-stage Peat Management Plan

6.2.2 Prior to construction, and based on any additional refinement of the peat model that is possible, and further detailed design, the OPMP shall be refined by the Contractor in consultation with SEPA, SNH and CNPA as necessary. This will become the construction-stage Peat Management Plan (PMP) and shall include as a minimum, refinement of estimated volumes of peaty soil, topsoil and peat that will be excavated, details of where and how these will be used in landscaping, habitat re-instatement or other ways, and details/ method statements related to their excavation, storage, transportation, handling and monitoring for doing so.

Monitoring

6.2.3 Outline monitoring requirements for additional baseline establishment prior to construction, assessing change to peatland areas during and following construction, and for monitoring the areas of peat re-use post-construction are provided in sub-section 6.4. To obtain the greatest value from the monitoring, it is essential that baseline conditions, particularly ecology and hydrology, are well understood and used to set realistic targets for post-construction mitigation and restoration.

6.3 Good Practice during Construction

Excavation

6.3.1 During the construction of all infrastructure, the Contractor shall adopt the following good practice in relation to peat excavation:

- Peat turves shall be excavated as intact blocks of upper peat comprising the surface vegetation layer (acrotelm) and adjoining upper catotelm
- Underlying turves shall be extracted as close to intact as is feasible, with remoulding by the excavator kept to a minimum
- Excavation of contaminated peat turves (those incorporating substrate) shall be avoided if possible, and where unavoidable, these shall be stored separately to non-contaminated peat turves to avoid further contamination on re-instatement, re-use or during transport.

6.3.2 Where possible and practical, a technique known as ‘macroturfing’ (large scale cutting and re-laying of turf blocks) (Bruelheide and Flintrop, 2000) shall be employed during construction, to extract intact full depth acrotelm layers from the top surface of the peat deposits. This technique will maintain connectivity between the surface vegetation and the partially-decomposed upper layers of the catotelm.

6.3.3 Classification of excavated materials will depend on their identified re-use or re-instatement. For the Proposed Scheme, it is anticipated that the material to be excavated will comprise peaty soils and topsoil, peat (which may be sub-divided into fibrous, pseudo-fibrous, locally amorphous peat and turf), mineral soils (substrate) and rock.

Temporary Storage

6.3.4 Temporary storage of peat shall be avoided where possible by re-instating or transporting it to allocated re-use locations, to minimise the volume in storage, retain as much structural integrity within the peat as possible and to minimise the likelihood of drying. However, this shall not be undertaken at the expense of re-instatement, re-use or restoration outcomes (i.e. if, on balance, storage will produce a better long-term outcome, then storage can be employed prior to re-use).

6.3.5 Outline provisional locations for the temporary storage of peat have therefore been identified within the permanent and temporary works boundaries of the Proposed Scheme as shown in **Drawings 10.47** to **10.58** (**Volume 3**). These take into account land available within the permanent and temporary works boundaries of the Proposed Scheme, proximity to the points of excavation and watercourses, the presence of existing woodland, areas of floodplain, the existing presence of deep peat and the level of peat landslide hazard determined by **Appendix 10.5** (**Volume 2**); covering a footprint of sufficient collective area to store excavated peat from nearby locations at a height no greater than 1.00m.

6.3.6 These areas, or alternative and additional ones identified by the Contractor shall be documented in the refined, construction-stage PMP, which shall apply the following outline good practice:

- Peat shall be stored at sufficient distance from excavation faces to prevent overburden induced failure. Slope analysis based on geotechnical characteristics derived from additional detailed ground investigation shall be employed to assess failure potential and stand-off distances set appropriately

- Local gullies, diffuse drainage lines (or very wet ground) and locally steep slopes shall be avoided for peat storage
- Stored upper turves incorporating vegetation shall be stored vegetation side up and organised and labelled according to NVC community, under the supervision of the Contractor's Environmental Clerk of Works (EnvCoW) and Ecological Clerk of Works (ECoW), for re-instatement adjacent to like communities within intact surrounding peat
- Stores of catotelm peat shall be smoothed or 'bladed off' to reduce their surface area and minimise desiccation. Where required, additional measures to prevent drying such as light irrigation should be used.
- Where transport cannot be undertaken immediately, stored peat shall be irrigated to limit drying and stored on a geotextile mat to promote stability, although this is unlikely to be critical for peat stored less than two months
- Monitoring of peat storage areas during wet weather or snowmelt may be required and shall be undertaken as necessary by the Contractor, to identify any early signs of peat instability.
- Run-off from the stored peat should be managed to avoid impacts to habitats or watercourses.
- Locations for temporary storage should avoid good quality habitat (incl. moderately and/or highly dependent groundwater dependent terrestrial ecosystems (GWDTE)) and buffers around watercourses appropriate to the location should be determined according to the terrain and sensitivity of the watercourse and storage within these avoided.

6.3.7 It is anticipated that peat will not be stored for more than three years and therefore, will not require a permit under The Landfill (Scotland) Regulations 2003.

Handling

6.3.8 Through refinement of the peat depth model and as part of the construction-stage PMP, detailed storage and handling procedures for peat shall be prepared and documented by the Contractor, specifying details of the following:

- The refined estimated excavation volumes at each infrastructure location (including volumes of acrotelm, turf or catotelm)
- The volumes that may require storage locally and volumes that may be transferred directly upon excavation to re-instatement, re-use or restoration areas, in order to minimise handling
- The refined location and size of storage areas (or additional areas) if considered to be required, relative to points of excavation, watercourses, drainage features and slope
- Irrigation requirements and methods to minimise desiccation of excavated peat during short term storage.

Re-instatement and Re-use

6.3.9 The Contractor may identify additional or alternative uses of peat (additional or alternative to that identified in this OPMP) within the temporary and permanent boundaries of the Proposed

Scheme or elsewhere, by agreement with landowners or stakeholders prior to or during construction.

6.3.10 The following principles shall apply wherever peat is being re-instated or re-used in any way:

- Re-instatement of peat turves shall ensure that surface vegetation is incorporated and where possible, peat turves with vegetation communities similar to the communities present on the intact peat at receiver sites should be used
- Re-seeding of any significant areas of bare peat shall be undertaken with species appropriate to the surrounding peatland and habitats
- Grazing may need to be prevented by installation of fencing until the peat has fully recovered
- If peat does become dewatered/ desiccated, it shall not be exposed at the top of any re-instatement or re-use areas.

Access Tracks

6.3.11 The peat depth data collected to date indicates that there are likely to be very limited, if any, opportunities to use floated access tracks or other similar techniques. However, should design alterations or additional data identify this is possible, existing vegetation shall be left in place under the new running track surface and adjacent vegetation under the planned shoulder footprint shall be rolled back for emplacement of peat beneath. The rolled vegetation shall then be re-lain over the emplaced peat.

6.3.12 For cut-and-fill tracks, any bare peat surfaces created during the construction of side drains shall be re-instated with peat turves to stabilise the surface and prevent drying.

Timing

6.3.13 The available best practice guidance makes various recommendations regarding the preferred seasons in which peat management work should be undertaken, whether for ease of construction or the efficacy of restoration. In practice, these seasonal preferences often conflict. For example, restoration guidance generally indicates that peat turve cutting is best conducted in autumn or winter to minimise drying. However, most construction guidance suggests that major excavation activities should be conducted in drier months, typically during spring and summer.

6.3.14 This scheduling conflict is often difficult to resolve, but where it is genuinely impossible to undertake certain activities in the most appropriate season, the adoption of the good practice measures outlined in this OPMP, and as shall be refined by the Contractor in the construction-stage PMP, especially concerning irrigation during dry weather, will minimise the effects of seasonal dependencies.

6.4 Monitoring Requirements

6.4.1 Prior to construction, monitoring of groundwater levels in selected areas of peat shall be undertaken monthly, ideally for a twelve-month period; in order to understand the expected annual cycle of fluctuation in groundwater levels in the context of the planned construction activities and potentially inform proposed peat re-use options and activities.

6.4.2 The groundwater monitoring shall continue during the construction period, when frequent and repeat visual inspections of peat areas adjacent to the Proposed Scheme and areas where peat is re-used by a team of suitably qualified geotechnical engineers and Ecological/ Environmental Clerk of Works (ECoW) shall also be undertaken – to monitor for signs of settlement, instability or other impact, to oversee all peat management, placement and re-use activities and to conduct repeat vegetation/ NVC surveys in accordance with the OHMP in **Appendix 12.13** (**Volume 2**).

6.4.3 **Table 5** identifies typical monitoring requirements for particular elements of the Proposed Scheme (SNH/FCS, 2010) during and following construction, and **Table 6** presents example threshold conditions under which construction may require to be stopped.

Table 4: Monitoring During Construction and Post-Construction

Scheme Element	Monitoring During Construction	Potential Mitigation	Monitoring Post-Construction	Potential Mitigation
All excavations	• monitor water table drawdown around excavation perimeter • monitor free faces for signs of instability (cracking, settlement, standing water) • monitor stored peat for signs of drying or local slumping and collapse	• consider irrigation of peat if signs of drying • reinforce excavation or drain	• monitor backfilled excavation for water table relative to surrounding non-excavated peatland to determine recovery • monitor vegetation cover to ensure acrotelm remains functional	• consider re-routing local surface drainage into former excavation to maintain water levels
Access tracks (cut and fill)	• monitor upslope sides of tracks traversing slopes for waterlogging from impeded subsurface drainage • monitor transitions to floating track sections for settlement	• undertake maintenance of under-track drainage as necessary • undertake remedial work to track as necessary	• monitor upslope sides of tracks traversing slopes for waterlogging from impeded subsurface drainage	• undertake maintenance of under-track drainage as necessary
Access tracks (floating)	• monitor shoulders for drying • monitor upslope sides of tracks traversing slopes for waterlogging from impeded subsurface drainage • monitor track for lateral displacement and rate of vertical settlement (using line of sight pegs) • monitor for evidence of lateral migration into cable trenches	• consider irrigation of dried shoulders, or re-seeding dry areas with nurse crops tolerant of drier peat • if waterlogging leads to enhanced settlement, consider installation of drains	• monitor shoulders for drying • monitor upslope sides of tracks traversing slopes for waterlogging from impeded subsurface drainage • monitor track for lateral displacement and vertical settlement	• consider irrigation of dried shoulders, or re-seeding dry areas with nurse crops tolerant of drier peat • if waterlogging leads to enhanced settlement, consider installation of drains

Table 5: Threshold 'Stop' Conditions (used in Ireland) for Floating Road Construction

Stop Rule	Requirements[1]
High Intensity Rainfall	Rainfall during construction >10mm hour
Long Duration Rainfall	Rainfall in the preceding 24 hours >25mm
7-day Cumulative Rainfall (1)	Rainfall 7-days of rainfall >50% of monthly average
7-day Cumulative Rainfall (2)	Preceding 7-days of rainfall >50mm

Table Notes:

1. Monitoring of rainfall for stop conditions would require an appropriate meteorological station to measure these conditions on site, or a suitable local source of data to allow identification of these conditions being exceeded, so that appropriate action can be taken.

6.4.4 Monitoring intervals during construction and post-construction monitoring shall be determined by the Contractor via the refined construction-stage PMP. The monitoring shall cover all principal areas of peat re-use and a range of additional treatment work might be required during this, to help understand the long-term prognosis for excavated peat that has been placed and re-used. This may include:

- Flattening of the re-instated surfaces to try and reduce the degree to which local surface drawdown in the summer will lead to local oxidative wastage of placed peat
- Compacting the peat in places where there is a high degree of void spaces, if evident

- Tapering of the peat masses at its edges
- Re-seeding
- Removal of any invasive species present, if and as they colonise
- Temporarily fencing off of areas where peat has been re-used, to prevent grazing of young vegetation and enable heath/ bog vegetation to establish as necessary.

6.4.5 The implementation of these additional treatments and their timing shall be subject to ongoing discussions between the Contractor and SEPA, SNH and CNPA as necessary, and vegetation-based post-placement care measures and monitoring shall also be undertaken in tandem with this work as detailed in the OHMP in **Appendix 12.13** (**Volume 2**).

6.4.6 It is important that good record keeping is undertaken to ensure that the most can be made of the data collected during construction. In relation to peat, these would include photographs and records of as-built and post-construction peat condition around all infrastructure locations, collected by a suitably qualified ECoW.

7 References

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Annex 10.6.1

Good Practice for Developments on Peatland

Sources of Good Practice Information

In the last decade, considerable guidance material relating to developments on peatland have been produced, particularly in Scotland. This has typically focused on wind farm developments, but where relevant to the Proposed Scheme, this section summarises advice from Scottish and other sources that together effectively constitute UK-wide best practice. Relevant guidance documents referenced as part of this OPMP are identified in **Table 1**.

While much of this guidance is less than ten years old, it is also supplemented where appropriate by older, but still relevant, academic and industry literature that provides case studies on many aspects of peat relevant to built infrastructure, including its geotechnical behaviour, hydrological response to disturbance and ability to recover ecologically. A number of manuals and guidelines have also been prepared to promote effective peat restoration (Quinty and Rochefort, 2003; Schumann and Joosten, 2008; Peatlands and Uplands Biodiversity Group, 2010).

Table 1: Sources of Good Practice Information in Relation to Developments on Peatland

Source	Indicative Content
Guidance on the assessment of peat volumes, re-use of excavated peat and the minimisation of waste (SR/SEPA, 2012)	Guidance on pre-consent, post consent and post construction assessment in support of evaluation of the peat resource in order to minimise waste
SEPA Regulatory Position Statement – Developments on Peat (SEPA, 2010)	Outline guidance on peat as a by-product of development, with specific focus on peat as a waste material, and with steer on re-use, recycling, storage and disposal
Floating roads on peat (SNH/ FCS, 2010)	Detailed guidance on floating road construction over peatlands, suitable to aid road design at the design stage
Constructed tracks in the Scottish Uplands (SNH, 2005)	Outline guidance on track construction in all types of Scottish upland, with emphasis on minimising impacts on landscape and natural heritage
Good practice during windfarm construction (SR/ SNH/ SEPA/ FCS, 2010)	Outline guidance on all aspects of wind farm construction (although not always related to peat), suitable to identifying good practice at the consenting stage
Calculating carbon savings from wind farms on Scottish peat lands, a new approach (Nayak *et al*., 2008)	Context to and detailed guidance on calculation of carbon losses associated with wind farm construction (in support of carbon balance calculations)
Peat landslide hazard and risk assessments: best practice guide (Scottish Government, 2006)	Guidance on undertaking peat landslide hazard assessments to support assessment of potential wind farm development sites
Guidelines for the Risk Management of Peat Slips (MacCulloch, 2006)	Outline guidance on minimising the likelihood of local and more extensive instability of peat during construction of excavated and floating tracks
Investigating the impacts of windfarms on peatlands (Natural England, 2010)	Guidance for Natural England to support consenting decisions on wind farms in England, based on understanding of wind farm impacts on peat
CCW Guidance Note: Assessing the impact of wind farm developments on peatlands in Wales (CCW, 2010)	Guidance on assessment methodology for characterising peatland resource and identifying hydrological, stability and carbon impacts of proposed wind farms, and guidance on the content of habitat management plans
A Strategic Assessment of the afforested peat resource in Wales (Vanguela *et al*., 2012)	Review of the status of peatlands under the Assembly Government Woodland Estate (AGWE) and their potential for restoration

Good Practice Pre-construction

Many of the concerns associated with peat on a development site can be addressed by modifying the scheme layout to avoid sensitive areas. Such areas would include:

- areas of deep peat, requiring potentially large volumes of excavation
- areas of very wet peat such as flushes, pool and hummock complexes and gullied peatland
- areas of moderately sloping deep peat where site infrastructure might increase the chance of peat instability
- areas of sensitive habitat in which planning consent may be difficult to achieve

Avoiding these areas requires sufficient baseline data and investigation at the planning and design stage. In relation to this, SEPA make a number of recommendations for best practice in relation to the assessment of peat depths and the means of mitigation and compensation at developments in peatland, which are detailed below.

Peat Depth Model

In relation to peat depth assessment as an input to design, the following is recommended:

- That peat depth probing should be undertaken to provide a 'low resolution' survey, to identify where peat is present and provide information on peat depth variability (SG/SNH/SEPA/JHI, 2017)
- A detailed survey at 50m intervals along proposed track and road locations using 10m right-angled offsets (SG/ SNH/ SEPA/ JHI, 2017)
- That a representative sample of cores be logged to assist in classification of the peat characteristics (e.g. through the von Post method) (CCW, 2010)
- That the collated peat data be used to develop a peat depth model for the site, and that the method used to prepare the model be clearly stated (CCW, 2010)
- That the peat model be used to undertake preliminary excavation and re-use calculations and to identify intended methods of re-use (SR/ SEPA, 2012) through preparation of a peat management plan (an example format for which is provided in Annex 1 of the SEPA guidance).

Layout Planning

Given preparation of a site wide peat model, the following principles are recommended by CCW in relation to layout planning:

- Minimise infrastructure overlap with peat
- Minimise construction of/ the area covered by permanent crane pads and consider piling construction methodologies as alternatives to bulk excavation of foundations
- Minimise carbon loss by re-use of excavated peat in compensatory restoration (e.g. in use as peat dams, for infilling grips and drains)
- Minimise protracted storage of excavated peat by careful phasing of ditch blocking/ filling
- Minimise the width of peat batters on floating roads

- Employ best practice construction and restoration methodologies.

Good Practice during Construction

Assuming that the Proposed Scheme has been designed to take best advantage of site conditions, there are a number of ways in which detailed design and construction activities can be specified, to further minimise adverse effects on peatlands. The sections below consider specific good practice measures in relation to access tracks. Guidance is generally focused on floating tracks and cut-and-fill tracks (CCW, 2010), and is summarised below.

Floating Tracks

Over deeper peat (typically >1.00m), floating tracks provide a good option for minimising peat excavation and the potential disruption of hydrological pathways. The success of construction requires careful planning to take account of the unique characteristics of peat soils. Specific guidance is available on design, the duration and timing of construction, the sequence of construction and the re-use of peat as shoulders at the margin of the floating track (SNH/ FCS, 2010). This is summarised below:

Design

The following issues should be considered during detailed design:

- Adoption of conservative values for peat geotechnical properties during detailed design (post-consent) (SNH/ FCS, 2010)
- Use of a maximum depth rule whereby an individual layer of geogrid and aggregate should not normally exceed 450mm without another layer of geogrid being added (SNH/FCS, 2010)
- The routing of access tracks on flat ground in order to avoid any requirement for drainage design and works (SNH/ FCS, 2010)
- Where sloping ground cannot be avoided and where the track runs transverse to the prevailing slope, the protection of natural hydrological pathways such as flushes and peat pipes through the installation of a permanent conduit within or underneath the floating road (SNH/ FCS, 2010)
- Ensuring transitions between floating tracks and excavated tracks (or other forms of track not subject to long term settlement) are gentle (e.g. 1:10 basal transition slope) in order to minimise likelihood of track failure at the boundary between construction types (SNH/ FCS, 2010)
- The scheduling of track construction to accommodate for peat settlement characteristics (see below) (SNH/ FCS, 2010).

Further detail is provided in *Floating Roads on Peat* (SNH/ FCS, 2010) and *Guidelines for the Risk Management of Peat Slips* (MacCulloch, 2006).

Duration and Timing of Construction

The critical factor in the successful construction of floating tracks is the timescale of construction, to which end the following good practice guidance is provided:

- the settlement characteristics of peat (see earlier sections) should be accommodated by appropriate scheduling of track construction, as follows:
  - allowing peat to undergo primary consolidation, which takes place in a matter of days, by adopting rates of road construction appropriate to weather conditions (SNH/ FCS, 2010)
  - monitoring the effects of secondary compression on track integrity, which will follow the primary consolidation phase and continue through the life of the development while the tracks are utilised (up to 25 years) (SNH/ FCS, 2010)
  - identifying 'stop' rules, e.g. weather dependent criteria for cessation of track construction based on local meteorological data (SNH/ FCS, 2010)
  - maximising the interval between material deliveries over newly constructed tracks that are still observed to be within the primary consolidation phase (SNH/ FCS, 2010)
  - prior to construction, setting out the centreline of the proposed track to identify any ground instability concerns or particularly wet zones (SR/ SNH/ SEPA/ FCS, 2010)

Adoption of an appropriate track construction rate will generally prevent the need for drainage under floating roads on flat ground.

Sequence of Construction

The sequence of construction is normally stipulated in guidance provided by the supplier of the geotextile or geogrid layer, and suppliers are often involved in the detailed track design. Good practice in relation to the sequence of track construction is as follows (SNH/ FCS, 2010; SR/ SNH/ SEPA/ FCS, 2010):

- Retaining rather than stripping the vegetation layer (i.e. the acrotelm, providing tensile strength), and laying the first geotextile/geogrid directly on the peat surface
- Adding the first rock layer and incorporating culverting if any major surface or near surface drainage pathways have been identified during the set-out phase prior to construction (see above)
- Adding the second geotextile/ geogrid, and add overlying graded rockfill as a running surface
- Heavy plant and HGVs using the tracks during the construction period should be trafficked gently to minimise dynamic loading from cornering, breaking and accelerating
- Ensuring wheel loads should remain at least 0.5m from the edge of the geogrid, and markers should be laid out, monitored and maintained on the track surface to emphasise these boundaries
- 'Toolbox' talks and subsequent feedback to construction and maintenance workers and drivers to emphasise the importance of the implementing the above measures

Use of Peat as Trackside Shoulders

A key opportunity to re-use peat is to employ it in landscaping of constructed access tracks. Wedge-shaped berms at the margins of a floating track (which is elevated above the peat surface) are termed shoulders, and good practice guidance is as follows:

- Re-use peat excavated from elsewhere on site as shoulders adjacent to the floating track

- Peat shoulders should taper from just below the track sides to join the surrounding peat surface, thereby preventing over high shoulders from causing ponding on the track surface (SR/ SNH/ SEPA/ FCS, 2010)
- Limiting the width of peat shoulders to avoid the unnecessary smothering of intact vegetation adjacent to the floating track

Cut and Fill Tracks

Cut-and-fill tracks require the complete excavation of peat to a competent substrate. This peat will require storage ahead of its re-use or disposal. Good practice guidance relates mainly to drainage in association with excavated tracks, as follows (SNH/ FCS, 2010; SR/ SNH/ SEPA/ FCS, 2010):

- Trackside ditches should capture surface water from within the acrotelm before it reaches the road
- Interceptor drains should be shallow, flat bottomed and preferably entirely within the acrotelm to limit drawdown of the water table
- Any stripped peat turves should be placed back in the invert and sides of the ditch to assist regeneration
- Culverts should be installed under excavated tracks to maintain subsurface drainage pathways (such as natural soil pipes or flushes)

Although excavation is normally undertaken in peat of limited depth (< 1.00m), there is a possibility of minor slippage from the cut face of the peat mass. Accordingly:

- Free faces should be inspected for evidence of instability including cracking, bulging, excessive discharge of water or sudden cessation in discharge, and
- Where substantial depths of peat are to be stored adjacent to an excavation, stability analysis should be conducted to determine the Factor of Safety (FoS) and an acceptable FoS adopted for loaded areas (MacCulloch, 2006)

Peat Excavation, Storage and Transport

If peat is to be re-used or reinstated with the intention that the habitat it supports continues to be viable, the following good practice applies (SEPA, 2010):

Excavation

- Excavated peat should be excavated as turves, including the acrotelm (surface vegetation) and a layer of adjoining catotelm (humified peat) typically up to 300mm thick in total (SR/ SNH/ SEPA/ FCS, 2010), or as blocks of catotelm; the acrotelm should not be separated from its underlying peat
- The turves should be as large as possible to minimise desiccation during storage (Peatlands and Uplands Biodiversity Group, 2010)
- Contamination of excavated peat with substrate materials should be avoided (SR/ SNH/ SEPA/ FCS, 2010)

- Consider the timing of excavation activities to avoid very wet weather, to minimise the likelihood of excavated peat remoulding into peat slurry (with potential consequences off site) (SR/ SNH/ SEPA/ FCS, 2010).

Storage

- Peat turves should be stored in wet conditions, for example, within waterlogged former excavations, or should be irrigated in order to prevent desiccation (once dried, peat will not re-wet) (SR/ SNH/ SEPA/ FCS, 2010)
- Peat should be stockpiled in large volumes to minimise exposure to wind and sun which can lead to desiccation, but with due consideration for slope stability (SR/ SNH/ SEPA/ FCS, 2010)
- Excavated topsoils should be stored on geotextile matting to a maximum of 1m thickness (SNH, 2005)
- Stores of non-turf (catotelm) peat should be bladed off to reduce the surface area and desiccation of the stored peat (SR/ SNH/ SEPA/ FCS, 2010)
- Peat storage areas and areas of steep peat should be monitored during periods of very wet weather, or during snowmelt, to identify early signs of peat instability (Scottish Government, 2017)

Transport

- Movement of excavated turves should be kept to a minimum, and it is preferable to transport peat intended for translocation to its destination at the time of excavation (Peatlands and Uplands Biodiversity Group, 2010)
- If vehicles that are used for transporting non-peat material are also to be used for peat materials, measures should be taken to minimise cross-contamination of peat soils with other materials

Restoration

- Carefully evaluate potential restoration sites for their suitability, and agree that these sites are appropriate with landowners and relevant consultees (SR/ SNH/ SEPA/ FCS, 2010)
- Undertake restoration and revegetation work outside winter months
- Consider the exclusion of livestock from areas of the site undergoing restoration, to minimise impacts on revegetation (SR/ SNH/ SEPA/ FCS, 2010)
- Where feasible, restoration should be carried out concurrently with construction rather than at its conclusion

Peat Restoration and Good Practice Post-Construction

Once project design and construction activities have been optimised with respect to the preservation of peat, the remaining good practice opportunities relate to the restoration of degraded parts of the development site, where there is opportunity to do so, and to the monitoring of peatland adjoining scheme elements to determine if there is a need for further mitigation. Good practice guidance indicates the following:

Restoration

- If a development is sited on degraded peatland, it is desirable to implement measures to restore the peatland for biodiversity and to improve the carbon balance of the development (SR/ SNH/ SEPA/ FCS, 2010)
- Any opportunities to enhance local habitats by rewetting former drained peatland, such as by drain blocking, should be considered (SR/ SNH/ SEPA/ FCS, 2010)
- Where peat drains are extensive and frequent, and generally on shallow slopes, peat should be considered the preferred blocking material from the perspective of minimising peat wastage, rather than other alternatives such as plastic sheeting (SR/ SNH/ SEPA/ FCS, 2010)
- Where drain blocking is identified as a possibility, re-used peat should comprise humified catotelm peat which retains sealing properties, in preference to desiccated or dried peat which would be buoyant (SR/ SNH/ SEPA/ FCS, 2010)
- Critical to the restoration of viable peatland is raising and maintaining water tables to a level sufficient to support peat forming vegetation communities (SR/ SNH/ SEPA/ FCS, 2010; SNH, 2005)
- Also critical is the maintenance of a functioning acrotelm, and therefore careful excavation that supports this should be encouraged (SR/ SEPA, 2012)

Monitoring

Peat habitat restoration can be a slow process and monitoring might need to be specified over a very long period. Monitoring refers to ongoing restoration measures and to inspection of the integrity of the Proposed Scheme and the peatland adjoining it. Good practice guidance suggests:

- Monitoring should be put in place around major scheme components located in peat to check for water table drawdown, and this should trigger mitigation, if required (SR/ SNH/ SEPA/ FCS, 2010)
- The settlement of floating tracks during and post-construction should also be monitored to determine if consolidation is occurring as expected, and to identify signs of lateral displacement (SNH/ FCS, 2010)
- Comprehensive inspection and maintenance records should be kept for all floating tracks on site to enable reasons for track degradation to be identified (e.g. heavy rainfall) (SNH/ FCS, 2010)
- There should be a commitment to the monitoring of rehabilitating peatland through the life of the development, given the typical timescale for peat restoration projects to achieve their objectives (from 5 - 30 years) (SR/ SNH/ SEPA/ FCS, 2010)